
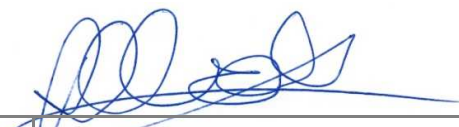


EMC Test Report	
For:	Displaydata Limited
Product:	Electronic Shelf Tag
Model Number (HVIN):	DD60-3A
	
Project Engineer:	Graeme Lawler
	
Approval Signatory:	Andy Coombes

Document Reference:	4896B FR
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Issue Number:	Date:	Test Report Revisions History:
1	17 th October 2023	Original report issued
2	18 th January 2024	Updated with additional 15.249 and 15B testing

UKAS Accredited:	1871
FCC Registered:	UK2006
KC Lab ID:	UK 1871
Canada CAB ID:	UK0005

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1.0 OVERVIEW

1.1 Introduction

The equipment under test (EUT) as described within this document was submitted for testing as agreed with the customer.

1.2 Objective

The purpose of the test was to measure and report the EUT against limits and methods of the requested standards as listed in section 2.0 Test Summary.

1.3 Product Modifications

None to sample submitted.

1.4 Conclusion

The EUT met the emission and immunity requirements of the tests defined in section 2.0 Test Summary.

This report relates to the sample tested and may not represent the entire population. It is valid only for the product identified, either in part or in full, to the standards and/or tests covered in this document.

1.5 EMC Test Lab Reference

Eurofins E&E UK Hursley Laboratory File: 4896

1.6 Test Deviations

None.

2.0 TEST SUMMARY

2.1 Summary

The EUT, as described and reported within this document, complies with the applied requested sections of the standards listed below.

The EUT met the emissions and immunity test requirements of the following standards:		
Description	Referenced Standard	Status
Radiated Emissions	FCC CFR 47 Part 15 (15.109, 15.209, 15.249) ANSI C63.4: 2013 + 4a:2017 ANSI C63.10: 2013 RSS-210 issue 10: 2019 RSS-GEN issue 5:2018 (Amendment 2: February 2021)	Pass
Occupied Bandwidth	FCC CFR 47 Part 15 (15.215) ANSI C63.10: 2013 RSS-GEN issue 5:2018 (Amendment 2: February 2021) AS/NZ 4268 Section 8.3.2	Pass

Note(s):

- The highest internal operating frequency declared by the manufacturer is 928 MHz.

3.0 EQUIPMENT AND TEST DETAILS

3.1 General

Product (EUT):	Electronic Shelf Tag		
Model Number (HVIN):	DD60-3A	Serial Numbers:	SN10000064C
Model Name (PMN):	Chroma Aeon 60		
FCC:	VC7-A001650		
IC:	8910A-A001650		
Hardware Version:	EDK711 A001D		
Software Version	See section 3.4 EUT Test Exerciser		
Sample Build:	Production Sample		
Modulation Type:	GFSK		
Number of Channels:	50		
Operating Frequency:	902.5 MHz ~ 927.5 MHz		
Channel Spacing:	500 kHz		
EUT Power:	Battery Power		
Customer Test Plan:	Not Applicable		
Alternate Models:	Not Applicable		
EUT Manufacturer:	Displaydata Limited		
Customer Name:	Displaydata Limited		
Customer Address:	Unit 12 Headley Park 10 Woodley Reading Berkshire RG5 4SW United Kingdom		
Test Commissioned By:	Andy Lee		
Date EUT Received:	5 th July 2023 and 9 th January 2024*		
Test Date(s):	5 th to 11 th July 2023 and 9 th to 11 th January 2024		
EMC Measurement Site:	Eurofins E&E UK Hursley Laboratory Trafalgar Close, Chandlers Ford, Hampshire, United Kingdom		
Product Category:	IT and Multimedia Electrical Equipment		

*The EUT was with the customer between 11th July 2023 and 9th January 2024.

3.2 EUT Description

The EUT is an Electronic Shelf Label operating in the 915MHz band for FCC and 866MHz band for EU.

3.3 Support Equipment

Description	Manufacturer	Model	Serial Number
Access point to set RF test Mode	Displaydata Limited	E2 Dynamic Communicator	ZC00018021

3.4 EUT Test Exerciser

In normal operation the ESL has an extremely low duty cycle. Therefore, to facilitate emissions testing, the ESL is loaded with special RF test software. Displaydata's 1.4.0 release of RF test software was used during the testing of the ESL.

By default, when running the RF test software, the ESL is idle, waiting for a test command to be sent from the laptop via the Dynamic Communicator.

Radiated Emissions testing:

The Dynamic Communicator / Laptop are used to send a command to the ESL which causes the ESL to continuously transmit a continuous (100% duty cycle) modulated carrier, using data rate of 100 kbps. The duration of the continuous modulated transmission is programmable. The duration of transmission is chosen to ensure that the modulated transmission continues for the length of each emissions scan.

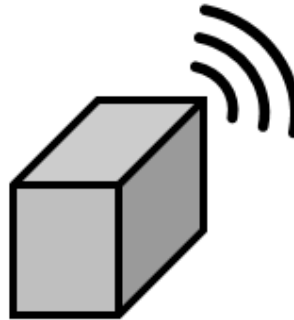
Radiated emissions testing was carried out on bottom, middle and top channels, 902.5MHz, 913.5MHz and 927.5 MHz respectively.

Idle Emissions testing:

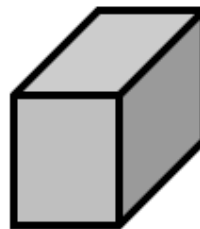
During Idle Emissions testing of the ESL, running the RF test software, is left in its idle state, there is no active transmission.

3.5 EUT Test Configuration #1

3.5.1 Transmit Mode



3.5.2 Idle Mode



4.0 TEST RESULTS

4.1 Radiated Emissions; Top Channel

4.1.1 Test Parameters

A profile scan was taken using a spectrum analyser continuously sweeping at a distance of three metres. A continuous turntable rotation from 0 degrees to 360 degrees was performed in both the vertical and horizontal polarisation of the field in a semi-anechoic chamber.

Using the pre-scan results as a guide, each emission from the EUT was maximised. Measurements were carried out at a distance of three metres using the specified detector in a CISPR 16-1-4 compliant semi-anechoic chamber. Antenna and turntable positions were then finally adjusted to produce the maximum emission levels. The worst-case results are reported below.

Test Equipment						
#ID	CP	Manufacturer	Type	Serial Number	Description	Calibration Due Date
750	1	Global	CISPR16	-	11 x 7 x 6.2m, Chamber (Jupiter)	19/12/2024
652	1	TFA	Weather Station	Jupiter	Weather Station	02/11/2024
788	1	Rohde & Schwarz	ESW44	101799	EMI Test Receiver (44GHz)	22/08/2024
877	1	Huber & Suhner	SUCOTEST_18A	602608/18A	ST_18A/Nm/Nm (3m)	08/11/2024
272	1	Sucoflex	106	72467-6	Cable SMA	31/10/2024
073	3	Schwarzbeck	BBHA9120B	237	Horn Antenna (1GHz - 10GHz)	20/05/2024
949	1	Wainwright Instruments	WHKX12-1290-1500-15000-80SS	SN 2	High Pass Filter (1.5GHz)	05/04/2024
821	0	York EMC	CNE	542	Comparison Noise Emitter	Not Required
823	0	York EMC	1.5 to 7GHz	CNE 6507	High Frequency Comparison Noise Emitter	Not Required
250	1	HP	8449B	3008A01077	Pre-amplifier (1 GHz - 26.5GHz)	06/03/2024
516	1	Suhner	Cable N-Type	-	Cable N-Type (for #250)	06/03/2024
949	1	Wainwright Instruments	WHKX12-1290-1500-15000-80SS	SN 2	High Pass Filter (1.5GHz)	05/04/2024
Test Equipment Software						
#ID	CP	Manufacturer	Type		Description	Calibration Due Date
856	0	Rohde & Schwarz	Software	0	EMC32 v11.30.0	Not required

Environmental Test Conditions		
Frequency	Below 1 GHz	Above 1 GHz
Temperature	16.3° Celsius	18.9° Celsius
Relative Humidity	33 %	28 %
Atmospheric Pressure	1032.5 millibars	1040.5 millibars
Test Date:	9 th January 2024	11 th January 2024
Test Engineer:	Graeme Lawler	Graeme Lawler

Note: "Calibration due date" means the instrument is certified within UKAS or traceable calibration certificate. "Internal" means the instrument is calibrated using Eurofins Hursley procedures. "Not required" means the asset does not require calibration. "CP" is the interval period [year] prescribed for external calibration.

