FCC 47CFR part 15C
Test Report
For
Traka21

Reference Standard: FCC 47CFR part 15C
Manufacturer: Traka plc
For type of equipment and serial number, refer to section 3
Report Number: 11-7811-1-14 Issue 02
This report supersedes report: 11-7811-1-14 Issue 01

Report Produced by: -

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Certificate of Test 7811-1

The unit noted below has been tested by **R.N. Electronics Limited** and, where appropriate, conforms to the relevant subpart of FCC 47CFR Part 15. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

Equipment:	Traka21
Model Number:	Traka21
Proposed FCC ID:	2ADNX-KC10156
Unique Serial Numbers:	T21A2400001 = Frequency Error test only, T21A3400016 = All other tests
Manufacturer:	Traka plc N.B. House 30 Stilebrook Road Olney Buckinghamshire MK46 5EA
Full measurement results are detailed in Report Number:	11-7811-1-14 Issue 02
Test Standards:	FCC 47CFR Part 15C Effective date **October 1st 2013,** Class DXX Intentional Radiator

DEVIATIONS:
Deviations from the standards have been applied. For details refer to section 4.1 of this report.

This certificate relates only to the unit tested as identified by a unique serial number and in the condition at the time it was tested. It does not relate to any other similar equipment and performance of the product before or after the test cannot be guaranteed. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of unit not meeting the intentions of the standard or the requirements of the Federal Regulations, particularly under different conditions to those during testing. Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Date of Test: 21st to 27th November 2014

Test Engineer: Digitally signed by: Daniel Sims DN: CN = Daniel Sims C = GB O = RN Electronics Ltd Date: 2015.01.15 12:31:04 Z

Approved By:
Technical Director

Customer representative:

1 Contents

2 Equipment Under Test (EUT)

2.1 Equipment Specification

Applicant	Traka plc N.B. House 30 Stilebrook Road Olney Buckinghamshire MK46 5EA	
Manufacturer of EUT	Traka plc	
Brand name of EUT	Traka21	
Model Number of EUT	Traka21	
Serial Number of EUT	T21A2400001 = Frequency Error test only, T21A3400016 = All other tests	
Date when equipment was received by RN Electronics	21st November 2014	
Date of test:	21st to 27th November 2014	
Visual description of EUT:	Metal and plastic enclosure with integrated display and access door on the front. Behind the access door are 21 key fob positions with surround LED's and a USB port. On the rear of the unit at the bottom is a DC input port for connection of the supplied AC/DC adapter. Housed in the top of the unit is an integral rechargeable battery.	
Main function of the EUT:	Electronic key management system	
Height	427 mm	
Width	246 mm	
Depth	95 mm	
Weight	3.94 kg	
Voltage	90-264V AC via AC/DC adapter, 10-15V DC 13.6V nominal via battery backup	
Current required from above voltage source	<0.4 A	
EUT supplied PSU:	Manufacturer	Meanwell
	Model number	FRA024-S15-I
	Serial number	Not specified
	Input voltage	100-240V AC 50/60 Hz
	Input current	0.7A
	Output	15V DC @ 1.7A

2.2 EUT Configurations for testing

General parameters	
EUT Normal use position	Wall mounted
Choice of model(s) for type tests	Production prototype
Antenna details	21 PCB coils multiplexed via RF switches
Antenna port	No
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	480MHz Internal processing
Lowest Signal generated in EUT	13.56MHz (RFID)
TX Parameters	
Alignment range – transmitter	13.56MHz
EUT Declared Modulation	ISO15693, 26.48kbps, 2 sub carriers 1 of 4 encoding

Parameters	
EUT Declared Power level	200mW Theoretical
EUT Declared Signal Bandwidths	Not specified
EUT Declared Channel Spacing's	N/A single channel equipment
EUT declared Duty Cycle	98%
Unmodulated carrier available?	Yes (via programming)
Declared frequency stability	+/-10ppm
RX Parameters	
Alignment range – receiver	13.56MHz
EUT Declared RX Signal Bandwidth	1MHz based on RFID IC (TRF7970A)

2.3 Functional Description

The Traka21 product is an electronic key cabinet used to manage 21 physical keys. The system controls the removal of keys to authorized personnel and logs an audit trail. It consists of a metal and plastic body with solenoid-actuated locking hinged door. Behind the door are 21 'receptors' used to hold 'iFobs' – these are plastic key fobs attached to each key bunch to be controlled. The iFob's are inserted into the receptors and held in place with sprung solenoids released under software control. The iFob's are detected and identified using 13.56MHz RFID technology – an RFID coil is imbedded in the PCB behind each receptor and the iFob contains a 13.56MHz RFID tag. The user interface is via 5" colour resistive touch screen. The product is powered from an external mains power brick creating a 15V regulated supply. The system can also operate from an internal sealed-lead-acid battery in the event of mains failure.

2.4 EUT Modes

Mode Reference	Description	Used for testing
13.56MHz CW position 11	EUT constantly transmitting a CW tone from coil position 11	Yes
Normal (not logged in)	EUT repeatedly switching through each of 21 coils in sequence with fobs in place, display awaiting key input	Yes
Normal (user logged in) Door open	EUT repeatedly switching through each of 21 coils in sequence with fobs in place, key code entered and display showing fob positions	Yes
Normal (user logged in) Door closed	EUT repeatedly switching through each of 21 coils in sequence with fobs in place, key code entered and display showing fob positions	Yes
13.56MHz modulated fixed position 1	EUT constantly transmitting with modulation from coil position 1	Yes
13.56MHz modulated fixed position 11	EUT constantly transmitting with modulation from coil position 11	Yes
13.56MHz modulated fixed position 21	EUT constantly transmitting with modulation from coil position 21	Yes

Note: All modes were with the EUT door wide open.

Description of ancillary equipment connected to the equipment under test, for the purpose of tests, can be found in Section 11.

Any modifications made to the EUT, whilst under test, can be found in Section 12.

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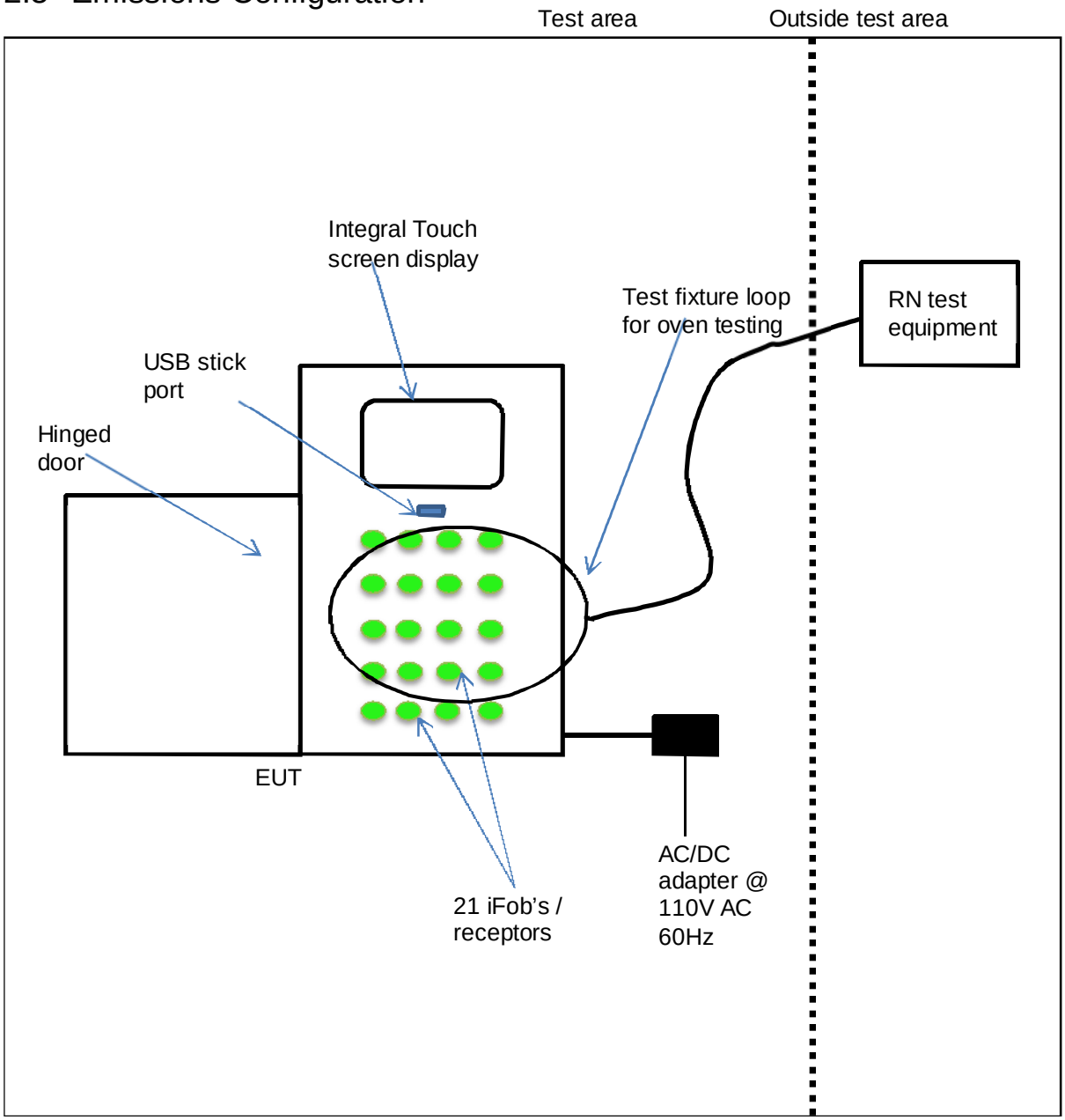
2.5 Emissions Configuration



The EUT was powered via the manufacturer supplied AC/DC power supply, normally supplied with the unit. The unit also had in place an internal re-chargeable battery. 21 iFob's were also located in the respective receptors. In normal operational mode the RFID switches through the RF to each of the 21 coils in turn and then repeats the sequence continuously. For the purposes of test, two units were provided. The 2nd unit s/n T21A2400001 had a programming lead attached to it to allow different modes of test to be programmed in to it. For frequency error tests the internal battery was removed and a bench top supply connected in its place. This allowed the battery end points to be set as declared by the manufacturer. The EUT was set to a fixed coil position (11) for the frequency error tests.
During initial pre-scans it was determined that the worst case emissions were with the door open. Emissions profile did not change whether the user was logged in or not, therefore the unit was tested with the user "logged in". See section 2.4 for further details on modes of operation.

A Magnetic loop test fixture was used to couple the 13.56MHz signal to a Spectrum Analyser / frequency counter for oven testing.

3 Summary of test results

The **Traka21** was tested to the following standards: -

FCC 47CFR Part 15.225 (effective date October 1st, 2013); Class DXX Intentional Radiator

Any compliance statements are made reliant on the modes of operation as instructed to us by the Manufacturer based on their specific knowledge of the application and functionality of the equipment tested. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of equipment not meeting the intentions of the standard, particularly under different conditions to those during testing.

Title	Reference	Results
1. AC power line conducted emissions	FCC Part 15C §15.207	PASSED
2. Intentional radiator field strength & spectrum mask	FCC Part 15C §15.225(a)(b)(c)	PASSED
3. Radiated emissions	FCC Part 15C §15.205, §15.209 and §15.225(d)	PASSED
4. Frequency stability	FCC Part 15C §15.225(e)	PASSED
5. Occupied bandwidth	FCC Part 15C §15.215	PASSED[1]

[1] No limits apply however, per 15.215, the 20dB bandwidth of the emission is to remain within the band over expected variations in temperature and supply voltage. It is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimise the possibility of out-of-band operation.

4 Specifications

The tests were performed and operated in accordance with the RN Electronics procedures and the basic standards listed below.

Reference	Standard Number	Year	Description
4.1.1	47CFR15	2013	Federal Communications Commission PART 15 – RADIO FREQUENCY DEVICES
4.1.2	ANSI C63.10	2009	American National Standard for Testing Unlicensed Wireless Devices
4.1.3	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

R.N. Electronics Ltd sites M and OATS are listed with the FCC; Registration Number 293246
R.N. Electronics Ltd site H is listed with the FCC; Registration Number 823977

4.1 Deviations

ANSI C63-10-2009 deviations:
The reference standard ANSI C63.4-2003 was used, not the latest ANSI C63.4-2009

FCC Part 15 deviations:
None.

4.2 Tests at Extremes of Temperature & Voltage

The following test conditions were used to simulate testing at nominal or extremes.

Temperature Test Conditions		Voltage Test Conditions	
T amb	20 °C	V nom	13.6 dc
T cold	-30 °C	V min	10 dc
T hot	50 °C	V max	15 dc

Extremes of voltage are based on manufacturer's end point declaration for the internal battery operation.
Extremes of temperature are based upon 15.225 requirements.
The ambient test conditions of humidity and pressure in the laboratory were as follows:
40-48 %; 101kPa.

4.2.1 Test fixtures

To enable testing at extremes the following test fixtures were utilised:

☐ A permanent internal RF port was used for testing.
☒ A test fixture was used for testing.
☐ A temporary RF port was created for testing.
☐ The equipment external RF port was used for testing.

4.3 Measurement Uncertainties

Parameter	Uncertainty
Transmitter Tests	
RF frequency	<± 0.7 ppm
Conducted RF power	<± 1.0 dB
Bandwidth	<± 1.9 %
Radiated RF Power	<± 3.5 dB
Radiated Spurious Emissions	<± 3.4 dB

5 Tests, Methods and Results

5.1 Conducted emissions

5.1.1 Test Methods

Test Requirements	FCC Part 15C, Reference (15.207)
Test Method:	ANSI C63.10, Reference (6.2)

5.1.2 Configuration of EUT

The EUT and AC/DC adapter were placed on a wooden table 0.8m above the ground plane and the adapter connected to a LISN via a 1m mains cable.

Details of the Peripheral and Ancillary Equipment connected for this test is listed in section 11.

No discernible difference was noted in emissions between modes and no difference was observed in emissions between the two modification options listed in section 12, therefore the EUT was operated in mode **Normal (User logged in) Door closed** for full tests with the “single spring finger modification” in place.

5.1.3 Test Procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted in the ‘Test Equipment’ Section. Measurements were made on the live and neutral conductors using both average and quasi-peak detection.
At least 6 signals within 20dB and/or all signals within 10dB of the limit were investigated.

Tests were performed in Test Site F.

5.1.4 Test Equipment used

E150, E035, E410, E411, E412, E570

See Section 10 for more details.

5.1.5 Test results

Ambient conditions.
Temperature: 18 °C Relative humidity: 48 %

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6.1 of this report.

Table of signals measured.

Quasi-Peak and Average Live (Mains)

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)	AV Amp (dBuV)	AV Lim (dB)
1	0.187	54.4	51.9	-12.3	34.8	-19.4
2	0.249	46.9	43.5	-18.3	28.2	-23.6
3	0.261	45.2	42.0	-19.4	27.3	-24.1
4	0.316	39.0	35.3	-24.5	24.0	-25.8
5	0.502	33.9	29.8	-26.2	22.9	-23.1
6	13.560	51.0	48.5	-11.5	44.3	-5.7
7	18.275	36.3	33.1	-26.9	26.4	-23.6

Table of signals measured.

Quasi-Peak and Average Neutral (Mains)

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)	AV Amp (dBuV)	AV Lim (dB)
1	0.160	43.4	35.8	-29.7	18.1	-37.4
2	0.189	53.9	51.6	-12.5	34.3	-19.8
3	0.250	46.5	43.2	-18.6	28.6	-23.2
4	0.311	39.5	36.1	-23.8	24.5	-25.4
5	0.331	37.1	33.6	-25.8	21.7	-27.7
6	13.560	51.0	49.2	-10.8	44.7	-5.3
7	18.043	42.8	38.9	-21.1	32.3	-17.7
8	18.327	43.4	39.2	-20.8	32.2	-17.8

Plot reference tables

Frequency range	Plot reference
150kHz to 30MHz	7811-1 Cond 1 AC Live 150k-30M Average
150kHz to 30MHz	7811-1 Cond 1 AC Live 150k-30M Quasi-Peak
150kHz to 30MHz	7811-1 Cond 1 AC Neutral 150k-30M Average
150kHz to 30MHz	7811-1 Cond 1 AC Neutral 150k-30M Quasi-Peak

LIMITS:
15.207: as given in the above tables / drawn on the respective plots.

These results show that the **EUT** has **PASSED** this test.

5.2 Intentional radiator field strength & Spectrum mask

5.2.1 Test Methods

Test Requirements FCC Part 15C, Reference (15.225)
Test Method: ANSI C63.10, Reference (6.5)

5.2.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at distances of 3 metres, 1 metre and 30cm. The antenna was orientated in both Parallel and perpendicular polarisations. The EUT was rotated in all three orthogonal planes. No difference in fundamental field strength was observed when either of the modifications listed in section 12 were fitted to the EUT. No discernible difference was also noted in emissions between modes, however, having the door open did provide a slight increase in field strength and as such was found to be worst case mode of operation. Therefore the EUT was operated in **Normal (User logged in) Door open** mode and had the "single spring finger modification" in place.

5.2.3 Test Procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Measurements were made in a semi-anechoic chamber and on an OATS. These sites are listed with the FCC.

