

FCC and ISEDC Test Report

Apple Inc
Model: A2289

In accordance with FCC 47 CFR Part 15B and ICES-003

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

FCC ID: BCGA2289 IC: 579C-A2289



Add value.
Inspire trust.

COMMERCIAL-IN-CONFIDENCE

Document 75947591-09 Issue 01

SIGNATURE

| NAME | JOB TITLE | RESPONSIBLE FOR | ISSUE DATE |
|-------------|-----------------|----------------------|------------------|
| Andy Lawson | Senior Engineer | Authorised Signatory | 12 February 2020 |

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 and ICES-003. The sample tested was found to comply with the requirements defined in the applied rules.

| RESPONSIBLE FOR | NAME | DATE | SIGNATURE |
|-----------------|----------------|------------------|-----------|
| Testing | Connor Lee | 12 February 2020 | |
| Testing | Mohammad Malik | 12 February 2020 | |

FCC Accreditation

90987 Octagon House, Fareham Test Laboratory

ISEDC 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: 2018 and ICES-003: 2016 for the tests detailed in section 1.3.



DISCLAIMER AND COPYRIGHT

This non-binding report has been prepared by TÜV SÜD with all reasonable skill and care. The document is confidential to the potential Client and TÜV SÜD. No part of this document may be reproduced without the prior written approval of TÜV SÜD. © 2020 TÜV SÜD. This report relates only to the actual item/items tested.

ACCREDITATION

Our UKAS Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our UKAS Accreditation. Results of tests not covered by our UKAS Accreditation Schedule are marked NUA (Not UKAS Accredited).

TÜV SÜD
is a trading name of TÜV SÜD Ltd
Registered in Scotland at East Kilbride,
Glasgow G75 0QF, United Kingdom
Registered number: SC215164

TÜV SÜD Ltd is a
TÜV SÜD Group Company

Phone: +44 (0) 1489 558100
Fax: +44 (0) 1489 558101
www.tuv-sud.co.uk

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



Contents

| | | |
|----------|--|-----------|
| 1 | Report Summary | 2 |
| 1.1 | Report Modification Record..... | 2 |
| 1.2 | Introduction..... | 2 |
| 1.3 | Brief Summary of Results | 3 |
| 1.4 | Product Information | 4 |
| 1.5 | Deviations from the Standard..... | 4 |
| 1.6 | EUT Modification Record | 5 |
| 1.7 | Test Location | 5 |
| 2 | Test Details | 6 |
| 2.1 | Conducted Disturbance at Mains Terminals | 6 |
| 2.2 | Radiated Disturbance..... | 11 |
| 3 | Incident Reports | 20 |
| 4 | Measurement Uncertainty | 21 |



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 | 12 February 2020 |

Table 1

1.2 Introduction

| | |
|-------------------------------|---|
| Applicant | Apple Inc |
| Manufacturer | Apple Inc |
| Model Number(s) | A2289 |
| Serial Number(s) | C02ZG009P09V and C02ZG007P0C9 |
| Hardware Version(s) | Rev1.0 |
| Software Version(s) | 19C4 and 19D2013 |
| Number of Samples Tested | 2 |
| Test Specification/Issue/Date | FCC 47 CFR Part 15B: 2018 ICES-003: 2016 |
| Order Number | PTP |
| Date | 26-November-2019 |
| Date of Receipt of EUT | 18-December-2019 and 27-November-2019 |
| Start of Test | 12-December-2019 |
| Finish of Test | 07-February-2020 |
| Name of Engineer(s) | Connor Lee 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 and ICES-003 is shown below.

| Section | Specification Clause | | Test Description | Result | Comments/Base Standard |
|--|----------------------|----------|--|--------|------------------------|
| | Part 15B | ICES-003 | | | |
| Configuration and Mode: 120 V AC Powered - Transmitters disabled | | | | | |
| 2.1 | 15.107 | 6.1 | Conducted Disturbance at Mains Terminals | Pass | ANSI C63.4: 2014 |
| 2.2 | 15.109 | 6.2 | Radiated Disturbance | Pass | ANSI C63.4: 2014 |

Table 2



1.4 Product Information

1.4.1 Technical Description

The Equipment Under Test (EUT) was a laptop computer with Bluetooth, Bluetooth Low Energy and 802.11 a/b/g/n/ac capabilities in the 2.4 GHz and 5.0 GHz bands.

1.4.2 EUT Port/Cable Identification

| Port | Max Cable Length specified | Usage | Type | Screened |
|--|----------------------------|-----------------------------|--------------------|----------|
| Configuration and Mode: 120 V AC Powered - Transmitters disabled | | | | |
| Live Line | 1.5 Meters | Power | AC Mains | No |
| Neutral Line | 1.5 Meters | Power | AC Mains | No |
| Signal Port | 1.5 Meters | Audio Output Port | 3.5 mm Audio Jack. | No |
| Signal Port | 0.8 Metres | Peripheral Connection Port. | Type-C Connector. | Yes |

Table 3

1.4.3 Test Configuration

| Configuration | Description |
|------------------|--|
| 120 V AC Powered | The EUT was powered from a 120 V AC mains supply using a USB power adapter model A1947. A set of headphones and a type-c connector to a USB adapter with a mouse attached were used to load the ports. |

