FCC and ISED Test Report

Apple Inc
Model: A2816

In accordance with FCC 47 CFR Part 15B, ICES-003 and ISED RSS-GEN (2.4 GHz Bluetooth, 2.4 GHz WLAN, 5 GHz WLAN, 6 GHz WLAN and Narrowband)

Prepared for: Apple Inc
One Apple Park Way, Cupertino
California, 95014, USA

FCC ID: BCGA2816 IC: 579C-A2816

Add value.
Inspire trust.

TUV SUD Digitally signed by TUV SUD Date: 2022.11.22 09:42:59 Z

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Document 75954420-02 Issue 01

SIGNATURE			
AJ Lawson			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Andrew Lawson	Chief Engineer, EMC	Authorised Signatory	22 November 2022

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD document control rules.

ENGINEERING STATEMENT
The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC 47 CFR Part 15B, ICES-003 and ISED RSS-GEN. The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Report Generation	Hollie Marshall	22 November 2022	

FCC Accreditation
90987 Octagon House, Fareham Test Laboratory

ISED Accreditation
12669A Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY
A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15B: 2020, ICES-003: Issue 7: 2020 and ISED RSS-GEN: Issue 5 (04-2018) + A2 (2021-02) for the tests detailed in section 1.3.

TÜV SÜD
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Glasgow G75 0QF, United Kingdom
Registered number: SC215164

TUV SUD Ltd is a
TÜV SÜD Group Company

Phone: +44 (0) 1489 558100
Fax: +44 (0) 1489 558101
www.tuvsud.com/en

TÜV SÜD
Octagon House
Concorde Way
Fareham
Hampshire PO15 5RL
United Kingdom

Contents

1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	22 November 2022

Table 1

1.2 Introduction

Applicant	Apple Inc
Manufacturer	Apple Inc
Model Number(s)	A2816
Serial Number(s)	LWPX9T56K4, Q64HTFJ22X and V712HT2WFF
Hardware Version(s)	REV 1.0
Software Version(s)	22A8375, 22A12320r and 22A12320r
Number of Samples Tested	3
Test Specification/Issue/Date	FCC 47 CFR Part 15B: 2020 ICES-003: Issue 7: 2020 ISED RSS-GEN: Issue 5 (04-2018) + A2 (02-2021)
Order Number	0540246998
Start of Test	13-October-2022
Finish of Test	09-November-2022
Name of Engineer(s)	Matthew Dawkins, Ahmad Javid, Pier Lorusso and Mohammad Malik
Related Document(s)	ANSI C63.4: 2014

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 15B, ICES-003 and ISED RSS-GEN is shown below.

Section	Specification Clause			Test Description	Result	Comments/Base Standard
	FCC Part 15	ICES-003	RSS-GEN			
Configuration and Mode: AC Powered - Transmitter Idle						
2.1	15.107	3.1	8.8	Conducted Disturbance at Mains Terminals	Pass	ANSI C63.4: 2014
2.2	15.109	3.2	7.1	Radiated Disturbance	Pass	ANSI C63.4: 2014

Table 2

1.4 Product Information

1.4.1 Technical Description

The equipment under test was an Apple desktop computer with Bluetooth® and IEEE 802.11 a/b/g/n/ac/ax Wi-Fi in the 2.4GHz, 5GHz and 6GHz bands.

1.4.2 EUT Port/Cable Identification

Port	Max Cable Length specified	Usage	Type	Screened
Configuration and Mode: 120 V AC Powered - Transmitter Idle				
AC Power Port - Live Line	2 m	Mains power to the EUT's AC/DC adapter	AC/DC adapter with USB-C output to EUT	No
AC Power Port - Neutral Line	2 m	Mains power to the EUT's AC/DC adapter	AC/DC adapter with USB-C output to EUT	No

Table 3

1.4.3 Test Configuration

Configuration	Description
120 V AC Powered	The EUT was powered from an AC/DC adapter using a USB-C output. The AC/DC adapter was supplied from a 120 V 60 Hz supply. A set of headphones was used to terminate the EUT's 3.5 mm audio jack port. A supplied support keyboard and cable were used to terminate the EUT's left hand side USB-C port. A mouse and adaptor were used to terminate the additional USB-C port on the right hand side of the EUT. A monitor was used to terminate the HDMI port.

Table 4

1.4.4 Modes of Operation

Mode	Description
Transmitter Idle	The EUT was configured to play audio through the headphones. A monitor was used to allow display settings of the EUT to set the brightness at maximum. Sleep mode was disabled and all transmitters were disabled.

