TEST REPORT

Test Report No. : UL-RPT-RP14394930-616A

Customer	:	VEGA Grieshaber KG
Model No.	:	VEGAPULS 6X
FCC ID	:	O6QPS6XW
Technology	:	Tank Level Probing Radar
Test Standard(s)	:	FCC Parts 15.31(q), 15.207 & 15.209(a)
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 2.0 supersedes all previous versions.

Date of Issue: 05 December 2022

Checked by:

Ben Mercer
Lead Project Engineer, Radio Laboratory

Company Signatory:

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RF Operations Leader, Radio Laboratory

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Customer Information

Company Name:	VEGA Grieshaber KG
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Report Revision History

Version Number	Issue Date	Revision Details	Revised By
1.0	30/11/2022	Initial Version	Ben Mercer
2.0	05/12/2022	Updated antenna gains	Ben Mercer

Table of Contents

1 Attestation of Test Results

1.1 Description of EUT

The equipment under test was a radar sensor for the continuous level measurement of liquids.

1.2 General Information

Specification Reference:	47CFR15.31
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart A (General) – Section 15.31
Specification Reference:	47CFR15.207 and 47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Sections 15.207 & 15.209
Site Registration:	685609
Lab Designation No.:	UK2011
Location of Testing:	Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	30 September 2022 to 07 November 2022

1.3 Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.31(q) & 15.209(a)	Transmitter Radiated Emissions	✓
Part 15.207	Transmitter AC Conducted Emissions	✓
Key to Results ✓ = Complied ✗ = Did not comply		

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	X
Site 17	X

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 FAQs v01r01
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
Radiated Emissions	9 kHz to 30 MHz	95%	±5.32 dB
Radiated Emissions	30 MHz to 1 GHz	95%	±3.30 dB
Radiated Emissions	1 GHz to 40 GHz	95%	±3.16 dB
Radiated Emissions	40 GHz to 200 GHz	95%	±5.12 dB
Transmitter AC Conducted Emissions	0.15 MHz to 30 MHz	95%	±1.96 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 Radiated Emissions Tests

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2040	Thermohygrometer	Testo	608-H1	45124934	09 Dec 2022	12
K0001	3m RSE Chamber	Rainford Solutions	N/A	N/A	05 Sep 2023	12
M2044	Test Receiver	Rohde & Schwarz	ESU26	100122	29 Apr 2023	12
A3165	Loop Antenna	ETS-Lindgren	6502	224383	05 May 2023	12
A3154	Pre-Amplifier	Com-Power	PAM-103	18020012	18 Aug 2023	12
A3112	Attenuator	AtlanTecRF	AN18-06	219706#2	23 Nov 2022	12
A553	Bi-Log Antenna	Chase EMC	CBL6111A	1593	23 Nov 2022	12
K0017	3m RSE Chamber	Rainford Solutions	N/A	N/A	26 Oct 2022	12
M2003	Thermohygrometer	Testo	608-H1	45046641	09 Dec 2022	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	12 Oct 2022	12
A3265	Pre-Amplifier	Schwarzbeck	BBV 9721	9721-069	03 Nov 2022	12
A2892	Horn Antenna	Schwarzbeck	BBHA 9170	9170-727	02 Nov 2022	12
A2948	Pre-amplifier	Com-Power	PAM-118A	551087	20 Oct 2022	12
A2889	Horn Antenna	Schwarzbeck	BBHA 9120 B	653	26 Oct 2022	12
A2890	Horn Antenna	Schwarzbeck	HWRD 750	14	29 Oct 2022	12
A2142	Attenuator	AtlanTecRF	AN18-20	081120-23	14 Nov 2023	12
M1832	Signal Analyzer	Keysight	N9010A	MY53470303	30 Jun 2023	24
M2065	Downconverter	Virginia Diodes	WR10SAX	SAX 393	30 Jul 2023	24
A2967	Horn Antenna	Link Microtek	AM10HA-ULV1	14933	13 Jul 2025	36
A2964	Horn Antenna	Link Microtek	AM15HA-ULV1	14930	24 Jun 2025	36
M2069	Downconverter	Virginia Diodes	WR15SAX	SAX 394	09 Jul 2023	24
A219915	Downconverter	Virginia Diodes	WR19SAX	SAX 897	14 Apr 2023	12
A2963	Horn Antenna	Link Microtek	AM19HA-ULV1	14929	20 Jun 2025	36
M2066	Downconverter	Virginia Diodes	WR6.5SAX	SAX 392	31 May 2024	24
A2968	Horn Antenna	Link Microtek Ltd.	AM7HA-ULV1	14934	04 Feb 2023	12
M2067	Downconverter	Virginia Diodes	WR4.3SAX	SAX 391	31 May 2024	24
A2969	Horn Antenna	Link Microtek	AM4HA-ULV1	14935	04 Feb 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 2022	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
M1273	Test Receiver	Rohde & Schwarz	ESIB26	100275	25 Nov 2022	12
A215746	Variable DC Power Supply	Rohde & Schwarz	NGSM 32/10	192.0810.31	Cal before use	-
M1251	Digital Voltmeter	Fluke	175	89170179	19 May 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:	VEGAPULS
Model No.:	VEGAPULS 6X
Test Sample Serial Number:	58644148 *(Radiated sample)*
Hardware Version:	1.1.0
Software Version:	1.1.0
FCC ID:	O6QPS6XW

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:	Tank Level Probing Radar	
Type of Unit:	Transceiver	
Modulation:	FMCW	
Power Supply Requirement(s):	Nominal	24.0 VDC
Transmit Frequency Range:	75 GHz to 85 GHz	
Transmit Channels Tested:	**Channel Bandwidth (GHz)**	**Channel Frequency (GHz)**
	8	80.000

3.4 Description of Available Antennas

The radio utilizes various external antennas, with the following maximum gains:

ID	Model Number	Type	Frequency Range (MHz)	Antenna Gain (dBi)
1	VEGAZW-6-83952	PVDF Thread 1 ½”	75000 to 85000	24.9
3	VEGAZW-6-84000	Hygienic Thread G1½“	75000 to 85000	24.0
11	VEGAZW-6-83998	Horn antenna 3”	75000 to 85000	33.0
14	VEGAZW-6-83999	Horn antenna 3” (High Temperature)	75000 to 85000	28.8

3.5 Description of Test Setup

Support Equipment

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

Description:	240 Litre Tank
Brand Name:	Speidel
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	DC Power Supply (UL Asset S0537)
Brand Name:	TTI
Model Name or Number:	EL302D
Serial Number:	249928

Operating Modes

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

- Transmitting at maximum power on the widest supported chirp bandwidth with FMCW modulation.

