

TEST REPORT

Test Report No. : UL-RPT-RP14585110-116A

Customer : Ubisense

Model No / PMN : UBISENSOR30V1

HVIN : UBISENSOR30V1

FCC ID : SEASENSOR33

ISED Certification No. : IC: 8673A-SENSOR33

Technology : IEEE 802.15.4 f

Test Standard(s) : FCC Parts 15.207, 15.209(a) & 15.249
Innovation, Science and Economic Development Canada
RSS-210 10 April 2020 & RSS-Gen Issue 5 February 2021

Test Laboratory : UL International (UK) Ltd, Basingstoke, Hampshire, RG24 8AH,
United Kingdom

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2. The results in this report apply only to the sample(s) tested.
3. The sample tested is in compliance with the above standard(s).
4. The test results in this report are traceable to the national or international standards.
5. Version 4.0 supersedes all previous versions.

Date of Issue: 24 March 2023

Checked by:



Ben Mercer
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Company Signatory:



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Customer Information

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Report Revision History

Version Number	Issue Date	Revision Details	Revised By
1.0	14/02/2023	Initial Version	Ben Mercer
2.0	24/02/2023	ISED certification no. corrected	Ben Mercer
3.0	20/03/2023	dB μ V/m to dB μ A/m conversion note added	Ben Mercer
4.0	24/03/2020	HVIN updated	Ben Mercer

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1 Attestation of Test Results

1.1 Description of EUT

The equipment under test was an ultra-wideband location tracking sensor, incorporating a proprietary 2.4 GHz 802.15.4 f based radio.

1.2 General Information

Specification Reference:	47CFR15.249
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.249
Specification Reference:	47CFR15.207 & 15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Sections 15.207 & 15.209
Specification Reference:	RSS-Gen Issue 5 February 2021
Specification Title:	General Requirements for Compliance of Radio Apparatus
Specification Reference:	RSS-210 Issue 10 April 2020
Specification Title:	Licence-Exempt Radio Apparatus: Category I Equipment
Site Registration:	FCC: 685609, ISEDC: 20903
FCC Lab. Designation No.:	UK2011
ISEDC CABID:	UK0001
Location of Testing:	Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	10 January 2023 to 13 January 2023

1.3 Summary of Test Results

FCC Reference (47CFR)	ISED Canada Reference	Measurement	Result
Part 15.249(a)(e)	RSS-Gen 6.12 / RSS-210 B.10(a)	Transmitter Fundamental Field Strength	
Part 15.35(c)	RSS-Gen 6.10	Duty cycle	Note 1
Part 2.1049	N/A	Transmitter 20 dB Bandwidth	
N/A	RSS-Gen 6.7	Transmitter 99% Emission Bandwidth	
Part 15.249(d)(e) / 15.209(a)	RSS-Gen 6.13, 8.9 & 8.10 / RSS-210 B.10(b)	Transmitter Radiated Emissions	
Part 15.249(d) / 15.209(a)	RSS-Gen 6.13, 8.9 & 8.10 / RSS-210 A2.9(d)	Transmitter Band Edge Radiated Emissions	
Part 15.207	RSS-Gen 8.8	Transmitter AC Conducted Emissions	
Key to Results  = Complied  = Did not comply			

Note(s):

1. Duty cycle measurements were performed to assist in the calculation of average levels as the EUT was not constantly transmitting.

1.4 Deviations from the Test Specification

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specification identified above.

2 Summary of Testing

2.1 Facilities and Accreditation

The test site and measurement facilities used to collect data are located at Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom. The following table identifies which facilities were utilised for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

Site 1	X
Site 2	-
Site 17	-

UL International (UK) Ltd is accredited by the United Kingdom Accreditation Service (UKAS). UKAS is one of the signatories to the International Laboratory Accreditation Co-operation (ILAC) Arrangement for the mutual recognition of test reports. The tests reported herein have been performed in accordance with its terms of accreditation.

2.2 Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference:	KDB 174176 D01 Line Conducted FAQ v01r01 June 3, 2015
Title:	AC Power-Line Conducted Emissions Frequently Asked Questions

2.3 Calibration and Uncertainty

Measuring Instrument Calibration

In accordance with UKAS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period on the date of testing.

Measurement Uncertainty & Decision Rule

Overview

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

Decision Rule

The decision rule applied is based upon the accuracy method criteria. The measurement uncertainty is met and the result is considered in conformance with the requirement criteria if the observed value is within the prescribed limit.

Measurement Uncertainty

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor such that a confidence level of approximately 95% is maintained. For the purposes of this document “approximately” is interpreted as meaning “effectively” or “for most practical purposes”.

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
Fundamental Field Strength	2400 MHz to 2483.5 MHz	95%	±3.16 dB
20 dB Bandwidth	2400 MHz to 2483.5 MHz	95%	±4.59 %
Radiated Spurious Emissions	9 kHz to 30 MHz	95%	±5.32 dB
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±3.30 dB
Radiated Spurious Emissions	1 GHz to 25 GHz	95%	±3.16 dB
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±2.42 dB

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty the published guidance of the appropriate accreditation body is followed.

2.4 Test and Measurement Equipment

Test Equipment Used for Transmitter Fundamental Field Strength, Transmitter 20 dB Bandwidth, 99% Emission Bandwidth & Transmitter Band Edge Radiated Emissions

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2040	Thermohygrometer	Testo	608-H1	45124934	09 Dec 2023	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	05 Sep 2023	12
M2077	Test Receiver	Rohde & Schwarz	ESW44	102026	15 Feb 2023	12
A3179	Pre-Amplifier	Hewlett Packard	8449B	3008A00934	14 Sep 2023	12
A3138	Antenna	Schwarzbeck	BBHA 9120 B	00702	22 Aug 2023	12
A2523	Attenuator	AtlanTecRF	AN18W5-10	832827#1	27 Jan 2023	12

Test Equipment Used for Transmitter Radiated Emissions

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2040	Thermohygrometer	Testo	608-H1	45124934	09 Dec 2023	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	05 Sep 2023	12
M2077	Test Receiver	Rohde & Schwarz	ESW44	102026	15 Feb 2023	12
A3154	Pre-Amplifier	Com Power	PAM-103	18020012	18 Aug 2023	12
A3179	Pre-Amplifier	Hewlett Packard	8449B	3008A00934	14 Sep 2023	12
A222867	Pre-Amplifier	Atalntic Microwave	A-LNAKX-380116-S5S5	210865001	26 Aug 2023	12
A3265	Pre-Amplifier	Schwarzbeck	BBV 9721	9721-069	31 Oct 2023	12
A3165	Magnetic Loop Antenna	ETS-Lindgren	6502	00224383	05 May 2023	12
A3161	Antenna	Teseq	CBL6111D	50859	03 May 2023	12
A3138	Antenna	Schwarzbeck	BBHA 9120 B	00702	22 Aug 2023	12
A3139	Antenna	Schwarzbeck	HWRD 750	00027	22 Aug 2023	12
A2892	Antenna	Schwarzbeck	BBHA 9170	9170-727	31 Oct 2023	12
A3113	Attenuator	AtlanTecRF	AN18-06	219706#3	03 May 2023	12
A2523	Attenuator	AtlanTecRF	AN18W5-10	832827#1	27 Jan 2023	12
A3093	High Pass Filter	AtlanTecRF	AFH-03000	18051800077	27 Jan 2023	12
A3095	High Pass Filter	AtlanTecRF	AFH-07000	18051600012	27 Jan 2023	12

Test and Measurement Equipment (continued)**Test Equipment Used for Transmitter AC Conducted Spurious Emissions:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2037	Thermohygrometer	Testo	608-H1	45124925	08 Dec 2023	12
A649	LISN	Rohde & Schwarz	ESH3-Z5	825562/008	01 Sep 2023	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	31 May 2023	12
M1124	Test Receiver	Rohde & Schwarz	ESIB 26	100046	06 Oct 2023	12

Test Measurement Software/Firmware Used:

Name	Version	Release Date
Rohde & Schwarz EMC32	6.30.0	2018

3 Equipment Under Test (EUT)

3.1 Identification of Equipment Under Test (EUT)

Brand Name:	Ubisense
Model Name or Number / PMN:	UBISENSOR30V1
HVIN:	UBISENSOR30V1
Test Sample Serial Number:	0011CE0163C9
Hardware Version:	Build revision D
Software Version:	D4 3.7sp3
Firmware Version:	D4 3.7sp3
FCC ID:	SEASENSOR33
ISED Canada Certification Number:	8673A-SENSOR33

3.2 Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.3 Additional Information Related to Testing

Technology Tested:	IEEE 802.15.4 f	
Type of Unit:	Transceiver	
Modulation Type:	GFSK	
Data Rate:	250 kbps	
Power Supply Requirement(s):	Nominal	48 VDC
Channel Spacing:	750 KHz	
Transmit Frequency Range:	2401.75 MHz to 2481.75 MHz	
Transmit Channels Tested:	Channel ID	Channel Frequency (MHz)
	Bottom	2401.750
	Middle	2442.000
	Top	2481.750

3.4 Description of Available Antenna

The radio utilizes an integrated antenna, with the following peak gain:

Frequency Range (MHz)	Antenna Gain (dBi)
2400 to 2483.5	2.1

3.5 Description of Test Setup

Support Equipment

The following support equipment was used to exercise the EUT during testing:

Description:	PoE Switch
Brand Name:	TP Link
Model Name or Number:	TL-SF1008P
Serial Number:	2152073004310

Description:	AC power Supply (PoE Switch)
Brand Name:	Leader Electronics Inc.
Model Name or Number:	NU-F480125-I1
Serial Number:	Not marked or stated

Description:	Laptop PC
Brand Name:	Lenovo
Model Name or Number:	T14
Serial Number:	00329101A316555AA736

Description:	USB Memory stick
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	Companion device – Location tracking sensor #1
Brand Name:	Ubisense
Model Name or Number:	UBISENSOR30v1
Serial Number:	0011CE015ABC
Hardware Version:	RevC
Software Version:	D4 3.7sp3

Description:	Companion device – Location tracking sensor #2
Brand Name:	Ubisense
Model Name or Number:	UBISENSOR30v1
Serial Number:	0011CED404D6
Hardware Version:	RevC
Software Version:	D4 3.7sp3

Support Equipment (continued)

Description:	Companion device – Location tracking sensor #3
Brand Name:	Ubisense
Model Name or Number:	UBISENSOR30v1
Serial Number:	0011CE00BAA1
Hardware Version:	RevC
Software Version:	D4 3.7sp3

Description:	Companion device – Location tracking sensor #4
Brand Name:	Ubisense
Model Name or Number:	UBISENSOR30v1
Serial Number:	0011CEFF004B
Hardware Version:	RevC
Software Version:	D4 3.7sp3

Description:	Companion device – Location tracking sensor #5
Brand Name:	Ubisense
Model Name or Number:	UBISENSOR30v1
Serial Number:	0011CE0163C3
Hardware Version:	RevC
Software Version:	D4 3.7sp3

Description:	Etherent Cables. Quantity 3. Length 1.0 m Etherent Cables. Quantity 1 Length 2.0 m Etherent Cables. Quantity 6. Length 3.0 m Etherent Cables. Quantity 1. Length 5.0 m
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Operating Modes

The EUT was tested in the following operating mode(s):

- Transmitting continuously with a modulated carrier and maximum power setting on bottom, middle and top channels as required.
- Transmitting non-continuously using the worst case operational duty cycle with a modulated carrier and maximum power setting on bottom channel, for duty cycle measurements only.

