**EMC Test Report**

**For**

**Raspberry Pi Trading Limited**

**On**

**Raspberry Pi Camera V2**

**Report No. TRA-029291-44-00A**

**20th November 2015**

Report Number: TRA-029291-44-00A
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**REPORT ON THE EMC TESTING OF A**
**Raspberry Pi Trading Limited**
**Raspberry Pi Camera V2**
**WITH RESPECT TO SPECIFICATION**
**EN 55032:2012, EN 55024:2010,**
**EN 61000-3-2:2014 AND EN 61000-3-3:2013**

TEST DATES: 11/11/15 to 18/11/15

Written by: _____ M.Baker
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Approved by: _____ M.Leach
Department Manager - EMC

Date: 20th November 2015

**Distribution:**

Copy 1: Element
Copy 2: Raspberry Pi Trading Limited
Copy 3: Not Applicable





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Company Reg No. 02536659

# 1 Revision Record

| *Issue Number* | *Issue Date* | *Revision History* |
|---|---|---|
| A | 20/11/15 | Original |

# 2 Summary

| | |
|---|---|
| TEST REPORT NUMBER: | TRA-029291-44-00A |
| PURPOSE OF TEST: | Electromagnetic Compatibility – Emissions and Immunity |
| TEST SPECIFICATION: | EN 55032:2012, EN55024:2010, EN61000-3-2:2014 and EN61000-3-3:2013 |
| DEVIATIONS FROM SPECIFICATION: | Not Applicable |
| EQUIPMENT UNDER TEST (EUT): | Raspberry Pi Camera V2 |
| EUT SERIAL NUMBER: | None |
| TEST RESULT: | Measured As Compliant<br>Given any modifications stated in the relevant section of this report.<br>The display, expander and audio ports of the Raspberry Pi A+ support equipment were not terminated and are excluded from the scope of the report |
| MANUFACTURER/AGENT: | Raspberry Pi Trading Limited |
| ADDRESS: | Mount Pleasant House<br>Mount Pleasant<br>Cambridge<br>CB30RN |
| CLIENT CONTACT: | Mike Stimson<br>☎ 01223322633<br>✉ mike@raspberrypi.org |
| ORDER NUMBER: | PO-0185 |
| TEST DATES: | 11/11/15 to 18/11/15 |
| TESTED BY: | M.Baker<br>Element |

# 3 Contents

# 4 Introduction

This report TRA-029291-44-00A presents the results of the EMC testing on a Raspberry Pi Trading Limited, Raspberry Pi Camera V2 to specifications EN 55032:2012, EN 55024:2010, EN 61000-3-2:2014 and EN 61000-3-3:2013.

The testing was carried out for Raspberry Pi Trading Limited by Element, an independent test house, at their EMC test facility located at:

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This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

All test and measurement equipment under the control of the laboratory and requiring calibration is subject to an established programme and procedures to control and maintain measurement standards. The quality management system meets the principles of ISO 9001, and has quality control procedures for monitoring the validity of tests undertaken. Records and sufficient detail are retained to establish an audit trail of calibration records relating to its test results for a defined period. Under control of the established calibration programme, key quantities or values of the test and measurement instrumentation are within specification and comply with the relevant traceable internationally recognised and appropriate standard specifications, which are UKAS calibrated as such where these properties have a significant effect on results. Participation in inter-laboratory comparisons and proficiency testing ensures satisfactory correlation of results conform to Element's own procedures, as well as statistical techniques for analysis of test data providing the appropriate confidence in measurements.

It is Element policy to always use the latest version of any applicable base test standards. Where a product specification calls up a superseded dated revision or an undated basic standard, the latest version will be used. This may be a deviation to the product standard if dated references have been used.

Throughout this report EUT denotes equipment under test.

# 5 Normative References

## *5.1 EN 55032 References*

- *IEC 60083:2006, *Plugs and socket-outlets for domestic and similar general use standardised in member countries of IEC*
- EN 55011:2009 + A1:2010, *Industrial, scientific and medical (ISM) radio-frequency equipment – Electro-magnetic disturbance characteristics – Limits and methods of measurement*
- EN 55013:2013, *Sound and television broadcast receivers and associated equipment – Radio disturbance characteristics – Limits and methods of measurement*
- *EN 55016-1-1:2010 + A1:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measurement apparatus – Measuring apparatus*
- *EN 55016-1-2:2004 + A2:2006, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measurement apparatus – Ancilliary equipment – Conducted disturbances*
- *EN 55016-1-4:2010 + A1:2012, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Radiated disturbances*
- *EN 55016-2-3:2010 +A1:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbance and immunity – Radiated disturbance measurements*
- *EN 55016-2-1:2009 +A1:2011*, Specification for radio disturbance and immunity measuring apparatus and methods –Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*
- *EN 55016-2-3:2010+A1:2010, *Specification for radio disturbance and immunity measuring apparatus and methods –Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements*
- *EN 55016-4-2:2011, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics and limit modelling – Measurement instrumentation uncertainty*
- *CISPR 16-4-3:2004+A1:2006*, Specification for radio disturbance and immunity measuring apparatus and methods –Part 4-3: Uncertainties, statistics and limit 8odelling – Statistical considerations in the determination of EMC compliance of mass-produced products*
- EN 61000-4-6:2009*, Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

## *5.2 EN 55024 References*

- *IEC 60050(161) ed1.0 (1990-08), International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility.
- *EN 60318-1:2009, Electroacoustics – Simulators of human head and ear – Part 1: Ear simulator for the measurement of supra-aural and circumaural earphones.
- EN 61000-4-2:2009, Electromagnetic compatibility (EMC) – Part 4-2 Testing and measurement techniques – Electrostatic discharge immunity test.
- EN 61000-4-3:2006 + A2:2010, Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test.
- EN 61000-4-4:2012, Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test.
- EN 61000-4-5:2006, Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test.
- *EN 61000-4-6:2014, Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields.
- EN 61000-4-8:2010, Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test.
- EN 61000-4-11:2004, Electromagnetic compatibility (EMC). Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests.
- *EN 55016-1-2:2004 + A2:2006, Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measurement apparatus – Ancillary equipment – Conducted disturbances
- *EN 55020:2007 + A1:2011, Sound and television broadcast receivers and associated equipment – Immunity characteristics – Limits and methods of measurement.
- EN 55022:2010, Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement.

*Indicates a specification or standard or specific amendment that is not listed on the Element UKAS scope of accreditation.

## *5.3 EN 61000-3-2 References*

- *IEC 60050(131) ed2.0 (2002-06), International Electrotechnical Vocabulary (IEV) – Chapter 131: Electric and magnetic circuits
- *IEC 60050(161) ed1.0 (1990-08), International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility.
- *EN 60107-1:1997, Methods of measurement on receivers for television broadcast transmissions – Part 1: General considerations – Measurements at radio and video frequencies
- *EN 60155:1995, Glow-starters for fluorescent lamps.
- *IEC 60268-1 ed20. (1985-01), Sound system equipment – Part 1: General
- *EN 60268-3:2013, Sound systems equipment – Part 3: Amplifiers.
- *EN 60335-2-2:201 + A1:2013, Household and similar electrical appliances – Safety – Part 2-2: Particular requirements for vacuum cleaners and water-suction cleaning appliances
- *EN 60335-2-14:2006 + A1:2008, Household and similar electrical appliances – Safety – Part 2-14: Particular requirements for kitchen machines.
- *EN 60974-1:2012, Arc welding equipment – Part 1: Welding power sources
- *EN 61000-2-2:2002, Electromagnetic compatibility (EMC) – Part 2: Environment – Section 2: Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems
- *IEC/TS 61000-3-4 ed1.0 (1998-10), Electromagnetic compatibility (EMC) – Part 3-4: Limits – Limitation of emission of harmonics currents in low-voltage power supply systems for equipment with rated current greater than 16A
- *EN 61000-3-12:2011 - Electromagnetic compatibility (EMC) - Part 3-12: Limits - Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase
- *EN 61000-4-7:2002 + A1:2009, Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto
- ITU-R Recommendation BT.471.1, Nomenclature and description of colour bar signals

## *5.4 EN 61000-3-3 References*

- *IEC/TR 60725 ed3.0 (2012-06), Consideration of reference impedances and public supply impedances for use in determining disturbance characteristics of electrical equipment having a rated current ≤75 A per phase
- *EN 60974-1:2012, Arc welding equipment – Part 1: Welding power sources
- EN 61000-3-2:2006 +A2:2009, Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤16 A per phase).
- *EN 61000-4-7:2002 + A1:2009, Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto
- ITU-R Recommendation BT.471.1, Nomenclature and description of colour bar signals

*Indicates a specification or standard or specific amendment that is not listed on the Element UKAS scope of accreditation.

# 6 Equipment Under Test

## *6.1 EUT Identification*

- Name: Raspberry Pi Camera V2
- Serial Number: None
- Model Number: Raspberry Pi Camera V2
- Software Revision: Raspbian Jesse – release 2015-09-24
- Build Level / Revision Number: V2.0
- Element Sample: S01

Incorporating the following external cables / test ports;

| ***Type*** | | ***Description*** | ***Outdoor Cable Y / N*** | ***Test Length*** | ***Max Installation Length*** |
|---|---|---|---|---|---|
| 1 | CSI camera | Ribbon cable | N | 15cm | 15cm |

## *6.2 System Equipment*

Equipment listed below forms part of the overall test setup and is required for equipment functionality and/or monitoring during testing. The compliance levels achieved in this report relate only to the EUT and not items given in the following list.

- Name: Raspberry Pi A+
- Model Number: Raspberry Pi A+
- Element Sample: S02

- Name: Stontronics Ltd Plug top PSU
- Part Number: T5454DV
- Model Number: DSA-12CA-05
- Build Level / Revision Number: Production
- Element Sample: S04

- Name: Panasonic TV
- Model Number: TX-L22-X20E
- Build Level / Revision Number: Production
- Element Equipment reference: RFG683

- Name: BELKIN USB Keyboard
- Model Number: F8206-BLK-USB
- Build Level / Revision Number: R2.0

## *6.3 EUT Mode of Operation*

### *6.3.1 Emissions*

The camera was generating a live image, which was displayed on a supporting monitor via a Raspberry Pi A+.

### *6.3.2 Immunity*

The camera was generating a live image of a moving clock, which was displayed on a supporting monitor via a Raspberry Pi A+.

## *6.4 EUT Monitoring*

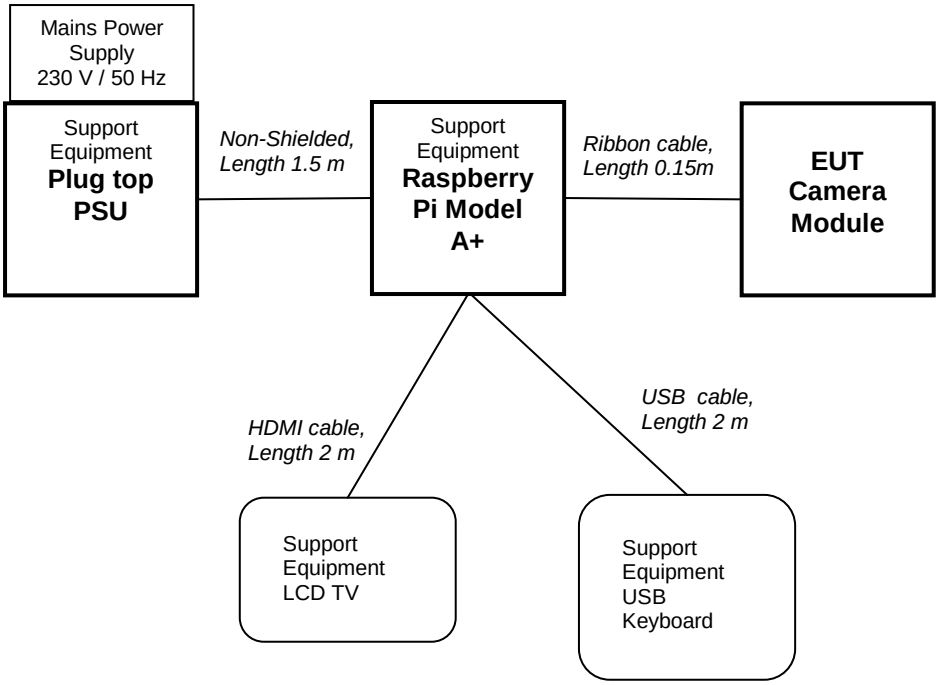
During immunity testing the performance of the EUT was assessed by visually monitoring the supporting display (connected via HDMI).

## *6.5 EUT Description*

The EUT was a colour video camera, connected to a Raspberry Pi A+ via a short 15cm ribbon cable.

# 7 Block Diagram

The following diagram shows basic EUT interconnections with cable type and cable lengths identified.