Configuration and Peripherals

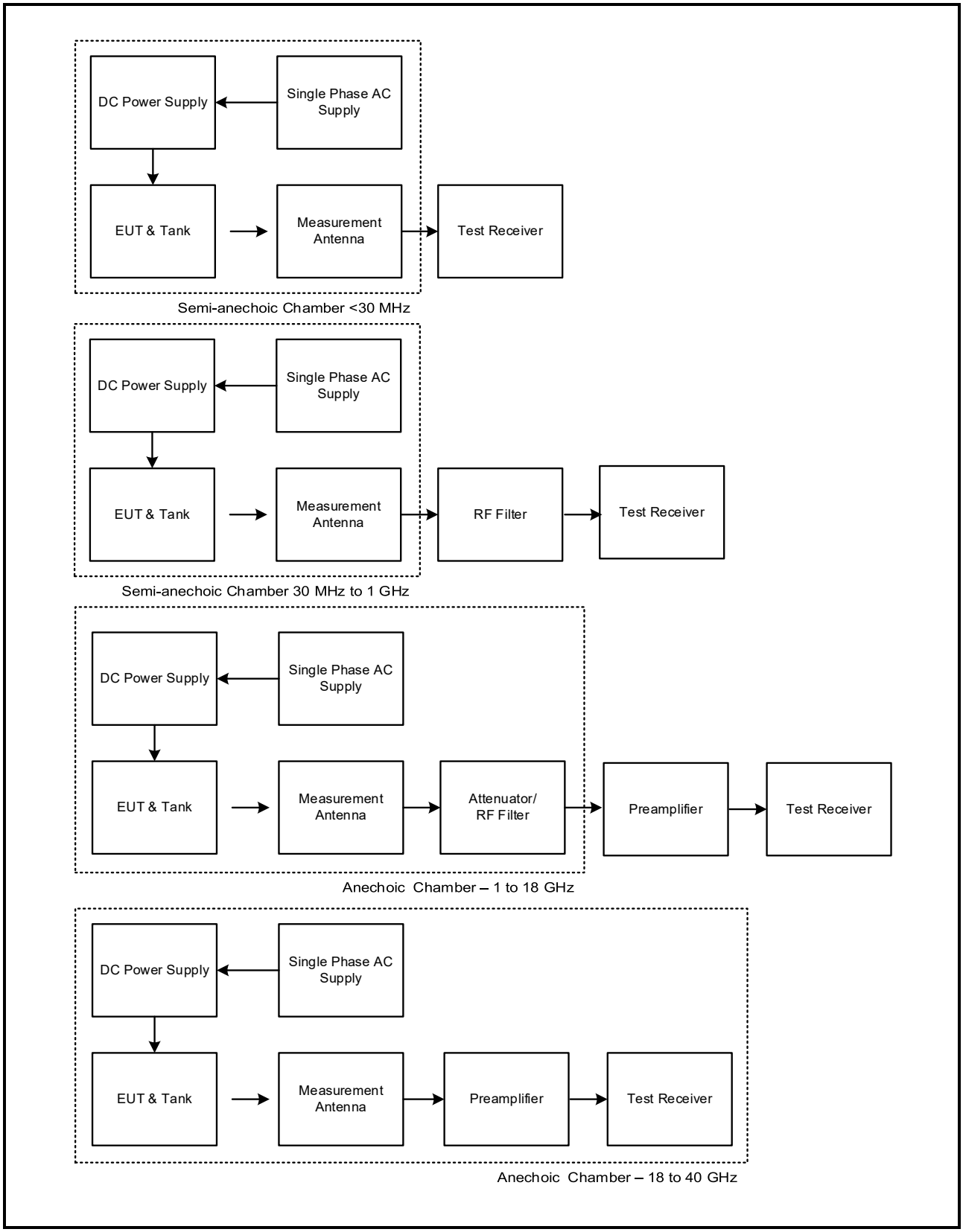
The EUT was tested in the following configuration(s):

- The EUT was configured using the built-in user interface. The chirp bandwidth was set by varying the maximum measurement distance setting.
- The EUT was powered via a 24 VDC bench power supply connected to a 120 VAC 60 Hz mains supply.
- Testing was performed with the EUT installed in a representative metal tank. No accessories/peripherals were employed during test as there were no ports on the EUT to populate.
- Testing was performed with the EUT transmitting an 8 GHz chirp bandwidth, as preliminary investigation showed this to be the worst case with respect to emissions.
- The EUT can be supplied with a range of antennas. Testing was performed on the highest gain antenna of each type.

Test Setup Diagrams

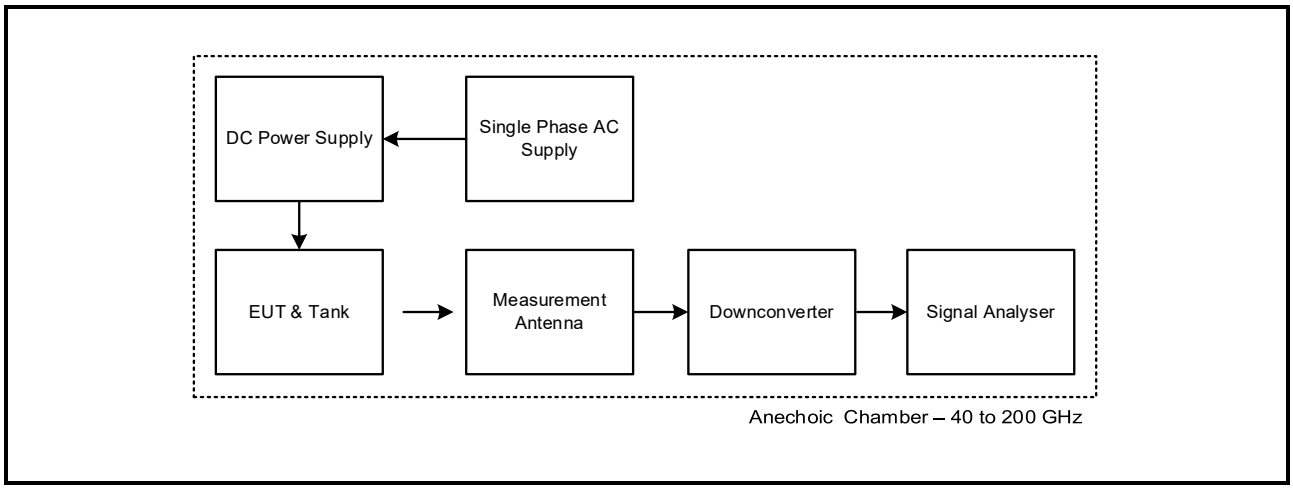
Radiated Tests:

