Radio Test Report

Keymat Technology Ltd trading as Storm Interface

S40

47 CFR Part 15.225
Test Date: 8th – 17th April 2015
Report Number: 04-7698-3-15 Issue 01

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Certificate of Test 7698-3

The unit noted below has been tested by R.N. Electronics Limited and, where appropriate, conforms to the relevant part of 47 CFR Part 15.225. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

Equipment:	S40
Model Number:	S40
Unique Serial Number:	150011000
Manufacturer:	Keymat Technology Ltd trading as Storm Interface 14 Bentinck Court, Bentinck Road West Drayton Middlesex UB7 7RQ
Full measurement results are detailed in Report Number:	04-7698-3-15 Issue 01
Test Standards:	47 CFR Part 15.225 Effective date October 1st 2014, Class DXX Intentional Radiator

DEVIATIONS:
Deviations have not been applied.

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: 8th – 17th April 2015

Test Engineer: Digitally signed by: Graham Blake
DN: CN = Graham Blake C = GB O = RN Electronics Ltd
Date: 2015.05.22 13:47:22 +01'00'

Approved By:
Radio Approvals Manager: Digitally signed by: Daniel Sims
DN: CN = Daniel Sims C = GB O = RN Electronics Ltd
Date: 2015.05.22 13:01:35 Z

Customer Representative

1 Contents

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Keymat Technology Ltd trading as Storm Interface 14 Bentinck Court Bentinck Road West Drayton Middlesex UB7 7RQ	
Manufacturer of EUT	Storm Interface	
Brand name of EUT	S40	
Model Number of EUT	S40	
Serial Number of EUT	150011000	
Date Received	26 March 2015	
Date of test:	8th – 17th April 2015	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Printed	19 May 2015	
Visual Description	A rugged black plastic enclosure designed to be wall mounted, housing a keypad and recessed LED status indicator. The keypad assembly is attached to the enclosure using tamperproof screws. The keypad features 12 tactile keys and is available with both metal and plastic keys.	
Main Function	A combined PIN and Contactless Access Control Keypad.	
Information specification	Height	118 mm
	Width	99 mm
	Depth	45 mm
	Weight	0.5 kg
	Voltage	10.8 to 13.8 VDC (12V line) 4.5 to 5.5 VDC (5V line)
	Current	0.5 A
EUT supplied PSU	Manufacturer	FWGB
	Model number	FW7362M-12
	Serial number	Not stated
	Input voltage	100 - 240 VAC
	Input current	0.7 Amp
	Output	12 VDC 2.5 Amp

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Wall mounted
Choice of models for type tests	Production Prototype
Antenna details	Integral
Antenna port	No
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	13.56 MHz
Lowest Signal generated in EUT	4 MHz
TX Parameters	
Alignment range – transmitter	13.56 MHz (Single Frequency Equipment)
EUT Declared Modulation Parameters	ASK
EUT Declared Power level	0.4 Watts
EUT Declared Signal Bandwidths	14 kHz (Max)
EUT Declared Channel Spacing's	Single Frequency Equipment Only
EUT Declared Duty Cycle	50%
Unmodulated carrier available?	Yes, via APDU
Declared frequency stability	50 PPM
RX Parameters	
Alignment range – receiver	13.56 MHz
EUT Declared RX Signal Bandwidth	14 kHz (Max)

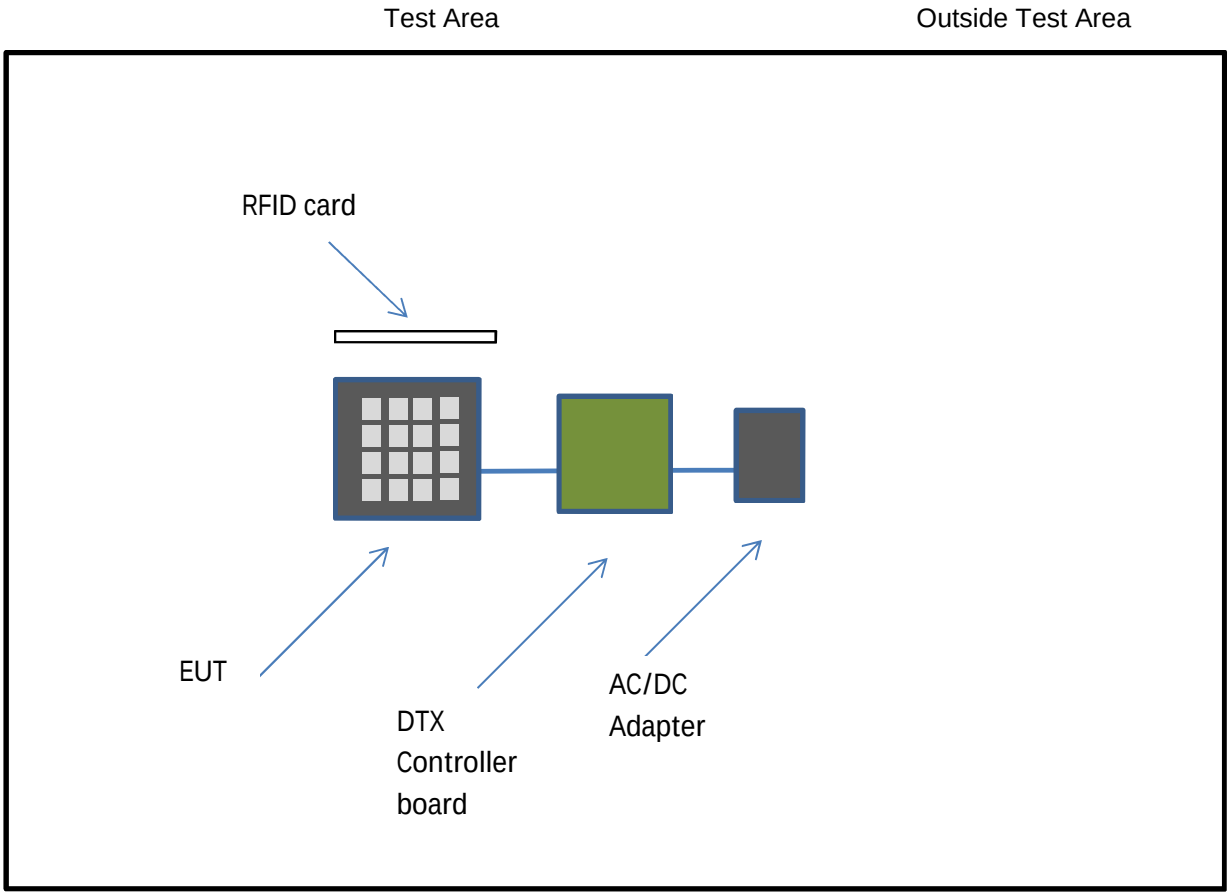
2.3 Functional description

The unit is powered from either a 5V or 12V supply, and in service will be connected to an Access Control Panel. The entry method is either by entering a key-code or by presenting an RFID pass-card in close proximity to the EUT. When a PIN code is entered or a card is presented to the unit, a message is sent over the Wiegand interface to the host. The EUT has a 13.56 MHz RFID reader and uses a loop magnetic coupling antenna which is etched into the PCB material.

2.4 Modes of operation

Mode Reference	Description	Used for testing
Normal Operation	The EUT transmits a 15ms burst every 100ms	Yes
TX Card Read	The EUT transmits a 100ms burst every 545ms	Yes

2.5 Emissions configuration



The unit was powered from the provided AC/DC adapter, via the ancillary DTX controller board. Initially the EUT was pre-tested to establish any worst-case in terms of radiated emissions and AC conducted emissions. It was found that worst-case emissions were observed when the RFID card was in close proximity to the EUTs' card reader and therefore this mode was used for full test. The transmit mode was a 100ms burst every 545ms, and used normal modulation. The power setting used throughout was fixed at maximum by the manufacturer.

In normal use the EUT can be powered by using either the 12 VDC line or the 5 VDC line. For radiated emissions, frequency error and field strength testing, a comparison was made between the 12 VDC and 5 VDC power lines. There was no significant difference between these powering methods, and therefore for full test the 12 VDC power line was used.

For AC conducted emissions, initially the test was performed with the EUT in its' normal configuration. Since the test is performed over the frequency range of 150 kHz – 30 MHz the fundamental carrier was visible on the plots and exceeded the emission limit. To prove that the emission was due to the EUTs' radio, the test was repeated with the EUT's integral antenna disconnected and a 50 ohm termination soldered in place of the antenna. Two sets of results and plots have been included in this test report.

