# 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)

Add value.
Inspire trust.

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

FCC ID: BCGA2686 IC: 579C-A2686

TUV SUD Digitally signed by TUV SUD Date: 2022.11.23 09:04:36 Z

## COMMERCIAL-IN-CONFIDENCE

Document 75954423-11 Issue 02

| SIGNATURE | | | |
|---|---|---|---|
| AJ Lawson. | | | |
| **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 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 | 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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# 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 | 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<br>ICES-003: Issue 7: 2020<br>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.<br>A set of headphones was used to terminate the EUT's 3.5 mm audio jack port.<br>A supplied support keyboard and cable were used to terminate the EUT's USB-C port.<br>A mouse was used to terminate the EUT's USB port.<br>A switchbox was used to terminate the EUT's ethernet port.<br>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.<br>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.<br>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 (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

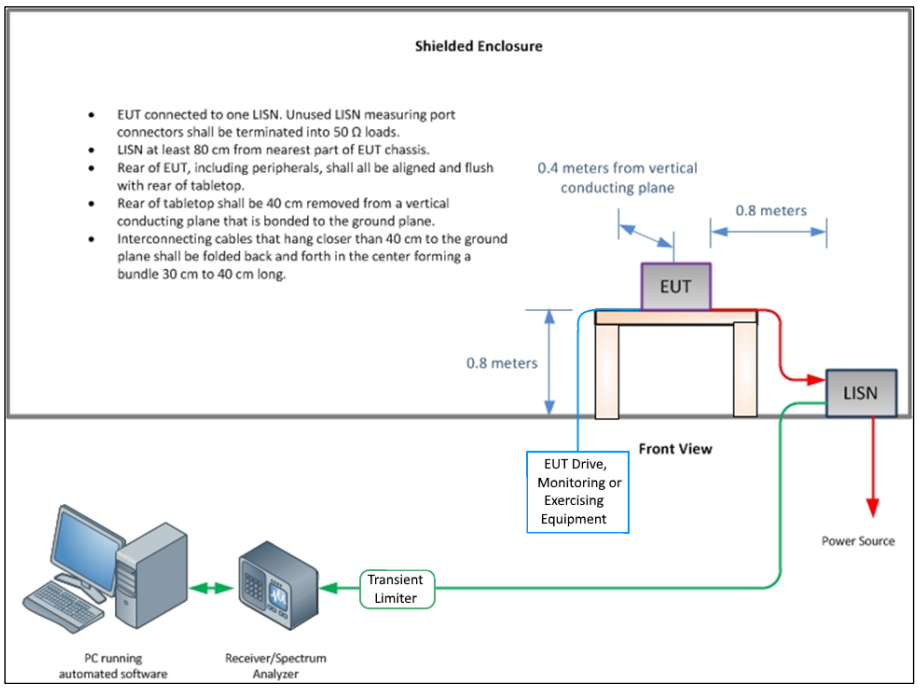


**Figure 1 - Conducted Emissions**

### 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 (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: 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.

