EMC Test Report

For

Raspberry Pi Trading Limited

On

Raspberry Pi Camera V2

Report No. TRA-029291-44-02A

20th November 2015

Report Number: TRA-029291-44-02A
Copy Number: PDF

REPORT ON THE EMC TESTING OF A
Raspberry Pi Trading Limited
Raspberry Pi Camera V2
WITH RESPECT TO SPECIFICATION
VCCI V-3:2014.04

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

Written by: ---------- M.Baker
Senior EMC Test Engineer

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

Element Materials Technology Warwick Ltd.
Registered in England and Wales. Registered Office: 5 Fleet Place, London, EC4M 7RD
Company Reg No. 02536659

1 Revision Record

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

2 Summary

TEST REPORT NUMBER:	TRA-029291-44-02A
PURPOSE OF TEST:	Electromagnetic Compatibility – Emissions
TEST SPECIFICATION:	VCCI V-3:2014.04
DEVIATIONS FROM SPECIFICATION:	None
EQUIPMENT UNDER TEST (EUT):	Raspberry Pi Camera V2
EUT SERIAL NUMBER:	None
EUT Category:	The EUT has been categorised as Information Technology Equipment (ITE)
TEST RESULT:	Measured As Compliant Given any modifications stated in the relevant section of this report. 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 Mount Pleasant Cambridge CB30RN
CLIENT CONTACT:	Mike Stimson ☎ 01223322633 ✉ mike@raspberrypi.org
ORDER NUMBER:	PO-0185
TEST DATES:	11/11/15 to 18/11/15
TESTED BY:	M.Baker Element

3 Contents

4 Introduction

This report TRA-029291-44-02A presents the results of the EMC testing on a Raspberry Pi Trading Limited, Raspberry Pi Camera V2 to specification VCCI V-3:2014.04 Class B.

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

☐ Element Malvern
100 Frobisher Business Park
Leigh Sinton Road
Malvern
Worcestershire
WR14 1BX
UK

Facility Registration Numbers:

☐	G-575	Radiated Disturbances >1 GHz
☐	R-3894	Radiated Disturbances <1 GHz
☐	R-3893	
☐	C-4362	Conducted Disturbances – Mains
☐	C-4363	Ports
☐	T-1349	Conducted Disturbances – Telecommunication Ports

☒ Element Hull
Unit E
South Orbital Trading Park
Hedon Road
Hull
East Yorkshire
HU9 1NJ
UK

Facility Registration Numbers:

☒	G-486	Radiated Disturbances >1 GHz
☒	R-2778	Radiated Disturbances <1 GHz
☒	C-3066	Conducted Disturbances – Mains
☐	C-3067	Ports
☐	T-1974	Conducted Disturbances – Telecommunication Ports
☐	T-1975	

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

- CISPR 22: Ed 6.0 :2008: Information Technology Equipment – Radio disturbance characteristics - Limits and methods of measurement
- CISPR 16-1-1 Ed2.2:2007: Specification for radio disturbance and immunity measuring apparatus and method – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus. and Amd2(2007)
- CISPR 16-1-2 Ed1.2:2006 Specification for radio disturbance and immunity measuring apparatus and methods –Part 1-2: Radio disturbance and immunity measuring apparatus – Measuring apparatus – Ancillary equipment – Conducted disturbances
- CISPR 16-1-4 Ed2.0:2007 Specification for radio disturbance and immunity measuring apparatus and methods –Part 1-4: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Radio disturbances
- CISPR 16-2-3 Ed2.0 : 2006 Specification for radio disturbance and immunity measuring apparatus and methods –Part 2-3: Methods of measurement of disturbance and immunity – Radiated disturbance measurements
- CISPR 16-4-2 Ed1.0:2003 Specification for radio disturbance and immunity measuring apparatus and methods –Part 4-2: Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements
- ANSI C63.4-2003 ‘American National Standard for Methods of measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz’
- ANSI C63.4-2009 ‘American National Standard for Methods of measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz’
- Report of Telecommunication Technology Council: 2007*: Partial Reply to the Inquiry No. 3 “About Various Standards of International Special Committee on Radio Interference (CISPR)”: “Technical requirement for open area antenna calibration test site for frequency between 30 MHz and 1000 MHz”
- Report of Telecommunication Technology Council: 2010*: Partial reply to the Inquiry No.3, “About Various Standards of International Special Committee on Radio Interference (CISPR)”: “Limits and Measurement Method of Disturbance from IT Equipment”
- DIN/VDE 0876 Teil 1:1978*: Radio Interference Measuring Instrument: Radio Disturbance Measuring Receiver with Load Indication and its Accessories.
- JIS-C 8303: 1993*: Plug and Receptacles for Domestic and Similar General Use
- ITU-T Recommendation G.117: 1996*: Transmission aspects of unbalance about earth.
- JIS X 5150: 2004*: Information technology-Generic cabling for customer premises (ISO/IEC 11801: 2002)