Table 5

1.5 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

1.6 EUT Modification Record

The table below details modifications made to the EUT during the test programme.
The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Model: A2816, Serial Number: Q64HTFJ22X			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: A2816, Serial Number: V712HT2WFF			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: A2816, Serial Number: LWPX9T56K4			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 6

1.7 Test Location

TÜV SÜD conducted the following tests at our Octagon House Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: 120 V AC Powered - Transmitter Idle		
Conducted Disturbance at Mains Terminals	Matthew Dawkins	UKAS
Radiated Disturbance	Ahmad Javid and Pier Lorusso	UKAS

Table 7

Office Address:

TÜV SÜD
Octagon House
Concorde Way
Fareham
Hampshire
PO15 5RL, United Kingdom

TÜV SÜD conducted the following tests at our Concorde Park Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: 120 V AC Powered - Transmitter Idle		
Radiated Disturbance	Mohammad Malik	UKAS

Table 8

Office Address:

TÜV SÜD
Concorde Park
Concorde Way
Fareham
Hampshire
PO15 5FG, United Kingdom

2 Test Details

2.1 Conducted Disturbance at Mains Terminals

2.1.1 Specification Reference

FCC 47 CFR Part 15B, Clause 15.107
ICES-003, Clause 3.1
ISED RSS-GEN, Clause 8.8

2.1.2 Equipment Under Test and Modification State

A2816, S/N: LWPX9T56K4 - Modification State 0

2.1.3 Date of Test

28-October-2022

2.1.4 Test Method

The EUT was setup according to ANSI C63.4, clause 5.2.

The EUT was placed on a non-conductive table 0.8 m above a reference ground plane. A vertical coupling plane was placed 0.4 m from the EUT boundary.

A Line Impedance Stabilisation Network (LISN) was directly bonded to the ground-plane. The EUT was located so that the distance between the boundary of the EUT and the closest surface of the LISN was 0.8 m.

Interconnecting cables that hanged closer than 0.4 m to the ground plane were folded back and forth in the centre forming a bundle 0.3 m to 0.4 m long.

Input and output cables were terminated with equipment or loads representative of real usage conditions.

The EUT was configured to give the highest level of emissions within reason of a typical installation as described by the manufacturer.

2.1.5 Example Calculation

Quasi-Peak level (dBµV) = Receiver level (dBµV) + Correction Factor (dB)
Margin (dB) = Quasi-Peak level (dBµV) - Limit (dBµV)

CISPR Average level (dBµV) = Receiver level (dBµV) + Correction Factor (dB)
Margin (dB) = CISPR Average level (dBµV) - Limit (dBµV)

2.1.6 Test Setup Diagram

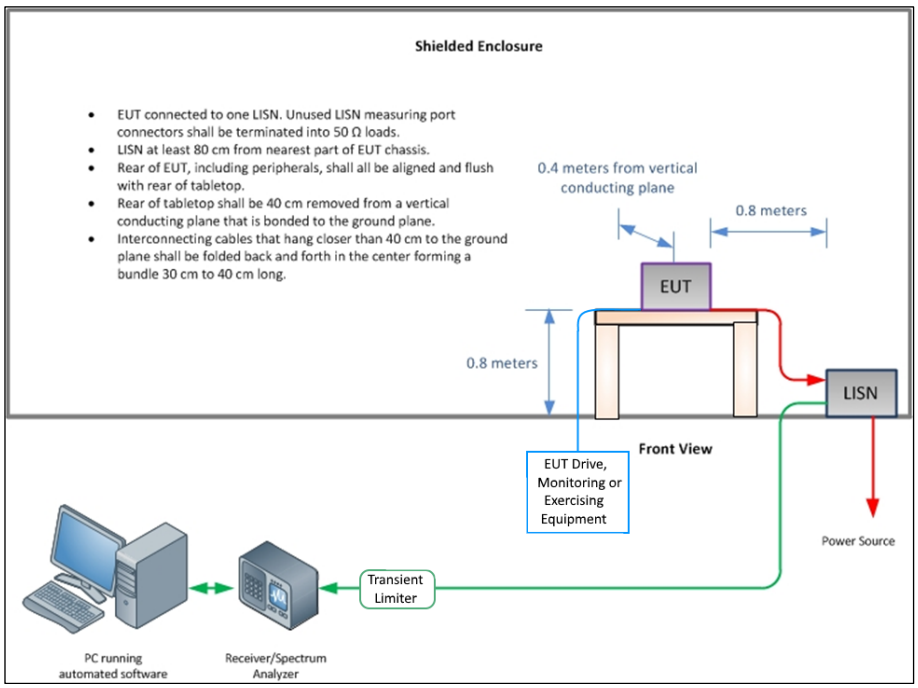

Figure 1 - Conducted Emissions - Example Test Setup Diagram

2.1.7 Environmental Conditions

Ambient Temperature	19.5 °C
Relative Humidity	60.2 %
Atmospheric Pressure	1004.0 mbar

2.1.8 Specification Limits

Required Specification Limits - Class B			
Line Under Test	Frequency Range (MHz)	Quasi-Peak Test Limit (dBµV)	CISPR Average Test Limit (dBµV)
AC Power Port	0.15 to 0.5	66 to 56[(1)]	56 to 46[(1)]
	0.5 to 5	56	46
	5 to 30	60	50
Supplementary information: Note 1. Decreases with the logarithm of the frequency.			

