

EMC Test Report
For
Raspberry Pi Trading Limited
On
Raspberry Pi Camera V2
Report No. TRA-029291-44-01A
20th November 2015


RF088 9.0

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**REPORT ON THE EMC TESTING OF A
Raspberry Pi Trading Limited
Raspberry Pi Camera V2
WITH RESPECT TO SPECIFICATION
FCC RULES CFR 47:2013 PART 15.107 AND 15.109 CLASS B**

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

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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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[1] THIS DOCUMENT MAY BE REPRODUCED ONLY IN ITS ENTIRETY AND WITHOUT CHANGE
[2] THE RESULTS CONTAINED IN THIS DOCUMENT RELATE ONLY TO THE ITEM(S) TESTED

1 Revision Record

<i>Issue Number</i>	<i>Issue Date</i>	<i>Revision History</i>
A	20/11/15	Original

2 Summary

TEST REPORT NUMBER:	TRA-029291-44-01A
PURPOSE OF TEST:	Electromagnetic Compatibility – Emissions
TEST SPECIFICATION:	FCC Rules CFR 47:2013 Part 15.107 and 15.109 Class B
DEVIATIONS FROM SPECIFICATION:	Not Applicable (refer to individual sections)
EQUIPMENT UNDER TEST (EUT):	Raspberry Pi Camera V2
EUT SERIAL NUMBER:	None
EUT CATEGORY:	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

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4 Introduction

This report TRA-029291-44-01A presents the results of the EMC testing on a Raspberry Pi Trading Limited, Raspberry Pi Camera V2 to specification FCC Rules CFR 47:2013 Part 15.107 and 15.109 Class B.

The results obtained within this FCC CFR 47 Part 15 report are deemed satisfactory evidence to comply with the requirements of Industry Canada Interference-Causing Equipment Standard ICES-003

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

- | | |
|--|---|
| <input type="checkbox"/> Element Malvern
100 Frobisher Business Park
Leigh Sinton Road
Malvern
Worcestershire
WR14 1BX
UK

FCC Site Registration Number: 452983 | <input type="checkbox"/> Element Skelmersdale
Unit 1
Pendle Place
Skelmersdale
West Lancashire
WN8 9PN
UK

FCC Site Registration Number: 444512 |
| <input type="checkbox"/> Element Wimborne
74-78 Condor Close
Woolsbridge Industrial Park
Three Legged Cross
Wimborne
Dorset
BH21 6SU
UK

FCC Site Registration Number: 430273 | <input checked="" type="checkbox"/> Element Hull
Unit E
South Orbital Trading Park
Hedon Road
Hull
East Yorkshire
HU9 1NJ
UK

FCC Site Registration Number: 378340 |

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

- 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.
- CISPR 22:2008 '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.

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;

<i>Type</i>		<i>Description</i>	<i>Outdoor Cable Y / N</i>	<i>Test Length</i>	<i>Max Installation Length</i>
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

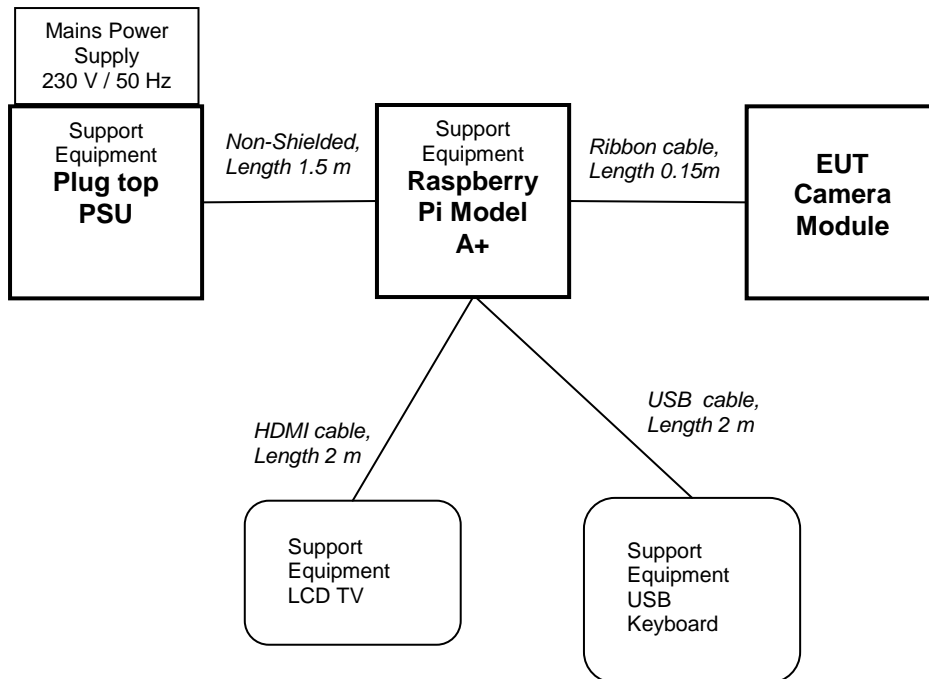
The camera was generating a live image, which was displayed on a supporting monitor via a Raspberry Pi A+.