* - 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

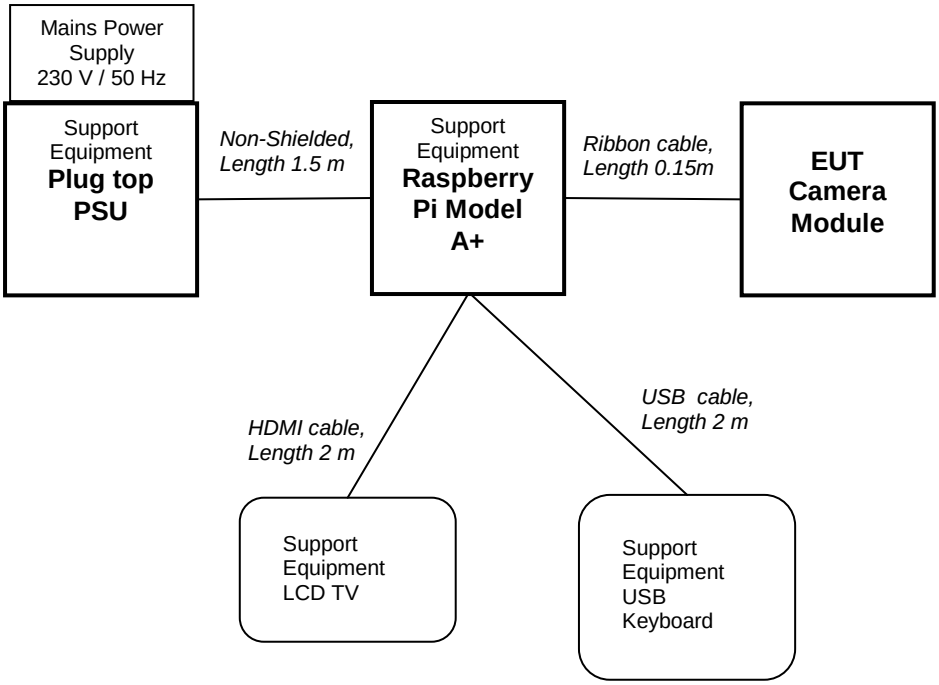
The camera was generating a live image, which was displayed on a supporting monitor via a Raspberry Pi A+.

6.4 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 in Section 6.1.



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:

VCCI V-3:2014.04 Technical Requirements

8.2 Basic Test Standard Selection

Basic Test Standard	***Applicable***		***Notes***
	Class A	***Class B***	
CISPR 22:2008 Edition 6.0 – Radiated Emissions	☐	☒	
CISPR 22:2008 Edition 6.0 – Conducted Emissions	☐	☒	
CISPR 22:2008 Edition 6.0 – Telecommunication Ports Common Mode Emissions	☐	☐	

Notes:
[1] Not applicable, EUT contains no test ports.

9 Radiated Emissions as per CISPR 22:2008

9.1 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 CISPR 22:2008 Edition 6.0. 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 CISPR16-4-2:2003, 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.