2.5.1 Signal leads

Port Name	Cable Type	Connected
Power Line +5V	Single core	Yes
Power Line +12V	Single core	Yes
Power 0V	Single core	Yes
Interface Port	Single core	Yes

3 Summary of test results

The S40 was tested for compliance to the following standards :

47 CFR Part 15.225 (effective date October 1st, 2014); 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	References	Results
Transmitter Tests		
1. AC power line conducted emissions	47 CFR Part 15.207	PASSED
2. Intentional radiator field strength	47 CFR Part 15.225(a)	PASSED
3. Radiated emissions - 150 kHz - 30 MHz	47 CFR Part 15.205, 15.209(d), 15.225	PASSED
4. Radiated emissions - 9 kHz - 150 kHz	47 CFR Part 15.205, 15.209(d), 15.225	PASSED
5. Occupied bandwidth	47 CFR Part 15.215	PASSED[1]
6. Radiated emissions - 30 MHz -1 GHz	47 CFR Part 15.205, 15.209(d), 15.225	PASSED
7. Spectrum mask	47 CFR Part 15.225 Clause 15.225 (a)(b)(c)	PASSED
8. Frequency stability	47 CFR Part 15.225(e)	PASSED

[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 R.N. Electronics Ltd procedures and the relevant standards listed below.

4.1 Relevant standards

Ref.	Standard Number	Version	Description
4.1.1	47 CFR Part 15	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 H, M and OATS are listed with the FCC. Registration Number 293246

4.2 Deviations

No deviations were applied.

4.3 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 norm	20 °C	V nom	12V DC
T cold	-20 °C	V min	10.8V DC
T hot	50 °C	V max	13.8V DC

Extremes of voltage are based on manufacturer's end point declarations.

Extremes of temperature are based upon 15.225 requirements.

The ambient test conditions of humidity and pressure in the laboratory were as follows:

35 %; 101 kPa.

4.4 Test fixtures

In order to measure RF parameters at temperature extremes, the EUT was tested in a temperature controlled chamber as follows:

A test fixture was used for testing.

4.5 Measurement uncertainties

RN Electronics Ltd measurement uncertainty figures;

Parameter	Uncertainty
Transmitter Tests	
Radiated Emissions	30MHz - 1000MHz ±5.1dB, 1000MHz - 2000MHz ±4.5dB, 1 – 18 GHz ±3.5dB, 18 – 26.5 GHz ±3.9dB
Bandwidth	<± 1.9 %
Radiated RF Power	<± 3.5 dB
Spectrum Mask	<± 4.1 dB
AC power line conducted emissions	150kHz to 30MHz ±3.6dB
RF frequency	<± 0.7 ppm

5 Tests, methods and results

5.1 AC power line conducted emissions

5.1.1 Test methods

Test Requirements:	47 CFR Part 15.207 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.2 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15.207 [Reference 4.1.1 of this report]

5.1.2 Configuration of EUT

The EUT was placed on a wooden table 0.8m above the ground plane, positioned next to the DTX controller board. The provided AC/DC adapter was connected to a LISN via a 1m mains cable. The AC/DC adapter was powered using 110 VAC, 60Hz.

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

During the initial scan, mode TX Card Read was found to be worst case mode of operation.

The test was performed with the EUTs integral antenna connected normally and was repeated with the antenna disconnected and the RF output loaded with a 50 ohm termination.

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 of the limit were investigated.

Tests were performed in Test Site F.

5.1.4 Test equipment

E150, E035, E410, E411, E412, E465

See Section 8 for more details

5.1.5 Test results

Temperature of test environment	22°C
Humidity of test environment	34 - 35%
Pressure of test environment	103kPa

Band	13.553-13.567 MHz
Power Level	Maximum
Channel Spacing	Single Frequency Equipment
Mod Scheme	ASK
Mid channel	13.56 MHz

Plot reference tables

Frequency range	Plot reference
150kHz to 30MHz	7698-3 Cond 1 AC Live 150k-30M Average Antenna connected
150kHz to 30MHz	7698-3 Cond 1 AC Live 150k-30M Quasi-Peak Antenna connected
150kHz to 30MHz	7698-3 Cond 1 AC Neutral 150k-30M Average Antenna connected
150kHz to 30MHz	7698-3 Cond 1 AC Neutral 150k-30M Quasi-Peak Antenna connected

Table of signals measured for "Antenna connected" Live 150kHz – 30 MHz

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)	AV Amp (dBuV)	AV Lim (dB)
1	0.222	35.8	32.7	-30.0	26.7	-26.0
2	0.222	35.9	33.3	-29.4	26.9	-25.8
3	12.498	31.2	20.6	-39.4	3.1	-46.9
4	12.927	43.6	32.6	-27.4	5.8	-44.2
5	13.413	51.8	41.8	-18.2	11.9	-38.1
6	**13.560**	**73.6**	**70.0**	**10.0***	**63.5**	**13.5***
7	13.721	12.2	38.1	-21.9	18.1	-31.9
8	27.120	41.2	37.0	-23.0	32.1	-17.9

Table of signals measured for "Antenna connected" Neutral 150kHz – 30 MHz

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)	AV Amp (dBuV)	AV Lim (dB)
1	0.161	38.8	39.4	-26.0	26.6	-28.8
2	0.186	38.4	37.0	-27.2	23.4	-30.8
3	13.153	13.2	32.0	-28.0	11.8	-38.2
4	**13.561**	**75.1**	**71.4**	**11.4***	**65.0**	**15.0***
5	13.614	11.7	49.9	-10.1	25.0	-25.0
6	13.706	51.0	36.3	-23.7	17.8	-32.2
7	14.036	37.3	29.4	-30.6	11.1	-38.9
8	27.122	43.5	39.9	-20.1	31.1	-18.9

*The results tables above show the fundamental frequency of the EUT at 13.56 MHz exceeding the limit. This was due to the EUTs integral antenna radiating the fundamental carrier on to the 1 metre mains lead used as part of the test setup. To confirm that the emission was generated by the EUTs' radio, the test was repeated with the EUTs' integral antenna disconnected and the EUTs' RF output fitted with a 50 ohm load. Please refer to the following result tables for the test with the antenna disconnected.

Plot reference tables

Frequency range	Plot reference
150kHz to 30MHz	7698-3 Cond 1 AC Live 150k-30M Average Antenna disconnected
150kHz to 30MHz	7698-3 Cond 1 AC Live 150k-30M Quasi-Peak Antenna disconnected
150kHz to 30MHz	7698-3 Cond 1 AC Neutral 150k-30M Average Antenna disconnected
150kHz to 30MHz	7698-3 Cond 1 AC Neutral 150k-30M Quasi-Peak Antenna disconnected

Table of signals measured for "Antenna disconnected and loaded with 50 ohm" Live 150 kHz – 30 MHz

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)	AV Amp (dBuV)	AV Lim (dB)
1	0.161	39.3	35.9	-29.5	23.1	-32.3
2	0.222	34.9	32.5	-30.2	26.8	-25.9
3	0.254	31.8	24.9	-36.7	12.2	-39.4
4	0.322	25.7	23.0	-36.7	15.1	-34.6
5	3.998	22.0	19.3	-36.7	15.7	-30.3
6	13.560	25.4	22.2	-37.8	10.9	-39.1

Table of signals measured for "Antenna disconnected and loaded with 50 ohm" Neutral 150 kHz – 30 MHz

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)	AV Amp (dBuV)	AV Lim (dB)
1	0.157	40.5	34.3	-31.3	19.8	-35.8
2	0.161	40.7	37.4	-28.0	24.4	-31.0
3	0.173	37.8	35.0	-29.8	22.1	-32.7
4	0.222	35.9	32.9	-29.8	27.1	-25.6
5	0.271	28.6	25.1	-36.0	18.0	-33.1
6	3.896	26.3	23.3	-32.7	18.9	-27.1
7	13.560	25.9	23.3	-36.7	11.6	-38.4

Analyser plots for the Quasi-Peak / Average values as applicable can be found in Section 6 of this report.

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 Radiated emissions - 9 kHz - 150 kHz

5.2.1 Test methods

Test Requirements:	47 CFR Part 15.209 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.4 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15.209 [Reference 4.1.1 of this report]

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 a distance of 3 metres. The EUT was rotated in all three orthogonal planes. The EUT was operated in TX Card Read mode.

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 listed with the FCC. The antenna was placed 1m above the ground. The equipment and the antenna were rotated 360 degrees to record the worst case emissions. Tests were performed in Test Site M, with any final measurements required made on an OATS.

5.2.4 Test equipment

E411, E412, TMS81, E570

See Section 8 for more details

5.2.5 Test results

Temperature of test environment	20°C
Humidity of test environment	38%
Pressure of test environment	103kPa

Band	13.553-13.567 MHz
Power Level	Maximum
Channel Spacing	Single Frequency Equipment
Mod Scheme	ASK
Mid channel	13.56 MHz

Channel	Parallel Plots	Perpendicular Plots
Single channel	7698-3 Parallel 9-150k	7698-3 Perpendicular 9-150k

No emissions were observed within 20 dB of the limit line.

Analyser plots for the Quasi-Peak / Average values as applicable can be found in Section 6 of this report.

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

These results show that the EUT has PASSED this test.