Configuration and Peripherals

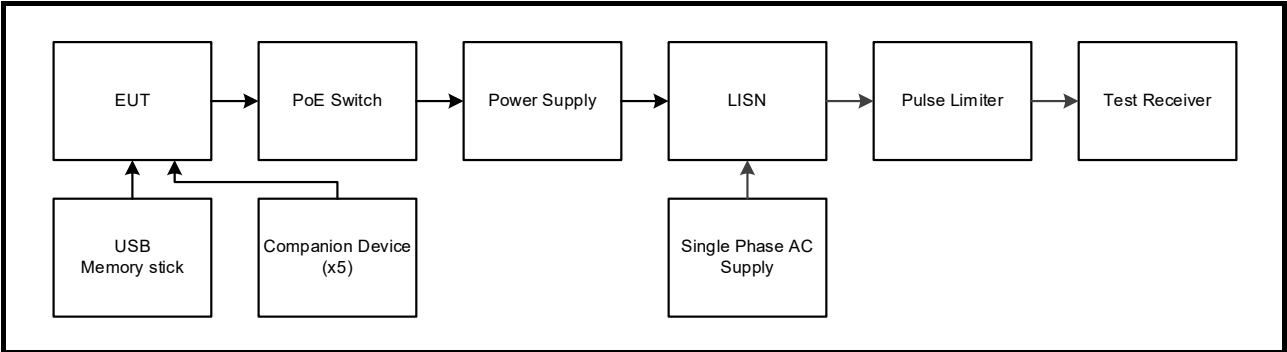
The EUT was tested in the following configuration(s):

- Controlled in test mode using a software application on the laptop PC. The laptop was connected to the EUT via a PoE switch. The application was used to enable continuous transmission and to select the test channels, data rate and packet length as required. The customer supplied test instructions "Test Instruction for UBISENSOR30V1.pdf".
- For radiated measurements, the EUT was positioned in its normal mode of operation and powered from the PoE switch. A USB memory stick and five companion Ubisense UBISENSOR30v1 devices were connected to the EUT to terminated all active ports. The companion Ubisense UBISENSOR30v1 devices were placed under the turntable.
- The EUT was powered by a 48 VDC PoE supply, which in turn was powered by a 120 VAC 60 Hz single phase mains supply.
- The EUT has two antennas used for diversity. All measurements were performed on both antennas individually.
- For AC conducted emissions measurements, the EUT was powered from the PoE switch. A USB memory stick and five companion Ubisense UBISENSOR30v1 devices were connected to the EUT to terminated all active ports. The laptop PC was disconnected once the EUT was configured.

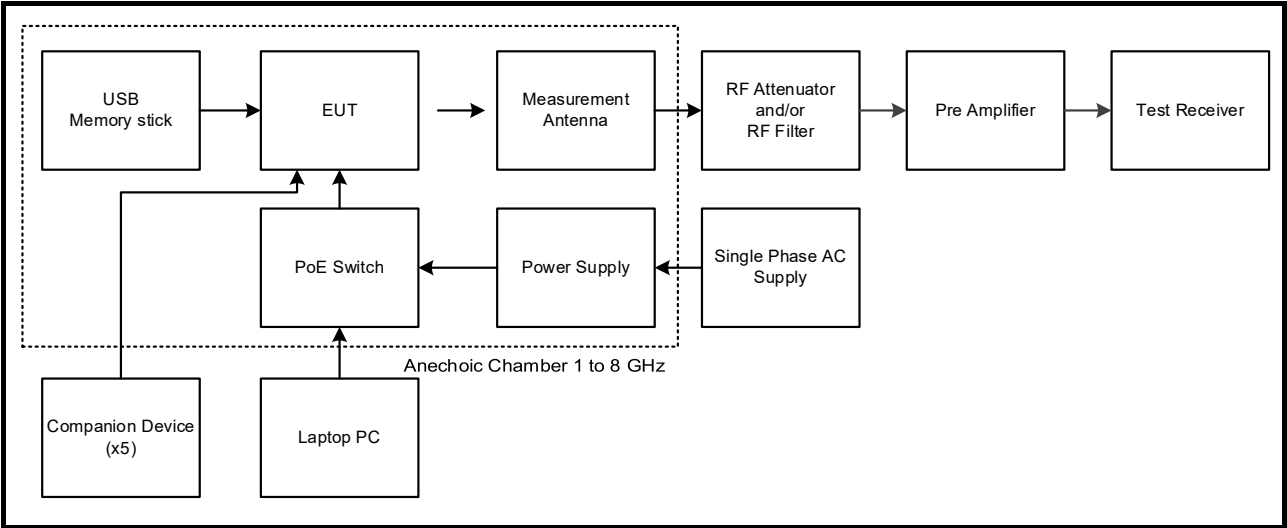
Test Setup Diagrams

Radiated Tests:

Test Setup for Transmitter AC Conducted Spurious Emissions

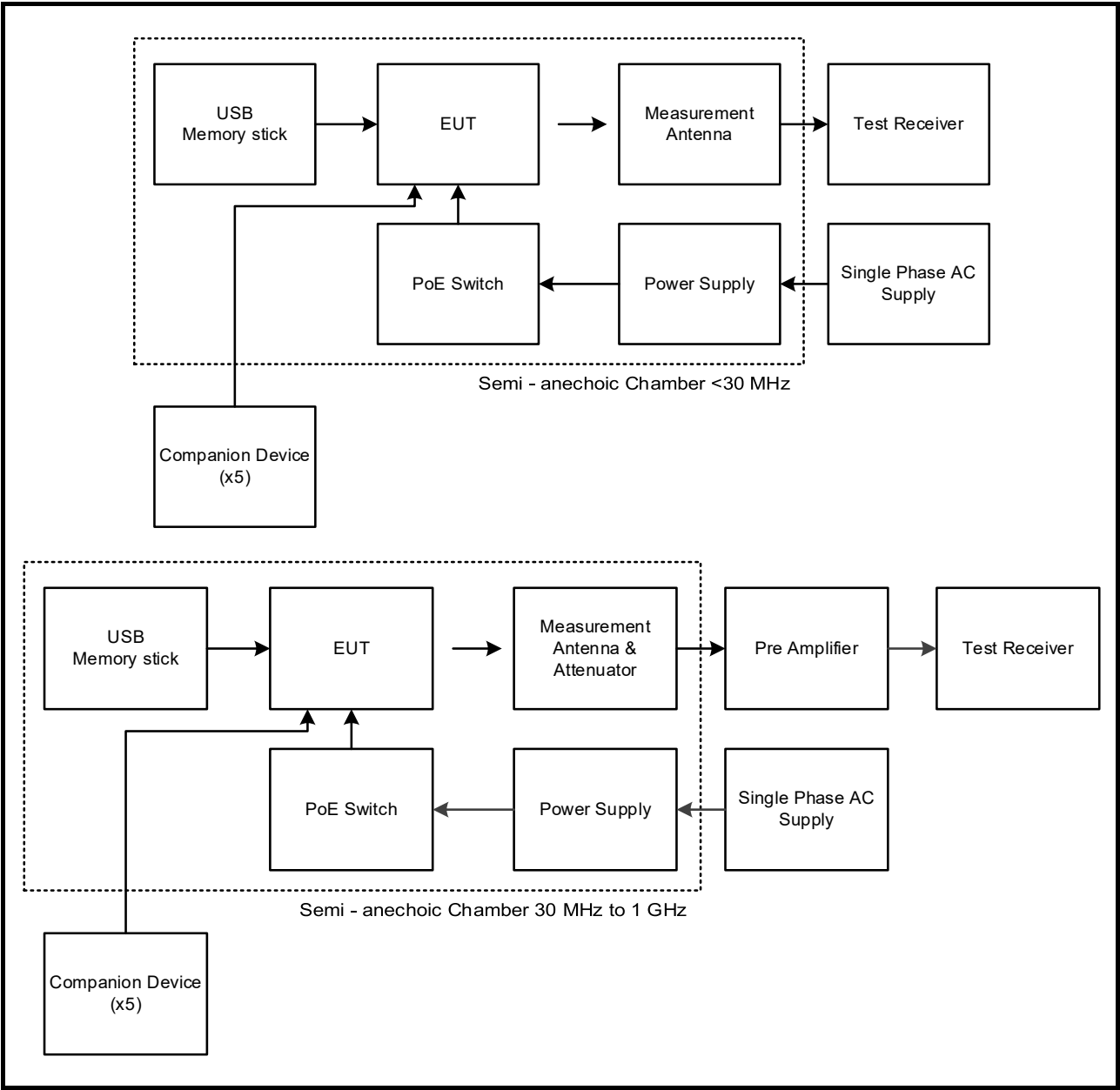


Test Setup for Transmitter Fundamental Field Strength, Transmitter Duty Cycle, Transmitter 20 dB Bandwidth, Transmitter 99% Emission Bandwidth & Transmitter Band Edge Radiated Emissions



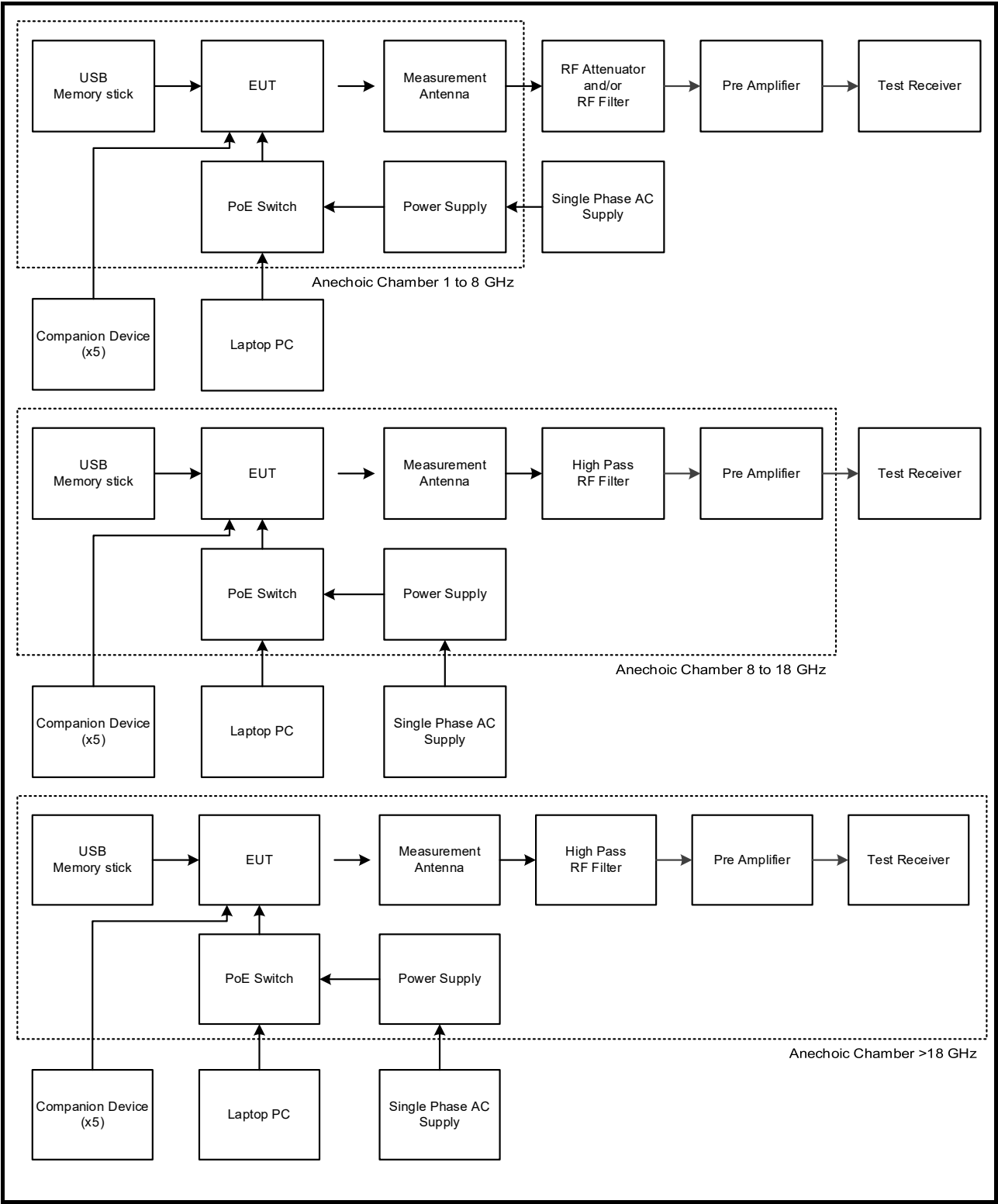
Test Setup Diagrams (continued)

Test Setup for Transmitter Radiated Emissions



Test Setup Diagrams (continued)

Test Setup for Transmitter Radiated Emissions



4 Radiated Test Results

4.1. Transmitter Fundamental Field Strength

Test Summary:

