TEST REPORT

Test Report No. : UL-RPT-RP14655984-216A

Customer	:	VEGA Grieshaber KG
Model No. / HVIN	:	PS40WM
PMN	:	VEGAPULS 42
FCC ID	:	O6QPS40W
ISED Certification No.	:	IC: 3892A-PS40W
Technology	:	*Bluetooth* – Low Energy & Tank Level Probing Radar
Test Standard(s)	:	FCC Parts 15.31(q), 15.209(a) & 15.247(d) ISED Canada RSS-211 5.1(d), RSS-Gen 6.13 & RSS-247 5.5
Test Laboratory	:	UL International (UK) Ltd, Basingstoke, Hampshire, RG24 8AH, United Kingdom

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

Date of Issue: 24 April 2023

Checked by:

Ben Mercer
Lead Project Engineer, Radio Laboratory

Company Signatory:

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Customer & Manufacturer Information

Customer

Company Name:	VEGA Grieshaber KG
Address:	Am Hohenstein 113, D-77761 Schiltach, Germany

Manufacturer

Company Name:	VEGA Americas, Inc.
Address:	3877 Mason Research Parkway Ohio Mason 45036 United States of America

Company Name:	VEGA India Level and Pressure Measurement Pvt. Ltd
Address:	Plot No. 1, Gat No. 181, Village – Phulgaon Tal. Haveli Pune 412216 India

Report Revision History

Version Number	Issue Date	Revision Details	Revised By
1.0	29/03/2023	Initial Version	Ben Mercer
2.0	05/04/2023	HVIN, FCC ID, IC number and Bluetooth antenna gain updated.	Ben Mercer
3.0	17/04/2023	HVIN updated	Ben Mercer
4.0	24/04/2023	HVIN updated	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 measurement of liquids, operating in the 75 GHz to 85 GHz band using FMCW. The EUT contains a Bluetooth LE transciever for commissioning and monitoring.

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:	47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Section 15.209
Specification Reference:	47CFR15.247
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Section 15.247
Specification Reference:	RSS-Gen Issue 5 February 2021
Specification Title:	General Requirements for Compliance of Radio Apparatus
Specification Reference:	RSS-211 Issue 1 March 2015
Specification Title:	Level Probing Radar Equipment
Specification Reference:	RSS-247 Issue 2 February 2017
Specification Title:	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
Site Registration:	FCC: 685609, ISEDC: 20903
FCC Lab Designation No.:	UK2011
ISEDC CABID:	UK0001
Location of Testing:	Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	04 February 2023 to 11 February 2023

1.3 Summary of Test Results

FCC Reference (47CFR)	ISED Canada Reference	Measurement	Result
15.31(q) / 15.209(a) / 15.247(d)	RSS-211 5.1(d) / RSS-Gen 6.13 / RSS-247 5.5	Transmitter Radiated 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	
Site 17	

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

2.2 Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference:	KDB 558074 D01 15.247 Meas Guidance v05r02, April 2, 2019
Title:	Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under Section 15.247 of the FCC Rules

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

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 2023	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	05 Sep 2023	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	02 Nov 2023	12
M2077	Test Receiver	Rohde & Schwarz	ESW44	102026	15 Feb 2023	12
M1874	Test Receiver	Rohde & Schwarz	ESU40	100553	19 May 2023	12
A3165	Magnetic Loop Antenna	ETS-Lindgren	6502	00224383	05 May 2023	12
A3154	Pre-Amplifier	Com-Power	PAM-103	18020012	18 Aug 2023	12
A3161	Antenna	Chase	CBL6111A	50859	03 May 2023	12
A3113	6dB Attenuator	AtlanTecRF	AN18-06	219706#3	03 May 2023	12
A3085	Low Pass Filter	AtlanTecRF	AFL-02000	18051600014	26 Jan 2024	12
A3138	Antenna	Schwarzbeck	BBHA 9120 B	00702	22 Aug 2023	12
A3139	Antenna	Schwarzbeck	HWRD750	00027	22 Aug 2023	12
A222867	Pre-Amplifier	Atlantic Microwave	A-LNAKX-380116-S5S5	210865001	26 Aug 2023	12
A2523	10dB Attenuator	AtlanTecRF	AN18W5-10	832827#1	26 Jan 2024	12
A3093	High Pass Filter	AtlanTecRF	AFH-03000	18051800077	26 Jan 2024	12
A212041	High Pass Filter	MICRO-TRONICS	HPS20723	001	26 Jan 2024	12
A2892	Antenna	Schwarzbeck	BBHA 9170	9170-727	31 Oct 2023	12
A3265	Pre-Amplifier	Schwarzbeck	BBV 9721	9721-069	31 Oct 2023	12
M1832	Signal Analyser	Keysight	N9010A	MY53470303	18 May 2024	24
A219915	Downconverter	Virginia Diodes	WR19SAX	SAX 897	14 Apr 2023	12
M2069	Downconverter	Virginia Diodes	WR15SAX	SAX 394	09 Jul 2023	24
M2064	Downconverter	Virginia Diodes	WR12SAX	SAX 325	29 Jul 2023	24
M2065	Downconverter	Virginia Diodes	WR10SAX	SAX 393	30 Jul 2023	24
M2066	Downconverter	Virginia Diodes	WR6.5SAX	SAX 392	31 May 2024	24
M2067	Downconverter	Virginia Diodes	WR4.3SAX	SAX 391	31 May 2024	24
A2963	Antenna	Link Microtek	AM19HA-ULV1	14929	20 Jun 2023	12
A2964	Antenna	Link Microtek	AM15HA-ULV1	14930	24 Jun 2023	12
A2967	Antenna	Link Microtek	AM10HA-ULV1	14933	13 Jul 2023	12
A1928	Antenna	Flann Microwave	29240-20	166411	04 Feb 2025	36
A1930	Antenna	Link Microtek	AM4HA-RFI1	None	04 Feb 2025	36

3 Equipment Under Test (EUT)

3.1 Identification of Equipment Under Test (EUT)

Brand Name:	VEGAPULS
Model No. / HVIN:	PS40WM
PMN:	VEGAPULS 42 (Antenna 1)
Test Sample Serial Number:	61489212 *(Radiated sample #1)*
Hardware Version:	1.0.0
Software Version:	1.0.0
FCC ID:	O6QPS40W
ISED Canada Certification Number:	IC: 3892A-PS40W
Date of Receipt:	20 January 2023

