EMC Test Report	
For:	**Senceive Limited**
Product:	**Mesh Radio**
Model:	**EdgeHub FM3G-LTE**
	
Project Engineer:	**Richard Pennell**
	
Approval Signatory:	**Dan Tiroke**

Document Reference:	**3912 FR**

Issue Number:	**Date:**	**Test Report Revisions History:**
1	13th April 2022	Original Report Issued

UKAS Accredited:	1871
FCC Registered:	UK2006
KC Lab ID:	UK1871
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&S Hursley File: 3912
Customer Test Plan: SC_SEN_TP15_A

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** test requirements of the following standards:			
Description	**General Standard**	**Referenced Standard**	**Status**
Radiated Emissions	FCC/CFR 47: Part 15B 15.109 and 15.107	ANSI C63.4:2014, Class A	Pass
Conducted Emissions	FCC/CFR 47: Part 15.247 and 15.209	ANSI C63.10:2013	Pass

Note(s):

- The highest internal operating frequency declared by the manufacturer is 2475MHz.

3.0 EQUIPMENT AND TEST DETAILS

3.1 General

Product (EUT):	Mesh Radio		
Model:	EdgeHub FM3G-LTE	**Serial Number:**	2AMFBFM3H
Sample Build:	Production Sample		
EUT Power:	110V/60Hz		
Customer Test Plan:	SC_SEN_TP15_A		
Alternate Models:	Not Applicable		
EUT Manufacturer:	Senceive Limited		
Customer Name:	Senceive Limited		
Customer Address:	7B / 7C Imperial Studios		
	Imperial Road		
	Fulham		
	London		
	SW6 2AG		
	United Kingdom		
Test Commissioned By:	Charlie Blackham (Sulis Consultants)		
Date EUT Received:	17th March 2022		
Test Date(s):	17th March 2022		
EMC Measurement Site:	Eurofins E&S Hursley Limited		
	Trafalgar Close, Chandlers Ford, Hampshire, United Kingdom		
Product Category:	Wireless Measurement Equipment		

3.2 EUT Description

The EUT is a Mesh Radio used for monitoring civil engineering works. The EUT operates inside the 2400 to 2483.5MHz band with a single bandwidth and single modulation.

3.3 Support Equipment

Description	Manufacturer	Model	Serial Number
Antenna	Not Applicable	External Connectorised 4.0 dBi	Not Applicable
DC Power Supply	Not Applicable	XP Power VEC40US24	11-21050004-29529
Camera	Senceive	4G Camera	112764

3.4 EUT Test Exerciser

The EUT was configured with test firmware that transmitted continuously with a 100% duty cycle.

3.5 EUT Test Configuration #1

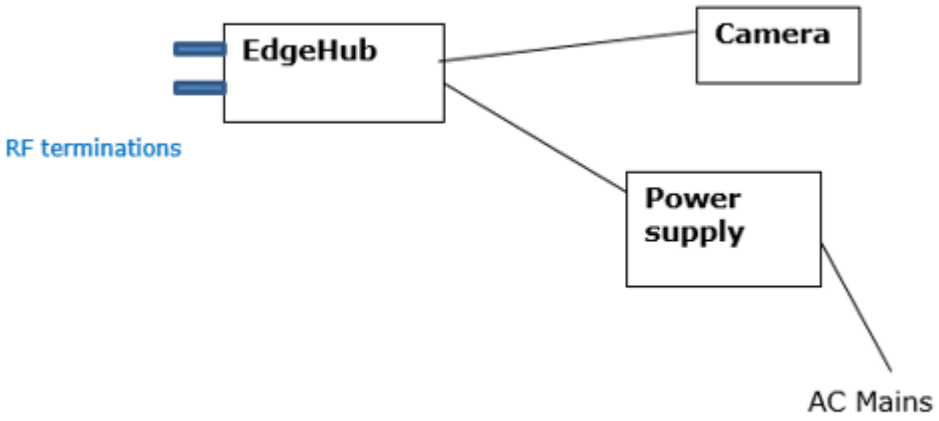


Figure 2: Test Configuration (radiated tests)

4.0 TEST RESULTS

4.1 Radiated Emissions

4.1.1 Test Parameters

A profile scan was taken using an EMI receiver at a distance of three metres on eight azimuths of the EUT 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. Cable 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
053	1	HP	8449B	3008A01394	Pre-amplifier (1.0-26.5GHz) (with #516)	19/10/2022
073	3	Schwarzbeck	BBHA9120B	237	Horn antenna (1-10GHz)	20/05/2024
399	3	Q-par Angus	WBH18-40k	10300	18 to 40GHz Horn	18/06/2022
676	3	Schwarzbeck	BBHA 9120 C	576	2-18GHz Horn	20/05/2024
750	1	Global	CISPR16	1	11 x 7 x 6.2m, chamber	14/12/2022
762	3	Schwarzbeck	VULB9162	129	30-7000MHz	04/03/2024
762a	3	Schwarzbeck	DGA 9552N	0	6dB attenuator for #762	04/03/2024
893	1	Rohde & Schwarz	ESW44	103044	EMI test receiver	24/09/2022
Test Equipment Software						
#ID	CP	Manufacturer	Type		Description	Calibration Due Date
856	0	Rohde & Schwarz	Software	0	EMC32 v10.50.10	Not required

Environmental Test Conditions	
Temperature	18° Celsius
Relative Humidity	49%
Atmospheric Pressure	1034.7 millibars
Test Date:	17th March 2022
Test Engineer:	Richard Pennell

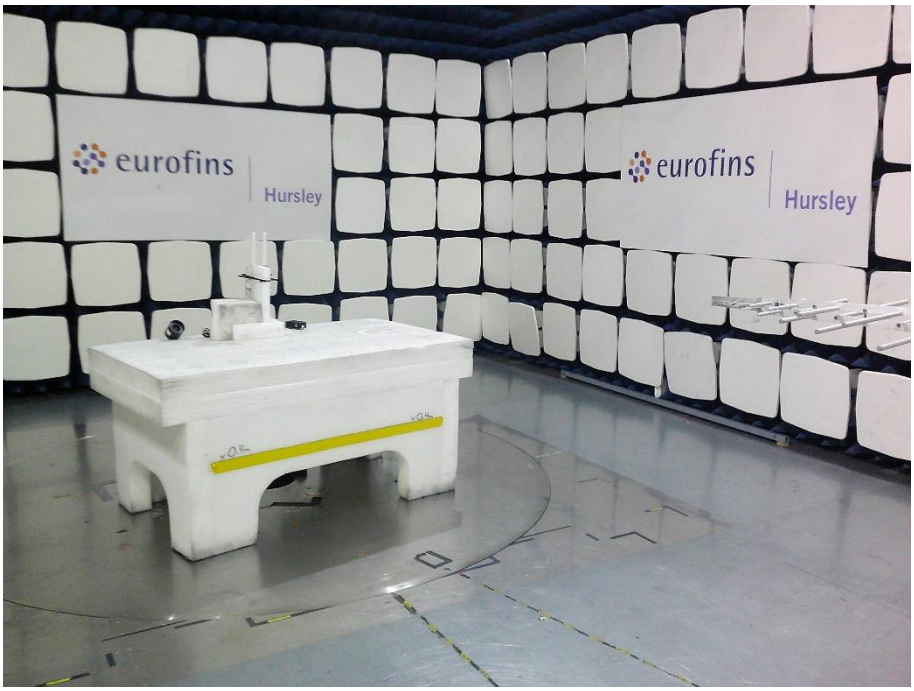
Note: “Calibration due date” means the instrument is certified within UKAS or traceable calibration certificate. “Internal” means the instrument is calibrated using Eurofins Hursley procedures. “Not required” means the asset does not require calibration. “CP” is the interval period [year] prescribed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

4.1.2 Test Configuration

Please refer to EUT Test Configuration #1.