Table 9

2.1.9 Test Results

Results for Configuration and Mode: 120 V AC Powered - Transmitter Idle.

This test was performed to the requirements of the Class B limits.

Performance assessment of the EUT made during this test: Pass.

Detailed results are shown below.

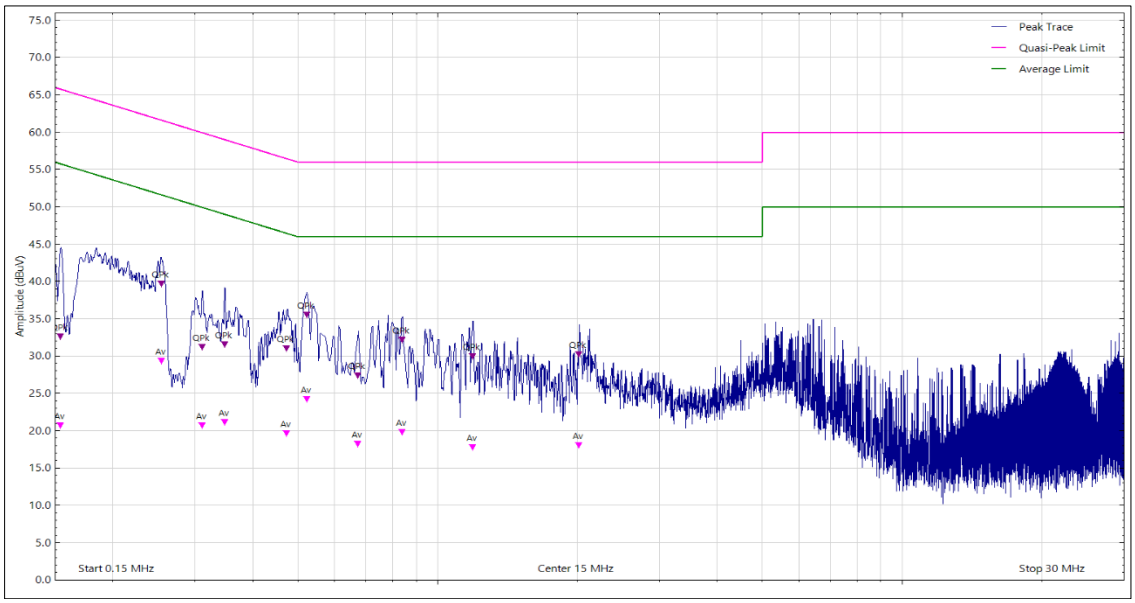

Figure 2 - Graphical Results - Live Line

Frequency (MHz)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector
0.154	32.01	65.80	-33.79	Q-Peak
0.154	20.08	55.80	-35.72	CISPR Avg
0.254	39.07	61.60	-22.53	Q-Peak
0.254	28.77	51.60	-22.83	CISPR Avg
0.311	20.08	49.90	-29.82	CISPR Avg
0.311	30.62	59.90	-29.28	Q-Peak
0.348	20.51	49.00	-28.49	CISPR Avg
0.348	30.98	59.00	-28.02	Q-Peak
0.473	18.99	46.50	-27.51	CISPR Avg
0.473	30.40	56.50	-26.10	Q-Peak
0.523	34.95	56.00	-21.05	Q-Peak
0.523	23.57	46.00	-22.43	CISPR Avg
0.674	26.82	56.00	-29.18	Q-Peak
0.674	17.63	46.00	-28.37	CISPR Avg
0.839	19.23	46.00	-26.77	CISPR Avg
0.839	31.52	56.00	-24.48	Q-Peak
1.188	29.31	56.00	-26.69	Q-Peak
1.188	17.14	46.00	-28.86	CISPR Avg
2.015	29.60	56.00	-26.40	Q-Peak
2.015	17.47	46.00	-28.53	CISPR Avg