The equipment and antenna were rotated 360° to record the maximised emission.

5.2.4 Test Equipment used

E411, E412, TMS81

See Section 9 for more details

5.2.5 Test results

Ambient conditions.
Temperature: 11-18°C Relative humidity: 38-45 % Pressure: 101 kPa

Radio Parameter 1

Band	13.553-13.567 MHz
Power level	dBuV/m @3m
Channel spacing	single channel
Mod scheme	28.64 kbps
Low channel	13.56 MHz

Results relating to Radio Parameters 1

Distance	PK Result dBuV/m	Plot reference
3metres	40.8	N/A
1metres	63.7	7811-1 1m field strength OATS, 360 sweep max held EUT on side
0.3metres	80.0	N/A
Spectrum mask at 30metres	1.6	7811-1 Spectrum mask FCC15.225 at 30metres

Highest field strength was measured with EUT on its side with the door open and the loop antenna in the parallel position. 1 metre distance was used to increase the fundamental signal amplitude with respect to the noise floor. An extrapolation figure of 39.2dB was used (as measured between two distances) instead of the 40dB factor as per ANSI C63.10. This gave a field strength result at 30 metres of 1.6dBuV/m.

Analyser plots can be found in Section 6.2 of this report.

LIMITS:
15.225(a) QP/Peak = the field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 µV/m @ 30m = 84 dBµV/m @ 30m.
15.225(b) QP/Peak = within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 µV/m @ 30m = 50.5 dBµV/m @ 30m.
15.225(c) QP/Peak = within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 µV/m @ 30m = 40.5 dBµV/m @ 30m.
15.225(d) QP/Peak = outside of the 13.110-14.010 MHz band shall not exceed the general radiated emissions limits of 15.209.

These results show that the EUT has **PASSED** this test.

5.3 Radiated emissions

5.3.1 Test Methods

Test Requirements	FCC Part 15C, Reference (15.209)
Test Method:	ANSI C63.10, Reference (6.4 – 6.6.)

5.3.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. Radiated Emissions testing was performed with the internal battery in a discharged state. No discernible difference was noted in emissions between modes, however, having the door open did provide a slight increase in emissions and as such was found to be worst case mode of operation. Therefore the EUT was operated in mode **Normal (User logged in) Door open** for full tests.

5.3.3 Test Procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Below 30MHz, measurements were made in a semi-anechoic chamber (pre-scan) with final measurements on an OATS without a ground plane. The centre of the antenna was placed 1m above the ground. The equipment and the antenna were rotated 360° to record the worst case emissions.

30MHz - 1GHz, measurements were made on a site listed with the FCC. The equipment was rotated 360° and the antenna scanned 1 – 4 metres in both horizontal and vertical polarisations to record the worst case emissions.

Above 1GHz, measurements were made in a semi-anechoic chamber with appropriate absorbing material for use in this range. The EUT was rotated through 360° to record the worst case emissions. A measurement distance of 3m was used in the test range
1 - 2GHz.

At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.

Tests were performed using Test Site M and OATS**.**

5.3.4 Test Equipment used

TMS81**,** TMS82, TMS933, E268, E410, E411, E412, E570

See Section 10 for more details

5.3.5 Test results

Ambient conditions (Radiated emissions 9kHz-150kHz)
Temperature: 11-18 °C Relative humidity: 38-45 %

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) and any tables of signals within 20dB of the limit line can be found in Section 6.3 of this report.

5.3.5.1 Below 30MHz.

Plot references for Low Frequency Radiated emissions measurements (9kHz to 30MHz)

Channel	Parallel Plots	Perpendicular Plots
Single channel	7811-1 Parallel 9-150k measured at 3metres	7811-1 Perpendicular 9-150k measured at 3metres
Single channel	7811-1 Parallel 150k-30M measured at 3metres	7811-1 Perpendicular 150k-30M measured at 3metres

5.3.5.2 30MHz - 1GHz.

Plot references for Radiated emissions measurements (30-1000MHz) mode **Normal (User logged in) Door open** with the modification "Dual position Folded tin strip" in place. Please see modifications section 12.

Frequency Range	Antenna Polarisation	Plot reference
30 – 300 MHz	Horizontal	7811-1 Rad 1 VHF Horiz
30 – 300 MHz	Vertical	7811-1 Rad 1 VHF Vert
300 – 1000 MHz	Horizontal	7811-1 Rad 1 UHF Horiz
300 – 1000 MHz	Vertical	7811-1 Rad 1 UHF Vert

Plot references for Radiated emissions measurements (30-1000MHz) mode **Normal (User logged in) Door open** with the modification "Single position tinned copper spring finger" in place. Please see modifications section 12.

Frequency Range	Antenna Polarisation	Plot reference
30 – 300 MHz	Horizontal	7811-1 Rad 2 VHF Horiz
30 – 300 MHz	Vertical	7811-1 Rad 2 VHF Vert
300 – 1000 MHz	Horizontal	7811-1 Rad 2 UHF Horiz
300 – 1000 MHz	Vertical	7811-1 Rad 2 UHF Vert

Table of signals measured (Normal (User logged in) Door open with the modification "Dual position Folded tin strip" in place)

Horizontal

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)
1	30.462	29.8	23.6	-16.4
2	232.616	32.7	30.6	-15.4
3	361.501	37.4	34.4	-11.6
4	362.825	36.7	33.6	-12.4
5	378.788	36.5	33.8	-12.2
6	392.728	44.6	*43.0	-3.0
7	589.113	37.1	30.9	-15.1
8	594.090	36.3	27.9	-18.1
9	785.456	41.2	39.1	-6.9

*These signals were found to be generic emissions associated with the integral display of the unit (i.e. not associated with the RFID transmitter) and as such the requirements of part 15.215 (b) are considered satisfied.

Vertical

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)
1	32.931	34.5	29.2	-10.8
2	53.728	34.3	30.4	-9.6
3	72.060	33.5	29.9	-10.1
4	313.501	37.2	33.8	-12.2
5	392.728	43.5	*41.6	-4.4
6	589.108	39.4	34.8	-11.2
7	594.313	42.4	34.4	-11.6
8	599.743	36.4	29.2	-16.8

*These signals were found to be generic emissions associated with the integral display of the unit (i.e. not associated with the RFID transmitter) and as such the requirements of part 15.215 (b) are considered satisfied.

Table of signals measured (Normal (User logged in) Door open with the modification "Single position tinned copper spring finger" in place)

Horizontal

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)
1	265.847	36.6	34.0	-12.0
2	392.728	44.0	*41.8	-4.2
3	518.999	35.0	30.2	-15.8
4	589.084	40.4	35.6	-10.4
5	594.056	34.9	27.6	-18.4
6	785.456	44.4	*42.7	-3.3

*These signals were found to be generic emissions associated with the integral display of the unit (i.e. not associated with the RFID transmitter) and as such the requirements of part 15.215 (b) are considered satisfied.

Vertical

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)
1	51.061	38.0	34.5	-5.5
2	77.433	35.7	32.0	-8.0
3	316.501	35.7	33.6	-12.4
4	392.728	43.6	*41.7	-4.3
5	589.088	41.9	38.1	-7.9
6	594.274	41.8	33.5	-12.5
7	785.456	42.8	40.5	-5.5

*These signals were found to be generic emissions associated with the integral display of the unit (i.e. not associated with the RFID transmitter) and as such the requirements of part 15.215 (b) are considered satisfied.

5.3.5.3 Above 1GHz.

Plot references for Radiated emissions measurements (1-2GHz) mode **Normal (User logged in) Door open**.

Frequency Range	Antenna Polarisation	Plot reference
1 – 2 GHz	Horizontal	7811-1 Rad 1 1-2GHz Horiz
1 – 2 GHz	Vertical	7811-1 Rad 1 1-2GHz Vert

No signals observed within 20dB of limits in any mode listed in section 2.4.
No signals / difference observed when either of the modifications listed in section 12 were fitted.

LIMITS:
15.209: as given in the above tables / drawn on the respective plots.

These show that the **EUT** has **PASSED** this test.

5.4 Frequency stability

5.4.1 Test Methods

Test Requirements FCC Part 15C, Reference (N/A)
Test Method: ANSI C63.10, Reference (6.8)

5.4.2 Configuration of EUT

The EUT was placed in a temperature controlled chamber. The EUT emissions were observed by means of a test fixture. The EUT was operated in mode 13.56MHz CW position 11 for this test. No difference was observed in frequency reading between either of the modifications listed in section 12; therefore for full tests the single spring copper finger was in place.

5.4.3 Test Procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Temperature stability was achieved at each temperature level before taking measurements. A frequency count was made on a CW signal. At nominal temperature the EUT supply was varied to the manufacturer's declared battery end points as this was considered worst case. However, a further test was made at nominal temperature with the EUT powered from its AC/DC adapter with the input voltage varied by +/-15%.

Tests were performed using Test Site **A.**

5.4.4 Test Equipment used

E227, E324, E342, E434, L264, TMS38, TMS57, TMS80, E541

See Section 10 for more details

5.4.5 Test results

Ambient conditions.
Temperature: 20 °C Relative humidity: 40-48 % Pressure: 103 kPa

Radio Parameter 1

Band	13.553-13..567 MHz
Power level	dBuV/m @3m
Channel spacing	single channel
Mod scheme	28.64 kbps
Low channel	13.56 MHz

Results relating to Radio Parameters 1 (**Battery end points used)**

Temp (°C)	Voltage (V)	Single channel (MHz)
-30	**13.6**	13.559768
-20	**13.6**	13.559852
-10	**13.6**	13.559873
0	**13.6**	13.559880
10	**13.6**	13.559867
20	**10**	13.559831
20	**13.6**	13.559831
20	**15**	13.559830
30	**13.6**	13.559822
40	**13.6**	13.559798
50	**13.6**	13.559789
Max Frequency Error observed (MHz)		+0.000 / -0.000232
% error		+0 / -0.0017

Results relating to Radio Parameters 1 (**AC power input variation)**

Temp (°C)	Voltage (V)	Single channel (MHz)
20	**93.5**	13.559833
20	**110**	13.559834
20	**126.5**	13.559834
Max Frequency Error observed (MHz)		+0.000 / -0.000167
% error		+0 / -0.0012

LIMITS:
+/- 0.01%. (+/- 1.356 kHz)

These results show that the **EUT** has **PASSED** this test.

5.5 Occupied bandwidth (20 dB)

5.5.1 Test Methods

Test Requirements FCC Part 15C, Reference (15.215)
Test Method: ANSI C63.10, Reference (6.9)

5.5.2 Configuration of EUT

The EUT was placed in to a test fixture. The EUT was tested whilst connected to the AC power for maximised emissions. No discernible difference was noted in emissions between modes, however, having the door open did provide a slight increase in fundamental field strength and as such was found to be worst case mode of operation. For ease of test the EUT was operated in mode **13.56MHz modulated fixed position 11** for full tests.

5.5.3 Test Procedure

Tests were performed using Test Site A.
Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. A 3kHz RBW, 3x VBW, 300kHz span, auto sweep time and max hold settings were used for the 20 dB bandwidth.

5.5.4 Test Equipment used

E410, E411, E412, E570

See Section 10 for more details.

5.5.5 Test results

Ambient conditions.
Temperature: 18°C Relative humidity: 45 % Pressure: 101 kPa

Analyser plots for the 20 dB bandwidth can be found in Section 6.4 of this report.

20dB BW Result (kHz)	Plot reference
61.4	7811-1 20dB BW, 3k RBW, 300k Span

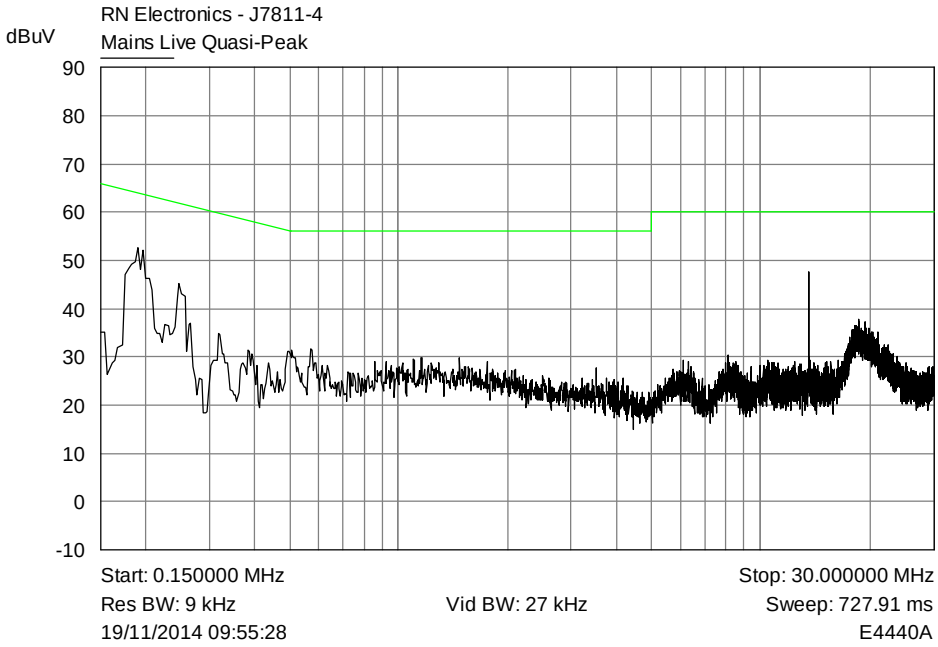
LIMITS:
No limits apply, however, per 15.215, the 20dB bandwidth of the emission is to remain within the band over expected variations in temperature and supply voltage. It is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimise the possibility of out-of-band operation.

These results show that the EUT has **PASSED** this test.

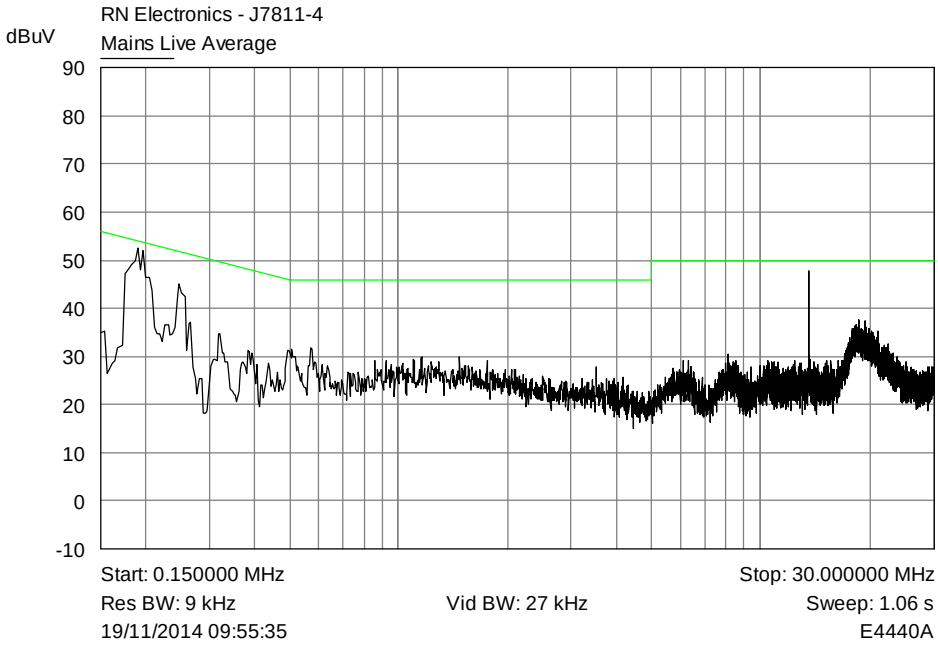
6 Plots and Results

6.1 AC power line conducted emissions plots

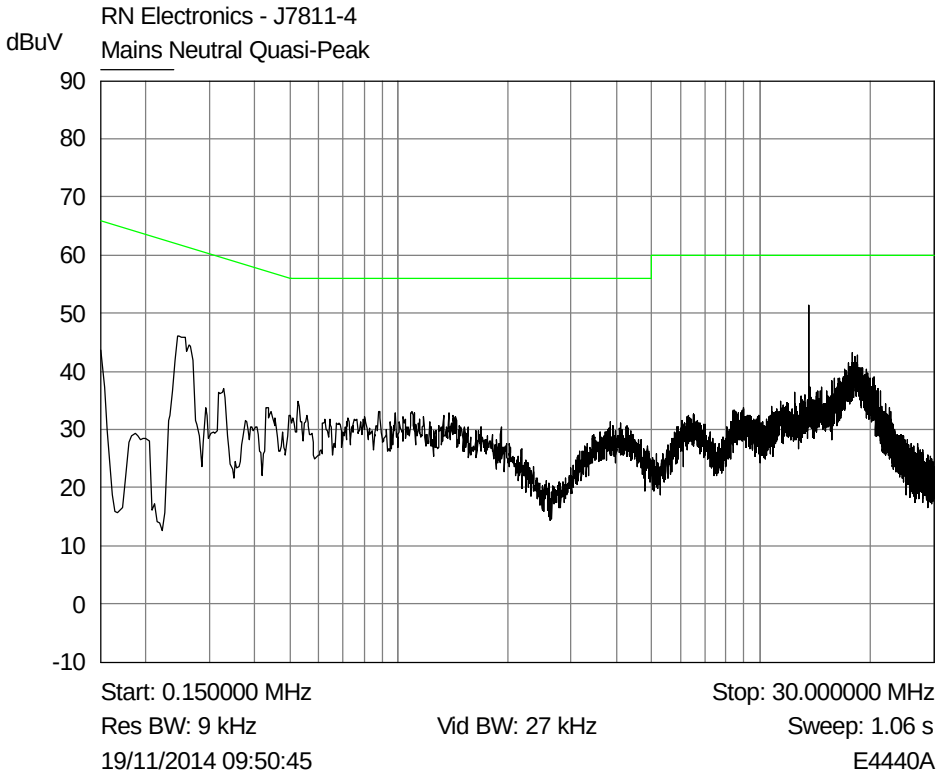
No discernible difference was noted in emissions between the “Single position tinned copper finger” modification & the “Dual position tin strip” modification. Therefore only one set of AC emissions plots are shown within this report.