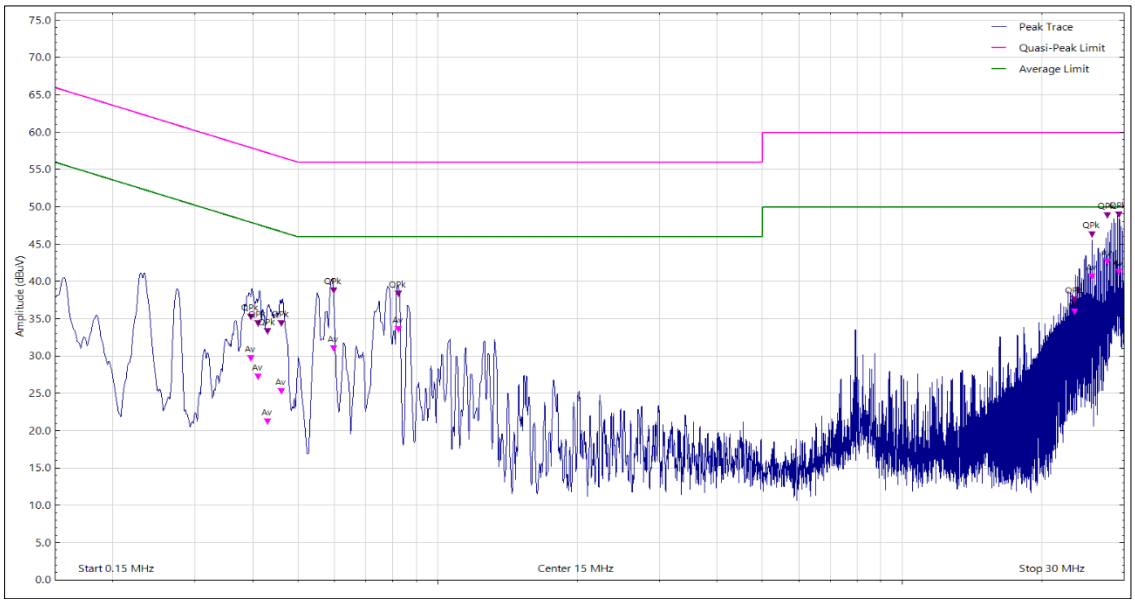


**Figure 2 - Graphical Results - AC Power Port - Live Line**

| 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**

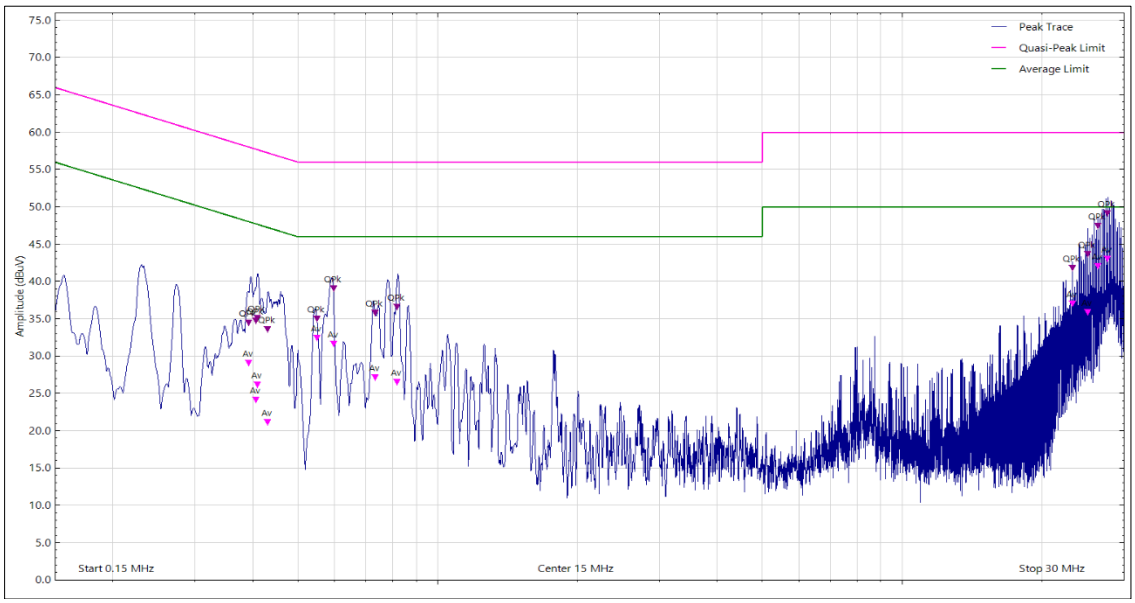


**Figure 3 - Graphical Results - AC Power Port - Neutral Line**

| 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 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