Test Setup for Transmitter Radiated Emissions

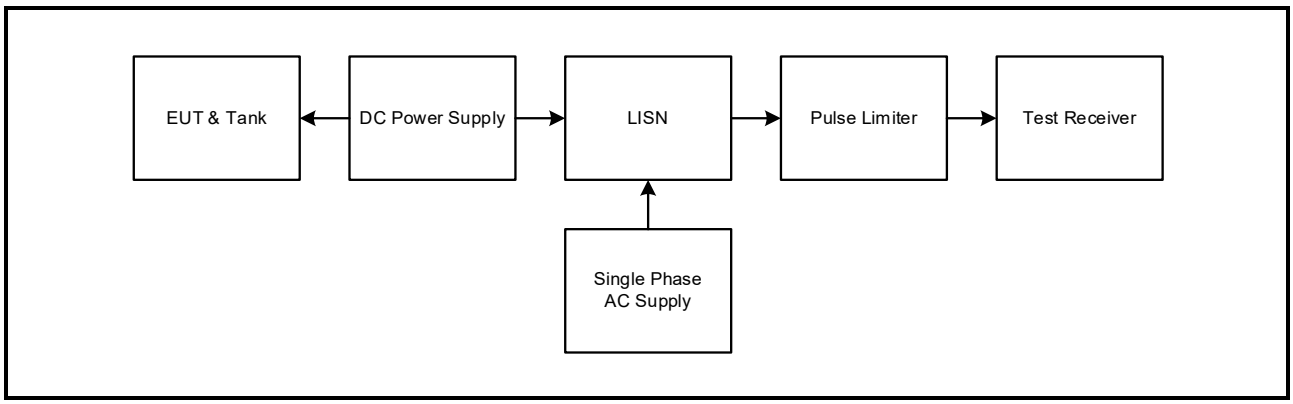


Test Setup Diagrams (continued)

Test Setup for Transmitter Radiated Emissions (continued)



Test Setup for Transmitter AC Conducted Spurious Emissions



4 Radiated Test Results

4.1 Transmitter Radiated Emissions <1 GHz

Test Summary:

Test Engineers:	John Ferdinand & Vi Van	**Test Dates:**	01 October 2022 & 07 November 2022
Test Sample Serial Number:	58644148		

FCC Reference:	Part 15.31(q) & 15.209(a)
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 to 23
Relative Humidity (%):	45 to 48

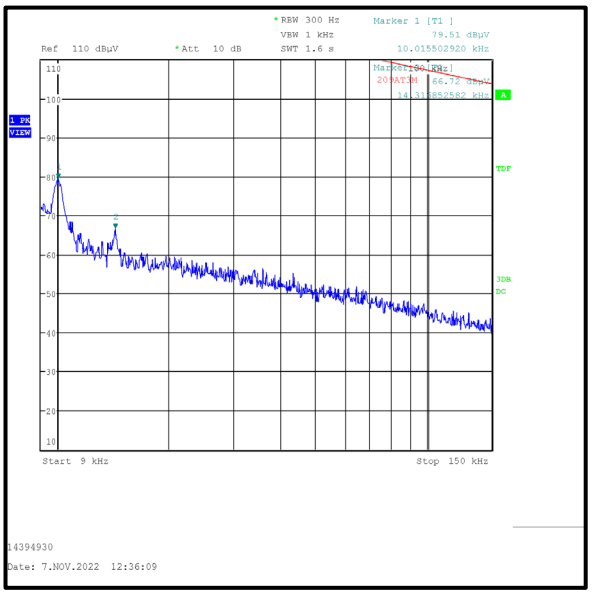
Note(s):

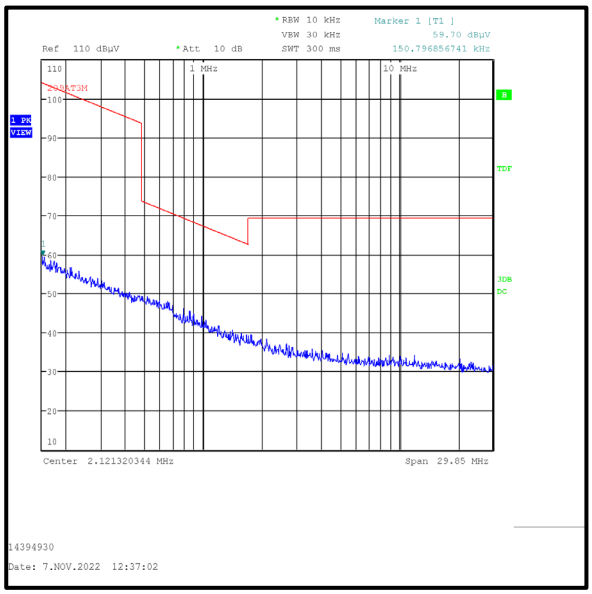
1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. All other emissions shown on the pre-scans were investigated and found to be ambient, or > 20 dB below the appropriate limit or below the noise floor of the measurement system.
3. Measurements below 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. Between 30 MHz and 1 GHz, maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
4. 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.
5. Pre-scans were performed with each antenna. Emission frequencies and amplitudes did not vary between antennas, therefore final measurements were performed on the PVDF Thread 1 ½” antenna.
6. Final measurements were performed on the marker frequencies and the results entered into the table below. The test receiver resolution bandwidth was set to 120 kHz, using a CISPR quasi-peak detector and span wide enough to see the whole emission.

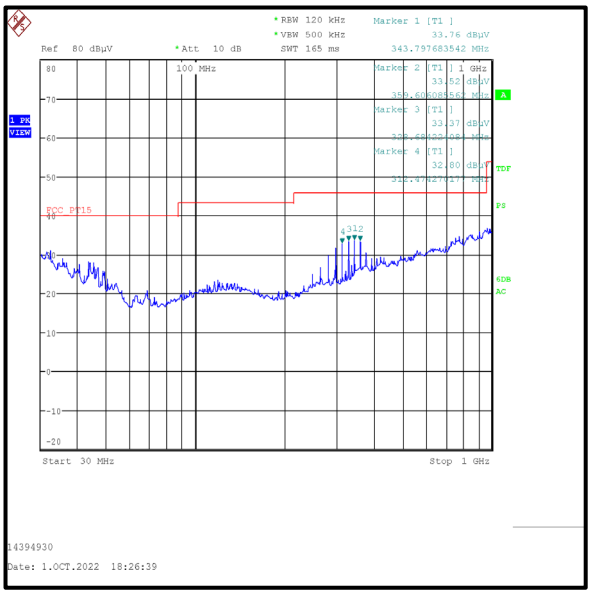
Transmitter Radiated Emissions (continued)

Results: Quasi-Peak

Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
279.998	Horizontal	26.9	46.0	19.1	Complied
295.990	Horizontal	28.6	46.0	17.4	Complied
311.993	Horizontal	30.8	46.0	15.2	Complied
327.979	Horizontal	31.2	46.0	14.8	Complied
344.006	Horizontal	32.3	46.0	13.7	Complied
360.007	Horizontal	32.1	46.0	13.9	Complied







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

4.2 Transmitter Radiated Emissions >1 GHz

Test Summary:

Test Engineer:	Vi Van	**Test Dates:**	30 September 2022 to 29 October 2022
Test Sample Serial Number:	58644148		

FCC Reference:	Part 15.31(q) & 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3, 6.6, 9.8 and 9.12
Frequency Range	1 GHz to 200 GHz

Environmental Conditions:

Temperature (°C):	22 to 24
Relative Humidity (%):	42 to 56

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, or > 20 dB below the appropriate limit or below the noise floor of the measurement system. Where no emissions < 20 dB from the applicable limit were identified, the highest noise floor reading was reported in the tables below.
3. Pre-scans above 1 GHz were performed in fully anechoic chambers (Asset Numbers K0001, K0002 & K0017) 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. All measurement antennas were placed at a fixed height of 1.5 metres above the test chamber floor, in line with the EUT.
4. Final measurements between 1 GHz and 40 GHz were performed in fully anechoic chambers (Asset Numbers K0001 & K0017) at a distance of 3 metres. The EUT was placed at a height of 1.5 m 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.
5. Measurements above 40 GHz were performed in accordance with ANSI C63.10 Clause 9.12.
6. Measurement distances above 40 GHz were determined according to ANSI C63.10 Clause 9.8. Measurement distances were reduced until 6 dB noise floor clearance was achieved:

   40-110 GHz – 0.5 metres
   110-150 GHz – 0.3 metres
   150-200 GHz – 0.2 metres

7. *Levels appended by an asterisk indicate noise floor measurements.