Table 4

1.4.4 Modes of Operation

| Mode | Description |
|---------|--|
| TX Idle | All transmitters within the EUT were not transmitting. |

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: A2289, Serial Number: C02ZG007P0C9 | | | |
| 0 | As supplied by the customer | Not Applicable | Not Applicable |
| Model: A2289, Serial Number: C02ZG009P09V | | | |
| 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 - Transmitters disabled | | |
| Conducted Disturbance at Mains Terminals | Connor Lee | UKAS |
| Radiated Disturbance | Mohammad Malik | UKAS |

Table 7

Office Address:

Octagon House
Concorde Way
Segensworth North
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 6.1

2.1.2 Equipment Under Test and Modification State

A2289, S/N: C02ZG007P0C9 - Modification State 0

2.1.3 Date of Test

07-February-2020

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 Example Test Setup Diagram

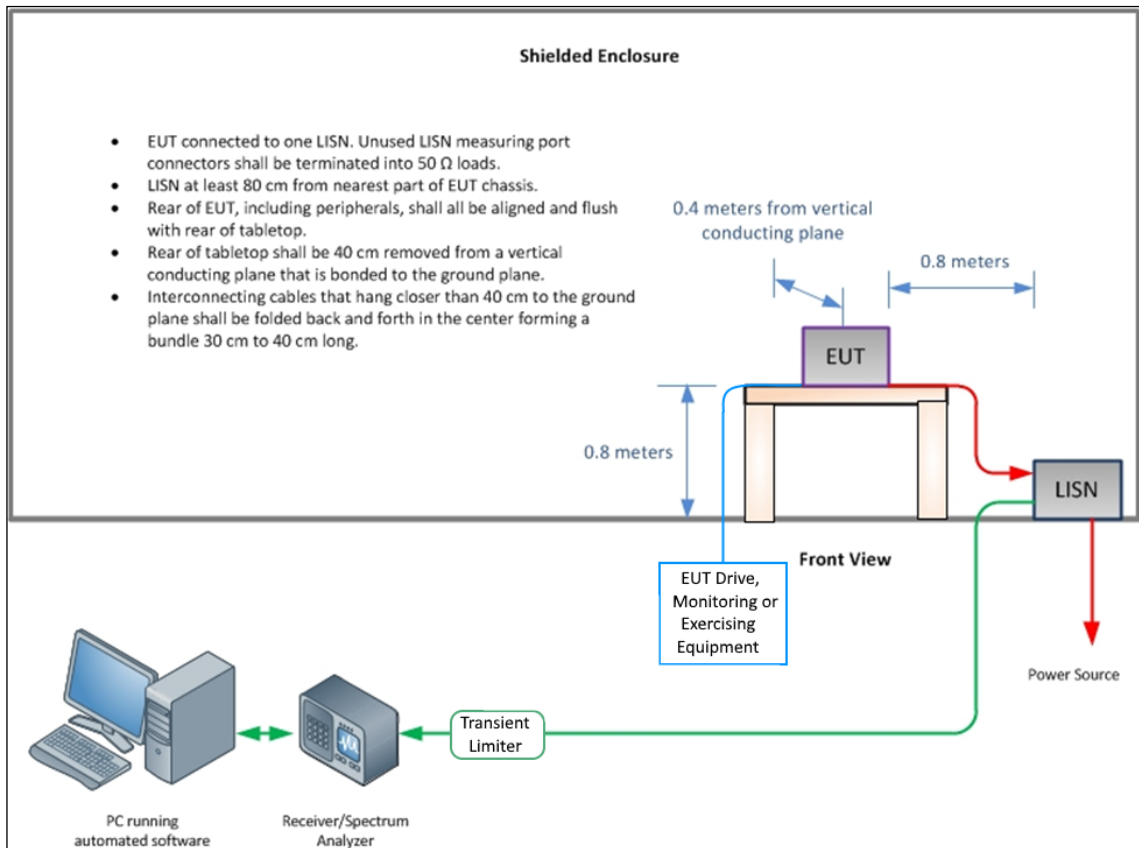


Figure 1 - Conducted Disturbance Example Test Setup

2.1.7 Environmental Conditions

Ambient Temperature 18.4 °C
 Relative Humidity 35.0 %

2.1.8 Specification Limits

| Required Specification Limits (Class B) | | | |
|---|-----------------------|-------------------|----------------------|
| Line Under Test | Frequency Range (MHz) | Quasi-peak (dBμV) | CISPR Average (dBμV) |
| AC Power Port | 0.15 to 0.5 | 66 to 56* | 56 to 46* |
| | 0.5 to 5 | 56 | 46 |
| | 5 to 30 | 60 | 50 |

Supplementary information: *Decreases with the logarithm of the frequency.

Table 8



2.1.9 Test Results

Results for Configuration and Mode: 120 V AC Powered - Transmitters disabled.

The test was performed in accordance with the Class B limits.

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

Detailed results are shown below.