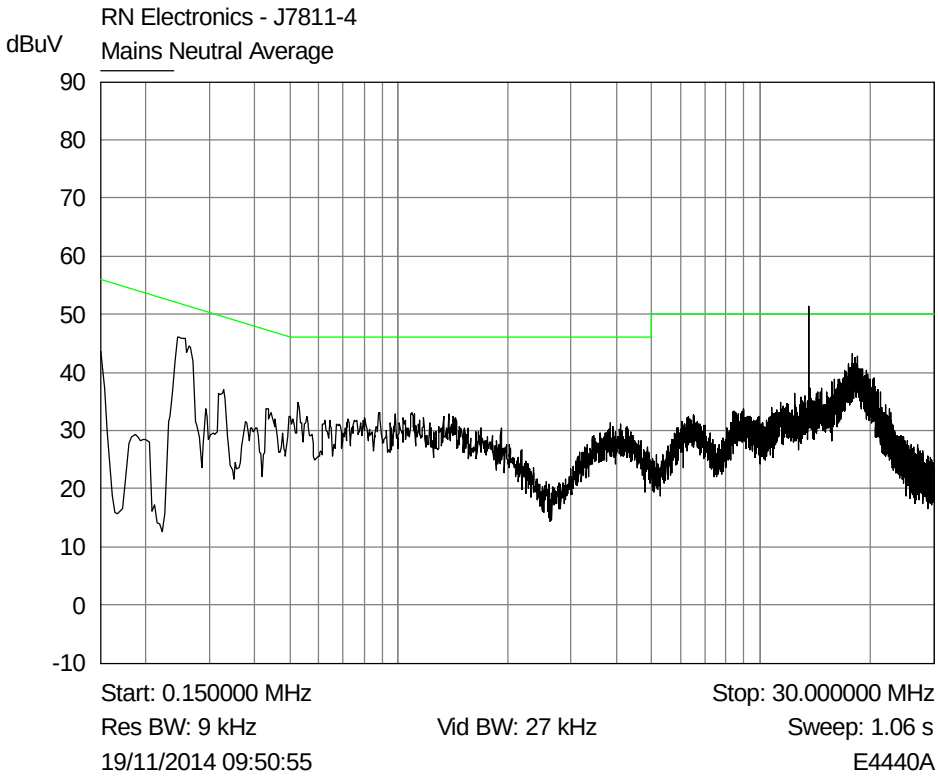
Plot of peak emissions 150kHz - 30MHz on the Mains live terminal against the quasi-peak limit line.



Plot of peak emissions 150kHz - 30MHz on the Mains live terminal against the average limit line.



Plot of peak emissions 150kHz - 30MHz on the Mains neutral terminal against the quasi-peak limit line.

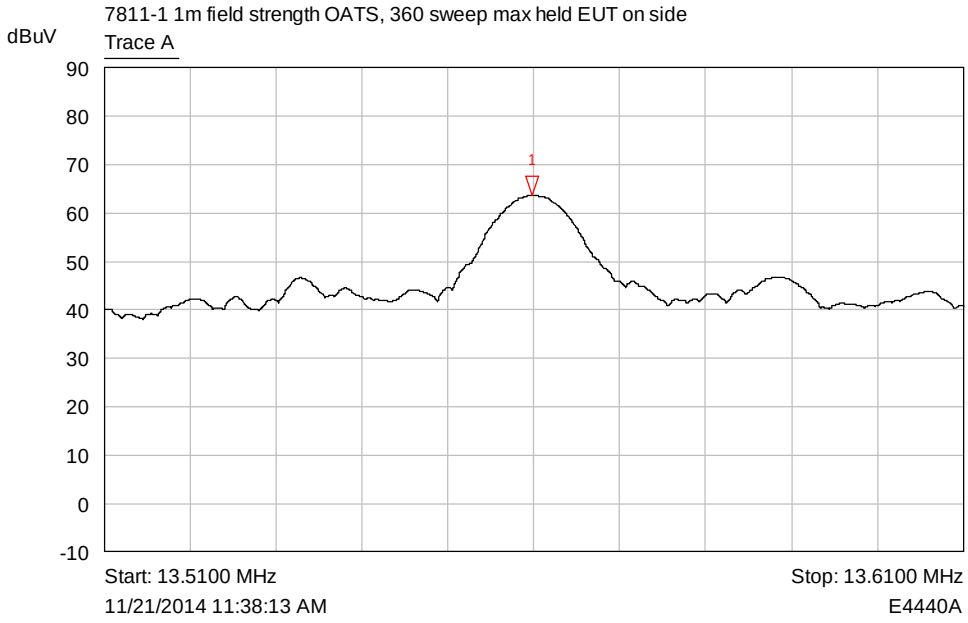


Plot of peak emissions 150kHz - 30MHz on the Mains neutral terminal against the average limit line.

6.2 Intentional radiator field strength / Spectrum mask

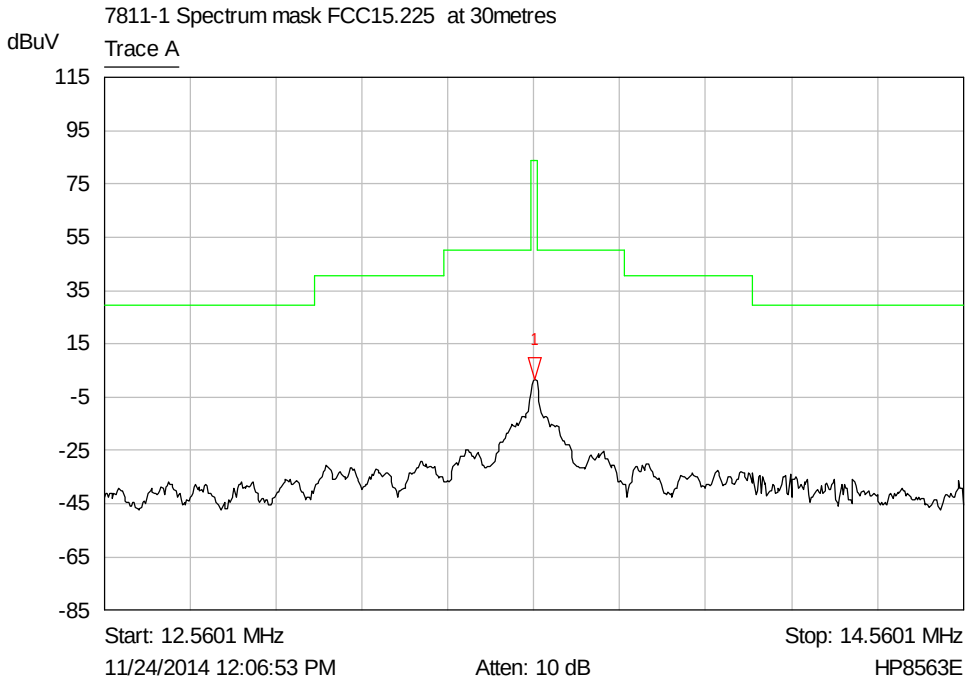
6.2.1 Plots for 13.56MHz Band, Max Power, Single channel

1 metre measurement distance



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	13.5599 MHz	63.71 dBuV	

Spectrum Mask referenced to 30metres

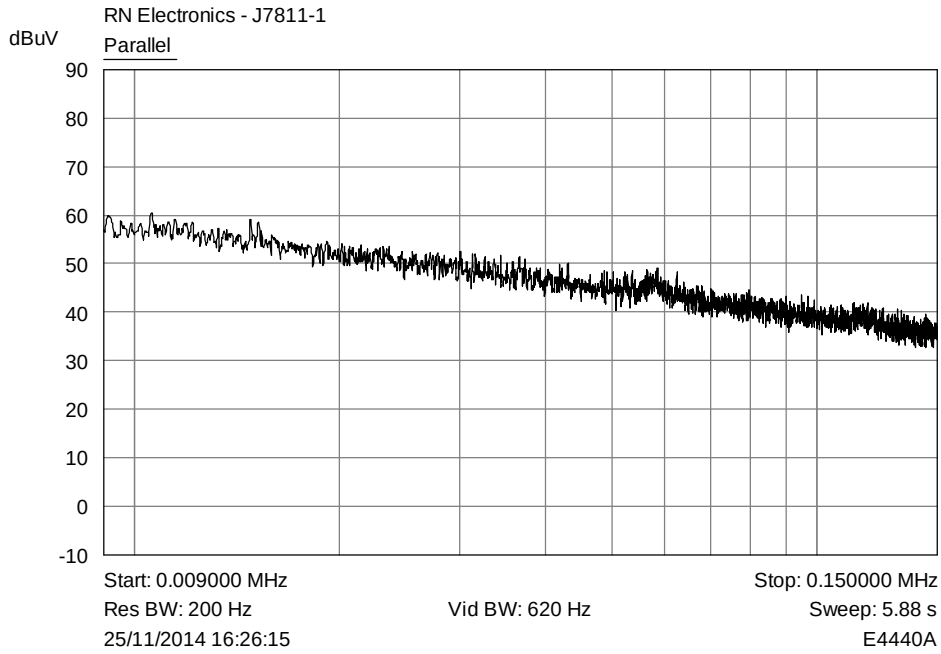


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	13.5634 MHz	1.63 dBuV	

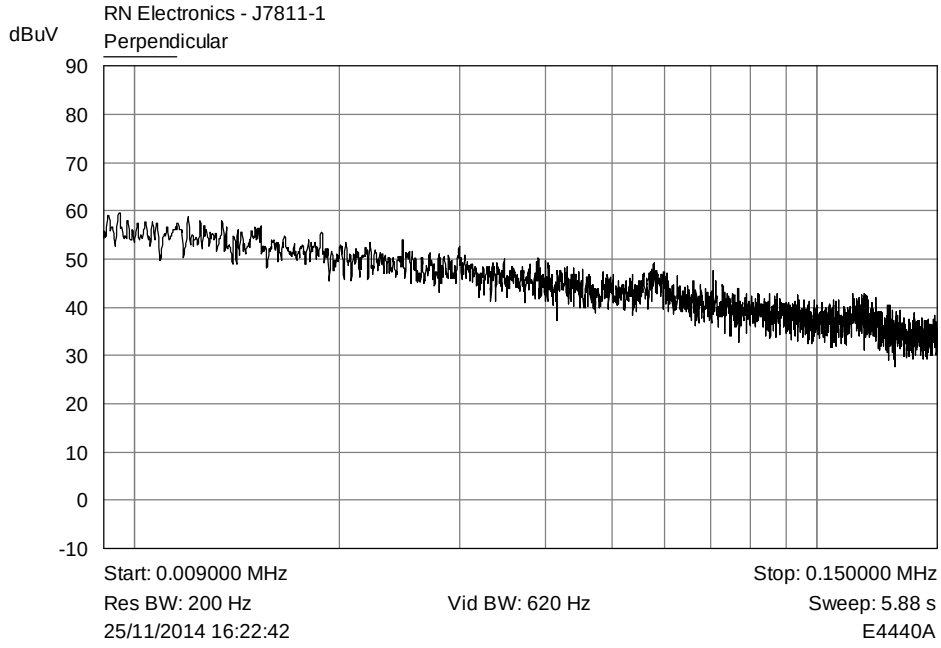
6.3 Radiated emissions plots

No discernible difference was noted in emissions between the “Single position tinned copper finger” modification & the “Dual position tin strip” modification. Therefore only one set of low frequency radiated emissions plots are shown within this report.

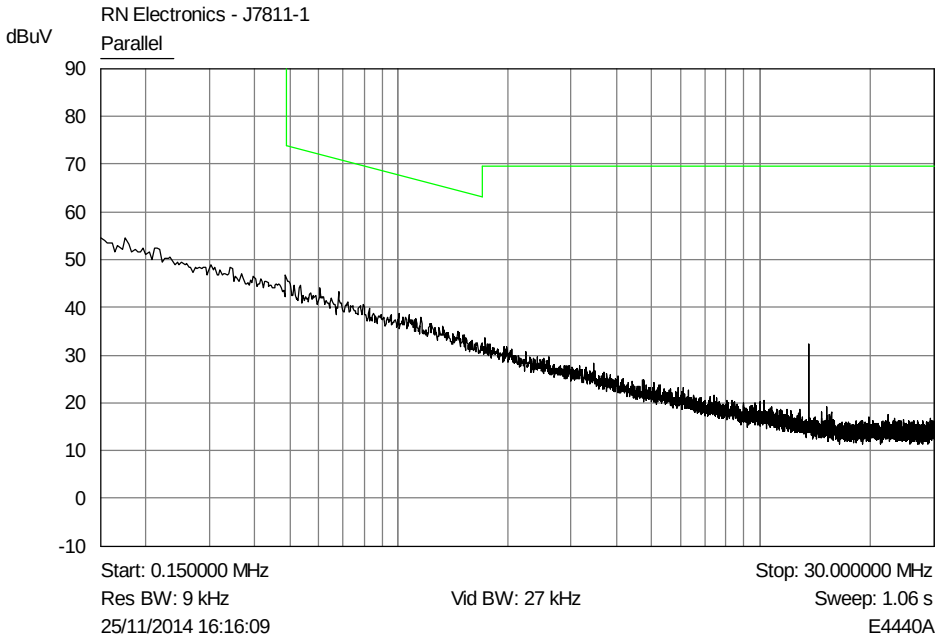
6.3.1 Low frequency radiated emissions plots