Transmitter Radiated Emissions (continued)

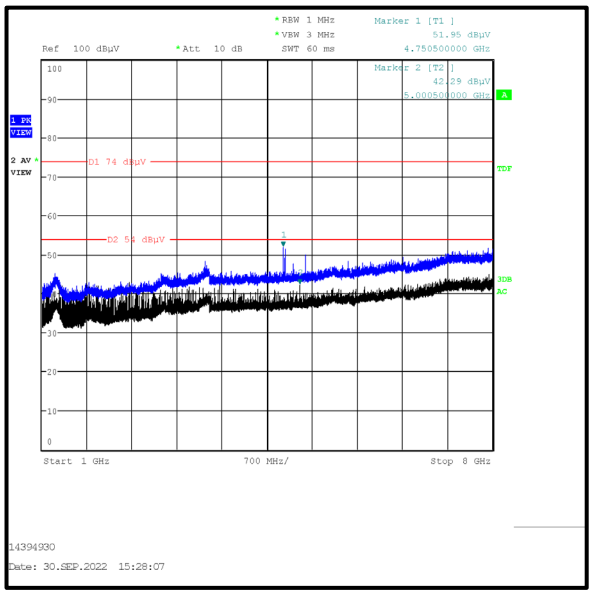
Results: Antenna 1 / Peak

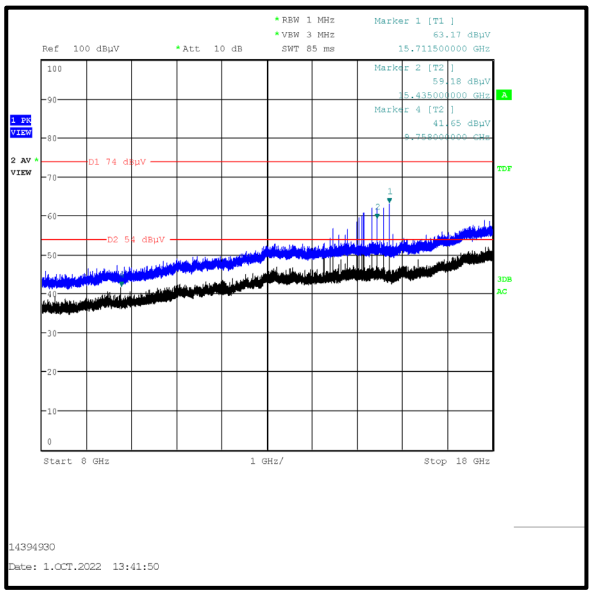
Frequency (MHz)	Antenna Polarity	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
4750.003	Vertical	58.7	74.0	15.3	Complied
5250.119	Vertical	54.0	74.0	20.0	Complied
9500.046	Vertical	51.5	74.0	22.5	Complied
15750.223	Vertical	64.1	74.0	9.9	Complied
23749.878	Vertical	51.4	74.0	22.6	Complied
38000.011	Vertical	55.5	74.0	18.5	Complied
39073.643	Vertical	54.5	74.0	19.5	Complied
40182.899	Vertical	60.0	74.0	14.0	Complied
76109.175	Vertical	72.0	74.0	2.0	Complied

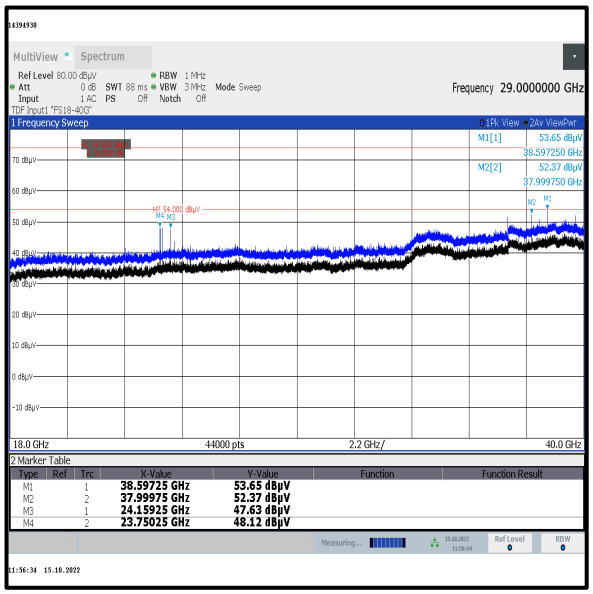
Results: Antenna 1 / Average

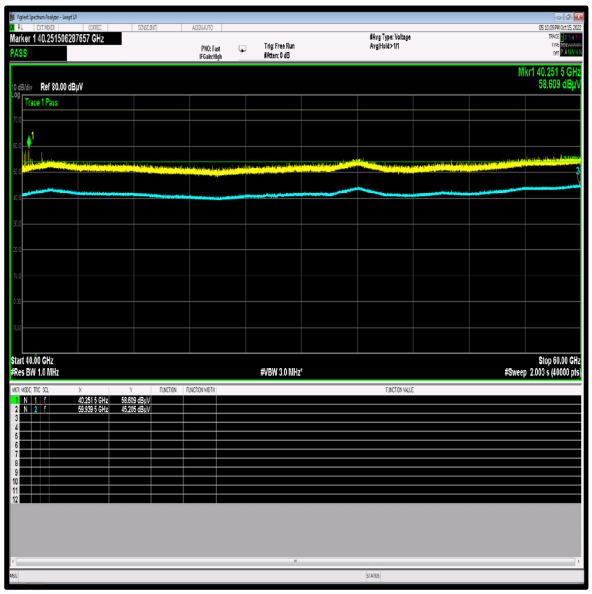
Frequency (MHz)	Antenna Polarity	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
4750.003	Vertical	43.3	54.0	10.7	Complied
5250.119	Vertical	34.0	54.0	20.0	Complied
9500.046	Vertical	38.1	54.0	15.9	Complied
15750.223	Vertical	42.0	54.0	12.0	Complied
23749.878	Vertical	43.1	54.0	10.9	Complied
38000.011	Vertical	40.4	54.0	13.6	Complied
39073.643	Vertical	37.8	54.0	16.2	Complied
40182.899	Vertical	40.7	54.0	13.3	Complied
76109.175	Vertical	48.5	54.0	5.5	Complied