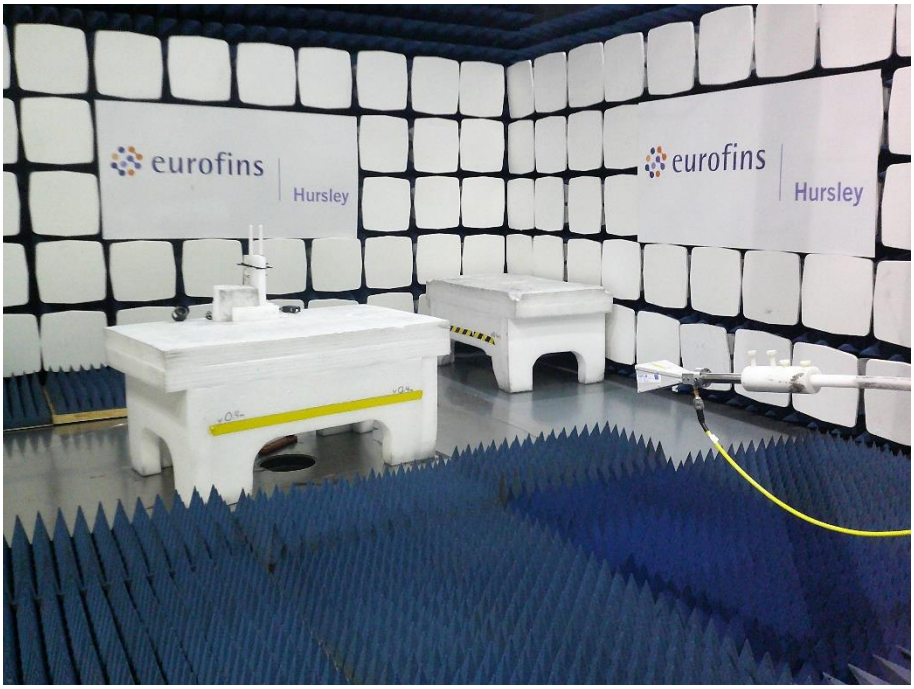
4.1.3 Set-up Photos

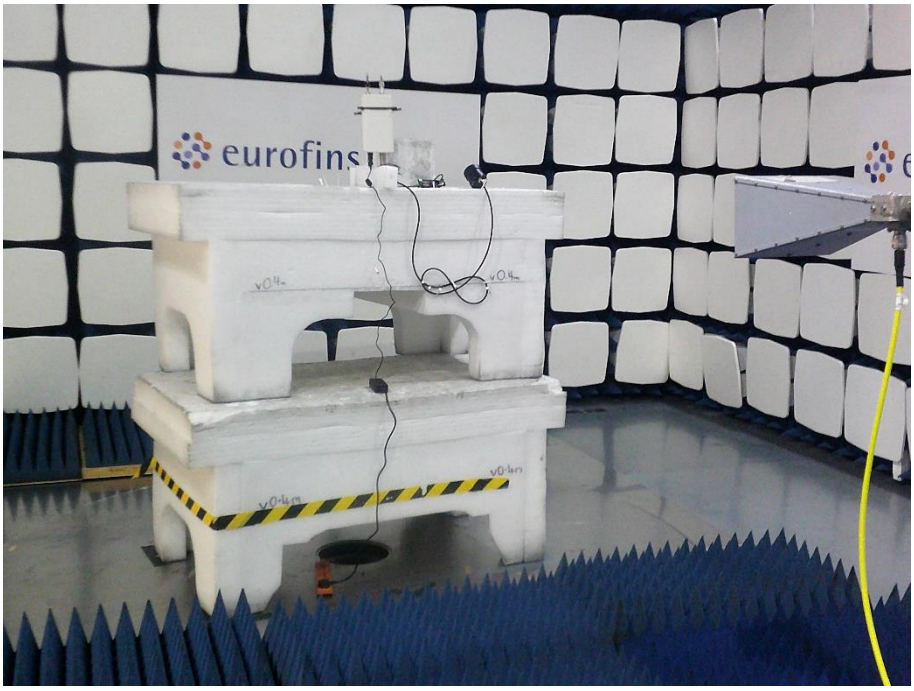
Radiated Emissions; Below 1GHz



4.1.4 Set-up Photos (Continued)

Radiated Emissions; Above 1GHz



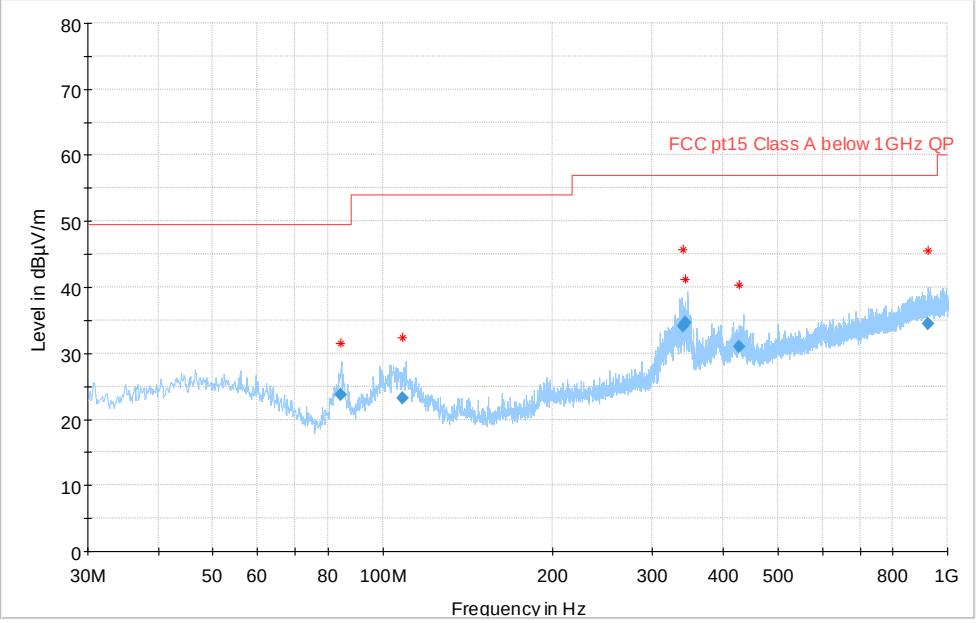


4.2 Radiated Emissions, 30MHz to 1GHz (Continued)

4.2.1 Profile; 30MHz to 1GHz, Receive

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

30MHz to 1GHz



4.2.2 Data; 30MHz to 1GHz, Receive

Emission Frequency	Measured Quasi-Peak Value	Class A Specified Quasi-Peak Limit	Pass Margin	Antenna Polarisation	Antenna Height	Turntable Azimuth	
MHz	dBµV/m	dBµV/m	dB	H/V	cm	deg	Status
84.009161	23.66	49.60	25.94	V	123.0	211.0	Pass
108.560223	23.22	54.00	30.78	V	172.0	5.0	Pass
340.119010	34.13	56.90	22.77	H	119.0	182.0	Pass
342.682779	34.71	56.90	22.19	H	100.0	171.0	Pass
427.129984	30.96	56.90	25.94	H	100.0	226.0	Pass
922.556320	34.39	56.90	22.51	V	288.0	276.0	Pass

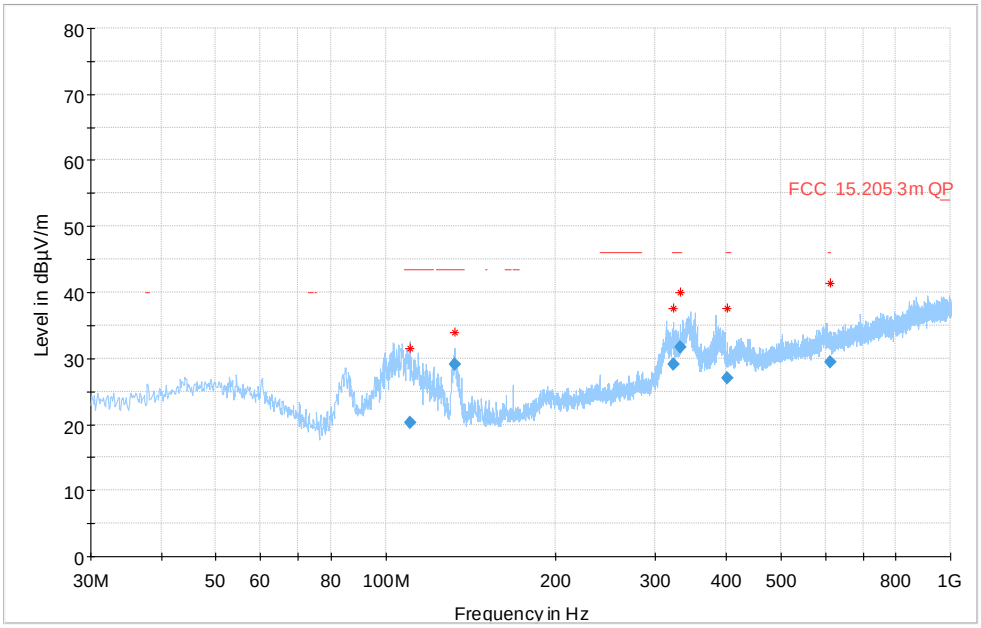
V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC Class A limits and take into account the correction factor*. Measurements made according to the ANSI C63.4 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.

4.2.3 Profile; 30MHz to 1GHz, Middle Channel

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

30MHz to 1GHz



4.2.4 Data; 30MHz to 1GHz, Middle Channel

Emission Frequency	Measured Quasi-Peak Value	Class A Specified Quasi-Peak Limit	Pass Margin	Antenna Polarisation	Antenna Height	Turntable Azimuth	
MHz	dBµV/m	dBµV/m	dB	H/V	cm	deg	Status
110.510000	20.30	43.50	23.20	V	297.0	117.0	Pass
132.577500	29.16	43.50	14.34	V	119.0	266.0	Pass
322.940000	29.15	46.00	16.85	H	100.0	160.0	Pass
332.155000	31.71	46.00	14.29	H	106.0	188.0	Pass
402.480000	26.94	46.00	19.06	V	244.0	70.0	Pass
613.576250	29.51	46.00	16.49	H	109.0	98.0	Pass

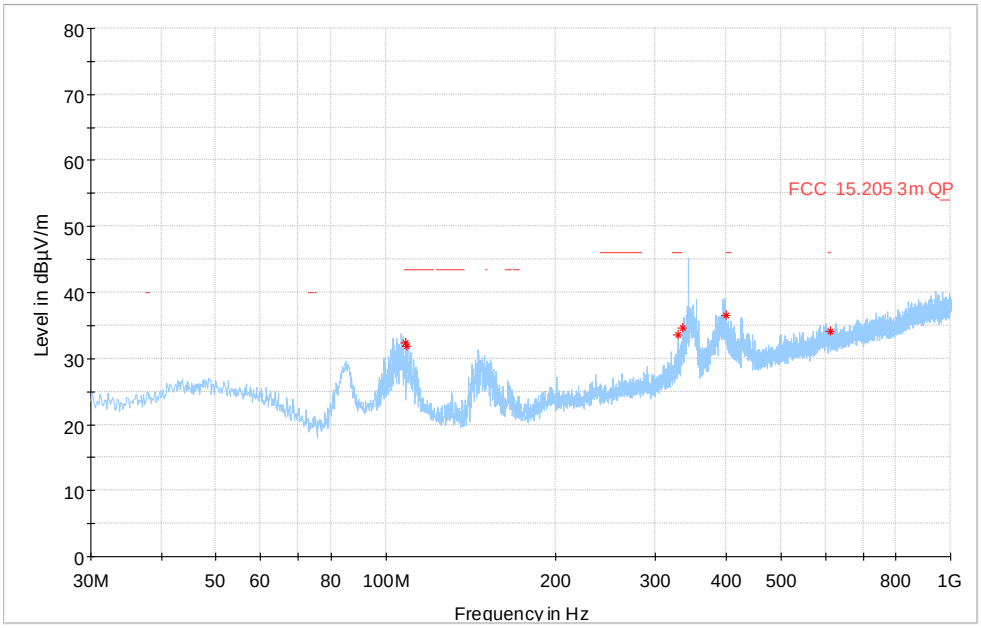
V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the 15.209 limit as per 15.205 and take into account the correction factor*. Measurements made according to the ANSI C63.10 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.

4.2.5 Profile; 30MHz to 1GHz, Bottom Channel

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

30MHz to 1GHz



4.2.6 Data; 30MHz to 1GHz, Bottom Channel

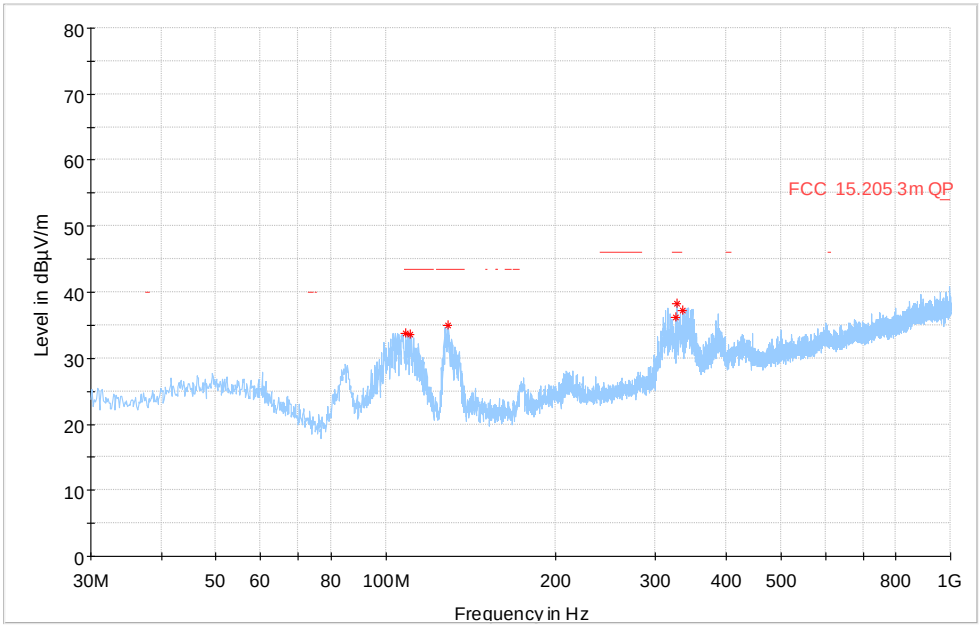
The measurements reported are the highest emissions relative to the 15.209 limit as per 15.205 and take into account the correction factor*. Measurements made according to ANSI C63.10 and Eurofins Hursley test procedure RAD-01.
Final measurements have been presented for middle channel which was worst case

*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.