Table 10

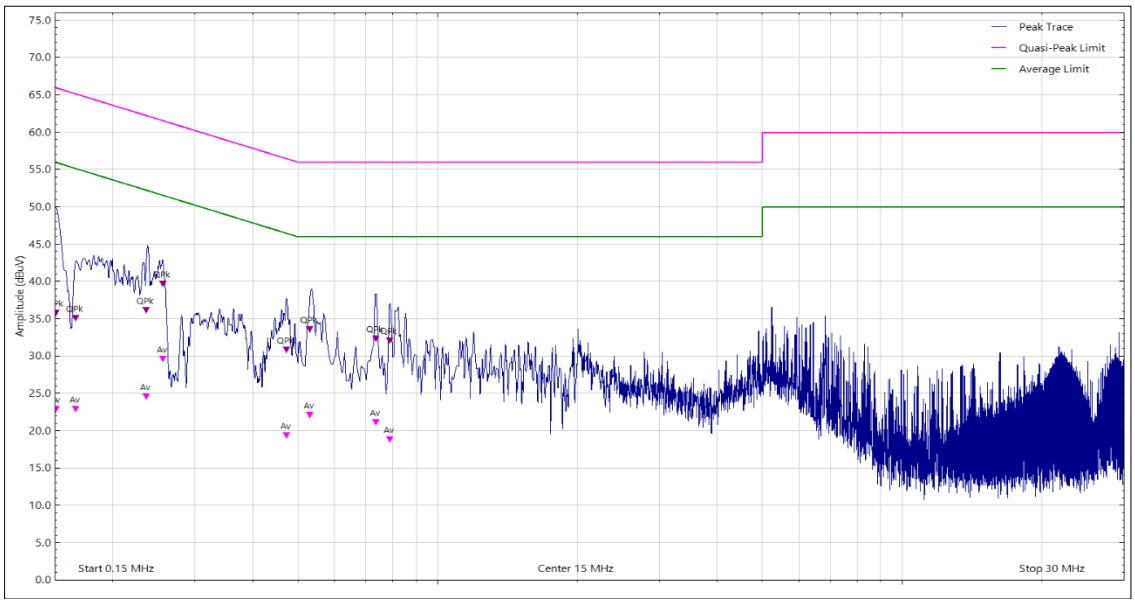

Figure 3 - Graphical Results - Neutral Line

Frequency (MHz)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector
0.151	22.29	55.90	-33.61	CISPR Avg
0.151	35.21	65.90	-30.69	Q-Peak
0.166	22.29	55.20	-32.91	CISPR Avg
0.166	34.47	65.20	-30.73	Q-Peak
0.236	23.93	52.20	-28.27	CISPR Avg
0.236	35.55	62.20	-26.65	Q-Peak
0.256	39.07	61.60	-22.53	Q-Peak
0.256	29.02	51.60	-22.58	CISPR Avg
0.472	18.77	46.50	-27.73	CISPR Avg
0.472	30.20	56.50	-26.30	Q-Peak
0.531	21.52	46.00	-24.48	CISPR Avg
0.531	32.97	56.00	-23.03	Q-Peak
0.736	20.49	46.00	-25.51	CISPR Avg
0.736	31.72	56.00	-24.28	Q-Peak
0.790	18.26	46.00	-27.74	CISPR Avg
0.790	31.49	56.00	-24.51	Q-Peak

Table 11

2.1.10 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 12.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Screened Room (12)	MVG	EMC-3	5621	36	11-Aug-2023
Emissions Software	TUV SUD	EmX V3.1.4	5125	-	Software
Test Receiver	Rohde & Schwarz	ESU40	3506	12	25-Mar-2023
Transient Limiter	Hewlett Packard	11947A	2377	12	28-Feb-2023
Load (50ohm, 30W)	Weinschel	50T-054-201	5468	12	02-Mar-2023
Cable (SMA to SMA, 2 m)	Rhophase	3PS-1801A-2000-3PS	4113	12	27-Jan-2023
Cable (N-Type to N-Type, 8 m)	Scott Cables	FSB800-NMNM-08.00M	6054	6	23-Dec-2022
LISN (CISPR 16, Single Phase)	Chase	MN 2050	336	12	04-Jul-2023
LISN (CISPR 16, Single Phase)	Rohde & Schwarz	ESH3-Z5	1390	12	31-Jan-2023

Table 12

2.2 Radiated Disturbance

2.2.1 Specification Reference

FCC 47 CFR Part 15B, Clause 15.109
ICES-003, Clause 3.2
ISED RSS-GEN, Clause 7.1

2.2.2 Equipment Under Test and Modification State

A2816, S/N: Q64HTFJ22X - Modification State 0
A2816, S/N: V712HT2WFF - Modification State 0

2.2.3 Date of Test

13-October-2022 to 09-November-2022

2.2.4 Test Method

The EUT was set up on a non-conductive table 0.8 m above a reference ground plane within a semi-anechoic chamber on a remotely controlled turntable.

