

FCC and ISED Test Report

Apple Inc
Model: A2686

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



Add value.
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FCC ID: BCGA2686

IC: 579C-A2686

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Document 75954423-11 Issue 02

SIGNATURE

NAME	JOB TITLE	RESPONSIBLE FOR	ISSUE DATE
Andrew Lawson	Chief Engineer, EMC	Authorised Signatory	23 November 2022

Signatures in this approval box have checked this document in line with the requirements of TUV SUD 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	Lauren Walters	23 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 and A1 (2019-03) for the tests detailed in section 1.3.



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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	14 October 2022
2	Updated Report Title to Include Narrowband	32 November 2022

Table 1

1.2 Introduction

Applicant	Apple Inc
Manufacturer	Apple Inc
Model Number(s)	A2686
Serial Number(s)	WX9C36FFWC
Hardware Version(s)	REV 1.0
Software Version(s)	22A271
Number of Samples Tested	1
Test Specification/Issue/Date	FCC 47 CFR Part 15B: 2020 ICES-003: Issue 7: 2020 ISED RSS-GEN: Issue 5 and A1 (2019-03)
Order Number	0540246998
Date of Receipt of EUT	05-April-2022
Start of Test	13-June-2022
Finish of Test	14-June-2022
Name of Engineer(s)	James Cumming
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
	Part 15B	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 2.4 GHz, 5 GHz and 6 GHz bands.

1.4.2 EUT Port/Cable Identification

Port	Max Cable Length specified	Usage	Type	Screened
Configuration and Mode: 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	Yes (USB-C cable)
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	Yes (USB-C cable)

Table 3

1.4.3 Test Configuration

Configuration	Description
AC Powered	The EUT was powered from an AC/DC adapter using a USB-C output. The adapter was supplied from a 115 V 60 Hz AC 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 USB-C port. A mouse was used to terminate the EUT's USB port. A switchbox was used to terminate the EUT's ethernet port. A monitor was used to terminate the EUT's HDMI port.

Table 4



1.4.4 Modes of Operation

Mode	Description
Transmitter Idle	The EUT's intentional transmitters were turned OFF from the internal settings of the EUT. During conducted emissions tests, the EUT was additionally configured to display video on the EUT screen whilst playing audio through the headphones. The display was set to maximum brightness and sleep mode was disabled. A ping request was established with the EUT's ethernet port using a support laptop. During emissions tests, the EUT was additionally configured to play audio through the headphones. The display port was terminated into a load box. A ping request was established with the EUT's ethernet port using a support laptop.

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: A2686, Serial Number: WX9C36FFWC			
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: AC Powered - Transmitter Idle		
Conducted Disturbance at Mains Terminals	James Cumming	UKAS
Radiated Disturbance	James Cumming	UKAS

Table 7

Office Address:

TÜV SÜD
Octagon House
Concorde Way
Fareham
Hampshire
PO15 5RL
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

A2686, S/N: WX9C36FFWC - Modification State 0

2.1.3 Date of Test

14-June-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 (dB μ V) = Receiver level (dB μ V) + Correction Factor (dB)
Margin (dB) = Quasi-Peak level (dB μ V) - Limit (dB μ V)