5.3 Radiated emissions - 150 kHz - 30 MHz

5.3.1 Test methods

Test Requirements:	47 CFR Part 15.209 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.4 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15.209 [Reference 4.1.1 of this report]

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. The EUT was rotated in all three orthogonal planes. The EUT was operated in TX Card Read mode.

5.3.3 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 listed with the FCC. The antenna was placed 1m above the ground. The equipment and the antenna were rotated 360 degrees to record the worst case emissions. Tests were performed in Test Site M, with any final measurements required made on an OATS.

5.3.4 Test equipment

E411, E412, TMS81, E570

See Section 8 for more details

5.3.5 Test results

Temperature of test environment	20°C
Humidity of test environment	38%
Pressure of test environment	103kPa

Band	13.553-13.567 MHz
Power Level	Maximum
Channel Spacing	Single Frequency Equipment
Mod Scheme	ASK
Mid channel	13.56 MHz

Channel	Parallel Plots	Perpendicular Plots
Single channel	7698-3 Parallel 150k-30M	7698-3 Perpendicular 150k-30M

With exception of the fundamental transmit frequency, no emissions were observed within 20 dB of the limit line.

Analyser plots for the Quasi-Peak / Average values as applicable can be found in Section 6 of this report.

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

These results show that the EUT has PASSED this test.

5.4 Radiated emissions - 30 MHz -1 GHz

5.4.1 Test methods

Test Requirements:	47 CFR Part 15.209 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.5 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15.209 [Reference 4.1.1 of this report]

5.4.2 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. The EUT was rotated in all three orthogonal planes. The EUT was operated in TX Card Read mode.

5.4.3 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 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. Tests were performed in Test Site M

5.4.4 Test equipment

TMS933, E533, E534, E535

See Section 8 for more details

5.4.5 Test results

Temperature of test environment	21°C
Humidity of test environment	50%
Pressure of test environment	103kPa

Band	13.553-13.567 MHz
Power Level	Maximum
Channel Spacing	Single Frequency Equipment
Mod Scheme	ASK
Mid channel	13.56 MHz

Frequency Range	Antenna Polarisation	Plot reference
30 – 300 MHz	Horizontal	7698-3 Rad 1 VHF Horiz
30 – 300 MHz	Vertical	7698-3 Rad 1 VHF Vert
300 – 1000 MHz	Horizontal	7698-3 Rad 1 UHF Horiz
300 – 1000 MHz	Vertical	7698-3 Rad 1 UHF Vert

Horizontal

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)
1	176.287	17.7	29.5	-14.0
2	189.847	17.7	31.8	-11.7
3	203.420	27.5	24.4	-19.1
4	257.640	23.0	29.6	-16.4
5	528.864	36.7	33.8	-12.2
6	555.985	38.6	33.4	-12.6

Vertical

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)
1	35.470	34.8	26.9	-13.1
2	40.680	37.0	33.2	-6.8
3	40.682	25.0	34.7	-5.3
4	189.841	32.4	29.8	-13.7
5	203.404	32.7	29.9	-13.6
6	528.863	28.9	30.8	-15.2

Analyser plots for the Quasi-Peak / Average values as applicable can be found in Section 6 of this report.

LIMITS:

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

These results show that the EUT has PASSED this test.

5.5 Occupied bandwidth

5.5.1 Test methods

Test Requirements:	47 CFR Part 15.215 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.9 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15.215 [Reference 4.1.1 of this report]

5.5.2 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. The EUT was operated in TX Card Read mode.

5.5.3 Test procedure

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

5.5.4 Test equipment

E411, E412, TMS81

See Section 8 for more details

5.5.5 Test results

Temperature of test environment	20°C
Humidity of test environment	20%
Pressure of test environment	103kPa

Band	13.553-13.567 MHz
Power Level	Maximum
Channel Spacing	Single Frequency Equipment
Mod Scheme	ASK
Mid channel	13.56 MHz

	Mid
20dB Bandwidth (KHz)	76.8
Plot reference	7698-3 FCC OBW 20dB

Analyser plots can be found in Section 6 of this report.

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.

5.6 Intentional radiator field strength

5.6.1 Test methods

Test Requirements:	47 CFR Part 15.225 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.4 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15.225 (a) [Reference 4.1.1 of this report]

5.6.2 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. The antenna was orientated in both Parallel and perpendicular polarisations. The EUT was rotated in all three orthogonal planes. The EUT was operated in TX Card Read mode.

5.6.3 Test procedure

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

Measurements were made on an OATS. This site is listed with the FCC.

Both the equipment and the antenna were rotated 360 degrees to record the maximised emission.

5.6.4 Test equipment

TMS81, E226

See Section 8 for more details

5.6.5 Test results

Temperature of test environment	21°C
Humidity of test environment	26%
Pressure of test environment	103kPa

Band	13.553-13.567 MHz
Power Level	Maximum
Channel Spacing	Single Frequency Equipment
Mod Scheme	ASK
Single channel	13.56 MHz

	Single
Peak Level (dBµV/m)	70.58
Plot reference	7698-3 13.56MHz
Antenna Polarisation	Parallel
EUT Polarisation	Upright

An analyser plot can be found in Section 6 of this report.

Highest field strength was measured with the EUT upright and the loop antenna in the parallel position. 3 metre distance was used to increase the fundamental signal amplitude with respect to the noise floor. An extrapolation figure of 40 dB was used as per ANSI C63.10. This gave an equivalent field strength result at 30 metres of 30.58 dBuV/m.

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.

These results show that the EUT has PASSED this test.

5.7 Frequency stability

5.7.1 Test methods

Test Requirements:	47 CFR Part 15.225(e) [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.8 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15.225(e) [Reference 4.1.1 of this report]

5.7.2 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 connected to a bench top power supply which allowed the supply voltage to be adjusted. As the unit could be powered via a 12V input line or a 5V input line two tests were performed. The EUT was operated in TX Card Read mode for this test.

5.7.3 Test procedure

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

Temperature stability was achieved at each test level before taking measurements.
The spectrum analyser was used to monitor the frequency of the carrier. The analyser was set with a suitable span, RBW and VBW to allow for a measurement resolution of 1Hz. At nominal temperature the EUT supply was varied by +/-15% on 12V supply and on the 5V supply. The EUT emissions were observed by means of a test fixture.

Tests were performed using Test Site A.

5.7.4 Test equipment

E227, E412, E434, L264, TMS38, TMS80, P266

See Section 8 for more details

5.7.5 Test results

Temperature of test environment	20°C
Humidity of test environment	20%
Pressure of test environment	103kPa

Band	13.553-13.567 MHz
Power Level	Maximum
Channel Spacing	Single Frequency Equipment
Mod Scheme	ASK
Single channel	13.56 MHz

12V supply input results

Temp (°C)	Voltage (V)	Frequency Reading (MHz) Single
-20	12	0.000069
-10	12	0.000077
0	12	0.000082
10	12	0.000073
20	10.2	-0.000004
	12	-0.000006
	13.8	-0.000008
30	12	-0.000010
40	12	-0.000076
50	12	-0.000116
Max Frequency Error per chan (Hz)		+82 / -116
Max Frequency Error observed (MHz)		-0.000116

5V supply input results

Temp (°C)	Voltage (V)	Frequency Reading (MHz) Single
-20	5	0.000070
-10	5	0.000100
0	5	0.000084
10	5	0.000068
20	4.25	-0.000003
	5	0.000000
	5.75	-0.000004
30	5	-0.000006
40	5	-0.000079
50	5	-0.000113
Max Frequency Error per chan (Hz)		+100 / -113
Max Frequency Error observed (MHz)		-0.000113

Maximum variation observed using both supply inputs was +100 / -116 Hz.

LIMITS:

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

These results show that the EUT has PASSED this test.

5.8 Spectrum mask

5.8.1 Test methods

Test Requirements:	47 CFR Part 15.225 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.4 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15.225(a)(b)(c)(d) [Reference 4.1.1 of this report]

5.8.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The EUT was positioned/referenced to the maximised field strength result. The EUT was operated in TX Card Read mode.

5.8.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.
A reference was made to the 30m field strength limits on the analyser. A max held plot was then taken and the limits applied to the plot as a mask.

5.8.4 Test equipment

E411, E412, TMS81

See Section 8 for more details

5.8.5 Test results

Temperature of test environment	20°C
Humidity of test environment	20%
Pressure of test environment	103kPa

Band	13.553-13.567 MHz
Power Level	Maximum
Channel Spacing	Single Frequency Equipment
Mod Scheme	ASK
#Channel# channel	13.56 MHz

	Single
Nominal plot reference	7698-3 Spectrum mask FCC15.225 at 30 metres

Analyser plots can be found in Section 6 of this report.