# 8 Test Standard Selection

## *8.1 Product Standard*

The following product standard was used as the basis of the test levels required and has been deemed the most appropriate product standard to apply to the Raspberry Pi Camera V2, or has been requested by the manufacturer:

| | |
|---|---|
| EN 55032 | Electromagnetic compatibility of multimedia equipment – Emission requirements |
| EN 55024 | Information technology equipment – Immunity characteristics – Limits and methods of measurement |
| EN 61000-3-2 | Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤16 A per phase) |
| EN 61000-3-3 | Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤16 A per phase and not subject to conditional connection |

### *8.2 Basic Test Standard Selection*

| ***Basic Test Standard*** | ***Applicable*** | | ***Notes*** |
|---|---|---|---|
| EN 61000-4-2:2009 – Electrostatic Discharge Immunity | ☒ | | Note 4 |
| EN 61000-4-3:2006 +A1:2008 +A2:2010 – Radiated RF Immunity | ☒ | | |
| EN 61000-4-4:2012 – Electrical Fast Transients Immunity | ☒ | | |
| EN 61000-4-5:2014 – Voltage Surge Immunity | ☒ | | |
| EN 61000-4-6:2014 – Conducted RF Immunity | ☒ | | |
| EN 61000-4-8:2010 – Power Frequency Magnetic Field Immunity | ☐ | | Note 3 |
| EN 61000-4-11:2004 – Voltage Dips and Short Interruptions Immunity | ☒ | | |
| | ***Class A*** | ***Class B*** | |
| EN 55032:2012 – Radiated Emissions | ☐ | ☒ | |
| EN 55032:2012 – Conducted Emissions | ☐ | ☒ | |
| EN 55032:2012 – Conducted Asymmetric Mode Emissions (AAN Measurement per EN 55032:2012 C4.1.6.2) | ☐ | ☐ | Note 2 |
| EN 55032:2012 – Conducted Asymmetric Mode Emissions (150 Ω / Current Probe per EN 55032:2012 C4.1.6.3) | ☐ | ☐ | Note 2 |
| EN 55032:2012 – Conducted Asymmetric Mode Emissions (CVP / Current Probe per EN 55032:2012 C4.1.6.4) | ☐ | ☐ | Note 2 |
| EN 61000-3-2:2014 – Harmonic Current Emissions | ☒ | | |
| EN 61000-3-3:2013 – Voltage Fluctuations and Flicker | ☒ | | |

*Notes:*
*[1] Tests marked with an asterisk* in the Normative References Section indicate a dated specification or specific amendment which falls outside the laboratories UKAS scope of accreditation, but are within the laboratories scope of competence. However, Element are UKAS accredited for the superseded version of the specification.*
*[2] Not applicable, EUT contains no test port.*
*[3] Not applicable, EUT contains no devices susceptible to magnetic field.*
*[4] No direct discharge applied as the EUT has no enclosure so ESD precautions to be implemented during normal use as detailed in the Raspberry Pi documentation.*

# 9 Performance Criteria

## *9.1 General Performance Criteria*

The test results may be classified on the basis of the operating conditions and the functional specifications of the equipment under test, according to the following performance criteria taken from EN 55024:2010.

**Performance Criterion A**

During and after the test the EUT shall continue to operate as intended without operator intervention. No degradation of performance or loss of function is allowed below a minimum performance level specified by the manufacturer when the EUT is used as intended. The performance level may be replaced by a permissible loss of performance.

If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation, and by what the user may reasonably expect from the EUT if used as intended.

**Performance Criterion B**

After the test, the EUT shall continue to operate as intended without operator intervention. No degradation of performance or loss of function is allowed, after the application of the phenomena below a performance level specified by the manufacturer, when the EUT is used as intended. The performance level may be replaced by a permissible loss of performance.

During the test, degradation of performance is allowed. However, no change of operating state or stored data is allowed to persist after the test.

If the minimum performance level (or the permissible performance loss) is not specified by the manufacturer, then either of these may be derived from the product description and documentation, and by what the user may reasonably expect from the EUT if used as intended.

**Performance Criterion C**

During and after testing, a temporary loss of function is allowed, provided the function is self-recoverable, or can be restored by the operation of the controls or cycling of the power to the EUT by the user in accordance with the manufacturer's instructions.

Functions, and/or information stored in non-volatile memory, or protected by a battery backup, shall not be lost.

### *9.2 Specification Based Performance Criteria*

The following specific criteria were used from Annexes A to H of EN 55024:2010, as applicable:

| *EN55024 Annex* | *Applicable* |
|---|---|
| Annex A - Telephony Terminal Equipment | ☐ |
| Annex B - Data Processing Equipment | ☒ |
| Annex C - Local Area Networks (LAN) | ☐ |
| Annex D - Printers and Plotters | ☐ |
| Annex E - Copying Machines | ☐ |
| Annex F - Automatic Teller Machines (ATM) | ☐ |
| Annex G - Point of Sale Terminals (POST) | ☐ |
| Annex H - xDSL Terminal Equipment | ☐ |

#### *9.2.1 Annex B – Data Processing Equipment Performance Criteria*

**B.2 Read, Write and Storage of Data**

**Performance Criterion A**
During the test storage devices shall maintain normal operation both in read/write and in standby conditions.

**Performance Criterion B**
During and after the test failures which can be recovered by read and write retries are permissible (temporary delay in processing caused by this process is acceptable). Normal operation of the EUT shall be restored after the test, self-recovery to the conditions immediately prior to the application of the test is accepted where this is a normal means of recovery. In these cases, operator response is permitted to re-initialise an operation.

**Performance Criterion C**
Failures during test that result in a delay in processing or a system abort, which after testing can be recovered to normal operation by reset or reboot, are permissible.

**B.3 Data Display**

**Performance Criterion A**
During the test, when seen from the normal viewing distance, the EUT shall operate with no change beyond the manufacturer's specification, in flicker, colour, focus and jitter (except for the power frequency magnetic field test).

**Power Frequency Magnetic Field Test**

For CRT monitors, the following also applies:

The jitter shall be measured when the CRT monitor is immersed in a continuous magnetic field of 1 A/m (r.m.s.) at one of the power frequencies of 50 Hz or 60 Hz.

For displays with pixels having continuous luminance distributions only, jitter may be measured using a measuring microscope of at least 20 power. The movement is determined by visual

alignment of the microscope cursor or comparator reticle with the extreme positions of the centroid or edge of a character or test object during the observation period.

For any display type, a special display-measuring device may be used. This device shall determine, on a scan-by-scan basis, the relative location of a character or test object. If a device is used that determines movement along the horizontal and vertical axes only, the extent of the jitter shall be defined as the square root of the sum of the squares of the maximum horizontal and vertical differences.

Observations shall extend for periods of at least 4 s. Measuring devices that sample scans shall accumulate a number of scans equivalent to at least 4s of continuous observation.

The maximum jitter permitted is given by:

$$J \leq \frac{(\mathrm{C} - 0.3)\mathrm{x}2.5}{33.3}$$

Where:
J is the jitter (in mm);
C is the character height (in mm).

Alternatively, a field of 50 A/m may be applied, and a transparent graduated mask used to assess the jitter. In this case, the jitter shall not exceed 50 times the value in the above formula.

The EUT shall be tested in two positions, both perpendicular to the magnetic field.

**Performance Criterion B**
Screen disturbances during the application of the test are permissible if they self-recover after removal of the external disturbance.

**Performance Criterion C**
Failures during the test that cannot self-recover after removal of the external disturbance, but which can be recovered after the test to normal operation by reset or reboot are permissible.

**B.4 Data input**

**Performance Criterion A**
During testing unintended input from an input device is not allowed. During testing input devices shall maintain the specified quality image data.

**Performance Criterion B**
During testing keyboard/mouse "lock up" is not allowed.

For EUT with manually inputted data that can be confirmed by reading the display, errors are permissible during testing if they can be recognised by the operator and easily corrected.

**Performance Criterion C**
Failures during test that result in a delay in processing or a system abort, which after testing can be recovered to normal operation by reset or reboot, are permissible.

**B.5 Data printing**

**Performance Criterion A**
During testing printers shall maintain the specified printing quality and normal operation.

**Performance Criterion B**
During testing no degradation of the printing quality beyond the manufacturer's specification (such as distortion of character(s) or missing pixels) is permissible. A paper feed failure is allowed if after removal of the jammed sheets the job is automatically recovered and there is no loss of printed information.

**Performance Criterion C**
During testing printing errors or omission of character(s) which require reprinting are permissible. Input/output failures that occur during testing that can be recovered to normal operation after testing by reset or reboot are also permissible.

**B.6 Data processing**

**Performance Criterion A**
During testing failures which do not influence the specified operation within the product specification, and which do not prevent automatic recovery are permissible.

**Performance Criterion B**
During testing failures which are recovered automatically but cause temporary delay in processing are permissible.

**Performance Criterion C**
Failures during testing that result in a delay in processing after the external disturbance is removed, but which can be recovered after testing to normal operation by a reset or reboot are permissible.

Failures during testing that result in a system abort, which can be recovered to normal operation after testing by reset or reboot, are permissible.
Failures during testing that are followed by alarms and can be recovered to normal operation by the operator's intervention after testing are permissible.

### *9.3 Actual Performance Criteria*

**Performance Criterion A**

During and after the test the EUT shall continue to operate as intended without operator intervention. During the test there is to be no interruption or noticeable degradation (colour loss, macro blocking and freezing of image) on the displayed video on the supporting TV outputted via the HDMI port.

**Performance Criterion B**

During and after the test the EUT shall continue to operate as intended. During the test there may be interruption or noticeable degradation (colour loss, macro blocking and freezing of image) on the displayed video on the supporting TV outputted via the HDMI port providing the EUT self recovered upon completion of the test.

**Performance Criterion C**

During the application of the test, complete loss of function is allowed, but must self recover without user intervention upon completion of the test.

# 10 Electrostatic Discharge Immunity as per EN 61000-4-2:2009

## *10.1 General*

This test simulates human body static discharge that equipment may be subject to. The test also includes discharges that may occur in the vicinity of the equipment thereby setting up a rapidly fluctuating short term electric field.

Two types of discharge are used – Air and Contact. Air discharges are applied to points that are classified as insulating surfaces and contact discharges are applied directly with no air interface on to conducting metallic surfaces of the EUT.

Where an EUT is defined as a class II apparatus then contact points will be connected to ground using two 470 kΩ resistors to provide a leakage path to ground so as to prevent charge build up.

The test setup used complies with all the dimension requirements set out in EN 61000-4-2:2009. The discharge generator is UKAS calibrated as such.

## *10.2 Electrostatic Discharge Test Parameters*

| | |
|---|---|
| Energy Storage Capacitor: | 150 pF |
| Discharge Resistance: | 330 Ω |
| Output Voltage: | Up to 8 kV – Contact Discharge<br>Up to 15 kV – Air Discharge |
| Discharge Rise Time: | 0.7 to 1 ns |
| Deviation from Basic Test Standard: | None |

Testing will only be carried out (unless otherwise stated so in this section) if the following environmental conditions are met:

Ambient temperature in the range 15 °C to 35 °C
Relative humidity in the range 30 % to 60 %
Atmospheric pressure in the range 860 mbar to 1060 mbar

## *10.3 Electrostatic Discharge Levels*

The following test voltages were used for contact and air discharge:

| | | | | | |
|---|---|---|---|---|---|
| Air Discharge | ±2 kV | ☒ | Contact Discharge | ±2 kV | ☒ |
| | ±4 kV | ☒ | | ±4 kV | ☒ |
| | ±6 kV | ☐ | | | |
| | ±8 kV | ☒ | | | |

A minimum of 50 discharges at each point with a minimum of 4 test points as per EN 55024:2010+A1:2015* Section 4.2.1(a) were applied.

Note: Refer to EN 55024:2010 Clause 4.2.1 Electrostatic discharges (ESD):

“The test procedure shall be in accordance with IEC 61000-4-2, with the following modifications and clarifications…

…For contact discharge, the requirement to apply ESD discharges at lower levels, as defined in Clause 5 of IEC 61000-4-2, is not applicable.”

### *10.4 EUT Test Results*

For pass/fail criteria definitions please see section 9 of this report. Where a departure from the pass/fail criteria is given for a specific test then this will be noted in this section after the results table.

#### *10.4.1 Air Discharge*

Test levels applied are identified in the previous section.

| | ***EUT Test Points*** | ***Performance Criteria Achieved*** | ***Performance Criteria Required*** |
|---|---|---|---|
| 1 | Plug Top PSU enclosure | A | B |

#### *10.4.2 Contact Discharge*

Test Levels applied are identified in the previous section.

| | ***EUT Test Points*** | ***Performance Criteria Achieved*** | ***Performance Criteria Required*** |
|---|---|---|---|
| 1 | Horizontal Coupling Plane (HCP) | A | B |
| 2 | Vertical Coupling Plane (VCP) – 4 sides | A | B |

Note: As the Raspberry Pi A+ and Raspberry Camera V2 has no enclosure, no direct electrostatic discharges were applied to these, only indirect discharges (HCP and VCP) were applied.

# 11 Radiated RF Immunity as per EN 61000-4-3:2006 +A1:2008 +A2:2010

## *11.1 General*

This test simulates the threat imposed by operating the equipment in the vicinity of intentional transmitters both fixed and mobile.