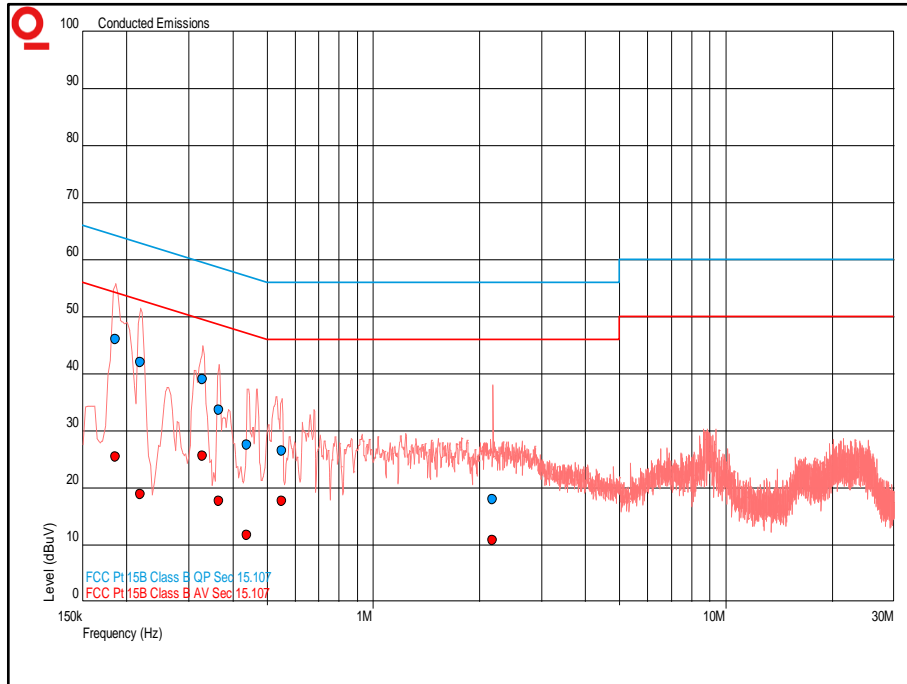


Figure 2 - Graphical Results - Live Line

| Frequency (MHz) | QP Level (dBµV) | QP Limit (dBµV) | QP Margin (dB) | CISPR Average Level (dBµV) | CISPR Average Limit (dBµV) | CISPR Average Margin (dB) |
|-----------------|-----------------|-----------------|----------------|----------------------------|----------------------------|---------------------------|
| 0.186 | 46.1 | 64.2 | -18.1 | 25.4 | 54.2 | -28.8 |
| 0.219 | 42.1 | 62.9 | -20.8 | 18.8 | 52.9 | -34.0 |
| 0.329 | 39.1 | 59.5 | -20.4 | 25.7 | 49.5 | -23.8 |
| 0.365 | 33.6 | 58.6 | -25.0 | 17.7 | 48.6 | -30.9 |
| 0.440 | 27.5 | 57.1 | -29.6 | 11.7 | 47.1 | -35.3 |
| 0.550 | 26.5 | 56.0 | -29.5 | 17.7 | 46.0 | -28.3 |
| 2.180 | 17.9 | 56.0 | -38.1 | 10.8 | 46.0 | -35.2 |

Table 9

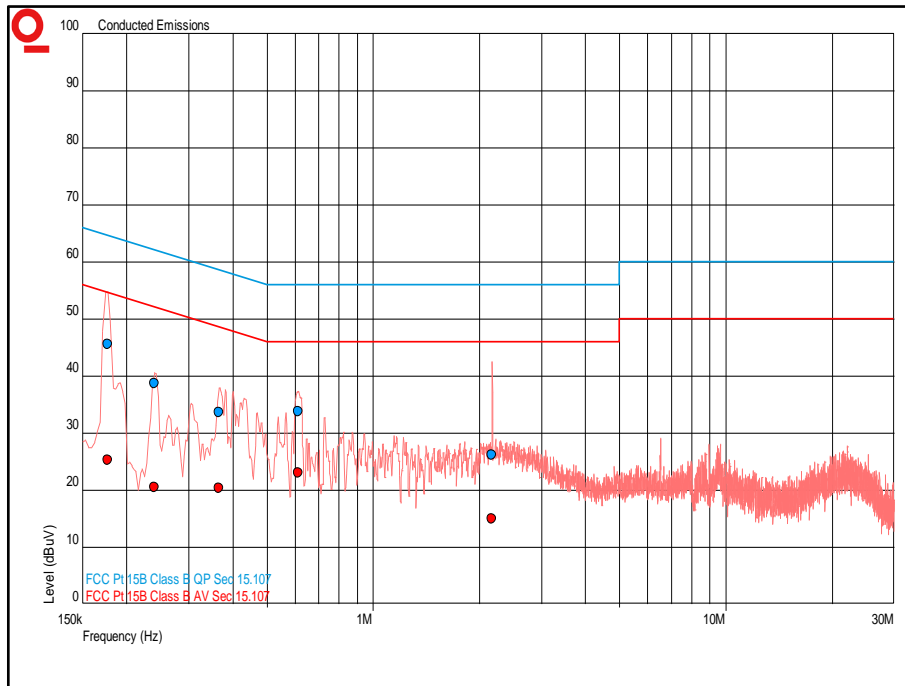


Figure 3 - Graphical Results - Neutral Line

| Frequency (MHz) | QP Level (dBµV) | QP Limit (dBµV) | QP Margin (dB) | CISPR Average Level (dBµV) | CISPR Average Limit (dBµV) | CISPR Average Margin (dB) |
|-----------------|-----------------|-----------------|----------------|----------------------------|----------------------------|---------------------------|
| 0.177 | 45.6 | 64.6 | -19.1 | 25.3 | 54.6 | -29.3 |
| 0.240 | 38.8 | 62.1 | -23.3 | 20.5 | 52.1 | -31.6 |
| 0.365 | 33.7 | 58.6 | -24.9 | 20.3 | 48.6 | -28.3 |
| 0.613 | 33.9 | 56.0 | -22.1 | 23.1 | 46.0 | -22.9 |
| 2.174 | 26.2 | 56.0 | -29.8 | 15.0 | 46.0 | -31.0 |

Table 10

No other measurements were made as all other peak emissions seen were greater than 6 dB below the CISPR Average test limit.