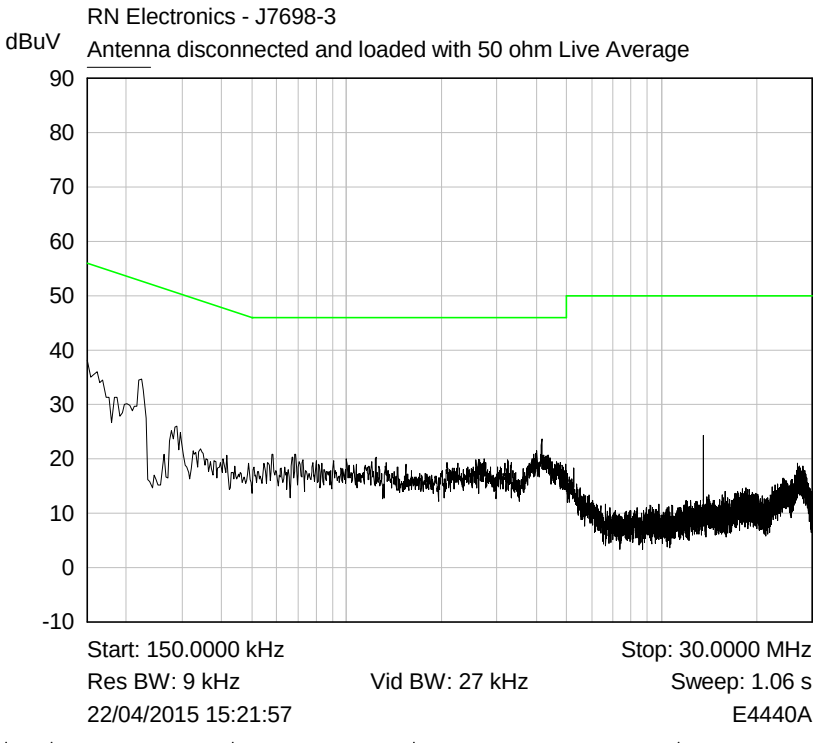
LIMITS:
15.225(a) QP/Peak = the field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 µV/m @ 30m = 84 dBµV/m @ 30m.
15.225(b) QP/Peak = within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 µV/m @ 30m = 50.5 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.
The limits are shown on the plot.

These results show that the EUT has PASSED this test.

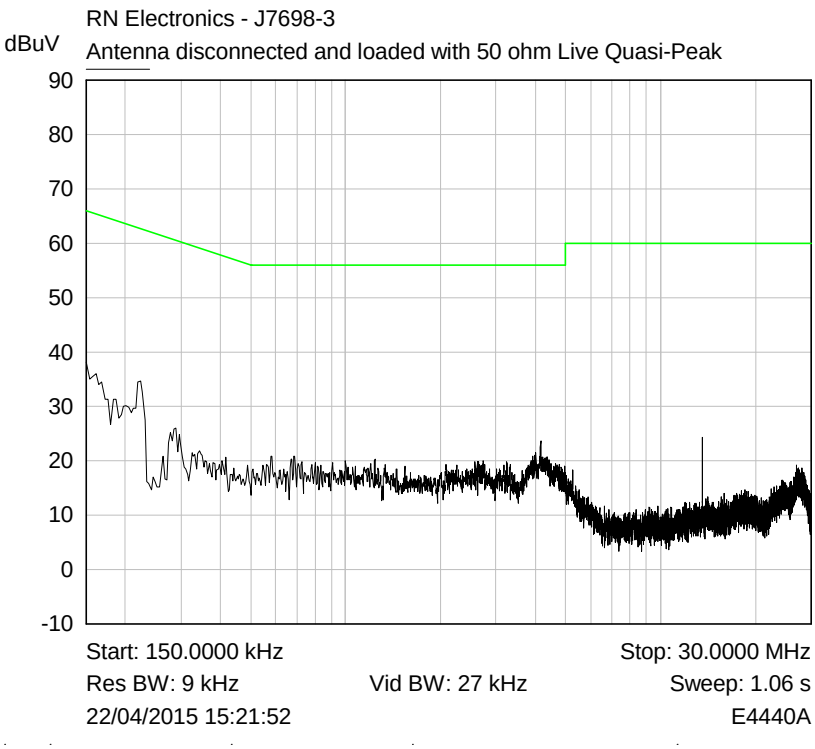
6 Plots/Graphical results

6.1 AC power line conducted emissions

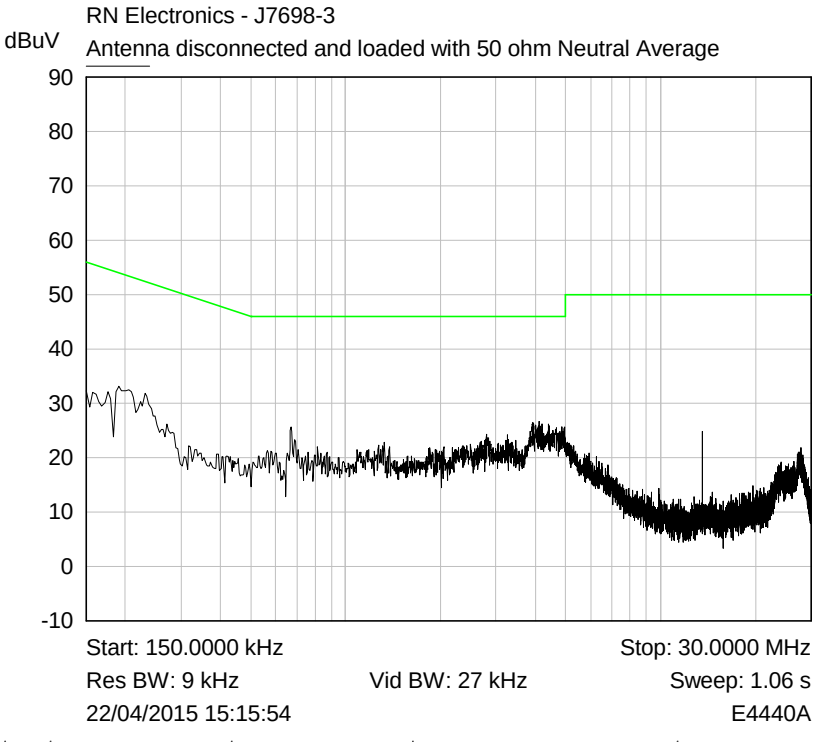
Band 13.553-13.567 MHz, Power Maximum, Channel Spacing Single Frequency Equipment, ASK Modulation, Channel 13.56 MHz, Antenna disconnected



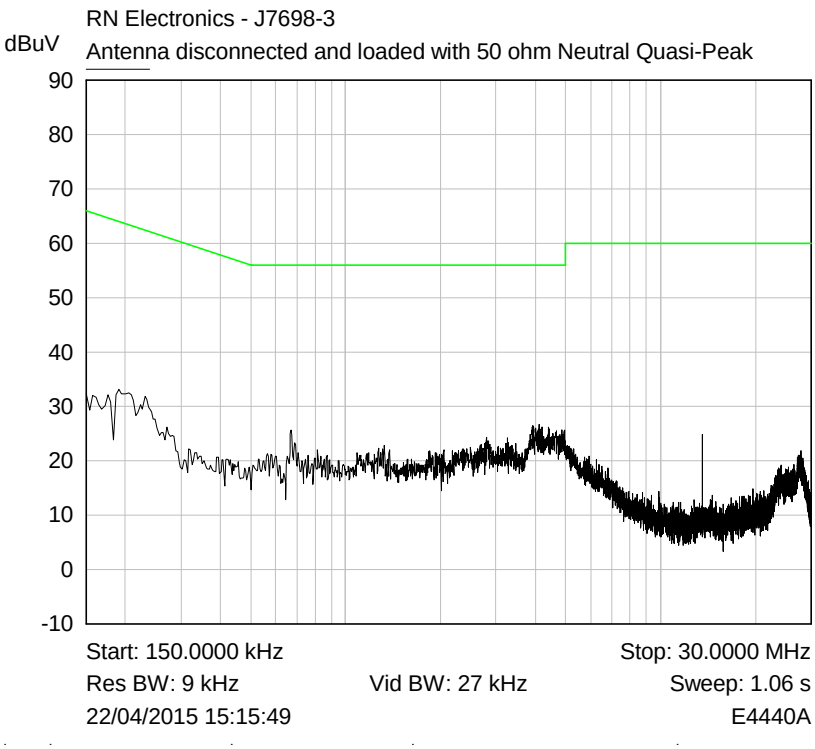
Plot of peak emissions 150kHz - 30MHz on the Mains live terminal against the average limit line.