Transmitter Radiated Emissions (continued)









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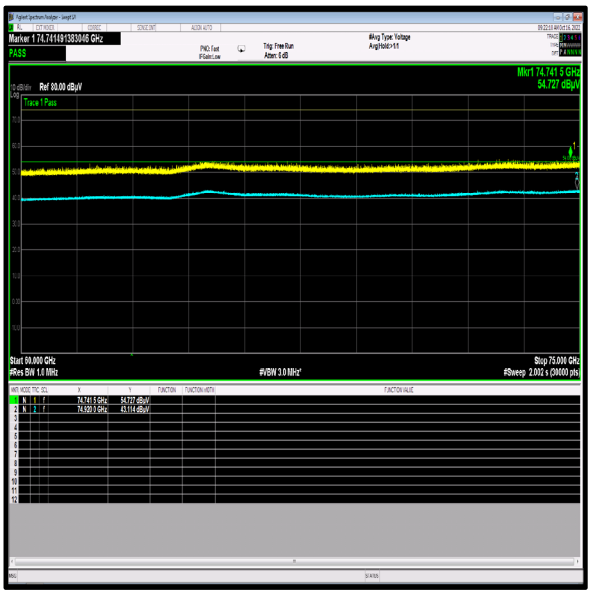
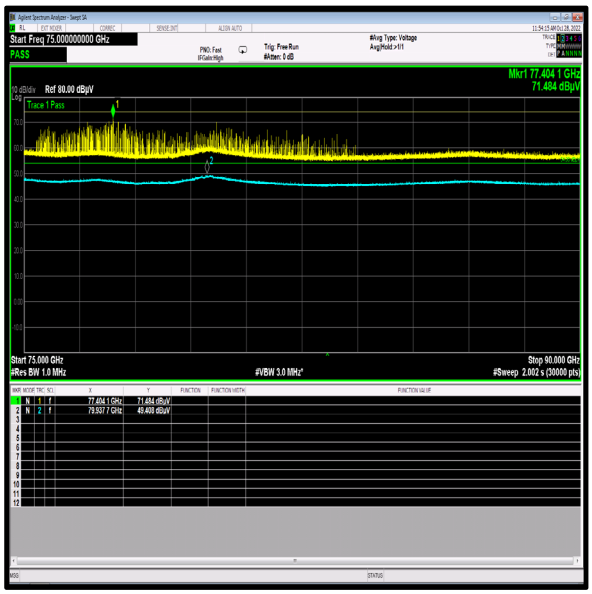
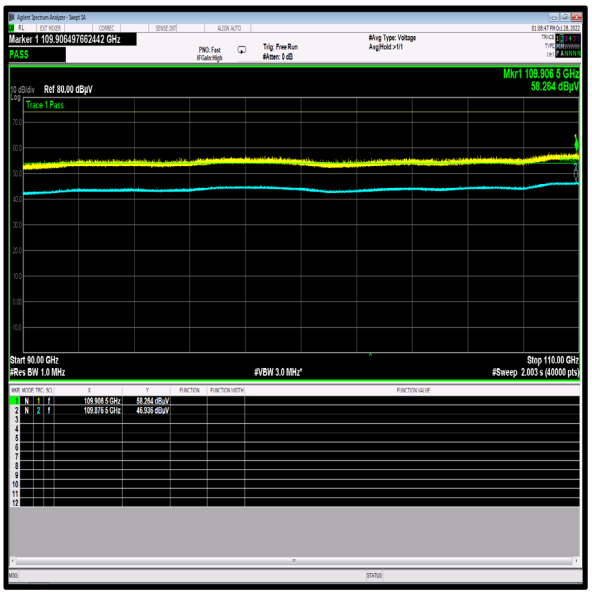
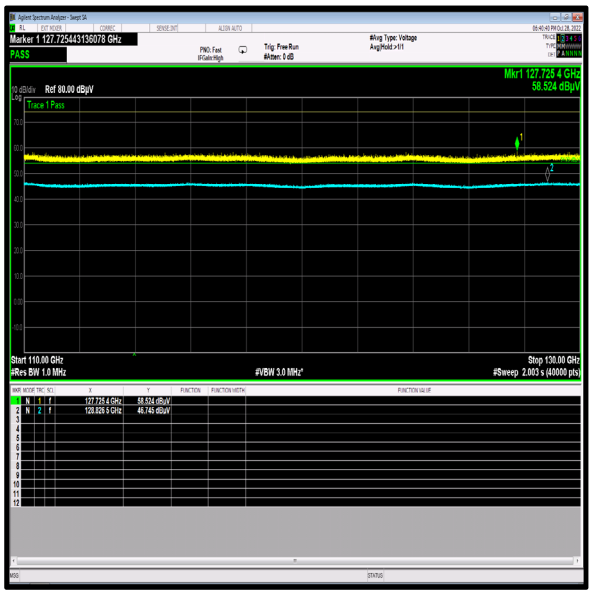
Transmitter Radiated Emissions (continued)