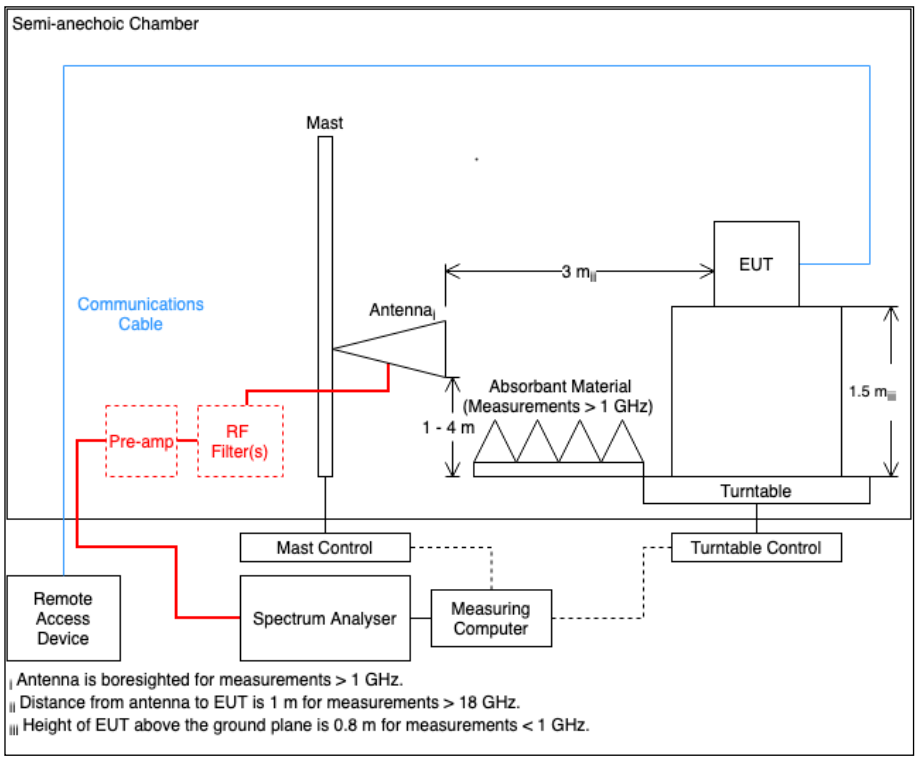


**Figure 4 – Radiated Emissions**

### 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:**<br>Note 1. A Quasi-peak detector is to be used for measurements below 1 GHz.<br>Note 2. A CISPR Average detector is to be used for measurements above 1 GHz.<br>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