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

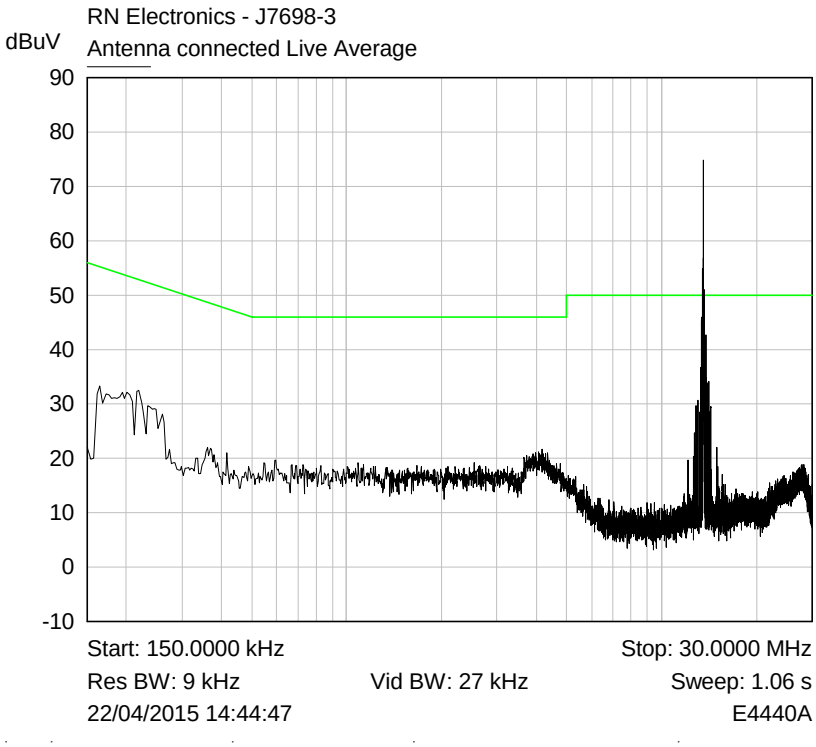


Plot of peak emissions 150kHz - 30MHz on the Mains Neutral terminal against the average limit line.

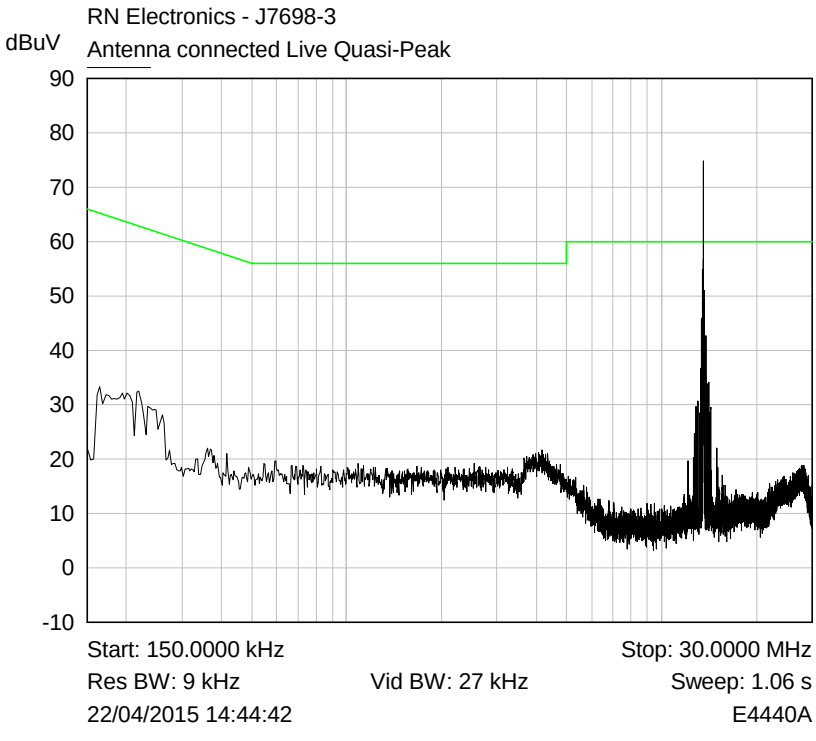


Plot of peak emissions 150kHz - 30MHz on the Mains Neutral terminal against the quasi-peak limit line.

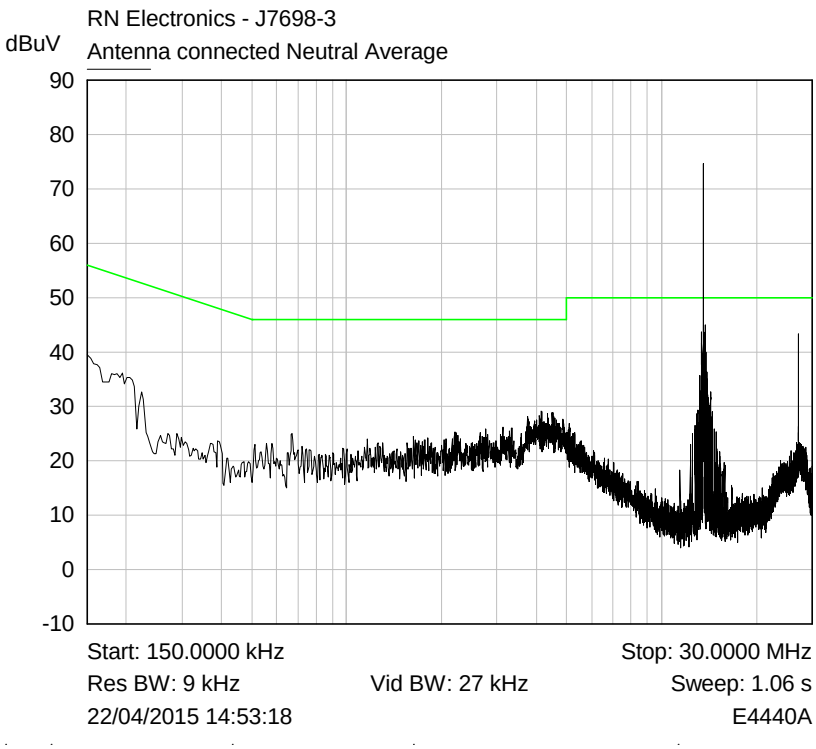
Band 13.553-13.567 MHz, Power Maximum, Channel Spacing Single Frequency Equipment, ASK Modulation, Channel 13.56 MHz, Antenna connected



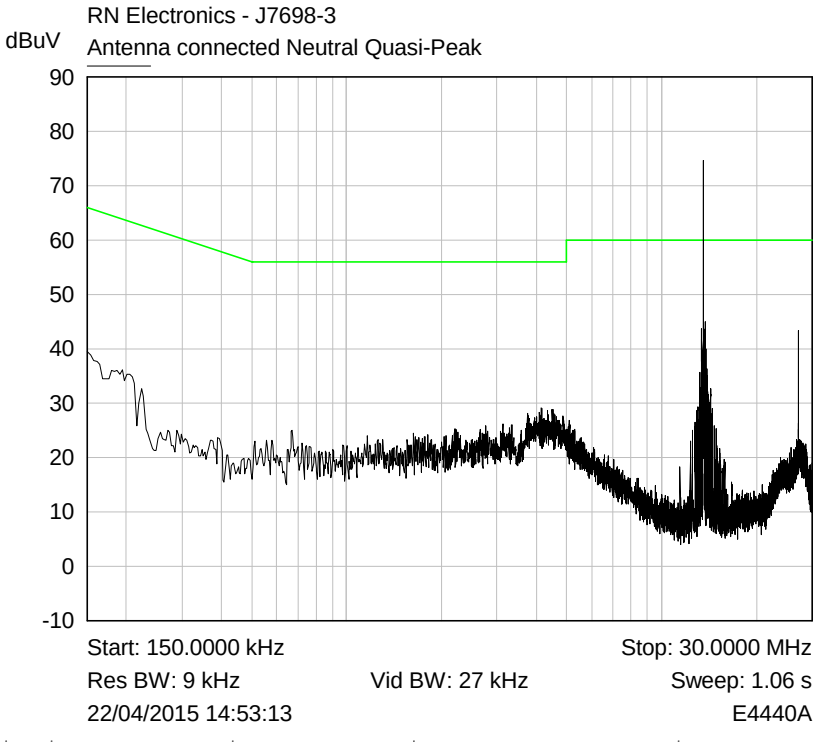
Plot of peak emissions 150kHz - 30MHz on the Mains live terminal against the average limit line.