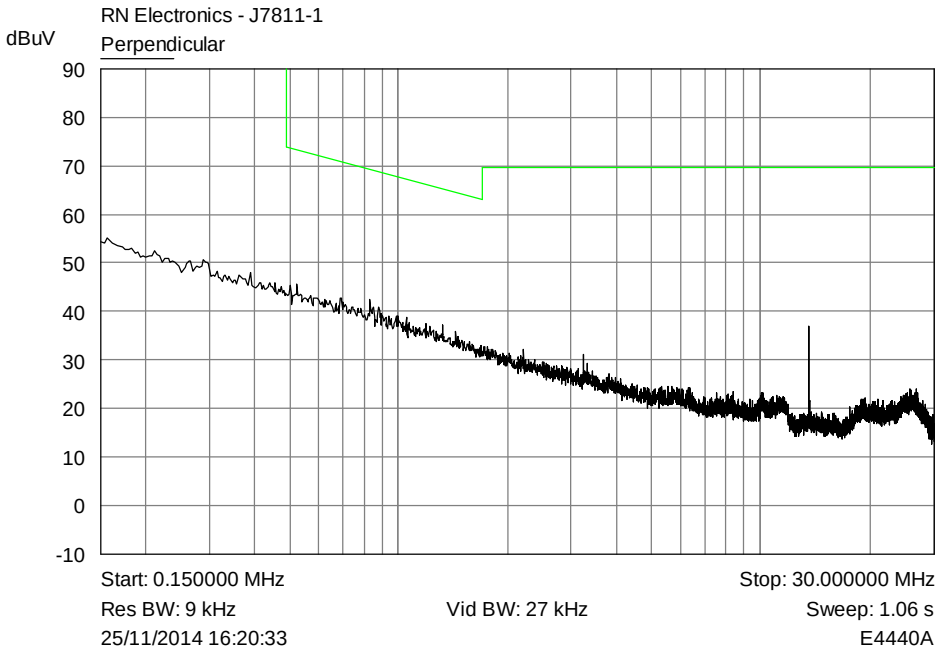
Single channel - Parallel Plot



Single channel - Perpendicular Plot



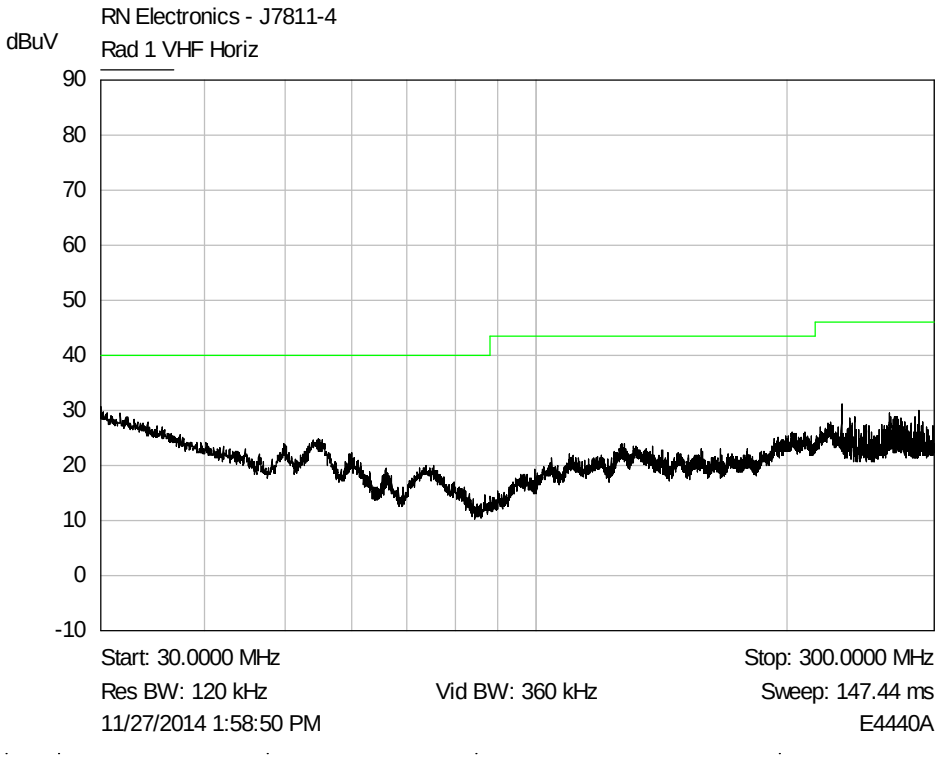
Single channel - Parallel Plot



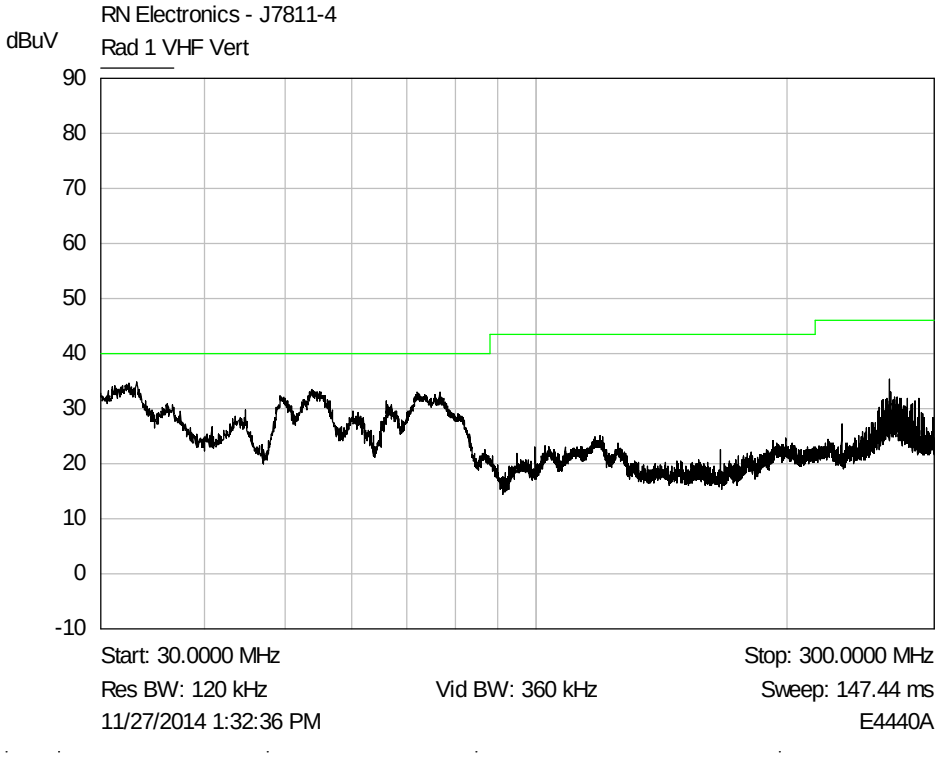
Single channel - Perpendicular Plot

6.3.2 Radiated emissions - 30MHz - 1GHz

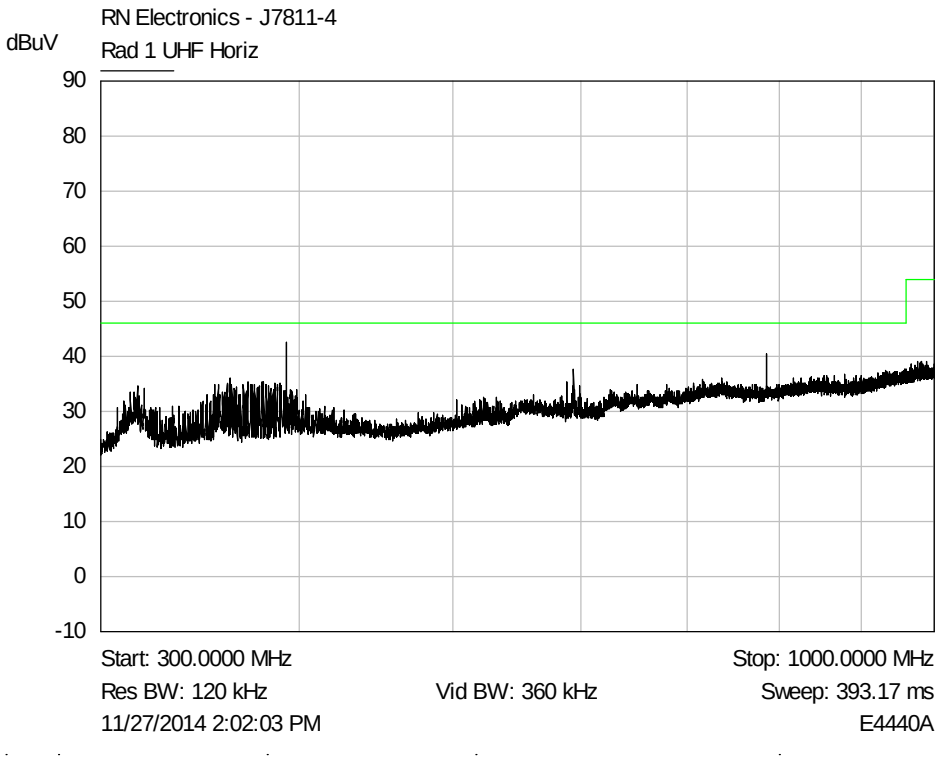
Dual position tin strip modification in place.



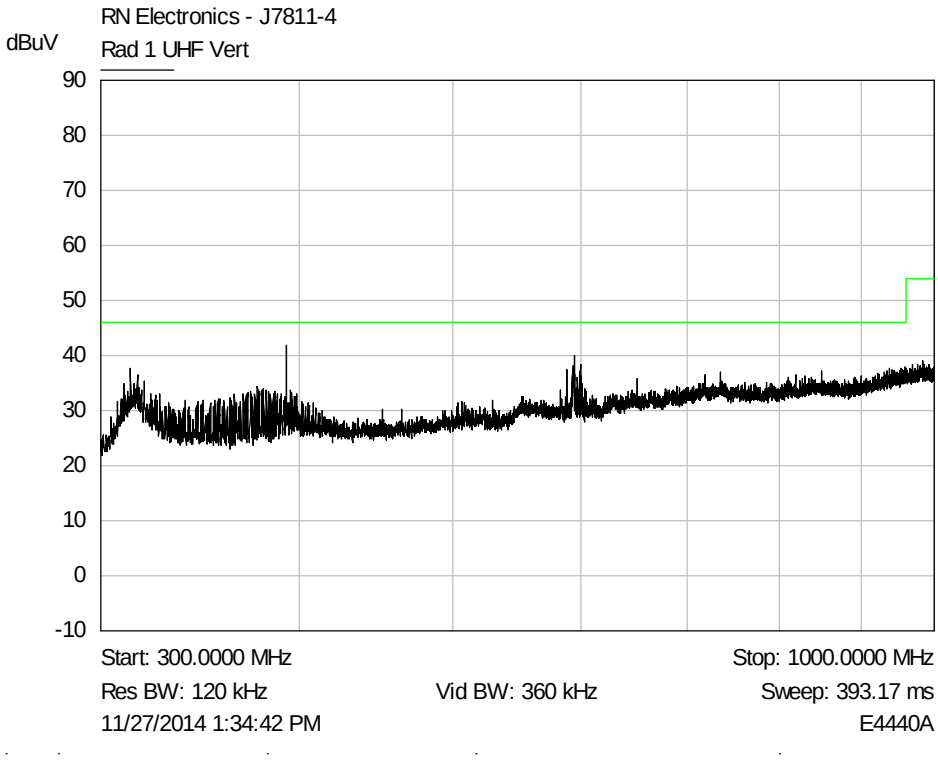
Plot of peak horizontal emissions 30MHz - 300MHz against the quasi-peak limit line.



Plot of peak vertical emissions 30MHz - 300MHz against the quasi-peak limit line.

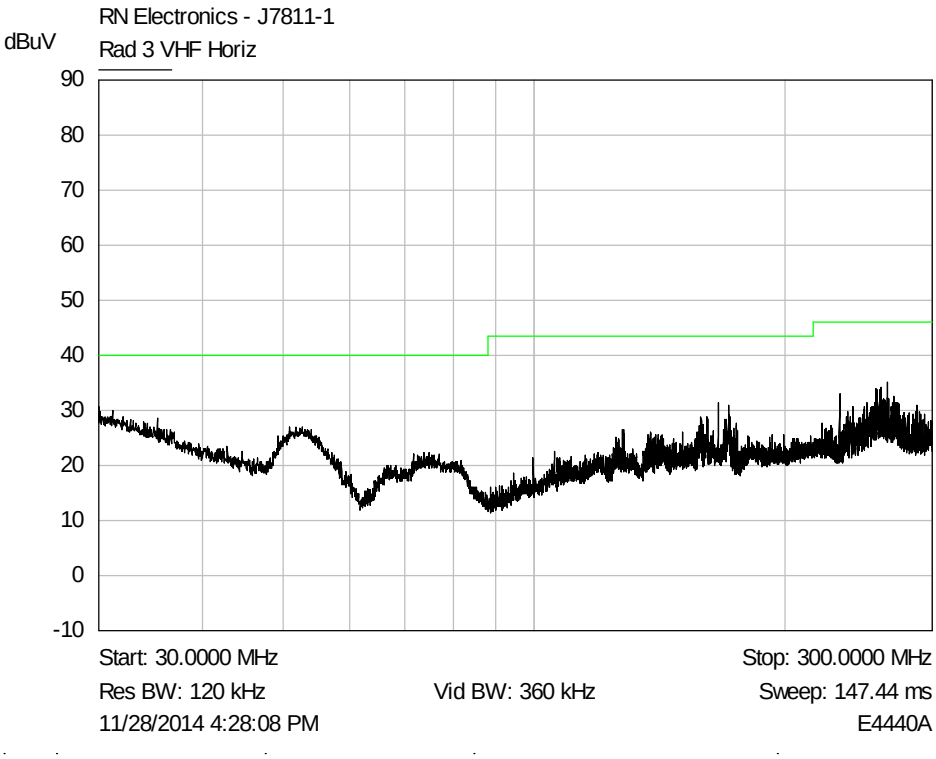


Plot of peak horizontal emissions 300MHz - 1GHz against the quasi-peak limit line.

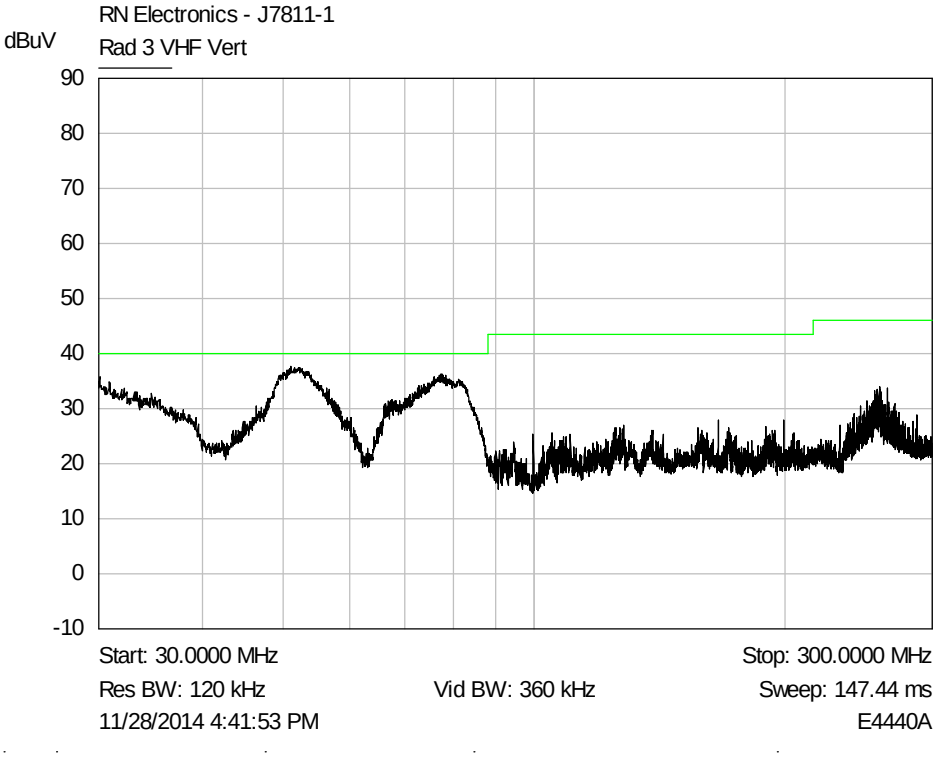


Plot of peak vertical emissions 300MHz - 1GHz against the quasi-peak limit line.

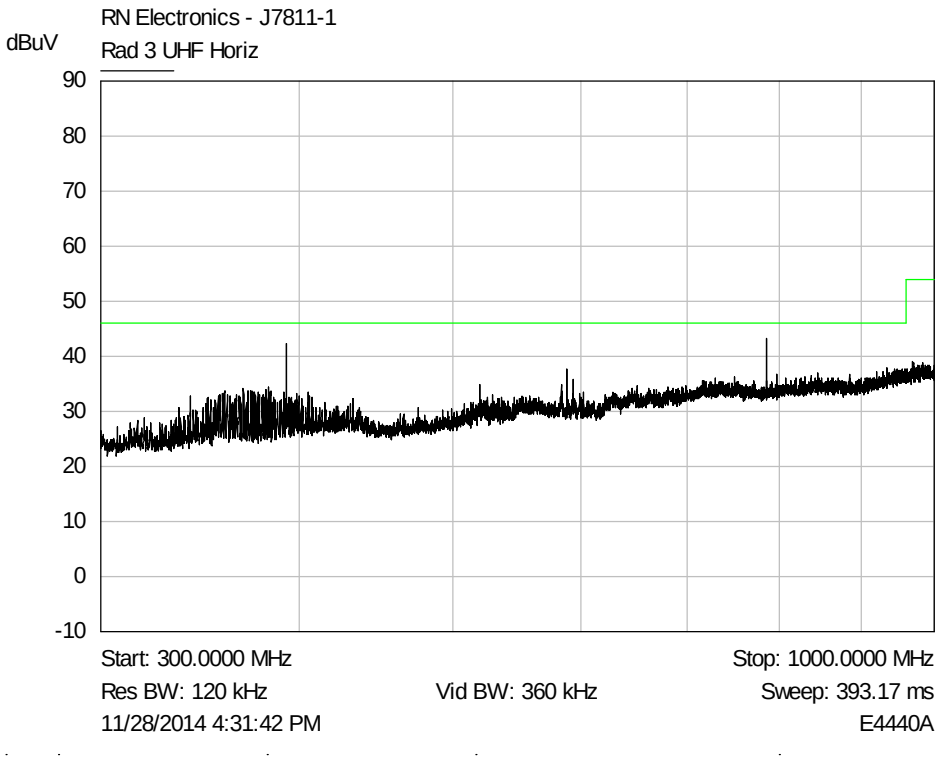
Single copper-tinned spring finger modification in place.



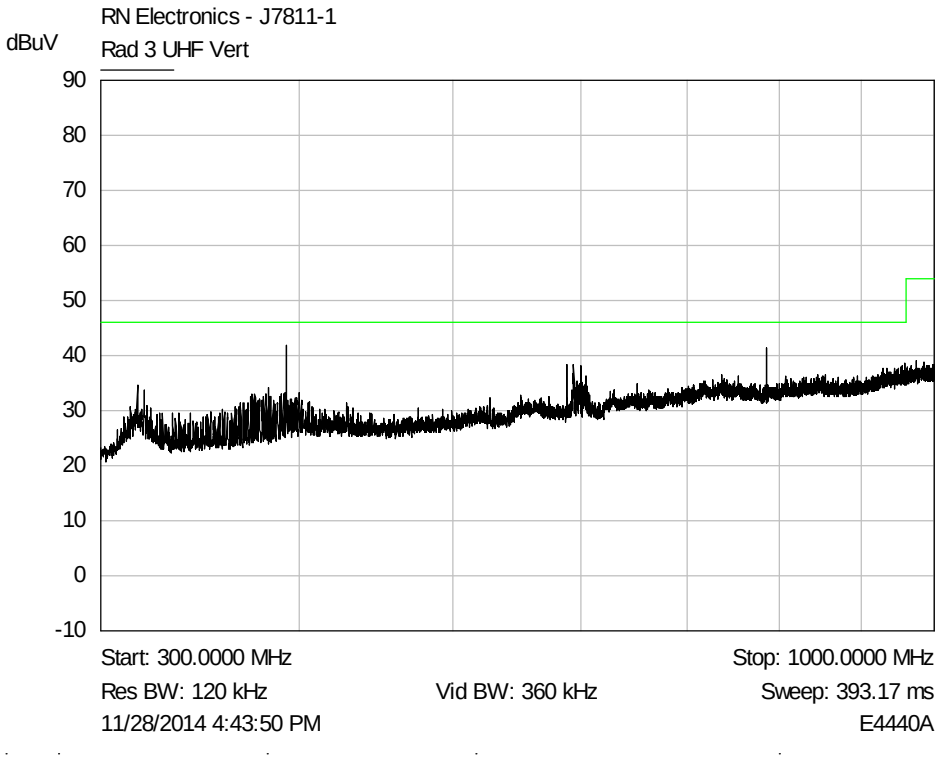
Plot of peak horizontal emissions 30MHz - 300MHz against the quasi-peak limit line.