2.1.10 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 Due |
|------------------------|-----------------|---------------|-------|-----------------------------|-----------------|
| Screened Room (5) | Rainford | Rainford | 1545 | 36 | 23-Jan-2021 |
| Compliance 5 Emissions | Teseq | V5.26.51 | 3275 | - | Software |
| Test Receiver | Rohde & Schwarz | ESIB40 | 2941 | 12 | 16-Oct-2020 |
| Transient Limiter | Hewlett Packard | 11947A | 2377 | 12 | 26-Feb-2020 |
| LISN | Rohde & Schwarz | ESH3-Z5 | 1390 | 12 | 27-Jan-2021 |
| 2 Meter Cable | Teledyne | PR90-088-2MTR | 5196 | 12 | 06-Oct-2020 |
| 8 Meter Cable | Teledyne | PR90-088-8MTR | 5212 | 12 | 30-Aug-2020 |

Table 11



2.2 Radiated Disturbance

2.2.1 Specification Reference

FCC 47 CFR Part 15B, Clause 15.109
ICES-003, Clause 6.2

2.2.2 Equipment Under Test and Modification State

A2289, S/N: C02ZG009P09V - Modification State 0

2.2.3 Date of Test

12-December-2019 to 13-December-2019

2.2.4 Test Method

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

A pre-scan of the EUT emissions profile was made while varying the antenna-to-EUT azimuth, and antenna-to-EUT polarisation using a peak detector.

Measurements below 18GHz were taken at a 3m distance and measurements above 18GHz were taken at 1m distance.

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

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

2.2.5 Example Calculation

Below 1 GHz:

$$\begin{aligned} \text{Quasi-Peak level (dB}\mu\text{V/m)} &= \text{Receiver level (dB}\mu\text{V)} + \text{Correction Factor (dB)} \\ \text{Margin (dB)} &= \text{Quasi-Peak level (dB}\mu\text{V/m)} - \text{Limit (dB}\mu\text{V/m)} \end{aligned}$$

Above 1 GHz:

$$\begin{aligned} \text{CISPR Average level (dB}\mu\text{V/m)} &= \text{Receiver level (dB}\mu\text{V)} + \text{Correction Factor (dB)} \\ \text{Margin (dB)} &= \text{CISPR Average level (dB}\mu\text{V/m)} - \text{Limit (dB}\mu\text{V/m)} \end{aligned}$$

$$\begin{aligned} \text{Peak level (dB}\mu\text{V/m)} &= \text{Receiver level (dB}\mu\text{V)} + \text{Correction Factor (dB)} \\ \text{Margin (dB)} &= \text{Peak level (dB}\mu\text{V/m)} - \text{Limit (dB}\mu\text{V/m)} \end{aligned}$$