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



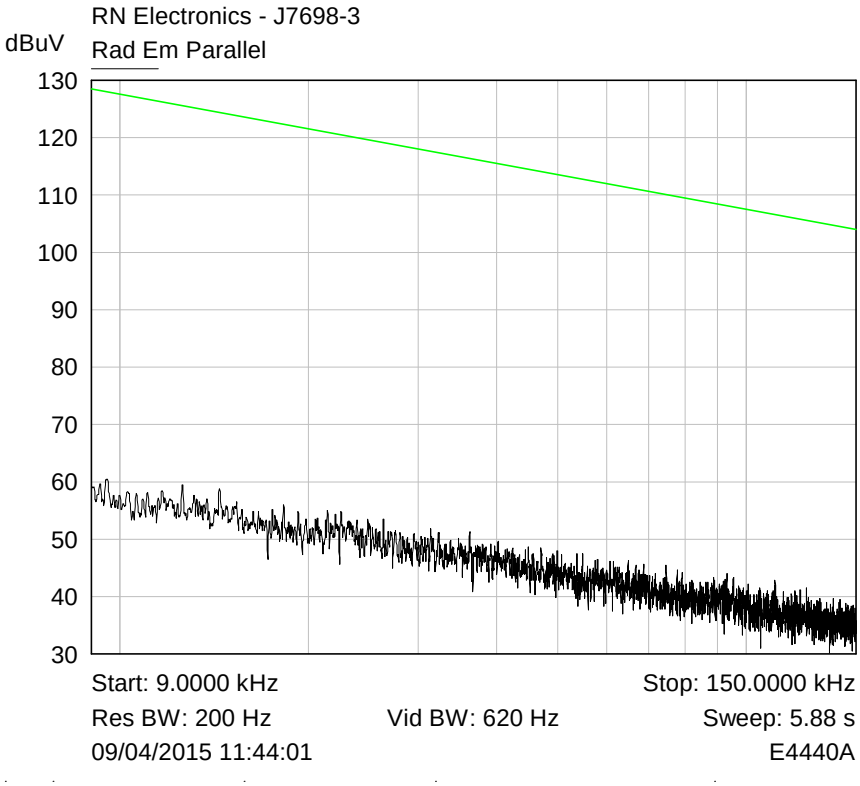
Plot of peak emissions 150kHz - 30MHz on the Mains Neutral terminal against the average limit line.



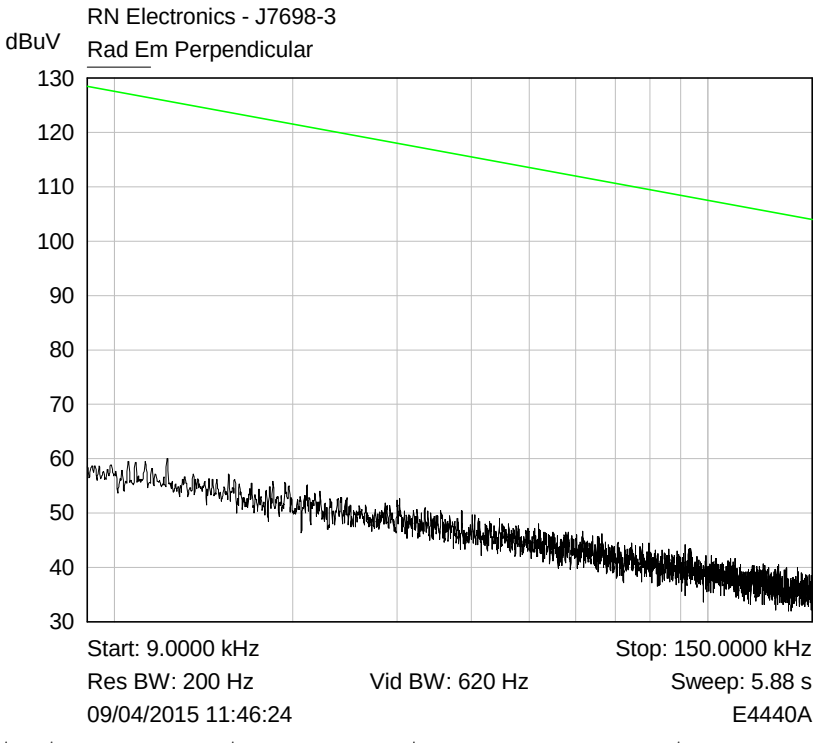
Plot of peak emissions 150kHz - 30MHz on the Mains Neutral terminal against the quasi-peak limit line

6.2 Radiated emissions - 9 kHz - 150 kHz

Band 13.553-13.567 MHz, Power Maximum, Channel Spacing Single Frequency Equipment, ASK Modulation, Channel 13.56 MHz.



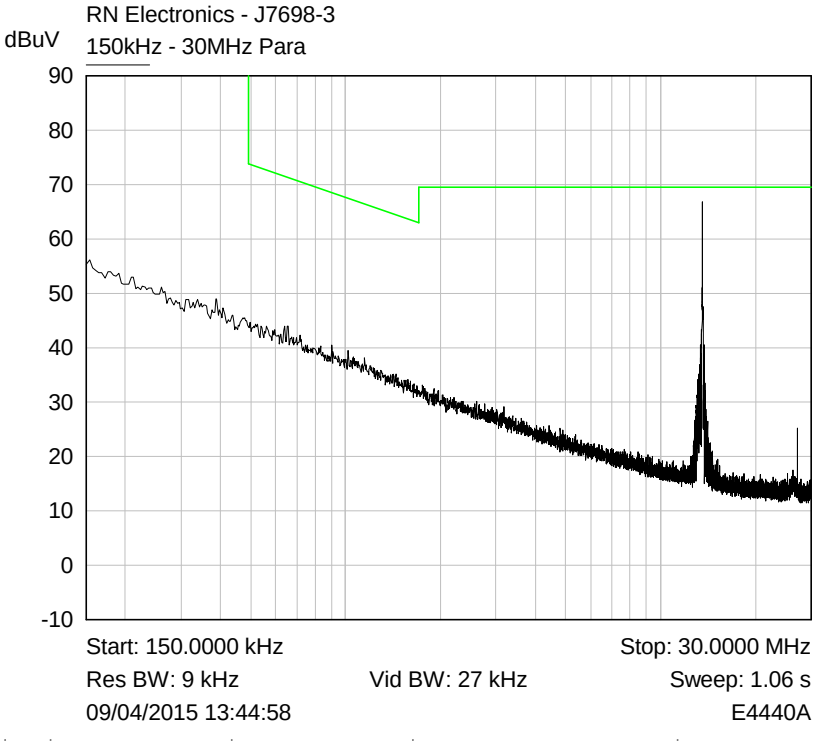
Plot of peak parallel emissions 9kHz – 150kHz against the limit line



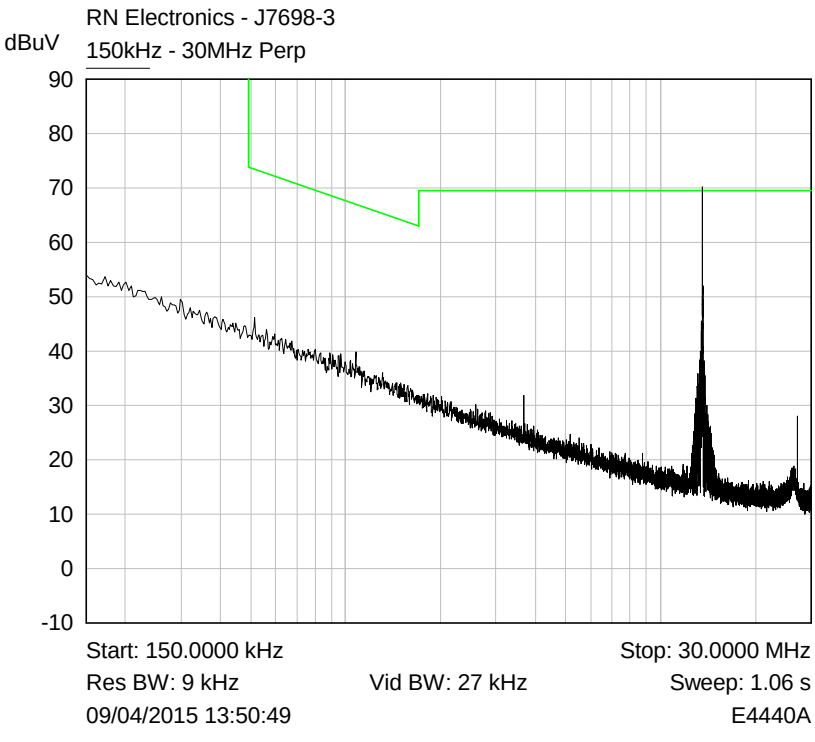
Plot of peak perpendicular emissions 9kHz – 150kHz against the limit line

6.3 Radiated emissions - 150 kHz - 30 MHz

Band 13.553-13.567 MHz, Power Maximum, Channel Spacing Single Frequency Equipment, ASK Modulation, Channel 13.56 MHz.