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

2.1.6 Test Setup Diagram

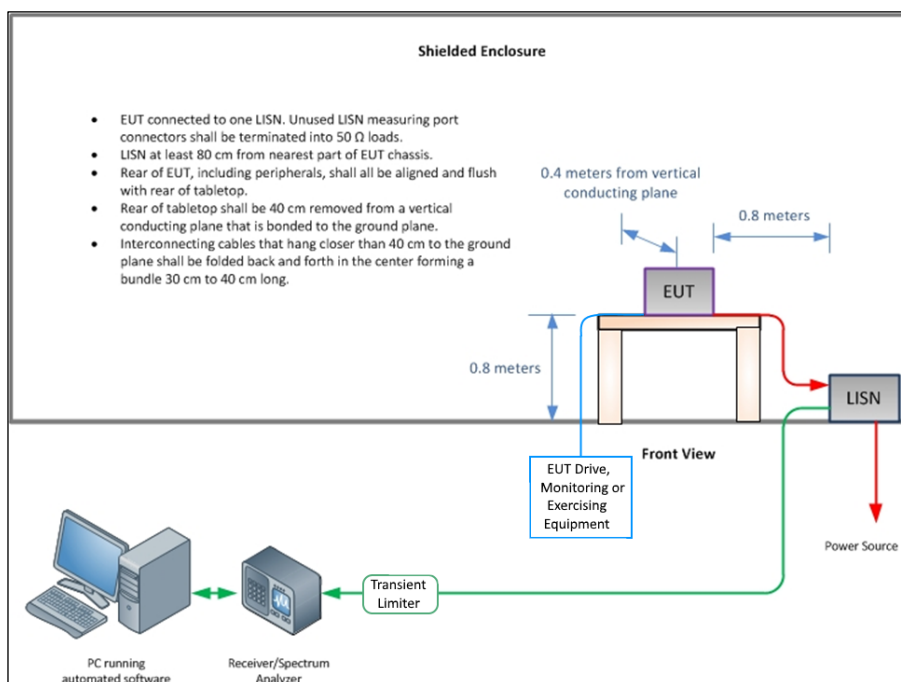


Figure 1 - Conducted Emissions

2.1.7 Environmental Conditions

Ambient Temperature	18.0 °C
Relative Humidity	52.4 %
Atmospheric Pressure	1013.0 mbar

2.1.8 Specification Limits

Required Specification Limits - Class B			
Line Under Test	Frequency Range (MHz)	Quasi-Peak Test Limit (dB μ V)	CISPR Average Test Limit (dB μ V)
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 8

2.1.9 Test Results

Results for Configuration and Mode: 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.