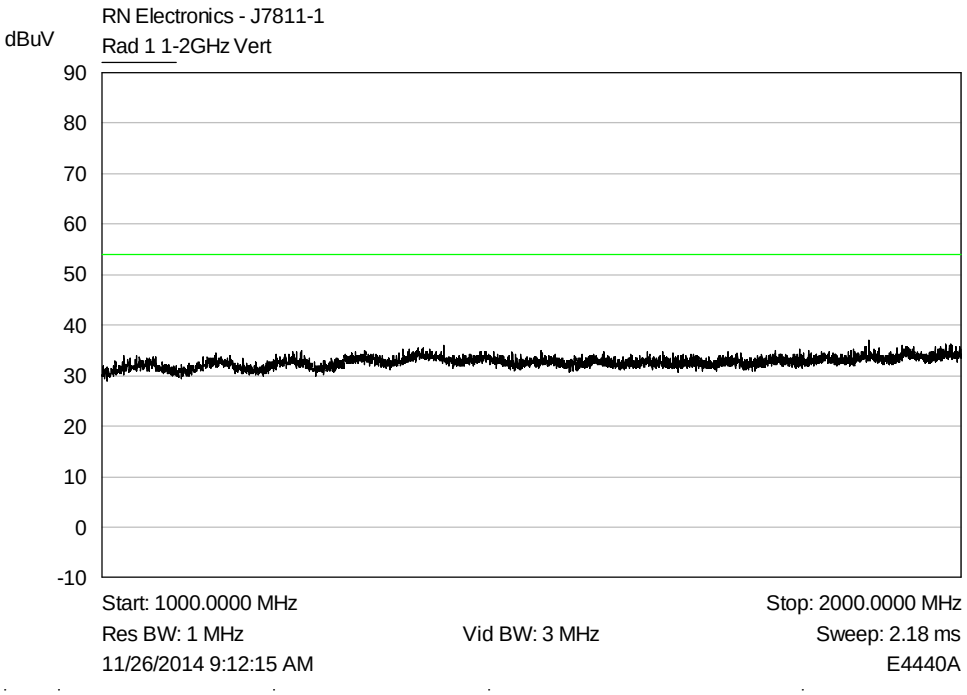
Plot of peak vertical emissions 30MHz - 300MHz against the quasi-peak limit line.



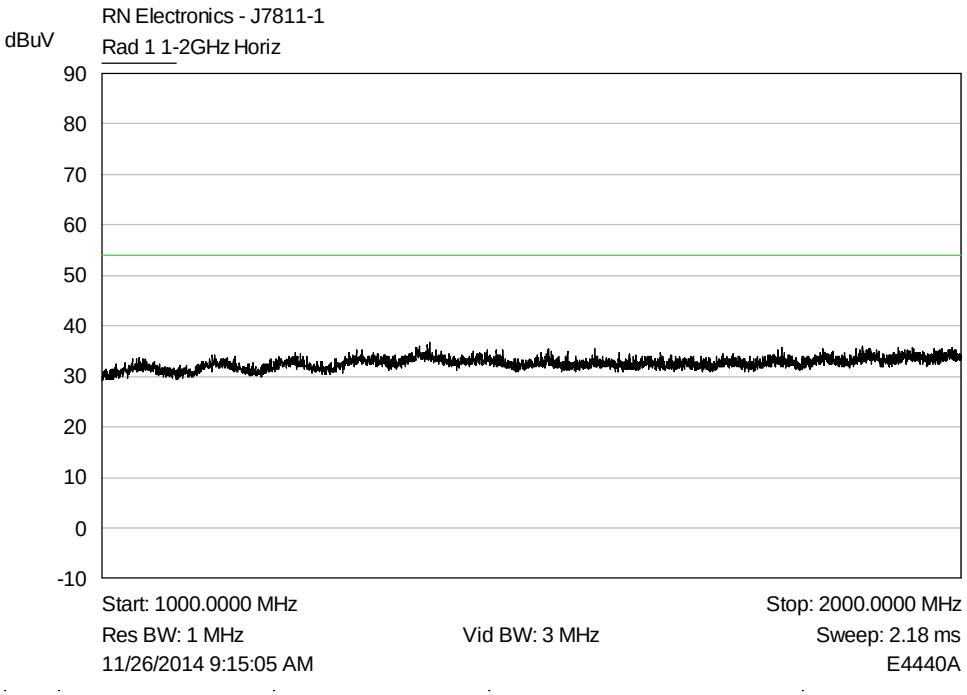
Plot of peak horizontal emissions 300MHz - 1GHz against the quasi-peak limit line.



Plot of peak vertical emissions 300MHz - 1GHz against the quasi-peak limit line.

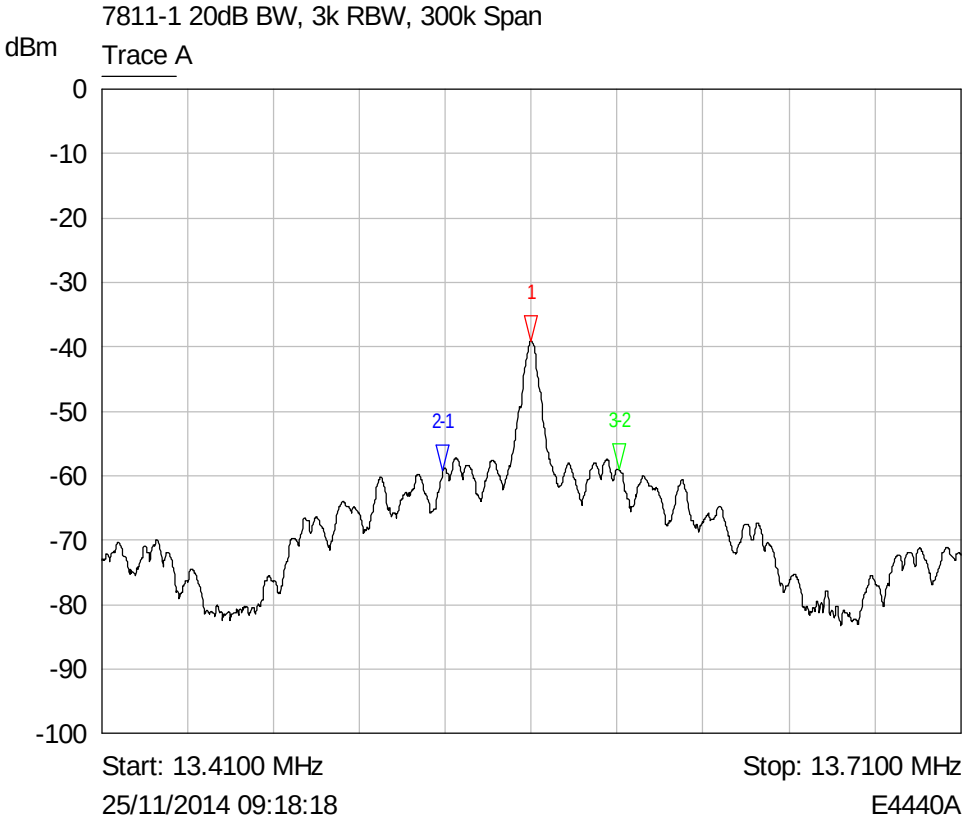


Plot of peak vertical emissions 1 - 2GHz against the average limit line.



Plot of peak horizontal emissions 1 - 2GHz against the average limit line.

6.4 Occupied bandwidth (20 dB) plots



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	13.5599 MHz	-39.13 dBm	
2-1	Trace A	-0.0306 MHz	-20.03 dB	
3-2	Trace A	0.0614 MHz	0.08 dB	

7 Explanatory Notes

7.1 Explanation of Table of Signals Measured

Measurements are made as required by the standard. These measurements are made and recorded using detectors, either peak, quasi peak or average dependant on the test. A table of results has been given following the relevant plots. This table looks similar to the one illustrated below dependant on the measurements required by the test: -

Signal No.	Freq (MHz)	Peak Amp (dBuV)	Pk – Lim 1 (dB)	QP Amp (dBuV)	QP - Lim1 (dB)	Av Amp (dBuV)	Av - Lim1 (dB)
1	12345	54.9	-10.5	48.0	-12.6	37.6	-14.4

Column One - Labelled Signal No. is an incremental number that the receiver has given to each signal that has been measured.

Column Two - Labelled Freq (MHz) is the approximate frequency of the signal received.

Column Three - Labelled Peak Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the peak detector.

Column Four - Labelled Pk - Lim1 (dB) is the difference in level from the peak signal given to the active limit line. If this column appears in the table the peak detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Column Five - Labelled QP Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the quasi-peak detector.

Column Six - Labelled QP - Lim1 (dB) is the difference in level from the quasi-peak signal given to the active limit line. If this column appears in the table the quasi-peak detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Column Seven - Labelled Av Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the average detector.

Column Eight - Labelled Av - Lim1 (dB) is the difference in level from the average signal given to the active limit line. If this column appears in the table the average detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Only signals highlighted in red are deemed to exceed the limit of the detector required.

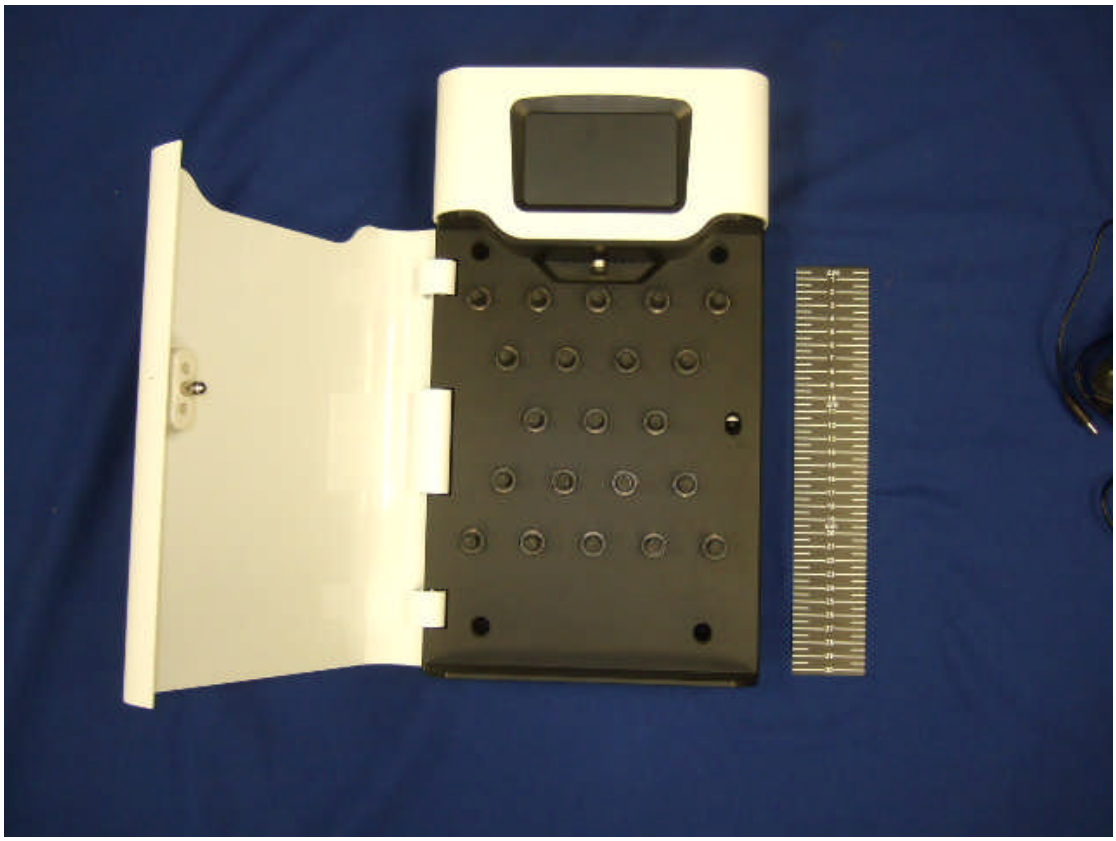
7.2 Explanation of limit line calculations for radiated measurements

The limits given in the test standard are normally expressed as absolute values (e.g. in μV/m at a specified distance), whereas the measured values are expressed as peak, quasi peak or average values in dBμV/m referenced to the measuring instrument inputs. RN Electronics calibrate the test set-up to account for any path losses, antenna gains, etc. so that the value read at the receiver relates directly to the absolute value required, except that it is expressed in dB relative to one microVolt and may need to take account of any alternative measuring distance used. Examples:

(a) limit of 500 μV/m equates to 20.log (500) = 54 dB μV/m.
(b) limit of 300 μV/m at 10m equates to 20.log (300 . 10/3) = 60 dB μV/m at 3m
(c) limit of 30 μV/m at 30m, but below 30MHz, equates to 20.log(30) + 40.log(30/3) = 69.5 dBμV/m at 3m, as extrapolation factor below 30MHz is 40dB/decade per 15.31(f)(2).