4.2.7 Profile; 30 to 1000MHz, Top Channel

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

30 to 1000MHz



4.2.8 Data, 30 to 1000MHz, Top Channel

The measurements reported are the highest emissions relative to the 15.209 limit as per 15.205 and take into account the correction factor*. Measurements made according to ANSI C63.10 and Eurofins Hursley test procedure RAD-01.
Final measurements have been presented for middle channel which was worst case

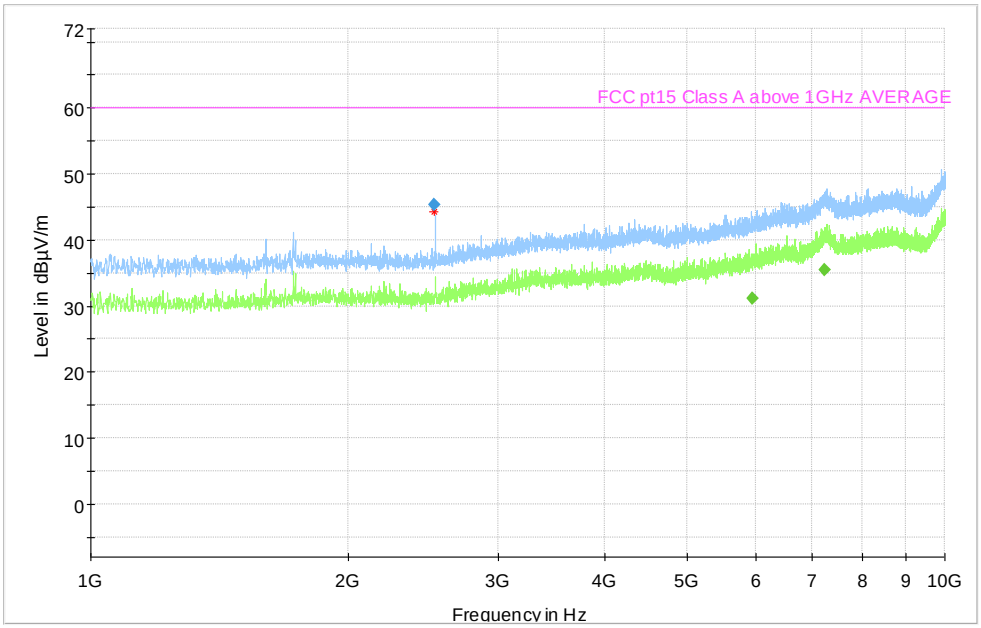
*Correction factor (dB) = cable and antenna losses as summed positive values (dB) – pre-amp gain where applicable (dB).
The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).
Note: Path losses are factored into the limit value, and given by the test standard. Chamber calibration data contributes to the measurement uncertainty figure.

4.3 Radiated Emissions, 1 to 10GHz (Continued)

4.3.1 Profile; 1 to 10GHz, Receive

Maximum hold trace with peak values (◆)
Peak measurements (✳)
Average measurements (◆)

1 to 10GHz



4.3.2 Data; 1 to 10GHz, Receive

Frequency	Peak	CISPR Average	Class A Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/m	dBµV/m	dBµV/m	dB	cm	H/V	Deg	dB/m	Status
2526.758205	45.39	---	80.00	34.61	109.0	V	183.0	-6.6	Pass
5947.851168	---	31.20	60.00	28.80	262.0	H	299.0	1.1	Pass
7240.293781	---	35.41	60.00	24.59	318.0	V	178.0	5.0	Pass

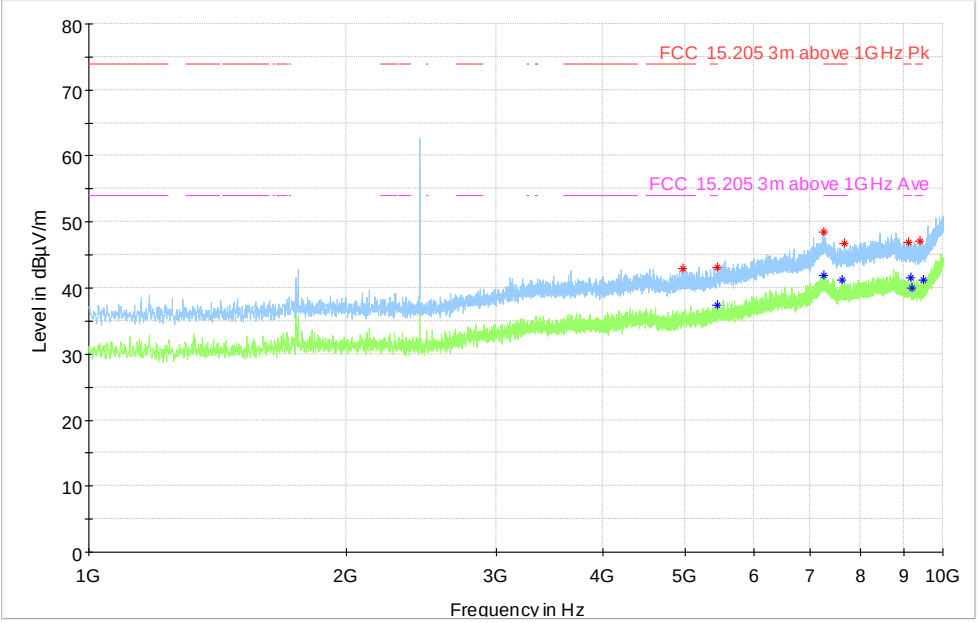
V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC Class A limits and take into account the correction factor*. Measurements made according to ANSI C63.4 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.

4.3.3 Profile; 1 to 10GHz, Middle Channel

Maximum hold trace with peak values (◆)
Peak measurements (✳)
Average measurements (◆)

1 to 10GHz



4.3.4 Data; 1 to 10GHz, Middle Channel

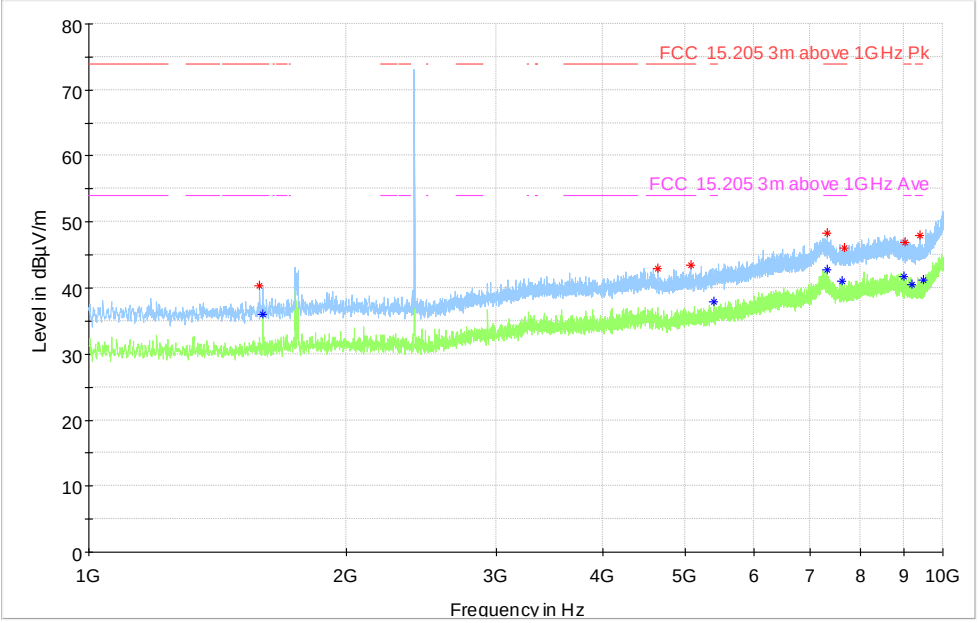
The measurements reported are the highest emissions relative to the 15.209 limit as per 15.205 and take into account the correction factor*. Measurements made according to ANSI C63.10 and Eurofins Hursley test procedure RAD-01.
Final measurements have been presented for top channel which was worst case

*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 10GHz, Bottom Channel

Maximum hold trace with peak values (◆)
Peak measurements (✳)
Average measurements (◆)

1 to 10GHz



4.3.7 Data; 1 to 10GHz, Bottom Channel

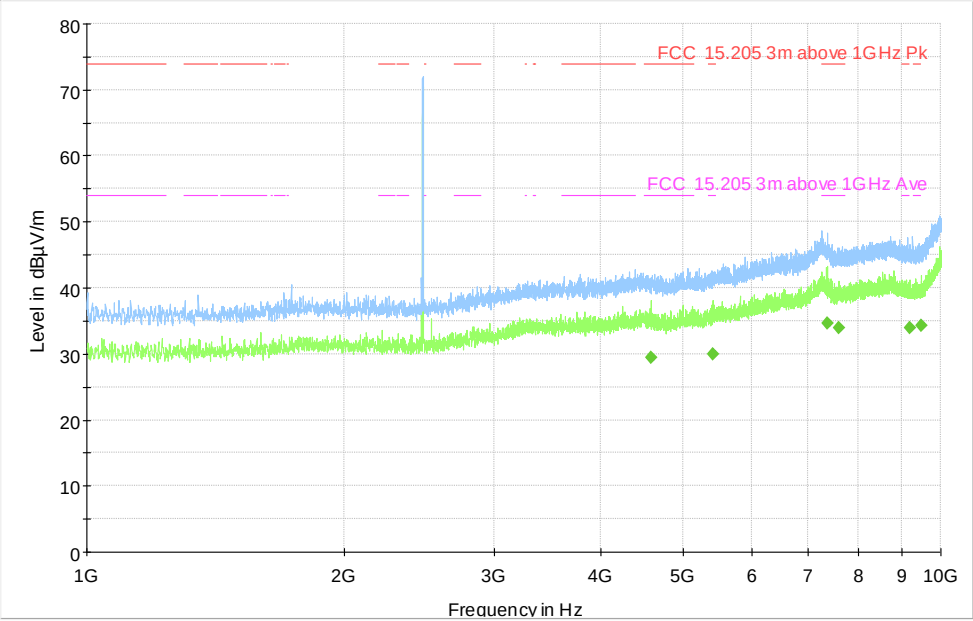
The measurements reported are the highest emissions relative to the 15.209 limit as per 15.205 and take into account the correction factor*. Measurements made according to ANSI C63.10 and Eurofins Hursley test procedure RAD-01.
Final measurements have been presented for top channel which was worst case#

*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.