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:

FCC RULES CFR 47 Federal Communications Commission Title 47 CFR Part 15: Radio Frequency Devices.

8.2 Basic Test Standard Selection

Basic Test Standard	Applicable		Notes
	Class A	Class B	
ANSI C63.4:2003 – Radiated Emissions	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
ANSI C63.4:2003 – Conducted Emissions	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

Notes:

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

9 Radiated Emissions as per ANSI C63.4:2003

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 set-up used complies with all the dimension requirements set out in ANSI C63.4:2003. The semi-anechoic chamber used meets the site attenuation measurements required by ANSI C63.4:2003 Clause 5.4.6.5.

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

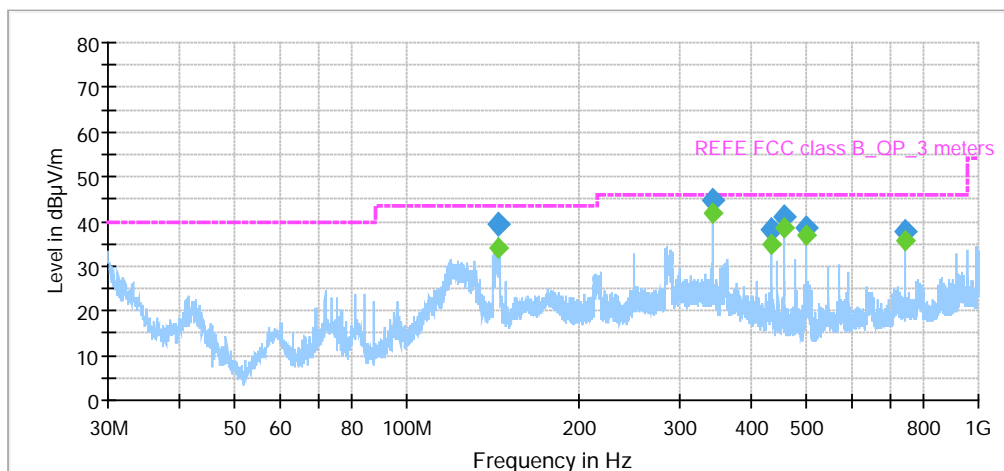
An initial scan is carried out in order to establish a frequency list that is attributable to the EUT. Any emissions measurements that fall within 20 dB μ V/m of the limit line are then maximised by rotating the equipment through 360° and raising/lowering the antenna through 1 to 4m height for each frequency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

9.2 Radiated Emission Test Parameters

EUT Classification:	<input type="checkbox"/> A	<input checked="" type="checkbox"/> B
Highest EUT Frequency:	800 MHz (if >1 GHz upper frequency of measurement will be 5 th harmonic of highest EUT frequency or 40 GHz whichever is lower)	
Frequency Range:	30 MHz to 1 GHz <input checked="" type="checkbox"/> 1 GHz to 2 GHz <input type="checkbox"/> N/A – Max EUT Freq Used <108 MHz <input checked="" type="checkbox"/> 2 GHz to 5G Hz <input type="checkbox"/> N/A – Max EUT Freq Used <500 MHz <input checked="" type="checkbox"/> 5 GHz to 6 GHz <input type="checkbox"/> N/A – Max EUT Freq Used <1 GHz	
Measurement Bandwidth:	120 kHz (Measurements \leq 1 GHz) 1 MHz (Measurements \geq 1 GHz)	
Video Bandwidth:	>500 kHz (Measurements \leq 1 GHz) 3 MHz (Measurements \geq 1 GHz)	
Detectors:	Peak (\leq 1 GHz scan / \geq 1 GHz Final Measurements) Average (\geq 1 GHz Final Measurements) Quasi-peak (\leq 1 GHz Final Measurements)	
Receiver Frequency Step Size:	50 kHz (Measurements <1 GHz) 450 kHz (Measurements >1 GHz)	
Analyser Frequency Sweep Point Size:	\leq 50 kHz (Measurements <1 GHz) \leq 450 kHz (Measurements >1 GHz)	
Quasi-peak Detector Dwell:	Minimum 2 s per Frequency Point	
Antenna Height:	1 to 4 Metres	
EUT to Antenna Distance:	<input type="checkbox"/> 1 m	<input checked="" type="checkbox"/> 3 m
EUT Measurement Height:	<input checked="" type="checkbox"/> 0.8 m Insulated Table <input type="checkbox"/> 0.1 m Insulated Support/Pallet	
EUT Operation Voltage:	120 V ac	
EUT Operating Frequency:	<input checked="" type="checkbox"/> 60 Hz	<input type="checkbox"/> dc

