FCC and ISED Test Report

Apple Inc
Model: A2681

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

Add value.
Inspire trust.

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

FCC ID: BCGA2681 IC: 579C-A2681

Jensen Adams Digitally signed by Jensen Adams Date: 2022.05.16 16:25:38 +01'00'

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Document 75954421-08 Issue 02

SIGNATURE			
Jensen Adams			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Jensen Adams	Technical Solutions, Manager	Authorised Signatory	16 May 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	16 May 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 + A2 (2021-02) for the tests detailed in section 1.3.

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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	03 May 2022
2	Typographical error on the cover page corrected	16 May 2022

Table 1

1.2 Introduction

Applicant	Apple Inc
Manufacturer	Apple Inc
Model Number(s)	A2681
Serial Number(s)	LM461YV61Y, DQH576VJ7N and MW4P32N6T0
Hardware Version(s)	REV 1.0
Software Version(s)	21F27, 21E61410w and 21E71860f
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 + A2 (2021-02)
Order Number	0540246998
Date of Receipt of EUT	16-February-2022
Start of Test	11-March-2022
Finish of Test	28-March-2022
Name of Engineer(s)	James Cumming, Mohammad Malik, Thomas Randall, Ahmad Javid and Ian Hart
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: 120 V 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 laptop computer with Bluetooth® and IEEE 802.11 a/b/g/n/ac/ax Wi-Fi in the 2.4 GHz and 5 GHz 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	2 m	Power	230 V 50 Hz AC Power	No
USB	2 m	Power / Data	Type - C	No
Audio	2 m	Line - Out	3.5mm Jack	No

Table 3

1.4.3 Test Configuration

Configuration	Description
120 V AC Powered	The EUT was powered from a 120 V AC power supply. One USB-C port was loaded with a mouse and the audio port was loaded using headphones.

Table 4

1.4.4 Modes of Operation

Mode	Description
Transmitter Idle	All transmitters within the EUT were disabled. The EUT was 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.

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: A2681, Serial Number: LM461YV61Y			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: A2681, Serial Number: MW4P32N6T0			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: A2681, Serial Number: DQH576VJ7N			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 6

1.7 Test Location

TÜV SÜD conducted the following tests at our Fareham Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: 120 V AC Powered - Transmitter Idle		
Conducted Disturbance at Mains Terminals	James Cumming	UKAS
Radiated Disturbance	Mohammad Malik, Thomas Randall, Ahmad Javid and Ian Hart	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

A2681, S/N: LM461YV61Y - Modification State 0

2.1.3 Date of Test

16-March-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 Example Test Setup Diagram