4.1.2 Test Configuration

Please refer to EUT Test Configuration #1.

4.1.3 Set-up Photos

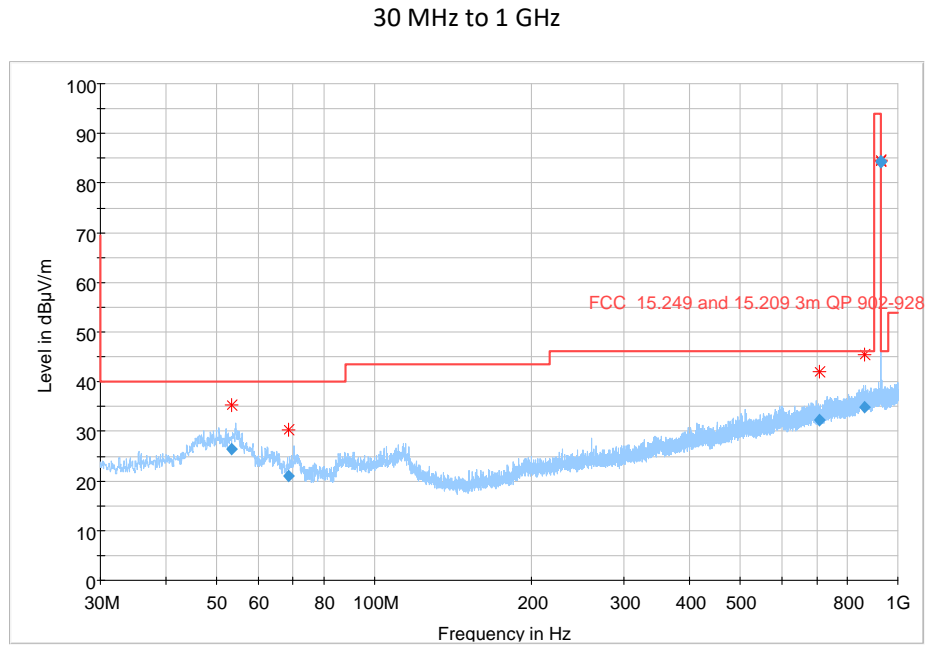
Radiated Emissions; Below 1 GHz



Radiated Emissions; Above 1 GHz



4.1.4 Profile; 30 MHz to 1 GHz, Top Channel
 Maximum peak hold trace with quasi-peak values (◆)
 Peak measurements (✱)



4.1.5 Data; 30 MHz to 1 GHz, Top Channel

Emission Frequency	Measured Quasi-Peak Value	FCC 15.249 Specified Quasi-Peak Limit	Pass Margin	Antenna Polarisation	Antenna Height	Turntable Azimuth	Status
MHz	dBµV/m	dBµV/m	dB	H/V	cm	deg	
53.414267	26.43	40.00	13.57	H	145.0	108.0	Pass
68.525901	21.02	40.00	18.98	H	125.0	222.0	Pass
709.198028	32.34	46.00	13.66	H	227.0	234.0	Pass
862.735622	34.91	46.00	11.09	V	333.0	292.0	Pass
928.000000	29.60	46.00	16.40	V	115.0	200.0	Pass
927.555030	84.37	94.00	9.63	V	115.0	200.0	Pass

V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC 15.249 limits and take into account the correction factor*. Measurements made according to the CISPR test standard and Eurofins Hursley test procedure RAD-01.
 *Correction factor (dB) = cable and antenna losses as summed positive values (dB) – pre-amp gain where applicable (dB).
 The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).
 Note: Path losses are factored into the limit value, and given by the test standard. Chamber calibration data contributes to the measurement uncertainty figure.

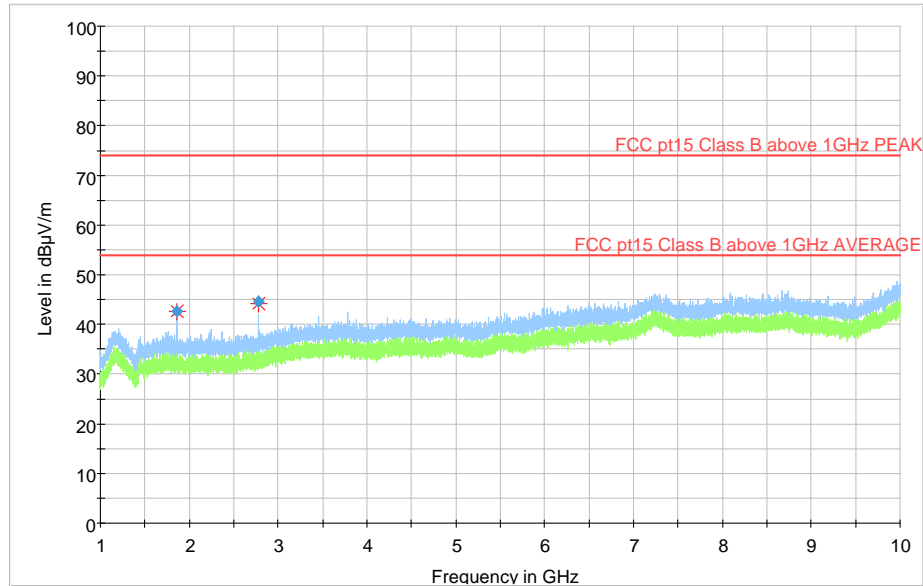
4.1.6 Profile; 1 to 10 GHz, Top Channel

Maximum hold trace with peak values (◆)

Peak measurements (✱)

Average measurements (◆)

1 to 10 GHz



4.1.7 Data; 1 to 10 GHz, Top Channel

Frequency	Peak	CISPR Average	FCC 15.249 Limit	Margin	Height	Pol	Azimuth	Corr.	Status
MHz	dBµV/m	dBµV/m	dBµV/m	dB	cm	H/V	Deg	dB/m	
1854.500000	42.65	---	74.00	31.35	201.0	H	145.0	-8.7	Pass
2782.500000	44.60	---	74.00	29.40	171.0	V	192.0	-6.9	Pass

V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC 15.249 limits and take into account the correction factor*. Measurements made according to the CISPR test standard and Eurofins Hursley test procedure RAD-01.

*Correction factor (dB) = cable and antenna losses as summed positive values (dB) – pre-amp gain where applicable (dB).

The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).

Note: path losses are factored into the limit value, and given by the test standard. Chamber calibration data contributes to the measurement uncertainty figure.

4.2 Radiated Emissions; Middle Channel

4.2.1 Test Parameters

A profile scan was taken using a spectrum analyser continuously sweeping at a distance of three metres. A continuous turntable rotation from 0 degrees to 360 degrees was performed in both the vertical and horizontal polarisation of the field in a semi-anechoic chamber.

Using the pre-scan results as a guide, each emission from the EUT was maximised. Measurements were carried out at a distance of three metres using the specified detector in a CISPR 16-1-4 compliant semi-anechoic chamber. Antenna and turntable positions were then finally adjusted to produce the maximum emission levels. The worst-case results are reported below.