A pre-scan of the EUT emissions profile using a peak detector was made at a 3 m antenna distance whilst varying the antenna-to-EUT azimuth and polarisation.

For an EUT which could reasonable be used in multiple planes, pre-scans were performed with the EUT orientated in X, Y and Z planes with reference to the ground plane.

Using a list of the highest emissions detected during the pre-scan along with their bearing and associated antenna polarisation, the EUT was then formally measured using a Quasi-Peak, Peak or CISPR Average detector as appropriate.

The readings were maximised by adjusting the antenna height, polarisation and turntable azimuth, in accordance with the specification.

2.2.5 Example Calculation

Below 1 GHz:

Quasi-Peak level (dBµV/m) = Receiver level (dBµV) + Correction Factor (dB/m)
Margin (dB) = Quasi-Peak level (dBµV/m) - Limit (dBµV/m)

Above 1 GHz:

CISPR Average level (dBµV/m) = Receiver level (dBµV) + Correction Factor (dB/m)
Margin (dB) = CISPR Average level (dBµV/m) - Limit (dBµV/m)

Peak level (dBµV/m) = Receiver level (dBµV) + Correction Factor (dB/m)

2.2.6 Test Setup Diagram

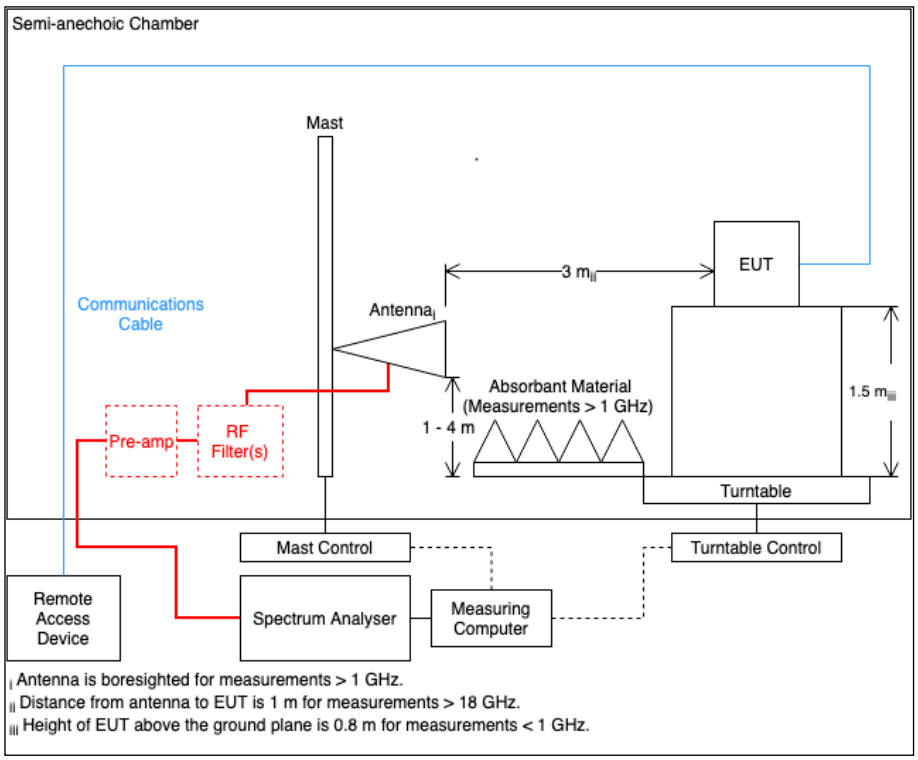

Figure 4 – Radiated Emissions - Example Test Setup Diagram

2.2.7 Environmental Conditions

Ambient Temperature	20.3 - 23.5 °C
Relative Humidity	38.4 - 58.3 %
Atmospheric Pressure	1011.0 mbar

2.2.8 Specification Limits

Required Specification Limits, Field Strength - Class B Test Limit at a 3 m Measurement Distance		
Frequency Range (MHz)	Test Limit (µV/m)	Test Limit (dBµV/m)
30 to 88	100	40.0
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0
Supplementary information: Note 1. A Quasi-peak detector is to be used for measurements below 1 GHz. Note 2. A CISPR Average detector is to be used for measurements above 1 GHz. Note 3. The Peak test limit above 1 GHz is 20 dB higher than the CISPR Average test limit.		

Table 13

2.2.9 Test Results

Results for Configuration and Mode: 120 V AC Powered - Transmitter Idle.

This test was performed to the requirements of the Class B limits.

Performance assessment of the EUT made during this test: Pass.

Detailed results are shown below.