4.3.8 Profile; 1 to 10GHz, Top Channel

Maximum hold trace with peak values (◆)
Peak measurements (✳)
Average measurements (◆)

1 to 10GHz



4.3.9 Data; 1 to 10GHz, Top Channel

Frequency	Peak	CISPR Average	Class A Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/m	dBµV/m	dBµV/m	dB	cm	H/V	Deg	dB/m	Status
4583.125000	---	29.37	54.00	24.63	136.0	H	5.0	-1.3	Pass
5414.500000	---	30.03	54.00	23.97	105.0	H	160.0	0.1	Pass
7364.125000	---	34.64	54.00	19.36	119.0	H	49.0	4.2	Pass
7586.875000	---	33.90	54.00	20.10	158.0	H	316.0	3.2	Pass
9195.625000	---	33.99	54.00	20.01	381.0	H	8.0	2.7	Pass
9499.375000	---	34.37	54.00	19.63	119.0	V	210.0	2.8	Pass

V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the 15.209 limit as per 15.205 and take into account the correction factor*. Measurements made according to ANSI C63.10 and Eurofins Hursley test procedure RAD-01.

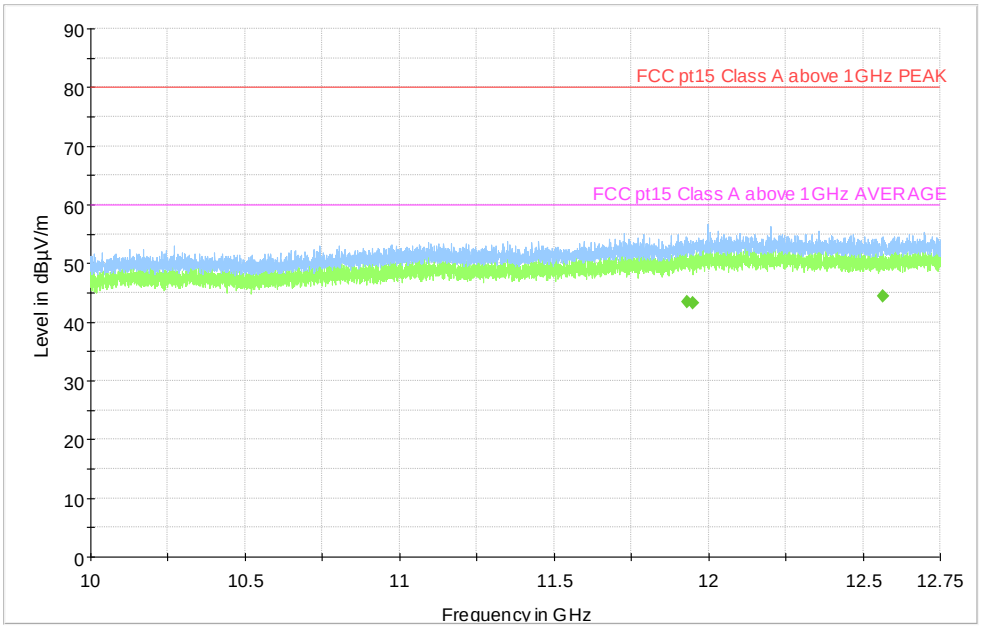
*Correction factor (dB) = cable and antenna losses as summed positive values (dB) – pre-amp gain where applicable (dB).
The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).
Note: path losses are factored into the limit value, and given by the test standard. Chamber calibration data contributes to the measurement uncertainty figure.

4.4 Radiated Emissions, 10 to 12.75GHz (Continued)

4.4.1 Profile; 10 to 12.75GHz, Receive

Maximum hold trace with peak values (◆)
Peak measurements (✳)
Average measurements (◆)

10 to 12.75GHz



4.4.2 Data; 10 to 12.75GHz, Receive

Frequency	Peak	CISPR Average	Class A Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/m	dBµV/m	dBµV/m	dB	cm	H/V	Deg	dB/m	Status
11929.89563	---	43.44	60.00	16.56	215.0	H	3.0	12.4	Pass
11948.62134	---	43.30	60.00	16.70	237.0	V	305.0	12.5	Pass
12566.15116	---	44.34	60.00	15.66	138.0	V	132.0	13.4	Pass

V = Vertical / H = Horizontal

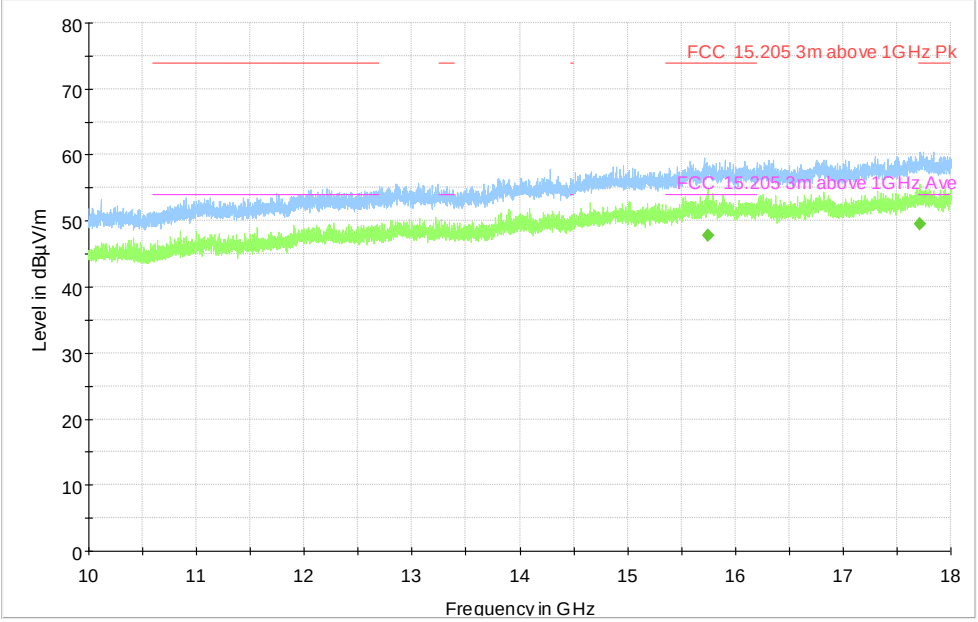
The measurements reported are the highest emissions relative to the FCC Class A limits and take into account the correction factor*. Measurements made according to the ANSI C63.4 test standard and Eurofins Hursley test procedure RAD-01.
*Correction factor (dB) = cable and antenna losses as summed positive 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 Radiated Emissions, 10 to 18GHz (Continued)

4.5.1 Profile; 10 to 18GHz, Middle Channel

Maximum hold trace with peak values (▽)
Maximum hold trace with average values (▼)

10 to 18GHz



4.5.2 Data; 10 to 18GHz, Middle Channel

Frequency	Peak	CISPR Average	Class A Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/m	dBµV/m	dBµV/m	dB	cm	H/V	Deg	dB/m	Status
15743.00000	---	47.78	54.00	6.22	167.0	H	272.0	16.8	Pass
17715.00000	---	49.51	54.00	4.49	215.0	H	271.0	19.2	Pass

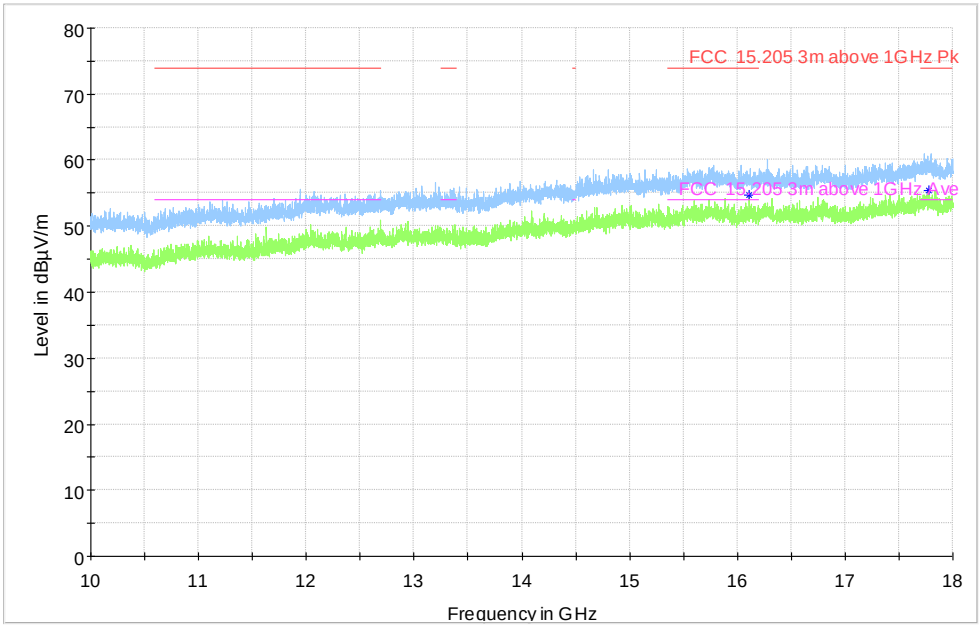
V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the 15.209 limit as per 15.205 limits and take into account the correction factor*. Measurements made according to the ANSI C63.10 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.

4.5.3 Profile; 10 to 18GHz, Bottom Channel

Maximum hold trace with peak values (▽)
Maximum hold trace with average values (▼)

10 to 18GHz



4.5.4 Data; 10 to 18GHz, Bottom Channel

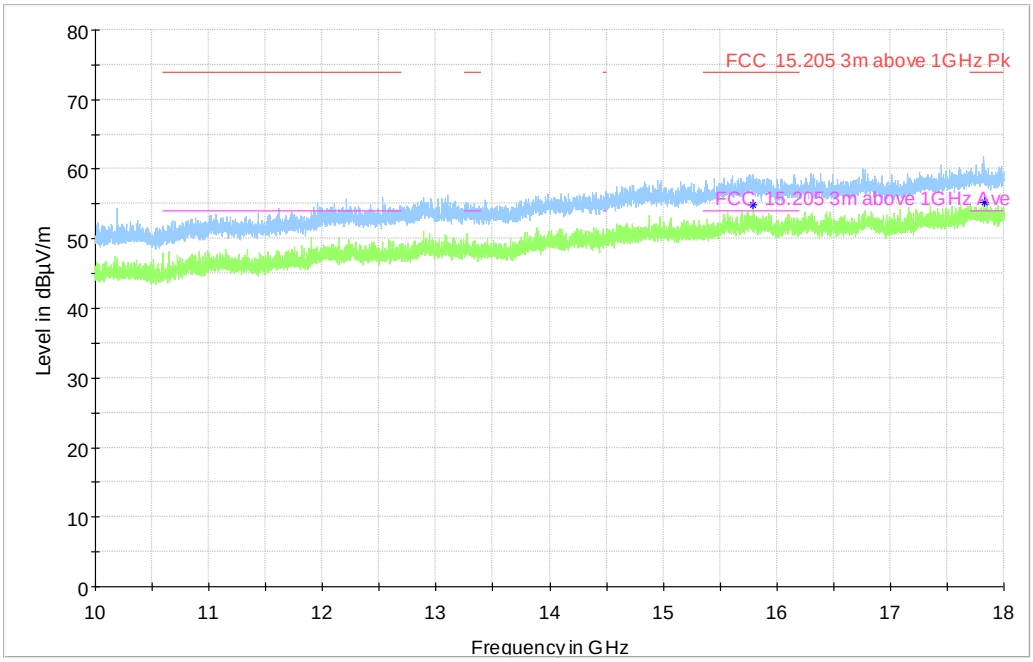
The measurements reported are the highest emissions relative to the 15.209 limit as per 15.205 and take into account the correction factor*. Measurements made according to ANSI C63.10 and Eurofins Hursley test procedure RAD-01.
Final measurements have been presented for middle channel which was worst case

*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.