Test Equipment						
#ID	CP	Manufacturer	Type	Serial Number	Description	Calibration Due Date
750	1	Global	CISPR16	-	11 x 7 x 6.2m, Chamber (Jupiter)	19/12/2024
652	1	TFA	Weather Station	Jupiter	Weather Station	02/11/2024
788	1	Rohde & Schwarz	ESW44	101799	EMI Test Receiver (44GHz)	22/08/2024
877	1	Huber & Suhner	SUCOTEST_18A	602608/18A	ST_18A/Nm/Nm (3m)	08/11/2024
272	1	Sucoflex	106	72467-6	Cable SMA	31/10/2024
073	3	Schwarzbeck	BBHA9120B	237	Horn Antenna (1GHz - 10GHz)	20/05/2024
949	1	Wainwright Instruments	WHKX12-1290-1500-15000-80SS	SN 2	High Pass Filter (1.5GHz)	05/04/2024
821	0	York EMC	CNE	542	Comparison Noise Emitter	Not Required
823	0	York EMC	1.5 to 7GHz	CNE 6507	High Frequency Comparison Noise Emitter	Not Required
250	1	HP	8449B	3008A01077	Pre-amplifier (1 GHz - 26.5GHz)	06/03/2024
516	1	Suhner	Cable N-Type	-	Cable N-Type (for #250)	06/03/2024
949	1	Wainwright Instruments	WHKX12-1290-1500-15000-80SS	SN 2	High Pass Filter (1.5GHz)	05/04/2024
Test Equipment Software						
#ID	CP	Manufacturer	Type		Description	Calibration Due Date
856	0	Rohde & Schwarz	Software	0	EMC32 v11.30.0	Not required

Environmental Test Conditions		
Frequency	Below 1 GHz	Above 1 GHz
Temperature	16.3° Celsius	18.9° Celsius
Relative Humidity	33 %	28 %
Atmospheric Pressure	1032.5 millibars	1040.5 millibars
Test Date:	9 th January 2024	11 th January 2024
Test Engineer:	Graeme Lawler	Graeme Lawler

Note: "Calibration due date" means the instrument is certified within UKAS or traceable calibration certificate. "Internal" means the instrument is calibrated using Eurofins Hursley procedures. "Not required" means the asset does not require calibration. "CP" is the interval period [year] prescribed for external calibration.

4.2.2 Test Configuration

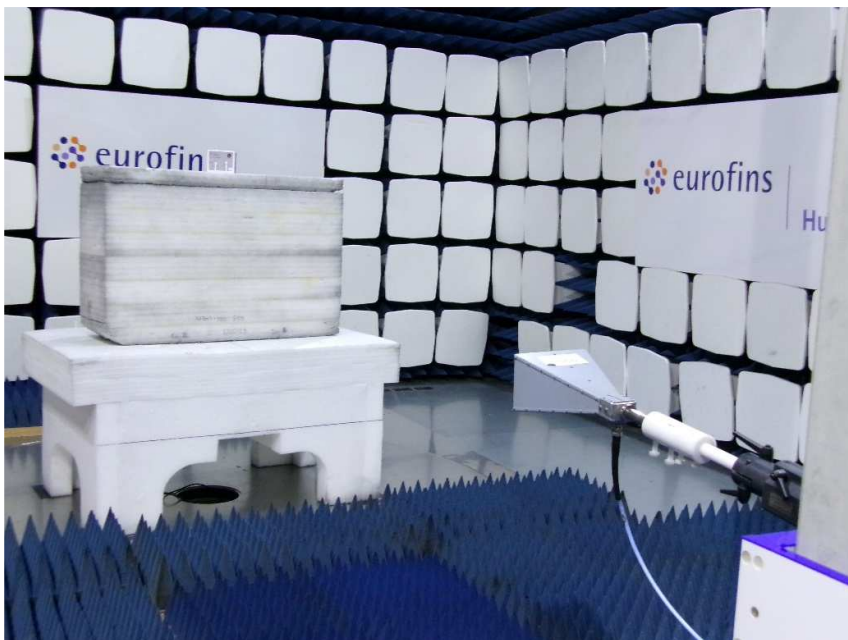
Please refer to EUT Test Configuration #1.

4.2.3 Set-up Photos

Radiated Emissions; Below 1 GHz

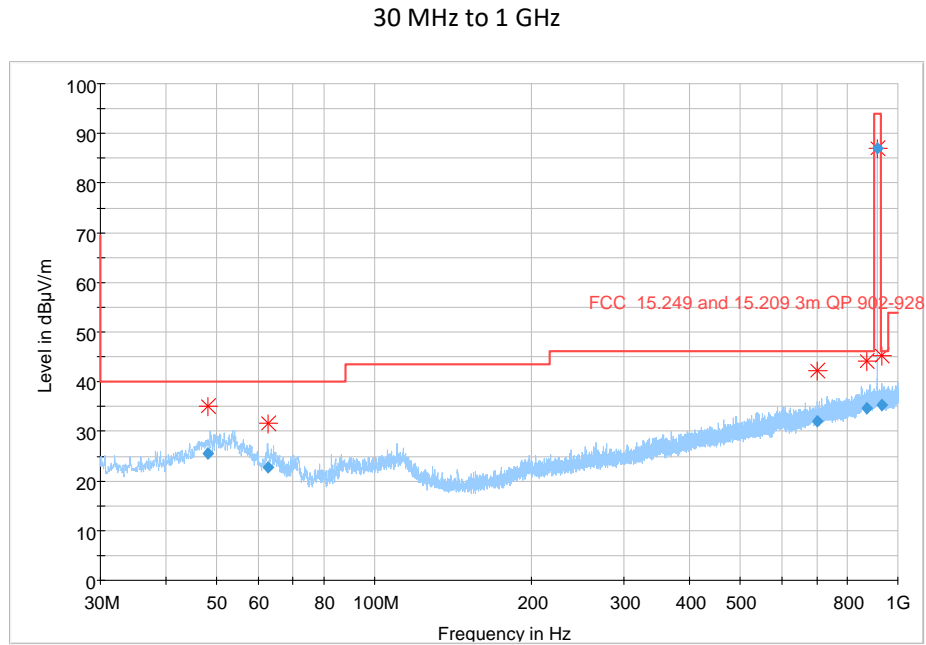


Radiated Emissions; Above 1 GHz



4.2.4 Profile; 30 MHz to 1 GHz, Middle Channel

Maximum peak hold trace with quasi-peak values (◆)
 Peak measurements (✱)



4.2.5 Data; 30 MHz to 1 GHz, Middle Channel

Emission Frequency	Measured Quasi-Peak Value	FCC 15.249 Specified Quasi-Peak Limit	Pass Margin	Antenna Polarisation	Antenna Height	Turntable Azimuth	Status
MHz	dBµV/m	dBµV/m	dB	H/V	cm	deg	
48.181881	25.65	40.00	14.35	H	199.0	87.0	Pass
62.840096	22.66	40.00	17.34	H	128.0	100.0	Pass
700.794826	31.93	46.00	14.07	V	194.0	301.0	Pass
872.156056	34.66	46.00	11.34	V	355.0	356.0	Pass
913.457730	86.92	94.00	7.08	V	115.0	199.0	Pass
933.013699	35.35	46.00	10.65	H	100.0	161.0	Pass

V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC 15.249 limits and take into account the correction factor*. Measurements made according to the CISPR test standard and Eurofins Hursley test procedure RAD-01.
 *Correction factor (dB) = cable and antenna losses as summed positive values (dB) – pre-amp gain where applicable (dB).
 The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).
 Note: Path losses are factored into the limit value, and given by the test standard. Chamber calibration data contributes to the measurement uncertainty figure.

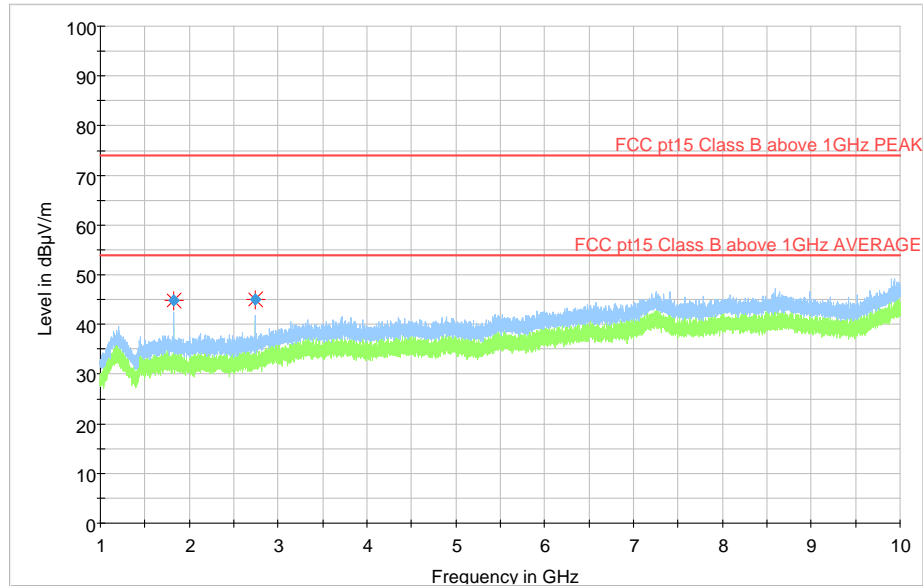
4.2.6 Profile; 1 to 10 GHz, Middle Channel

Maximum hold trace with peak values (◆)

Peak measurements (✱)

Average measurements (◆)

1 to 10 GHz



4.2.7 Data; 1 to 10 GHz, Middle Channel

Frequency	Peak	CISPR Average	FCC 15.249 Limit	Margin	Height	Pol	Azimuth	Corr.	Status
MHz	dBµV/m	dBµV/m	dBµV/m	dB	cm	H/V	Deg	dB/m	
1827.000000	44.87	---	74.00	29.13	160.0	H	144.0	-8.7	Pass
2740.500000	45.00	---	74.00	29.00	138.0	H	198.0	-7.1	Pass

V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC 15.249 limits and take into account the correction factor*. Measurements made according to the CISPR test standard and Eurofins Hursley test procedure RAD-01.