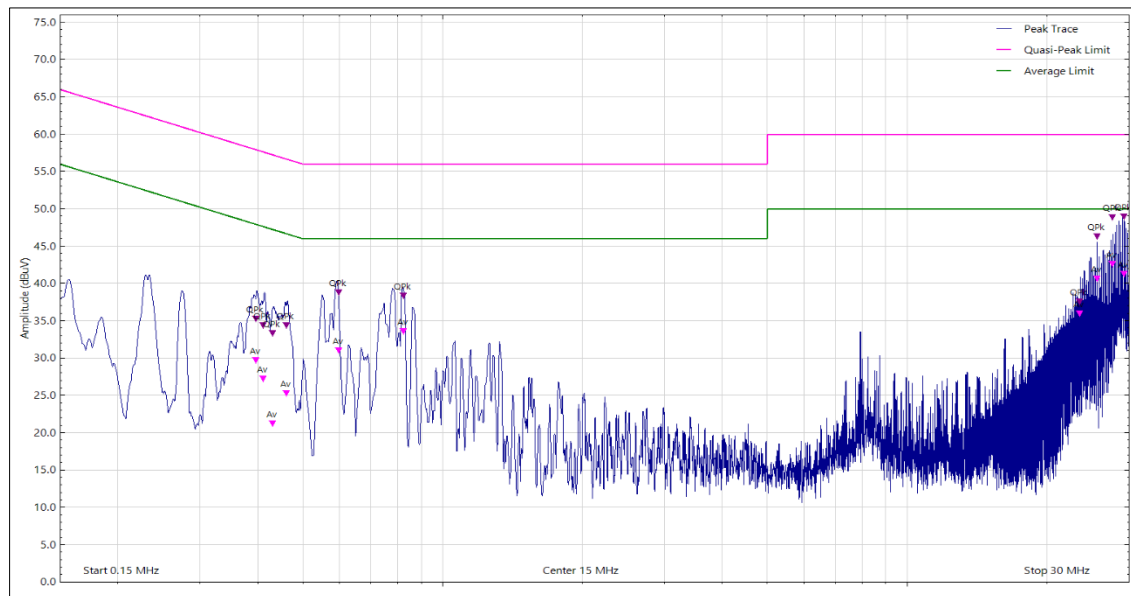


Figure 2 - Graphical Results - AC Power Port - Live Line



Frequency (MHz)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector
0.396	34.7	57.9	-23.2	Q-Peak
0.396	29.1	47.9	-18.8	CISPR Avg
0.411	33.8	57.6	-23.8	Q-Peak
0.411	26.6	47.6	-21.0	CISPR Avg
0.431	20.6	47.2	-26.6	CISPR Avg
0.431	32.7	57.2	-24.5	Q-Peak
0.461	24.7	46.7	-22.0	CISPR Avg
0.461	33.8	56.7	-22.9	Q-Peak
0.598	38.2	56.0	-17.8	Q-Peak
0.598	30.4	46.0	-15.6	CISPR Avg
0.823	37.7	56.0	-18.3	Q-Peak
0.823	33.0	46.0	-13.0	CISPR Avg
23.541	35.3	50.0	-14.7	CISPR Avg
23.541	37.0	60.0	-23.0	Q-Peak
25.620	40.0	50.0	-10.0	CISPR Avg
25.620	45.7	60.0	-14.3	Q-Peak
27.696	48.2	60.0	-11.8	Q-Peak
27.696	42.0	50.0	-8.0	CISPR Avg
29.268	48.4	60.0	-11.6	Q-Peak
29.268	40.6	50.0	-9.4	CISPR Avg