4.5.5 Profile; 10 to 18GHz, Top Channel

Maximum hold trace with peak values (▽)
Maximum hold trace with average values (▼)

10 to 18GHz



4.5.6 Data; 10 to 18GHz, Top Channel

The measurements reported are the highest emissions relative to the 15.209 limit as per 15.205 and take into account the correction factor*. Measurements made according to ANSI C63.10 and Eurofins Hursley test procedure RAD-01.
Final measurements have been presented for middle channel which was worst case

*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.

4.6 Radiated Emissions, 18 to 40GHz (Continued)

4.6.1 Profile; 18 to 40GHz, Middle Channel

Maximum hold trace with peak values (▽)
Maximum hold trace with average values (▼)

18 to 40GHz

4.6.2 Data; 18 to 40GHz, Middle Channel

No measurements were taken based on the max peak data values high margins relative to the limit lines. Measurements reported are the highest emissions relative to the 15.209 limit and take into account the correction factor*.

Measurements made according to ANSI C63.10 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.

4.6.3 Profile; 18 to 40GHz, Bottom Channel

Maximum hold trace with peak values (▽)

Maximum hold trace with average values (▼)

18 to 40GHz

4.6.4 Data; 18 to 40GHz, Bottom Channel

No measurements were taken based on the max peak data values high margins relative to the limit lines. The 800MHz emissions is an intentional cellular transmission from the EUT.

Measurements made according to ANSI C63.10 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.

4.6.5 Profile; 18 to 40GHz, Top Channel

Maximum hold trace with peak values (▽)

Maximum hold trace with average values (▼)

18 to 40GHz

4.6.6 Data; 18 to 40GHz, Top Channel

No measurements were taken based on the max peak data values high margins relative to the limit lines.

The measurements reported are the highest emissions relative to the 15.209 limit and take into account the correction factor*.

Measurements made according to ANSI C63.10 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.

4.7 Conducted Emissions

4.7.1 Test Parameters

A filtered supply was fed to the EUT via a 50Ω/50µH Artificial Mains Network (AMN). The AMN was bonded to a conductive ground plane. Line and neutral phases were measured separately.

An EMI receiver was set to scan between 0.15MHz and 30.0MHz with a 20s measurement time. A CISPR Average and Quasi-Peak trace was generated and compared to the limits and take into account the correction factor. Measurements made according to the test standard and Eurofins Hursley test procedure CON-02.

Test Equipment						
#ID	CP	Manufacturer	Type	Serial Number	Description	Calibration Due Date
252	1	Rohde & Schwarz	ESH 3 Z2	08970	10dB pulse limiter	28/05/2022
674	1	Rohde & Schwarz	ESH3-Z5	838576-018	1 phase LISN ANSI&CISPR	16/09/2022
699	1	Gauss	TDEMI30M	1506001	Time domain conducted receiver	16/09/2023
768	1	Pasternack	PE7025-10	0	10dB attenuator BNC for Gauss	Internal
785	0	EH	Ground plane	0	Ground plane work area	Not required
Test Equipment Software						
#ID	CP	Manufacturer	Type		Description	Calibration Due Date
857	0	Gauss	Software	0	TDMI 30 v5.00	Not required

Environmental Test Conditions	
Temperature	17.7° Celsius
Relative Humidity	33%
Atmospheric Pressure	1033.4 millibars
Test Date:	25th March 2022
Test Engineer:	Malcolm Musgrave

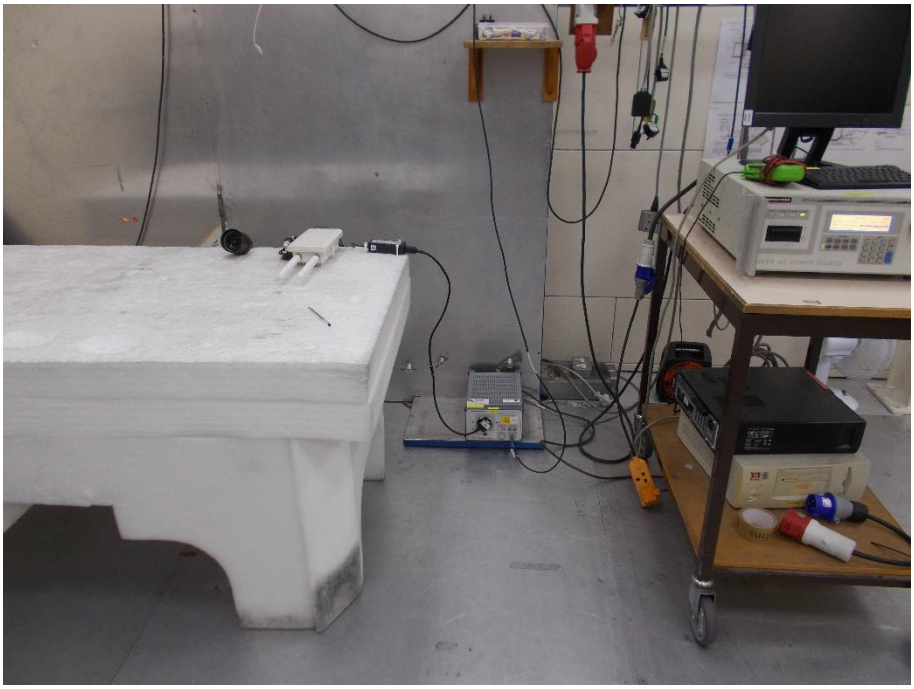
Note: “Calibration due date” means the instrument is certified within UKAS or traceable calibration certificate. “Internal” means the instrument is calibrated using Eurofins Hursley procedures. “Not required” means the asset does not require calibration. “CP” is the interval period [year] prescribed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

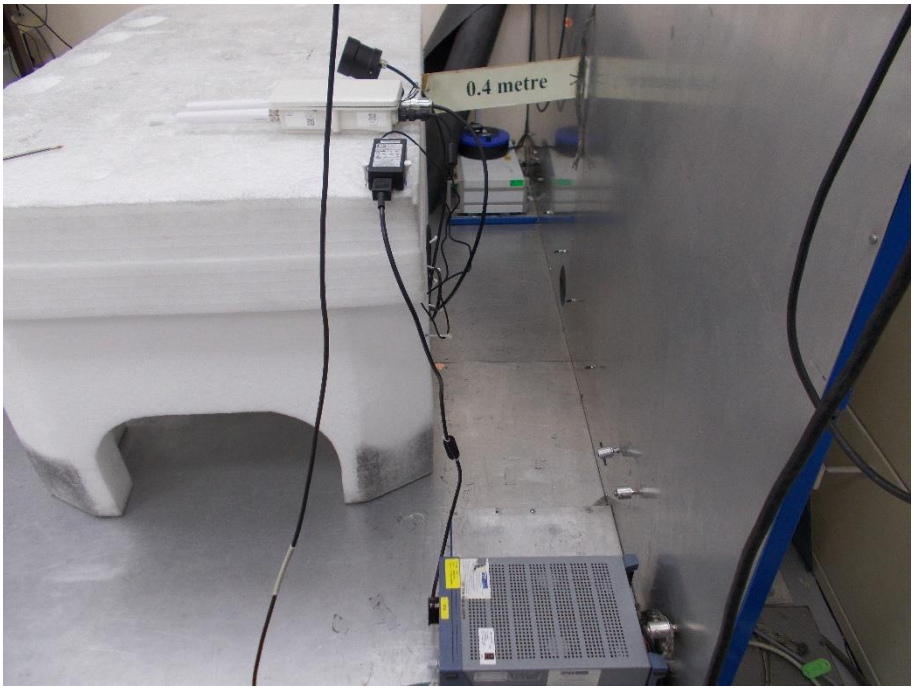
4.7.2 Test Configuration

Please refer to EUT Test Configuration #1.