The specification calls up a uniform field test area, Element meet the field uniformity requirements set out in EN 61000-4-3:2006 +A1:2008 +A2:2010 in the frequency range 80 MHz to 1 GHz.

A computer controlled pre-calibrated level is applied to the antenna and the frequency is swept across the range of test at a predefined step size and time.

No corrections to the selected test levels below were made to factor the uncertainty budget for this test, as instructed by the reference standard, hence field strength is as reported.

The test setup used complies with all the dimension requirements set out in EN 61000-4-3:2006 +A1:2008 +A2:2010.

## *11.2 Radiated RF Test Parameters*

| | |
|---|---|
| Frequency Range: | 80 MHz to 1 GHz |
| Spot Frequencies:<br>Note: When specified in Annex A of EN 55024, an additional comprehensive functional test shall be carried out at the selected spot frequencies. | ☒ Not Applicable – EUT not covered by Annex A<br>☐ 80 MHz ± 1 %<br>☐ 120 MHz ± 1 %<br>☐ 160 MHz ± 1 %<br>☐ 230 MHz ± 1 %<br>☐ 434 MHz ± 1 %<br>☐ 460 MHz ± 1 %<br>☐ 600 MHz ± 1 %<br>☐ 863 MHz ± 1 %<br>☐ 900 MHz ± 1 % |
| Modulation Type: | Amplitude – Sine Wave |
| Amplitude Modulation Frequency: | ☒ 1 kHz<br>☐ 400 Hz |
| Dwell Time per Momentary Frequency: | ☒ 3 seconds |
| Test Voltage:<br>Note: See frequency range above for any additional information on test levels applied in each range. | 3 V/m |
| Step Increment: | 1 % of the momentary frequency |
| Antenna Polarisations: | Horizontal and Vertical |
| Number of EUT Faces Tested: | ☒ 4 Faces<br>☐ 6 Faces |
| Deviation from Basic Test Standard: | None |

### *11.3 Radiated RF Test Frequencies*

A full list of frequency points is given here in MHz, the exact frequencies used will be dependent upon the test range selected in the table above.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 80.000 | 109.995 | 151.237 | 207.942 | 285.908 | 393.106 | 540.498 | 743.152 |
| 80.800 | 111.095 | 152.749 | 210.021 | 288.767 | 397.037 | 545.903 | 750.584 |
| 81.608 | 112.206 | 154.277 | 212.121 | 291.654 | 401.008 | 551.362 | 758.089 |
| 82.424 | 113.328 | 155.820 | 214.243 | 294.571 | 405.018 | 556.875 | 765.670 |
| 83.248 | 114.462 | 157.378 | 216.385 | 297.517 | 409.068 | 562.444 | 773.327 |
| 84.081 | 115.606 | 158.952 | 218.549 | 300.492 | 413.158 | 568.068 | 781.060 |
| 84.922 | 116.762 | 160.541 | 220.734 | 303.497 | 417.290 | 573.749 | 788.871 |
| 85.771 | 117.930 | 162.146 | 222.942 | 306.532 | 421.463 | 579.487 | 796.760 |
| 86.629 | 119.109 | 163.768 | 225.171 | 309.597 | 425.678 | 585.281 | 804.727 |
| 87.495 | 120.300 | 165.406 | 227.423 | 312.693 | 429.934 | 591.134 | 812.775 |
| 88.370 | 121.503 | 167.060 | 229.697 | 315.820 | 434.234 | 597.046 | 820.902 |
| 89.253 | 122.718 | 168.730 | 231.994 | 318.978 | 438.576 | 603.016 | 829.111 |
| 90.146 | 123.945 | 170.418 | 234.314 | 322.168 | 442.962 | 609.046 | 837.402 |
| 91.047 | 125.185 | 172.122 | 236.657 | 325.390 | 447.391 | 615.137 | 845.776 |
| 91.958 | 126.437 | 173.843 | 239.024 | 328.644 | 451.865 | 621.288 | 854.234 |
| 92.878 | 127.701 | 175.581 | 241.414 | 331.930 | 456.384 | 627.501 | 862.777 |
| 93.806 | 128.978 | 177.337 | 243.828 | 335.249 | 460.948 | 633.776 | 871.404 |
| 94.744 | 130.268 | 179.111 | 246.266 | 338.602 | 465.557 | 640.114 | 880.118 |
| 95.692 | 131.571 | 180.902 | 248.729 | 341.988 | 470.213 | 646.515 | 888.920 |
| 96.649 | 132.886 | 182.711 | 251.216 | 345.408 | 474.915 | 652.980 | 897.809 |
| 97.615 | 134.215 | 184.538 | 253.729 | 348.862 | 479.664 | 659.510 | 906.787 |
| 98.591 | 135.557 | 186.383 | 256.266 | 352.350 | 484.461 | 666.105 | 915.855 |
| 99.577 | 136.913 | 188.247 | 258.828 | 355.874 | 489.305 | 672.766 | 925.013 |
| 100.573 | 138.282 | 190.129 | 261.417 | 359.433 | 494.198 | 679.494 | 934.263 |
| 101.579 | 139.665 | 192.031 | 264.031 | 363.027 | 499.140 | 686.289 | 943.606 |
| 102.595 | 141.061 | 193.951 | 266.671 | 366.657 | 504.132 | 693.151 | 953.042 |
| 103.621 | 142.472 | 195.891 | 269.338 | 370.324 | 509.173 | 700.083 | 962.572 |
| 104.657 | 143.897 | 197.850 | 272.031 | 374.027 | 514.265 | 707.084 | 972.198 |
| 105.703 | 145.336 | 199.828 | 274.752 | 377.767 | 519.408 | 714.155 | 981.920 |
| 106.760 | 146.789 | 201.826 | 277.499 | 381.545 | 524.602 | 721.296 | 991.739 |
| 107.828 | 148.257 | 203.845 | 280.274 | 385.360 | 529.848 | 728.509 | 1000.000 |
| 108.906 | 149.740 | 205.883 | 283.077 | 389.214 | 535.146 | 735.794 | |

Additional spot frequencies due to equipment related harmonics / declared EUT sensitive frequencies: None

### *11.4 EUT Test Results*

For pass/fail criteria definitions please see section 9 of this report. Where a departure from the pass/fail criteria is given for a specific test then this will be noted in this section after the results table.

Test levels applied are identified in the previous section.

| ***Performance Criteria Achieved*** | ***Performance Criteria Required*** |
|---|---|
| A | A |

# 12 Electrical Fast Transient Immunity as per EN 61000-4-4:2012

## *12.1 General*

This test applies very fast low energy transients on to the specific line under test. This simulates inductive load switching either directly coupled from equipment on the same supply line or capacitively coupled between cable bundles.

Coupling is achieved directly via the Coupling Decoupling Network (CDN) incorporated within the interference generator, or applied via a capacitive clamp with a distributed capacitance of 150 pF.

The test setup used complies with all the dimension requirements set out in EN 61000-4-4:2012. The test generator is UKAS calibrated as such.

## *12.2 Electrical Fast Transient Test Parameters*

| | |
|---|---|
| Pulse Rise Time: | 5 ns |
| Pulse Duration: | 50 ns |
| Pulse Repetition Frequency: | 5 kHz |
| Test Burst Duration: | 15 ms |
| Test Burst Period: | 300 ms |
| Dwell: | 1 minute per test level |
| Polarity: | Positive and Negative |
| Deviation from Basic Test Standard: | None |

For mains testing the following coupling points are used:

| | ***Applicable*** |
|---|---|
| • Live, Neutral and Earth simultaneously (No Earth on PSU) (L1, L2, L3, N and E in the case of three phase systems) | ☒ |
| • Neutral only | ☐ |
| • Earth only | ☐ |
| • Live only (L1, L2 and L3 individually in the case of three phase systems) | ☐ |

## *12.3 Electrical Fast Transient Test Levels*

The following test voltages were used if applicable as per the cable group type:

| | | | | | |
|---|---|---|---|---|---|
| AC Supply | ±0.5 kV | ☒ | DC Supply | ±0.5 kV | ☐ |
| Line | ±1 kV | ☒ | Line | Not Applicable | ☒ |
| | Not Applicable | ☐ | | | |
| Signal | ±0.5 kV | ☐ | | | |
| Lines | Not Applicable | ☒ | | | |

### *12.4 EUT Test Results*

For pass/fail criteria definitions please see section 9 of this report. Where a departure from the pass/fail criteria is given for a specific test then this will be noted in this section after the results table.

Test levels applied are identified in the previous section.

| | ***EUT test points – Direct Application*** | ***Performance Criteria Achieved*** | ***Performance Criteria Required*** |
|---|---|---|---|
| 1 | ac power | A[1] | B |

Note 1: during the application of the test the supporting USB keyboard 'NUM Lock', 'CAP Lock' and 'SCROLL Lock' LED indicators intermittently flashed. Normal operation of the device remained throughout.

# 13 Voltage Surge Immunity as per EN 61000-4-5:2014

## *13.1 General*

This test applies a high energy voltage surge on to the selected line under test. This simulates the surge created on the mains and also capacitively coupled on to signal cables during an electrical storm.

- Coupling to dc and mains is achieved directly via the Coupling Decoupling Network (CDN) incorporated within the interference generator.
- Coupling on shielded signal lines is achieved directly as per the specification using the 2 Ω source impedance of the generator only using a 20 m length of cable.
- Coupling to non-shielded signal lines is achieved directly using a 40 Ω CDN giving a 40 Ω + 2 Ω = 42 Ω source impedance.

The test setup used complies with all the dimension requirements set out in EN 61000-4-5:2014. The test generator is UKAS calibrated as such.

## *13.2 Voltage Surge Test Parameters*

| | |
|---|---|
| Pulse Rise Time: | 1.2 µs ☒ / 10 µs ☒ |
| Pulse Duration: | 50 µs ☐ / 700 µs ☐ |
| Pulse Repetition Frequency: | Maximum of 1 per minute |
| Phase Angles: | 0° ☒, 90° ☒, 180° ☒, 270° ☒, N/A ☐ |
| Polarity: | Positive and Negative |
| Number of Discharges: | Five per polarity per phase angle per voltage |
| Deviation from Basic Test Standard: | None |

For mains testing the following coupling points are used:

- Live to Earth only (L1, L2 and L3 individually to E in the case of three phase systems)
- Neutral to Earth only
- Live to Neutral
- The following combinations in the case of three phase systems (L1-L2, L2-L3, L1-L3, L1-N, L2-N, L3-N)

## *13.3 Voltage Surge Test Levels*

The following test voltages were used if applicable as per the cable group type:

| | | | | | |
|---|---|---|---|---|---|
| AC Supply Line – Common Mode | ±0.5 kV | ☐ | AC Supply Line – Differential Mode | ±0.5 kV | ☒ |
| | ±1 kV | ☐ | | ±1 kV | ☒ |
| | ±2 kV | ☐ | | Not Applicable | ☐ |
| | Not Applicable | ☒ | | | |
| DC Supply Line – Common Mode | ±0.5 kV | ☐ | DC Supply Line – Differential Mode | ±0.5 kV | ☐ |
| | Not Applicable | ☒ | | Not Applicable | ☒ |
| Signal / Control Lines | ±0.5 kV | ☐ | | | |
| | ±1 kV | ☐ | | | |
| | ±2 kV | ☐ | | | |
| | ±4 kV | ☐ | | | |
| | Not Applicable | ☒ | | | |

### *13.4 EUT Test Results*

For pass/fail criteria definitions please see section 9 of this report. Where a departure from the pass/fail criteria is given for a specific test then this will be noted in this section after the results table.

Test levels applied are identified in the previous section.

| | ***EUT test points – Mains/DC supply cables*** | ***Performance Criteria Achieved*** | ***Performance Criteria Required*** |
|---|---|---|---|
| 1 | ac power | A | B |

# 14 Conducted RF Immunity as per EN 61000-4-6:2014

## *14.1 General*

This test simulates the threat imposed by operating the equipment in the vicinity of intentional transmitters both fixed and mobile. It simulates the main coupling method for longer wavelengths (3.75 m to 2 km) that couple onto cables that interface with the EUT.

Two coupling methods are used depending upon the type of cable under test:

Clamp
Coupling / Decoupling Network (CDN)

A computer controlled pre-calibrated level is applied to the coupling interface and the frequency is swept across the range of test at a predefined step size and time.

No corrections to the selected test levels below were made to factor the uncertainty budget for this test, as instructed by the reference standard, hence field strength is as reported.

The test setup used complies with all the dimension requirements set out in EN 61000-4-6:2014.