Table 9

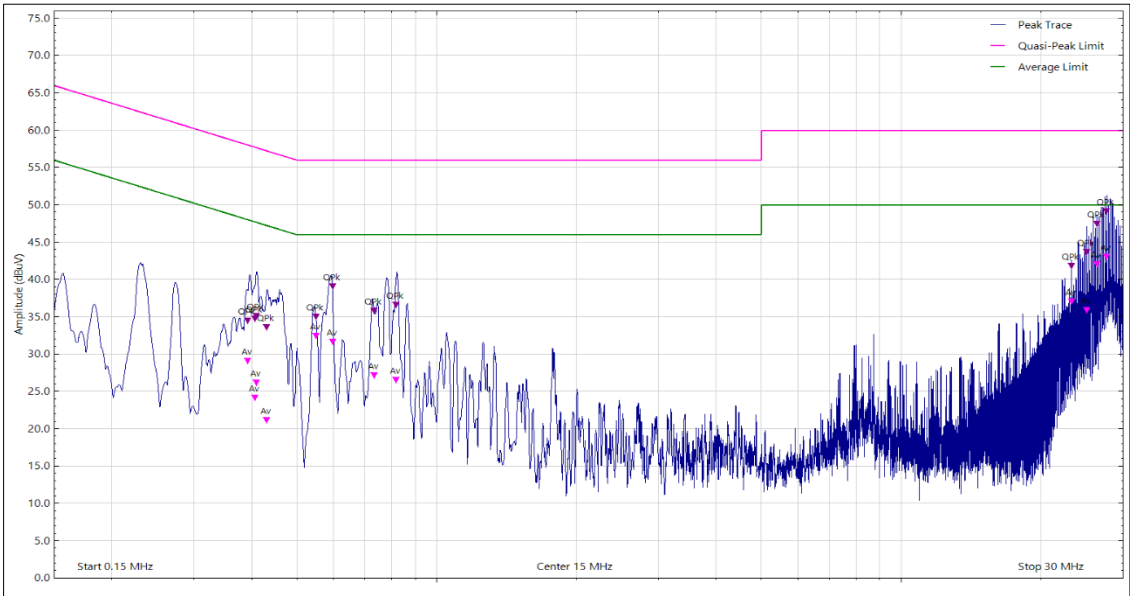


Figure 3 - Graphical Results - AC Power Port - Neutral Line



Frequency (MHz)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector
0.392	28.5	48.0	-19.5	CISPR Avg
0.392	33.8	58.0	-24.2	Q-Peak
0.407	23.5	47.7	-24.2	CISPR Avg
0.407	34.1	57.7	-23.6	Q-Peak
0.410	25.5	47.7	-22.2	CISPR Avg
0.410	34.5	57.7	-23.2	Q-Peak
0.431	33.0	57.2	-24.2	Q-Peak
0.431	20.6	47.2	-26.6	CISPR Avg
0.551	31.8	46.0	-14.2	CISPR Avg
0.551	34.4	56.0	-21.6	Q-Peak
0.597	31.0	46.0	-15.0	CISPR Avg
0.597	38.4	56.0	-17.6	Q-Peak
0.734	26.5	46.0	-19.5	CISPR Avg
0.734	35.2	56.0	-20.8	Q-Peak
0.819	25.9	46.0	-20.1	CISPR Avg
0.819	36.0	56.0	-20.0	Q-Peak
23.236	41.2	60.0	-18.8	Q-Peak
23.236	36.4	50.0	-13.6	CISPR Avg
25.083	35.3	50.0	-14.7	CISPR Avg
25.083	43.0	60.0	-17.0	Q-Peak
26.369	41.4	50.0	-8.6	CISPR Avg
26.369	46.9	60.0	-13.1	Q-Peak
27.682	42.4	50.0	-7.6	CISPR Avg
27.682	48.5	60.0	-11.5	Q-Peak

Table 10



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	ESW44	5914	12	21-Feb-2023
Transient Limiter	Hewlett Packard	11947A	2378	12	13-Oct-2022
Termination (50 ohm)	Meca	405-1	3517	12	16-Dec-2022
Cable (SMA to SMA, 2 m)	Rhophase	3PS-1801A-2000-3PS	4113	12	27-Jan-2023
Cable (N-Type to N-Type, 8 m)	Teledyne	PR90-088-8MTR	5212	12	06-Sep-2022
LISN (CISPR 16, Single Phase)	Rohde & Schwarz	ESH3-Z5	1390	12	31-Jan-2023

Table 11



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

A2686, S/N: WX9C36FFWC - Modification State 0

2.2.3 Date of Test

13-June-2022 to 14-June-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 reasonably 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 (dB μ V/m) = Receiver level (dB μ V) + Correction Factor (dB/m)
Margin (dB) = Quasi-Peak level (dB μ V/m) - Limit (dB μ V/m)

Above 1 GHz:

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

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

2.2.6 Test Setup Diagram

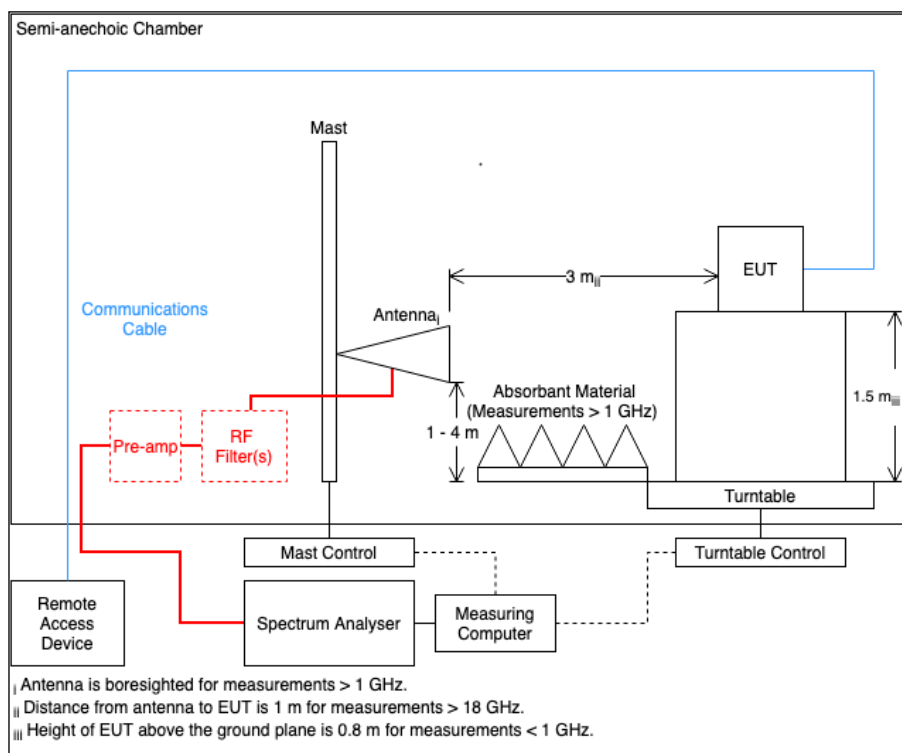


Figure 4 – Radiated Emissions

2.2.7 Environmental Conditions

Ambient Temperature	18.4 - 18.7 °C
Relative Humidity	52.1 - 53.2 %
Atmospheric Pressure	1014.0 - 1018.0 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 12