Brand Name:	VEGAPULS
Model No. / HVIN:	PS40WM
PMN:	VEGAPULS 42 (Antenna 3)
Test Sample Serial Number:	61489166 *(Radiated sample #2)*
Hardware Version:	1.0.0
Software Version:	1.0.0
FCC ID:	O6QPS40W
ISED Canada Certification Number:	IC: 3892A-PS40W
Date of Receipt:	20 January 2023

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		
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

Category of Equipment:	*Bluetooth* Low Energy (Digital Transmission System)
Channel Spacing:	2 MHz
Modulation:	GFSK
Data Rate: LE	1 Mbit/s
Data Rate: LE2M	2 Mbit/s
Data Rate: LE Coded S2	500 kbit/s
Data Rate: LE Coded S8	125 kbit/s
Transmit Frequency Range:	2400 MHz to 2483.5 MHz
Transmit Channels Tested:	Hopping

3.4 Description of Available Antennas

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

Radar

ID	Type	HPBW	Frequency Range (MHz)	Gain (dBi)
1	1” Thread	13.2°	75000 to 85000	22.2
2	¾” Thread	14.2°	75000 to 85000	18.2
3	1” Thread with Hygiene Adapter	14.1°	75000 to 85000	20.8

Bluetooth

Frequency Range (MHz)	Antenna Gain (dBi)
2400-2480	-2.0

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:	Test Laptop
Brand Name:	Lenovo
Model Name or Number:	L480
Serial Number:	PF1EJ3BY

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):

- The EUT was configured to simultaneously transmit *Bluetooth* LE in frequency hopping mode and level probing radar with 8 GHz chirp bandwidth.

Configuration and Peripherals

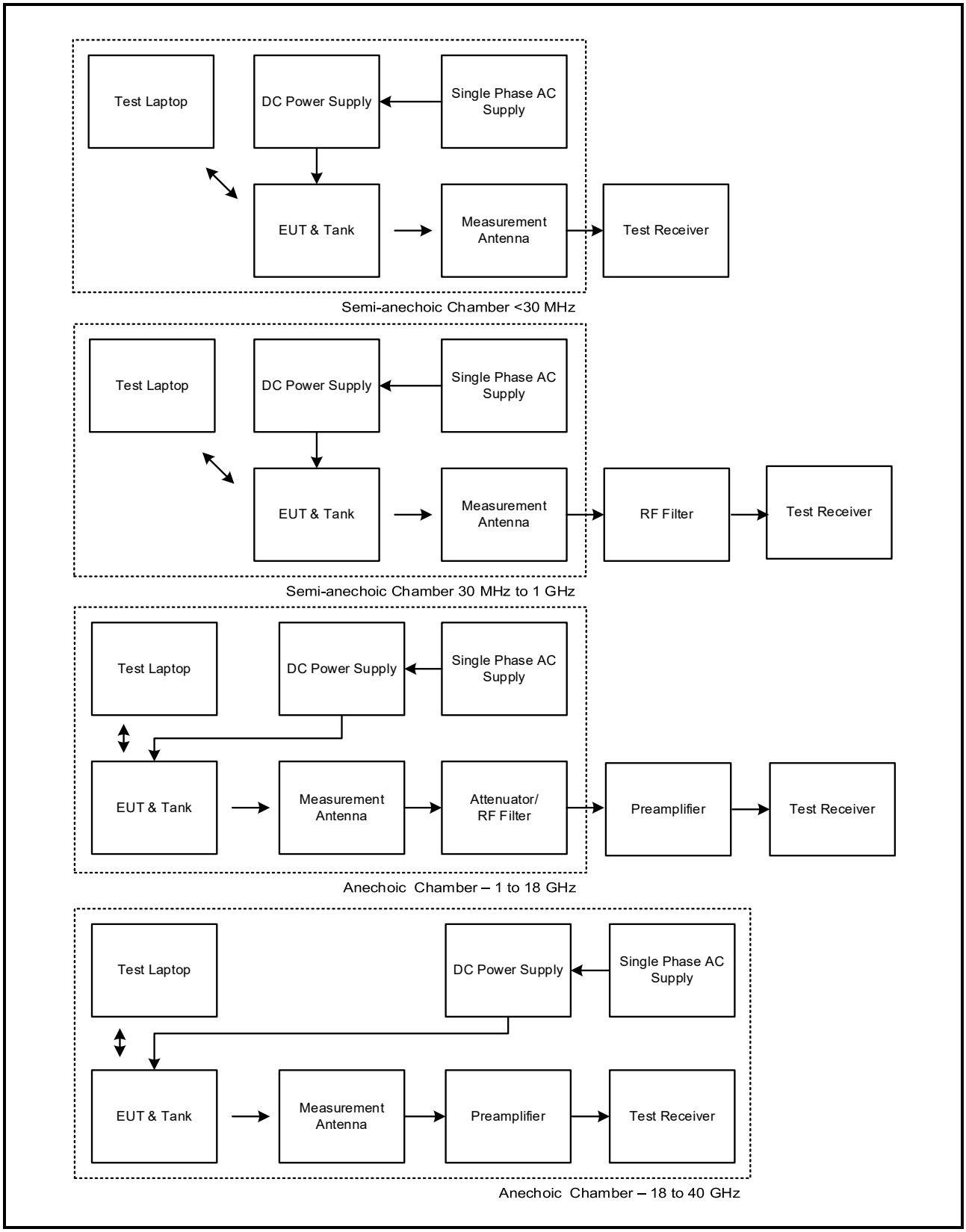
The EUT was tested in the following configuration(s):

- The radar transmission started automatically when the EUT was powered on. A test laptop with PACTware software application was used to enable a radiated *Bluetooth* LE connection with the EUT. The EUT transmitted radar information (fill level etc.) to the test laptop at regular intervals via the *Bluetooth* LE connection.
- The EUT was powered via a 24 VDC bench power supply.
- Radiated Transmitter Unwanted Emissions were performed with the EUT installed in a representative tank. The tank was placed on the turntable using non-conductive supports. No other accessories/peripherals were employed during test as there were no ports on the EUT to populate.
- Testing was performed with radar antennas 1 and 3 since these had the highest gain of each antenna type.