Highest frequency generated or used within the EUT: 7125 MHz
Which necessitates an upper frequency test limit of: 40 GHz

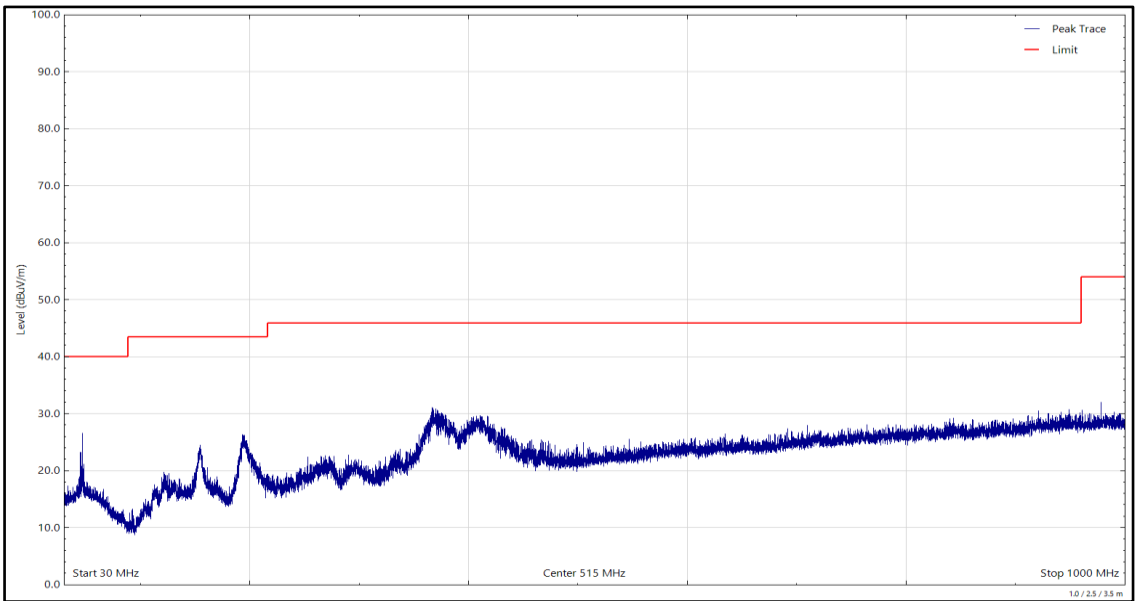

Figure 5 - 30 MHz to 1 GHz, Quasi-Peak, Horizontal

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
*							

Table 14

*No final measurements were made as all peak emissions seen above the measurement system noise floor during the pre-scan were greater than 10 dB below the test limit.

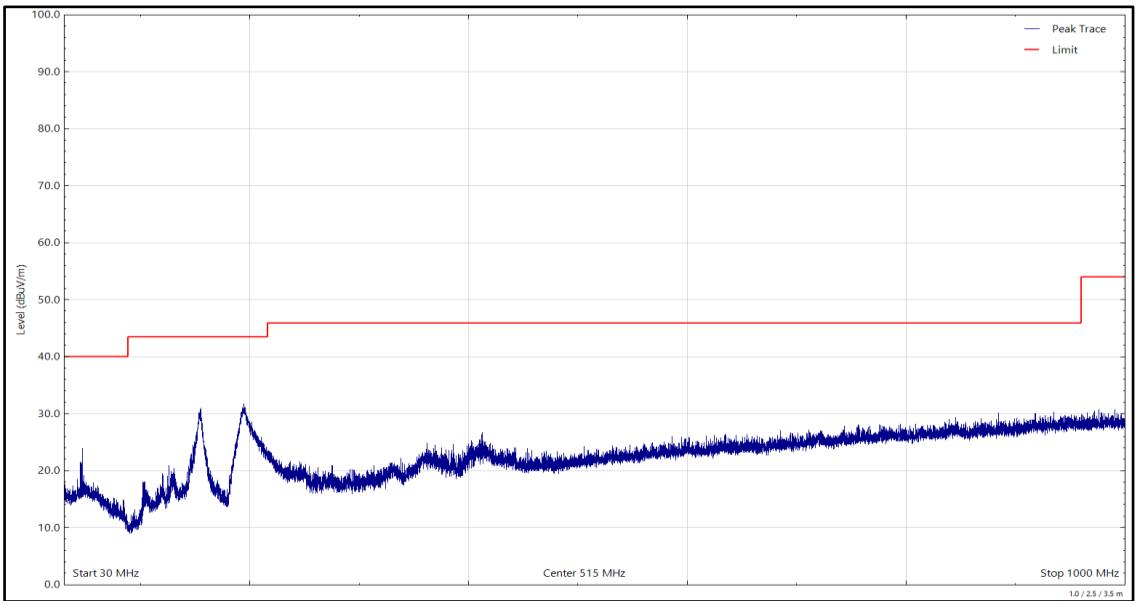

Figure 6 - 30 MHz to 1 GHz, Quasi-Peak, Vertical

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
*							

Table 15

*No final measurements were made as all peak emissions seen above the measurement system noise floor during the pre-scan were greater than 10 dB below the test limit.