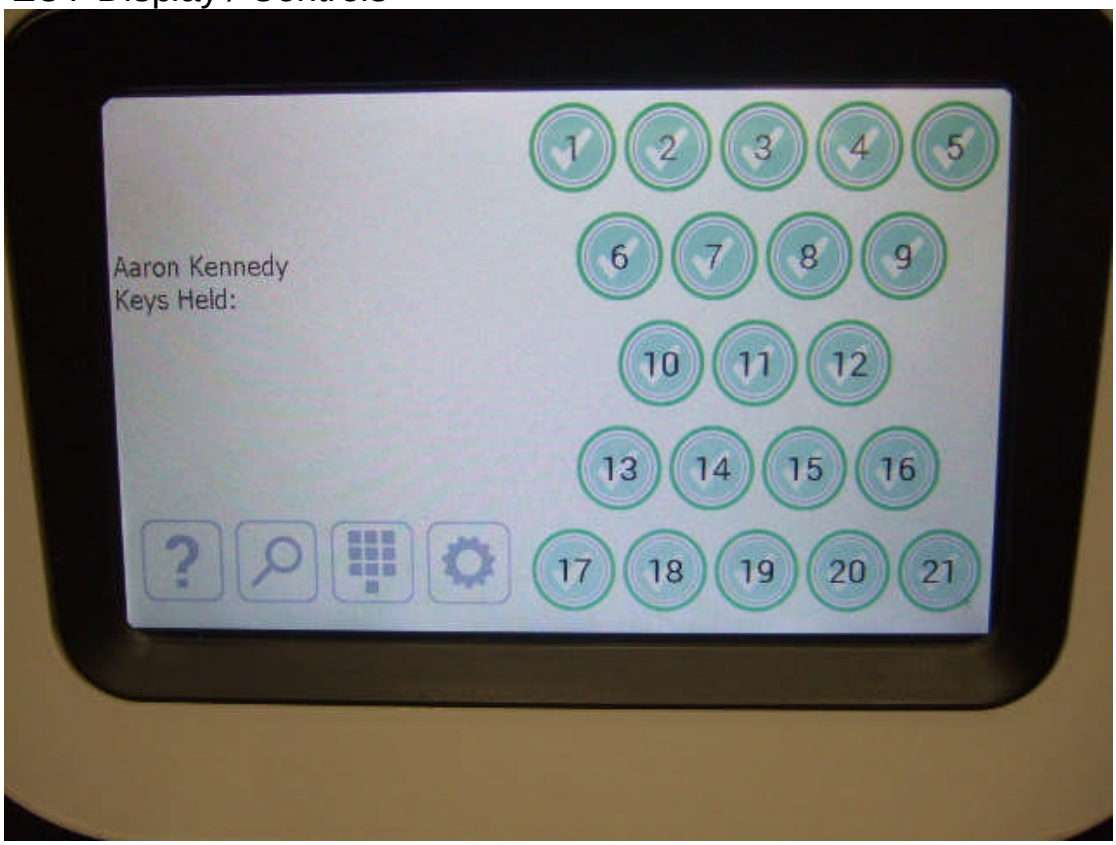
8 Photographs

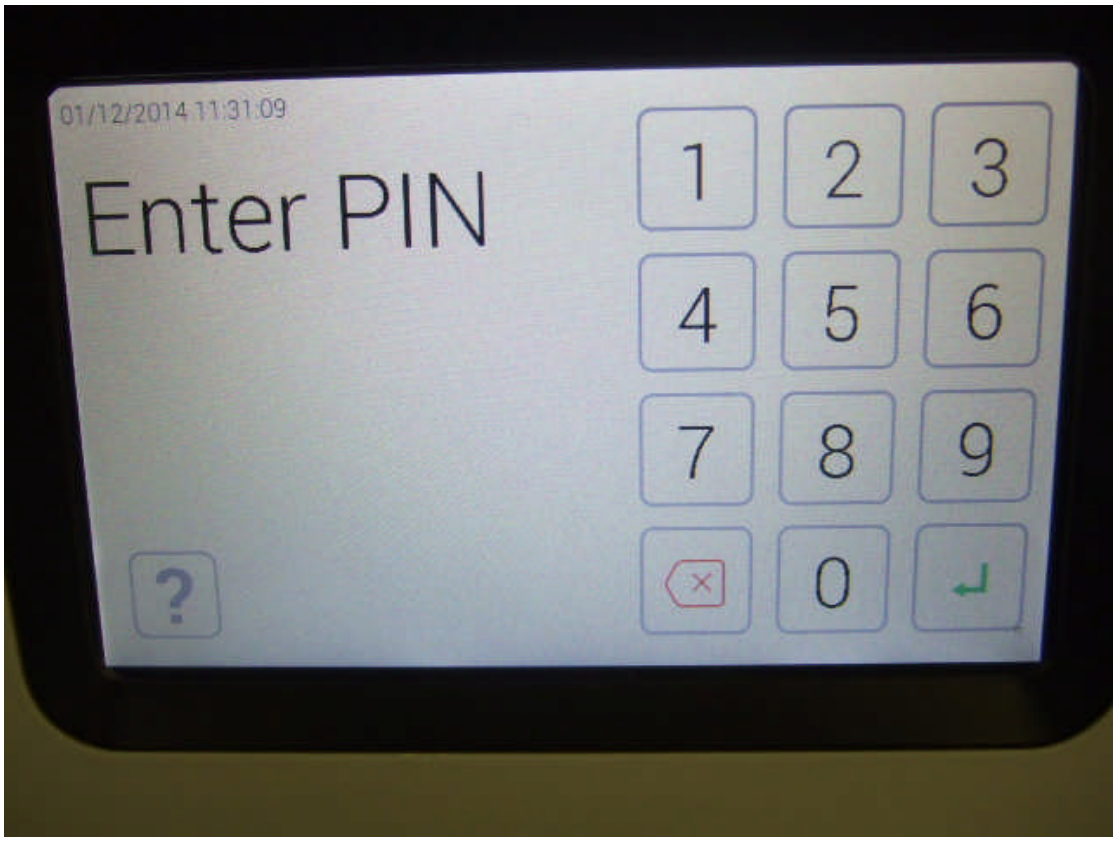
8.1 EUT Front View



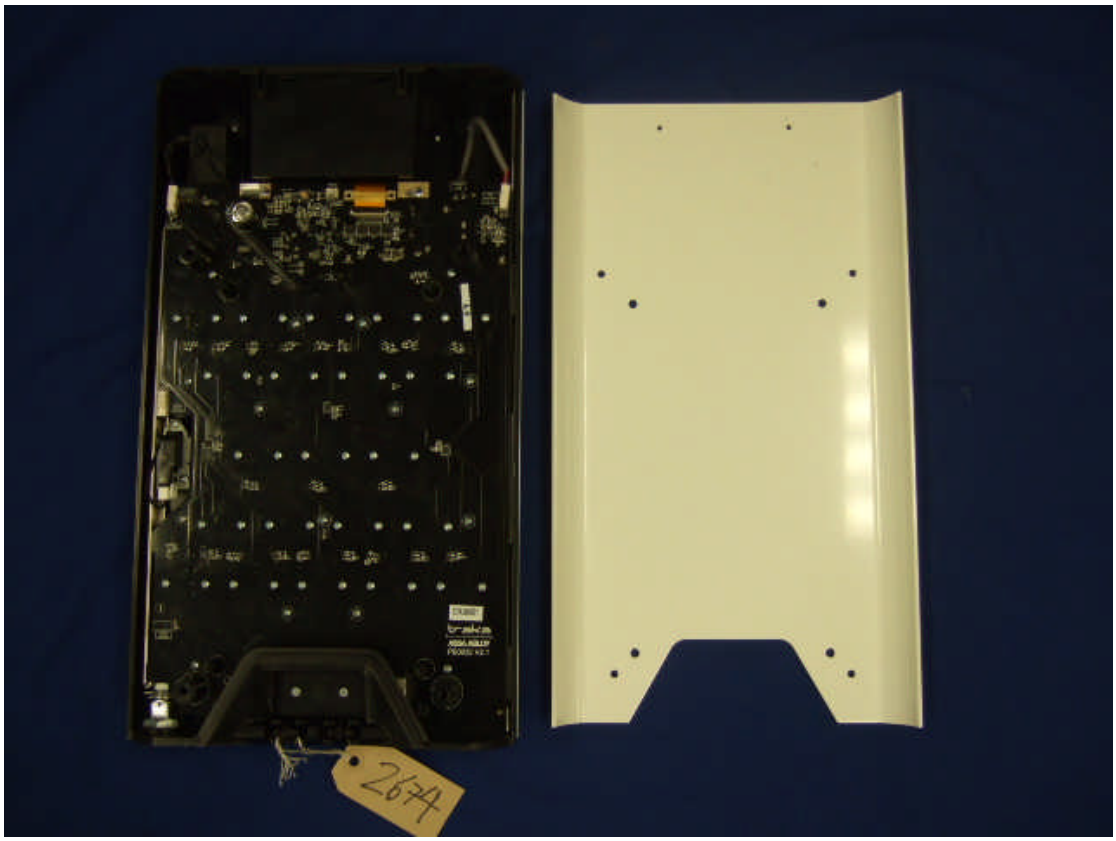
8.2 EUT Reverse Angle

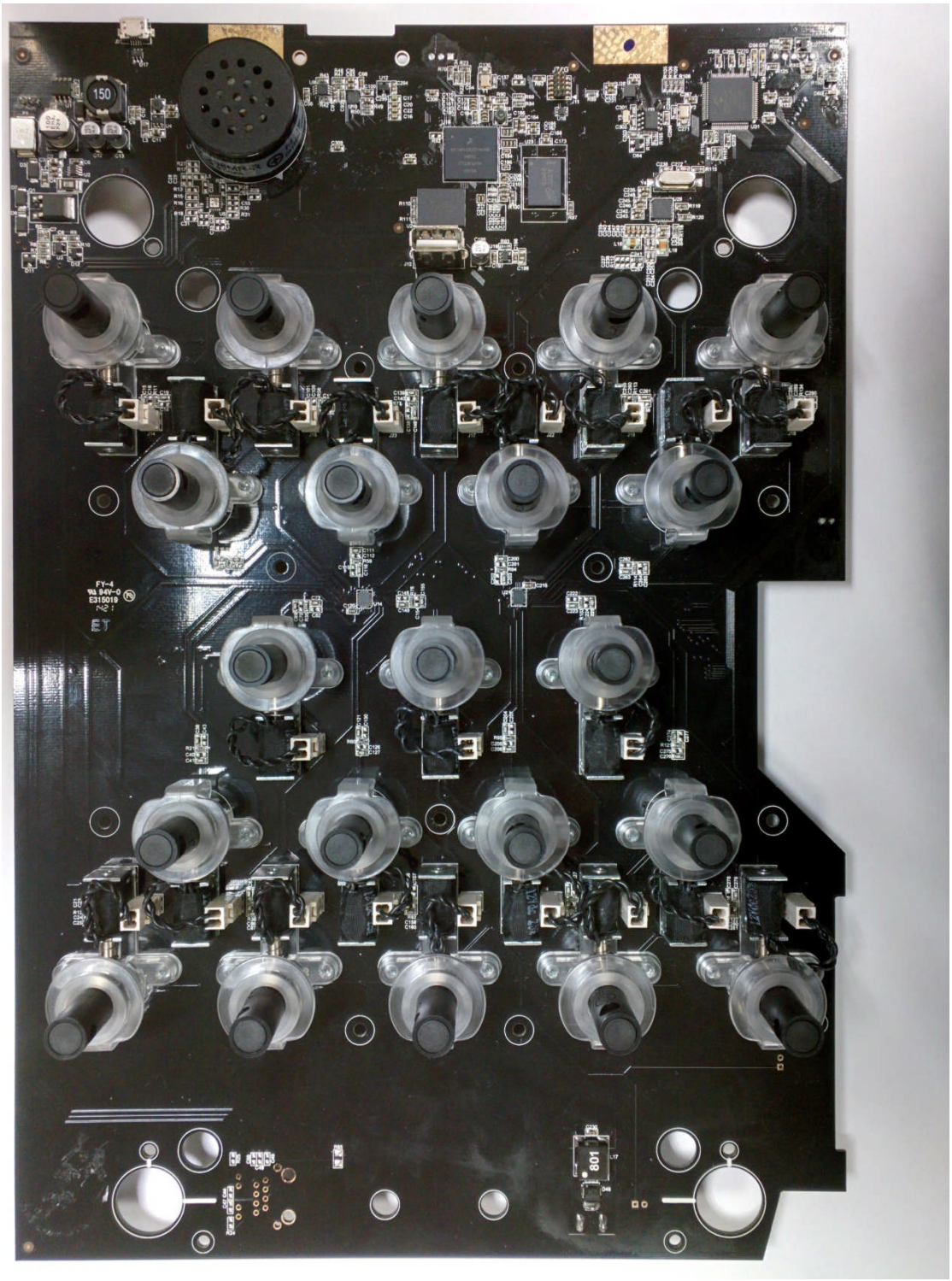
8.3 EUT Display / Controls

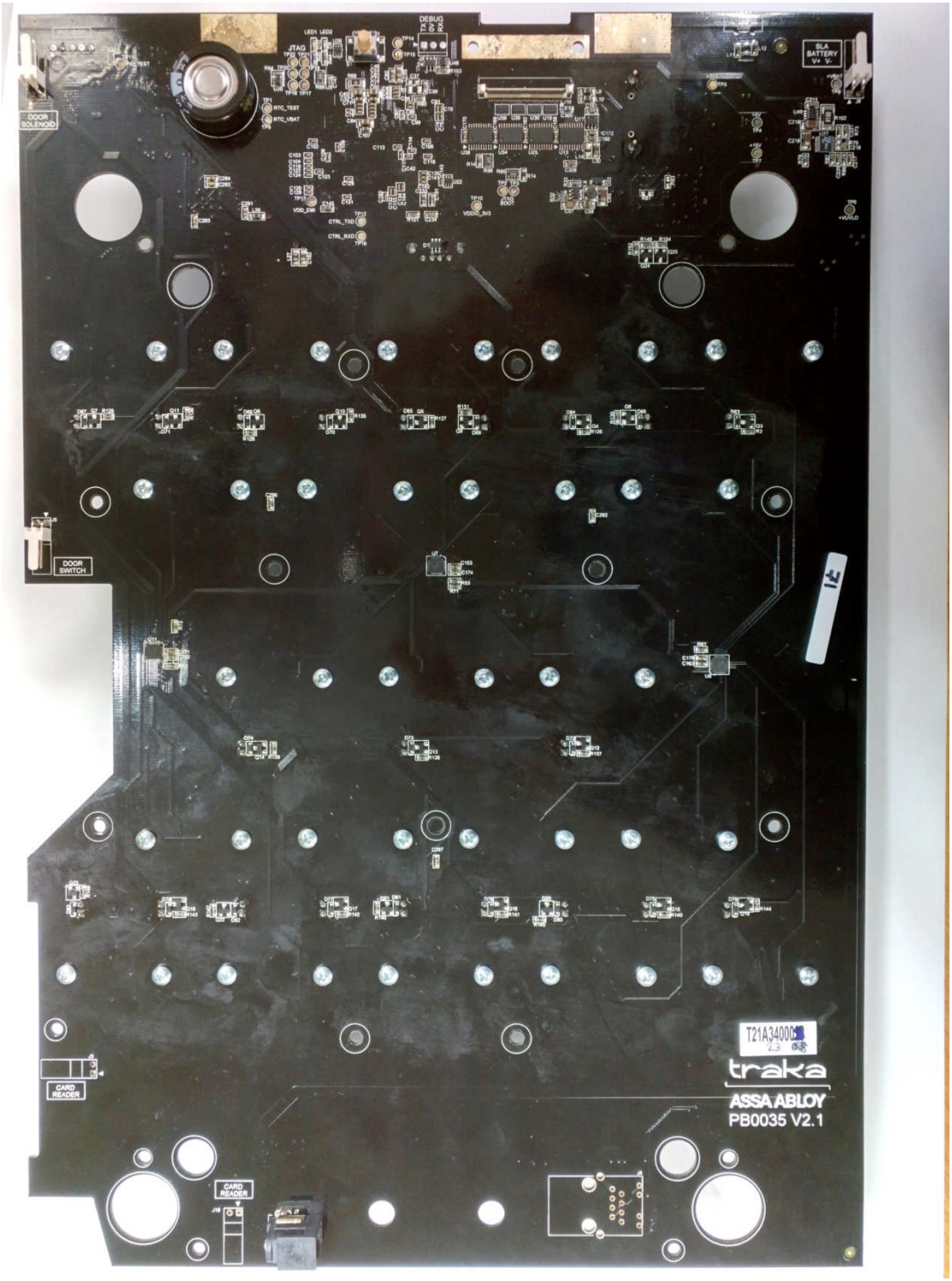


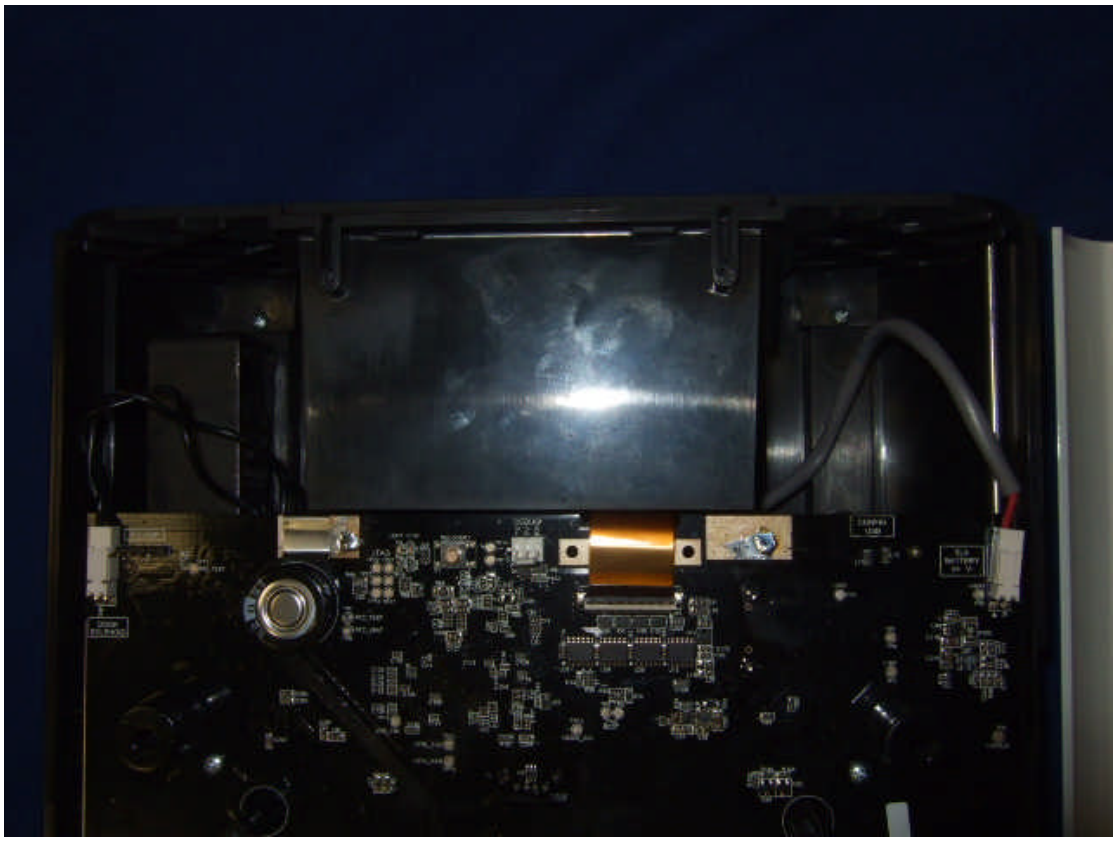

01/12/2014 11:31:09
Enter PIN
1
2
3
4
5
6
7
8
9
?
0

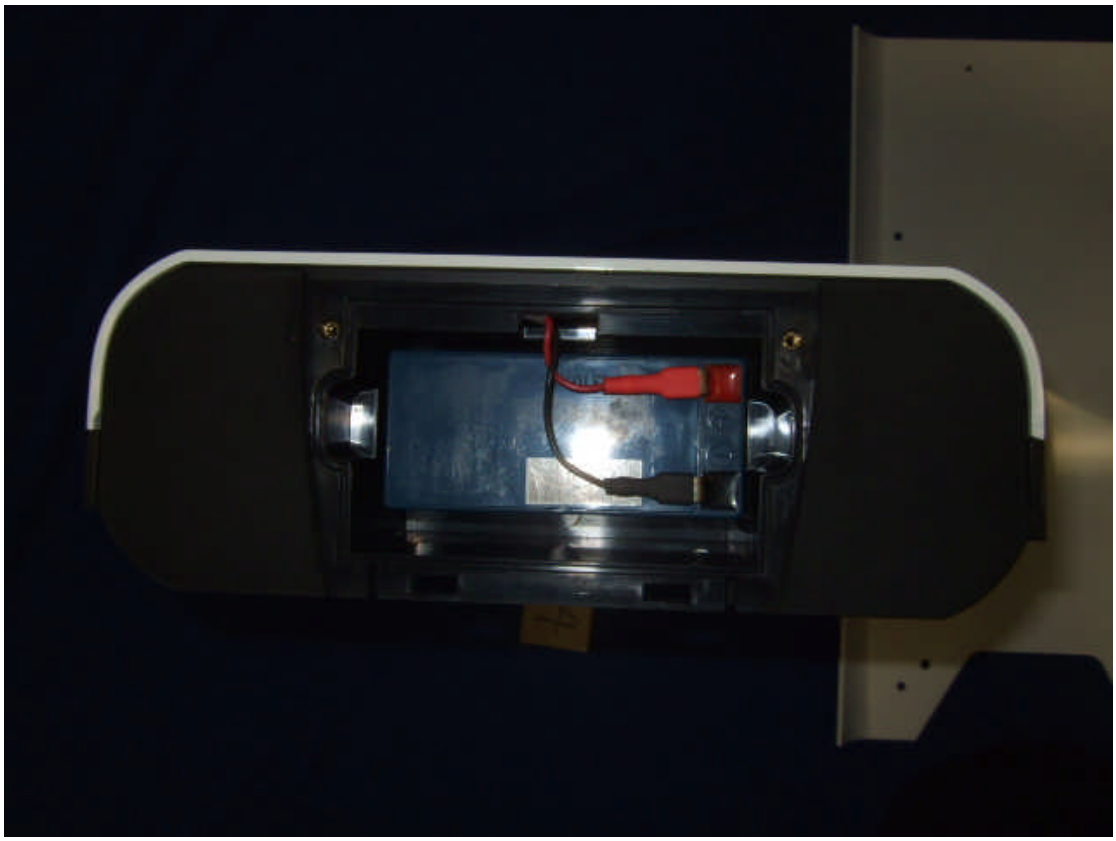
8.4 EUT Internal Construction





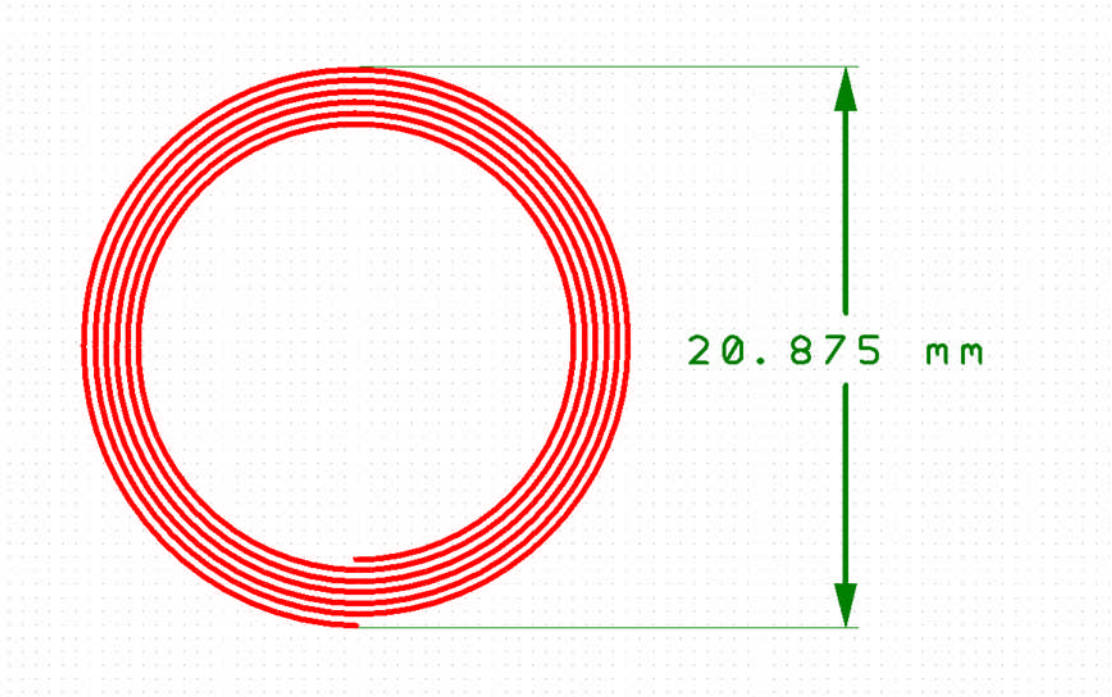

DOOR SOLENOID
DOOR SWITCH
CARD READER
CARD READER
traka
ASSA ABLOY