Test Setup Diagrams

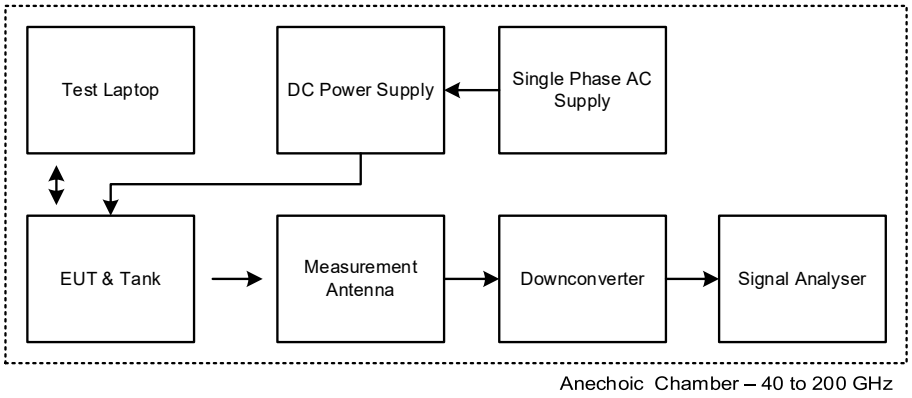
Radiated Tests:

Test Setup for Transmitter Radiated Emissions



Test Setup Diagrams (continued)

Test Setup for Transmitter Radiated Emissions (continued)



4 Radiated Test Results

4.1 Transmitter Radiated Emissions <1 GHz

Test Summary:

Test Engineer:	Vi Van	**Test Dates:**	05 February 2023 & 10 February 2023
Test Sample Serial Number:	61489212 & 61489166		

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):	20 to 21
Relative Humidity (%):	36

Note(s):

1. The purpose of the testing was to measure intermodulation products against the Radiated Spurious Emissions requirements when the EUT was transmitting *Bluetooth* LE and radar signals simultaneously.
2. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
3. All other emissions shown on the pre-scans were investigated and found to be ambient, >20 dB below the appropriate limit or below the noise floor of the measurement system.
4. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) at a distance of 3 metres. Radiated Transmitter Unwanted Emissions were performed with the EUT installed in a representative tank. The tank was placed on the turntable using non-conductive supports. No other accessories/peripherals were employed during test as there were no ports on the EUT to populate.
5. 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.
6. Pre-scans were performed and markers placed on the highest measured levels. The test receiver was configured as follows: For 9 kHz to 150 kHz, the resolution bandwidth was set to 300 Hz and video bandwidth 1 kHz. A peak detector was used and trace mode was Max Hold. For 150 kHz to 30 MHz, the resolution bandwidth was set to 10 kHz and video bandwidth 30 kHz, trace mode was Max Hold. For 30 MHz to 1 GHz, the resolution bandwidth was set to 120 kHz and video bandwidth 500 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.
7. Final measurements 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: Antenna 1 / Quasi-Peak

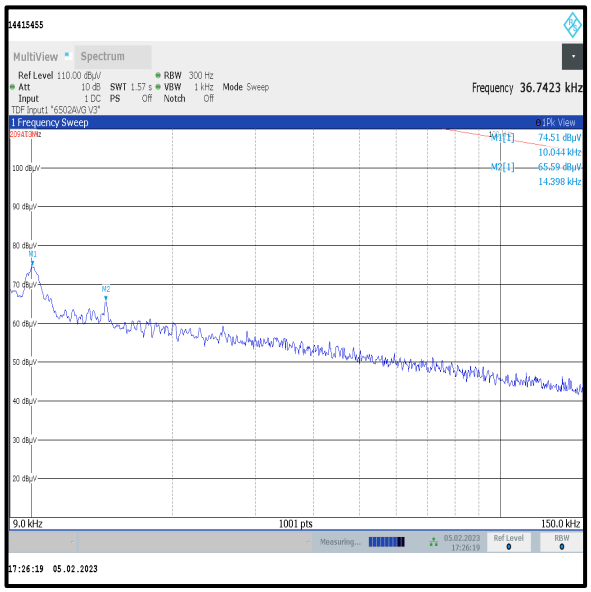
Frequency (MHz)	Antenna Polarity	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
168.006	Vertical	25.6	43	17.4	Complied
184.015	Vertical	25.1	43	17.9	Complied
200.002	Vertical	32.2	46	13.8	Complied
328.008	Vertical	37.0	46	9.0	Complied
344.000	Vertical	38.2	46	7.8	Complied
360.007	Vertical	34.2	46	11.8	Complied