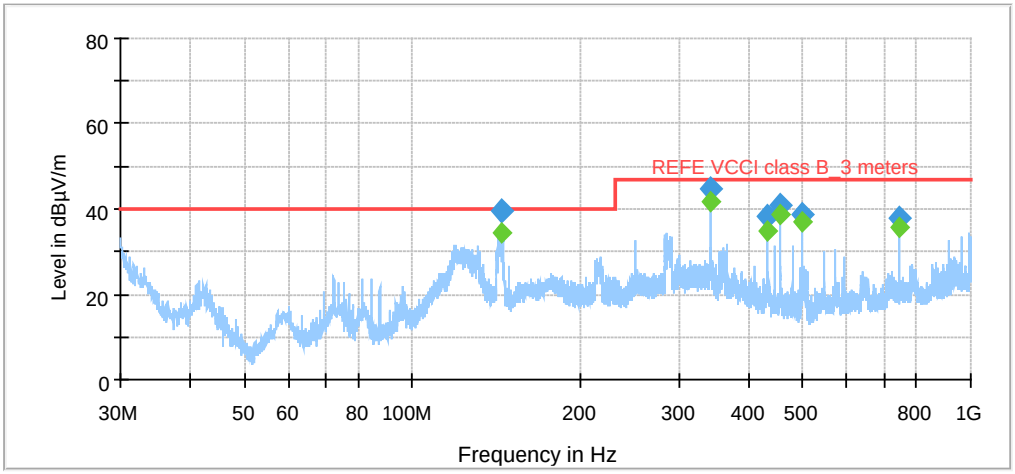
An initial scan is carried out in order to establish a frequency list that is attributable to the EUT. Any emissions measurements that fall within 20 dBµV/m of the limit line are then maximised by rotating the equipment through 360° and raising/lowering the antenna through 1 to 4 m height for each frequency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

9.2 Radiated Emission Test Parameters

EUT Classification:	☐ A ☒ B
Highest EUT Frequency:	800 MHz
Frequency Range:	☒ 30 MHz to 1 GHz ☒ 1 GHz to 2 GHz ☐ N/A – Max EUT Freq Used <108 MHz ☒ 2 GHz to 5 GHz ☐ N/A – Max EUT Freq Used <500 MHz ☒ 5 GHz to 6 GHz ☐ N/A – Max EUT Freq Used <1 GHz
Measurement Bandwidth:	☒ 120 kHz (Measurements ≤1 GHz) ☒ 1 MHz (Measurements ≥1 GHz)
Video Bandwidth (measurements >1GHz):	☒ 3 MHz (Peak Detector) ☒ <3 MHz (Average Detector)
Detectors:	Peak (≤1 GHz scan / ≥1 GHz Final Measurements) Average (≥1 GHz Final Measurements) 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 ☐ 0.1 m Insulated Support/Pallet
EUT Operation Voltage:	100 V ac
EUT Operating Frequency:	☐ 50 Hz ☒ 60 Hz ☐ dc