2.2.6 Example Test Setup Diagram

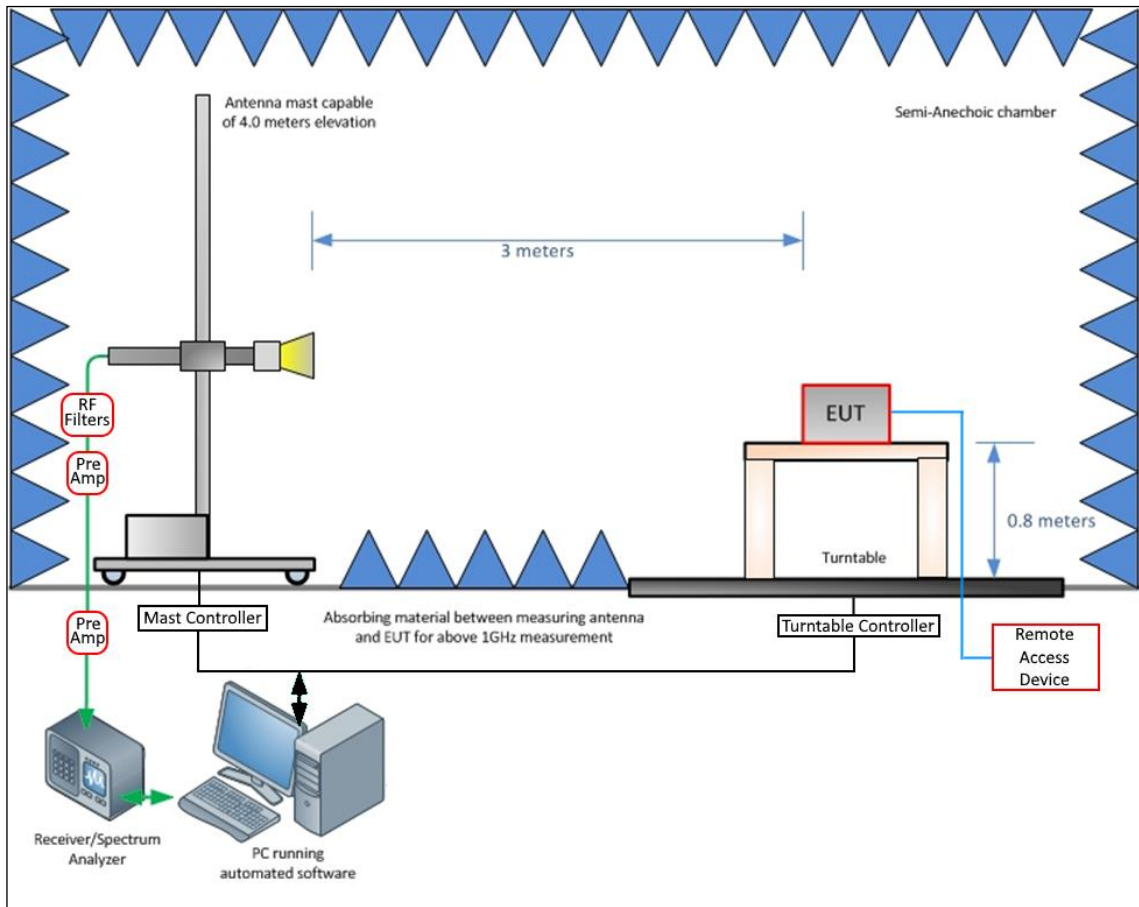


Figure 4 - Radiated Disturbance Example Test Setup

2.2.7 Environmental Conditions

Ambient Temperature 20.8 °C
 Relative Humidity 34.6 %

2.2.8 Specification Limits

| Required Specification Limits, Field Strength (Class B @ 3m) | | |
|--|----------------------------|-------------------------------------|
| Frequency Range (MHz) | ($\mu\text{V}/\text{m}$) | ($\text{dB}\mu\text{V}/\text{m}$) |
| 30 to 88 | 100 | 40 |
| 88 to 216 | 150 | 43.5 |
| 216 to 960 | 200 | 46.0 |
| Above 960 | 500 | 54 |

Supplementary information:
 Quasi-peak detector to be used for measurements below 1 GHz
 CISPR Average detector to be used for measurements above 1 GHz
 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 - Transmitters disabled.

The test was performed in accordance with 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: 6 GHz
 Which necessitates an upper frequency test limit of: 30 GHz

Frequency Range of Test: 30 MHz to 1 GHz

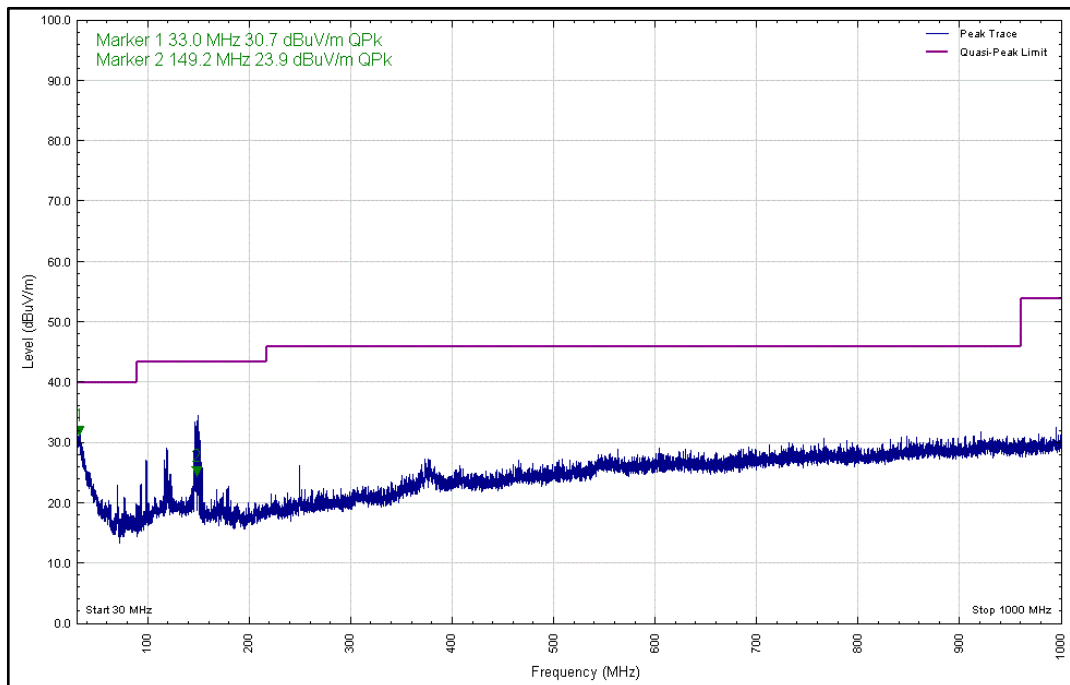


Figure 5 - Graphical Results - Vertical Polarity

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector | Angle (°) | Height (cm) | Polarisation |
|-----------------|----------------|----------------|-------------|----------|-----------|-------------|--------------|
| 33.0 | 30.7 | 40 | -9.3 | QP | 57 | 367 | Vertical |
| 149.230 | 23.88 | 43.5 | -19.6 | QP | 236 | 100 | Vertical |