## *14.2 Conducted RF Test Parameters*

| | |
|---|---|
| Frequency Range: | 150 kHz to 80 MHz |
| Spot Frequencies:<br>Note: When specified in Annex A of EN 55024, an additional comprehensive functional test shall be carried out at the selected spot frequencies. | ☒ Not Applicable – EUT not covered by Annex A<br>☐ 0.2 MHz ±1 %<br>☐ 1 MHz ±1 %<br>☐ 7.1 MHz ±1 %<br>☐ 13.56 MHz ±1 %<br>☐ 21 MHz ±1 %<br>☐ 27.12 MHz ±1 %<br>☐ 40.68 MHz ±1 % |
| Amplitude Modulation Frequency: | ☒ 1 kHz<br>☐ 400 Hz |
| Dwell Time per Momentary Frequency: | ☒ 3 seconds |
| Test Voltage Mains Supply Cables: | 3 V r.m.s. |
| Test Voltage DC Supply Cables: | 3 V r.m.s. |
| Test Voltage Signal/Control Cables: | 3 V r.m.s. |
| Step Increment: | 1 % of the momentary frequency |
| Deviation from Basic Test Standard: | None |

### *14.3 Conducted RF Test Frequencies*

A full list of frequency points is given here in MHz; the exact frequencies used will be dependent upon the test range selected in the table above.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0.150 | 0.284 | 0.536 | 1.013 | 1.916 | 3.622 | 6.847 | 12.944 | 24.470 | 46.260 |
| 0.152 | 0.286 | 0.541 | 1.024 | 1.935 | 3.658 | 6.915 | 13.073 | 24.715 | 46.722 |
| 0.153 | 0.289 | 0.547 | 1.034 | 1.954 | 3.695 | 6.985 | 13.204 | 24.962 | 47.189 |
| 0.155 | 0.292 | 0.552 | 1.044 | 1.974 | 3.732 | 7.054 | 13.336 | 25.212 | 47.661 |
| 0.156 | 0.295 | 0.558 | 1.055 | 1.994 | 3.769 | 7.125 | 13.470 | 25.464 | 48.138 |
| 0.158 | 0.298 | 0.563 | 1.065 | 2.014 | 3.807 | 7.196 | 13.604 | 25.718 | 48.619 |
| 0.159 | 0.301 | 0.569 | 1.076 | 2.034 | 3.845 | 7.268 | 13.740 | 25.975 | 49.106 |
| 0.161 | 0.304 | 0.575 | 1.087 | 2.054 | 3.883 | 7.341 | 13.878 | 26.235 | 49.597 |
| 0.162 | 0.307 | 0.580 | 1.097 | 2.075 | 3.922 | 7.414 | 14.016 | 26.498 | 50.093 |
| 0.164 | 0.310 | 0.586 | 1.108 | 2.095 | 3.961 | 7.488 | 14.157 | 26.763 | 50.594 |
| 0.166 | 0.313 | 0.592 | 1.119 | 2.116 | 4.001 | 7.563 | 14.298 | 27.030 | 51.099 |
| 0.167 | 0.316 | 0.598 | 1.131 | 2.137 | 4.041 | 7.639 | 14.441 | 27.300 | 51.610 |
| 0.169 | 0.320 | 0.604 | 1.142 | 2.159 | 4.081 | 7.715 | 14.586 | 27.573 | 52.127 |
| 0.171 | 0.323 | 0.610 | 1.153 | 2.180 | 4.122 | 7.792 | 14.731 | 27.849 | 52.648 |
| 0.172 | 0.326 | 0.616 | 1.165 | 2.202 | 4.163 | 7.870 | 14.879 | 28.128 | 53.174 |
| 0.174 | 0.329 | 0.622 | 1.177 | 2.224 | 4.205 | 7.949 | 15.028 | 28.409 | 53.706 |
| 0.176 | 0.333 | 0.629 | 1.188 | 2.246 | 4.247 | 8.029 | 15.178 | 28.693 | 54.243 |
| 0.178 | 0.336 | 0.635 | 1.200 | 2.269 | 4.289 | 8.109 | 15.330 | 28.980 | 54.786 |
| 0.179 | 0.339 | 0.641 | 1.212 | 2.292 | 4.332 | 8.190 | 15.483 | 29.270 | 55.333 |
| 0.181 | 0.343 | 0.648 | 1.224 | 2.315 | 4.376 | 8.272 | 15.638 | 29.562 | 55.887 |
| 0.183 | 0.346 | 0.654 | 1.237 | 2.338 | 4.419 | 8.355 | 15.794 | 29.858 | 56.446 |
| 0.185 | 0.349 | 0.661 | 1.249 | 2.361 | 4.464 | 8.438 | 15.952 | 30.157 | 57.010 |
| 0.187 | 0.353 | 0.667 | 1.261 | 2.385 | 4.508 | 8.523 | 16.112 | 30.458 | 57.580 |
| 0.189 | 0.356 | 0.674 | 1.274 | 2.409 | 4.553 | 8.608 | 16.273 | 30.763 | 58.156 |
| 0.190 | 0.360 | 0.681 | 1.287 | 2.433 | 4.599 | 8.694 | 16.435 | 31.070 | 58.738 |
| 0.192 | 0.364 | 0.687 | 1.300 | 2.457 | 4.645 | 8.781 | 16.600 | 31.381 | 59.325 |
| 0.194 | 0.367 | 0.694 | 1.313 | 2.482 | 4.691 | 8.869 | 16.766 | 31.695 | 59.918 |
| 0.196 | 0.371 | 0.701 | 1.326 | 2.506 | 4.738 | 8.957 | 16.933 | 32.012 | 60.517 |
| 0.198 | 0.375 | 0.708 | 1.339 | 2.531 | 4.786 | 9.047 | 17.103 | 32.332 | 61.122 |
| 0.200 | 0.378 | 0.715 | 1.352 | 2.557 | 4.833 | 9.137 | 17.274 | 32.655 | 61.734 |
| 0.202 | 0.382 | 0.723 | 1.366 | 2.582 | 4.882 | 9.229 | 17.446 | 32.982 | 62.351 |
| 0.204 | 0.386 | 0.730 | 1.380 | 2.608 | 4.931 | 9.321 | 17.621 | 33.312 | 62.975 |
| 0.206 | 0.390 | 0.737 | 1.393 | 2.634 | 4.980 | 9.414 | 17.797 | 33.645 | 63.604 |
| 0.208 | 0.394 | 0.744 | 1.407 | 2.661 | 5.030 | 9.508 | 17.975 | 33.981 | 64.240 |
| 0.210 | 0.398 | 0.752 | 1.421 | 2.687 | 5.080 | 9.603 | 18.155 | 34.321 | 64.883 |
| 0.212 | 0.402 | 0.759 | 1.436 | 2.714 | 5.131 | 9.699 | 18.336 | 34.664 | 65.532 |
| 0.215 | 0.406 | 0.767 | 1.450 | 2.741 | 5.182 | 9.796 | 18.520 | 35.011 | 66.187 |
| 0.217 | 0.410 | 0.775 | 1.464 | 2.769 | 5.234 | 9.894 | 18.705 | 35.361 | 66.849 |
| 0.219 | 0.414 | 0.782 | 1.479 | 2.796 | 5.286 | 9.993 | 18.892 | 35.715 | 67.517 |
| 0.221 | 0.418 | 0.790 | 1.494 | 2.824 | 5.339 | 10.093 | 19.081 | 36.072 | 68.192 |
| 0.223 | 0.422 | 0.798 | 1.509 | 2.852 | 5.392 | 10.194 | 19.272 | 36.433 | 68.874 |
| 0.226 | 0.426 | 0.806 | 1.524 | 2.881 | 5.446 | 10.296 | 19.464 | 36.797 | 69.563 |
| 0.228 | 0.431 | 0.814 | 1.539 | 2.910 | 5.501 | 10.399 | 19.659 | 37.165 | 70.259 |
| 0.230 | 0.435 | 0.822 | 1.555 | 2.939 | 5.556 | 10.503 | 19.856 | 37.536 | 70.961 |
| 0.232 | 0.439 | 0.831 | 1.570 | 2.968 | 5.611 | 10.608 | 20.054 | 37.912 | 71.671 |
| 0.235 | 0.444 | 0.839 | 1.586 | 2.998 | 5.668 | 10.714 | 20.255 | 38.291 | 72.388 |
| 0.237 | 0.448 | 0.847 | 1.602 | 3.028 | 5.724 | 10.821 | 20.457 | 38.674 | 73.112 |
| 0.239 | 0.453 | 0.856 | 1.618 | 3.058 | 5.781 | 10.930 | 20.662 | 39.061 | 73.843 |
| 0.242 | 0.457 | 0.864 | 1.634 | 3.089 | 5.839 | 11.039 | 20.869 | 39.451 | 74.581 |
| 0.244 | 0.462 | 0.873 | 1.650 | 3.120 | 5.898 | 11.149 | 21.077 | 39.846 | 75.327 |
| 0.247 | 0.466 | 0.882 | 1.667 | 3.151 | 5.957 | 11.261 | 21.288 | 40.244 | 76.080 |
| 0.249 | 0.471 | 0.890 | 1.683 | 3.182 | 6.016 | 11.373 | 21.501 | 40.647 | 76.841 |
| 0.252 | 0.476 | 0.899 | 1.700 | 3.214 | 6.076 | 11.487 | 21.716 | 41.053 | 77.609 |
| 0.254 | 0.480 | 0.908 | 1.717 | 3.246 | 6.137 | 11.602 | 21.933 | 41.464 | 78.385 |
| 0.257 | 0.485 | 0.917 | 1.734 | 3.279 | 6.198 | 11.718 | 22.152 | 41.878 | 79.169 |
| 0.259 | 0.490 | 0.927 | 1.752 | 3.312 | 6.260 | 11.835 | 22.374 | 42.297 | 79.961 |
| 0.262 | 0.495 | 0.936 | 1.769 | 3.345 | 6.323 | 11.954 | 22.598 | 42.720 | 80.000 |
| 0.264 | 0.500 | 0.945 | 1.787 | 3.378 | 6.386 | 12.073 | 22.824 | 43.147 | |
| 0.267 | 0.505 | 0.955 | 1.805 | 3.412 | 6.450 | 12.194 | 23.052 | 43.579 | |
| 0.270 | 0.510 | 0.964 | 1.823 | 3.446 | 6.515 | 12.316 | 23.282 | 44.014 | |
| 0.273 | 0.515 | 0.974 | 1.841 | 3.481 | 6.580 | 12.439 | 23.515 | 44.455 | |
| 0.275 | 0.520 | 0.984 | 1.860 | 3.515 | 6.646 | 12.563 | 23.750 | 44.899 | |
| 0.278 | 0.526 | 0.993 | 1.878 | 3.550 | 6.712 | 12.689 | 23.988 | 45.348 | |
| 0.281 | 0.531 | 1.003 | 1.897 | 3.586 | 6.779 | 12.816 | 24.228 | 45.802 | |

Additional spot frequencies due to equipment harmonics / declared EUT sensitive frequencies: None.

### *14.4 EUT Test Results*

For pass/fail criteria definitions please see section 9 of this report. Where a departure from the pass/fail criteria is given for a specific test then this will be noted in this section after the results table.

Test levels applied are identified in the previous section.

| | ***EUT test points – Mains/DC supply cables*** | ***Coupling Method*** | ***Performance Criteria Achieved*** | ***Performance Criteria Achieved*** |
|---|---|---|---|---|
| 1 | ac power | CDN-M2 | A | A |

# 15 Voltage Dips and Short Interruptions Immunity as per EN 61000-4-11:2004

## *15.1 General*

This test simulates short duration dips and interruptions that the equipment may be subjected to when connected to the public utility supply.

The test setup used complies with all the dimension requirements set out in EN 61000-4-11:2004. The test generator is UKAS calibrated as such.

## *15.2 Voltage Dips and Short Interruptions Test Levels*

The following test voltages were used if applicable as per the cable group type:

Phase Shift: 0°

Reduction: ☒ >95 % reduction for 10 ms
☒ 30 % reduction for 500 ms

Interruption: ☒ >95 % interruption for 5 s

Reduction Repetition Rate: 10 s

Number of Reductions/Interruptions: 3

Deviation from Basic Test Standard: None

## *15.3 EUT Test Results*

For pass/fail criteria definitions please see section 9 of this report. Where a departure from the pass/fail criteria is given for a specific test then this will be noted in this section after the results table.

Test levels applied are identified in the previous section.

| | ***Mains Supply Cable – Voltage Reductions*** | ***Performance Criteria Achieved*** | ***Performance Criteria Required*** |
|---|---|---|---|
| 1 | >95 % reduction for 10 ms | A | B |
| 2 | 30 % reduction for 500 ms | A | C |

| | ***Mains Supply Cable – Voltage Interruptions*** | ***Performance Criteria Achieved*** | ***Performance Criteria Required*** |
|---|---|---|---|
| 1 | 100 % reduction for 5 s | C[1] | C |

Note1: during the application of the 5 second voltage interruption the EUT lost power, upon completion of the test the EUT rebooted and returned to its normal operating mode without user intervention.

# 16 Radiated Emissions as per EN 55032:2012

## *16.1 General*

This test measures radiated electromagnetic emissions that may emanate from EUT enclosures and cables. This test ensures the protection of broadcast and telecommunication services used in the vicinity of the EUT.

The test setup used complies with all the dimension requirements set out in EN 55032:2012. The semi-anechoic chamber used meets the site attenuation measurements required by CISPR 16-1-4:2007 +A1:2007 +A2:2008.