9.3 EUT Test Results

9.3.1 Radiated Emissions Test Data – 30 MHz to 1 GHz

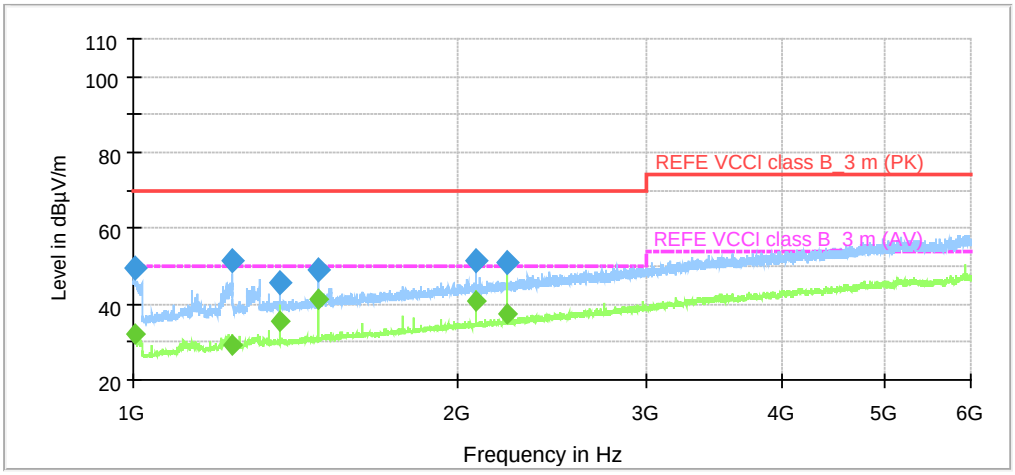


Note: The Blue Markers on the above plots are Peak detectors and are included for information purposes only, EN55032:2015* requires only the Quasi-Peak detector (Green Markers) in this frequency range to meet the specification limit represented. The marker details are included in table format below.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
144.658253	39.4	15000.0	120.000	100.0	V	163.0	-18.5	0.6	40.0
341.998560	44.7	15000.0	120.000	100.0	H	196.0	-15.3	2.3	47.0
433.212267	38.1	15000.0	120.000	100.0	H	157.0	-13.1	8.9	47.0
456.025267	41.1	15000.0	120.000	100.0	H	169.0	-12.7	5.9	47.0
500.013413	38.6	15000.0	120.000	199.0	H	178.0	-11.8	8.4	47.0
742.502133	37.7	15000.0	120.000	113.0	H	196.0	-6.9	9.3	47.0

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
144.658253	34.2	15000.0	120.000	100.0	V	163.0	-18.5	5.8	40.0
341.998560	41.7	15000.0	120.000	100.0	H	196.0	-15.3	5.3	47.0
433.212267	34.7	15000.0	120.000	100.0	H	157.0	-13.1	12.3	47.0
456.025267	38.7	15000.0	120.000	100.0	H	169.0	-12.7	8.3	47.0
500.013413	36.9	15000.0	120.000	199.0	H	178.0	-11.8	10.1	47.0
742.502133	35.5	15000.0	120.000	113.0	H	196.0	-6.9	11.5	47.0

9.3.2 Radiated Emissions Test Data – 1 GHz to 6 GHz



Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1005.329800	49.3	15000.0	1000.000	100.0	V	178.0	-7.9	20.7	70.0
1236.476000	51.7	15000.0	1000.000	100.0	V	236.0	-5.2	18.3	70.0
1368.120000	45.6	15000.0	1000.000	124.0	V	0.0	-3.9	24.4	70.0
1485.038000	48.9	15000.0	1000.000	105.0	V	40.0	-2.7	21.1	70.0
2079.076000	51.4	15000.0	1000.000	100.0	H	58.0	1.3	18.6	70.0
2227.732000	51.0	15000.0	1000.000	121.0	H	221.0	2.1	19.0	70.0

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1005.329800	32.0	15000.0	1000.000	100.0	V	178.0	-7.9	18.0	50.0
1236.476000	29.2	15000.0	1000.000	100.0	V	236.0	-5.2	20.8	50.0
1368.120000	35.6	15000.0	1000.000	124.0	V	0.0	-3.9	14.4	50.0
1485.038000	41.5	15000.0	1000.000	105.0	V	40.0	-2.7	8.5	50.0
2079.076000	40.9	15000.0	1000.000	100.0	H	58.0	1.3	9.1	50.0
2227.732000	37.3	15000.0	1000.000	121.0	H	221.0	2.1	12.7	50.0

10 Conducted Emissions as per CISPR 22:2008

10.1 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.

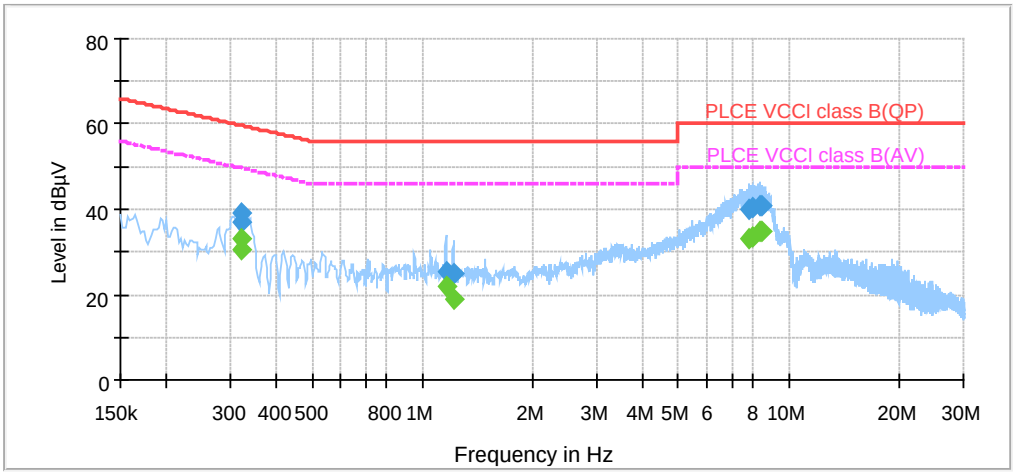
The test setup used complies with all the dimension requirements set out in CISPR 22:2008 Edition 6.0. Measurement instrumentation used meets the requirements of CISPR 16-4-2:2003, and expanded laboratory uncertainties U_{lab} are less than or equal to U_{cispr} Table 1. Therefore no compensation is required to the actual measured level in determining compliance with the applied limit.