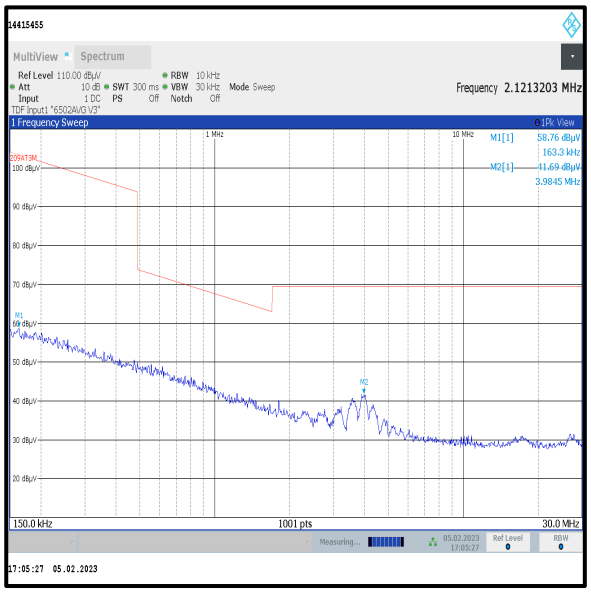
Results: Antenna 3 / Quasi-Peak

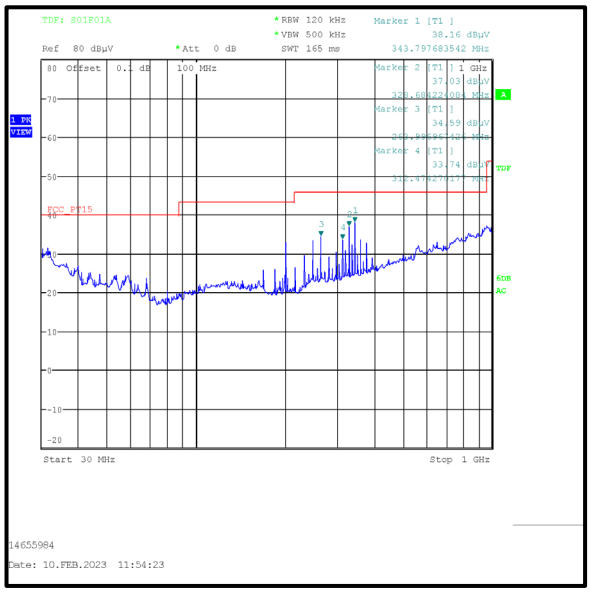
Frequency (MHz)	Antenna Polarity	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
40.010	Vertical	28.3	40	11.7	Complied
168.000	Vertical	26.4	43	16.6	Complied
184.021	Vertical	28.3	43	14.7	Complied
216.015	Vertical	25.9	46	20.1	Complied
232.002	Vertical	31.4	46	14.6	Complied
248.006	Vertical	36.2	46	9.8	Complied
264.003	Vertical	36.7	46	9.3	Complied
344.013	Vertical	32.3	46	13.7	Complied
359.997	Vertical	29.0	46	17.0	Complied

Transmitter Radiated Emissions (continued)

Antenna 1



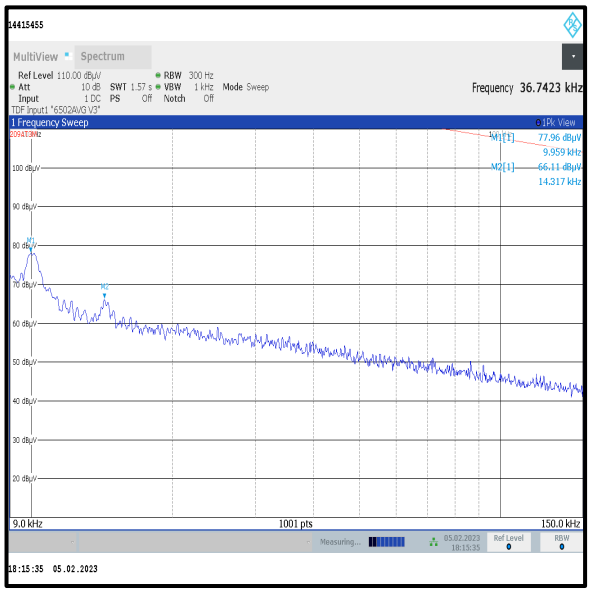


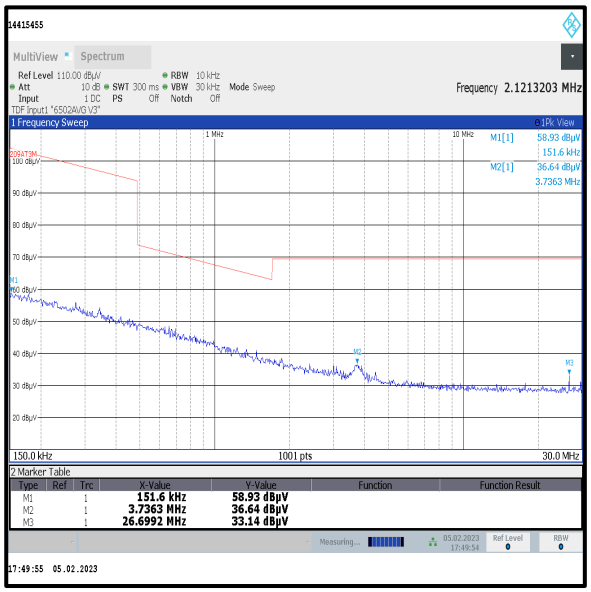


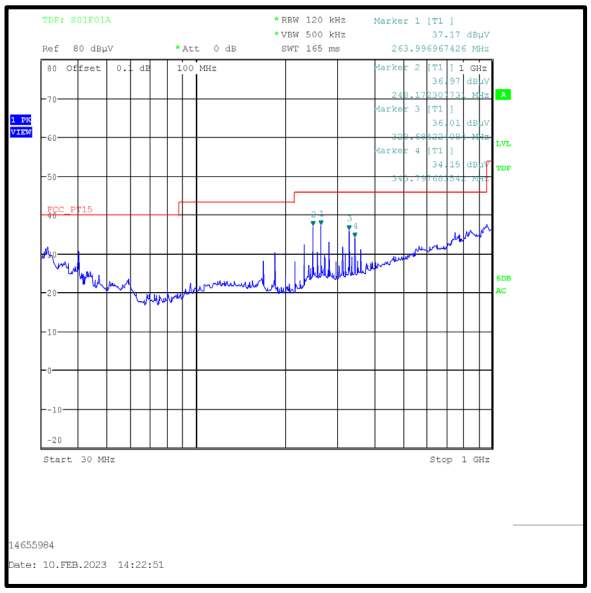
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying table.

Transmitter Radiated Emissions (continued)

Antenna 3







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:**	04 February 2023 to 11 February 2023
Test Sample Serial Number:	61489212 & 61489166		

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):	33 to 38
Relative Humidity (%):	19 to 21

Note(s):

1. The purpose of the testing was to measure intermodulation products against the Radiated Spurious Emissions requirements when the EUT was transmitting *Bluetooth* LE and radar signals simultaneously.
2. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
3. All other emissions shown on the pre-scans were investigated and found to be ambient, >20 dB below the appropriate limit or below the noise floor of the measurement system.
4. Radiated Transmitter Unwanted Emissions were performed with the EUT installed in a representative tank. The tank was placed on the turntable using non-conductive supports, the EUT is at 1.5m above the ground plance. No other accessories/peripherals were employed during test as there were no ports on the EUT to populate.
5. Pre-scans between 1 GHz and 18 GHz were performed in a fully anechoic chamber (Asset Number K0001) at a distance of 3 metres. Pre-scans between 18GHz and 40GHz were performed at a measurement distance of 1 metre.
6. Final measurements between 1 GHz and 40 GHz were performed in a fully anechoic chamber (Asset Number K0001). The tank was placed placed on the turntable using non-conductive supports in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
7. Measurements above 40 GHz were performed in accordance with ANSI C63.10 Clause 9.12.
8. 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

9. 1 GHz to 18 GHz pre-scan plots show an incorrect job number 14415455. The measurements were performed under job number 14655984.