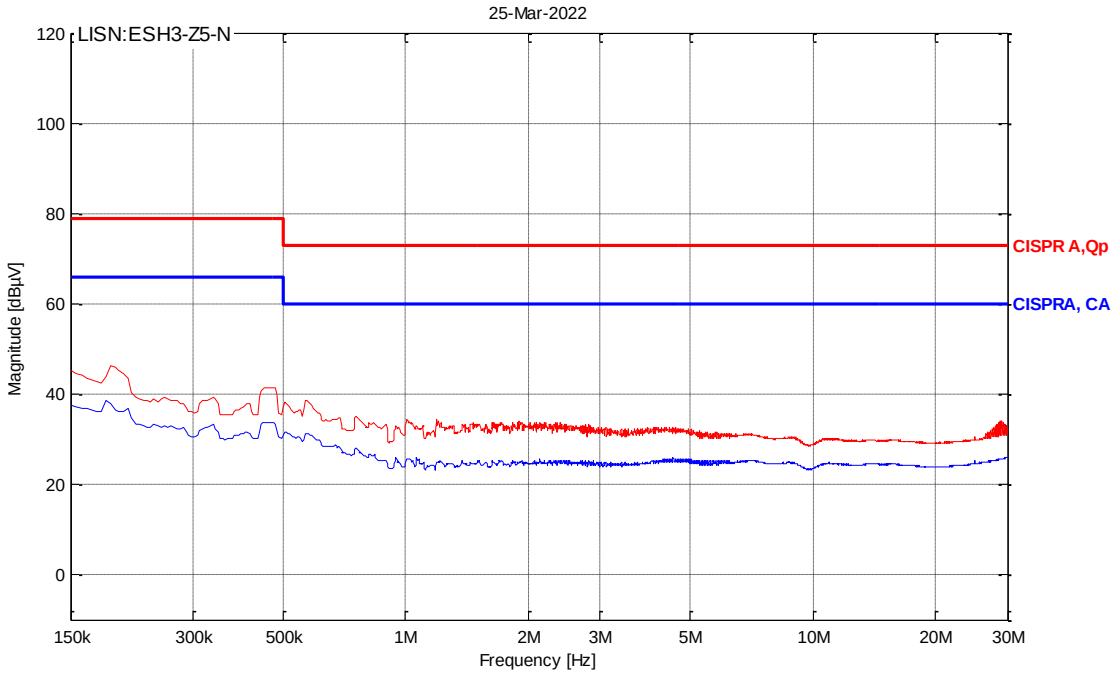
4.7.3 Set-up Photos

Conducted Emissions





4.7.4 Profile; Mains Neutral



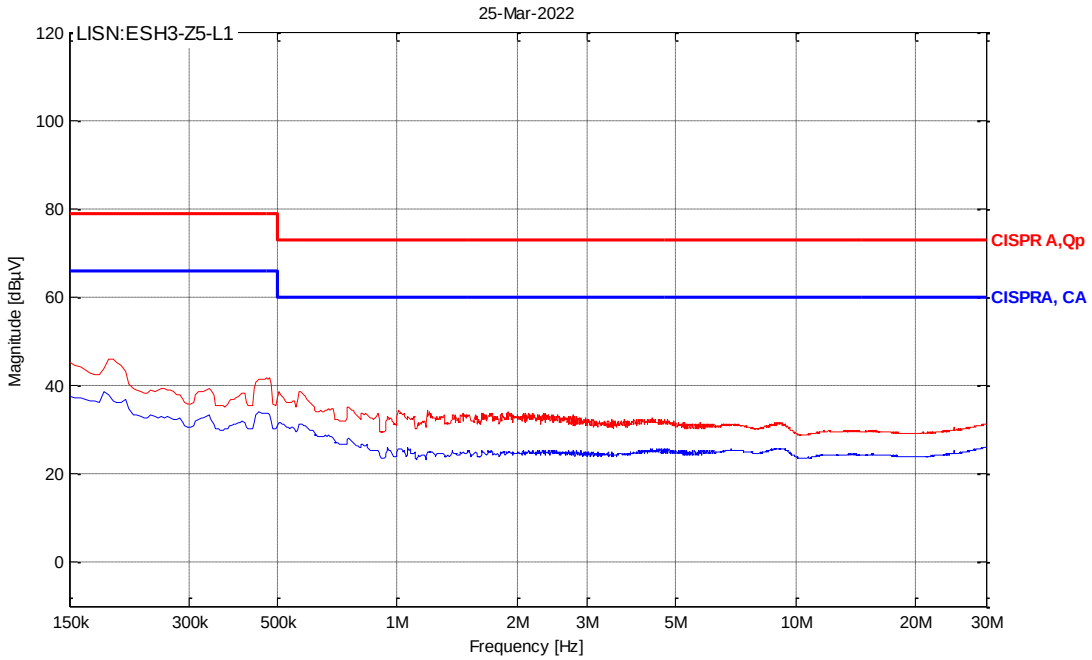
4.7.5 Data; Mains Neutral

Quasi-peak value (dBµV)				
Frequency	**Measured**	**Class A Limit**	**Margin**	**Status**
188.351 kHz	46.16	79.00	32.84	Pass
5.262 MHz	31.73	73.00	41.27	Pass
11.127 MHz	30.16	73.00	42.84	Pass
15.805 MHz	29.85	73.00	43.15	Pass
24.998 MHz	30.50	73.00	42.50	Pass
28.799 MHz	33.94	73.00	39.06	Pass

CISPR Average value (dBµV)				
Frequency	**Measured**	**Class A Limit**	**Margin**	**Status**
183.582 kHz	38.67	66.00	27.33	Pass
5.262 MHz	25.38	60.00	34.62	Pass
10.998 MHz	24.72	60.00	35.28	Pass
15.886 MHz	24.50	60.00	35.50	Pass
24.998 MHz	25.32	60.00	34.68	Pass
29.933 MHz	25.93	60.00	34.07	Pass

The measured value takes into account the correction factor.
Correction factor (dB) = cable, AMN, and pulse limiter losses as summed positive values (dB)
The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).

4.7.6 Profile; Mains Line



4.7.7 Data; Mains Line

Quasi-peak value (dBµV)				
Frequency	**Measured**	**Class A Limit**	**Margin**	**Status**
188.351 kHz	46.06	79.00	32.94	Pass
9.048 MHz	31.58	73.00	41.42	Pass
13.902 MHz	29.72	73.00	43.28	Pass
15.757 MHz	29.77	73.00	43.23	Pass
24.998 MHz	30.61	73.00	42.39	Pass
29.981 MHz	31.29	73.00	41.71	Pass

CISPR Average value (dBµV)				
Frequency	**Measured**	**Class A Limit**	**Margin**	**Status**
183.582 kHz	38.65	66.00	27.35	Pass
9.048 MHz	25.78	60.00	34.22	Pass
14.212 MHz	24.41	60.00	35.59	Pass
15.600 MHz	24.37	60.00	35.63	Pass
24.998 MHz	25.29	60.00	34.71	Pass
29.924 MHz	25.97	60.00	34.03	Pass

The measured value takes into account the correction factor.
Correction factor (dB) = cable, AMN, and pulse limiter losses as summed positive values (dB)
The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).

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 Ulab) are equal to or are less than the expected uncertainty values contained in CISPR 16-4-2 (known as Ucispr). Below is a list of the laboratories calculated measurement uncertainties:

Conducted emissions:

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

Radiated emissions:

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

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.

Published 17/01/2022

6.0 ANNEX – CONDUCTED EMISSIONS RESULTS

6.1 Summary

Test	Clause	Requirement	Result
6dB bandwidth	FCC 15.247(a)(2)	> 500 kHz	Pass
	RSS-247 clause 5.2(a)		Pass
Occupied bandwidth	None	None	Pass
	RSS Gen clause 6.7		Pass
Maximum peak conducted output power	FCC 15.247(b)(3)	1W	Pass
	RSS-247 clause 5.4(d)		Pass
Power Spectral Density	FCC 15.247(c)	8 dBm / 3 kHz	Pass
	RSS-247 clause 5.2(b)		Pass
Out of band emission Non-restricted bands	FCC 15.247(d)	-20 dBc (peak power)	Pass
	RSS-247 clause 5.5		Pass
Out of band emission Restricted bands	FCC 15.247(d) / 15.209(a)	15.209(a) table	Pass
	RSS Gen clauses 8.9/8.10		Pass
Maximum antenna gain	15.247(b)(4)(11)	≤ 6dBi	Pass
	No specific requirement, but links to maximum transmit power		Pass

6.2 DTS Bandwidth

6.2.1 Measurement method

Test was conducted in accordance with ANSI C63.10 Clause 11.8 Option 1:

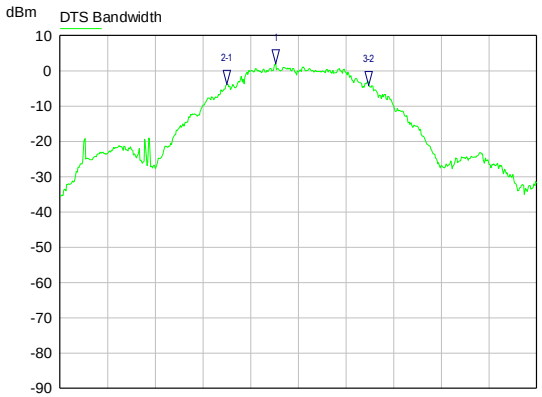
a) Set resolution bandwidth to 100 kHz
b) Set the video bandwidth to ≥ 3 x RBW
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

6.2.2 Test results

Channel	6dB DTS Bandwidth (MHz)	Requirement	Status
Bottom	1.490	> 500 kHz	Pass
Middle	1.540	> 500 kHz	Pass
Top	1.540	> 500 kHz	Pass

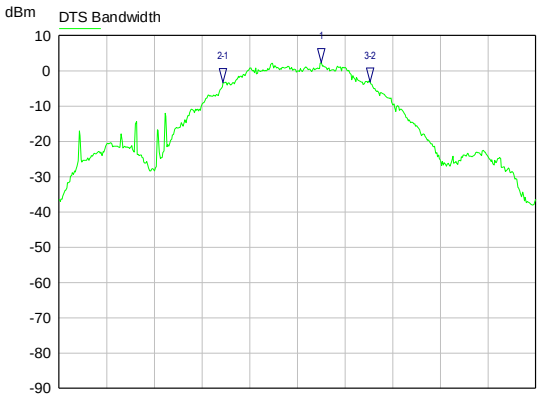
Table 6: DTS Bandwidth

6.2.3 Profile; DTS Bandwidth



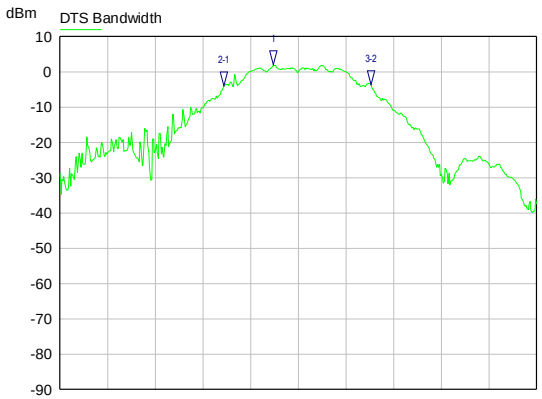
Mkr	Trace	X-Axis	Value	Notes
1	DTS Bandwidth	2.4048 GHz	2.06 dBm	
2-1	DTS Bandwidth	-510.0000 kHz	-5.91 dB	Relative to max
3-2	DTS Bandwidth	1.4900 MHz	-0.27 dB	Relative to marker 2

Bottom



Mkr	Trace	X-Axis	Value	Notes
1	DTS Bandwidth	2.4403 GHz	2.34 dBm	
2-1	DTS Bandwidth	-1.0300 MHz	-5.63 dB	Relative to max
3-2	DTS Bandwidth	1.5400 MHz	0.20 dB	Relative to marker 2

Middle



Mkr	Trace	X-Axis	Value	Notes
1	DTS Bandwidth	2.4747 GHz	2.00 dBm	
2-1	DTS Bandwidth	-520.0000 kHz	-5.92 dB	Relative to max
3-2	DTS Bandwidth	1.5400 MHz	0.29 dB	Relative to marker 2

Top

Figure 1: DTS Bandwidth plots

6.3 Maximum Peak Conducted Output Power

6.3.1 Measurement method

As the analyser could be set RBW ≥ DTS bandwidth, the test was conducted in accordance with ANSI C63.10 Clause 11.9.1.1:

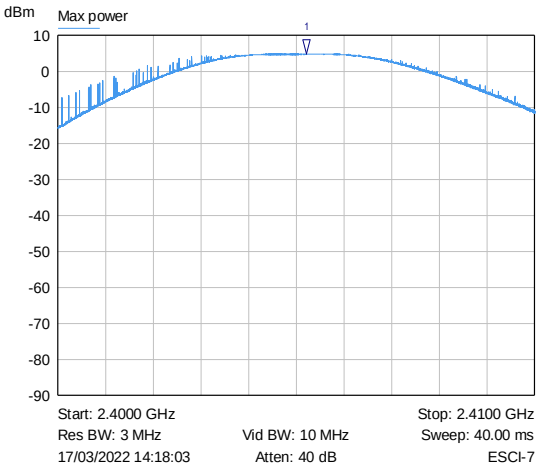
a) Set the RBW ≥ DTS bandwidth.
b) Set VBW ≥ 3 x RBW.
c) Set span ≥ 3 x RBW
d) Sweep time = auto couple.
e) Detector = peak.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use peak marker function to determine the peak amplitude level.