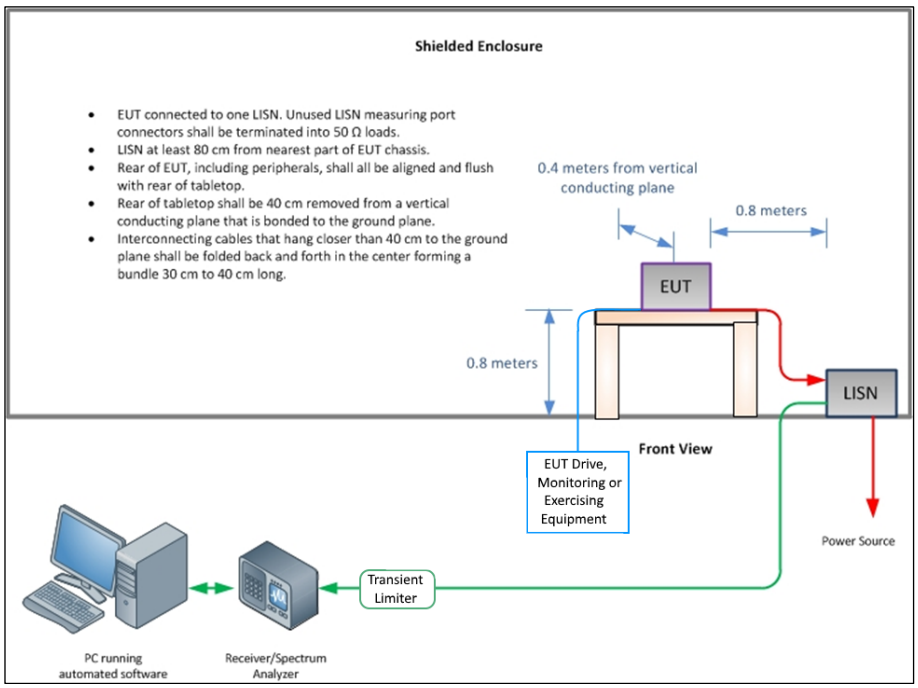

Figure 1 - Conducted Disturbance

2.1.7 Environmental Conditions

Ambient Temperature	18.8 °C
Relative Humidity	44.2 %

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 8

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.

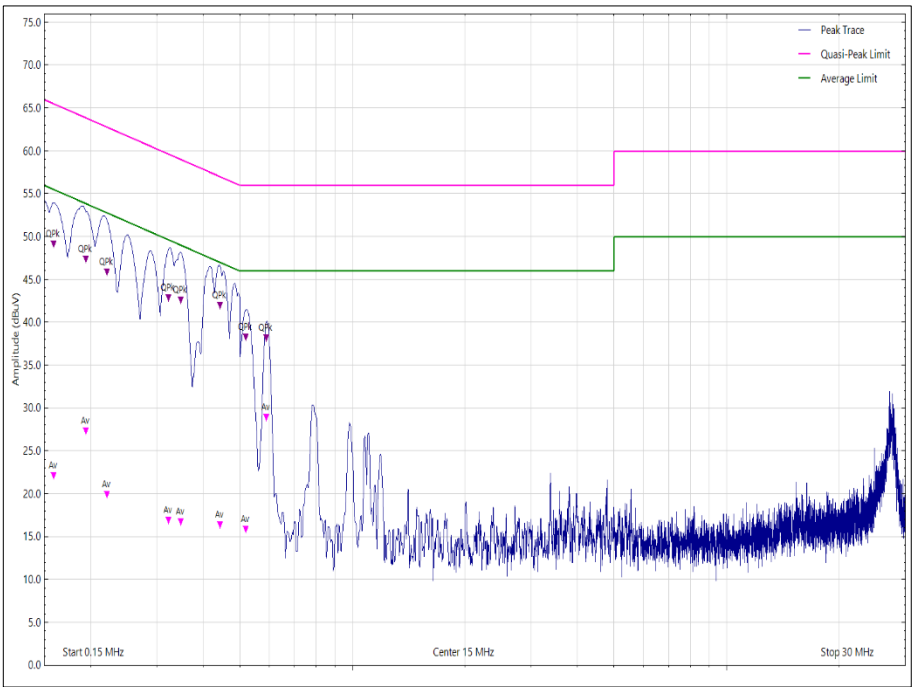

Figure 2 - Graphical Results - Live Line

Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Margin (dB)	Detector
0.159	48.5	65.5	-17.0	Q-Peak
0.159	21.5	55.5	-34.0	CISPR Avg
0.194	46.8	63.9	-17.1	Q-Peak
0.194	26.7	53.9	-27.2	CISPR Avg
0.221	45.2	62.8	-17.6	Q-Peak
0.221	19.3	52.8	-33.5	CISPR Avg
0.323	42.3	59.6	-17.3	Q-Peak
0.323	16.3	49.6	-33.4	CISPR Avg
0.348	42.0	59.0	-17.0	Q-Peak
0.348	16.1	49.0	-32.9	CISPR Avg
0.443	41.4	57.0	-15.7	Q-Peak
0.443	15.8	47.0	-31.2	CISPR Avg
0.520	37.7	56.0	-18.4	Q-Peak
0.520	15.3	46.0	-30.7	CISPR Avg
0.588	37.5	56.0	-18.5	Q-Peak
0.588	28.3	46.0	-17.7	CISPR Avg