*Correction factor (dB) = cable and antenna losses as summed positive values (dB) – pre-amp gain where applicable (dB).

The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).

Note: path losses are factored into the limit value, and given by the test standard. Chamber calibration data contributes to the measurement uncertainty figure.

4.3 Radiated Emissions; Bottom Channel

4.3.1 Test Parameters

A profile scan was taken using a spectrum analyser continuously sweeping at a distance of three metres. A continuous turntable rotation from 0 degrees to 360 degrees was performed in both the vertical and horizontal polarisation of the field in a semi-anechoic chamber.

Using the pre-scan results as a guide, each emission from the EUT was maximised. Measurements were carried out at a distance of three metres using the specified detector in a CISPR 16-1-4 compliant semi-anechoic chamber. Antenna and turntable positions were then finally adjusted to produce the maximum emission levels. The worst-case results are reported below.

Test Equipment						
#ID	CP	Manufacturer	Type	Serial Number	Description	Calibration Due Date
750	1	Global	CISPR16	-	11 x 7 x 6.2m, Chamber (Jupiter)	19/12/2024
652	1	TFA	Weather Station	Jupiter	Weather Station	02/11/2024
788	1	Rohde & Schwarz	ESW44	101799	EMI Test Receiver (44GHz)	22/08/2024
877	1	Huber & Suhner	SUCOTEST_18A	602608/18A	ST_18A/Nm/Nm (3m)	08/11/2024
272	1	Sucoflex	106	72467-6	Cable SMA	31/10/2024
073	3	Schwarzbeck	BBHA9120B	237	Horn Antenna (1GHz - 10GHz)	20/05/2024
949	1	Wainwright Instruments	WHKX12-1290-1500-15000-80SS	SN 2	High Pass Filter (1.5GHz)	05/04/2024
821	0	York EMC	CNE	542	Comparison Noise Emitter	Not Required
823	0	York EMC	1.5 to 7GHz	CNE 6507	High Frequency Comparison Noise Emitter	Not Required
250	1	HP	8449B	3008A01077	Pre-amplifier (1 GHz - 26.5GHz)	06/03/2024
516	1	Suhner	Cable N-Type	-	Cable N-Type (for #250)	06/03/2024
949	1	Wainwright Instruments	WHKX12-1290-1500-15000-80SS	SN 2	High Pass Filter (1.5GHz)	05/04/2024
Test Equipment Software						
#ID	CP	Manufacturer	Type		Description	Calibration Due Date
856	0	Rohde & Schwarz	Software	0	EMC32 v11.30.0	Not required

Environmental Test Conditions		
Frequency	Below 1 GHz	Above 1 GHz
Temperature	16.3° Celsius	18.9° Celsius
Relative Humidity	33 %	28 %
Atmospheric Pressure	1032.5 millibars	1040.5 millibars
Test Date:	9 th January 2024	11 th January 2024
Test Engineer:	Graeme Lawler	Graeme Lawler

Note: "Calibration due date" means the instrument is certified within UKAS or traceable calibration certificate. "Internal" means the instrument is calibrated using Eurofins Hursley procedures. "Not required" means the asset does not require calibration. "CP" is the interval period [year] prescribed for external calibration.

4.3.2 Test Configuration

Please refer to EUT Test Configuration #1.

4.3.3 Set-up Photos

Radiated Emissions; Below 1 GHz

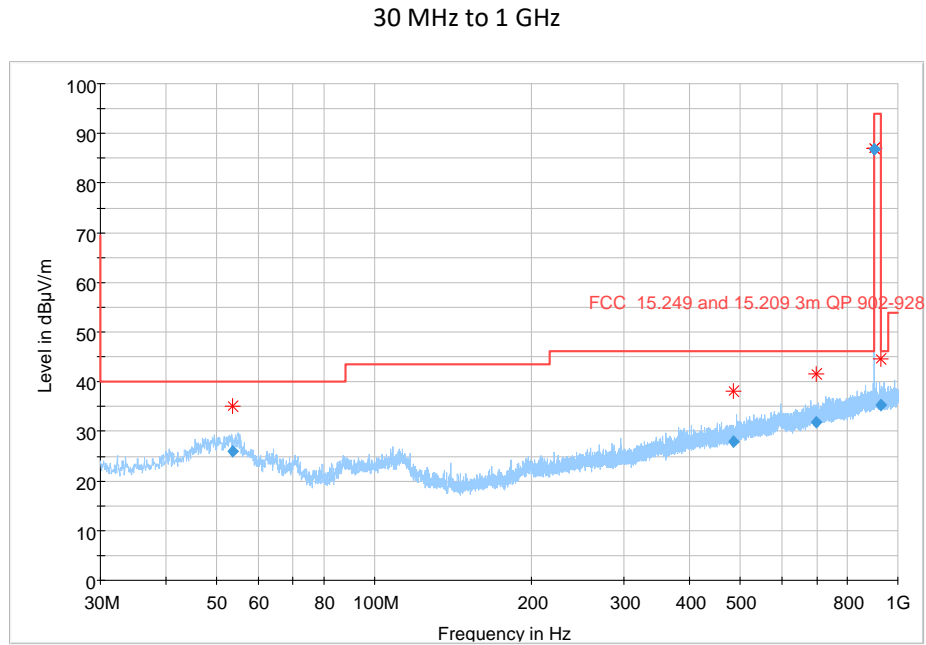


Radiated Emissions; Above 1 GHz



4.3.4 Profile; 30 MHz to 1 GHz, Bottom Channel

Maximum peak hold trace with quasi-peak values (◆)
 Peak measurements (✱)



4.3.5 Data; 30 MHz to 1 GHz, Bottom Channel

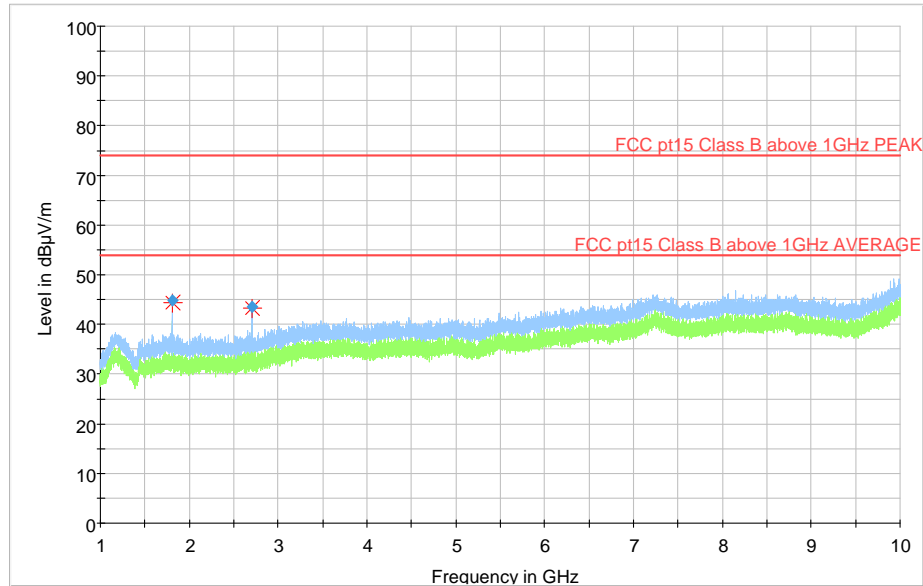
Emission Frequency	Measured Quasi-Peak Value	FCC 15.249 Specified Quasi-Peak Limit	Pass Margin	Antenna Polarisation	Antenna Height	Turntable Azimuth	Status
MHz	dBµV/m	dBµV/m	dB	H/V	cm	deg	
53.752614	25.88	40.00	14.12	H	122.0	117.0	Pass
486.244629	27.93	46.00	18.07	H	139.0	331.0	Pass
696.802308	31.88	46.00	14.12	V	115.0	306.0	Pass
902.462979	86.87	94.00	7.13	V	120.0	197.0	Pass
902.000000	29.50	46.00	16.50	V	120.0	197.0	Pass
927.492560	35.35	94.00	58.65	H	277.0	144.0	Pass