6.3.2 Test results

Channel	Channel Power (dBm)	Power (W)	Channel Power (dBm)	Status
Bottom	4.90	0.0031	1.0	Pass
Middle	5.29	0.0034	1.0	Pass
Top	4.72	0.0030	1.0	Pass

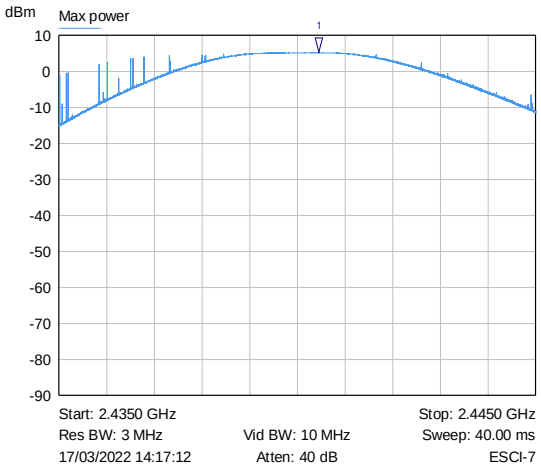
Table 1: Channel Power

6.3.3 Profile; Maximum Peak Conducted Power



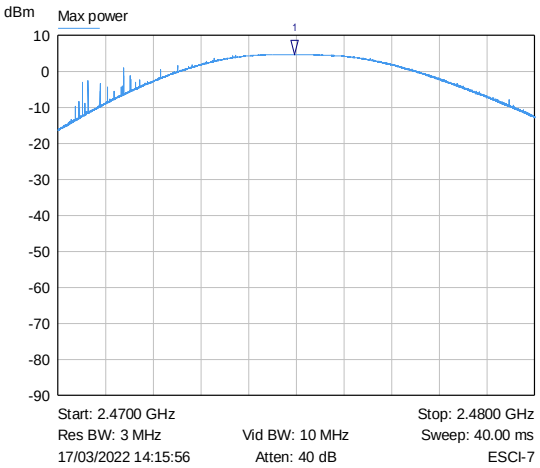
Mkr	Trace	X-Axis	Value	Notes
1	Max power	2.4052 GHz	4.90 dBm	

Bottom



Mkr	Trace	X-Axis	Value	Notes
1	Max power	2.4405 GHz	5.29 dBm	

Middle



Mkr	Trace	X-Axis	Value	Notes
1	Max power	2.4750 GHz	4.72 dBm	

Top

Figure 2: Peak Conducted Power plots

6.4 Maximum Power Spectral Density

6.4.1 Measurement method

As conducted power was measured as Maximum Peak Conducted Power, measurement was performed in accordance with ANSI C63.10 Clause 11.10.2:

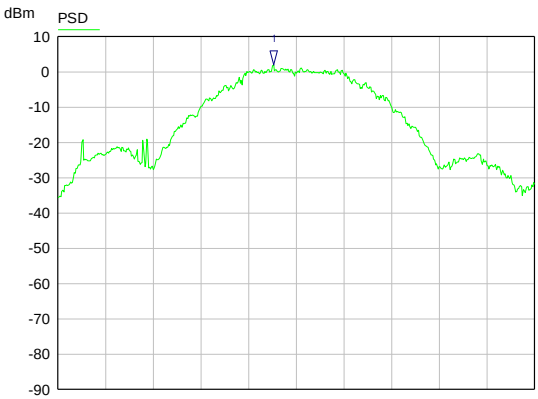
a) Set analyzer center frequency to DTS channel center frequency.
b) Set the span to 1.5 x DTS bandwidth.
c) Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
d) Set the VBW ≥ 3 x RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level within the RBW.
j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

6.4.2 Test results

Channel	Peak Marker reading (dBm)	Limit (dBm/3kHz)	Status
Bottom	2.06	8.0	Pass
Middle	2.34	8.0	Pass
Top	2.00	8.0	Pass

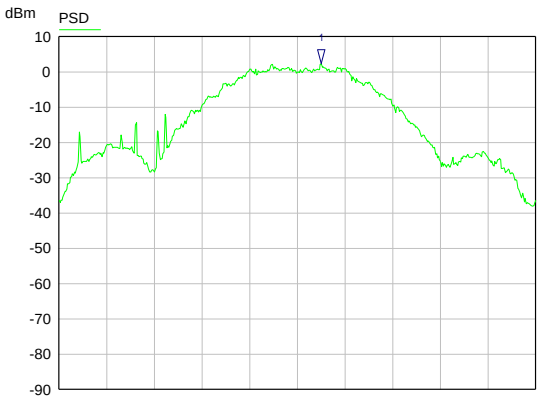
Table 8: Spectral Density results

6.4.3 Profile; Power Spectral Density



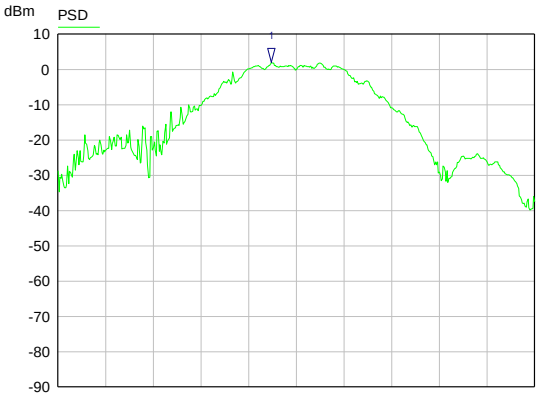
Mkr	Trace	X-Axis	Value	Notes
1	PSD	2.4048 GHz	2.06 dBm	

Bottom



Mkr	Trace	X-Axis	Value	Notes
1	PSD	2.4403 GHz	2.34 dBm	

Middle



Mkr	Trace	X-Axis	Value	Notes
1	PSD	2.4747 GHz	2.00 dBm	

Top

Figure 3: Power Spectral Density plots

6.5 Emissions in non-restricted frequency bands

6.5.1 Measurement method

Since peak power measurements were made using a peak detector, the same detector will be used for unwanted emissions. The unwanted emissions shall be at least 20dB lower than the wanted emission.

First, establish a reference level in accordance with ANSI C63.10 Clause 11.11.2:

a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 x DTS bandwidth.
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ 3 x RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum PSD level.

Then measure the emission levels in accordance with KDB 558074 section 11.3

a) Set the center frequency and span to encompass frequency range to be measured.
b) Set the RBW = 100 kHz.
c) Set the VBW ≥ 3 x RBW.
d) Detector = peak.
e) Sweep time = auto couple.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use the peak marker function to determine the maximum amplitude level.

6.5.2 Test results

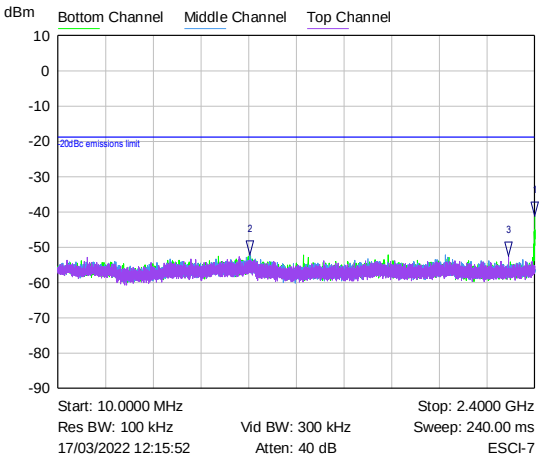
The reference trace was taken from the Power Spectral Density Measurement which used the same settings.

For ease of measurement, maximum values are reported anywhere in the frequency band of investigation, whether or not it is outside a restricted band. Further measurements in restricted bands are in the next section.

Channel	Maximum Peak level in 100 kHz RBW (dBm)	-20 dBc (dBm)	Maximum emission (dBm)	Status
Bottom	2.06	-17.94	-41.12	Pass
Middle	2.34	-17.66	-47.86	Pass
Top	2.00	-18.00	-47.59	Pass

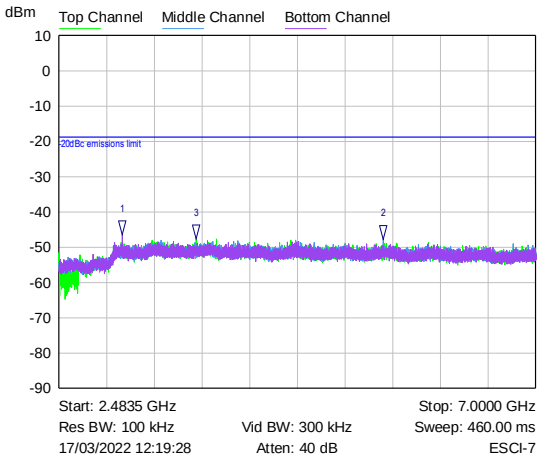
Table 2: Emissions in non-restricted bands

6.5.3 Profile; Non-restricted Frequency Bands



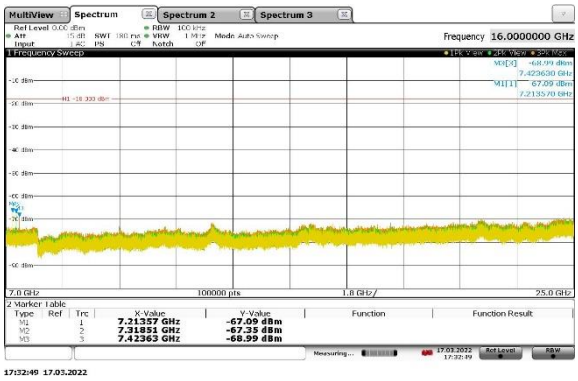
Mkr	Trace	X-Axis	Value	Notes
1	Bottom Channel	2.4000 GHz	-41.12 dBm	
2	Middle Channel	970.4813 MHz	-52.15 dBm	
3	Top Channel	2.2688 GHz	-52.46 dBm	

20 – 2400 MHz



Mkr	Trace	X-Axis	Value	Notes
1	Bottom Channel	3.0836 GHz	-46.46 dBm	
2	Middle Channel	5.5525 GHz	-47.86 dBm	
3	Top Channel	3.7826 GHz	-47.59 dBm	

2483.5 – 7000 MHz



7000 – 25000 MHz

Figure 4: Emissions in non-restricted frequency bands

6.6 Maximum Emissions in Restricted Band

This testing is done in two parts:

- Antenna port conducted measurement
- Radiated measurement with antenna port terminated

6.7 Conducted Antenna port

6.7.1 Measurement method

The conducted antenna port power is converted to a radiated emissions field strength limit specified in 15.209(a) as per ANSI C63.10 Clause 11.12.2:

Electric field strength, E = EIRP – 20log D + 104.8

Which can be re-written as EIRP = E + 20logD – 104.8

Since EIRP = conducted power + antenna gain + ground reflection

Max. conducted power = E + 20logD – 104.8 - antenna gain - ground reflection

If "E" is the limit, and the measurement distance taken as 3 m, the maximum conducted power can be determined as shown in the table:

Frequency range	Limit	Field strength (µV/m)	Field Strength (dBµV/m)	20logD	Antenna gain (dBi)	Ground reflection	Limit (dBm)
30 – 88 MHz	QP	100	40.0	9.54	4.0	4.7	-63.96
88 – 216 MHz	QP	150	43.5	9.54	4.0	4.7	-60.46
216 – 960 MHz	QP	200	46.0	9.54	4.0	4.7	-57.96
960 – 1000 MHz	QP	500	54.0	9.54	4.0	4.7	-49.96
> 1 GHz	Average	500	54.0	9.54	4.0	0	-45.26
> 1 GHz	Peak	Average + 20dB	74.0	9.54	4.0	0	-25.26

Table 3: Restricted band limits at antenna port

Initial measurement of antenna port emissions was performed with a peak detector as per ANSI C63.10 Clause 11.12.2.4:

a) RBW = as specified in Table 1.
b) VBW ≥ 3 x RBW.
c) Detector = Peak.
d) Sweep time = auto.
e) Trace mode = max hold.
f) Allow sweeps to continue until the trace stabilizes. (Note that the required measurement time may be longer for low duty cycle applications).