10.2 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 (Pre-scan)		
	Quasi-peak (Final Measurements)		
	Average (Final Measurements)		
Quasi-peak Detector Dwell:	Minimum 2 s per frequency point		
EUT Measurement Height:	☒ 0.8 m Insulated Table		
	☐ 0.1 m Insulated Support/Pallet Mounted		
EUT Operation Voltage:	110 V ac		
EUT Operating Frequency:	☐ 50 Hz	☒ 60 Hz	☐ dc

10.3 EUT Test Results

10.3.1 Conducted Emissions Test Data



Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.321125	37.1	15000.0	9.000	GND	L1	10.2	22.6	59.7
0.321250	39.1	15000.0	9.000	GND	N	10.1	20.6	59.7
1.162725	25.5	15000.0	9.000	GND	N	10.0	30.5	56.0
1.214500	25.1	15000.0	9.000	GND	L1	10.1	30.9	56.0
7.790500	40.2	15000.0	9.000	GND	N	10.4	19.8	60.0
7.990000	40.4	15000.0	9.000	GND	N	10.4	19.6	60.0
8.367000	41.0	15000.0	9.000	GND	N	10.4	19.0	60.0
8.463500	40.9	15000.0	9.000	GND	N	10.4	19.1	60.0

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.321125	30.7	15000.0	9.000	GND	L1	10.2	19.0	49.7
0.321250	32.9	15000.0	9.000	GND	N	10.1	16.7	49.7
1.162725	22.1	15000.0	9.000	GND	N	10.0	23.9	46.0
1.214500	19.1	15000.0	9.000	GND	L1	10.1	26.9	46.0
7.790500	33.3	15000.0	9.000	GND	N	10.4	16.7	50.0
7.990000	33.6	15000.0	9.000	GND	N	10.4	16.4	50.0
8.367000	34.7	15000.0	9.000	GND	N	10.4	15.3	50.0
8.463500	34.9	15000.0	9.000	GND	N	10.4	15.1	50.0

11 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*	*Calibration Due Date*
RF Pre-Amplifier	Hewlett Packard	8447D	2727A05574	H008	☐	
RF Current Probe	Rohde & Schwarz	ESH2-Z1	891 923/24	H026	☐	
Bi-Cone Antenna	Eaton	96002	2500	H95	☐	
Receiver	Rohde & Schwarz	ESHS10	830051/002	H125	☐	
Analyser/Receiver	Rohde & Schwarz	ESVS 20	872890/004	H126	☐	
DRG Horn Antenna	EMCO	3115	9303-4027	H130	☐	
LISN/AMN	Rohde & Schwarz	ESH3-Z5	838576/002	H189	☒	8 SEP 2016
Log Periodic Antenna	EMCO	3146	9412-3925	H191	☐	
3 Phase LISN/AMN	Rohde & Schwarz	ESH2-Z5	832769/010	H233	☐	
Microwave Pre-Amplifier	Hewlett Packard	8449B	3008A00873	H307	☒	21 JAN 2017
Shielded CDN	Teseq	ST08	26589	H370	☐	
Spectrum Analyser	Agilent	E4407B	US39441062	H404	☐	
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	☐	
Shielded ISN	Fischer FCC	ST08	26589	H655	☐	
Spectrum Analyser	Agilent	E4404B	US40240716	H657	☐	
Pulse Limiter	Rohde & Schwarz	ESH3-Z2	101157	H674	☐	
Bi-Log Antenna	Teseq	CBL6111	31217	H679	☒	6 MAY 2017
Pulse Limiter	Rohde & Schwarz	ESH3-Z2	0357.8810.54	H680	☒	29 JUN 2016
Log Periodic Antenna	Rohde & Schwarz	HL050	100540	H682	☒	8 JULY 2017
CAT 6 ISN	Teseq	ISN T8-CAT6	32192	H695		
Analyser/Receiver	Rohde & Schwarz	ESU40	100005	H701	☒	11 NOV 2015
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	☒	20 JUL 2016
Horn Antenna	FM Ltd	2240-2S	160356	REF820		

12 EMC Modifications

No modifications were performed during this assessment.