V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC 15.249 limits and take into account the correction factor*. Measurements made according to the CISPR test standard and Eurofins Hursley test procedure RAD-01.
 *Correction factor (dB) = cable and antenna losses as summed positive values (dB) – pre-amp gain where applicable (dB).
 The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).
 Note: Path losses are factored into the limit value, and given by the test standard. Chamber calibration data contributes to the measurement uncertainty figure.

- 4.3.6 Profile; 1 to 10 GHz, Bottom Channel
 - Maximum hold trace with peak values (◆)
 - Peak measurements (✱)
 - Average measurements (◆)

1 to 10 GHz



4.3.7 Data; 1 to 10 GHz, Bottom Channel

Frequency	Peak	CISPR Average	FCC 15.249 Limit	Margin	Height	Pol	Azimuth	Corr.	Status
MHz	dBµV/m	dBµV/m	dBµV/m	dB	cm	H/V	Deg	dB/m	
1805.000000	44.79	---	74.00	29.21	167.0	V	174.0	-8.7	Pass
2707.000000	43.56	---	74.00	30.44	233.0	H	191.0	-7.2	Pass

V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC 15.249 limits and take into account the correction factor*. Measurements made according to the CISPR test standard and Eurofins Hursley test procedure RAD-01.

*Correction factor (dB) = cable and antenna losses as summed positive values (dB) – pre-amp gain where applicable (dB).

The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).

Note: path losses are factored into the limit value, and given by the test standard. Chamber calibration data contributes to the measurement uncertainty figure.

4.4 Radiated Emissions; Idle Channel

4.4.1 Test Parameters

A profile scan was taken using a spectrum analyser continuously sweeping at a distance of three metres. A continuous turntable rotation from 0 degrees to 360 degrees was performed in both the vertical and horizontal polarisation of the field in a semi-anechoic chamber.

Using the pre-scan results as a guide, each emission from the EUT was maximised. Measurements were carried out at a distance of three metres using the specified detector in a CISPR 16-1-4 compliant semi-anechoic chamber. Antenna and turntable positions were then finally adjusted to produce the maximum emission levels. The worst-case results are reported below.

Test Equipment						
#ID	CP	Manufacturer	Type	Serial Number	Description	Calibration Due Date
750	1	Global	CISPR16	-	11 x 7 x 6.2m, Chamber (Jupiter)	19/12/2024
652	1	TFA	Weather Station	Jupiter	Weather Station	02/11/2024
788	1	Rohde & Schwarz	ESW44	101799	EMI Test Receiver (44GHz)	22/08/2024
877	1	Huber & Suhner	SUCOTEST_18A	602608/18A	ST_18A/Nm/Nm (3m)	08/11/2024
272	1	Sucoflex	106	72467-6	Cable SMA	31/10/2024
073	3	Schwarzbeck	BBHA9120B	237	Horn Antenna (1GHz - 10GHz)	20/05/2024
949	1	Wainwright Instruments	WHKX12-1290-1500-15000-80SS	SN 2	High Pass Filter (1.5GHz)	05/04/2024
821	0	York EMC	CNE	542	Comparison Noise Emitter	Not Required
823	0	York EMC	1.5 to 7GHz	CNE 6507	High Frequency Comparison Noise Emitter	Not Required
250	1	HP	8449B	3008A01077	Pre-amplifier (1 GHz - 26.5GHz)	06/03/2024
516	1	Suhner	Cable N-Type	-	Cable N-Type (for #250)	06/03/2024
949	1	Wainwright Instruments	WHKX12-1290-1500-15000-80SS	SN 2	High Pass Filter (1.5GHz)	05/04/2024
Test Equipment Software						
#ID	CP	Manufacturer	Type		Description	Calibration Due Date
856	0	Rohde & Schwarz	Software	0	EMC32 v11.30.0	Not required

Environmental Test Conditions		
Frequency	Below 1 GHz	Above 1 GHz
Temperature	16.3° Celsius	18.9° Celsius
Relative Humidity	33 %	28 %
Atmospheric Pressure	1032.5 millibars	1040.5 millibars
Test Date:	9 th January 2024	11 th January 2024
Test Engineer:	Graeme Lawler	Graeme Lawler

Note: "Calibration due date" means the instrument is certified within UKAS or traceable calibration certificate. "Internal" means the instrument is calibrated using Eurofins Hursley procedures. "Not required" means the asset does not require calibration. "CP" is the interval period [year] prescribed for external calibration.

4.4.2 Test Configuration

Please refer to EUT Test Configuration #1.

4.4.3 Set-up Photos

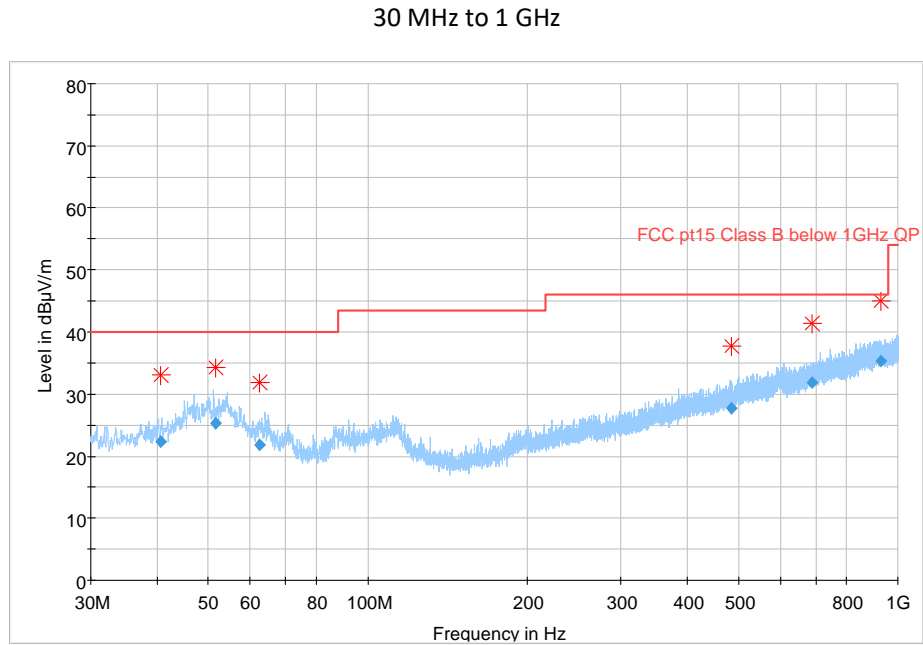
Radiated Emissions; Below 1 GHz



Radiated Emissions; Above 1 GHz



4.4.4 Profile; 30 MHz to 1 GHz, Idle Channel
 Maximum peak hold trace with quasi-peak values (◆)
 Peak measurements (✱)



4.4.5 Data; 30 MHz to 1 GHz, Idle Channel

Emission Frequency	Measured Quasi-Peak Value	FCC 15.249 Specified Quasi-Peak Limit	Pass Margin	Antenna Polarisation	Antenna Height	Turntable Azimuth	Status
MHz	dBµV/m	dBµV/m	dB	H/V	cm	deg	
40.619657	22.39	40.00	17.61	H	244.0	264.0	Pass
51.661516	25.24	40.00	14.76	H	122.0	322.0	Pass
62.501700	21.78	40.00	18.22	H	396.0	198.0	Pass
484.110340	27.73	46.00	18.27	V	118.0	227.0	Pass
687.810927	31.88	46.00	14.12	H	386.0	343.0	Pass
926.170820	35.24	46.00	10.76	H	353.0	342.0	Pass