Transmitter Radiated Emissions (continued)

Results: Antenna 1 Peak

Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2540.120	Vertical	47.3	74.0	16.7	Complied
2582.243	Vertical	47.8	74.0	16.2	Complied

Results: Antenna 1 Average

Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2540.120	Vertical	42.2	54.0	11.8	Complied
2582.243	Vertical	42.0	54.0	12.0	Complied

Results: Antenna 3 Peak

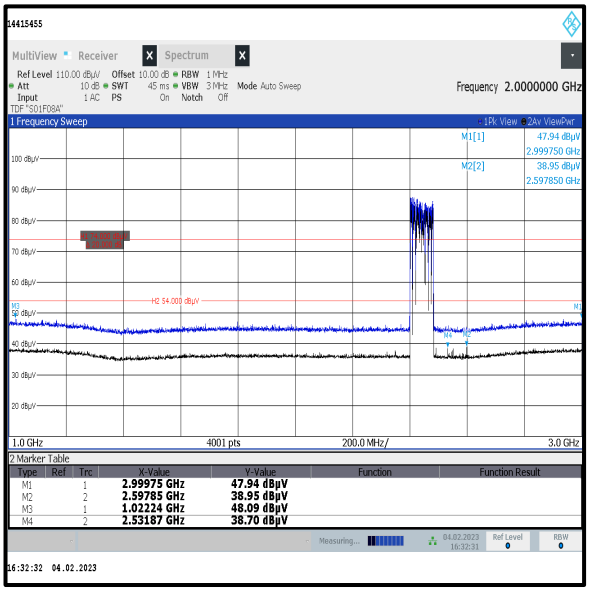
Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2532.036	Vertical	46.5	74.0	17.5	Complied

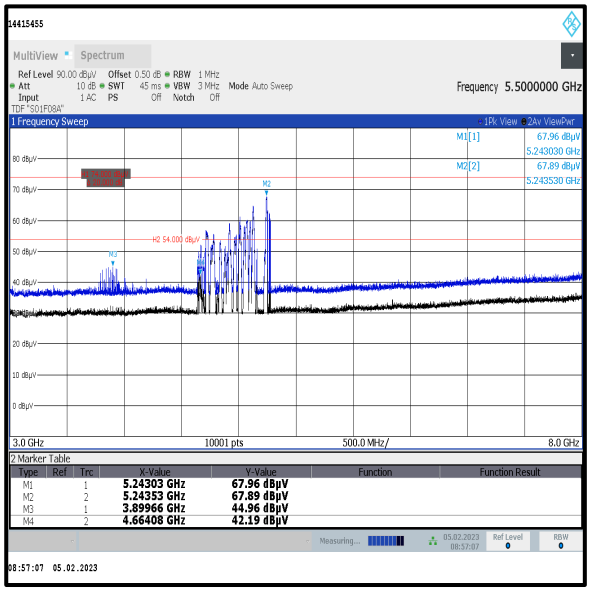
Results: Antenna 3 Average

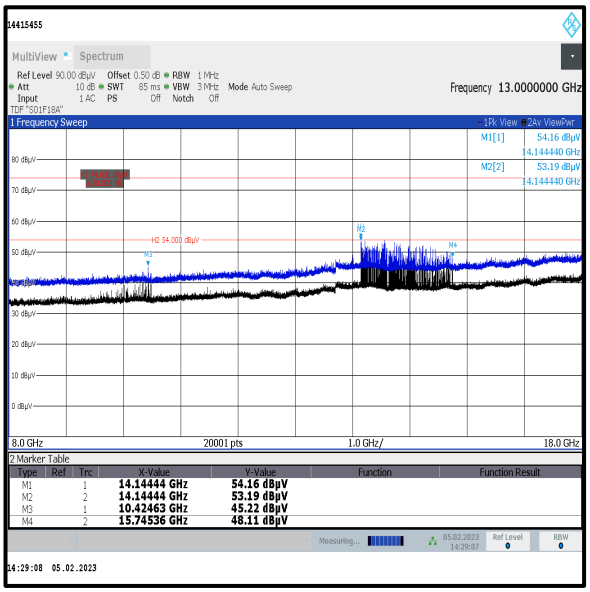
Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2532.036	Vertical	18.8	54.0	15.2	Complied

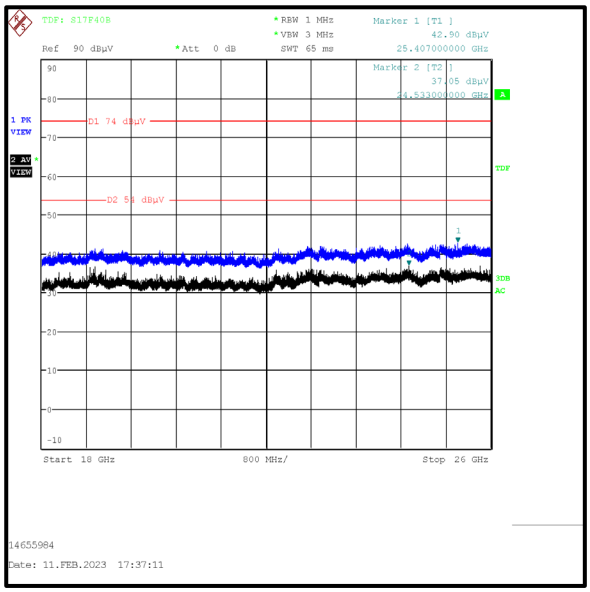
Transmitter Radiated Emissions (continued)