2.2.9 Test Results

Results for Configuration and Mode: 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: 37 GHz

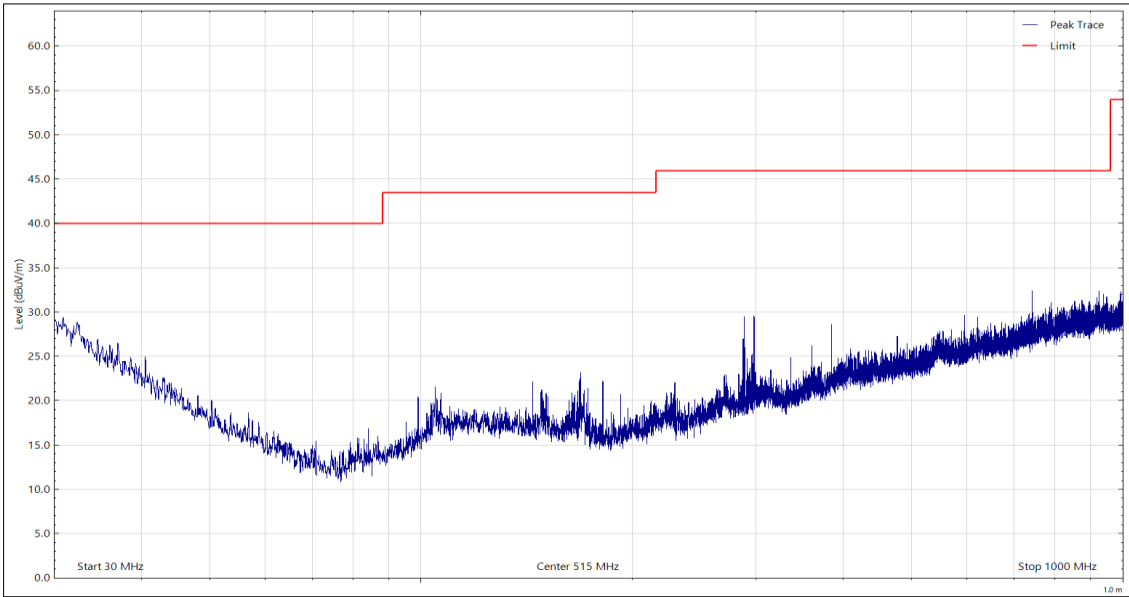


Figure 5 – 30 MHz to 1 GHz, Peak, Horizontal

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

Table 13

*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.