V = Vertical / H = Horizontal

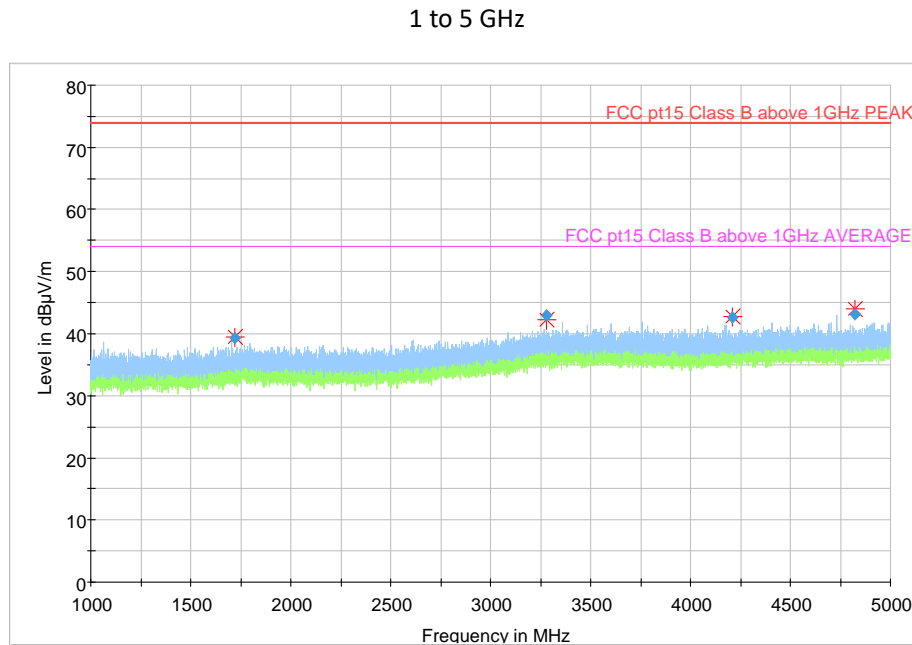
The measurements reported are the highest emissions relative to the FCC 15.249 limits and take into account the correction factor*. Measurements made according to the CISPR test standard and Eurofins Hursley test procedure RAD-01.
 *Correction factor (dB) = cable and antenna losses as summed positive values (dB) – pre-amp gain where applicable (dB).
 The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).
 Note: Path losses are factored into the limit value, and given by the test standard. Chamber calibration data contributes to the measurement uncertainty figure.

4.4.6 Profile; 1 to 5 GHz, Idle Channel

Maximum hold trace with peak values (◆)

Peak measurements (✱)

Average measurements (◆)



4.4.7 Data; 1 to 5 GHz, Idle Channel

Frequency	Peak	CISPR Average	FCC 15.249 Limit	Margin	Height	Pol	Azimuth	Corr.	Status
MHz	dBµV/m	dBµV/m	dBµV/m	dB	cm	H/V	Deg	dB/m	
1721.979943	39.28	---	74.00	34.72	118.0	V	105.0	-8.9	Pass
3278.436246	42.91	---	74.00	31.09	400.0	H	189.0	-4.8	Pass
4207.781500	42.68	---	74.00	31.32	224.0	V	65.0	-3.0	Pass
4825.061727	43.12	---	74.00	30.88	371.0	V	340.0	-2.8	Pass

V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC 15.249 limits and take into account the correction factor*. Measurements made according to the CISPR test standard and Eurofins Hursley test procedure RAD-01.

*Correction factor (dB) = cable and antenna losses as summed positive values (dB) – pre-amp gain where applicable (dB).

The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).

Note: path losses are factored into the limit value, and given by the test standard. Chamber calibration data contributes to the measurement uncertainty figure.

4.5 Occupied Bandwidth; ISED

4.5.1 Test Parameters

Test Equipment						
#ID	CP	Manufacturer	Type	Serial Number	Description	Calibration Due Date
456	1	Rohde & Schwarz	ESCI7	1144573407	EMI test receiver	30/08/2023
647	1	TFA	Weather Station	Saturn	Weather Station	02/11/2023
751	1	ETS	CISPR16	1	10 x 6 x 6m, chamber	25/05/2024

Environmental Test Conditions	
Temperature	23.4° Celsius
Relative Humidity	51%
Atmospheric Pressure	1011.3 millibars
Test Date:	11 th July 2023
Test Engineer:	Graeme Lawler

Note: "Calibration due date" means the instrument is certified within UKAS or traceable calibration certificate. "Internal" means the instrument is calibrated using Eurofins Hursley procedures. "Not required" means the asset does not require calibration. "CP" is the interval period [year] prescribed for external calibration.

4.5.2 Test Configuration

Please refer to EUT Test Configuration #1.

4.5.3 Occupied Bandwidth; ISED

RSS GEN Clause 6.7

The output from the measuring antenna was fed into the input of the ESW44 spectrum analyser/receiver. The bandwidth of the transmitter was measured with an ESW44 analyser set to 99% Occupied Bandwidth with a peak detector on max hold. The resolution bandwidth, span and video bandwidth are indicated on the occupied bandwidth plot (modulated) included with this report.

In TX mode with a 100kbps data rate the bandwidth of the modulated transmitter signal was measured.