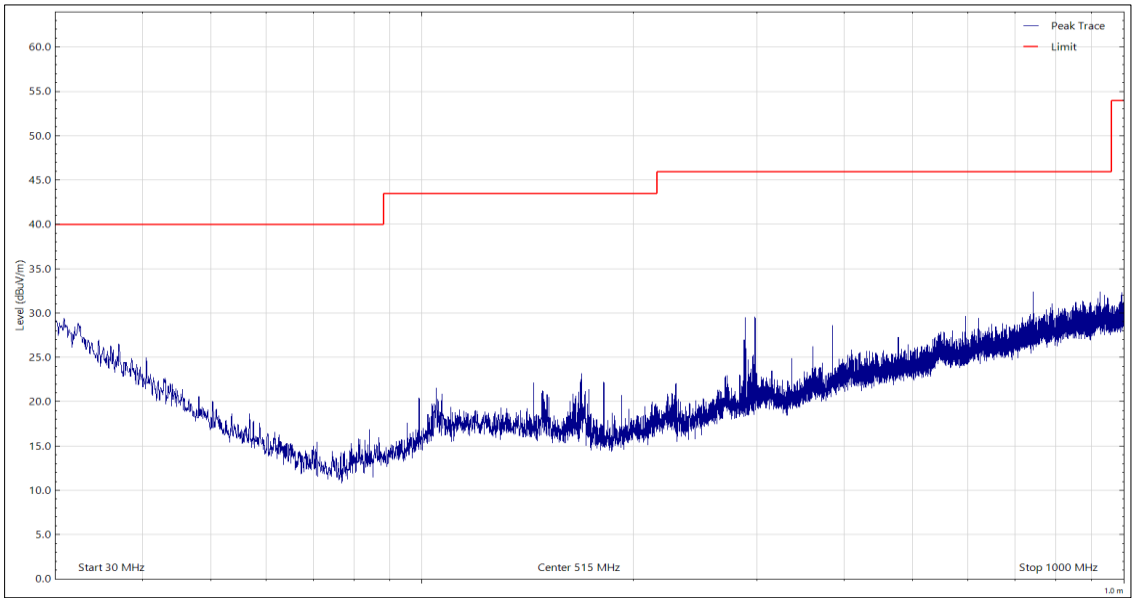


**Figure 5 – 30 MHz to 1 GHz, Peak, Horizontal**

| 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.

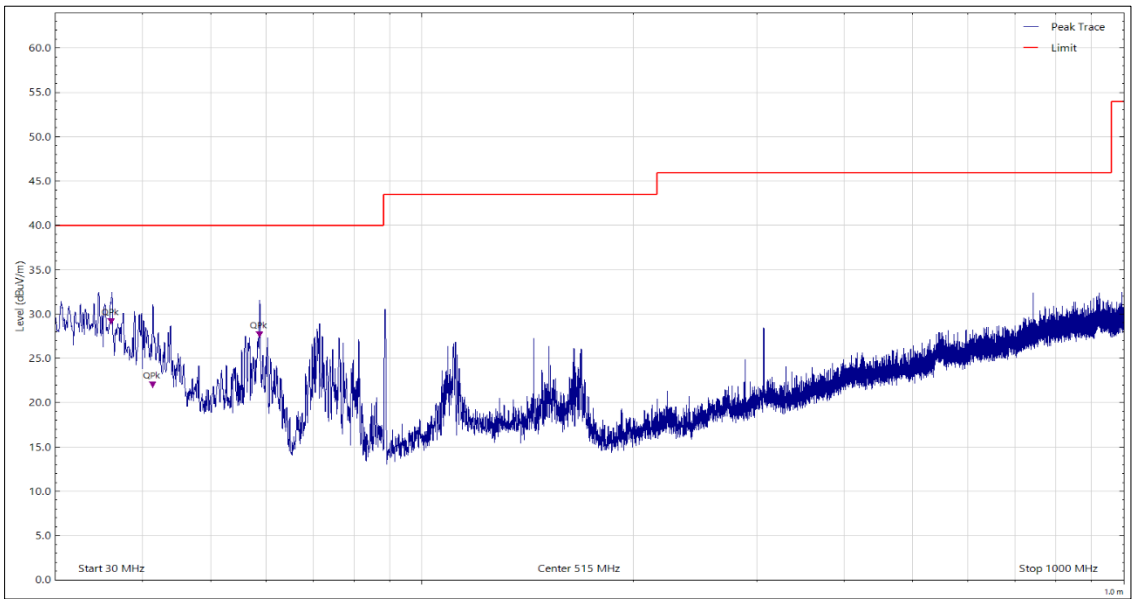


**Figure 6 – 30 MHz to 1 GHz, Peak, Vertical**

| 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.