Antenna 1





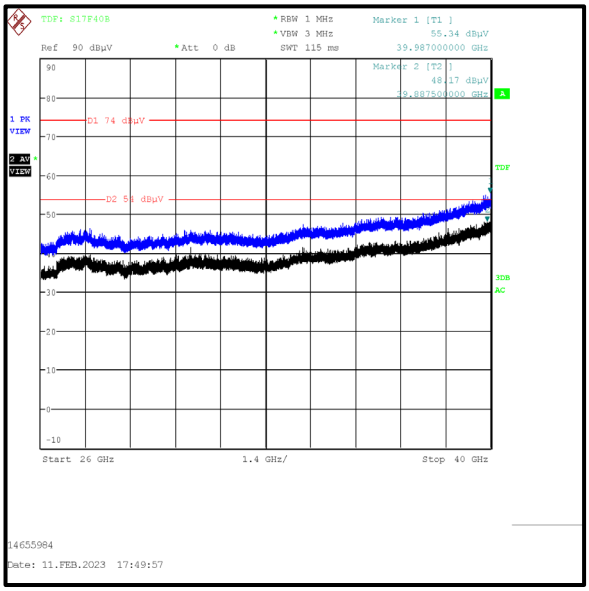


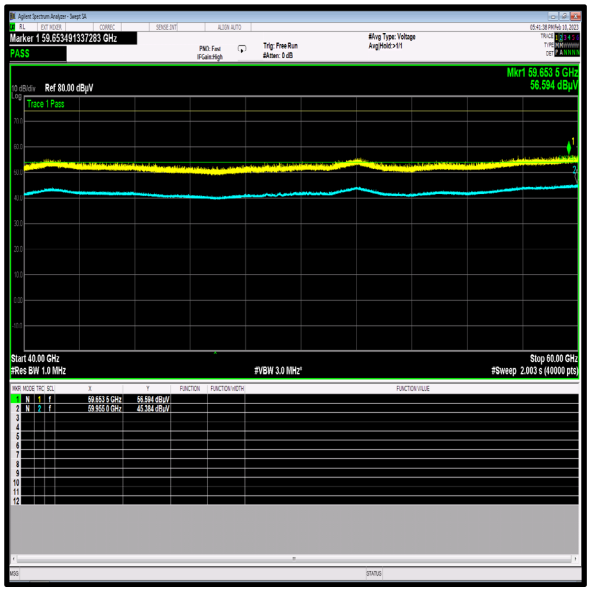


The above plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Radiated Emissions (continued)

Antenna 1

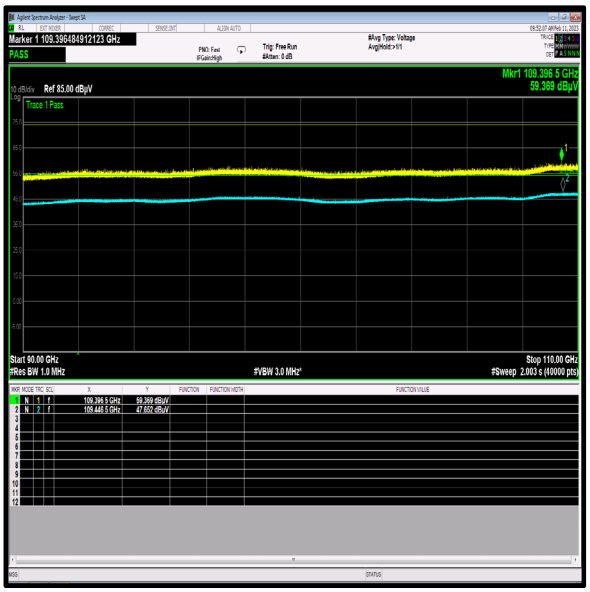


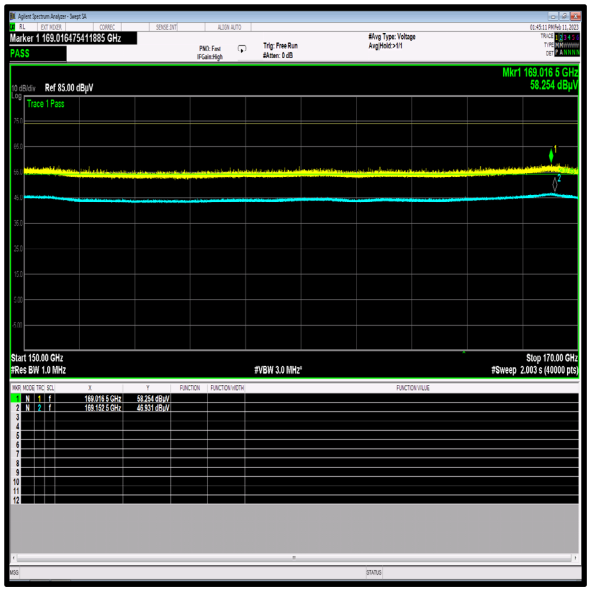


Note: The above plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Radiated Emissions (continued)

Antenna 1

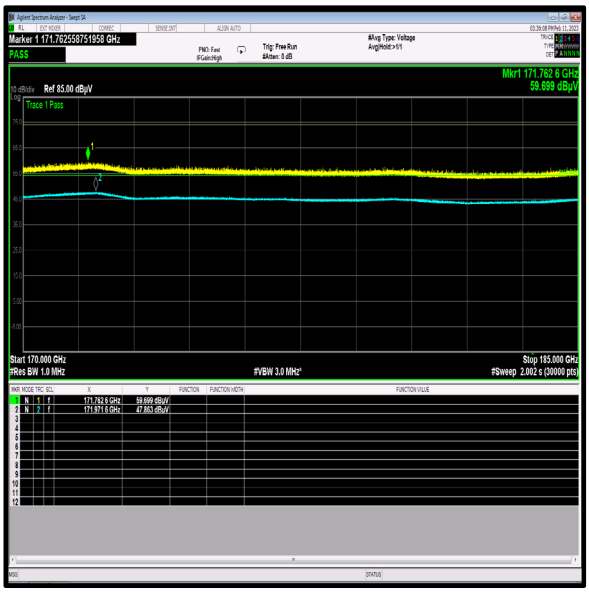




Note: The above plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Radiated Emissions (continued)