Measurement instrumentation used meets the requirements of CISPR 16-4-2:2003, and expanded laboratory uncertainties $U_{lab}$ are less than or equal to $U_{cispr}$.Table 1. Therefore no compensation is required to the actual measured level in determining compliance with the applied limit.

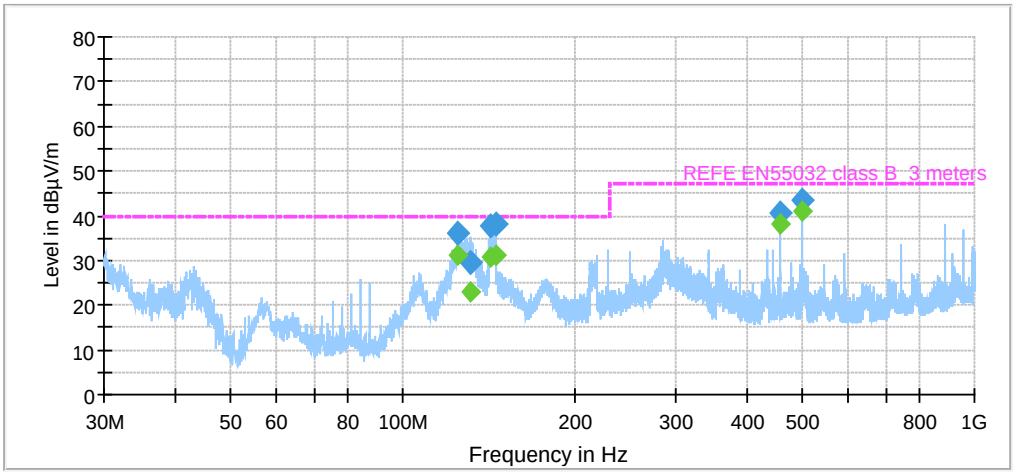
An initial scan is carried out in order to establish a frequency list that is attributable to the EUT. Any emissions measurements that fall within 20 dBµV/m of the limit line are then maximised by rotating the equipment through 360° and raising/lowering the antenna through 1 to 4 m height for each frequency of interest.

## *16.2 Radiated Emission Test Parameters*

| | |
|---|---|
| EUT Classification: | ☐ A ☒ B |
| Highest EUT Frequency: | 800 MHz |
| Frequency Range: | ☒ 30 MHz to 1 GHz<br>☒ 1 GHz to 2 GHz ☐ N/A – Max EUT Freq Used <108 MHz<br>☒ 2 GHz to 5 GHz ☐ N/A – Max EUT Freq Used <500 MHz<br>☒ 5 GHz to 6 GHz ☐ N/A – Max EUT Freq Used <1 GHz |
| Measurement Bandwidth: | ☒ 120 kHz (Measurements ≤1 GHz)<br>☒ 1 MHz (Measurements ≥1 GHz) |
| Video Bandwidth: (measurements >1 GHz) | ☒ 3 MHz (Peak Detector)<br>☒ <3 MHz (Average Detector) |
| Detectors: | Peak (≤1 GHz scan / ≥1 GHz Final Measurements)<br>Average (≥1 GHz Final Measurements)<br>Quasi-peak (≤1 GHz Final Measurements) |
| Quasi-peak Detector Dwell: | Minimum 2 s per Frequency Point |
| Frequency Step Size: | 50 kHz (Measurements <1 GHz) |
| Antenna Height: | 1 to 4 Metres |
| EUT to Antenna Distance: | ☐ 1 m ☒ 3 m |
| EUT Measurement Height: | ☒ 0.8 m Insulated Table<br>☐ 0.1 m Insulated Support/Pallet |
| EUT Operation Voltage: | V ac |
| EUT Operating Frequency: | ☒ 50 Hz ☐ dc |

## *16.3 EUT Test Results*

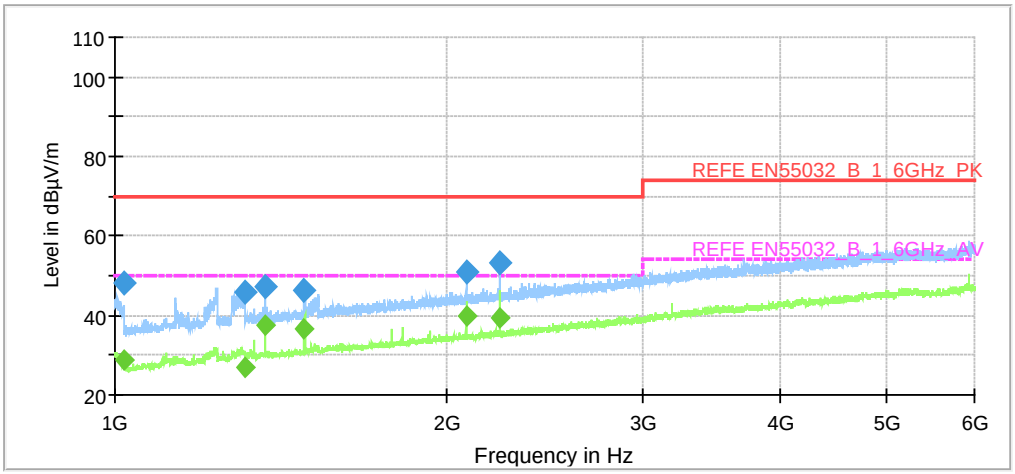
### *16.3.1 Radiated Emissions Test Data –30MHz to 1GHz*




Note: The Blue Markers on the above plots are Peak detectors and are included for information purposes only, EN 55032:2012 requires only the Quasi-Peak detector (Green Markers) in this frequency range to meet the specification limit represented. The marker details are included in table format below.

| Frequency (MHz) | QuasiPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 124.588267 | 31.0 | 15000.0 | 120.000 | 100.0 | V | 170.0 | -18.3 | 9.0 | 40.0 |
| 130.908587 | 23.0 | 15000.0 | 120.000 | 100.0 | V | 263.0 | -18.3 | 17.0 | 40.0 |
| 142.073160 | 30.8 | 15000.0 | 120.000 | 100.0 | V | 11.0 | -18.4 | 9.2 | 40.0 |
| 145.205453 | 31.4 | 15000.0 | 120.000 | 100.0 | V | 11.0 | -18.6 | 8.6 | 40.0 |
| 456.010387 | 38.2 | 15000.0 | 120.000 | 100.0 | H | 182.0 | -12.7 | 8.8 | 47.0 |
| 500.008133 | 41.2 | 15000.0 | 120.000 | 155.0 | H | 167.0 | -11.8 | 5.8 | 47.0 |

### *16.3.2 Radiated Emissions Test Data – 1GHz to 6GHz*




| Frequency (MHz) | MaxPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 1017.946000 | 48.2 | 15000.0 | 1000.000 | 100.0 | V | 170.0 | -7.8 | 21.8 | 70.0 |
| 1309.208000 | 45.8 | 15000.0 | 1000.000 | 100.0 | V | -1.0 | -4.5 | 24.2 | 70.0 |
| 1367.950000 | 47.1 | 15000.0 | 1000.000 | 105.0 | V | 10.0 | -3.9 | 22.9 | 70.0 |
| 1484.890000 | 46.2 | 15000.0 | 1000.000 | 115.0 | V | 15.0 | -2.7 | 23.8 | 70.0 |
| 2079.186000 | 50.8 | 15000.0 | 1000.000 | 100.0 | H | 55.0 | 1.3 | 19.2 | 70.0 |
| 2227.464000 | 53.3 | 15000.0 | 1000.000 | 108.0 | V | 0.0 | 2.1 | 16.7 | 70.0 |

| Frequency (MHz) | Average (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 1017.946000 | 28.8 | 15000.0 | 1000.000 | 100.0 | V | 170.0 | -7.8 | 21.2 | 50.0 |
| 1309.208000 | 27.1 | 15000.0 | 1000.000 | 100.0 | V | -1.0 | -4.5 | 22.9 | 50.0 |
| 1367.950000 | 37.4 | 15000.0 | 1000.000 | 105.0 | V | 10.0 | -3.9 | 12.6 | 50.0 |
| 1484.890000 | 36.6 | 15000.0 | 1000.000 | 115.0 | V | 15.0 | -2.7 | 13.4 | 50.0 |
| 2079.186000 | 39.7 | 15000.0 | 1000.000 | 100.0 | H | 55.0 | 1.3 | 10.3 | 50.0 |
| 2227.464000 | 39.4 | 15000.0 | 1000.000 | 108.0 | V | 0.0 | 2.1 | 10.6 | 50.0 |

# 17 Conducted Emissions as per EN 55032:2012

## *17.1 General*

This test measures conducted noise that may be present on an EUT's power supply cable. This test ensures the protection of broadcast and telecommunication services used in the vicinity of the EUT.

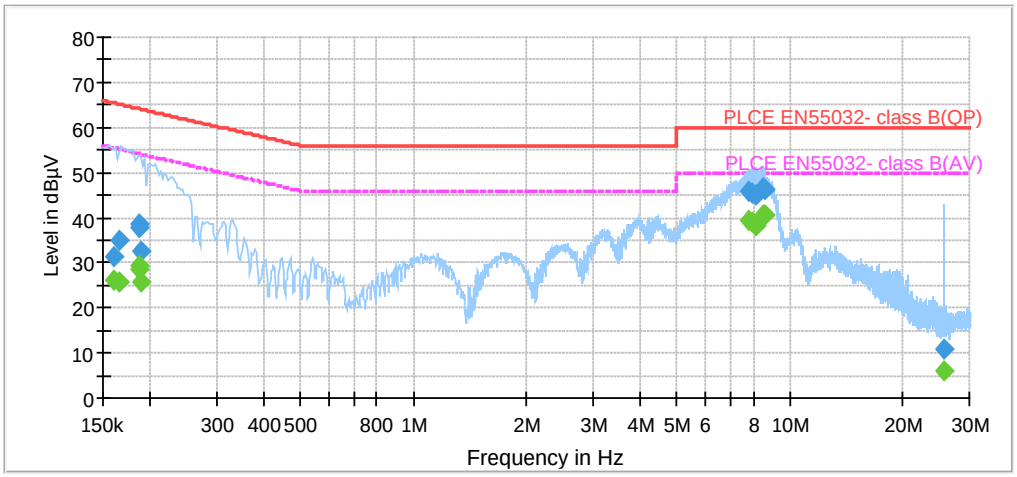
The test setup used complies with all the dimension requirements set out in EN 55032:2012. Measurement instrumentation used meets the requirements of CISPR 16-4-2:2003, and expanded laboratory uncertainties $U_{lab}$ are less than or equal to $U_{cispr}$.Table 1. Therefore no compensation is required to the actual measured level in determining compliance with the applied limit.

## *17.2 Conducted Emission Test Parameters*

| | |
|---|---|
| EUT Classification: | ☐ A ☒ B |
| Frequency Range: | 150 kHz to 30 MHz |
| Frequency Step Size: | 4.5 kHz/5 kHz |
| Measurement Bandwidth: | 9 kHz/10 kHz |
| Detectors: | Peak (scan)<br>Quasi-peak (Final Measurements)<br>Average (Final Measurements) |
| Quasi-peak Detector Dwell: | Minimum 2 s per frequency point |
| EUT Measurement Height: | ☒ 0.8 m Insulated Table<br>☐ 0.1 m Insulated Support/Pallet Mounted |
| EUT Operation Voltage: | Vac |
| EUT Operating Frequency: | ☒ 50 Hz ☐ dc |

## *17.3 EUT Test Results*

### *17.3.1 Conducted Emissions Test Data*




| Frequency (MHz) | QuasiPeak (dBµV) | Meas. Time (ms) | Bandwidth (kHz) | PE | Line | Corr. (dB) | Margin (dB) | Limit (dBµV) |
|---|---|---|---|---|---|---|---|---|
| 0.160600 | 31.2 | 15000.0 | 9.000 | GND | N | 10.1 | 34.3 | 65.4 |
| 0.166000 | 35.0 | 15000.0 | 9.000 | GND | L1 | 10.2 | 30.2 | 65.2 |
| 0.187275 | 38.7 | 15000.0 | 9.000 | GND | N | 10.1 | 25.5 | 64.2 |
| 0.187875 | 37.6 | 15000.0 | 9.000 | GND | N | 10.1 | 26.5 | 64.1 |
| 0.189475 | 32.5 | 15000.0 | 9.000 | GND | L1 | 10.2 | 31.6 | 64.1 |
| 7.799000 | 45.7 | 15000.0 | 9.000 | GND | N | 10.4 | 14.3 | 60.0 |
| 7.927500 | 45.4 | 15000.0 | 9.000 | GND | N | 10.4 | 14.6 | 60.0 |
| 8.110000 | 44.8 | 15000.0 | 9.000 | GND | N | 10.4 | 15.2 | 60.0 |
| 8.507500 | 46.5 | 15000.0 | 9.000 | GND | N | 10.5 | 13.5 | 60.0 |
| 8.575000 | 46.0 | 15000.0 | 9.000 | GND | N | 10.5 | 14.0 | 60.0 |
| 25.732500 | 10.7 | 15000.0 | 9.000 | GND | N | 11.3 | 49.3 | 60.0 |

| Frequency (MHz) | Average (dBµV) | Meas. Time (ms) | Bandwidth (kHz) | PE | Line | Corr. (dB) | Margin (dB) | Limit (dBµV) |
|---|---|---|---|---|---|---|---|---|
| 0.160600 | 26.2 | 15000.0 | 9.000 | GND | N | 10.1 | 29.3 | 55.4 |
| 0.166000 | 25.6 | 15000.0 | 9.000 | GND | L1 | 10.2 | 29.6 | 55.2 |
| 0.187275 | 28.7 | 15000.0 | 9.000 | GND | N | 10.1 | 25.5 | 54.2 |
| 0.187875 | 29.2 | 15000.0 | 9.000 | GND | N | 10.1 | 24.9 | 54.1 |
| 0.189475 | 25.6 | 15000.0 | 9.000 | GND | L1 | 10.2 | 28.4 | 54.1 |
| 7.799000 | 39.2 | 15000.0 | 9.000 | GND | N | 10.4 | 10.8 | 50.0 |
| 7.927500 | 39.0 | 15000.0 | 9.000 | GND | N | 10.4 | 11.0 | 50.0 |
| 8.110000 | 38.3 | 15000.0 | 9.000 | GND | N | 10.4 | 11.7 | 50.0 |
| 8.507500 | 40.5 | 15000.0 | 9.000 | GND | N | 10.5 | 9.5 | 50.0 |
| 8.575000 | 40.5 | 15000.0 | 9.000 | GND | N | 10.5 | 9.5 | 50.0 |
| 25.732500 | 5.9 | 15000.0 | 9.000 | GND | N | 11.3 | 44.1 | 50.0 |

# 18 Harmonic Current Emissions as per EN 61000-3-2:2014

## *18.1 General*

This test deals with the limitation of harmonic currents injected into the public supply system.