Test Engineer:	Andrew Edwards	Test Date:	11 January 2023
Test Sample Serial Number:	0011CE0163C9		

FCC Reference:	Part 15.249(a)(e)
ISED Canada Reference:	RSS-Gen 6.12 / RSS-210 B.10(a)
Test Method Used:	ANSI C63.10 Section 6.6

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	42

Note(s):

1. The final measured value in the tables below incorporates the calibrated antenna factor and cable loss.
2. Measurements were performed in a fully-anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 1.5m above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
3. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth to 3 MHz. Peak and average detectors were used, sweep time was set to auto and trace mode was Max Hold.
4. Peak Final measurements were performed on the marker frequencies and results entered into the table below. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. Peak detector was used, sweep time was set to auto and trace mode was Max Hold.
5. *A duty cycle correction factor was applied to measured peak levels to obtain the average result:

$$\text{Duty cycle correction} = 20 \text{ Log } (1/(28.04 \mu\text{s} / 93.71 \text{ ms})) = 10.5 \text{ dB}$$

Transmitter Fundamental Field Strength (continued)**Results: Antenna A****Results: Bottom Channel / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2401.750	Horizontal	100.3	114.0	13.7	Complied

Results: Bottom Channel / Average

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Duty Cycle Correction (dB)	Corrected Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2401.750	Horizontal	100.3	10.5	89.8	94.0	4.2	Complied

Results: Middle Channel / Peak

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2442.000	Horizontal	100.8	114.0	13.2	Complied

Results: Middle Channel / Average

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Duty Cycle Correction (dB)	Corrected Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2442.000	Horizontal	100.8	10.5	90.3	94.0	3.7	Complied

Results: Top Channel / Peak

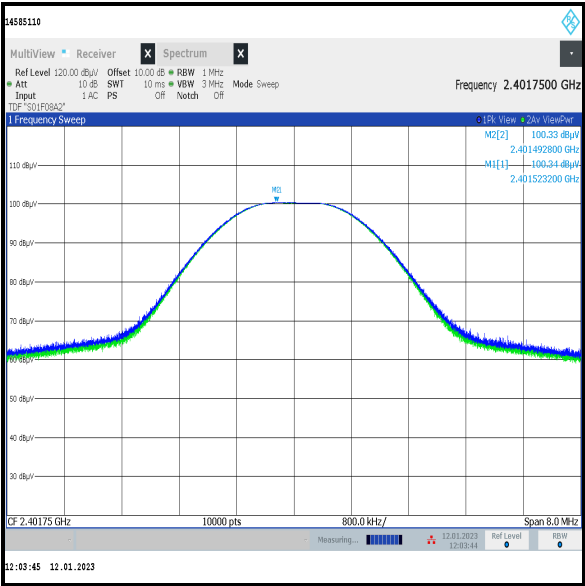
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2481.750	Horizontal	101.4	114.0	12.6	Complied

Results: Top Channel / Average

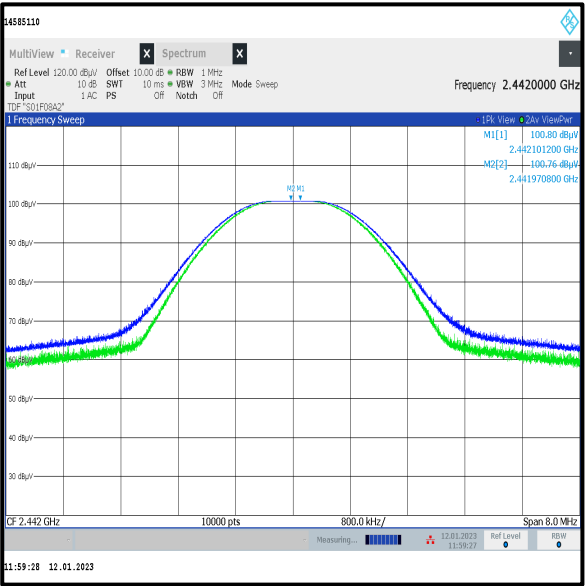
Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Duty Cycle Correction (dB)	Corrected Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2481.750	Horizontal	101.4	10.5	90.9	94.0	3.1	Complied

Transmitter Fundamental Field Strength (continued)

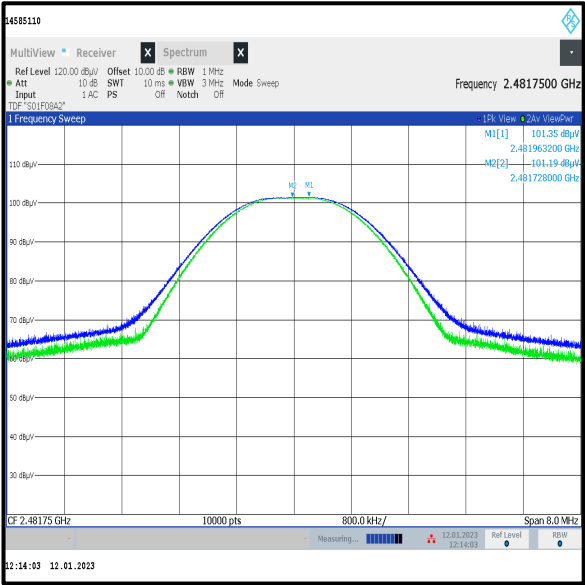
Results: Antenna A



Bottom Channel



Middle Channel



Top Channel

Transmitter Fundamental Field Strength (continued)**Results: Antenna B****Results: Bottom Channel / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2401.750	Horizontal	100.2	114.0	13.8	Complied

Results: Bottom Channel / Average

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Duty Cycle Correction (dB)	Corrected Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2401.750	Horizontal	100.2	10.5	89.7	94.0	4.3	Complied

Results: Middle Channel / Peak

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2442.000	Horizontal	100.1	114.0	13.9	Complied

Results: Middle Channel / Average

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Duty Cycle Correction (dB)	Corrected Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2442.000	Horizontal	100.1	10.5	89.6	94.0	4.4	Complied

Results: Top Channel / Peak

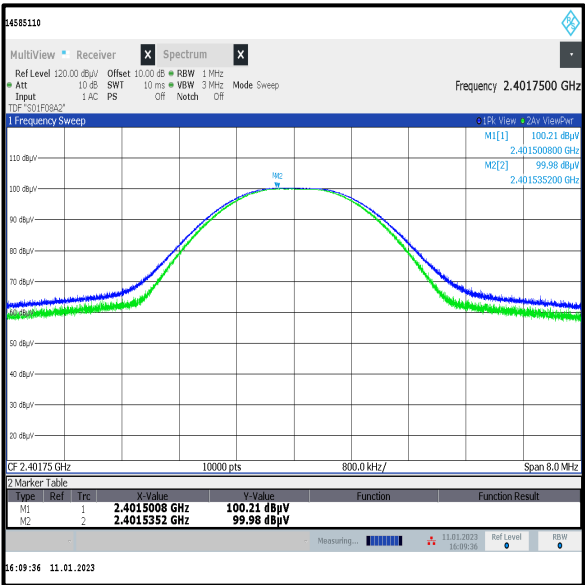
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2481.750	Horizontal	99.6	114.0	14.4	Complied

Results: Top Channel / Average

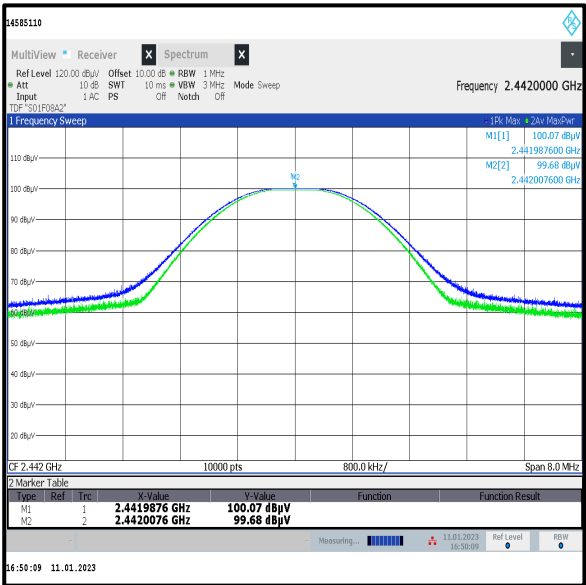
Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Duty Cycle Correction (dB)	Corrected Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2481.750	Horizontal	99.6	10.5	89.1	94.0	4.9	Complied

Transmitter Fundamental Field Strength (continued)

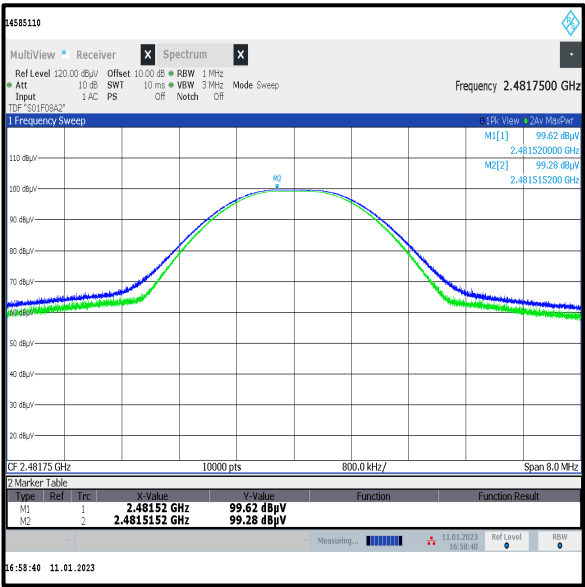
Results: Antenna B



Bottom Channel



Middle Channel



Top Channel

4.2. Transmitter Duty Cycle

Test Summary:

Test Engineer:	Andrew Edwards	Test Date:	13 January 2023
Test Sample Serial Number:	0011CE0163C9		

FCC Reference:	Part 15.35(c)
Industry Canada Reference:	RSS-Gen 6.10
Test Method Used:	ANSI C63.10 Section 7.5

Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	41

Note(s):

1. In order to assist with the determination of the average level of fundamental and spurious emissions field strength, measurements were made of duty cycle to determine the transmission duration and the silent period time of the transmitter. The transmitter duty cycle was measured using a spectrum analyser in the time domain and calculated by $20 \log(1/(\text{On Time} / [\text{Period or } 100 \text{ ms whichever is the lesser}]))$

$$\text{Duty cycle} = 20 \text{ Log } (1/(28.04 \mu\text{s} / 93.71 \text{ ms}))$$

$$\text{Duty cycle} = 20 \text{ Log } (1/0.299)$$

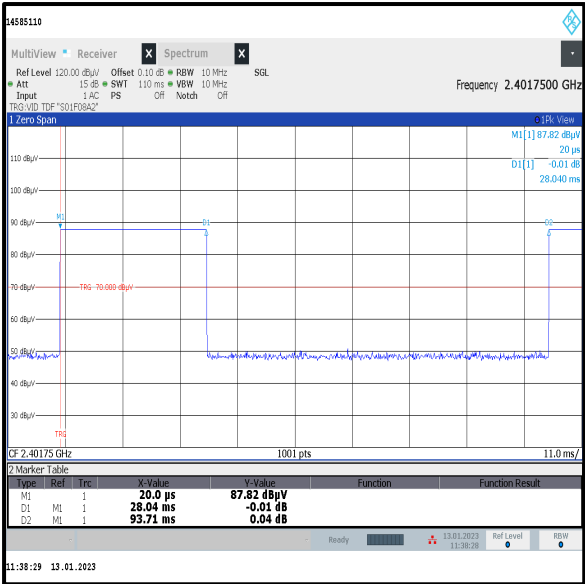
$$\text{Duty cycle} = 10.5 \text{ dB}$$

2. The measurement was performed in a fully anechoic chamber (Asset Number K0001) at a distance of 3 metres.
3. The test receiver resolution bandwidth was set to 10 MHz and video bandwidth to 10 MHz. A peak detector was used, sweep time was set to 110 ms with a trigger offset of -10 ms. The span was set to zero. Markers were placed on the rising edge of the first burst, a delta marker 1 was placed on the falling edge of the first burst and a second marker was placed on the rising edge of the next burst. The results are recorded in the tables below.