Table 9

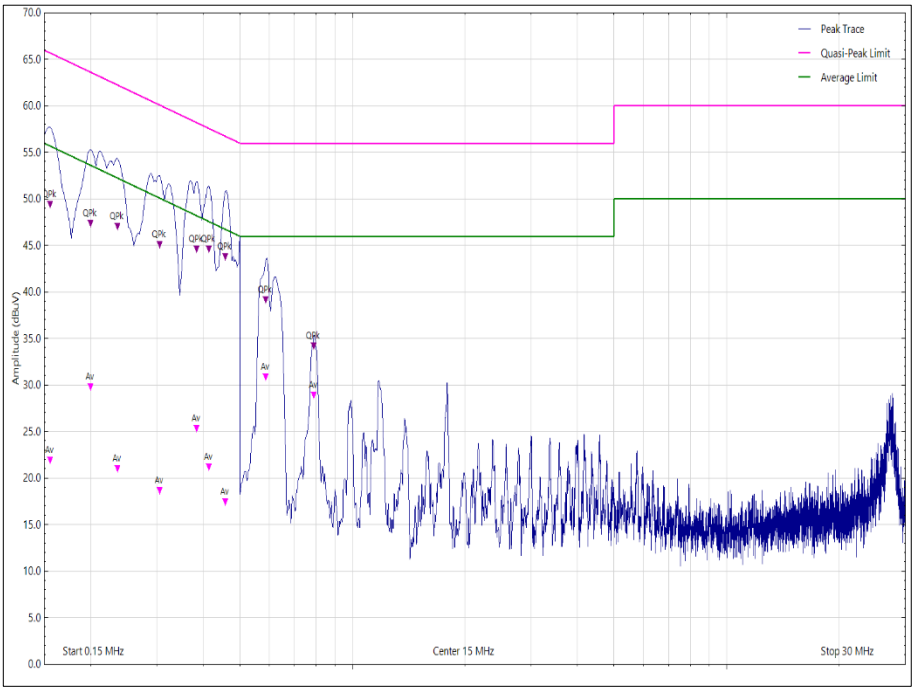

Figure 3 - Graphical Results - Neutral Line

Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Margin (dB)	Detector
0.156	48.8	65.7	-16.9	Q-Peak
0.156	21.4	55.7	-34.3	CISPR Avg
0.200	46.8	63.6	-16.8	Q-Peak
0.200	29.2	53.6	-24.4	CISPR Avg
0.236	46.5	62.2	-15.7	Q-Peak
0.236	20.5	52.2	-31.7	CISPR Avg
0.306	44.6	60.1	-15.6	Q-Peak
0.306	18.1	50.1	-32.0	CISPR Avg
0.384	44.0	58.2	-14.2	Q-Peak
0.384	24.8	48.2	-23.5	CISPR Avg
0.413	44.0	57.6	-13.6	Q-Peak
0.413	20.6	47.6	-27.0	CISPR Avg
0.458	43.2	56.7	-13.5	Q-Peak
0.458	16.9	46.7	-29.8	CISPR Avg
0.586	38.6	56.0	-17.4	Q-Peak
0.586	30.3	46.0	-15.7	CISPR Avg
0.789	33.6	56.0	-22.4	Q-Peak
0.789	28.3	46.0	-17.7	CISPR Avg

Table 10

2.1.10 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Screened Room (1)	Rainford	Rainford	1541	12	14-May-2022
Emissions Software	TUV SUD	EmX V2.1.12	5125	-	Software
EMI Test Receiver	Rohde & Schwarz	ESW44	5382	12	10-May-2022
Test Receiver	Rohde & Schwarz	ESU40	3506	12	25-Mar-2023
Transient Limiter	Hewlett Packard	11947A	2378	12	13-Oct-2022
Termination (50ohm)	Meca	405-1	365	12	06-Aug-2022
Cable (SMA to SMA, 2 m)	Junkosha	MWX221-02000AMSAMS/B	5725	6	11-Aug-2022
8 Meter Cable	Teledyne	PR90-088-8MTR	5212	12	06-Sep-2022
Cable (N-Type to N-Type, 5 m)	Teledyne	PR90-088-5MTR	5206	12	31-Aug-2022
LISN	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