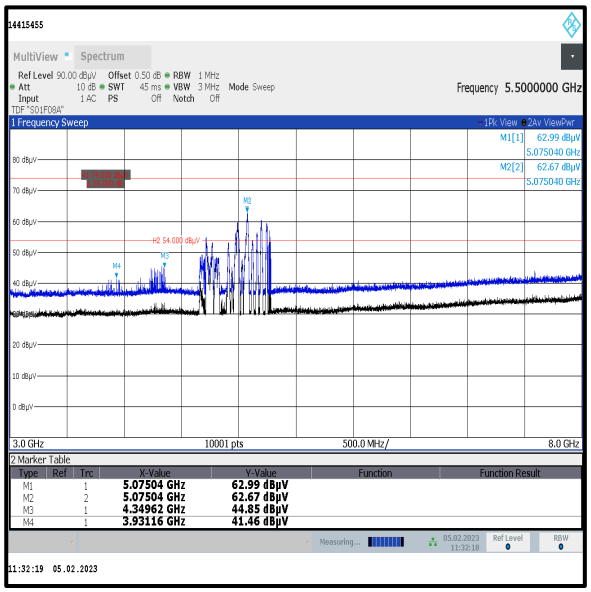
Antenna 1

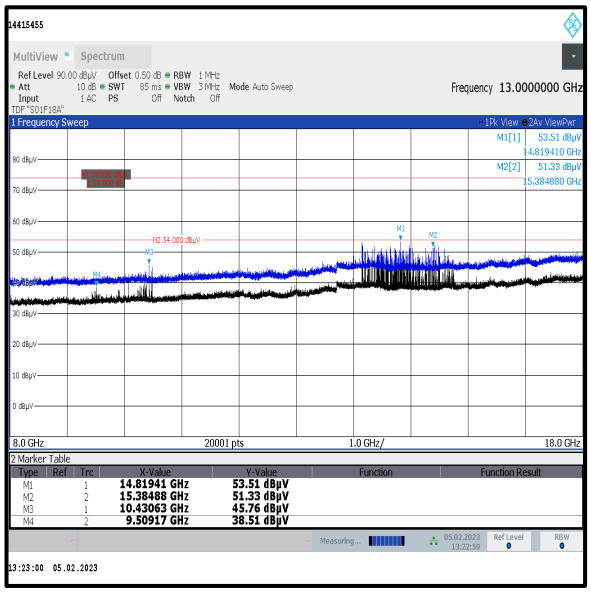


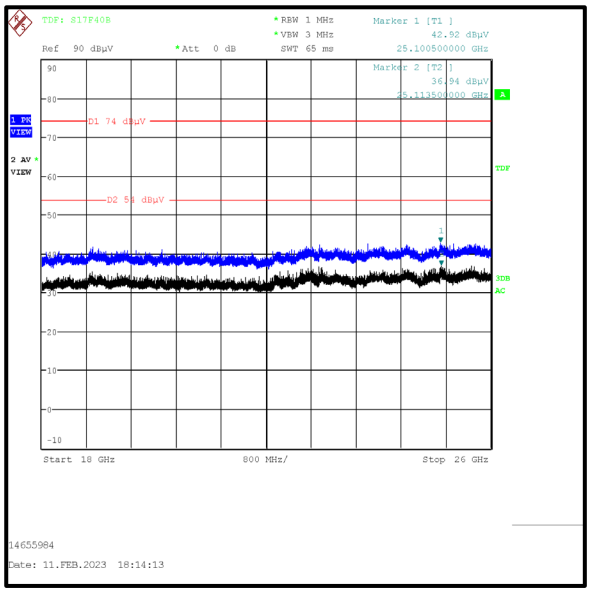
Note: The above plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Radiated Emissions (continued)

Antenna 3







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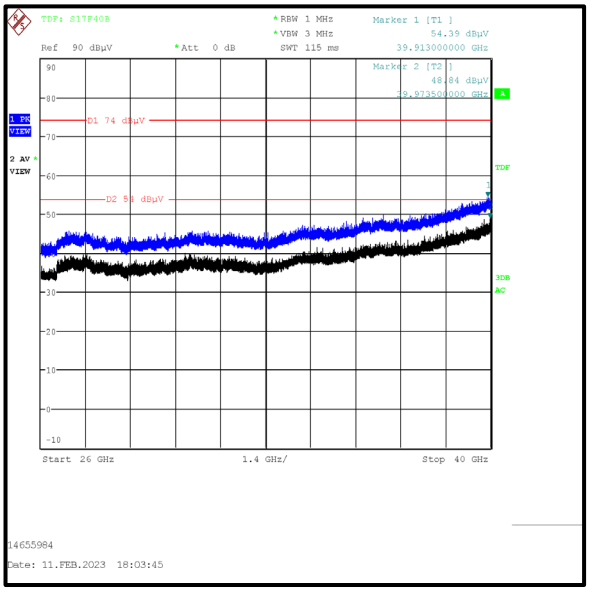
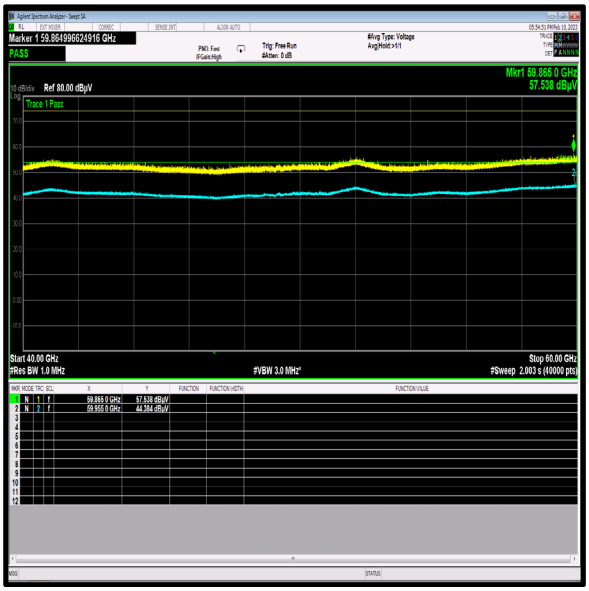
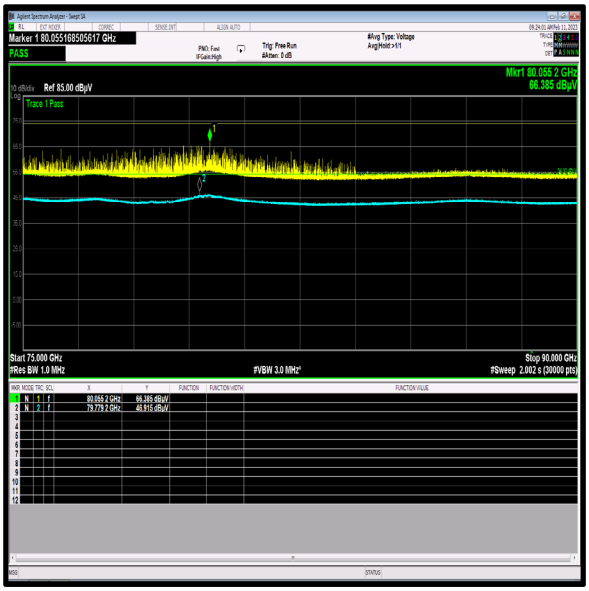
Transmitter Radiated Emissions (continued)