PB0035 V2.1



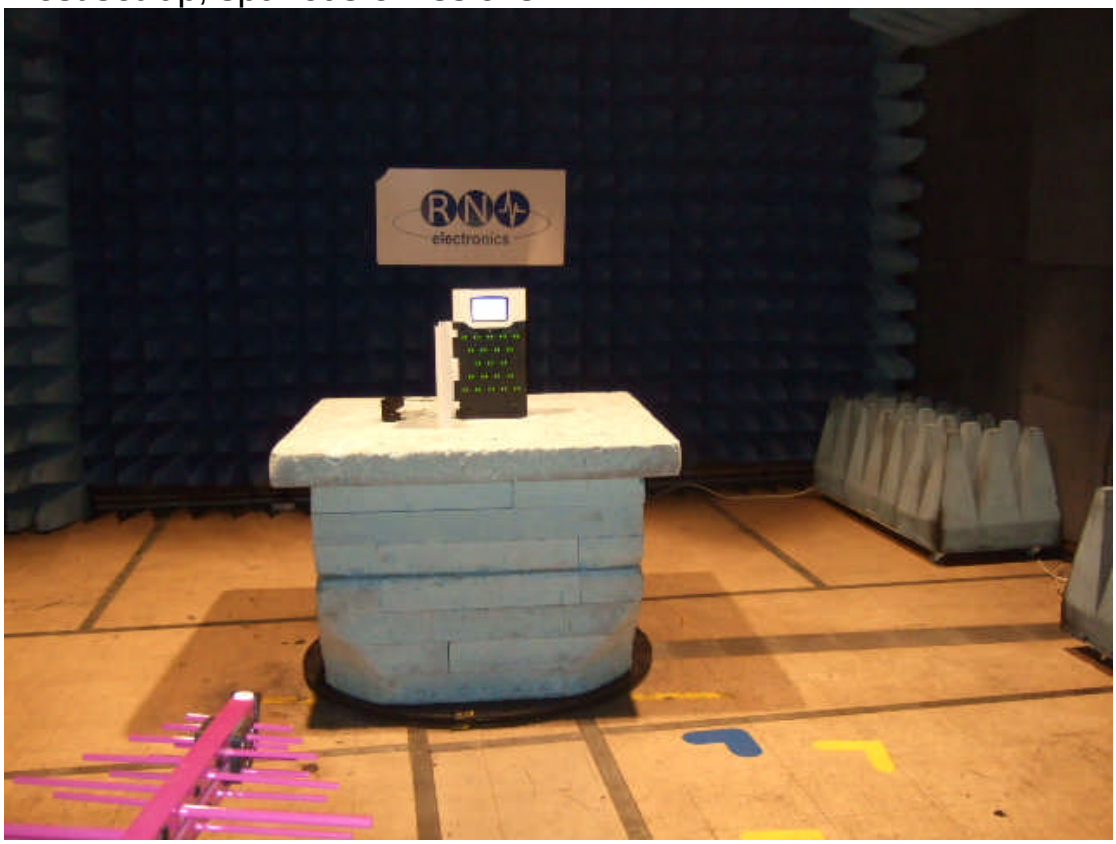


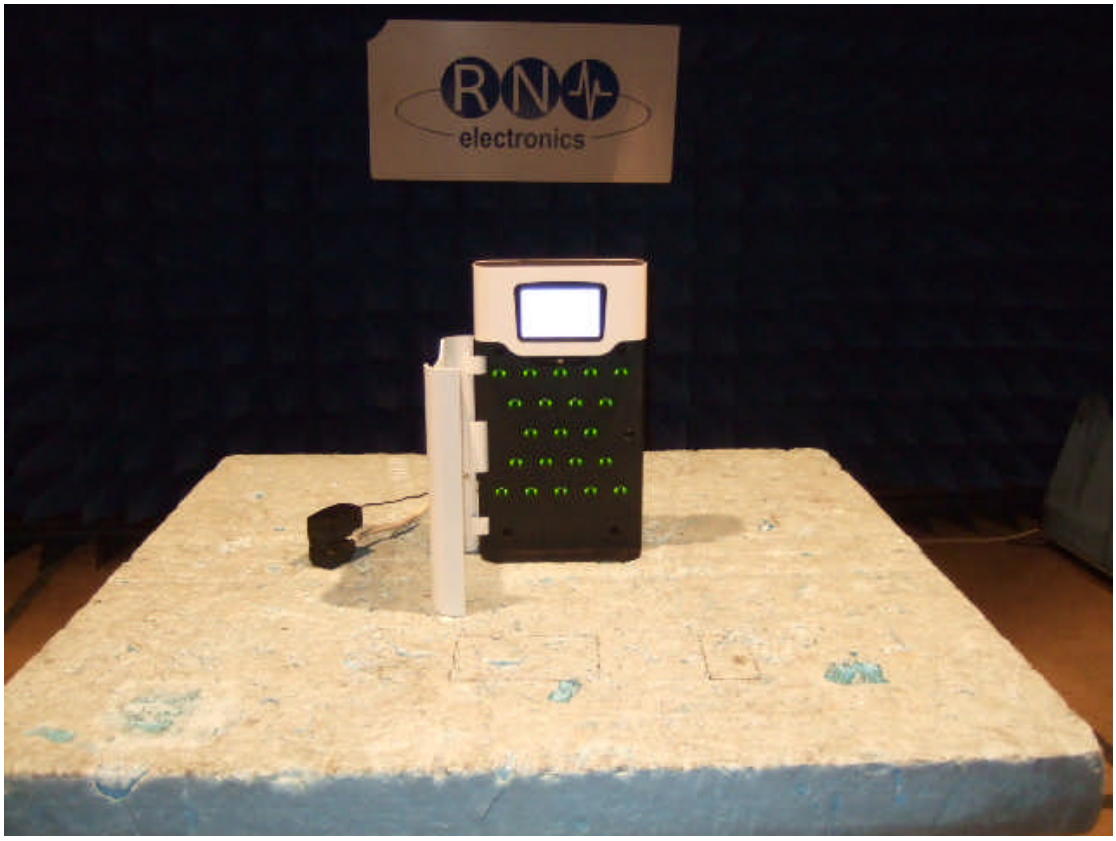
8.5 Antenna coils

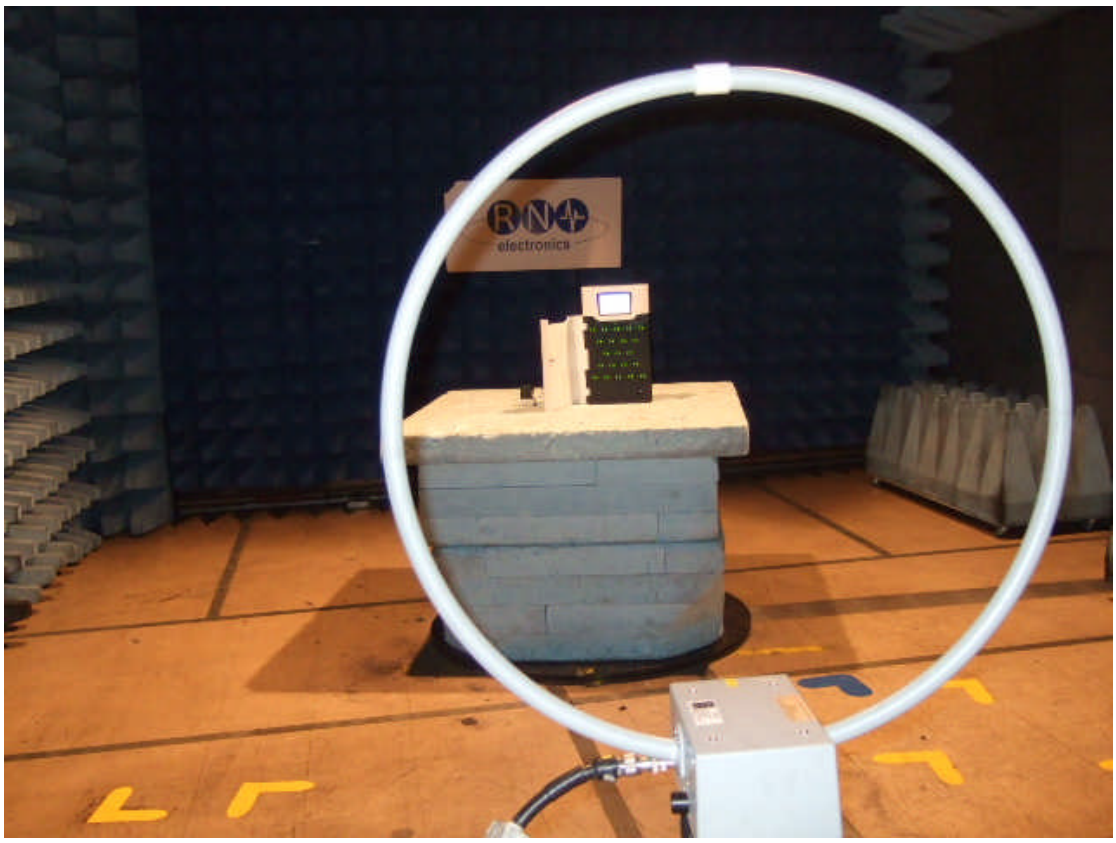
Antenna Coils are located on an internal layer of the main PCB, A Coil dimension diagram has been included for reference.

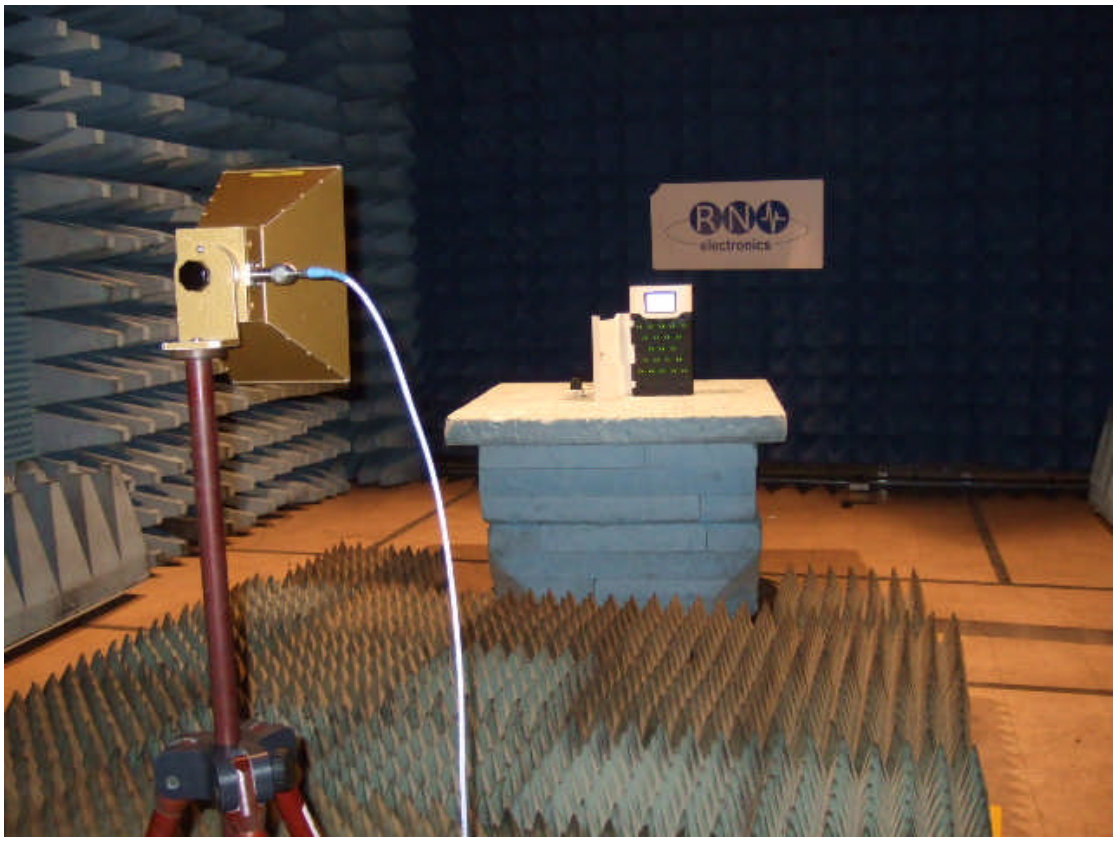


8.6 Test set-up, spurious emissions






RN
electronics


RN
electronics

8.7 Test set-up, AC power line conducted emissions

8.8 Test set-up diagrams

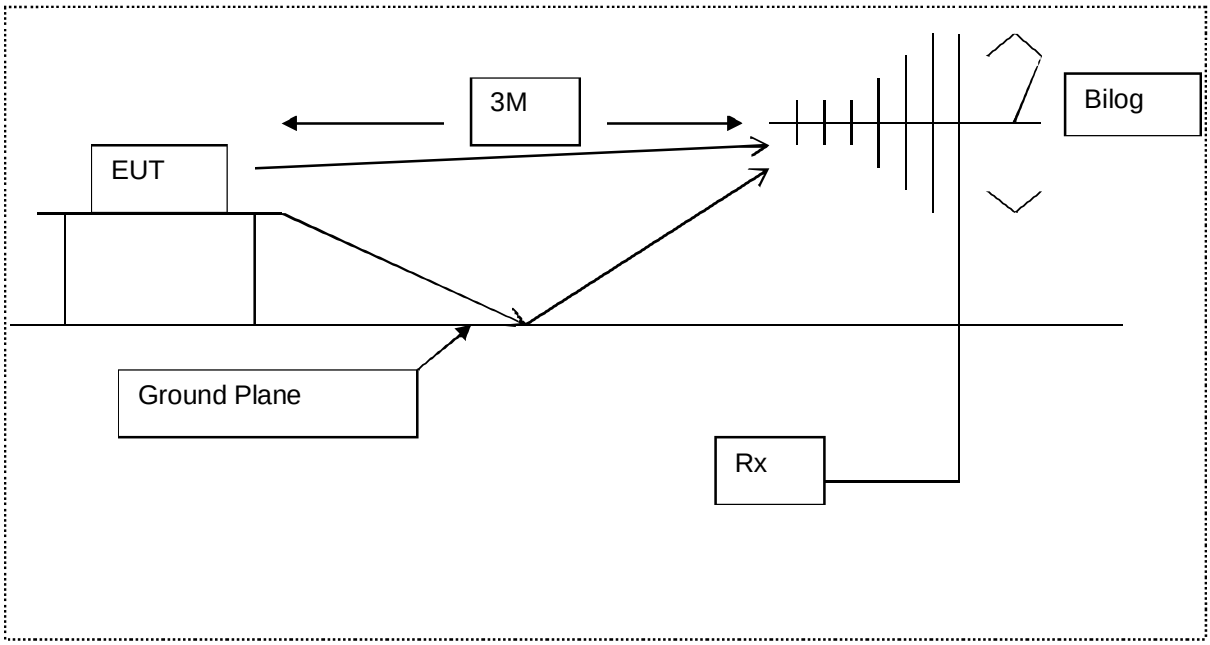


Diagram of the radiated emissions test setup.