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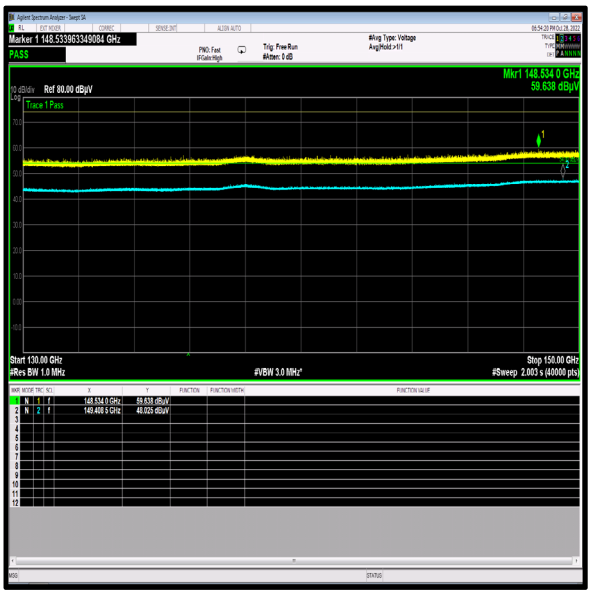
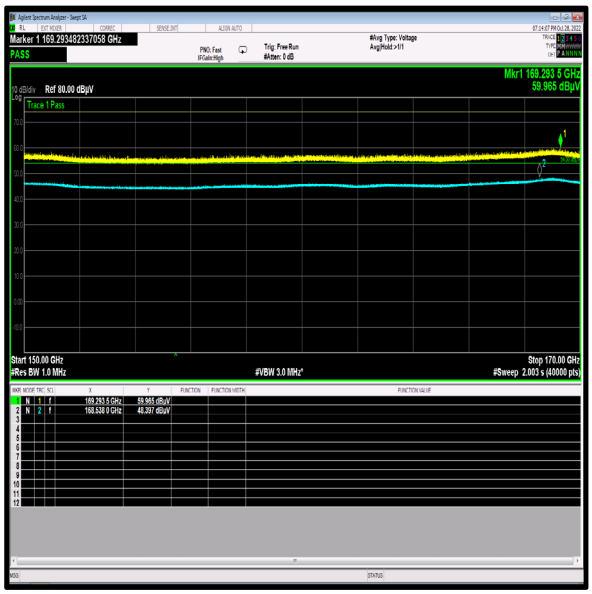
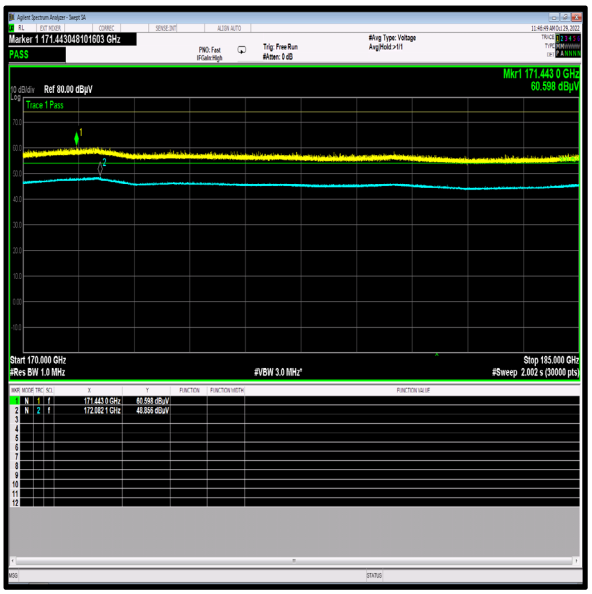
Transmitter Radiated Emissions (continued)







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

Transmitter Radiated Emissions (continued)

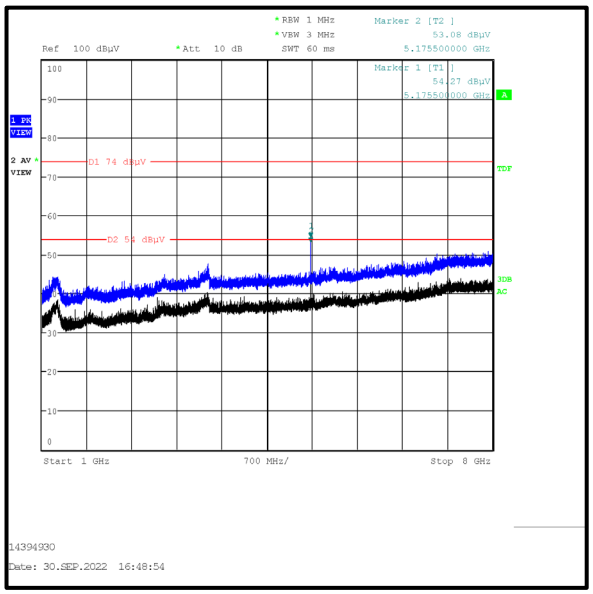
Results: Antenna 3 / Peak

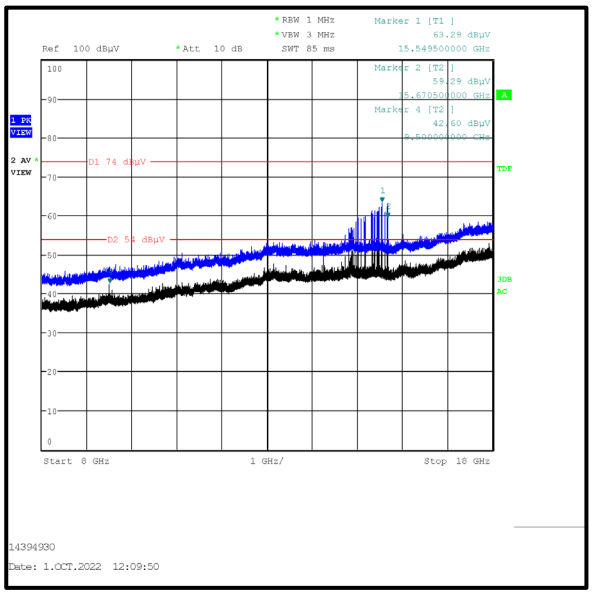
Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
4750.022	Vertical	58.0	74.0	16.0	Complied
5250.105	Vertical	52.7	74.0	21.3	Complied
9499.822	Vertical	49.5	74.0	24.5	Complied
15750.191	Vertical	64.0	74.0	10.0	Complied
23749.860	Vertical	50.0	74.0	24.0	Complied
37999.848	Vertical	58.3	74.0	15.7	Complied
80076.420	Vertical	70.9	74.0	3.1	Complied

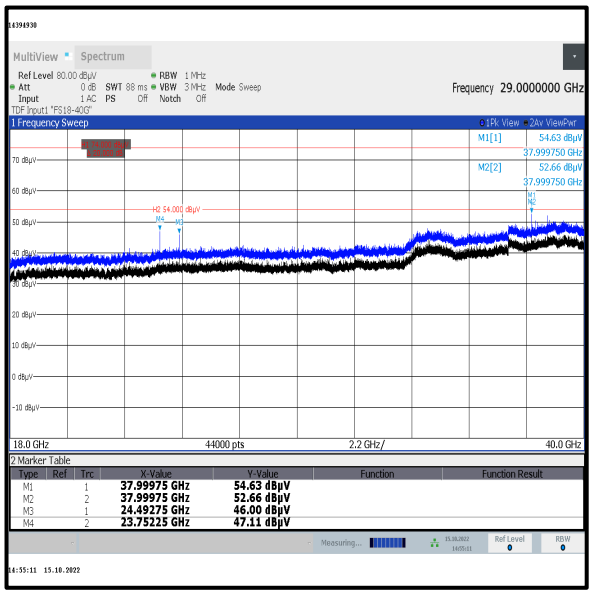
Results: Antenna 3 / Average

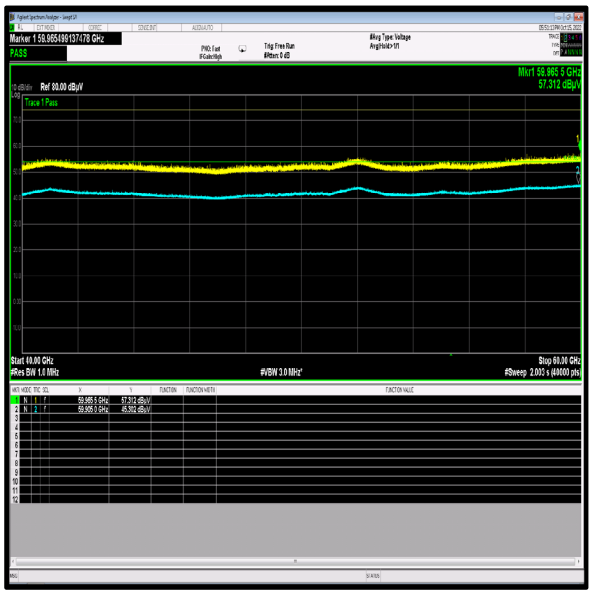
Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
4750.022	Vertical	42.6	54.0	11.4	Complied
5250.105	Vertical	33.9	54.0	20.1	Complied
9499.822	Vertical	36.0	54.0	18.0	Complied
15750.191	Vertical	42.0	54.0	12.0	Complied
23749.860	Vertical	41.6	54.0	12.4	Complied
37999.848	Vertical	42.7	54.0	11.3	Complied
80076.420	Vertical	47.6*	54.0	6.4	Complied