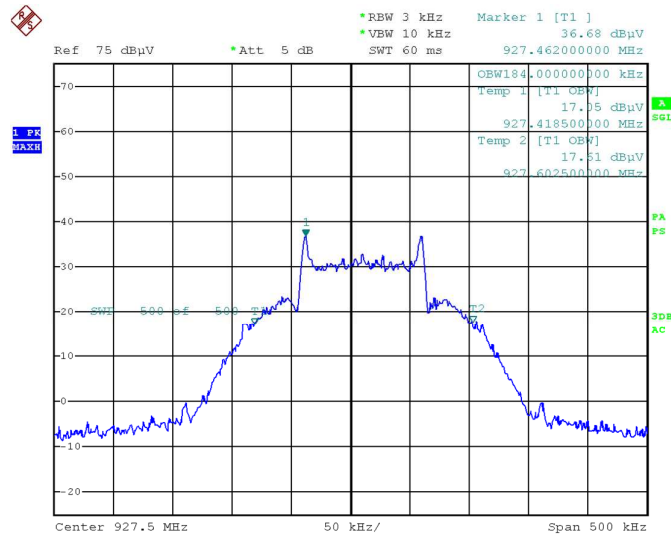
4.5.4 Set-up Photos

Occupied Bandwidth



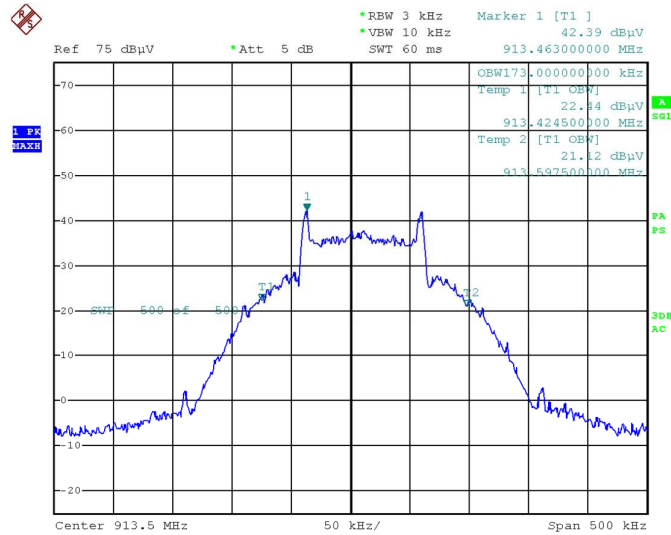
4.5.5 Profiles; ISED

Top channel
 184.000 kHz



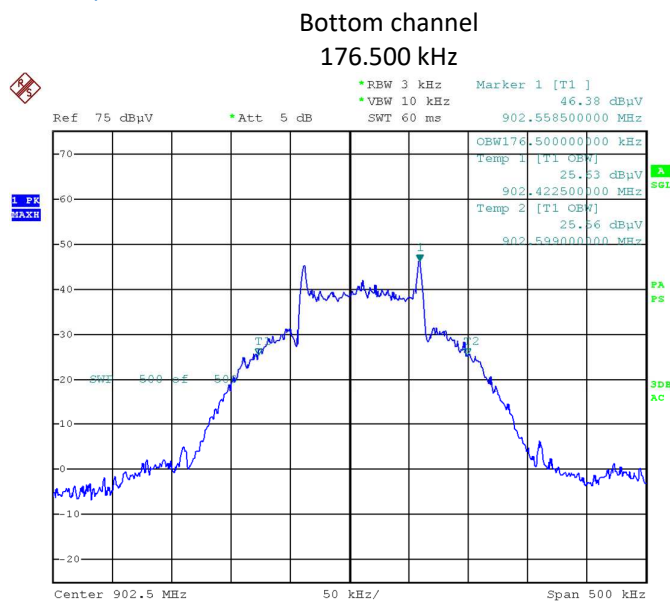
Date: 11.JUL.2023 09:16:12

Middle channel
 173.000 kHz



Date: 11.JUL.2023 09:07:57

4.5.6 Profiles; ISED (Continued)



Date: 11.JUL.2023 08:58:23

4.6 20 dB Bandwidth; FCC

4.6.1 Test Parameters

Test Equipment						
#ID	CP	Manufacturer	Type	Serial Number	Description	Calibration Due Date
456	1	Rohde & Schwarz	ESCI7	1144573407	EMI test receiver	30/08/2023
647	1	TFA	Weather Station	Saturn	Weather Station	02/11/2023
751	1	ETS	CISPR16	1	10 x 6 x 6m, chamber	25/05/2024

Environmental Test Conditions	
Temperature	23.4° Celsius
Relative Humidity	51%
Atmospheric Pressure	1011.3 millibars
Test Date:	11 th July 2023
Test Engineer:	Graeme Lawler

Note: "Calibration due date" means the instrument is certified within UKAS or traceable calibration certificate. "Internal" means the instrument is calibrated using Eurofins Hursley procedures. "Not required" means the asset does not require calibration. "CP" is the interval period [year] prescribed for external calibration.

4.6.2 Test Configuration

Please refer to EUT Test Configuration #1.

4.6.3 20 dB Bandwidth; FCC

FCC Clause 15.215

The output from the measuring antenna was fed into the input of the ESW 44 spectrum analyser/receiver. The 20 dB bandwidth of the transmitter was measured with an ESW 44 analyser trace with a peak detector on max hold. Markers were set either side of the trace 20dB down from the peak. The 20 dB Bandwidth is the difference in frequency between these two markers. The resolution bandwidth, span and video bandwidth are indicated on the 20dB bandwidth plot (modulated) included with this report.

In TX mode with a 100kbps data rate the bandwidth of the modulated transmitter signal was measured.

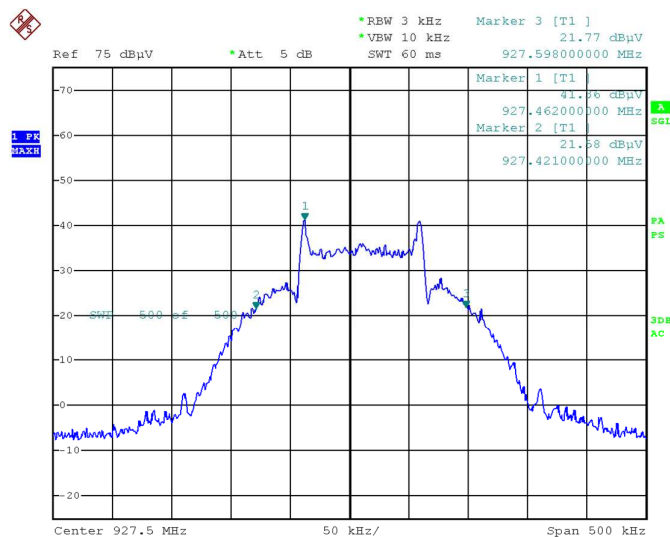
4.6.4 Set-up Photos

20 dB Bandwidth



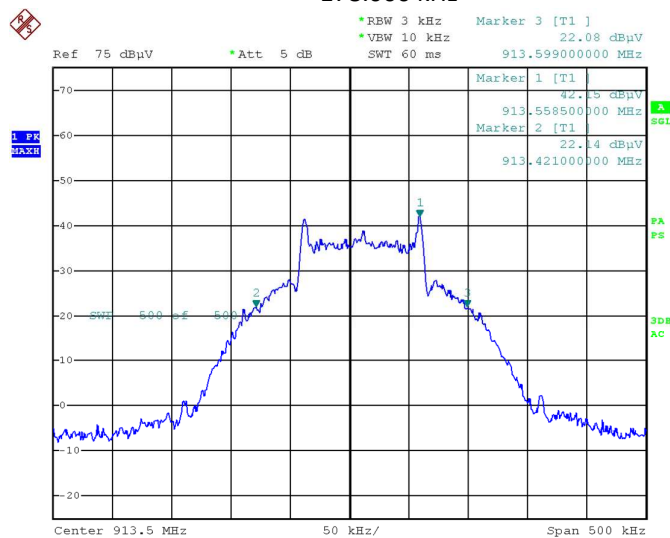
4.6.5 Profiles; FCC

Top channel
 177.000 kHz



Date: 11.JUL.2023 09:18:45

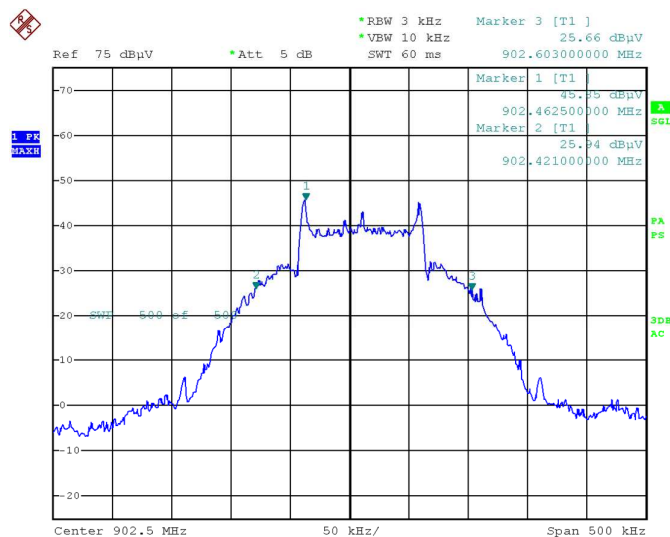
Middle channel
 178.000 kHz



Date: 11.JUL.2023 09:06:42

4.6.6 Profiles; FCC (Continued)

Bottom channel
 182.000 kHz



Date: 11.JUL.2023 09:00:50

4.7 Occupied Bandwidth; AS/NZ

4.7.1 Test Parameters

Test Equipment						
#ID	CP	Manufacturer	Type	Serial Number	Description	Calibration Due Date
456	1	Rohde & Schwarz	ESCI7	1144573407	EMI test receiver	30/08/2023
647	1	TFA	Weather Station	Saturn	Weather Station	02/11/2023
751	1	ETS	CISPR16	1	10 x 6 x 6m, chamber	25/05/2024

Environmental Test Conditions	
Temperature	23.4° Celsius
Relative Humidity	51%
Atmospheric Pressure	1011.3 millibars
Test Date:	11 th July 2023
Test Engineer:	Graeme Lawler

Note: “Calibration due date” means the instrument is certified within UKAS or traceable calibration certificate. “Internal” means the instrument is calibrated using Eurofins Hursley procedures. “Not required” means the asset does not require calibration. “CP” is the interval period [year] prescribed for external calibration.

4.7.2 Test Configuration

Please refer to EUT Test Configuration #1.