A2681, S/N: DQH576VJ7N - Modification State 0
A2681, S/N: MW4P32N6T0 - Modification State 0

2.2.3 Date of Test

11-March-2022 to 28-March-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.

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)
Margin (dB) = Peak level (dBµV/m) - Limit (dBµV/m)

2.2.6 Example Test Setup Diagram

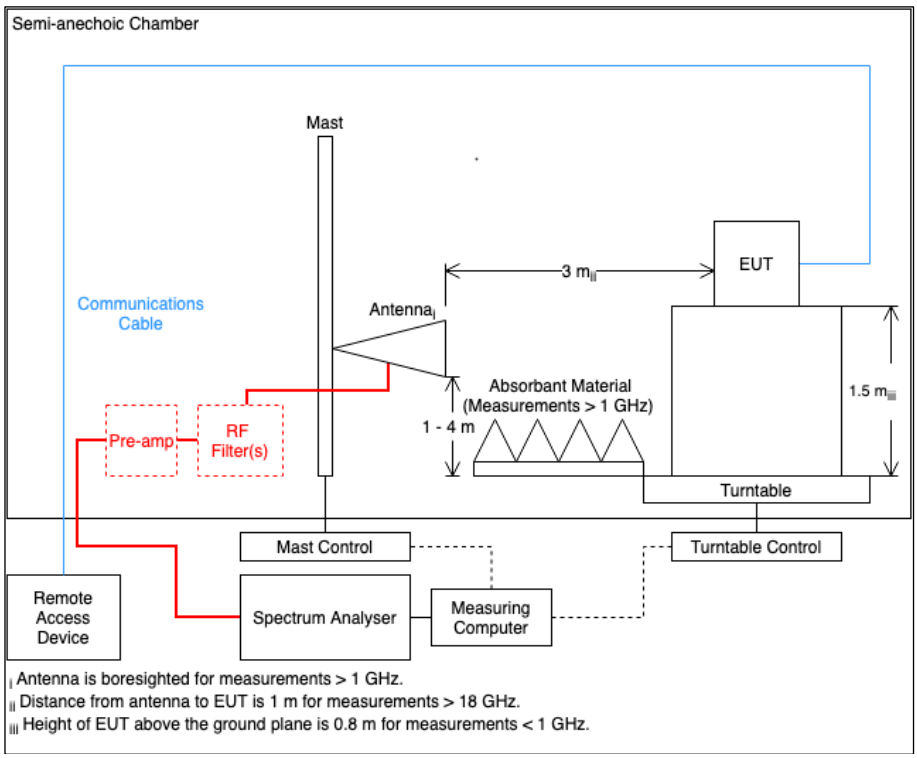

Figure 4

2.2.7 Environmental Conditions

Ambient Temperature	22.8 - 24.9 °C
Relative Humidity	32.1 - 36.8 %

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: 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: 5825 MHz
Which necessitates an upper frequency test limit of: 30 GHz