Transmitter Radiated Emissions (continued)



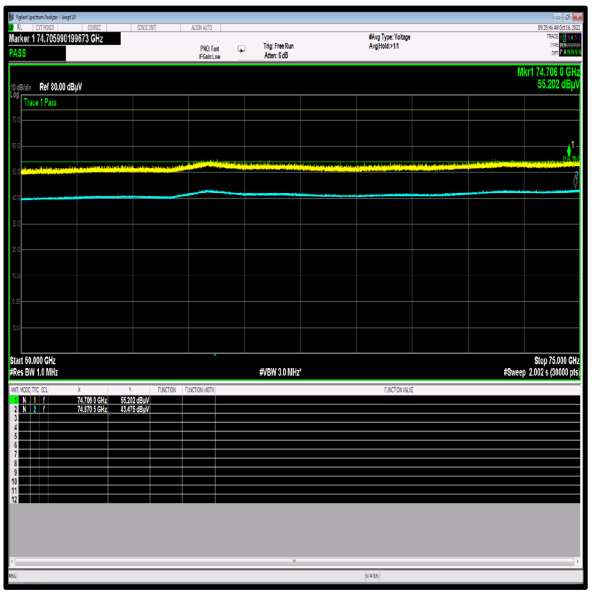


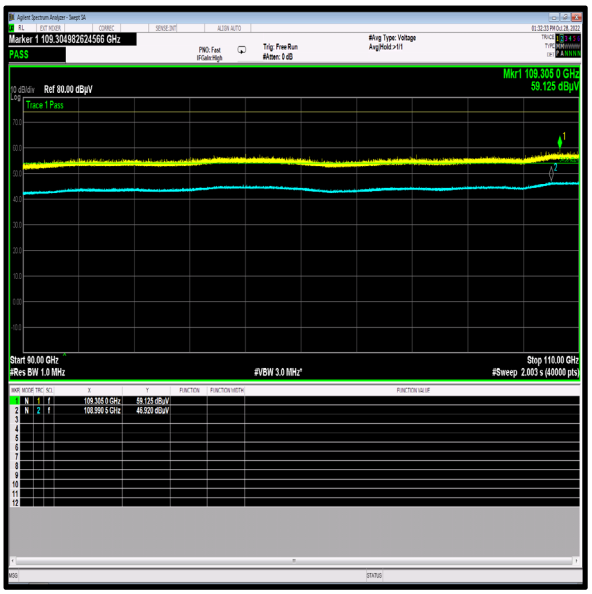


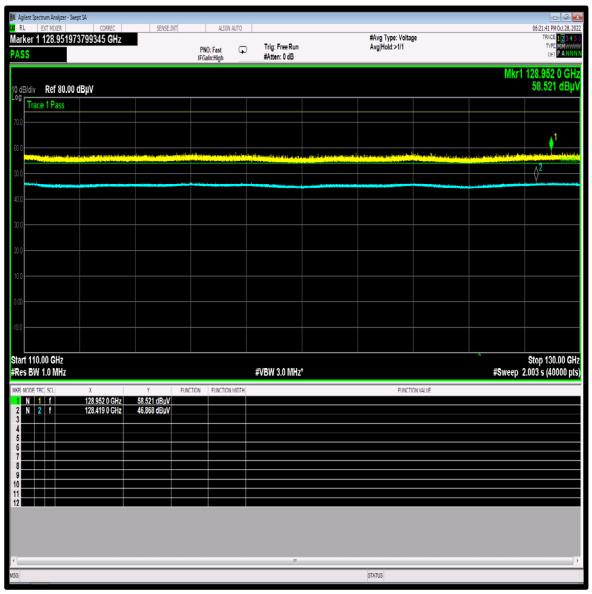


Note: The above plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Radiated Emissions (continued)