Transmitter Duty Cycle (continued)

Results:

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
28.04	93.71	10.5



4.3. Transmitter 20 dB Bandwidth

Test Summary:

Test Engineer:	Andrew Edwards	Test Date:	11 January 2023
Test Sample Serial Number:	0011CE0163C9		

FCC Reference:	Part 2.1049
Test Method Used:	ANSI C63.10 Section 6.9.2

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	42

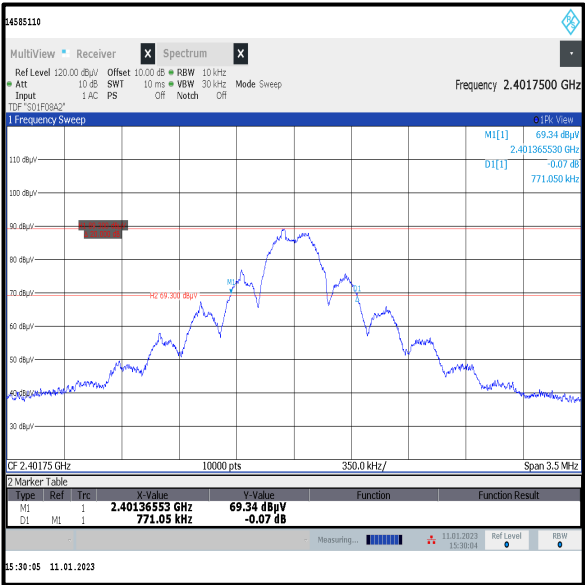
Note(s):

1. Transmitter 20 dB bandwidth was measured using the marker delta function of a test receiver. The resolution bandwidth was set between 1% and 5% of the occupied bandwidth and the video bandwidth set to 3 times the resolution bandwidth.
2. The test receiver resolution bandwidth was set to 10 kHz and video bandwidth to 30 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 3.5 MHz. Markers were placed 20 dB above and below the peak of the carrier. The marker delta function was used to calculate the 20 dB bandwidth. The results are recorded in the tables below.

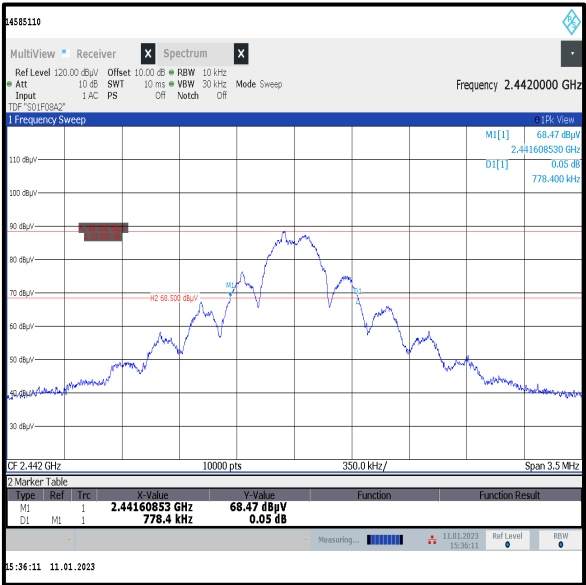
Transmitter 20 dB Bandwidth (continued)

Results: Antenna A

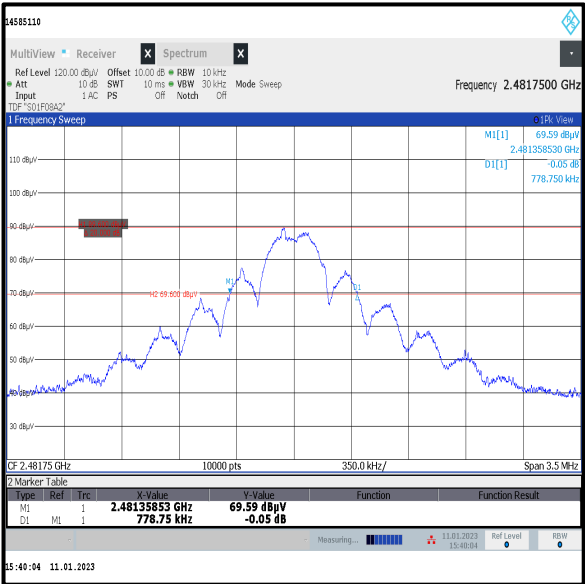
Channel	20dB Bandwidth (kHz)
Bottom	771.050
Middle	778.400
Top	778.750



Bottom Channel



Middle Channel

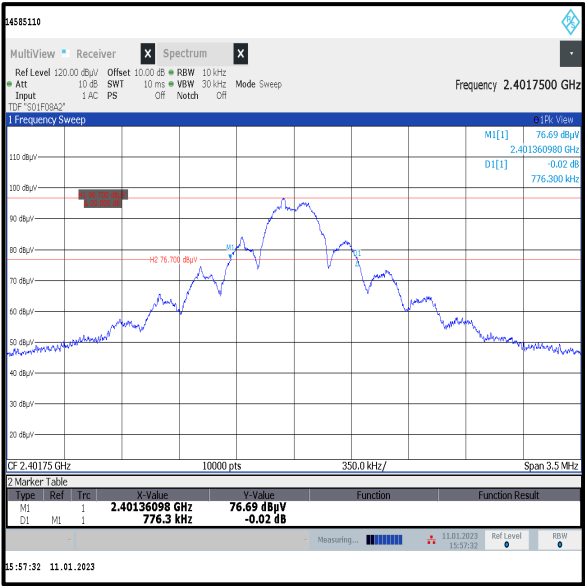


Top Channel

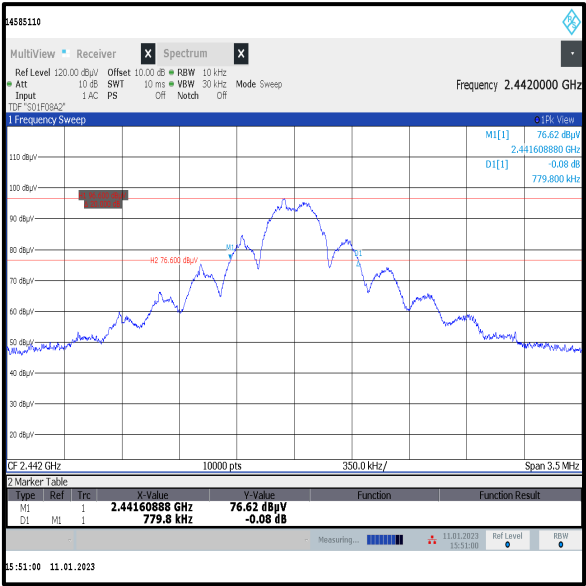
Transmitter 20 dB Bandwidth (continued)

Results: Antenna B

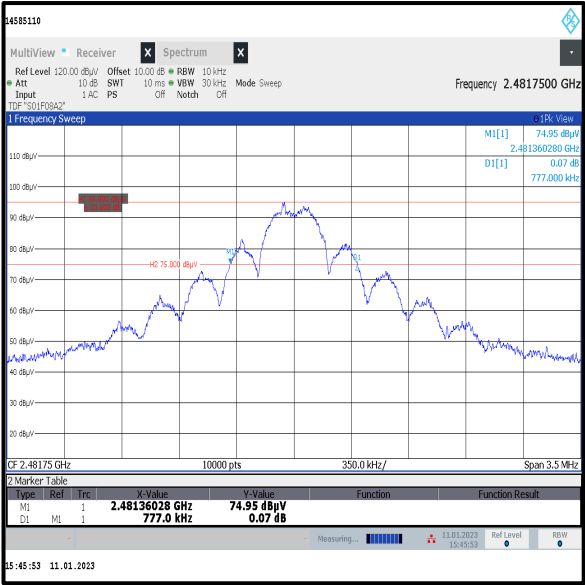
Channel	20dB Bandwidth (kHz)
Bottom	776.300
Middle	779.800
Top	777.000



Bottom Channel



Middle Channel



Top Channel

4.4. Transmitter 99% Emission Bandwidth

Test Summary:

Test Engineer:	Andrew Edwards	Test Date:	11 January 2023
Test Sample Serial Number:	0011CE0163C9		

ISED Canada Reference:	RSS-Gen 6.7
Test Method Used:	RSS-Gen 6.7

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	42

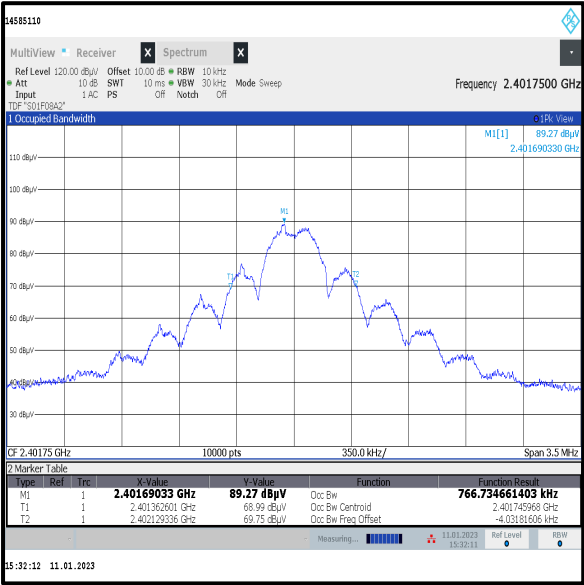
Note(s):

1. Occupied bandwidth (99% bandwidth) was measured using a test receiver occupied bandwidth function. The resolution bandwidth was set between 1 % and 5% of the occupied bandwidth and the video bandwidth set to 3 times the resolution bandwidth.
2. The test receiver resolution bandwidth was set to 10 kHz and video bandwidth 30 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 3.5 MHz. The test receiver function set the measurements to be made at 99% of the emission bandwidth. The results are given in the tables below.

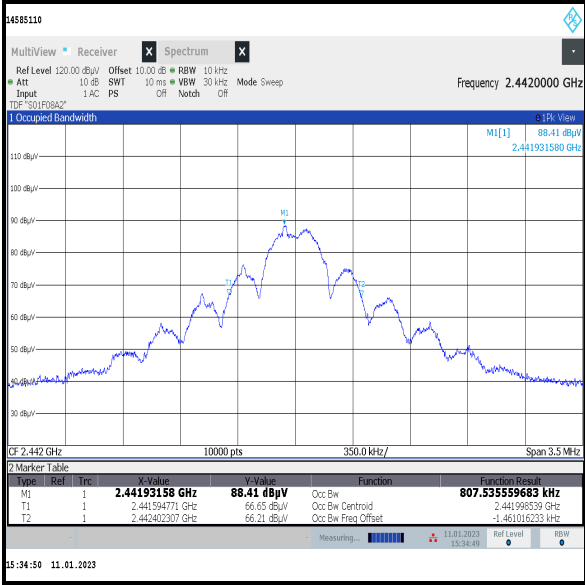
Transmitter 99% Emission Bandwidth (continued)

Results: Antenna A

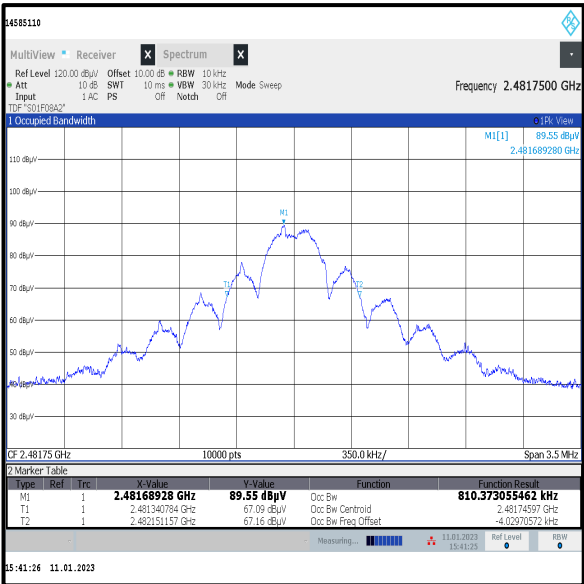
Channel	99% Emission Bandwidth (kHz)
Bottom	766.735
Middle	807.536
Top	810.373