9.3 EUT Test Results

9.3.1 Radiated Emissions Test Data – 30 MHz to 1 GHz

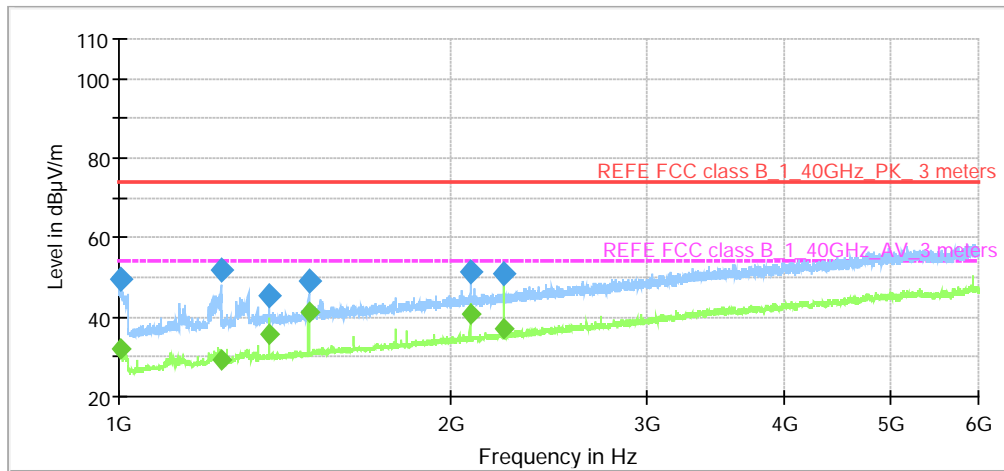


Note: The Blue Markers on the above plots are Peak detectors and are included for information purposes only, EN55032:2015* requires only the Quasi-Peak detector (Green Markers) in this frequency range to meet the specification limit represented. The marker details are included in table format below.

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	4.1	43.5
341.998560	44.7	15000.0	120.000	100.0	H	196.0	-15.3	1.3	46.0
433.212267	38.1	15000.0	120.000	100.0	H	157.0	-13.1	7.9	46.0
456.025267	41.1	15000.0	120.000	100.0	H	169.0	-12.7	4.9	46.0
500.013413	38.6	15000.0	120.000	199.0	H	178.0	-11.8	7.4	46.0
742.502133	37.7	15000.0	120.000	113.0	H	196.0	-6.9	8.3	46.0

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	9.3	43.5
341.998560	41.7	15000.0	120.000	100.0	H	196.0	-15.3	4.3	46.0
433.212267	34.7	15000.0	120.000	100.0	H	157.0	-13.1	11.3	46.0
456.025267	38.7	15000.0	120.000	100.0	H	169.0	-12.7	7.3	46.0
500.013413	36.9	15000.0	120.000	199.0	H	178.0	-11.8	9.1	46.0
742.502133	35.5	15000.0	120.000	113.0	H	196.0	-6.9	10.5	46.0

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	24.7	74.0
1236.476000	51.7	15000.0	1000.000	100.0	V	236.0	-5.2	22.3	74.0
1368.120000	45.6	15000.0	1000.000	124.0	V	0.0	-3.9	28.4	74.0
1485.038000	48.9	15000.0	1000.000	105.0	V	40.0	-2.7	25.1	74.0
2079.076000	51.4	15000.0	1000.000	100.0	H	58.0	1.3	22.6	74.0
2227.732000	51.0	15000.0	1000.000	121.0	H	221.0	2.1	23.0	74.0