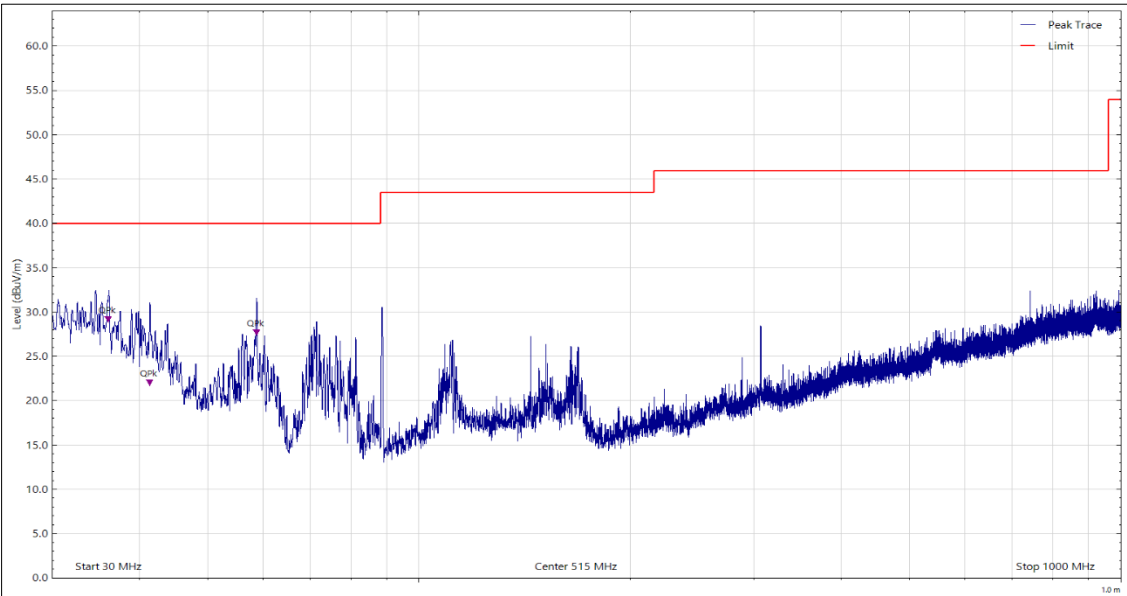


Figure 6 – 30 MHz to 1 GHz, Peak, Vertical

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
36.125	28.7	40.0	-11.3	Q-Peak	289	100	Vertical
41.345	21.5	40.0	-18.5	Q-Peak	214	101	Vertical
58.678	27.2	40.0	-12.8	Q-Peak	232	108	Vertical

Table 14

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

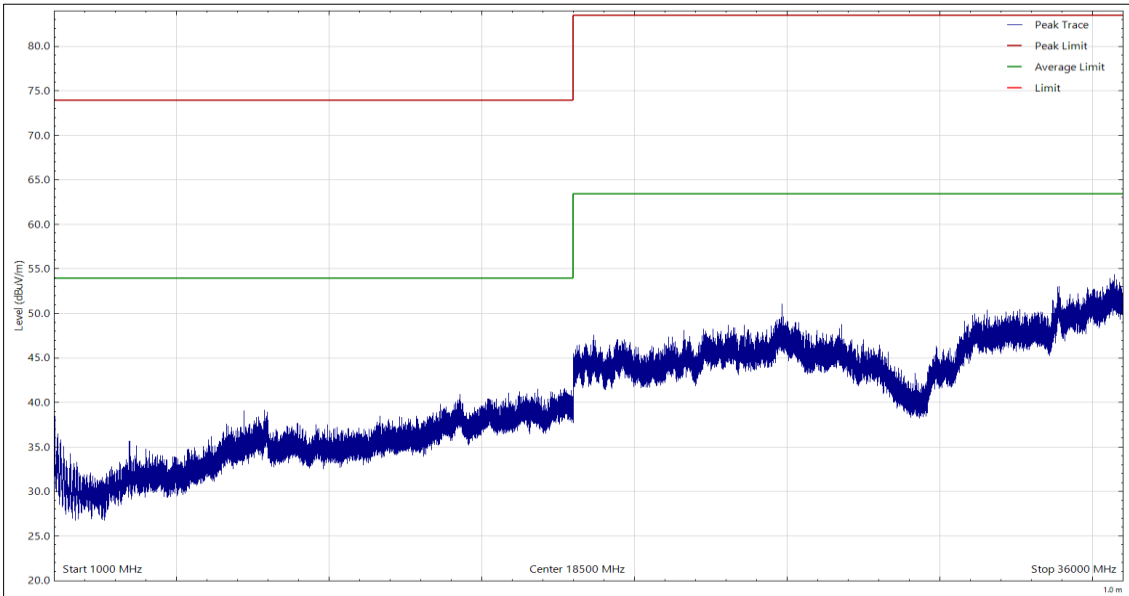


Figure 7 – 1 GHz to 36 GHz, Peak, Horizontal

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.