Table 13

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

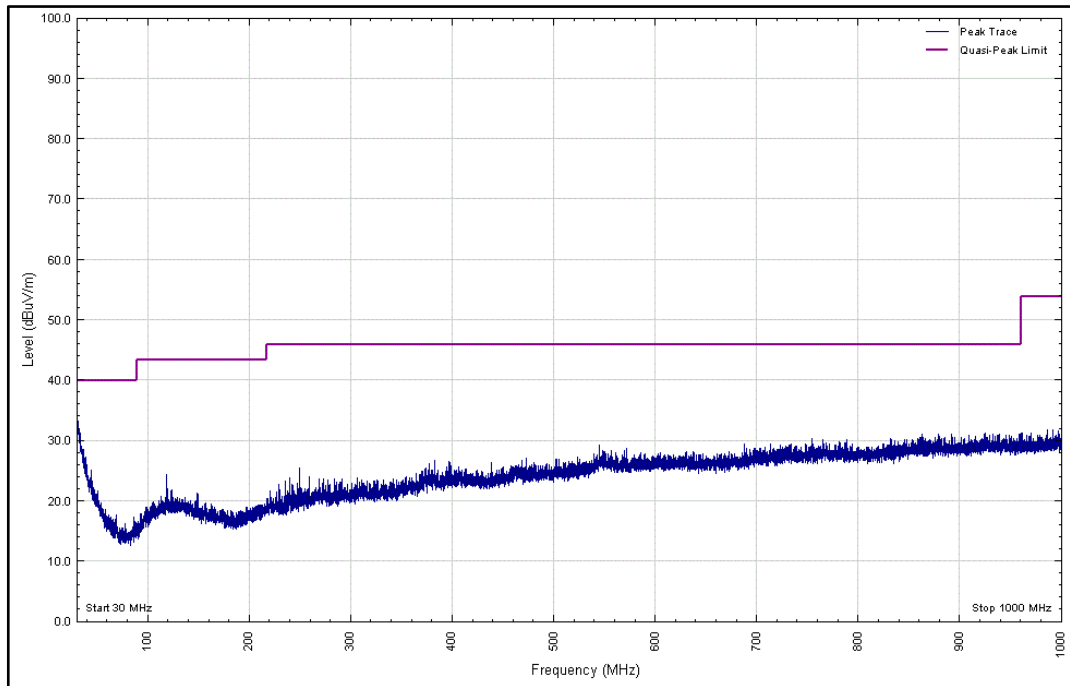


Figure 6 - Graphical Results - Horizontal Polarity

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

Table 14

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



Frequency Range of Test: 1 GHz to 30 GHz - Peak

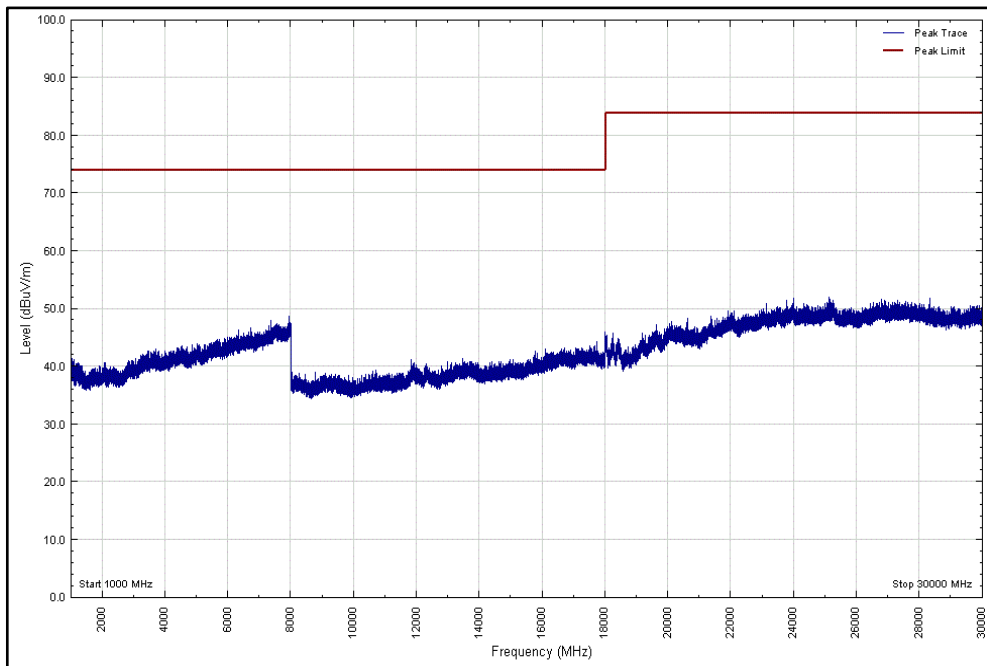


Figure 7 - Graphical Results - Vertical Polarity

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector | Angle (°) | Height (cm) | Polarisation | Orientation |
|-----------------|----------------|----------------|-------------|----------|-----------|-------------|--------------|-------------|
| * | | | | | | | | |