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	22.0	54.0
1236.476000	29.2	15000.0	1000.000	100.0	V	236.0	-5.2	24.8	54.0
1368.120000	35.6	15000.0	1000.000	124.0	V	0.0	-3.9	18.4	54.0
1485.038000	41.5	15000.0	1000.000	105.0	V	40.0	-2.7	12.5	54.0
2079.076000	40.9	15000.0	1000.000	100.0	H	58.0	1.3	13.1	54.0
2227.732000	37.3	15000.0	1000.000	121.0	H	221.0	2.1	16.7	54.0

10 Sample Calculation

The radiated emission levels used in the report are calculated thus:

<i>Frequency (MHz)</i>	<i>Measured Value (dBμV)</i>	<i>Combined Antenna & Cable Factor (dB/m)</i>	<i>Emission Level (dBμV/m)</i>
341.99856	26.4	15.3	41.7
456.025267	26.0	12.7	38.7
500.013413	25.1	11.8	36.9
144.658253	15.7	18.5	34.2
742.502133	28.6	6.9	35.5
433.212267	21.6	13.1	34.7

11 Conducted Emissions as per ANSI C63.4:2003

11.1 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.

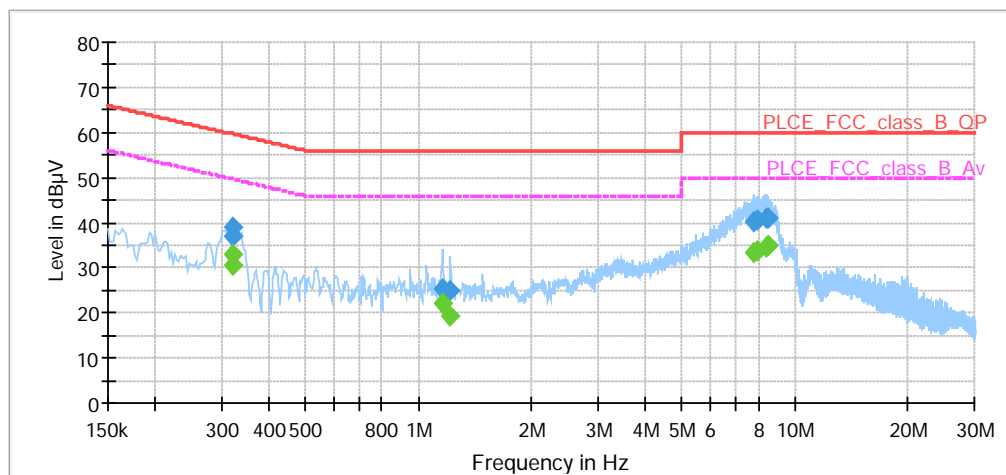
The test setup used complies with all the dimension requirements set out in ANSI C63.4:2003. Measurement instrumentation used meets the requirements of CISPR16-1-1:2003, and expanded laboratory uncertainties U_{lab} are less than or equal to U_{cisp} Table 1. Therefore no compensation is required to the actual measured level in determining compliance with the applied limit.

11.2 Conducted Emission Test Parameters

EUT Classification:	<input type="checkbox"/> A	<input checked="" type="checkbox"/> B
Frequency Range:	150 kHz to 30 MHz	
Receiver Frequency Step Size:	4.5 kHz / 5 kHz	
Analyser Frequency Sweep Point Size:	≤4.5 kHz	
Measurement Bandwidth:	9 kHz / 10 kHz	
Video Bandwidth:	>30 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:	<input checked="" type="checkbox"/> 0.8 m Insulated Table <input type="checkbox"/> 0.1 m Insulated Support/Pallet Mounted	
EUT Operation Voltage:	120 V ac	
EUT Operating Frequency:	<input checked="" type="checkbox"/> 60 Hz	<input type="checkbox"/> dc

11.3 EUT Test Results

11.3.1 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

12 Test Equipment List – Element Hull

The following test equipment was used:

<i>Type of Equipment</i>	<i>Maker/Supplier</i>	<i>Model Number</i>	<i>Serial Number</i>	<i>Element Number</i>	<i>Actual Equipment Used</i>	<i>Calibration Date</i>	<i>Interval</i>
RF Pre-Amplifier	Hewlett Packard	8447D	2727A05574	H008	<input type="checkbox"/>		
Bi-Cone Antenna	Eaton	96002	2500	H95	<input type="checkbox"/>		
Receiver	Rohde & Schwarz	ESHS10	830051/002	H125	<input type="checkbox"/>		
Analyser/Receiver	Rohde & Schwarz	ESVS 20	872890/004	H126	<input type="checkbox"/>		
DRG Horn Antenna	EMCO	3115	9303-4027	H130	<input type="checkbox"/>		
LISN/AMN	Rohde & Schwarz	ESH3-Z5	838576/002	H189	<input checked="" type="checkbox"/>	8 SEP 2015	12 MONTH
Log Periodic Antenna	EMCO	3146	9412-3925	H191	<input type="checkbox"/>		
3 Phase LISN/AMN	Rohde & Schwarz	ESH2-Z5	832769/010	H233	<input type="checkbox"/>		
Microwave Pre-Amplifier	Hewlett Packard	8449B	3008A00873	H307	<input checked="" type="checkbox"/>	21 JAN 2015	24 MONTH
Spectrum Analyser	Agilent	E4407B	US39441062	H404	<input type="checkbox"/>		
Horn Antenna	Q-Par Angus Ltd	QSH20S	5134	H630	<input type="checkbox"/>		
Spectrum Analyser	Agilent	E4404B	US40240716	H657	<input type="checkbox"/>		
Pulse Limiter	Rohde & Schwarz	ESH3-Z2	101157	H674	<input type="checkbox"/>		
Bi-Log Antenna	Teseq	CBL6111	31217	H679	<input checked="" type="checkbox"/>	6 MAY 2015	24 MONTH
Pulse Limiter	Rohde & Schwarz	ESH3-Z2	0357.8810.54	H680	<input checked="" type="checkbox"/>	29 JUN 2015	12 MONTH
Log Periodic Antenna	Rohde & Schwarz	HL050	100540	H682	<input checked="" type="checkbox"/>	8 JULY 2015	24 MONTH
Analyser/Receiver	Rohde & Schwarz	ESU40	100005	H701	<input checked="" type="checkbox"/>	11 NOV 2014	12 MONTH
RF Chamber	Belling Lee	Lab 5	None	H705	<input checked="" type="checkbox"/>		
RF Chamber	Ray Proof	Lab 6	None	H706	<input type="checkbox"/>		
RF Chamber	Ray Proof	Lab 7	None	H707	<input type="checkbox"/>		
RF Chamber	Panashield	Lab 10	None	H710	<input checked="" type="checkbox"/>	20 JUL 2014	24 MONTH
Ground plane area	Element	Lab 17	None	H717	<input type="checkbox"/>		
Horn Antenna	FM Ltd	2240-2S	160356	REF820	<input type="checkbox"/>		

13 EMC Modifications

No modifications were performed during this assessment.

14 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.

<i>Test Standard</i>	<i>Test Order</i>	<i>Class</i>		<i>Pass</i>
ANSI C63.4:2003 – Radiated Emissions	2	A <input type="checkbox"/>	B <input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
ANSI C63.4:2003 – Conducted Emissions	1	A <input type="checkbox"/>	B <input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

<i>Test Standard</i>	<i>Test Order</i>	<i>Class</i>		<i>Pass</i>
ANSI C63.4:2014 – Radiated Emissions	2	A <input type="checkbox"/>	B <input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
ANSI C63.4:2014 – Conducted Emissions	1	A <input type="checkbox"/>	B <input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

The results obtained within this FCC CFR 47 Part 15 report are deemed satisfactory evidence to comply with the requirements of Industry Canada Interference-Causing Equipment Standard ICES-003 Issue 5:2012.

14.1 Conformity in Production

Element has based this test report on results from the equipment sample(s) provided.

The manufacturer is advised that they may have an obligation to demonstrate that production samples are in conformity with the Standards noted.

The EMC performance reported above was achieved after incorporation of any modifications as detailed in Section 16 of this report.

15 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**

[3] Radiated Emissions 6 GHz to 26 GHz using HL050 Log Periodic Antenna = **5.2 dB**

[4] Radiated Emissions 26.5 GHz to 40 GHz using 22240-25 Horn Antenna = **3.8 dB**

Spurious Emissions up to 40 GHz

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

Cable Calibrations

[1] Cable calibration up to 40 GHz = **0.4 dB**

16 APPENDIX A – PHOTOGRAPHS

Radiated Emissions



Conducted Emissions