Bottom Channel



Middle Channel

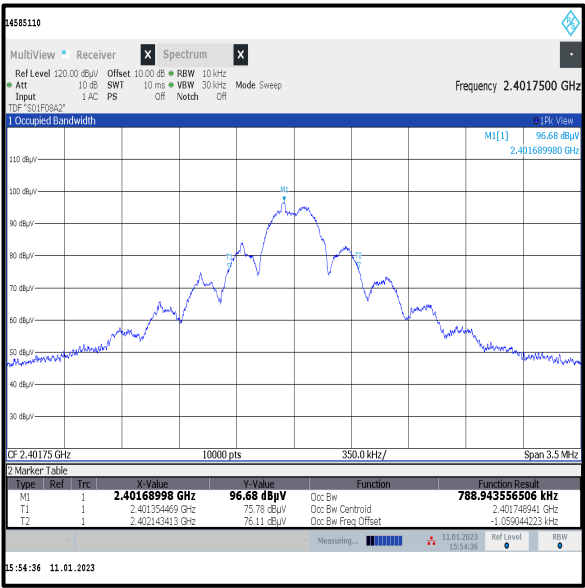


Top Channel

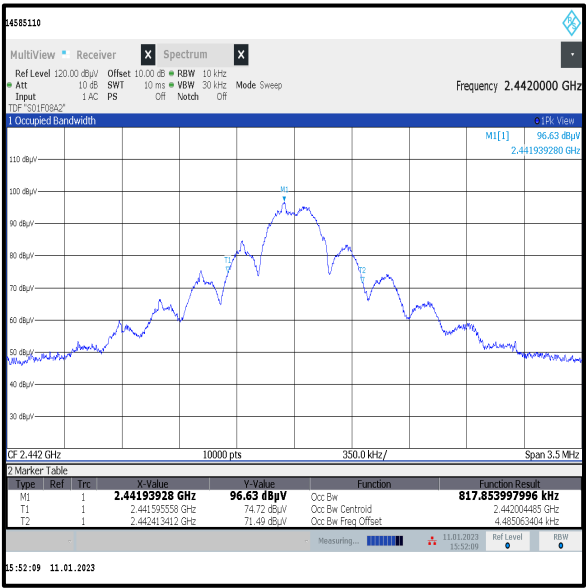
Transmitter 99% Emission Bandwidth (continued)

Results: Antenna B

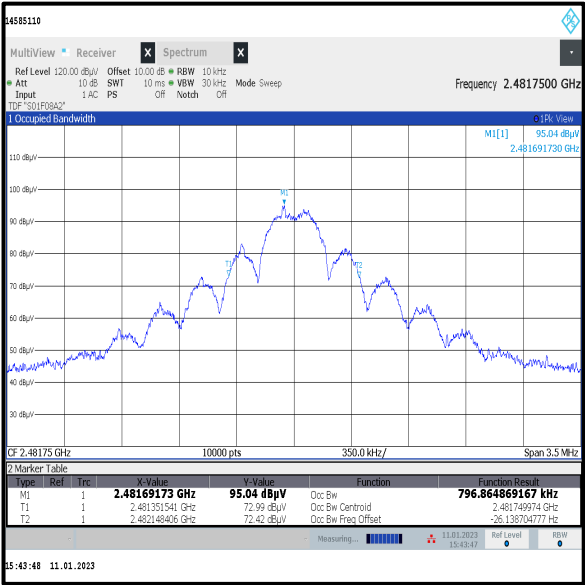
Channel	99% Emission Bandwidth (kHz)
Bottom	788.944
Middle	817.854
Top	796.865



Bottom Channel



Middle Channel



Top Channel

4.5 Transmitter Radiated Emissions <1 GHz

Test Summary:

Test Engineer:	Andrew Edwards	Test Dates:	11 January 2023 & 12 January 2023
Test Sample Serial Number:	0011CE0163C9		

FCC Reference:	Parts 15.249(d) & 15.209(a)
ISED Canada Reference:	RSS-Gen 6.13, 8.9 & 8.10 / RSS-210 B.10(b)
Test Method Used:	ANSI C63.10 Sections 6.3, 6.4 and 6.5
Frequency Range	9 kHz to 1000 MHz

Environmental Conditions:

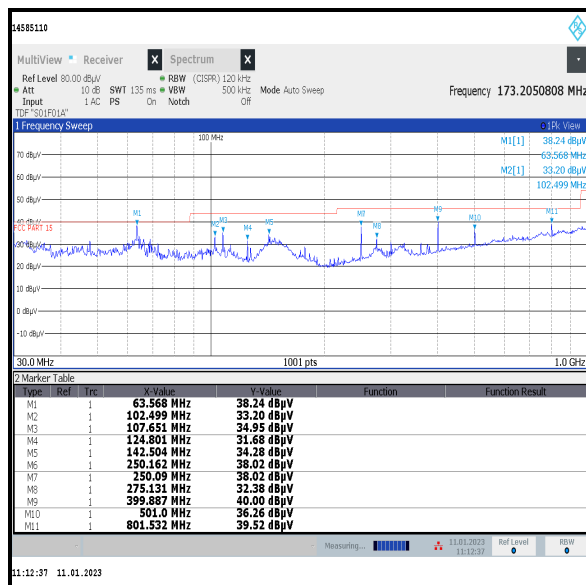
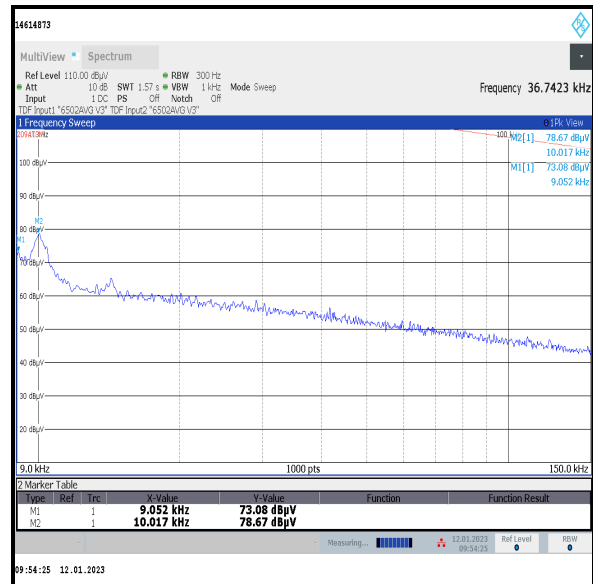
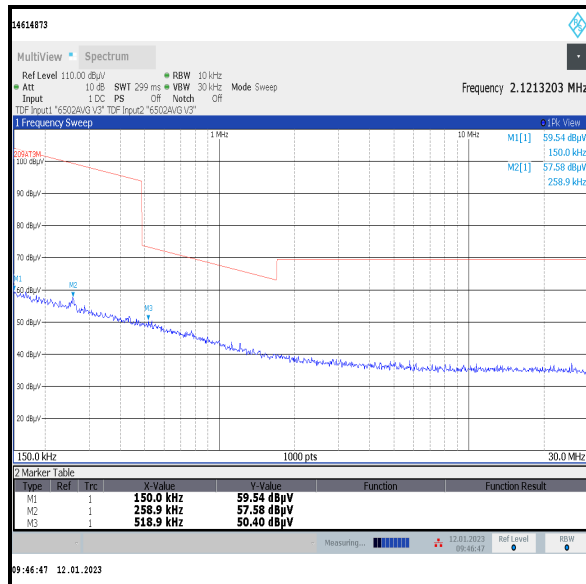
Temperature (°C):	22
Relative Humidity (%):	41 to 42

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. All other emissions shown on the pre-scans were investigated and found to be ambient, > 20 dB below the appropriate limit or below the noise floor of the measurement system.
3. Measurements below 30 MHz were performed in a semi-anechoic chamber (Asset Number K0001) at 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. The limit was extrapolated to 3 metres in accordance with ANSI C63.10 clause 6.4.3 using the method described in clause 6.4.4.2. ANSI C63.10 clause 5.2 states an alternative test site that can demonstrate equivalence to an open area test site may be used for measurements below 30 MHz. Therefore, measurements were performed in a semi-anechoic chamber. The correlation data between semi-anechoic chamber and an open field test site is available upon request.
4. The limits in CFR 47, Part 15, Subpart C, paragraph 15.209 (a), are identical to those in RSS-GEN Section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377Ω . For example, the measurement frequency X kHz resulted in a level of Y dB μ V/m, which is equivalent to $Y - 51.5 = Z$ dB μ A/m, which has the same margin, W dB, to the corresponding RSS-GEN Table 6 limit as it has to the 15.209(a) limit.
5. Measurements between 30 MHz and 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
6. Pre-scans were performed and markers placed on the highest measured levels. The test receiver was configured as follows: For 9 kHz to 150 kHz, the resolution bandwidth was set to 300 Hz and video bandwidth 1 kHz. A peak detector was used and trace mode was Max Hold. For 150 kHz to 30 MHz, the resolution bandwidth was set to 10 kHz and video bandwidth 30 kHz, trace mode was Max Hold. For 30 MHz to 1 GHz, the resolution bandwidth was set to 120 kHz and video bandwidth 500 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.
7. Final measurements between 30 MHz to 1 GHz were performed on the marker frequencies and results entered into the tables below. The test receiver resolution bandwidth was set to 120 kHz, using a CISPR quasi-peak detector.
8. In accordance with ANSI C63.10 section 6.5.4 only the highest six emissions were record the tables below.

Transmitter Radiated Emissions (continued)**Results: Antenna A****Results: Middle Channel / Quasi – Peak**

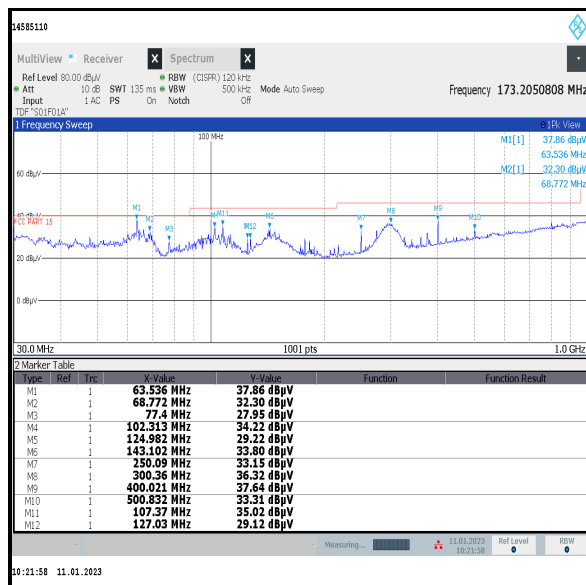
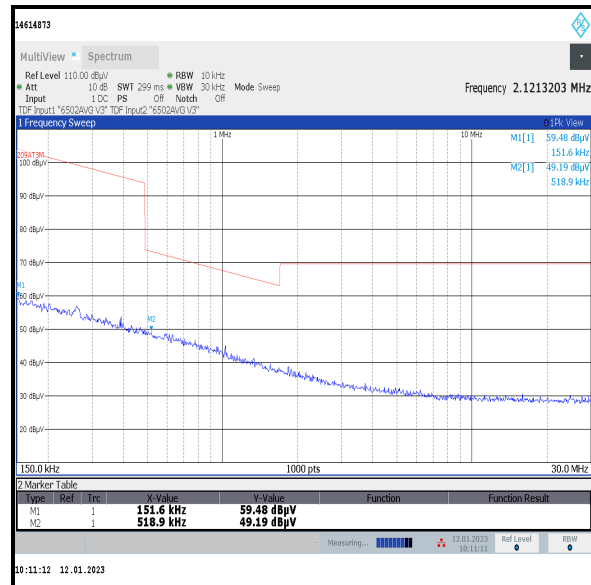
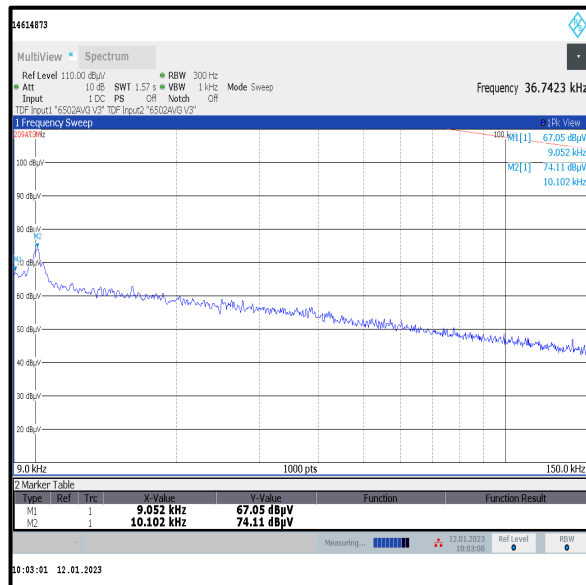
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
63.691	Vertical	36.8	40.0	3.2	Complied
73.140	Vertical	28.8	40.0	11.9	Complied
143.270	Vertical	35.9	43.5	7.6	Complied
399.998	Vertical	39.4	46.0	6.6	Complied
499.992	Vertical	35.3	46.0	10.7	Complied
799.989	Vertical	38.8	46.0	7.2	Complied



Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Radiated Emissions (continued)**Results: Antenna B****Results: Middle Channel / Quasi – Peak**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
63.691	Vertical	36.8	40.0	3.2	Complied
143.270	Vertical	35.9	43.5	7.6	Complied
300.000	Horizontal	35.7	43.5	7.8	Complied
399.998	Vertical	39.4	46.0	6.6	Complied
499.992	Vertical	35.3	46.0	10.7	Complied
799.989	Vertical	38.8	46.0	7.2	Complied



Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

4.6 Transmitter Radiated Emissions >1 GHz

Test Summary:

Test Engineer:	Andrew Edwards	Test Dates:	12 January 2023 & 13 January 2023
Test Sample Serial Number:	0011CE0163C9		

FCC Reference:	Parts 15.249(d)(e) & 15.209(a)
ISED Canada Reference:	RSS-Gen 6.13, 8.9 & 8.10 / RSS-210 B.10(b)
Test Method Used:	ANSI C63.10 Sections 6.3 and 6.6
Frequency Range	1 GHz to 25 GHz

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	41 to 43

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. The emission at approximately 2442 MHz is the EUT fundamental.
3. All other emissions shown on the pre-scan plot were investigated and found to be ambient, >20 dB below the appropriate limit or below the measurement system noise floor.
4. In accordance with FCC 15.249(d) / RSS-210 B.10(b) all emissions radiating outside of 2400-2483.5 MHz shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in 15.209 / RSS-Gen 8.9, whichever is the lesser attenuation. In this case 15.209 / RSS-Gen 8.9 limits apply.
5. *In accordance with ANSI C63.10 Section 6.6.4.3, Note 1, if the peak measured value complies with the average limit, it is unnecessary to perform an average measurement.
6. Pre-scans and final measurements above 1 GHz were performed in a fully anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the test chamber floor in the centre of the chamber turntable. During prescans, all measurement antennas were placed at a fixed height of 1.5 metres above the test chamber floor, in line with the EUT. Final measurements above 1 GHz were performed with the EUT placed at a height of 1.5 metres above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
7. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth to 3 MHz. The sweep time was set to auto. Peak and average measurements were performed with their respective detectors.
8. **A duty cycle correction factor was applied to peak measured level to obtain the average result

$$\text{Duty cycle correction} = 20 \log (1/(28.04 \mu\text{s} / 93.71 \text{ ms})) = 10.5 \text{ dB}$$

Transmitter Radiated Emissions (continued)**Results: Antenna A****Results: Bottom Channel / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2324.020	Horizontal	51.3*	54.0	2.7	Complied
2486.580	Horizontal	51.2*	54.0	2.8	Complied
2557.500	Horizontal	50.6*	54.0	3.4	Complied
4830.345	Vertical	56.0	74.0	18.0	Complied
9607.100	Horizontal	51.2*	54.0	2.8	Complied

Results: Bottom Channel / Average

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Duty Cycle Correction (dB)	Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
4803.345	Vertical	56.0	10.5	45.5**	54.0	8.5	Complied

Results: Middle Channel / Peak

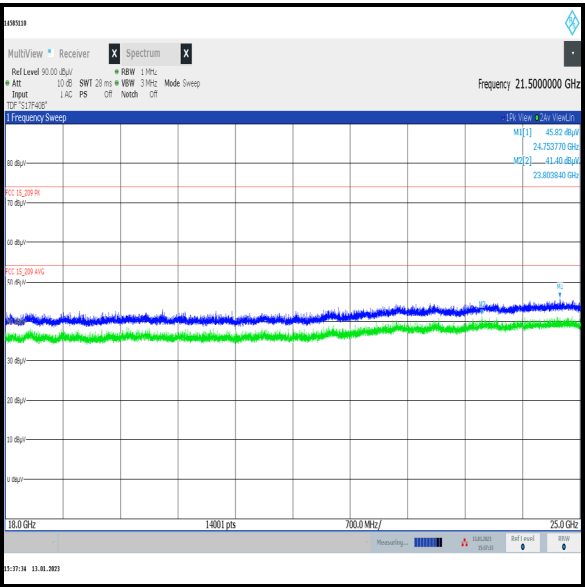
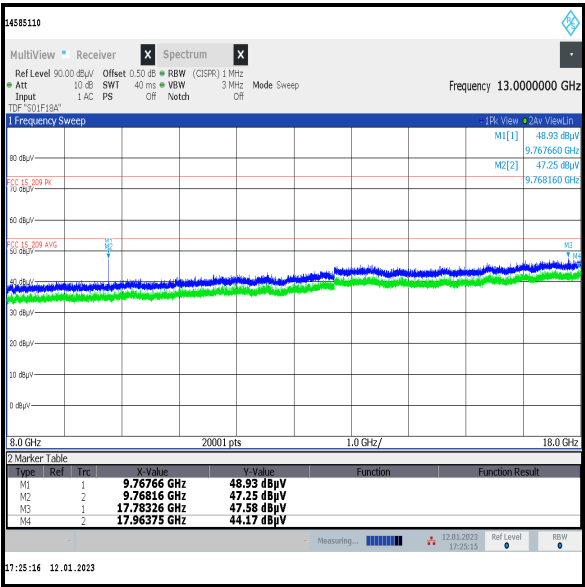
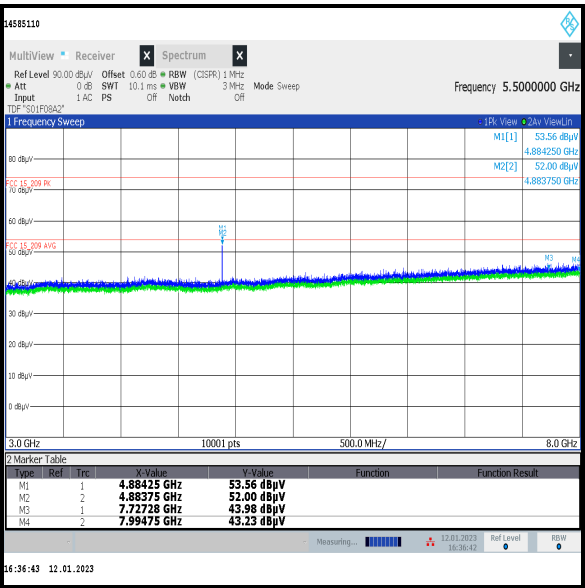
Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
2364.030	Horizontal	50.3*	54.0	3.7	Complied
2524.590	Horizontal	49.5*	54.0	4.5	Complied
4884.040	Vertical	53.3*	54.0	0.7	Complied
9768.050	Horizontal	50.4*	54.0	3.6	Complied

Results: Top Channel / Peak

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
2494.580	Horizontal	50.4*	54.0	3.6	Complied
2507.860	Horizontal	50.8*	54.0	3.2	Complied
2559.660	Horizontal	49.0*	54.0	5.0	Complied
2572.780	Horizontal	50.1*	54.0	3.9	Complied
4963.720	Vertical	52.3*	54.0	1.7	Complied
9927.09	Horizontal	49.1*	54.0	4.9	Complied

Transmitter Radiated Emissions (continued)

Results: Antenna A



Note: These plots are prescans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Radiated Emissions (continued)**Results: Antenna B****Results: Bottom Channel / Peak**

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
2321.100	Horizontal	50.6*	54.0	3.4	Complied
2487.140	Horizontal	49.6*	54.0	4.4	Complied
2557.980	Horizontal	49.2*	54.0	4.8	Complied
4803.260	Vertical	51.7*	54.0	2.3	Complied
9606.920	Horizontal	51.9*	54.0	2.1	Complied

Results: Middle Channel / Peak

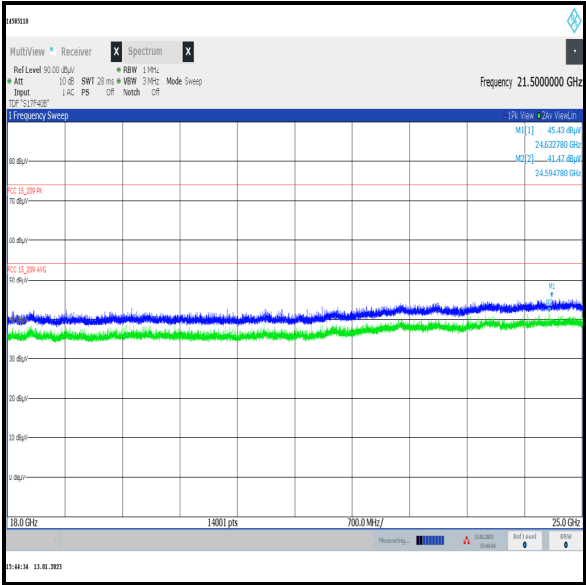
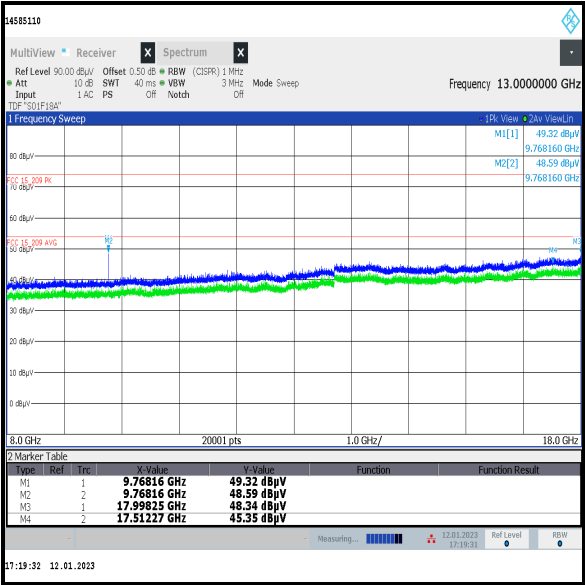
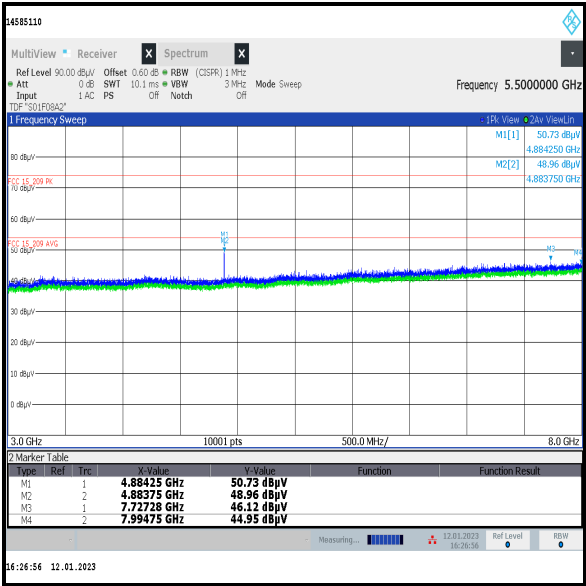
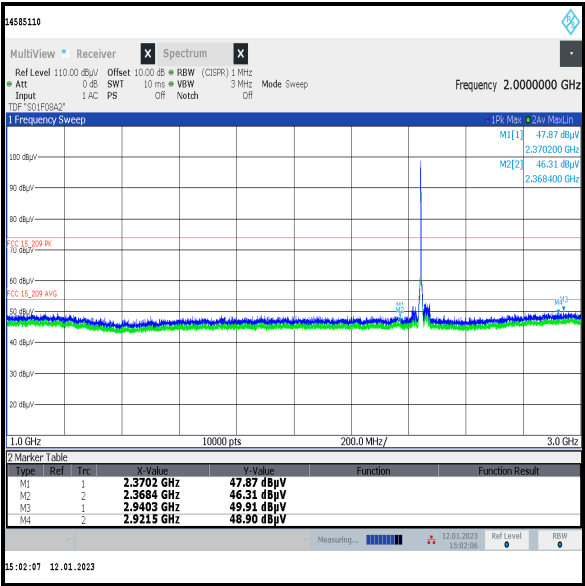
Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
2361.870	Horizontal	49.7*	54.0	4.3	Complied
2520.050	Horizontal	50.0*	54.0	4.0	Complied
4884.000	Vertical	52.4*	54.0	1.6	Complied
9767.880	Horizontal	50.3*	54.0	3.7	Complied

Results: Top Channel / Peak

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
2494.573	Horizontal	50.4*	54.0	3.6	Complied
2507.768	Horizontal	50.3*	54.0	3.7	Complied
2559.708	Horizontal	49.2*	54.0	4.8	Complied
4963.480	Vertical	51.3*	54.0	2.7	Complied
9927.080	Horizontal	49.2*	54.0	4.8	Complied

Transmitter Radiated Emissions (continued)

Results: Antenna B



Note: These plots are prescans and for indication purposes only. For final measurements, see accompanying tables.