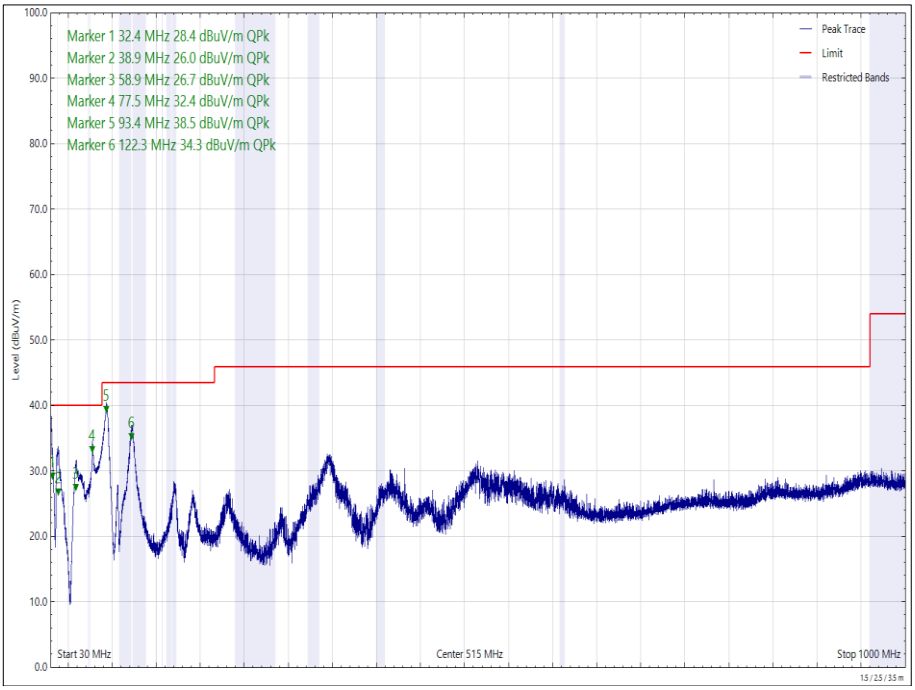

Figure 5 - 30 MHz to 1 GHz, Quasi-Peak, Vertical

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
32.438	28.4	40.0	-11.6	Q-Peak	170	100	Vertical
38.926	26.0	40.0	-14.0	Q-Peak	29	100	Vertical
58.924	26.7	40.0	-13.3	Q-Peak	61	100	Vertical
77.455	32.4	40.0	-7.6	Q-Peak	286	132	Vertical
93.397	38.5	43.5	-5.0	Q-Peak	165	100	Vertical
122.308	34.3	43.5	-9.2	Q-Peak	175	100	Vertical