Table 15

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

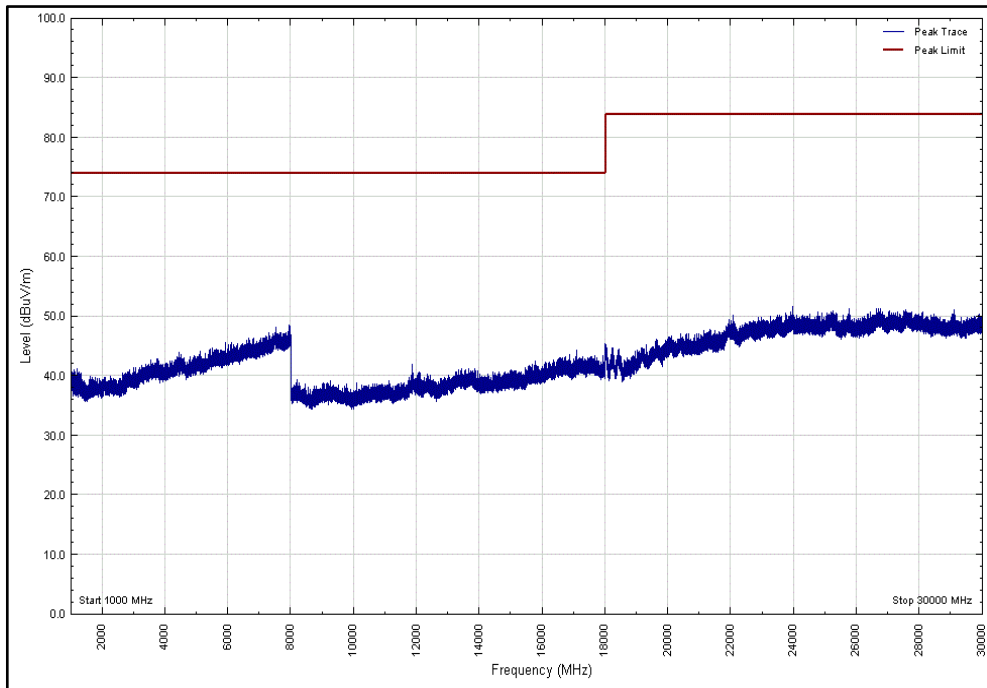


Figure 8 - Graphical Results - Horizontal Polarity

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector | Angle (°) | Height (cm) | Polarisation | Orientation |
|-----------------|----------------|----------------|-------------|----------|-----------|-------------|--------------|-------------|
| * | | | | | | | | |

Table 16

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



Frequency Range of Test: 1 GHz to 30 GHz – CISPR Average

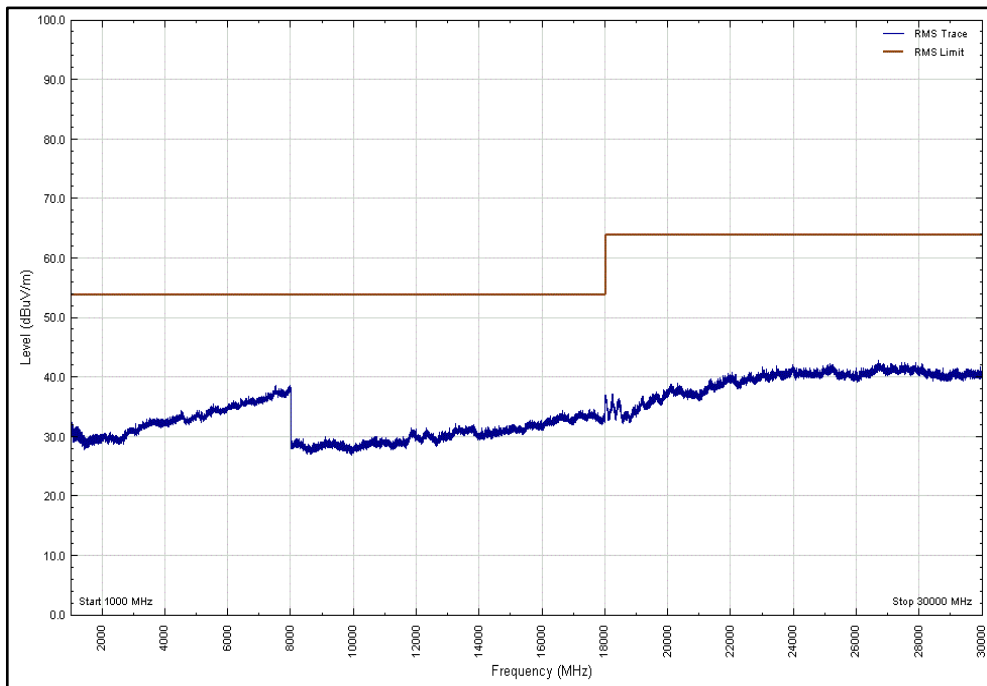


Figure 9 - Graphical Results - Vertical Polarity

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector | Angle (°) | Height (cm) | Polarisation | Orientation |
|-----------------|----------------|----------------|-------------|----------|-----------|-------------|--------------|-------------|
| * | | | | | | | | |