This test is applicable to electronic/electrical equipment having an input current up to and including 16 A/phase and intended to be connected to the public low voltage distribution network of either 50 Hz or 60 Hz line frequency. There are no limits defined for equipment operating at a voltage less than 230 V.

The measurement duration is defined by the 5 % repeatability requirement, which serves the purpose of identifying the necessary observation period.

For the purpose of harmonic current limitation and application of limits the equipment is classified as follows:

**Class A:**
- balanced three-phase equipment;
- household appliances, excluding equipment identified as class D;
- tools, excluding portable tools;
- dimmers for incandescent lamps;
- audio equipment.
- Equipment not specified in one of the three other classes shall be considered as class A
- equipment.

**Class B:**
- portable tools;
- arc welding equipment which is not professional equipment.

**Class C:**
- lighting equipment.

**Class D:**
Equipment having a specified power according to 6.2.2 less than or equal to 600 W, of the following types:
- personal computers and personal computer monitors;
- television receivers.

The following exemptions exist for which no limits are specified:

- equipment with a rated power of 75 W or less, other than lighting equipment;
- professional equipment with a total rated power greater than 1 kW;
- symmetrically controlled heating elements with a rated power less than or equal to 200 W;
- independent dimmers for incandescent lamps with a rated power less than or equal to 1 kW.

## *18.2 Harmonic Current Emissions Test Parameters*

| | |
|---|---|
| Equipment Classification: | ☒ Class A<br>☐ Class D |
| EUT Exemptions: | ☒ <75 W rated power<br>☐ Professional > 1 kW |
| EUT Measurement Height: | ☒ 0.8 m Insulated Table<br>☐ 0.1 m Insulated Support/Pallet Mounted |
| Line Frequency: | ☒ 50 Hz<br>☐ 60 Hz |
| Measurement Duration: | N/A – EUT <75 W rated power |
| Harmonic Current Repeatability: | N/A – EUT <75 W rated power |
| Deviation from Basic Test Standard: | None |

# 19 Voltage Fluctuations and Flicker as per EN 61000-3-3:2013

## *19.1 General*

This test deals with the limitation voltage fluctuations and flicker impressed on the public supply system.

This test is applicable to electronic/electrical equipment having an input current up to and including 16 A/phase and intended to be connected to the public low voltage distribution network. There are no limits defined for equipment operating at a voltage less than 230 V or line frequency of 60 Hz.

The following limits apply:

- the value of Pst shall not be greater than 1.0;
- the value of Plt shall not be greater than 0.65;
- the value of d(t) during a voltage change shall not exceed 3.3 % for more than 500 ms;
- the relative steady-state voltage change, dc, shall not exceed 3.3 %;
- the maximum relative voltage change dmax, shall not exceed
  4 % without additional conditions;
  6 % for equipment which is:
  – switched manually, or
  – switched automatically more frequently than twice per day, and also has either a delayed restart (the delay being not less than a few tens of seconds), or manual restart, after a power supply interruption.
  7 % for equipment which is
  – attended whilst in use (for example: hair dryers, vacuum cleaners, kitchen equipment such as mixers, garden equipment such as lawn mowers, portable tools such as electric drills), or
  – switched on automatically, or is intended to be switched on manually, no more than twice per day, and also has either a delayed restart (the delay being not less than a few tens of seconds) or manual restart, after a power supply interruption.

## *19.2 Voltage Fluctuations and Flicker Test Parameters*

EUT Exemptions:

☒ - EUT not likely to cause flicker
☐ - Low EUT supply power and no switching
☐ - Input <20 A and within 1.5 A (see note 3)
☐ - Other (see note below)

## 20 Test Equipment List – Element Hull

The following test equipment was used:

| *Type of Equipment* | *Maker/ Supplier* | *Model Number* | *Serial Number* | *Element Number* | *Actual Equipment Used* |
|---|---|---|---|---|---|
| RF Pre-Amplifier | Hewlett Packard | 8447D | 2727A05574 | H008 | ☐ |
| Signal Generator | Rohde & Schwarz | SMG | 883 744/070 | H016 | ☐ |
| Absorbing clamp | Schaffner | AMZ 41 | 15349 | H017 | ☐ |
| RF Current Probe | Rohde & Schwarz | ESH2-Z1 | 891 923/24 | H026 | ☐ |
| Bi-Cone Antenna | Eaton | 96002 | 2500 | H95 | ☐ |
| Directional Coupler | Amplifier Research | DC2000 | 11526 | H108 | ☒ |
| AC Mains Transformer | Element | N/A | None | H122 | ☐ |
| Receiver | Rohde & Schwarz | ESHS10 | 830051/002 | H125 | ☐ |
| Analyser/Receiver | Rohde & Schwarz | ESVS 20 | 872890/004 | H126 | ☐ |
| DRG Horn Antenna | EMCO | 3115 | 9303-4027 | H130 | ☐ |
| CDN 2-wire | MEB | M2 | 10219 | H186 | ☒ |
| CDN 3-wire | MEB | M3 | 10239 | H187 | ☐ |
| LISN/AMN | Rohde & Schwarz | ESH3-Z5 | 838576/002 | H189 | ☒ |
| Log Periodic Antenna | EMCO | 3146 | 9412-3925 | H191 | ☐ |
| Signal Generator | Marconi | 2024 | 112176041 | H227 | ☐ |
| 3 Phase LISN/AMN | Rohde & Schwarz | ESH2-Z5 | 832769/010 | H233 | ☐ |
| CDN 1-wire | MEB | M1 | 12026 | H237 | ☐ |
| T2 CDN / ISN | MEB | T2 | 12449 | H239 | ☐ |
| T4 CDN / ISN | MEB | T4 | 11424 | H240 | ☐ |
| Amplifier | Amplifier Research | 150A100 | 18239 | H242 | ☒ |
| Amplifier | Amplifier Research | 100W1000M1 | 18776 | H243 | ☐ |
| Bi-Log Antenna | Teseq | CBL6111 | 1855 | H244 | ☒ |
| Fast Transient Generator | Schaffner | NSG2025-1 | 1323 | H271 | ☐ |
| Capacitive Coupling Clamp | Schaffner | CDN 126 | 3034648 | H272 | ☐ |
| ESD Gun | Schaffner | NSG435 | 001865 | H273 | ☐ |
| Microwave Pre-Amplifier | Hewlett Packard | 8449B | 3008A00873 | H307 | ☐ |
| 1 m Square Induction Loop | Element | N/A | None | H319 | ☐ |
| CDN 118 | Schaffner | SL400-187 | 143 | H323 | ☐ |
| 1.5 m Square Induction Loop | Element | N/A | None | H330 | ☐ |
| Magnetic Field Meter | EnviroMentor | MM-1 | 0254 | H333 | ☐ |
| Signal Generator | Marconi | 2032 | 119626/042 | H349 | ☐ |
| Signal Generator | Rohde & Schwarz | SMP22 | 842194/007 | H360 | ☐ |
| T2 CDN / ISN | Schaffner | T200 | 16881 | H375 | ☐ |
| T4 CDN / ISN | Schaffner | T400 | 16908 | H376 | ☐ |
| Shielded CDN | Teseq | ST08 | 26589 | H370 | ☐ |
| Directional Coupler | Narda | 3020A | 40816 | H379 | ☐ |
| RF Power Meter | Amplifier Research | PM2002 | 305887 | H380 | ☐ |
| RF Power Meter | Amplifier Research | PM2002 | 301554 | H381 | ☒ |
| Spectrum Analyser | Agilent | E4407B | US39441062 | H404 | ☐ |
| Amplifier | Amplifier Research | 50S1G4A | 306696 | H418 | ☐ |
| Directional Coupler | Narda | 3022 | 72444 | H419 | ☐ |

| *Type of Equipment* | *Maker/ Supplier* | *Model Number* | *Serial Number* | *Element Number* | *Actual Equipment Used* |
|---|---|---|---|---|---|
| Isotropic E-Field Probe | Dare | RadiSense IV | 04D00215SNO-02 | H429 | ☐ |
| Flicker Unit | EM Test | DPA500 | V0602101066 | H455 | ☐ |
| DVM Multimeter | Hewlett Packard | 34401A | US36011922 | H465 | ☐ |
| T2 Balanced ISN | Fischer FCC | T2-02-09 | 20467 | H483 | ☐ |
| T2 Balanced ISN | Fischer FCC | T2-02-09 | 20468 | H484 | ☐ |
| T8 Balanced ISN | Fischer FCC | T8-02-09 | N/A | H485 | ☐ |
| T4 Balanced ISN | Fischer FCC | T4-02-09 | 20450 | H486 | ☐ |
| T4 Balanced ISN | Fischer FCC | T4-02-09 | 20451 | H487 | ☐ |
| Capacitive Voltage Probe | Schaffner | CVP220 | 18308 | H627 | ☐ |
| Horn Antenna | Q-Par Angus Ltd | QSH20S | 5134 | H630 | ☐ |
| EM Clamp | Fischer | F-203I-23MM | 537 | H633 | ☐ |
| AC Power Source | Schaffner | NSG2007 | 57875 | H636 | ☐ |
| EMC Multitester | EMC Partners | Transient 2000 | 925 | H639 | ☒ |
| ESD Gun | EMC Partners | ESD 2000 | 236 | H639 | ☒ |
| Variable Transformer | EMC Partners | VAR-EXT-1000 | 051 | H639 | ☒ |
| Amplifier | Amplifier Research | 250W1000A | 0326726 | H644 | ☒ |
| Bi-Log Antenna | Schaffner | CBL6140A | 1058 | H648 | ☐ |
| 75 Ω Directional Bridge | Agilent | 86207A | MY31400111 | H654 | ☐ |
| Shielded ISN | Fischer FCC | ST08 | 26589 | H655 | ☐ |
| Spectrum Analyser | Agilent | E4404B | US40240716 | H657 | ☐ |
| 1.6 m Square Helmholtz Coils | Element | N/A | None | H662 | ☐ |
| Power Supply | Farnell | AP60/50 | 001037 | H669 | ☐ |
| 75 Ω to 50 Ω pad | INMET | 9070-50-75 | None | H671 | ☐ |
| 75 Ω to 50 Ω pad | INMET | 9070-50-75 | None | H672 | ☐ |
| Pulse Limiter | Rohde & Schwarz | ESH3-Z2 | 101157 | H674 | ☐ |
| Bi-Log Antenna | Teseq | CBL6111 | 31217 | H679 | ☐ |
| Pulse Limiter | Rohde & Schwarz | ESH3-Z2 | 0357.8810.54 | H680 | ☐ |
| 1 m Square Helmholtz Coils | Element | N/A | None | H681 | ☐ |
| Log Periodic Antenna | Rohde & Schwarz | HL050 | 100540 | H682 | ☒ |
| CAT 6 ISN | Teseq | ISN T8-CAT6 | 32192 | H695 | ☐ |
| 8 Wire High Speed Surge CDN | Teseq | CDN HSS-2 | 38146 | H696 | ☐ |
| Signal Generator | Agilent | N5171B | MY53050700 | H698 | ☐ |
| Field Probe | DARE | RadiSense 6 | 10I00037SN036 | H699 | ☐ |
| Amplifier | TMD | PTS9612 | 17402 | H700 | ☐ |
| Analyser/Receiver | Rohde & Schwarz | ESU40 | 100005 | H701 | ☒ |
| RF Chamber | Belling Lee | Lab 5 | None | H705 | ☒ |
| RF Chamber | Ray Proof | Lab 6 | None | H706 | ☒ |
| RF Chamber | Ray Proof | Lab 7 | None | H707 | ☐ |
| RF Chamber | Panashield | Lab 10 | None | H710 | ☒ |
| Ground plane area | Element | Lab 17 | None | H717 | ☐ |
| Horn Antenna | FM Ltd | 2240-2S | 160356 | REF820 | ☐ |

# 21 EMC Modifications

No modifications were performed during this assessment.