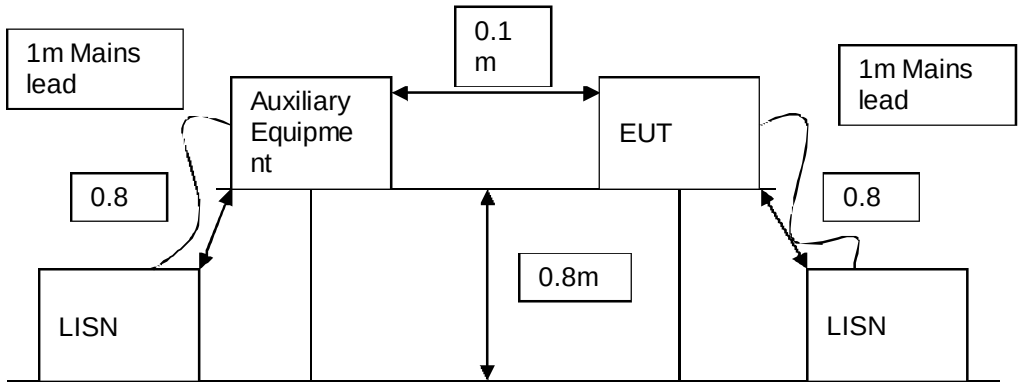


Diagram of the AC power line conducted emissions test setup.

9 Signal Leads

Port Name	Cable Type	Connected
DC Power	Twin insulated DC 2.1mm jack socket	Yes
AC/DC adapter	AC plug to DC twin cable 2.1mm plug	Yes

10 Test Equipment Calibration list

The following table lists the test equipment used, last calibration date and calibration interval. All test equipment used has been maintained within the calibration requirements of ***R.N. Electronics Ltd.*** test facility quality system. Calibration intervals are regularly reviewed dependent on equipment manufacturer's recommendations and actual usage of the equipment.

RN No.	Model	Description	Manufacturer	Calibration date	Cal period
E227	6632A	System DC Power Supply	Hewlett Packard	20-Feb-14	12 months
E268	BHA 9118	1-18 GHz Horn Antenna	Schaffner	29-Apr-14	24 months
E324	BARO	Barometer	TFA	*26-Nov-14	6 months
E342	8563E	Spectrum Analyser 26.5 GHz	HP	28-May-13	24 months
E410	N5181A	3 GHz MXG Signal Generator	Agilent Technologies	28-Oct-14	36 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	21-Jan-14	12 months
E412	E4440A	3 Hz - 26.5 GHz PSA	Agilent Technologies	21-Jan-14	24 months
E434	G3RUH	10 MHz GPS Oscillator	James Miller	N/A	N/A
E541	-	Magnetic Loop test fixture	RN Electronics Ltd	N/A	N/A
E570	K050120400F	3 Phase Power Supply	Harmer & Simmons	N/A	N/A
L264	DT75	Digital Thermometer	Instrotech Ltd	06-Dec-13	24 months
TMS10	TH200	ThermoHygrometer	RS Components	15-Sep-14	24 months
TMS38	VMT04/140	Environmental Oven	Heraeus Votsch	N/A	N/A
TMS57	2534	Digital Multimeter	Philips	24-Jan-13	24 months
TMS80	206-3722	Digital Thermometer & K Probe	RS Components Ltd	07-Nov-15	12 months
TMS81	6502	Active Loop Antenna	EMCO	*10-Dec-14	24 months
TMS82	8449B	Pre Amplifier 1 - 26 GHz	Agilent	*10-Dec-14	12 months
TMS933	CBL6141A	Bilog Antenna 30MHz - 2GHz	York EMC	29-Sep-14	24 months

*Equipment was in calibration and has been calibrated during or since date of tests.

11 Auxiliary equipment

11.1 Customer supplied Equipment

Auxiliary equipment used for the purpose of test supplied by the above has been listed below

No customer supplied equipment was used

11.2 Supplied by RN Electronics Limited

Auxiliary equipment used for the purpose of test supplied by the above has been listed below

Item No.	Model No.	Description	Manufacturer	Serial No.
1	13.56MHz	Loop test fixture	RN Electronics Ltd	E541

12 Modifications

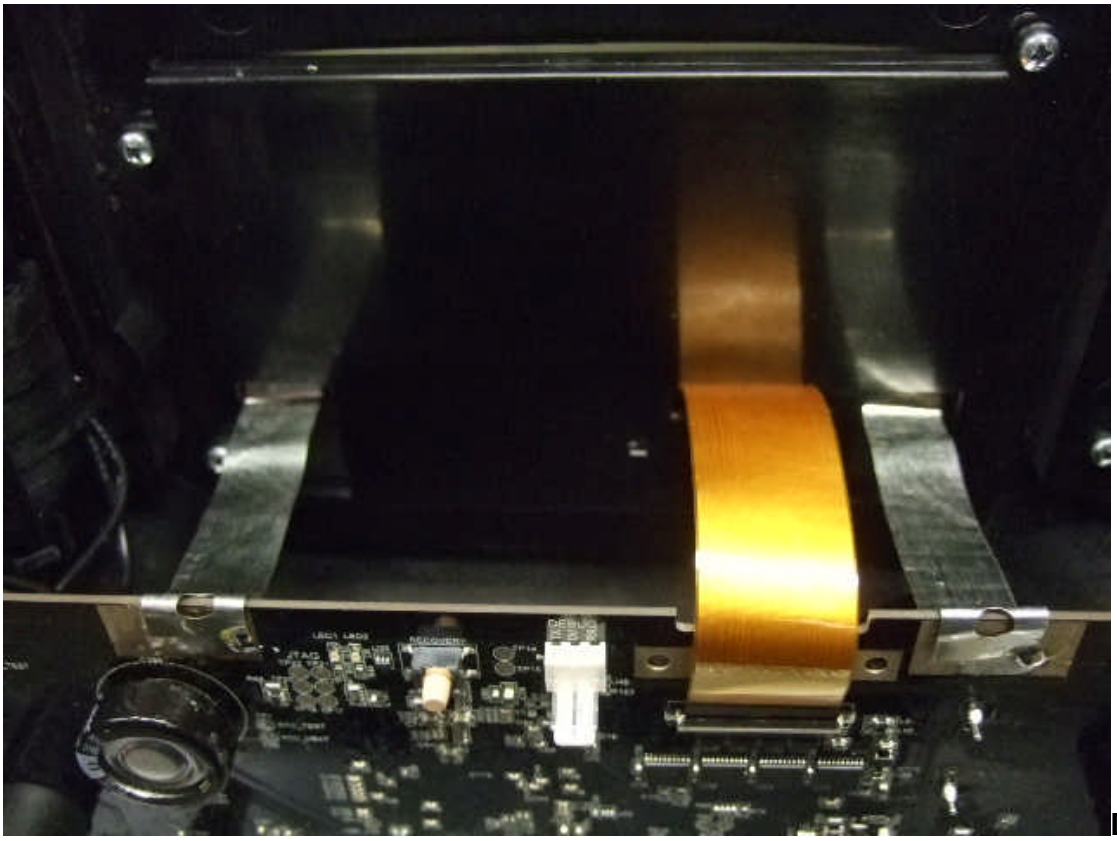
In order for the EUT to produce the results shown within this report the following modifications, if any, were implemented.

12.1 Table of modifications

Test	Modification	Time of modification
TX Rad Em	Ethernet port disabled in software as no longer used with the product	Before testing
TX Rad Em	Dual position Folded tin strip across back of display and soldered back to main pcb. Ground in two places	Before testing
TX Rad Em	Single position spring copper-tinned finger to left hand side back of display and clipped back to main pcb. Ground in one place	Before testing

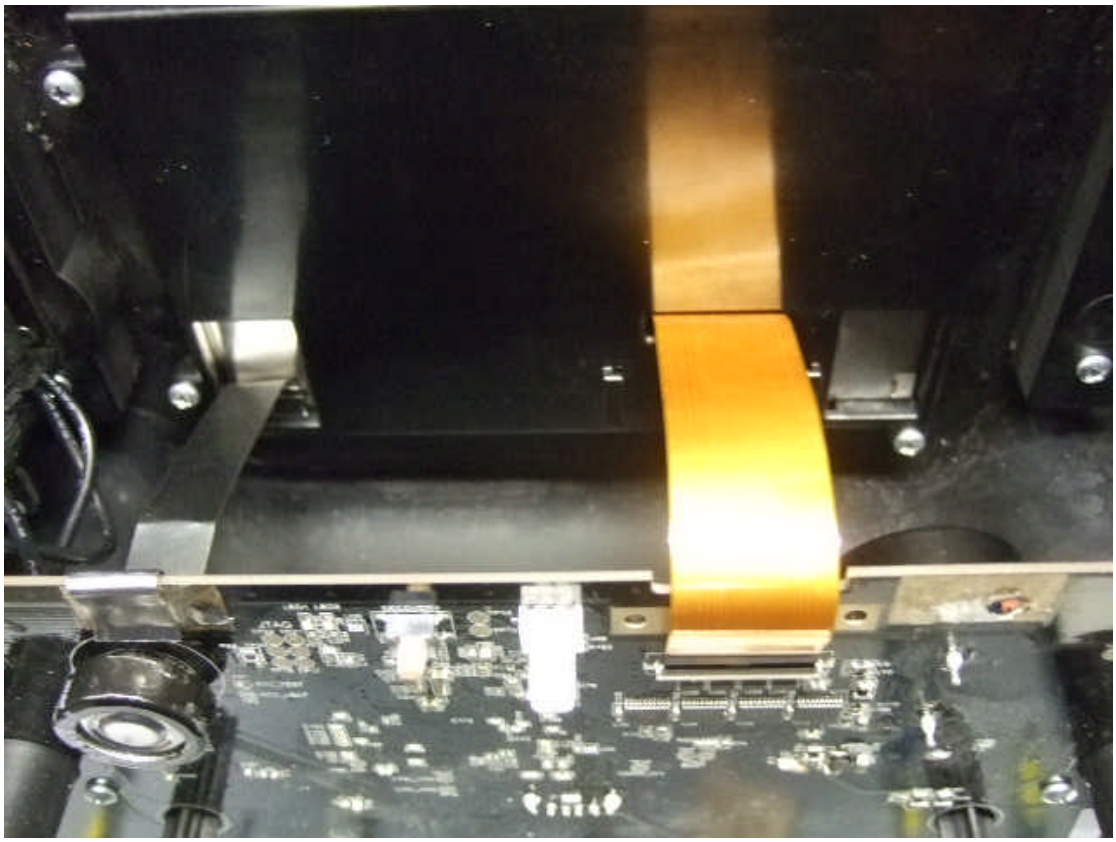
12.2 Modification photos

MOD 2



Dual position Folded tin strip across back of display and soldered back to main pcb. Ground in two places

MOD 3



Single position spring copper-tinned finger to left hand side back of display and clipped back to main pcb. Ground in one place

12.3 Modifications before test

The modifications below and referenced in the above table were performed before tests commenced.

1) Ethernet Hardware disabled in the software as it is no longer used within the product.

2) A Dual position Folded tin strip was fitted across back of display shield and sandwiched in via the plastic housing of the display. The two strips were then fed back to the main board, folded over the edge of the pcb, and spot soldered to the provided ground pads. See photo MOD2 above. A complete set of emissions testing was then performed with this modification in place. Please see test results referencing the “Dual position tin strip” modification within this report.

3) A Single position tinned copper spring finger was clipped onto the ground point on the right hand side of the main pcb, and then pressed down into position against the back of the display to make contact with the display shielding. See photo MOD3 above. A complete set of emissions testing was then performed with this modification in place. Please see test results referencing the “Single position finger” modification within this report.

Modification 1 above was in place for both of the sets of testing pertaining to Mod 2 and 3 above. The report demonstrates compliance with either of the display grounding modifications fitted in place, to allow flexibility in the modification performed to account for an excessive lead time on the spring finger part which is the preferred final production modification.

12.4 Modifications during test

No modifications were made during test by RN Electronics Ltd.

13 Compliance information

Products subject to the Declaration of Conformity procedure are required to be supplied with a compliance information statement. A copy of this statement may be included here:

Not Applicable – Equipment is to be Certified.

14 Description of Test Sites

Site A	Radio / Calibration Laboratory and anechoic chamber
Site B	Semi-anechoic chamber
Site B1	Control Room for Site B
Site C	Transient Laboratory
Site D	Screened Room (Conducted Immunity)
Site E	Screened Room (Control Room for Site D)
Site F	Screened Room (Conducted Emissions) VCCI Registration No. C-2823
Site G	Screened Room (Control Room for Site H)
Site H	3m Semi-anechoic chamber (indoor OATS) FCC Registration No. 823977 IC Registration No. 5612A-2
Site J	Screened Room
Site K	Screened Room (Control Room for Site M)
Site M	3m Semi-anechoic chamber (indoor OATS) FCC Registration No. 293246
Site Q	Fully-anechoic chamber
Site OATS	3m and 10m Open Area Test Site FCC Registration No. 293246 IC Registration No. 5612A-1 VCCI Registration No. R-2580
Site R	Screened Room (Conducted Immunity)
Site S	Safety Laboratory
Site T	Transient Laboratory

15 Abbreviations and Units

%	Percent	g	Grams
µV	microVolts	GHz	GigaHertz
µW	microWatts	Hz	Hertz
AC	Alternating Current	IF	Intermediate Frequency
ALSE	Absorber Lined Screened Enclosure	kHz	kiloHertz
		LO	Local Oscillator
AM	Amplitude Modulation	mA	milliAmps
Amb	Ambient	max	maximum
ANSI	American National Standards Institute	kPa	milliBars
		MHz	MegaHertz
ºC	Degrees Celsius	min	minimum
CFR	Code of Federal Regulations	mm	milliMetres
		ms	milliSeconds
CS	Channel Spacing	mW	milliWatts
CW	Continuous Wave	NA	Not Applicable
dB	deciBels	nom	Nominal
dBµV	deciBels relative to 1µV	nW	nanoWatt
dBc	deciBels relative to Carrier	OATS	Open Area Test Site
dBm	deciBels relative to 1mW	OFDM	Orthogonal Frequency Division Multiplexing
DC	Direct Current		
DSC	Part 15 security / remote control transmitter	ppm	Parts per million
		QAM	Quadrature Amplitude Modulation
DSR	Part 15 remote control / security device transceiver	QPSK	Quadrature Phase Shift Keying
EIRP	Equivalent Isotropic Radiated Power	Ref	Reference
		RF	Radio Frequency
ERP	Effective Radiated Power	RTP	Room Temperature and Pressure
EUT	Equipment Under Test		
FCC	Federal Communications Commission	s	Seconds
		Tx	Transmitter
FM	Frequency Modulation	V	Volts
FSK	Frequency Shift Keying		