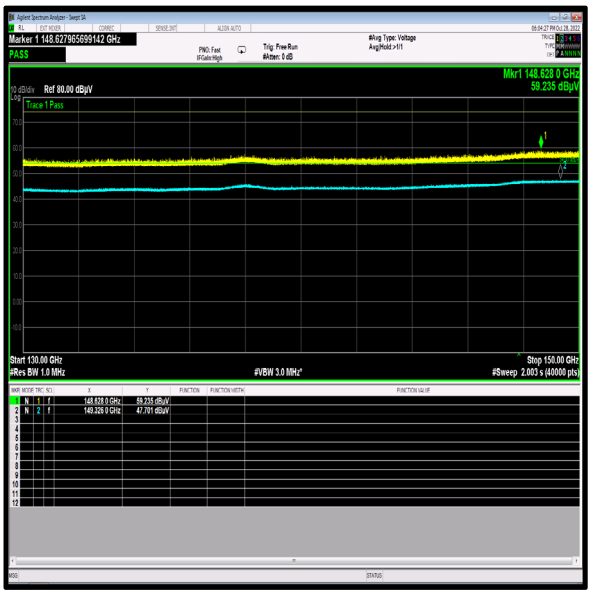


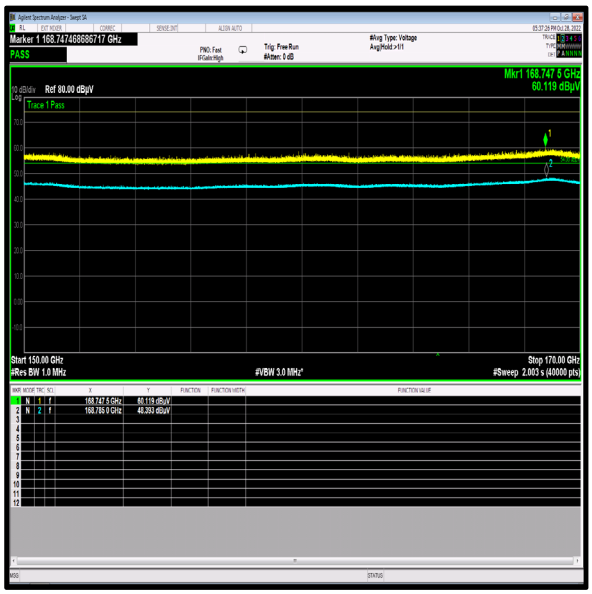


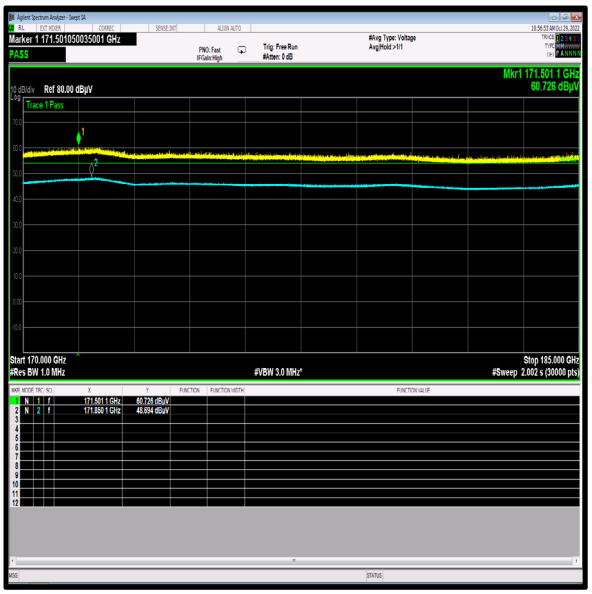


Note: The above plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Radiated Emissions (continued)







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

Transmitter Radiated Emissions (continued)

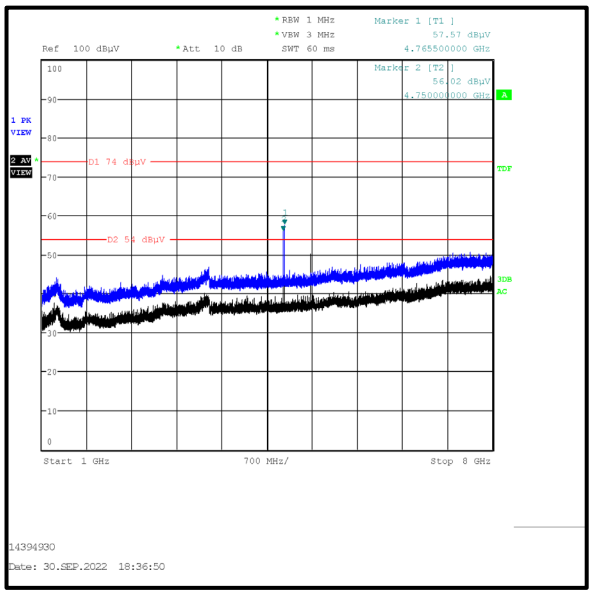
Results: Antenna 11 / Peak

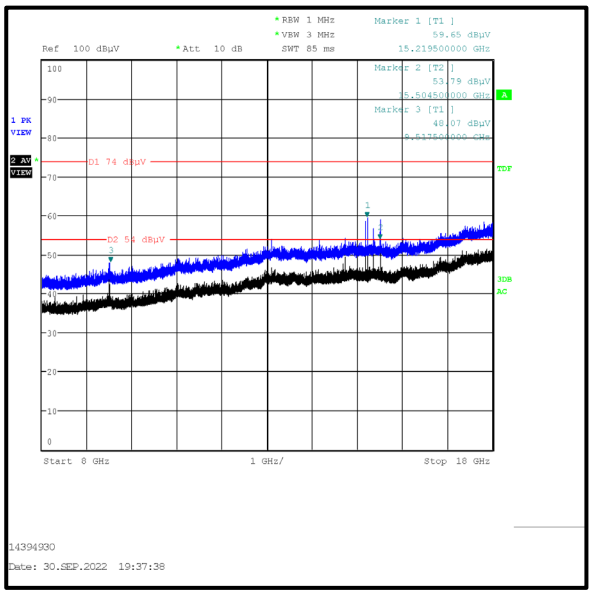
Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
4750.006	Vertical	59.8	74.0	14.2	Complied
9499.960	Vertical	52.4	74.0	21.6	Complied
15750.070	Vertical	61.9	74.0	12.1	Complied
23749.785	Vertical	50.0	74.0	24.0	Complied
37999.948	Vertical	61.9	74.0	12.1	Complied
79512.067	Vertical	71.8	74.0	2.2	Complied

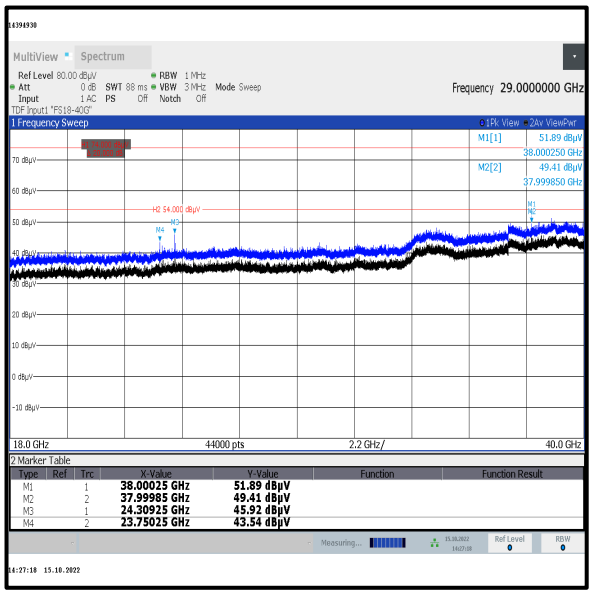
Results: Antenna 11 / Average

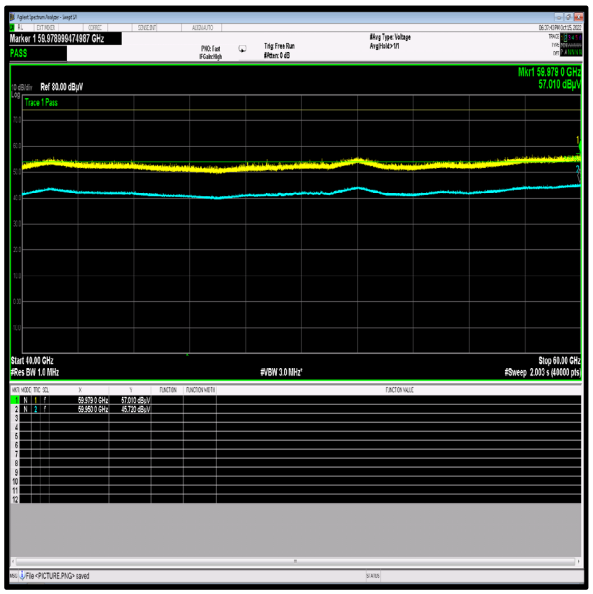
Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
4750.006	Vertical	44.2	54.0	9.8	Complied
9499.960	Vertical	38.5	54.0	15.5	Complied
15750.070	Vertical	41.3	54.0	12.7	Complied
23749.785	Vertical	39.6	54.0	14.4	Complied
37999.948	Vertical	46.6	54.0	7.4	Complied
79512.067	Vertical	45.0	54.0	9.0	Complied

Transmitter Radiated Emissions (continued)









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