4.7 Transmitter Band Edge Radiated Emissions

Test Summary:

Test Engineer:	Andrew Edwards	Test Date:	12 January 2023
Test Sample Serial Number:	0011CE0163C9		

FCC Reference:	Parts 15.249(d)(e) & 15.209(a)
ISED Canada Reference:	RSS-Gen 6.13, 8.9 & 8.10 / RSS-210 B.10(b)
Test Method Used:	ANSI C63.10 Sections 6.10.4, 6.10.5 and 6.10.6

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	43

Note(s):

- The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
- In accordance with FCC part 15.249(d) / RSS-210 B.10 (b), all emissions outside of the specified frequency band shall be attenuated by at least 50 dBc or the general radiated emission limits in 15.209 / RSS-Gen 8.10 whichever has less attenuation.
- The lower band edge falls in a non-restricted band, therefore 15.249(d) limits have been applied. 15.249(d) states all emissions radiating outside of 2400-2483.5 MHz shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in 15.209, whichever is the lesser attenuation.
- * The lower and upper average band edge measurements performed using the test method detailed in ANSI C63.10 Section 6.10.5 exceed the limits. The measurements were repeating using the marker-delta method in accordance with ANSI C63.10 Section 6.10.6. An in-band field strength measurement was initially performed. A second measurement was performed using a reduced RBW of 120 kHz which is 1% of the 12 MHz span. The amplitude delta between the peak of the fundamental emission and the emission level at each band edge was recorded. The delta was subtracted from the initial in-band field strength level to obtain the corrected peak band edge levels. The average band edge levels were then obtained by subtracting the duty cycle correction factor from the corrected peak band edge levels.
- ** During the marker-delta methods a second marker (M2) was placed on the highest emission level in the adjacent band (up to 2 MHz from the band edge frequency). It was not possible to apply multiple normal and delta markers at the same time. Therefore the adjacent value were calculated as shown below:

Adjacent Delta value: (Delta marker (D1) – (Adjacent marker (M2) - Band Edge marker (M1))

Antenna A / Lower Band Edge at 2399.914 MHz = (43.4 - (57.6 - 56.6)) = 42.4 dB

Antenna A / Upper Band Edge at 2484.186 MHz = (43.7 - (58.6 - 58.1)) = 42.2 dB

Antenna B / Lower Band Edge at 2399.989 MHz = (44.0 - (56.3 - 55.2)) = 42.9 dB

Antenna B / Upper Band Edge at 2484.349 MHz = (43.2 - (57.1 - 46.4)) = 42.5 dB

Transmitter Band Edge Radiated Emissions (continued)**Results: Antenna A****Results: Peak**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2400	Horizontal	69.2	74.0	4.8	Complied
2483.5	Horizontal	70.4	74.0	3.6	Complied

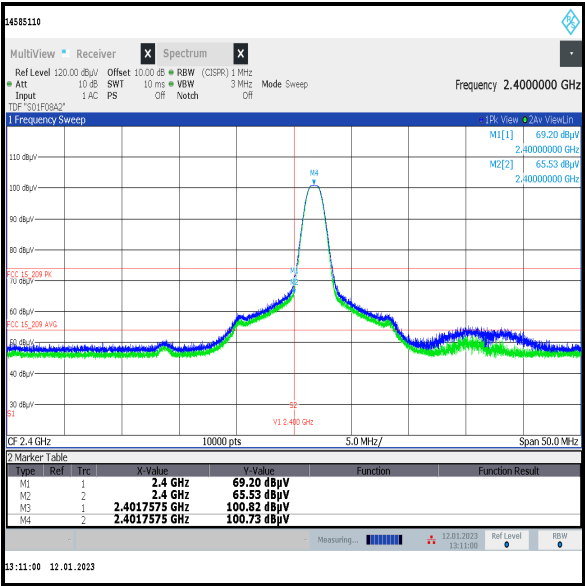
Results: Average

Frequency (MHz)	Antenna Polarity	Fundamental Peak Emission Level (dB μ V/m)	Fundamental and Band Edge Delta (dB)	Corrected Peak Level (dB μ V/m)
2399.914	Horizontal	100.8	42.4**	58.4
2400	Horizontal	100.8	43.4	57.4
2483.5	Horizontal	100.5	42.7	57.8
2484.186	Horizontal	100.5	42.2**	58.3

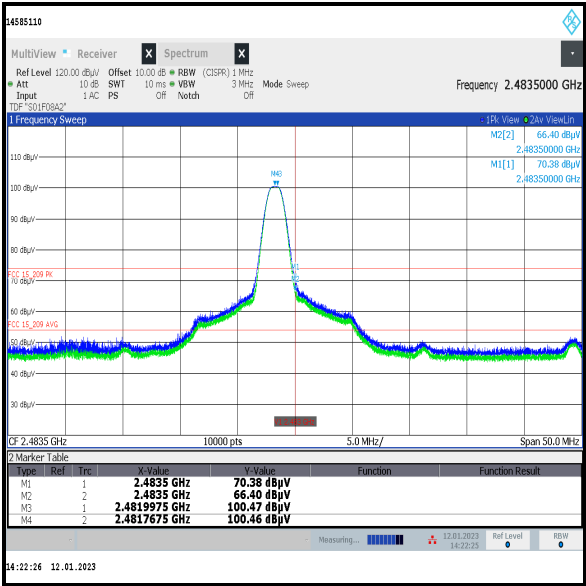
Frequency (MHz)	Antenna Polarity	Corrected Peak Level (dB μ V/m)	Duty Cycle Correction Factor (dB)	Corrected Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2399.914	Horizontal	58.4	10.5	47.9*	54.0	6.1	Complied
2400	Horizontal	57.4	10.5	46.9*	54.0	7.1	Complied
2483.5	Horizontal	57.8	10.5	47.3*	54.0	6.7	Complied
2484.186	Horizontal	58.3	10.5	47.8*	54.0	6.2	Complied

Transmitter Band Edge Radiated Emissions (continued)

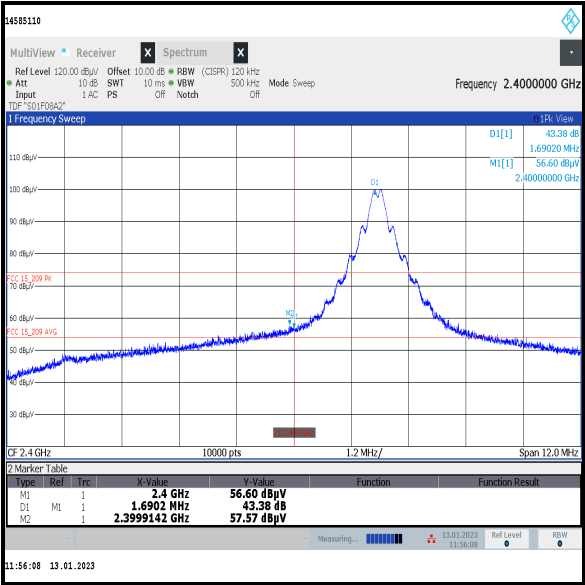
Results: Antenna A



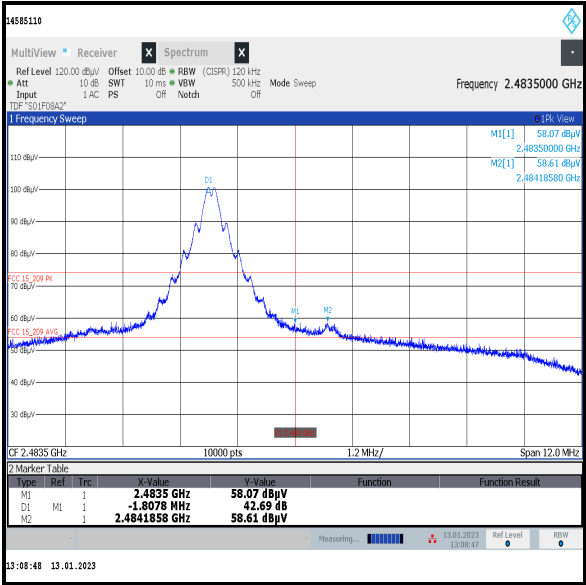
Lower Band Edge



Upper Band Edge



Lower Band Edge Peak Measurement – Marker Delta method



Upper Band Edge Peak Measurement – Marker Delta method

Transmitter Band Edge Radiated Emissions (continued)**Results: Antenna B****Results: Peak**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2400	Horizontal	68.8	74.0	5.2	Complied
2483.5	Horizontal	69.3	74.0	4.7	Complied

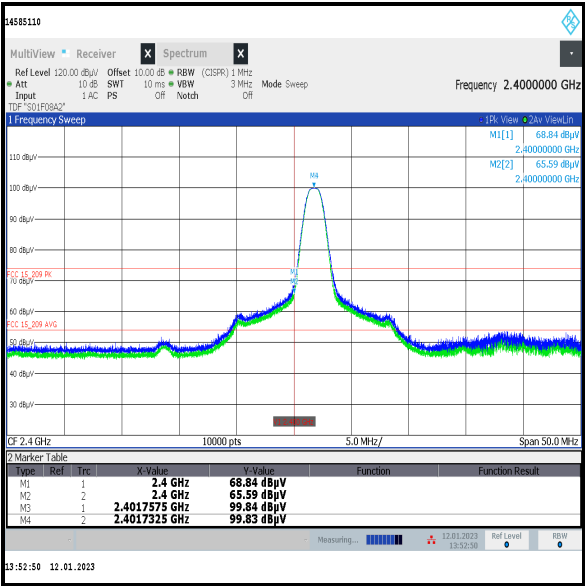
Results: Average

Frequency (MHz)	Antenna Polarity	Fundamental Peak Emission Level (dB μ V/m)	Fundamental and Band Edge Delta (dB)	Corrected Peak Level (dB μ V/m)
2399.989	Horizontal	99.8	42.9**	56.9
2400	Horizontal	99.8	44.0	55.8
2483.5	Horizontal	100.4	43.2	57.2
2484.349	Horizontal	100.4	42.5**	57.9