4.7.3 Occupied Bandwidth; As/Nz

AS/NZ 4268 Section 8.3.2

The output from the measuring antenna was fed into the input of the ESW 44 spectrum analyser/receiver. The bandwidth of the transmitter was measured with an ESW 44 analyser set to 99% Occupied Bandwidth with an RMS detector on max hold. The resolution bandwidth, span and video bandwidth are indicated on the occupied bandwidth plot (modulated) included with this report.

In TX mode with a 100kbps data rate the bandwidth of the modulated transmitter signal was measured.

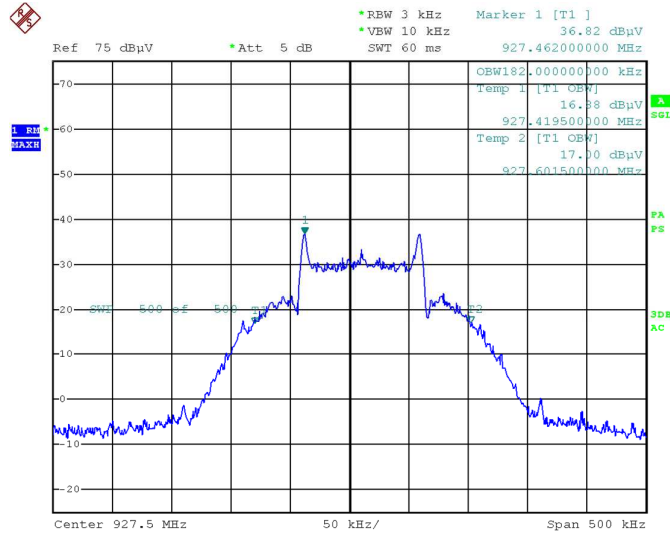
4.7.4 Set-up Photos

Occupied Bandwidth



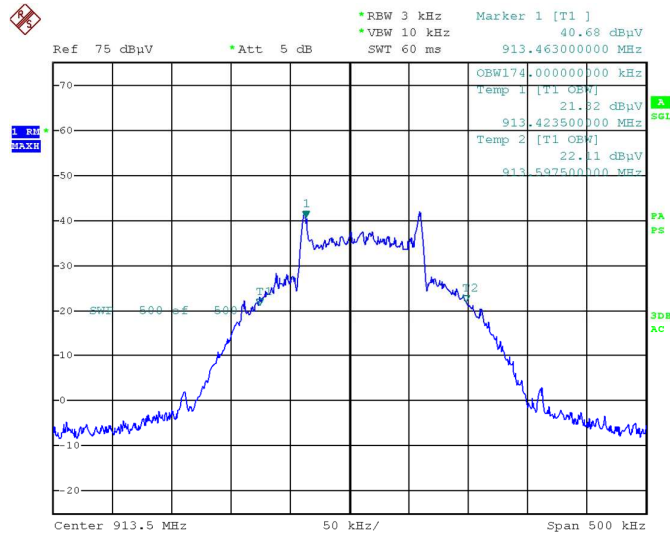
4.7.5 Profiles; AS/NZ

Top channel
 182.000 kHz



Date: 11.JUL.2023 09:14:38

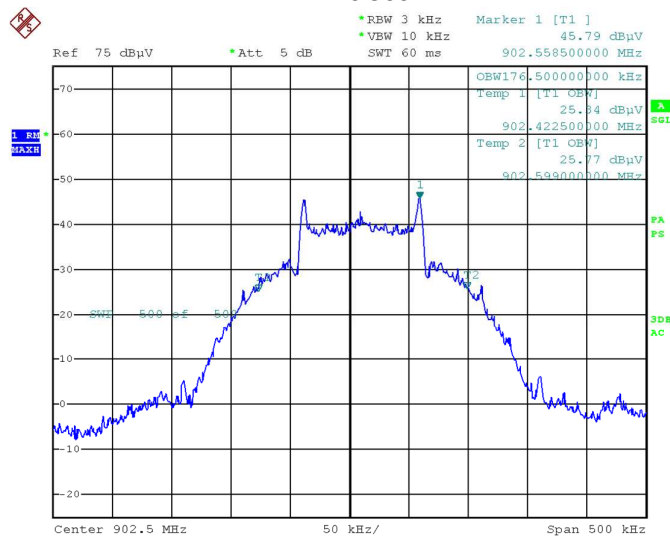
Middle channel
 174.000 kHz



Date: 11.JUL.2023 09:08:53

4.7.6 Profiles; AS/NZ (Continued)

Bottom channel
 176.500 kHz



Date: 11.JUL.2023 08:57:11

5.0 MEASUREMENT UNCERTAINTIES

Emissions tests

For all emissions tests, measurement uncertainties have been calculated in line with the requirements of CISPR 16-4-2 to give a confidence level of greater than 95 %. In all cases the laboratories calculated uncertainty values (known as U_{lab}) are equal to or are less than the expected uncertainty values contained in CISPR 16-4-2 (known as U_{cispr}). Below is a list of the laboratories calculated measurement uncertainties:

Conducted emissions:

Via AMN/LISN:	±3.27 dB (9 kHz – 150 kHz), ±3.27 dB (150 kHz – 30 MHz)
Via AAN/ISN:	±5.00 dB (150 kHz – 30 MHz)
Via CVP:	±3.47 dB (150 kHz – 30 MHz)
Via CP:	±2.69 dB (150 kHz – 30 MHz)
Via 100 Ω:	±2.68 dB (150 kHz – 30 MHz)
Clicks:	±2.83 dB (150 kHz – 30 MHz)
Harmonics:	±1.42 % (100 Hz – 2 kHz)
Flicker:	±1.76 % (worst case for all parameters)

Radiated emissions:

H-Field:	±2.84 dB (9 kHz – 3 MHz), ±2.92 dB (3 MHz – 30 MHz)
D = 3.0 m (Horizontal):	±3.91 dB (30 MHz – 1 GHz SAC), ±3.82 dB (30 MHz – 1 GHz FAC)
D = 3.0 m (Vertical):	±5.22 dB (30 MHz – 1 GHz SAC), ±3.82 dB (30 MHz – 1 GHz FAC)
D = 3.0 m:	±5.13 dB (1 GHz – 6 GHz SAC), ±5.15 dB (1 GHz – 10 GHz SAC), ±3.64 dB (10 GHz – 18 GHz SAC), ±3.10 dB (18 GHz – 40 GHz SAC), ±3.05 dB (1 GHz – 6 GHz FAC)

Radiated spurious emissions (RSE):

±1.71 dB (30 MHz – 1 GHz), ±1.81 dB (1 – 12.75 GHz), ±2.07 dB (12.75 – 18 GHz)

Immunity tests

For IEC 61000-4-2, IEC 61000-4-4, IEC 61000-4-5, IEC 61000-4-8, IEC 61000-4-9, IEC 61000-4-11 tests, the following applies:

Measurement uncertainty has been calculated or calibrated for the various required parameters to provide a confidence level of 95 % (k=2). These parameters have been compared to the basic standard tolerance requirements for each of the various parameters.

In all cases the calculated or calibrated uncertainty meets the basic standard requirements.

For IEC 61000-4-3, IEC 61000-4-6 tests, the following applies:

Measurement uncertainty has been calculated to provide a confidence level of 95 %, or k=2, but this has not been applied to the applied test level, therefore the applied test level has an uncertainty of ±50 %. This is in accordance with CENELEC and other international guidance.

In the case of Maritime equipment tested to EN/IEC 60945, there is a specific requirement that the applied test level be increased by the calculated measurement uncertainty. This is done by applying a coverage factor of k=1.64, which provides a 95 % confidence that the applied test level has been achieved.

Test Results - Decision Rules

As the decision is generally inherent in the standard for Commercial EMC a simple acceptance rule can be applied. The following statement will be added to EMC quotes and reports. "The Decision Rule is applied on the basis of CISPR16-4-2 and/or EN61000-4-x (TR61000-1-6) These standards provide guidance on how to calculate and apply measurement uncertainty whilst providing maximum uncertainties allowance. Due consideration will also be given to JCGM 106:2012, ILAC-G8:09/2019 and LAB 48. This laboratory has demonstrated by calibrating its equipment and facilities, and calculating its own uncertainties, that it complies with the above requirements and therefore no allowance of uncertainties has been given to the tolerances." Where a result is considered marginal in respect of its proximity to the limit line, for example, the customer would be made aware of situation so that they can make an informed decision on how to proceed.