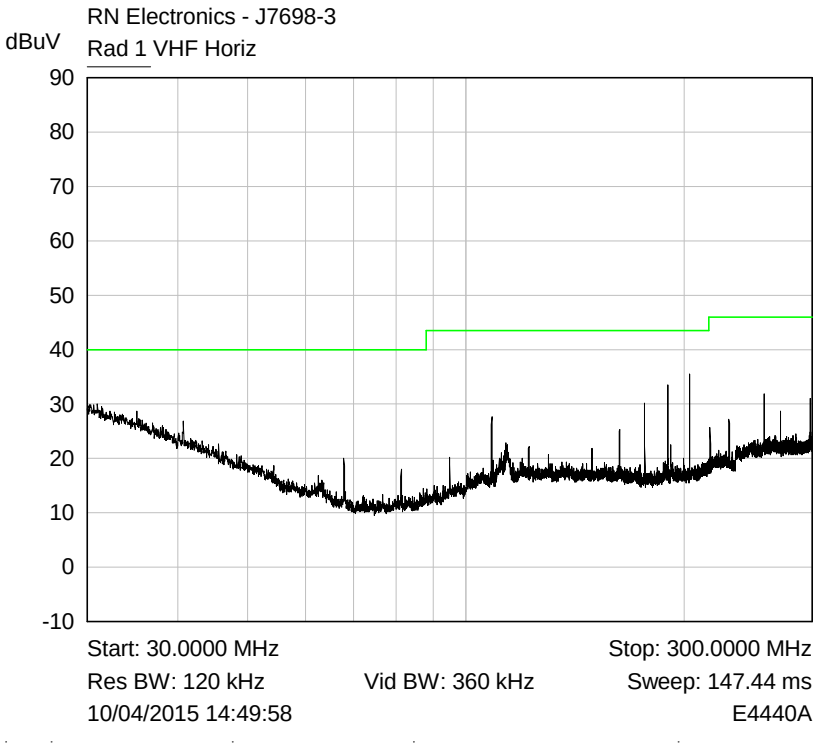
Plot of peak parallel emissions 150kHz – 30MHz against the quasi-peak limit line



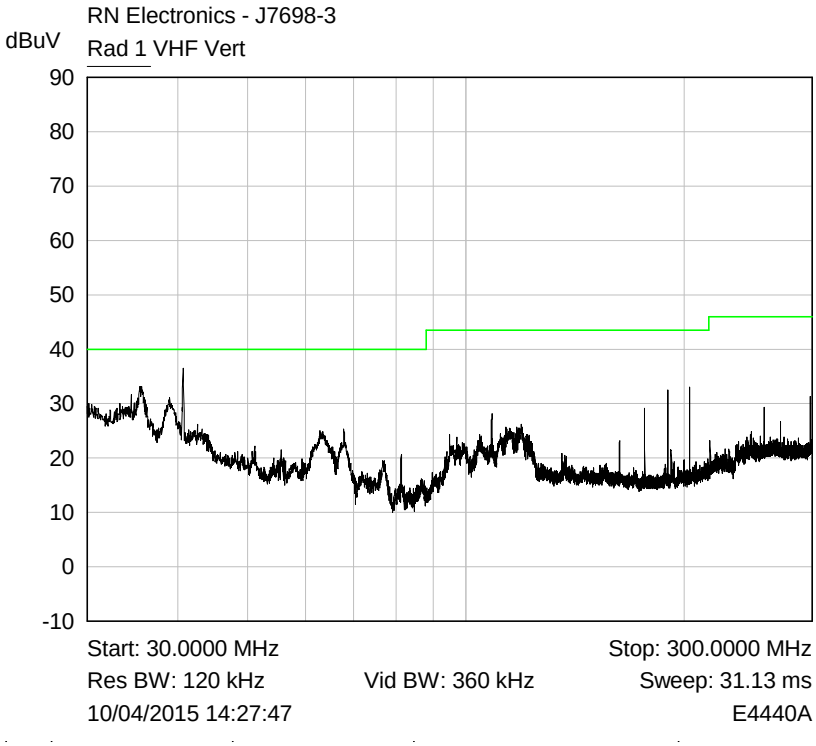
Plot of peak perpendicular emissions 150kHz – 30MHz against the quasi-peak limit line

6.4 Radiated emissions - 30 MHz -1 GHz

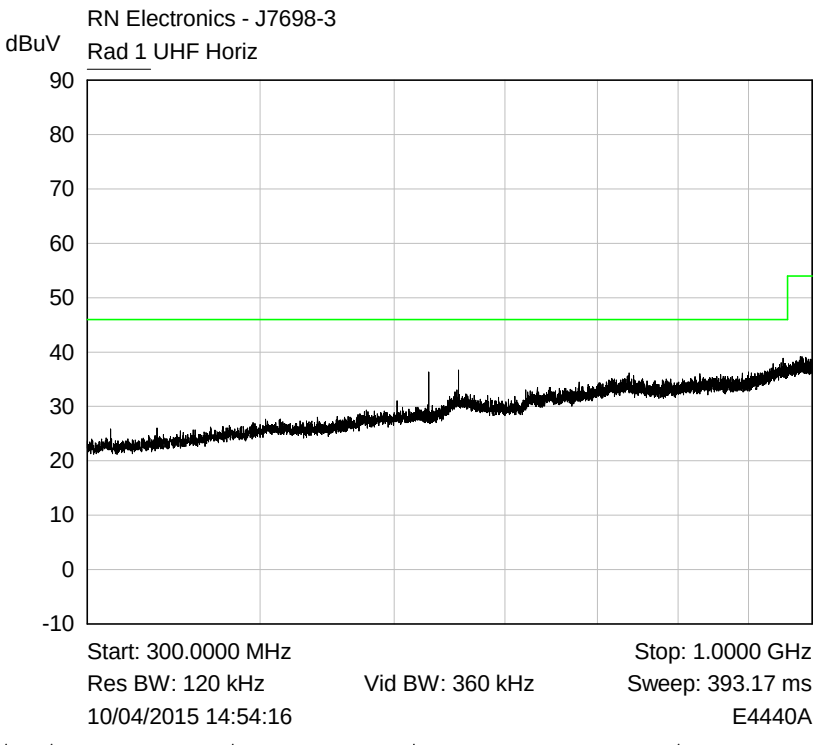
Band 13.553-13.567 MHz, Power Maximum, Channel Spacing Single Frequency Equipment, ASK Modulation, Channel 13.56 MHz



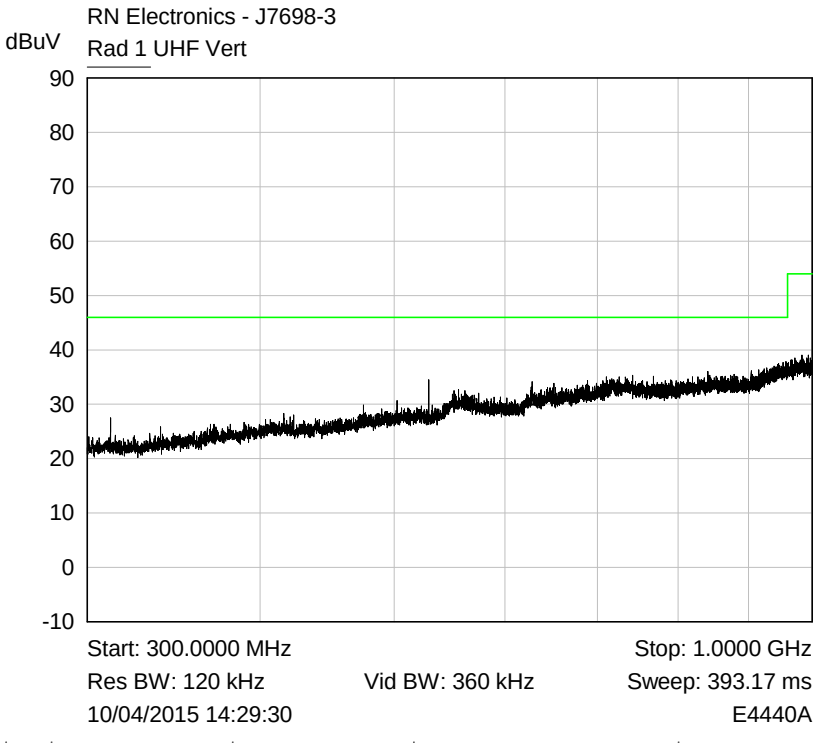
Plot of peak horizontal emissions 30MHz - 300MHz against the quasi-peak limit line.