## 22 Conclusion

The EUT meets the performance requirements of the specification, when tested in a system configuration described in section 6 of this report.

Note should be taken of any modifications listed in the relevant section of this report.

The EUT achieved the following performance criteria during the test programme.

**EMISSIONS**

| *Test Standard* | *Test Order* | *Class* | | *Pass* |
|---|---|---|---|---|
| EN 55032:2012 – Radiated Emissions | 2 | A ☐ | B ☒ | ☒ |
| EN 55032:2012 – Conducted Emissions | 1 | A ☐ | B ☒ | ☒ |

**IMMUNITY**

| *Basic Test Standard* | *Test Order* | *Applicable* | *Performance Criteria Required* | *Performance Criteria Achieved* |
|---|---|---|---|---|
| EN 61000-4-2:2009 – Electrostatic Discharge Immunity | 6 | ☒ | B | A |
| EN 61000-4-3:2006 +A1:2008 +A2:2010 – Radiated RF Immunity | 7 | ☒ | A | A |
| EN 61000-4-4:2012 – Electrical Fast Transients Immunity | 3 | ☒ | B | A |
| EN 61000-4-5:2014 – Voltage Surge Immunity | 4 | ☒ | B | A |
| EN 61000-4-6:2014 – Conducted RF Immunity | 8 | ☒ | A | A |
| EN 61000-4-11:2004 – Voltage Dips and Short Interruptions Immunity | 5 | ☒ | See Relevant Test Section | |

# 23 Measurement Uncertainty

## *Transient testing:*

Where a specification tolerance exists, the figure displayed is the calibration figure expanded by the calibration uncertainty. The worst case tolerance is then calculated and compared to the allowed specification tolerance.

### *Static Discharge (EN 61000-4-2)*

| Tolerance Parameter | Test Equipment Inventory Number | | | | | Allowed Tolerance |
|---|---|---|---|---|---|---|
| | ESD6 | ESD1 | R0061 | RFG273 | UH01 | |
| Negative Discharge Current at 2 kV (First Peak) | 5.90 % | 5.90 % | 7.15 % | 12.30 % | 6.46 % | 15 % |
| Negative Discharge Current at 8 kV (First Peak) | 12.68 % | 12.68 % | 6.37 % | 12.99 % | 7.37 % | 15 % |
| Negative Discharge Current at 2 kV | 14.37 % | 14.37 % | 14.90 % | 11.72 % | 18.60 % | 30 % |
| Negative Discharge Current at 8 kV | 16.09 % | 16.09 % | 9.87 % | 13.05 % | 9.67 % | 30 % |
| Negative Discharge Voltage | 2.32 % | 1.86 % | 2.52 % | 2.64 % | 3.31 % | 5 % |
| Negative Rise Time at 2 kV | 13.40 % | 15.78 % | 14.24 % | 17.46 % | 8.36 % | 25 % |
| Negative Rise Time at 8 kV | 16.20 % | 10.41 % | 16.20 % | 17.46 % | 6.54 % | 25 % |
| Positive Discharge Current at 2 kV (First Peak) | 9.85 % | 7.78 % | 8.53 % | 11.55 % | 6.32 % | 15 % |
| Positive Discharge Current at 8 kV (First Peak) | 11.58 % | 10.42 % | 7.56 % | 12.61 % | 6.01 % | 15 % |
| Positive Discharge Current at 2 kV | 14.90 % | 18.13 % | 12.78 % | 13.84 % | 11.78 % | 30 % |
| Positive Discharge Current at 8 kV | 16.09 % | 16.09 % | 17.02 % | 16.23 % | 10.53 % | 30 % |
| Positive Discharge Voltage | 2.65 % | 1.99 % | 2.62 % | 4.03 % | 2.32 % | 5 % |
| Positive Rise Time at 2kV | 14.80 % | 15.50 % | 15.36 % | 16.22 % | 9.82 % | 25 % |
| Positive Rise Time at 8kV | 13.96 % | 8.63 % | 18.44 % | 14.99 % | 6.96 % | 25 % |

| Tolerance Parameter | Test Equipment Inventory Number | | | | | Allowed Tolerance |
|---|---|---|---|---|---|---|
| | L327 | L085 | RFG639 | L697 | | |
| Negative Discharge Current at 2 kV (First Peak) | 6.90 % | 10.56 % | 11.27 % | 7.28 % | | 15 % |
| Negative Discharge Current at 8 kV (First Peak) | 12.30 % | 6.25 % | 13.52 % | 8.28 % | | 15 % |
| Negative Discharge Current at 2 kV | 24.72 % | 13.43 % | 17.90 % | 20.73 % | | 30 % |
| Negative Discharge Current at 8 kV | 7.78 % | 15.43 % | 25.23 % | 10.93 % | | 30 % |
| Negative Discharge Voltage | 2.65 % | 1.99 % | 4.96 % | 2.52 % | | 5 % |
| Negative Rise Time at 2 kV | 9.90 % | 22.78 % | 15.64 % | 17.46 % | | 25 % |
| Negative Rise Time at 8 kV | 10.18 % | 22.36 % | 13.12 % | 20.68 % | | 25 % |
| Positive Discharge Current at 2 kV (First Peak) | 7.45 % | 12.82 % | 13.10 % | 6.53 % | | 15 % |
| Positive Discharge Current at 8 kV (First Peak) | 10.42 % | 8.62 % | 11.05 % | 6.15 % | | 15 % |
| Positive Discharge Current at 2 kV | 22.37 % | 12.72 % | 15.55 % | 6.14 % | | 30 % |
| Positive Discharge Current at 8 kV | 11.92 % | 12.72 % | 23.77 % | 13.84 % | | 30 % |
| Positive Discharge Voltage | 2.01 % | 4.03 % | 5.33 % | 3.97 % | | 5 % |
| Positive Rise Time at 2 kV | 10.18 % | 23.90 % | 15.64 % | 19.98 % | | 25 % |
| Positive Rise Time at 8 kV | 6.96 % | 23.48 % | 14.24 % | 20.54 % | | 25 % |

### *Voltage Surge (EN 61000-4-5)*

| Tolerance Parameter | Test Equipment Inventory Number | | | | | Allowed Tolerance |
|---|---|---|---|---|---|---|
| | UH159 | UH42 | L449 | RFG639 | L429 | |
| Voltage, Positive Waveform | 8.11 % | 6.22 % | 9.71 % | 4.55 % | 5.74 % | 10 % |
| Voltage, Negative Waveform | 8.06 % | 6.43 % | 9.64 % | 5.72 % | 5.15 % | 10 % |
| Duration, Positive Waveform | 4.90 % | 7.11 % | 7.32 % | 27.63 % | 11.63 % | 20 % |
| Duration, Negative Waveform | 5.14 % | 8.35 % | 5.47 % | 27.43 % | 10.81 % | 20 % |
| Voltage Front Time, Positive Waveform | 29.92 % | 19.35 % | 10.48 % | 26.73 % | 22.76 % | 30 % |
| Voltage Front Time, Negative Waveform | 16.14 % | 16.79 % | 12.88 % | 24.77 % | 16.79 % | 30 % |
| Current, Positive Waveform | 6.39 % | 6.39 % | 9.50 % | 7.17 % | 6.09 % | 10 % |
| Current Duration | 6.50 % | 6.50 % | 19.40 % | 9.84 % | 19.89 % | 20 % |
| Current Front Time | 19.43 % | 19.43 % | 11.97 % | 11.35 % | 13.39 % | 20 % |
| Current Undershoot | Inside Tolerance | Inside Tolerance | Inside Tolerance | Inside Tolerance | Outside Tolerance | 30 % of Peak Current |

| Tolerance Parameter | Test Equipment Inventory Number | | | | | Allowed Tolerance |
|---|---|---|---|---|---|---|
| | EMT3 | UH415 | R801-5-1/2 | L952 | | |
| Voltage, Positive Waveform | 6.27% | 4.59% | 4.44% | 4.59% | | 10% |
| Voltage, Negative Waveform | 6.67% | 5.91% | 4.24% | 5.91% | | 10% |
| Duration, Positive Waveform | 19.16% | 14.15% | 27.22% | 14.15% | | 20% |
| Duration, Negative Waveform | 19.55% | 13.87% | 26.20% | 13.87% | | 20% |
| Voltage Front Time, Positive Waveform | 17.93% | 11.51% | 31.61% | 27.88% | | 30% |
| Voltage Front Time, Negative Waveform | 16.96% | 11.51% | 29.66% | 27.88% | | 30% |
| Current, Positive Waveform | 4.34% | 4.34% | 7.84% | 8.25% | | 10% |
| Current Duration | 19.25% | 19.25% | 7.98% | 2.50% | | 20% |
| Current Front Time | 10.58% | 10.58% | 11.04% | 2.90% | | 20% |
| Current Undershoot | Inside Tolerance | Inside Tolerance | Inside Tolerance | Inside Tolerance | | 30% of Peak Current |

### *Electrical Fast Transients (EN 61000-4-4)*

| Tolerance Parameter | Test Equipment Inventory Number | | | | | Allowed Tolerance |
|---|---|---|---|---|---|---|
| | L448 | UH161 | L429 | RFG639 | EMT5 | |
| Positive Voltage | 2.21% | 11.92% | 19.78% | 5.40% | 23.56% | 20% |
| Negative Voltage | 2.48% | 12.94% | 15.24% | 5.83% | 19.09% | 20% |
| Source Impedance | 11.91% | 1.00% | 20.21% | 4.56% | 27.91% | 30% |
| Pulse Parameters (5ns) | 7.16% | 5.22% | 7.52% | 7.42% | 7.21% | 30% |
| Pulse Parameters (50ns) | 19.13% | 3.08% | 24.38% | 9.69% | 18.29% | 30% |
| Burst Parameters | 2.32% | 1.03% | 2.32% | 1.99% | 2.32% | 10% |

***Electrical Fast Transients (EN 61000-4-4)***

| *Tolerance Parameter* | *Test Equipment Inventory Number* | | | | | *Allowed Tolerance* |
|---|---|---|---|---|---|---|
| | *RFG271* | *UH383* | *L952* | | | |
| **Positive Voltage** | 16.61 % | 23.56 % | 8.71 % | | | 20 % |
| **Negative Voltage** | 21.43 % | 19.09 % | 5.07 % | | | 20 % |
| **Source Impedance** | 21.05 % | 27.91 % | 19.79 % | | | 30 % |
| **Pulse Parameters (5ns)** | 20.92 % | 7.21 % | 16.27 % | | | 30 % |
| **Pulse Parameters (50ns)** | 11.06 % | 18.29 % | 6.05 % | | | 30 % |
| **Burst Parameters** | 2.32 % | 2.32 % | 1.00 % | | | 10 % |

***Voltage Dips and Interruptions (EN 61000-4-11)***

| *Tolerance Parameter* | *Test Equipment Inventory Number* | | | | | *Allowed Tolerance* |
|---|---|---|---|---|---|---|
| | *L429* | *L952* | *EMT1* | *RFG639* | *L415* | |
| **Switching Time at 90 °** | 1.7952 µs | 1.7442 % | 2.2542 % | 1.7952 % | 4.08 % | 5 µs Max |
| **Switching Time at 270 °** | 1.9584 µs | 1.7544 % | 2.244 % | 1.377 % | 4.08 % | 5 µs Max |
| **Voltage Change with Load (70 % dip)** | 2.64 % | 1.77 % | 1.74 % | 1.7 % | 1.8 % | 5 % Max |
| **Voltage Change with Load (40 % dip)** | 3.07 % | 4.04 % | 1.74 % | 1.7 % | 1.8 % | 5 % Max |
| **Worst Case Phase Shift** | 3.384 % | 5.65 º | 3.15 º | 3.15 º | 3.15 º | ±10 º |

***Emissions and Immunity testing (non-transient):***

All uncertainties listed are standard uncertainties multiplied by a coverage factor K = 2.00 for to give a 95 % confidence level.