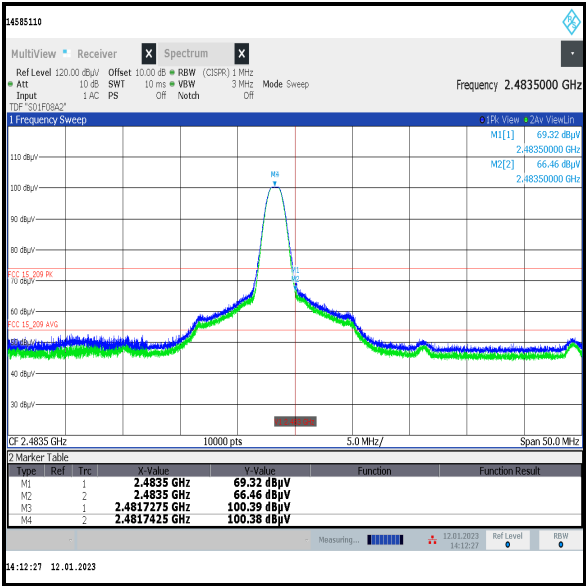
Frequency (MHz)	Antenna Polarity	Corrected Peak Level (dB μ V/m)	Duty Cycle Correction Factor (dB)	Corrected Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2399.989	Horizontal	56.9	10.5	46.4*	54.0	7.6	Complied
2400	Horizontal	55.8	10.5	45.3*	54.0	8.7	Complied
2483.5	Horizontal	57.2	10.5	46.7*	54.0	7.3	Complied
2484.349	Horizontal	57.9	10.5	47.4*	54.0	6.6	Complied

Transmitter Band Edge Radiated Emissions (continued)

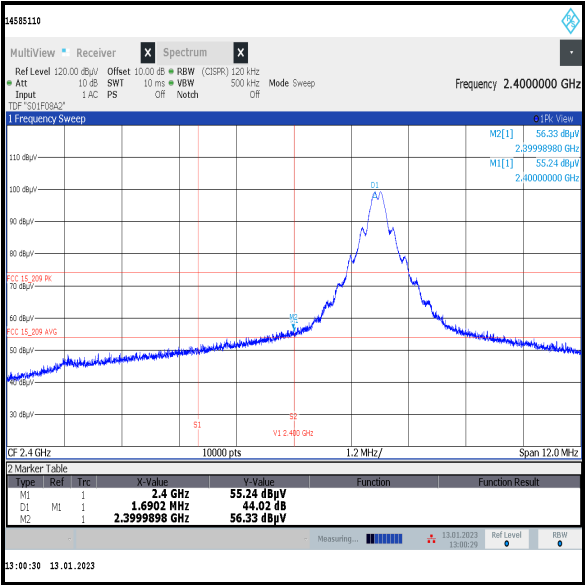
Results: Antenna B



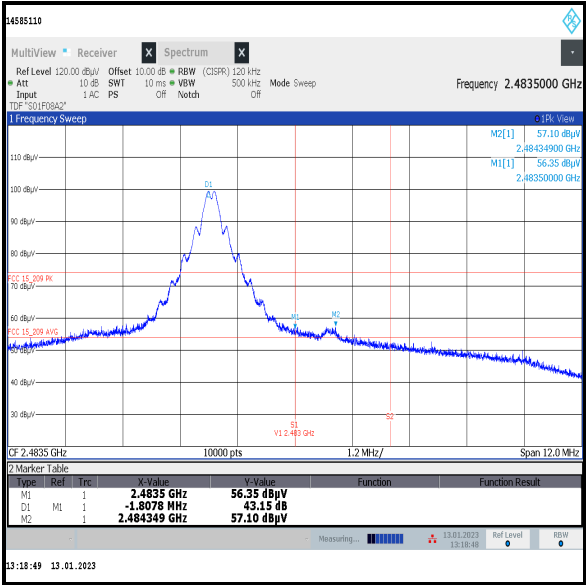
Lower Band Edge



Upper Band Edge



Lower Band Edge Peak Measurement – Marker Delta method



Upper Band Edge Peak Measurement – Marker Delta method

5 AC Power Line Conducted Emissions Test Results

5.1 Transmitter AC Conducted Spurious Emissions

Test Summary:

Test Engineers:	Alison Johnston	Test Date:	11 January 2023
Test Sample Serial Number:	0011CE0163C9		

FCC Reference:	Part 15.207
ISED Canada Reference:	RSS-Gen 8.8
Test Method Used:	ANSI C63.10 Section 6.2 / FCC KDB 174176 and notes below

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	44

Note(s):

1. The EUT was connected to a 120 VAC 60 Hz single phase supply via a LISN.
2. In accordance with FCC KDB 174176 Q4, tests were performed with a 240 VAC 60 Hz single phase supply as this was within the voltage range marked on the EUT power supply (120 to 277 VAC).
3. A pulse limiter was fitted between the LISN and the test receiver.
4. Pre-scans were performed, and markers placed on the highest live and neutral measured levels. Final measurements were performed on the marker frequencies and the results recorded in the tables below.
5. Measurements were performed on antenna A as this was deemed to be worst case.

Transmitter AC Conducted Spurious Emissions (continued)**Results: Live / Quasi Peak / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.213	Live	32.6	63.1	30.5	Complied
0.352	Live	39.8	58.9	19.1	Complied
0.510	Live	34.7	56.0	21.3	Complied
1.734	Live	31.8	56.0	24.2	Complied
2.125	Live	34.3	56.0	21.7	Complied
13.173	Live	26.5	60.0	33.5	Complied

Results: Live / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.357	Live	37.0	48.8	11.8	Complied
0.510	Live	36.1	46.0	9.9	Complied
0.820	Live	26.8	46.0	19.2	Complied
1.176	Live	26.3	46.0	19.7	Complied
1.783	Live	27.4	46.0	18.6	Complied
2.085	Live	28.4	46.0	17.6	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

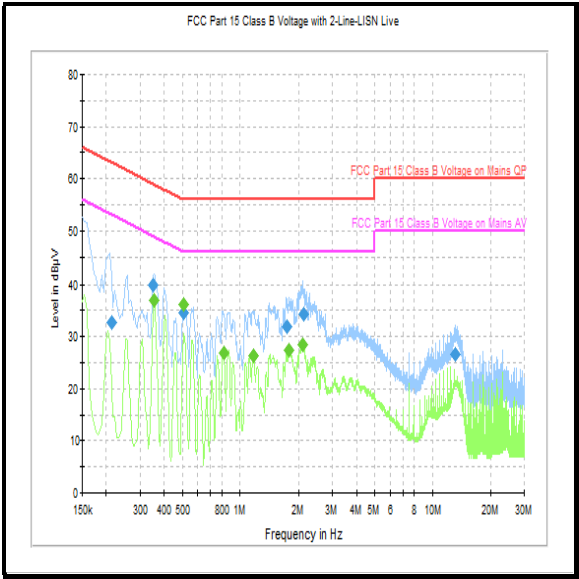
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.362	Neutral	39.7	58.7	19.0	Complied
0.510	Neutral	35.4	56.0	20.6	Complied
0.825	Neutral	32.2	56.0	23.8	Complied
1.730	Neutral	31.3	56.0	24.7	Complied
2.058	Neutral	33.8	56.0	22.2	Complied
13.600	Neutral	22.0	60.0	38.0	Complied

Results: Neutral / Average / 120 VAC 60 Hz

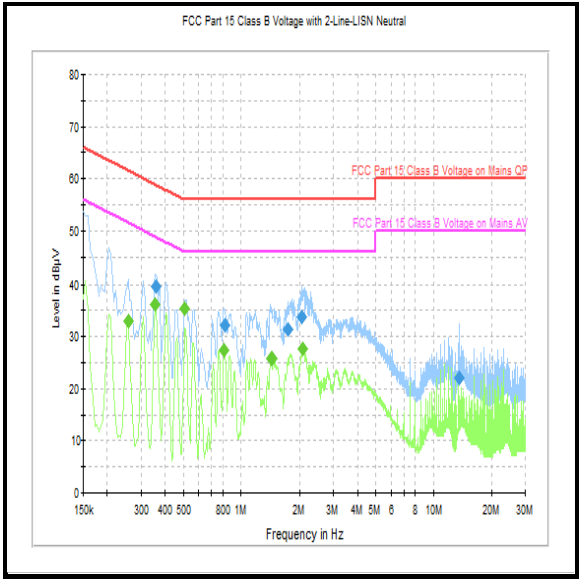
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.258	Neutral	32.9	51.5	18.6	Complied
0.357	Neutral	36.1	48.8	12.7	Complied
0.510	Neutral	35.3	46.0	10.7	Complied
0.816	Neutral	27.4	46.0	18.6	Complied
1.428	Neutral	25.9	46.0	20.1	Complied
2.081	Neutral	27.6	46.0	18.4	Complied

Transmitter AC Conducted Spurious Emissions (continued)

Results: 120 VAC 60 Hz



Live



Neutral

Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter AC Conducted Spurious Emissions (continued)**Results: Live / Quasi Peak / 240 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.168	Live	44.9	65.1	20.2	Complied
0.375	Live	42.9	58.4	15.5	Complied
0.465	Live	35.8	56.6	20.8	Complied
0.965	Live	33.4	56.0	22.6	Complied
1.464	Live	33.8	56.0	22.2	Complied
2.067	Live	35.9	56.0	20.1	Complied

Results: Live / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.168	Live	34.3	55.1	20.8	Complied
0.380	Live	39.5	48.3	8.8	Complied
0.461	Live	33.0	46.7	13.7	Complied
0.879	Live	31.1	46.0	14.9	Complied
1.473	Live	28.8	46.0	17.2	Complied
2.018	Live	29.9	46.0	16.1	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

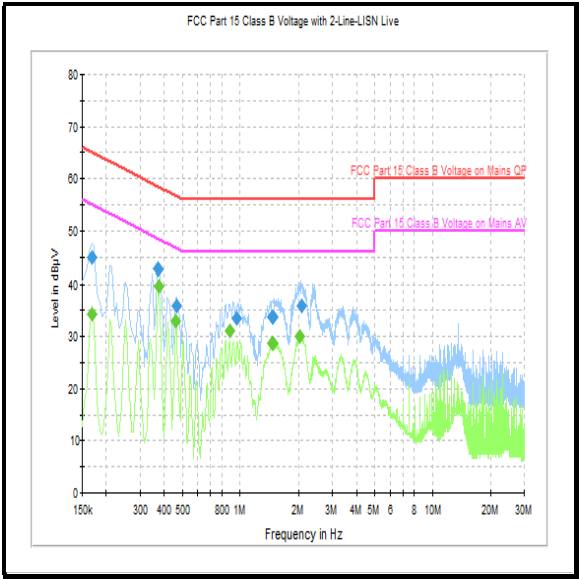
Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.168	Neutral	46.8	65.1	18.3	Complied
0.209	Neutral	42.6	63.3	20.7	Complied
0.375	Neutral	43.9	58.4	14.5	Complied
1.469	Neutral	33.8	56.0	22.2	Complied
2.396	Neutral	35.5	56.0	20.5	Complied
3.228	Neutral	32.4	56.0	23.6	Complied

Results: Neutral / Average / 240 VAC 60 Hz

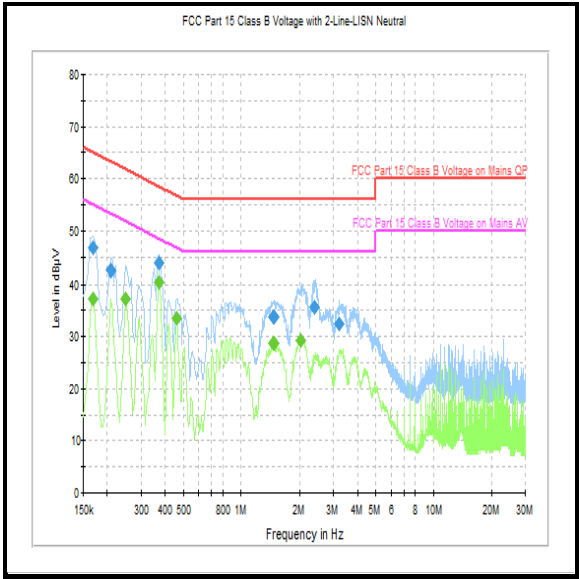
Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.168	Neutral	37.2	55.1	17.9	Complied
0.249	Neutral	37.2	51.8	14.6	Complied
0.375	Neutral	40.4	48.4	8.0	Complied
0.461	Neutral	33.4	46.7	13.3	Complied
1.478	Neutral	28.7	46.0	17.3	Complied
2.027	Neutral	29.1	46.0	16.9	Complied

Transmitter AC Conducted Spurious Emissions (continued)

Results: 240 VAC 60 Hz



Live



Neutral

Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

--- END OF REPORT ---