Table 13

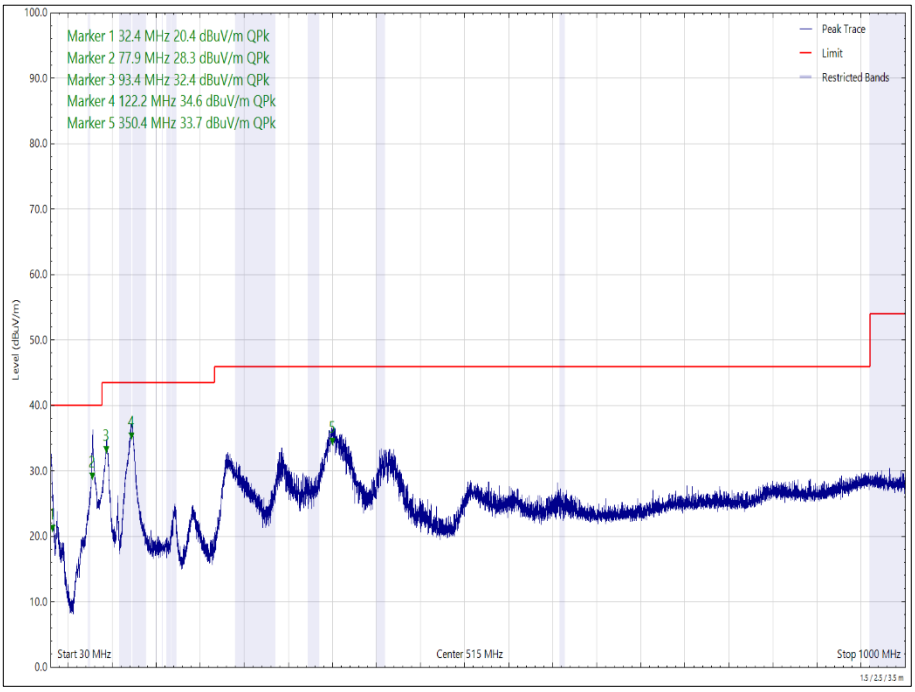

Figure 6 - 30 MHz to 1 GHz, Quasi-Peak, Horizontal

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
32.401	20.4	40.0	-19.6	Q-Peak	102	198	Horizontal
77.865	28.3	40.0	-11.7	Q-Peak	0	230	Horizontal
93.415	32.4	43.5	-11.1	Q-Peak	350	184	Horizontal
122.167	34.6	43.5	-9.0	Q-Peak	355	244	Horizontal
350.407	33.7	46.0	-12.4	Q-Peak	222	103	Horizontal

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.

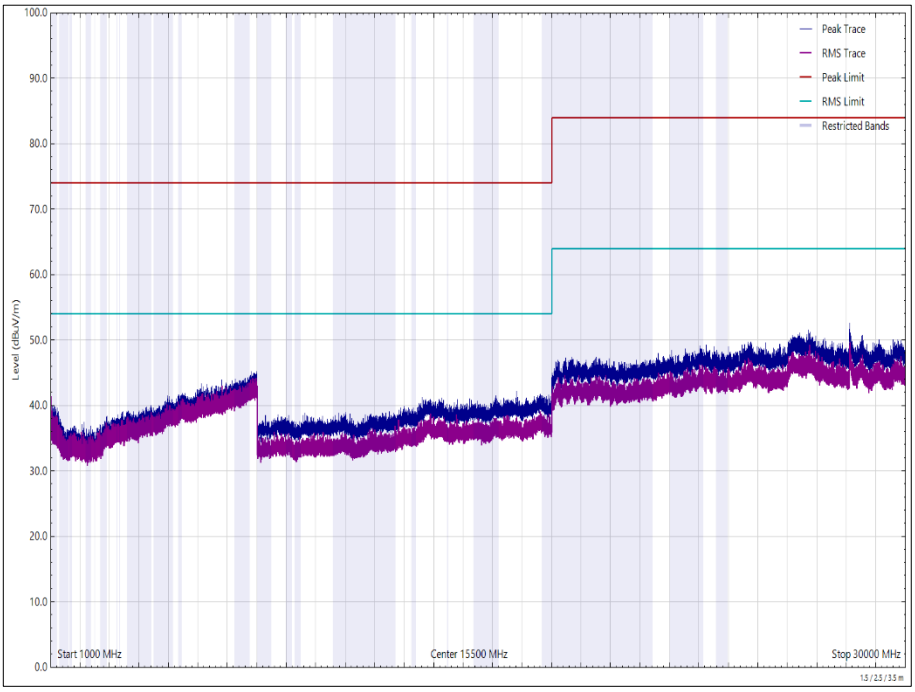

Figure 7 - 1 GHz to 30 GHz, Vertical

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/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 CISPR Average test limit.