13 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.

Test Standard	***Test Order***	***Class***		***Pass***
CISPR 22:2008 Edition 6.0 – Radiated Emissions	2	A ☐	B ☒	☒
CISPR 22:2008 Edition 6.0 – Conducted Emissions	1	A ☐	B ☒	☒

14 Measurement Uncertainty

SCHEDULE A – EMC MEASUREMENT UNCERTAINTY (LAB BASED)

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

Conducted Emissions Including Discontinuous Emissions

[1] Conducted Emissions 150 kHz to 30 MHz = **3.4 dB**

Radiated Emissions

[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**

Spurious Emissions up to 6 GHz

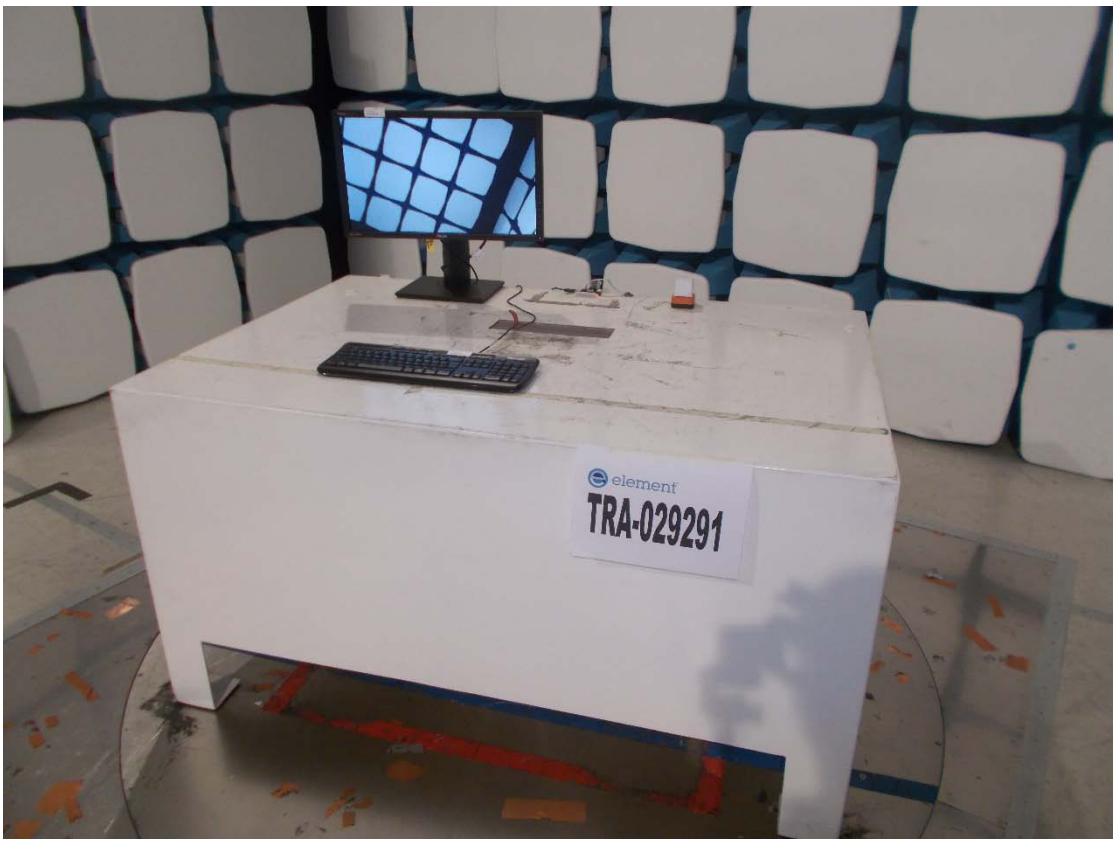
[1] Uncertainty in test result = **4.75 dB**

Cable Calibrations

[1] Cable calibration up to 6 GHz = **0.4 dB**

15 APPENDIX A – PHOTOGRAPHS

Radiated Emissions



Conducted Emissions