Table 17

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

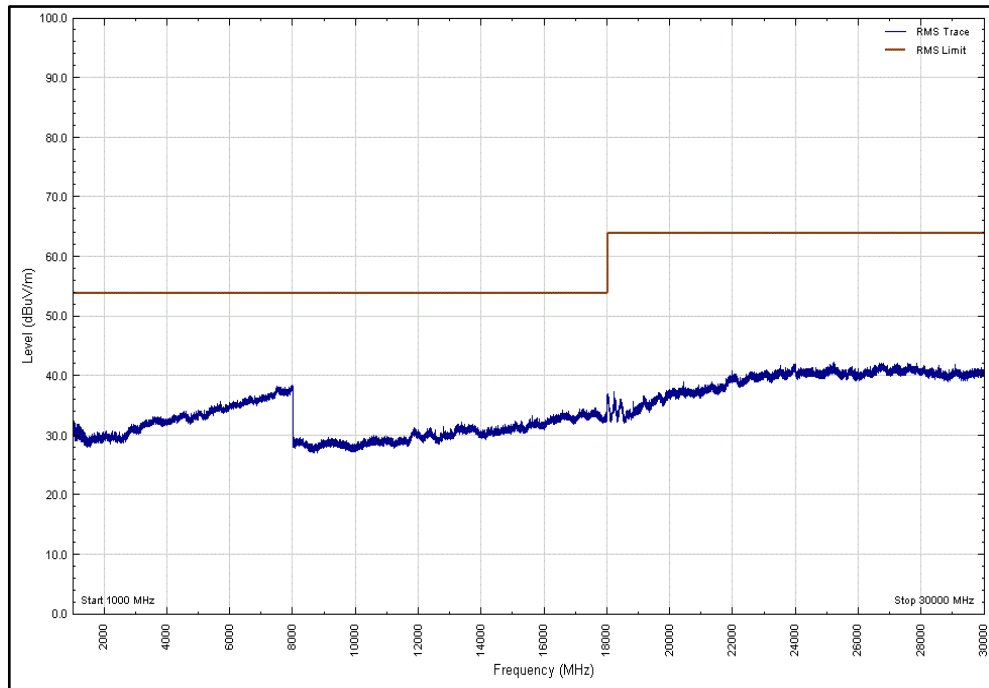


Figure 10 - Graphical Results - Horizontal Polarity

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector | Angle (°) | Height (cm) | Polarisation | Orientation |
|-----------------|----------------|----------------|-------------|----------|-----------|-------------|--------------|-------------|
| * | | | | | | | | |

Table 18

*No formal measurements were made as all peak emissions seen above the measurement system noise floor 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.

| Instrument | Manufacturer | Type No | TE No | Calibration Period (months) | Calibration Due |
|---|---------------------|---------------|-------|-----------------------------|-----------------|
| Screened Room (11) | Rainford | Rainford | 5136 | 36 | 01-Nov-2021 |
| EmX Emissions Software | TUV SUD | EmX | 5125 | - | Software |
| EMI Test Receiver | Rohde & Schwarz | ESW44 | 5084 | 12 | 28-Nov-2020 |
| Mast | Maturo | TAM 4.0-P | 5158 | - | TU |
| Mast and Turntable Controller | Maturo | Maturo NCD | 5159 | - | TU |
| Turntable | Maturo | TT 15WF | 5160 | - | TU |
| Pre-Amplifier | Phase One | PS04-0086 | 1533 | 12 | 08-Feb-2020 |
| 1GHz to 8GHz Low Noise Amplifier | Wright Technologies | APS04-0085 | 4365 | 12 | 14-Nov-2020 |
| Preamplifier (30 dB 18-40GHz) | Schwarzbeck | BBV 9721 | 5218 | 12 | 09-Apr-2020 |
| Antenna with permanent attenuator (Bilog) | Schaffner | CBL6143 | 287 | 24 | 15-May-2020 |
| Double Ridged Waveguide Horn Antenna | ETS-Lindgren | 3117 | 4722 | 12 | 05-Mar-2020 |
| Double Ridge Broadband Horn Antenna | Schwarzbeck | BBHA 9120 B | 4848 | 12 | 11-Mar-2020 |
| Horn Antenna (1-10GHz) | Schwarzbeck | BBHA 9120 B | 5215 | 12 | 11-Mar-2020 |
| Horn Antenna (15-40GHz) | Schwarzbeck | BBHA 9170 | 5217 | 12 | 09-Apr-2020 |
| DRG Horn Antenna (7.5-18GHz) | Schwarzbeck | HWRD750 | 5216 | 12 | 11-Mar-2020 |
| Hygrometer | Rotronic | HP21 | 4989 | 12 | 02-May-2020 |
| Cable (18 GHz) | Rosenberger | LU7-071-1000 | 5104 | 12 | 09-Dec-2020 |
| 8 Meter Cable | Teledyne | PR90-088-8MTR | 5212 | 12 | 30-Aug-2020 |

Table 19



3 Incident Reports

No incidents reports were raised.



4 Measurement Uncertainty

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

| Test Name | Measurement Uncertainty |
|--|---|
| Radiated Disturbance | 30 MHz to 1 GHz, Bilog Antenna, ± 5.2 dB 1 GHz to 40 GHz, Horn Antenna, ± 6.3 dB |
| Conducted Disturbance at Mains Terminals | 150 kHz to 30 MHz, LISN, ± 3.7 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: 2007, clause 4.4.3 and 4.5.1.