Where emissions above 1 GHz were close to the limit, these were re-measured using trace-averaging and RMS detector as per section 11.12.2.5.1:

a) RBW = 1 MHz (unless otherwise specified).
b) VBW ≥ 3 x RBW.
c) Detector = RMS, if span/(# of points in sweep) ≤ (RBW/2). Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak. (Note: 32001 measurement points used)
d) Averaging type = power (i.e., RMS).
    1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
    2) Some instruments require linear display mode in order to use linear voltage averaging. Log or dB averaging shall not be used.
e) Sweep time = auto.
f) Perform a trace average of at least 100 traces.

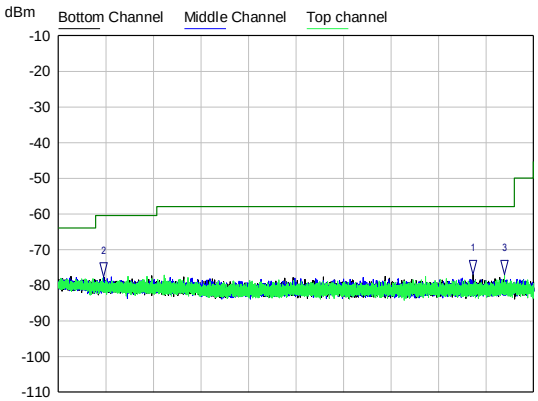
6.7.2 Test results

Maximum values for each frequency range are shown on the plots, and the worst case emissions for each channel where the emission is in a restricted band were re-measured using RMS detector and are detailed in the table below:

Channel	Frequency (MHz)	Detector	Level (dBm)	Peak limit (dBm)	Average limit (dBm)	Result
2405	2390	Peak	-51.67	-25.26	N/A	Pass
		RMS	-60.36	N/A	-45.26	
2475	2483.5	Peak	-40.60	-25.26	N/A	Pass
		RMS	-48.50	N/A	-45.26	Pass

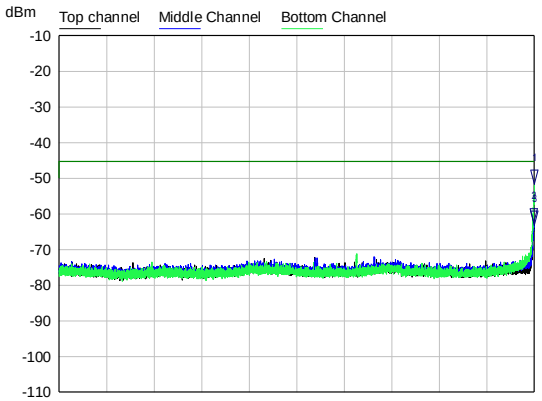
Table 4: Emissions in restricted bands

6.7.3 Profile; Emissions in restricted bands



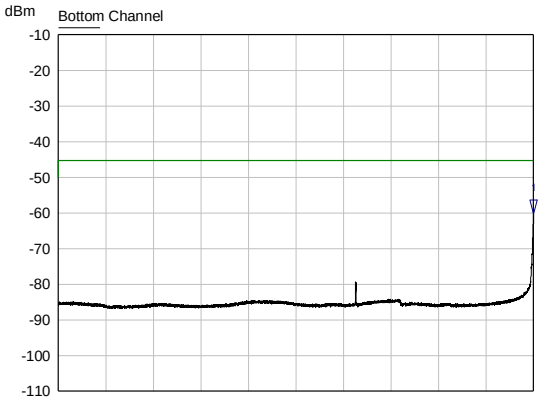
Mkr	Trace	X-Axis	Value	Notes
1	Bottom Channel	873.8988 MHz	-77.04 dBm	
2	Middle Channel	103.4313 MHz	-77.69 dBm	
3	Top channel	938.8675 MHz	-77.04 dBm	

30 – 1000 MHz (peak)



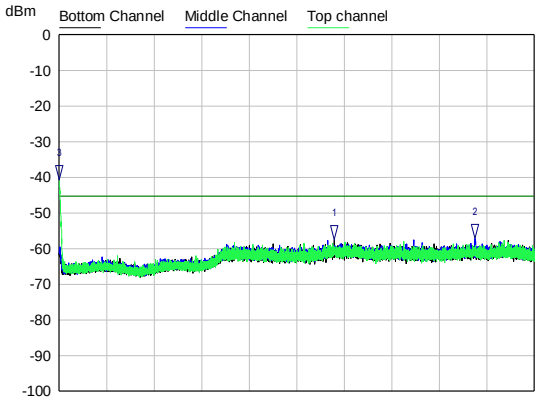
Mkr	Trace	X-Axis	Value	Notes
1	Bottom Channel	2.3900 GHz	-51.67 dBm	
2	Middle Channel	2.3883 GHz	-62.43 dBm	
3	Top channel	2.3898 GHz	-63.24 dBm	

1000 - 2390 MHz (Peak)



Mkr	Trace	X-Axis	Value	Notes
1	Bottom Channel	2.3900 GHz	-60.36 dBm	

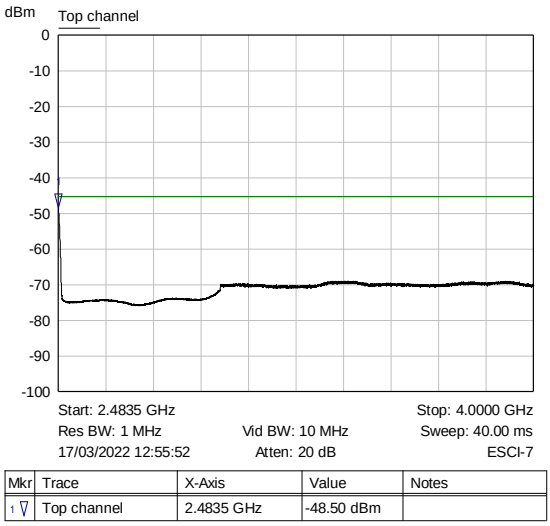
1000 - 2390 MHz (RMS) (Bottom channel)



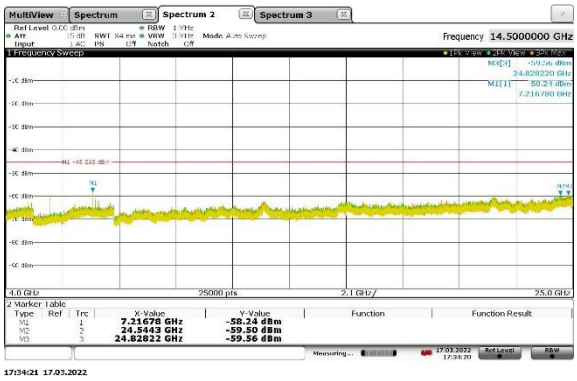
Mkr	Trace	X-Axis	Value	Notes
1	Bottom Channel	3.3604 GHz	-57.50 dBm	
2	Middle Channel	3.8095 GHz	-57.15 dBm	
3	Top channel	2.4835 GHz	-40.60 dBm	

2483.5 – 4000 MHz (Peak)

6.7.4 Profile; Emissions in restricted bands (Continued)



Mkr	Trace	X-Axis	Value	Notes
1	Top channel	2.4835 GHz	-48.50 dBm	



2483.5 – 4000 MHz (RMS) (Top channel)	4000 – 25000 MHz (Peak)

Figure 5: Emissions in restricted frequency bands

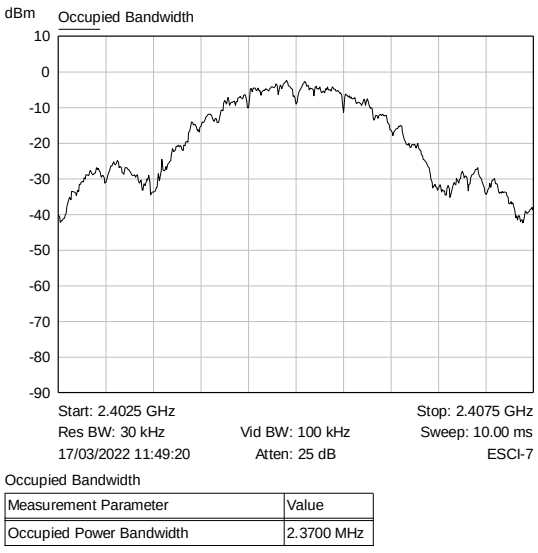
6.8 Occupied bandwidth

99% occupied bandwidth measured using the inbuilt function in the spectrum analyser

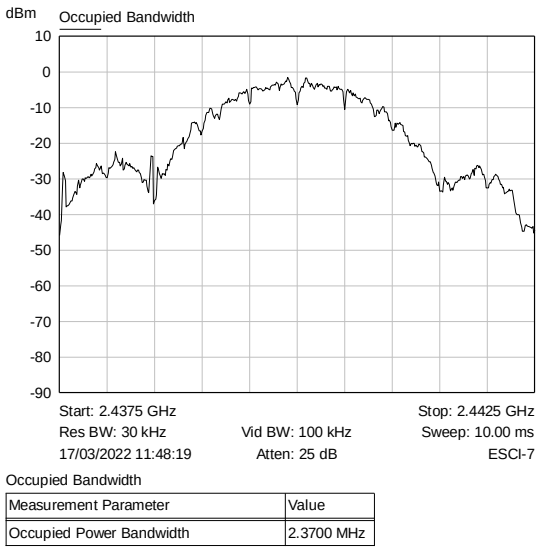
Channel	Peak limit (dBm)	Average limit (dBm)	Result
Bottom	2.37	None	For information
Middle	2.37	None	For information
Top	2.31	None	For information

Table 5: Occupied Bandwidth

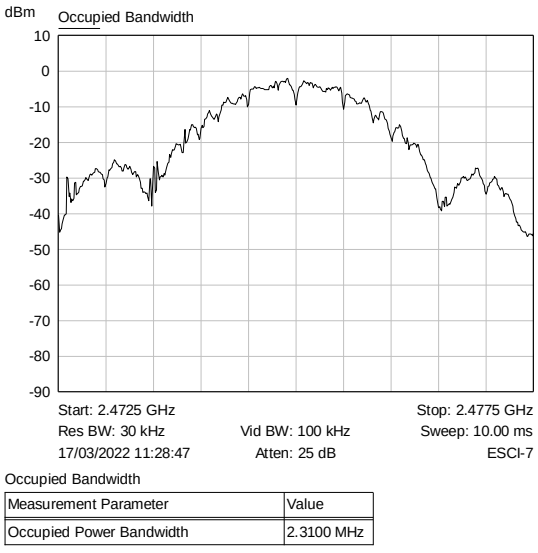
6.8.1 Profile; Occupied Bandwidth



Bottom



Middle



Top

Figure 6: Occupied Bandwidth

6.9 Test equipment

Description	Manufacturer	Name	Serial Number	Calibration certificate Or Calibration due
Spectrum Analyser	Rohde & Schwarz	ESCI 7	HEMC #289	14/09/2022
Spectrum Analyser	Rohde & Schwarz	ESW 44	HEMC #788	20/04/2022

End of Document