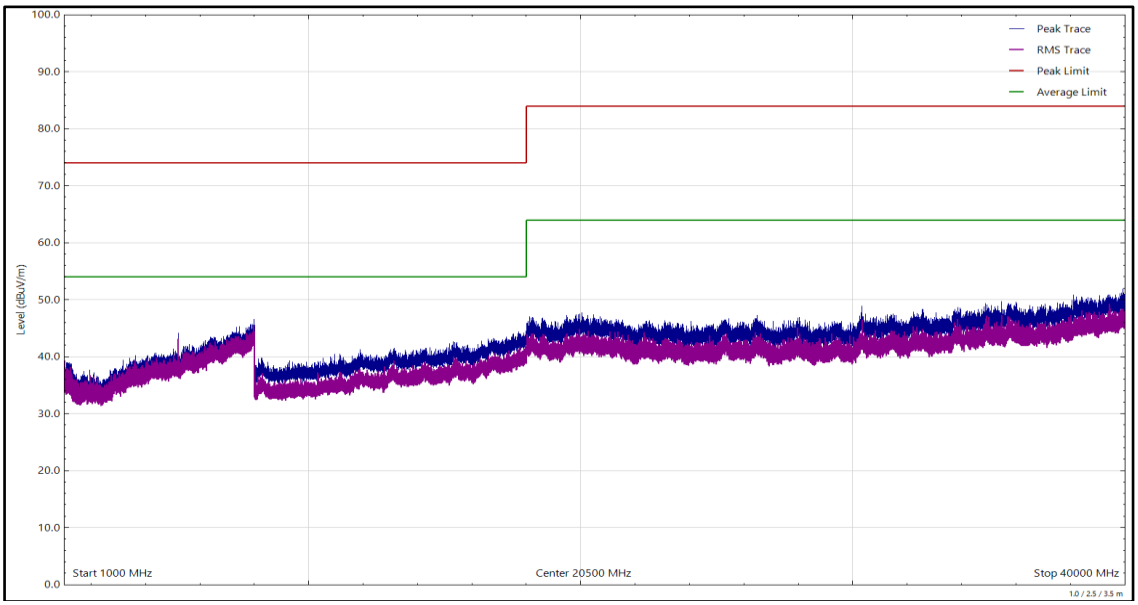

Figure 7 - 1 GHz to 40 GHz, Peak, Horizontal

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
*							

Table 16

*No final measurements were made as all peak emissions seen above the measurement system noise floor during the pre-scan were greater than 10 dB below the test limit.

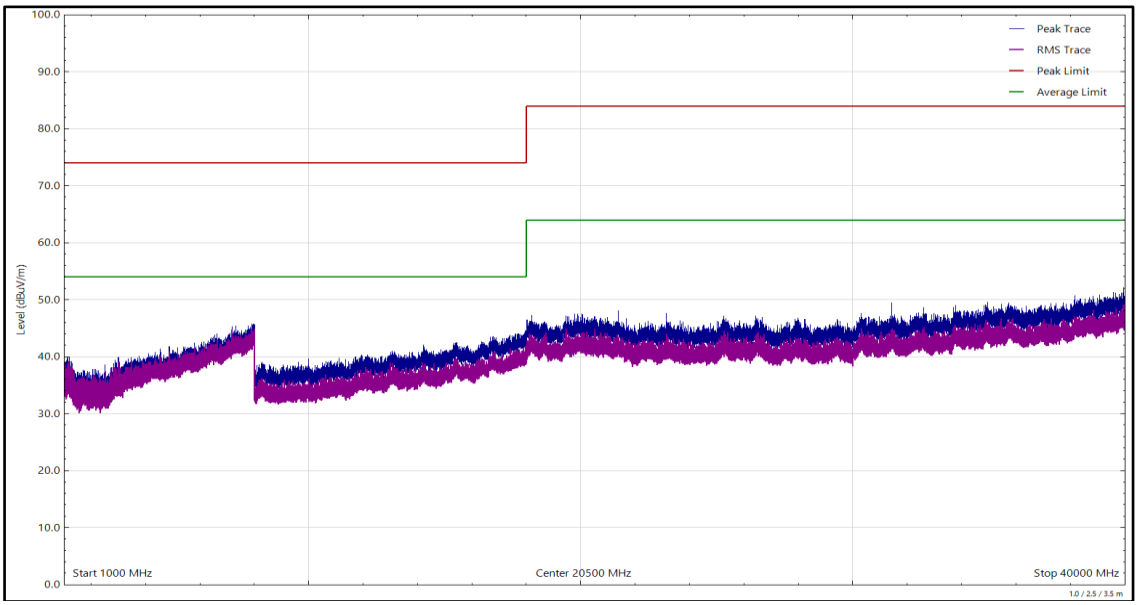

Figure 8 - 1 GHz to 40 GHz, Peak, Vertical

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
*							

Table 17

*No final measurements were made as all peak emissions seen above the measurement system noise floor during the pre-scan were greater than 10 dB below the test limit.