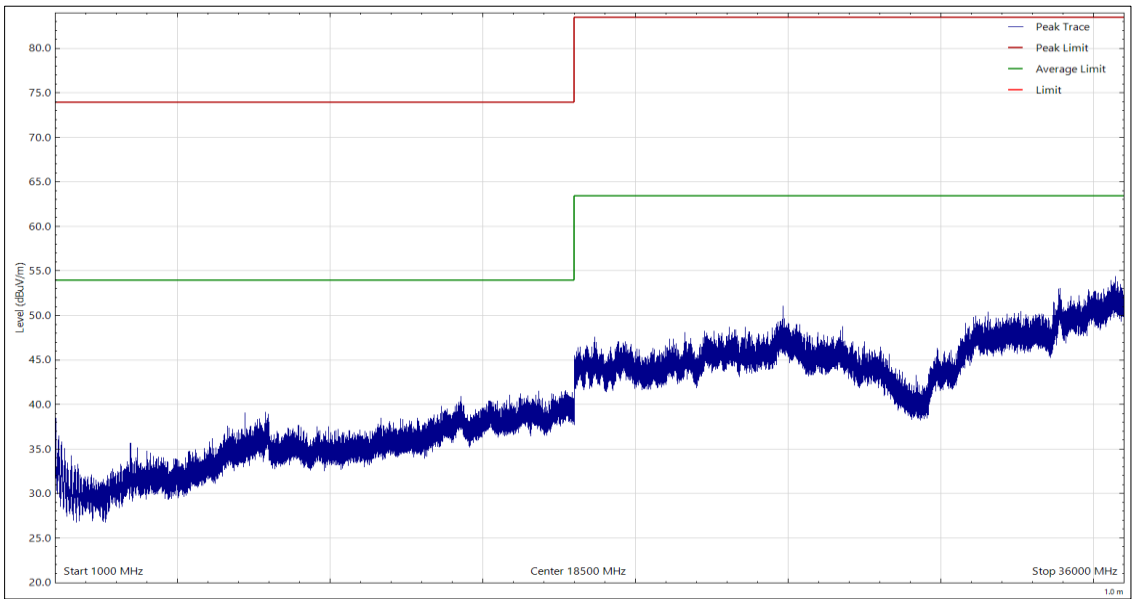


**Figure 7 – 1 GHz to 36 GHz, Peak, Horizontal**

| 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.

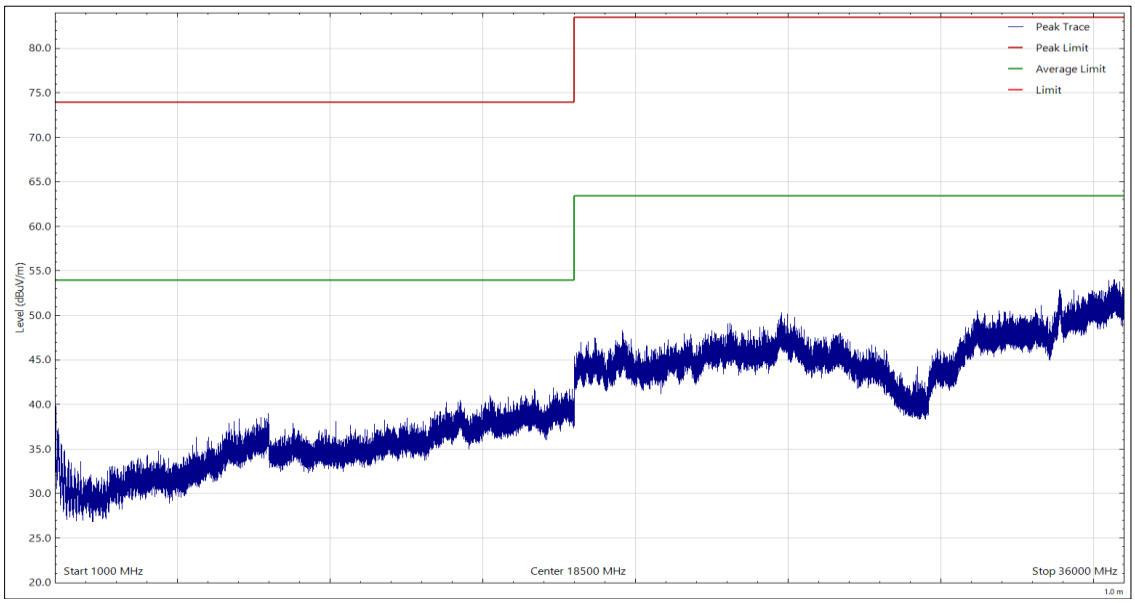


**Figure 8 - 1 GHz to 36 GHz, Peak, Vertical**

| 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<br>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.