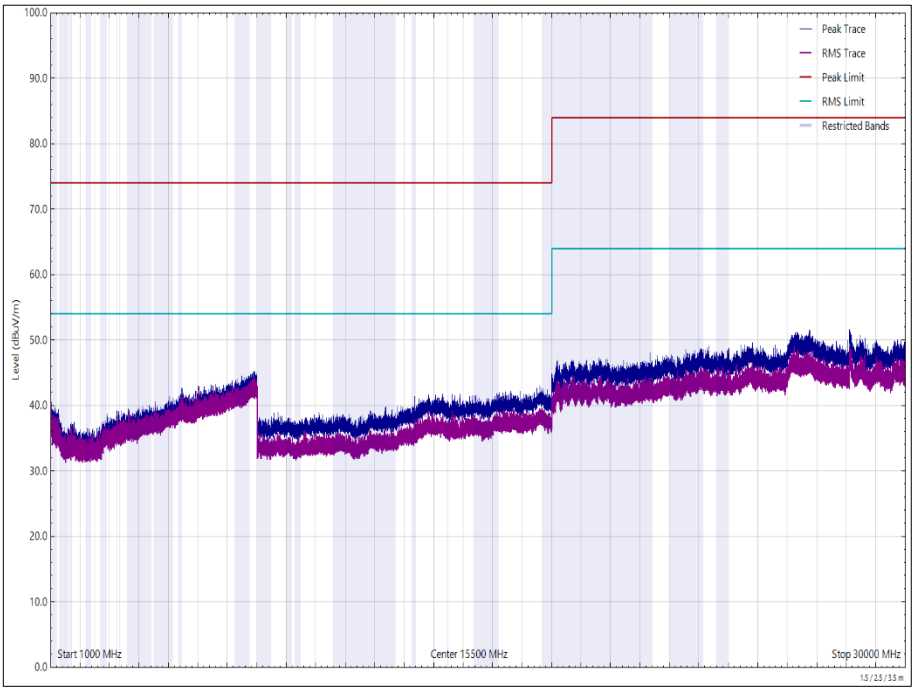

Figure 9 - 1 GHz to 30 GHz, Horizontal

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/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 CISPR Average test limit.

2.2.10 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Screened Room (5)	Rainford	Rainford	1545	36	15-Apr-2024
Emissions Software	TUV SUD	EmX V2.1.12	5125	-	Software
EMI Test Receiver	Rohde & Schwarz	ESW44	5527	12	15-Apr-2022
Mast Controller	Maturo Gmbh	NCD	4810	-	TU
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	4811	-	TU
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Cable (K-Type to K-Type, 1 m)	Junkosha	MWX241-01000KMSKMS/A	5511	12	09-Apr-2022
1m K-Type Cable	Junkosha	MWX241-01000KMSKMS/A	5512	12	09-Apr-2022
1m -SMA Cable	Junkosha	MWX221-01000AMSAMS/A	5513	12	09-Apr-2022
2m SMA Cable	Junkosha	MWX221-02000AMSAMS/A	5517	12	09-Apr-2022
8m N Type Cable	Junkosha	MWX221-08000NMSNMS/B	5519	12	07-Mar-2023
8m N-Type Cable	Junkosha	MWX221-08000NMSNMS/B	5520	12	24-Mar-2023
1200 MHz Low Pass Filter (01)	Mini-Circuits	VLF-1200+	5559	12	24-May-2022
Preamplifier (30dB 1GHz to 18GHz)	Schwarzbeck	BBV 9718 C	5261	12	08-Apr-2022
8 - 18 GHz pre amp	Wright Technologies	PS06-0061/PS06-0060	4971	6	09-Nov-2022
Pre-Amplifier (18 GHz to 40 GHz)	Phase One	PSO4-0087	1534	12	02-Aug-2022
Antenna (Bi-Log, 30 MHz to 1 GHz)	Teseq	CBL6111D	5615	24	16-Oct-2022
Antenna with attenuator (Bilog, 30 MHz to 3 GHz)	Schaffner	CBL6143	287	24	14-Oct-2022
Antenna (DRG Horn 7.5-18GHz)	Schwarzbeck	HWRD750	5348	12	15-Oct-2022
Antenna (DRG, 18 GHz to 40 GHz)	Link Microtek Ltd	AM180HA-K-TU2	230	24	27-Jul-2022
Double Ridge Broadband Horn Antenna	Schwarzbeck	BBHA 9120 B	4848	12	01-Apr-2022

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
Power Supply Unit	Farnell	D302T	609	12	O/P Mon
Multimeter	Fluke	79 Series II	3057	12	23-Aug-2022
Multimeter	Fluke	177	3812	12	15-Apr-2022
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB 40	5605	12	23-Sep-2022
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB-40	5473	12	01-Apr-2022

Table 18

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 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 115:2007, Clause 4.4.3 and 4.5.1. (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.