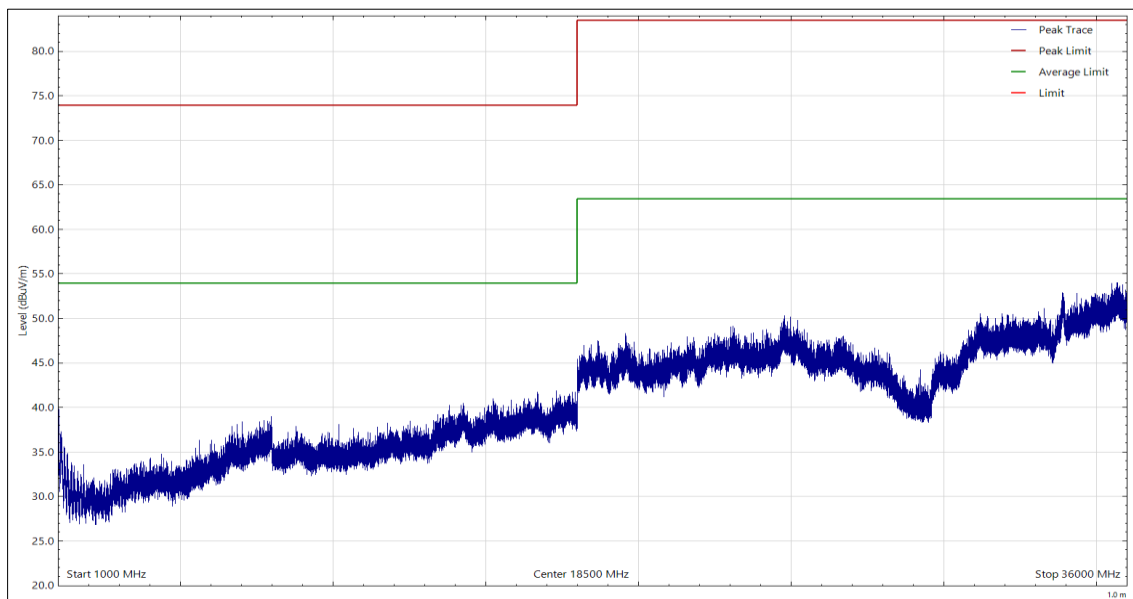


Figure 8 - 1 GHz to 36 GHz, Peak, Vertical

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.



2.2.10 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	ESW44	5914	12	21-Feb-2023
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	5613	-	TU
Turntable & Mast Controller	Maturo Gmbh	NCD/498/2799.01	5612	-	TU
Turntable	Maturo Gmbh	Turntable 1.5 SI-2t	5614	-	TU
Cable (SMA to SMA, 2 m)	Rhophase	3PS-1801A-2000-3PS	4113	12	27-Jan-2023
Cable (N-Type to N-Type, 1 m)	Rosenberger	LU7-036-1000	5031	12	23-Jul-2022
Cable (N-Type to N-Type, 8 m)	Teledyne	PR90-088-8MTR	5212	12	06-Sep-2022
Pre-Amplifier (1 GHz to 18 GHz)	Schwarzbeck	BBV 9718 C	5350	12	22-Sep-2022
Pre-Amplifier (18 GHz to 40 GHz)	Schwarzbeck	BBV 9721	5218	12	25-Jan-2023
Antenna with attenuator (Bilog, 30 MHz to 3 GHz)	Schaffner	CBL6143	287	24	14-Oct-2022
Antenna (DRG, 1 GHz to 10.5 GHz)	Schwarzbeck	BBHA9120B	5611	12	15-Oct-2022
Antenna (DRG, 7.5 GHz to 18 GHz)	Schwarzbeck	HWRD750	5610	12	15-Oct-2022
Antenna (DRG, 15 GHz to 40 GHz)	Schwarzbeck	BBHA 9170	5217	12	25-Jan-2023

Table 17

TU - Traceability Unscheduled



3 Test Equipment Information

3.1 General Test Equipment Used

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Comb Generator	Schaffner	RSG1000	3034	-	TU
Multimeter	Fluke	177	3832	12	08-Jul-2022
35V - 5A Bench Power Supply	Thurlby Thandar Instruments	EX355R	5224	-	TU
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB 40	5605	12	23-Sep-2022

Table 18

TU - Traceability Unscheduled



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 19

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.