2.2.10 Test Location and Test Equipment Used

This test was carried out in RF Chamber 11 and RF Chamber 15.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Screened Room (11)	Rainford	Rainford	5136	36	24-Nov-2024
5m Semi-Anechoic Chamber (Dual-Axis)	Albatross Projects	RF Chamber 15	5963	36	28-Apr-2025
Emissions Software	TUV SUD	EmX V3.1.4	5125	-	Software
EMI Test Receiver	Rohde & Schwarz	ESW44	5084	12	17-May-2023
EMI Test Receiver	Rohde & Schwarz	ESW44	5911	12	24-Feb-2023
Mast	Maturo	TAM 4.0-P	5158	-	TU
Mast and Turntable Controller	Maturo	Maturo NCD	5159	-	TU
Turntable	Maturo	TT 15WF	5160	-	TU
Compact Antenna Mast	Maturo Gmbh	CAM4.0-P	5964	-	TU
Mast & Turntable Controller	Maturo Gmbh	FCU3.0	5966	-	TU
Turntable	Maturo Gmbh	TT1.5SI	5968	-	TU
Cable (18 GHz)	Rosenberger	LU7-071-1000	5102	12	20-Oct-2022*
Cable (18 GHz)	Rosenberger	LU7-071-1000	5103	12	17-Nov-2022
2m SMA Cable	Junkosha	MWX221-02000AMSAMS/A	5518	12	12-Apr-2023
Cable (K Type 2m)	Junkosha	MWX241-02000KMSKMS/B	5937	12	14-May-2023
8m N Type Cable	Junkosha	MWX221-08000NMSNMS/B	5522	12	24-Mar-2023
Preamplifier (30dB 1GHz to 18GHz)	Schwarzbeck	BBV 9718 C	5261	12	08-Apr-2023
Pre-Amplifier (8 GHz to 18 GHz)	Phase One	PS04-0086	1533	12	21-Feb-2023
Attenuator 4dB	Pasternack	PE7074-4	6204	24	16-Jul-2024
TRILOG Super Broadband Test Antenna	Schwarzbeck	VULB 9168	5942	24	03-Feb-2024
Antenna (DRG 1-10.5GHz)	Schwarzbeck	BBHA9120B	5215	12	28-May-2023
DRG Horn Antenna (7.5-18GHz)	Schwarzbeck	HWRD750	5216	12	29-May-2023
Double Ridge Active Horn Antenna (18-40 GHz)	Com-Power	AHA-840	6187	24	02-Jun-2024

Table 18

TU - Traceability Unscheduled
* This item was only used on dates within its calibration period.

3 Test Equipment Information

3.1 General Test Equipment Used

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Thermo-Hygro-Barometer	PCE Instruments	OCE-THB-40	5470	12	07-Apr-2023
Humidity & Temperature meter	R.S Components	1364	6150	12	17-Jun-2023
Digital Multimeter	Fluke	115	6146	12	16-Jun-2023
1500W (300V 12A) AC Power Supply	iTech	IT7324	5956	-	O/P Mon

Table 19

O/P Mon – Output Monitored using calibrated equipment

4 Incident Reports

No incidents reports were raised.

5 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

Test Name	Measurement Uncertainty
Conducted Disturbance at Mains Terminals	150 kHz to 30 MHz, LISN, ±3.7 dB
Radiated Disturbance	30 MHz to 1 GHz, Bilog Antenna, ±5.2 dB 1 GHz to 40 GHz, Horn Antenna, ±6.3 dB

Table 20

Worst case error for both Time and Frequency measurement 12 parts in 10^6.

Measurement Uncertainty Decision Rule

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115:2021, Clause 4.4.3 (Procedure 2). The measurement results are directly compared with the test limit to determine conformance with the requirements of the standard.

Risk: The uncertainty of measurement about the measured result is negligible with regard to the final pass/fail decision. The measurement result can be directly compared with the test limit to determine conformance with the requirement (compare IEC Guide 115). The level of risk to falsely accept and falsely reject items is further described in ILAC-G8.