***Conducted Emissions Including Discontinuous Emissions***
[1] Conducted Emissions 9 kHz to 150 kHz = **3.7 dB**
[2] Conducted Emissions 150 kHz to 30 MHz = **3.4 dB**

***Radiated Emissions (E-Field)***
[1] Radiated Emissions 30 MHz to 1 GHz using CBL6111/2 Bilog Antenna = **4.6 dB**
[2] Radiated Emissions 1 GHz to 6 GHz using HL050 Log Periodic Antenna = **5.1 dB**
[3] Radiated Emissions 6 GHz to 26 GHz using HL050 Log Periodic Antenna = **5.2 dB**

***Conducted Immunity CDN Testing***
[1] Re-establishment of pre-calibrated field = **1.6 dB**
[2] Limiting of injected level using monitor coil = **2.1 dB**

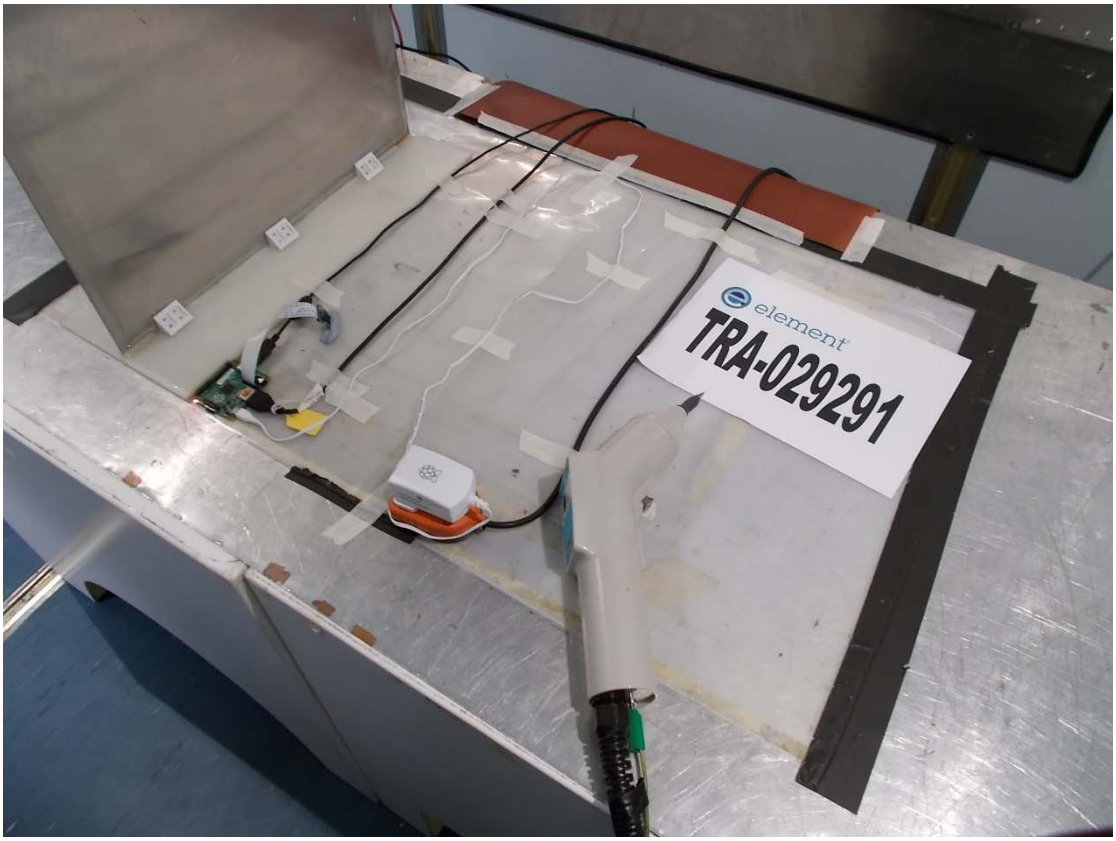
***Radiated Immunity 80 MHz to 3 GHz***
[1] Re-establishment of pre-calibrated field level = **2.12 dB**
[2] Dynamic feedback calibrated field level = **2.16 dB**

***Spurious Emissions up to 18GHz***
[1] Uncertainty in test result = **4.75 dB**

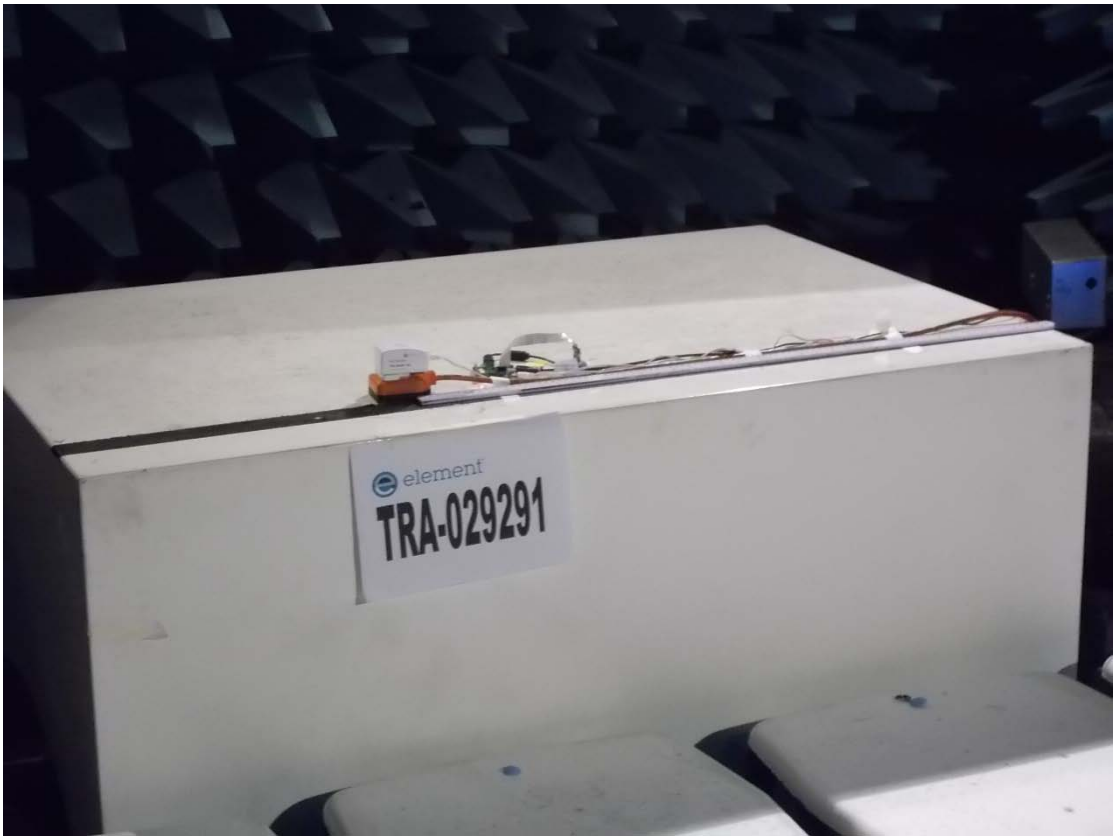
***Cable Calibrations***
[1] Cable calibration up to 18 GHz = **0.4 dB**

# 24 APPENDIX A – PHOTOGRAPHS

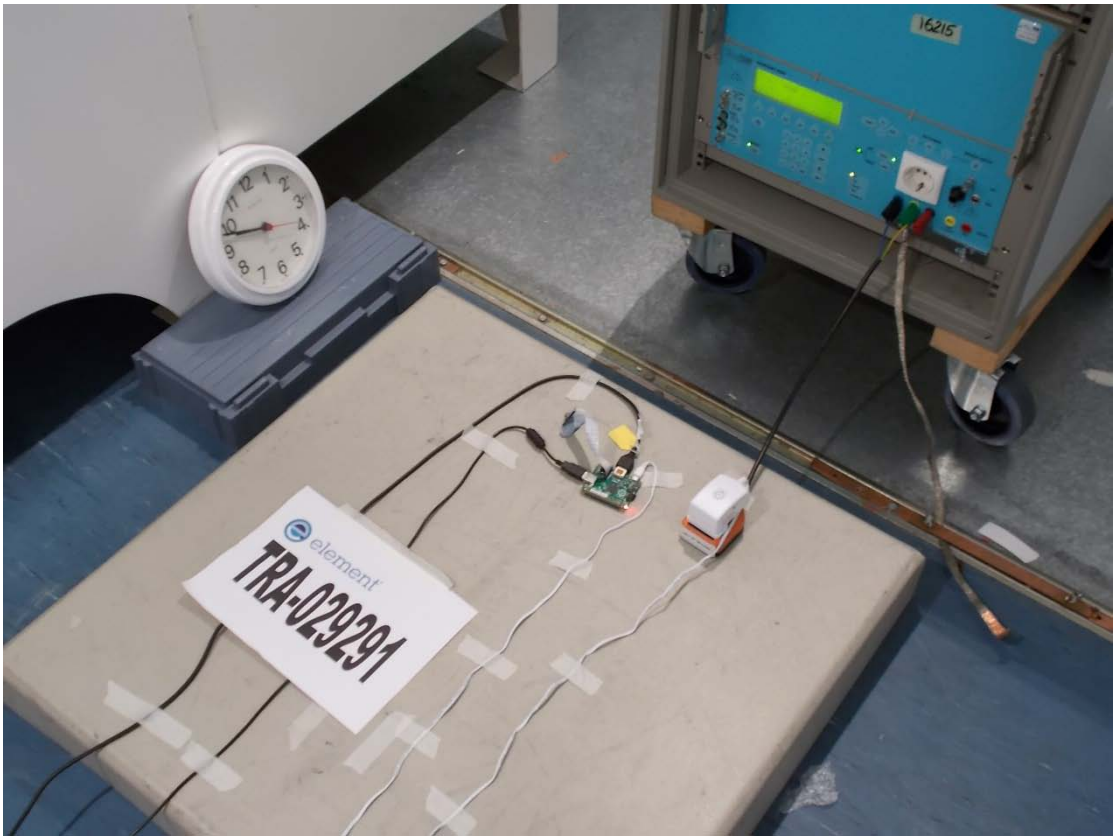
***Electrostatic Discharge Immunity***



***Radiated Immunity***



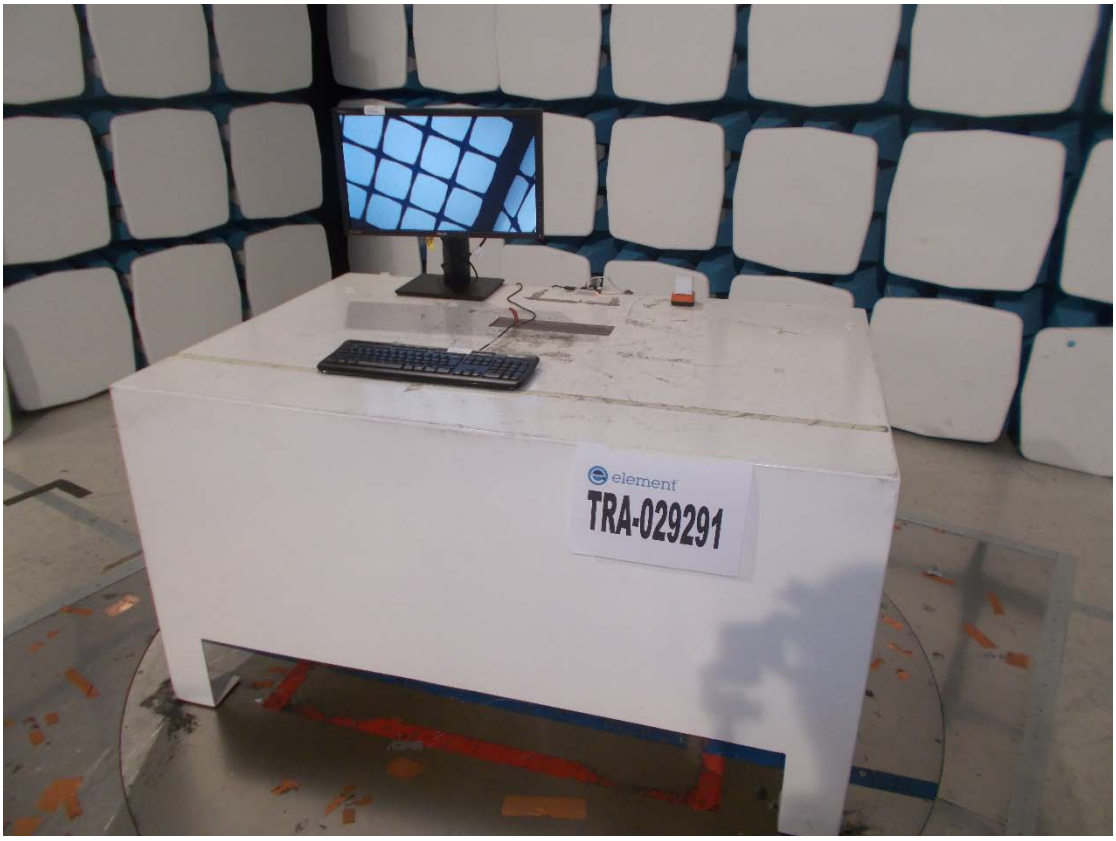
***Electrical Fast Transient Immunity***



***Voltage Surge Immunity***

***Conducted Radio Frequency Immunity***

***Radiated Emissions***



## *Conducted Emissions*