Antenna 3







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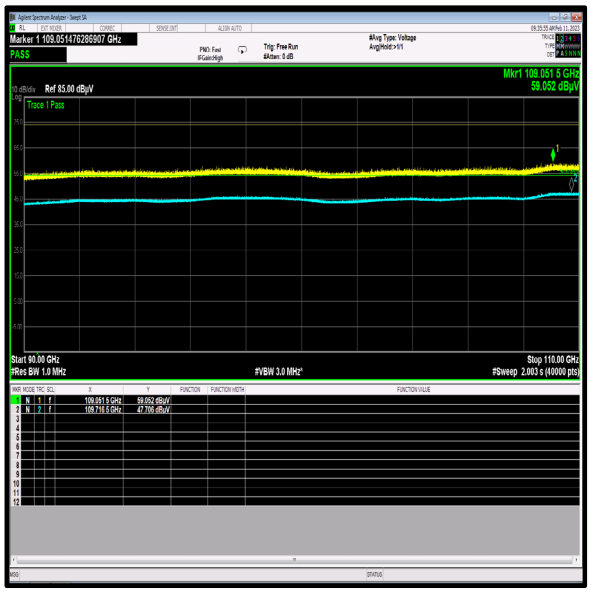
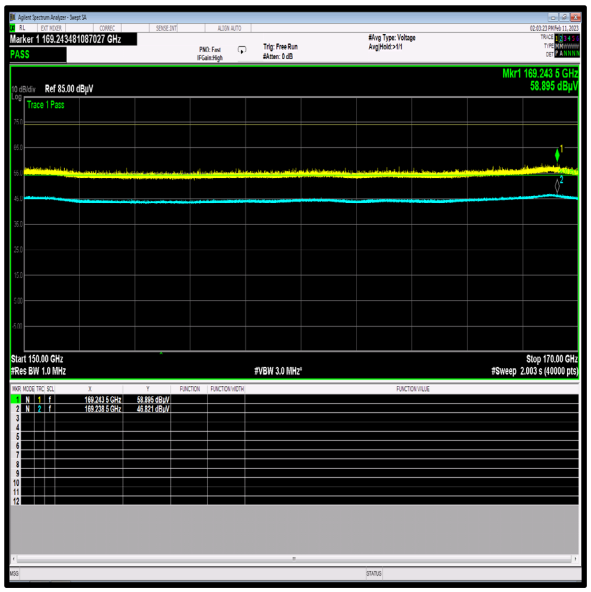
Transmitter Radiated Emissions (continued)

Antenna 3

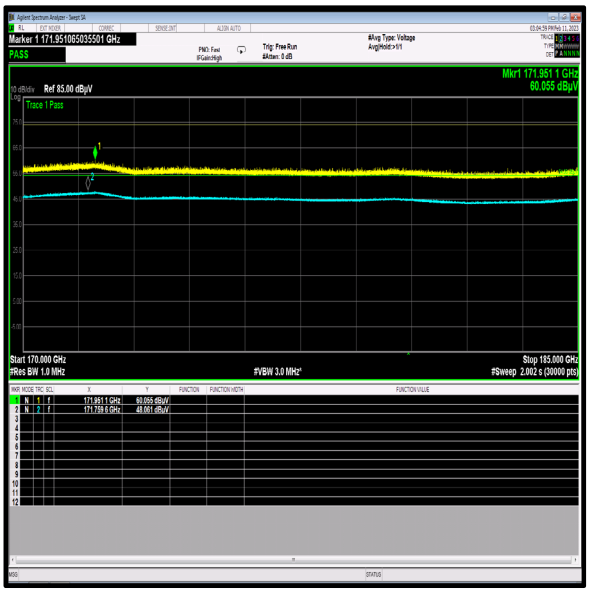


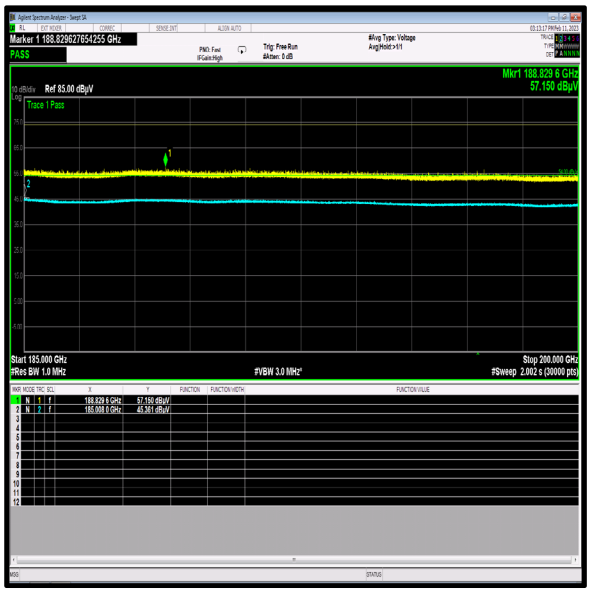


The above plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Radiated Emissions (continued)

Antenna 3





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