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



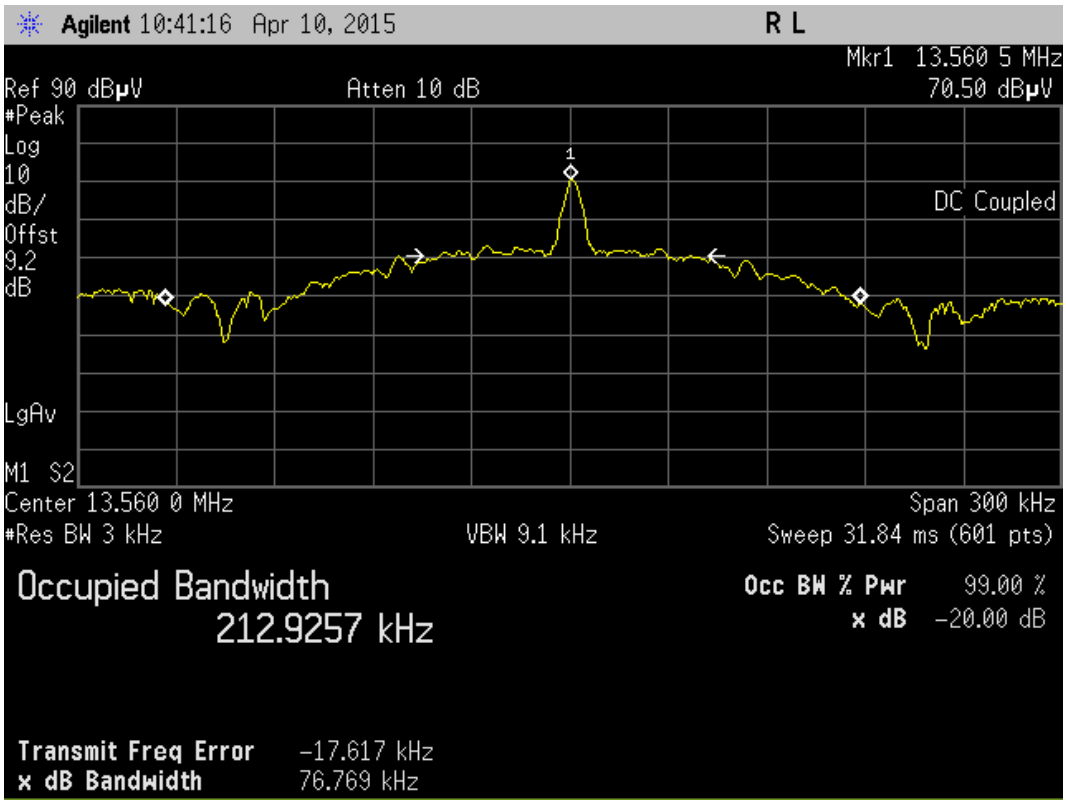
Plot of peak horizontal emissions 300MHz - 1000MHz against the quasi-peak limit line.



Plot of peak vertical emissions 300MHz - 1000MHz against the quasi-peak limit line.

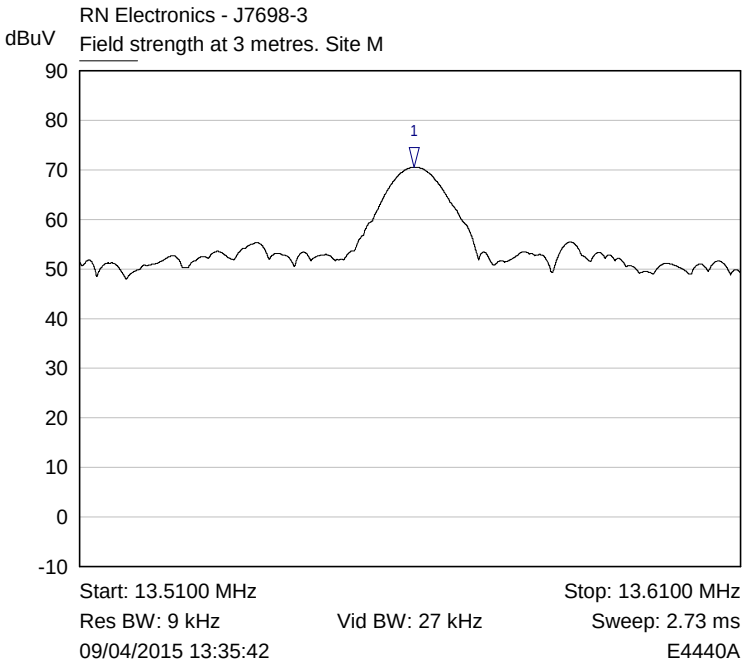
6.5 Occupied bandwidth

Band 13.553-13.567 MHz, Power Maximum, Channel Spacing Single Frequency Equipment, Channel 13.56 MHz



6.6 Intentional radiator field strength

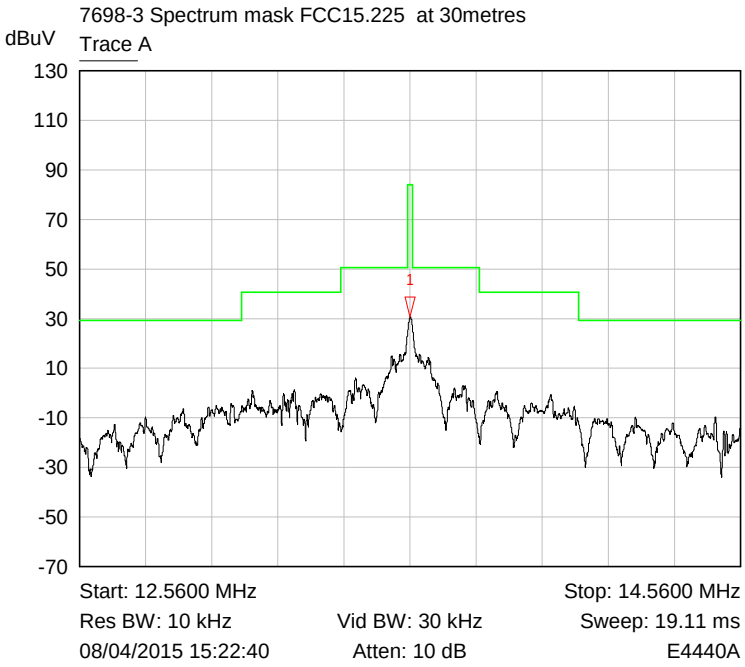
Band 13.553-13.567 MHz, Power Maximum, Channel Spacing Single Frequency Equipment, ASK Modulation, Channel 13.56 MHz



Mkr	Trace	X-Axis	Value	Notes
1	Field strength at 3 metres Site M	13.5606 MHz	70.58 dBuV	

6.7 Spectrum mask

Band 13.553-13.567 MHz, Power Maximum, Channel Spacing Single Frequency Equipment, ASK Modulation, Channel 13.56 MHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	13.5609 MHz	30.52 dBuV	

Band 13.553-13.567 MHz, Power Maximum, Channel 13.56 MHz

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.

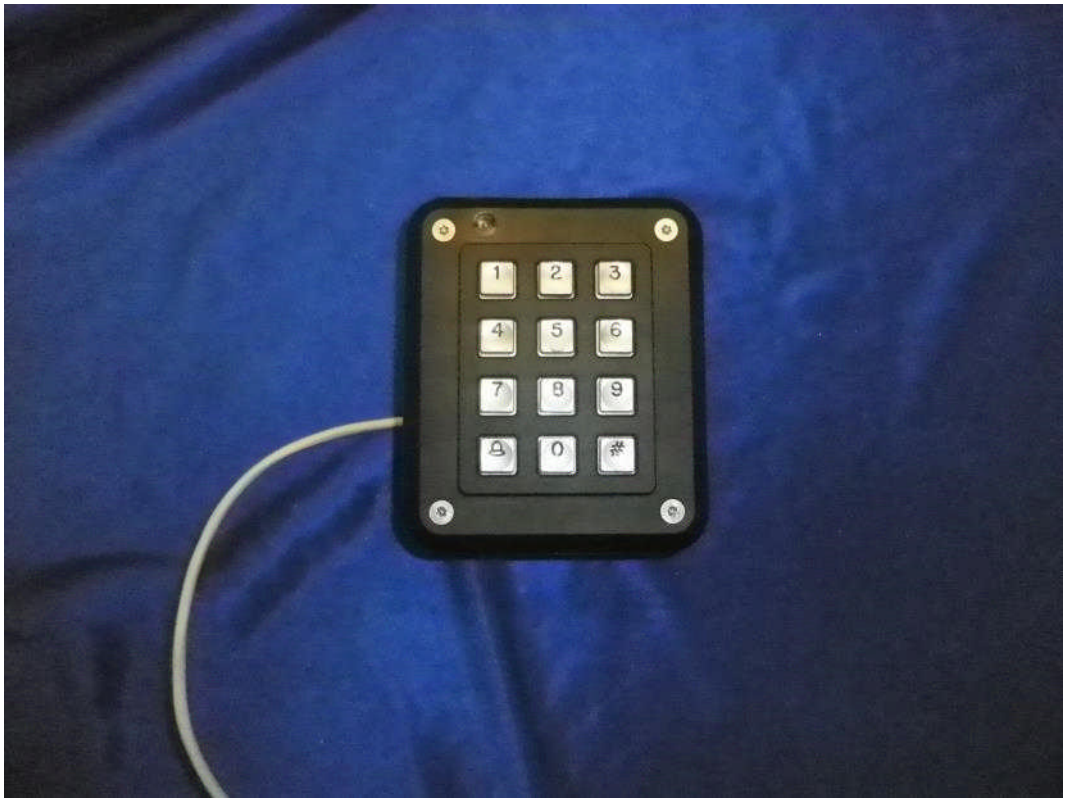
7.2 Explanation of limit line calculations for radiated measurements

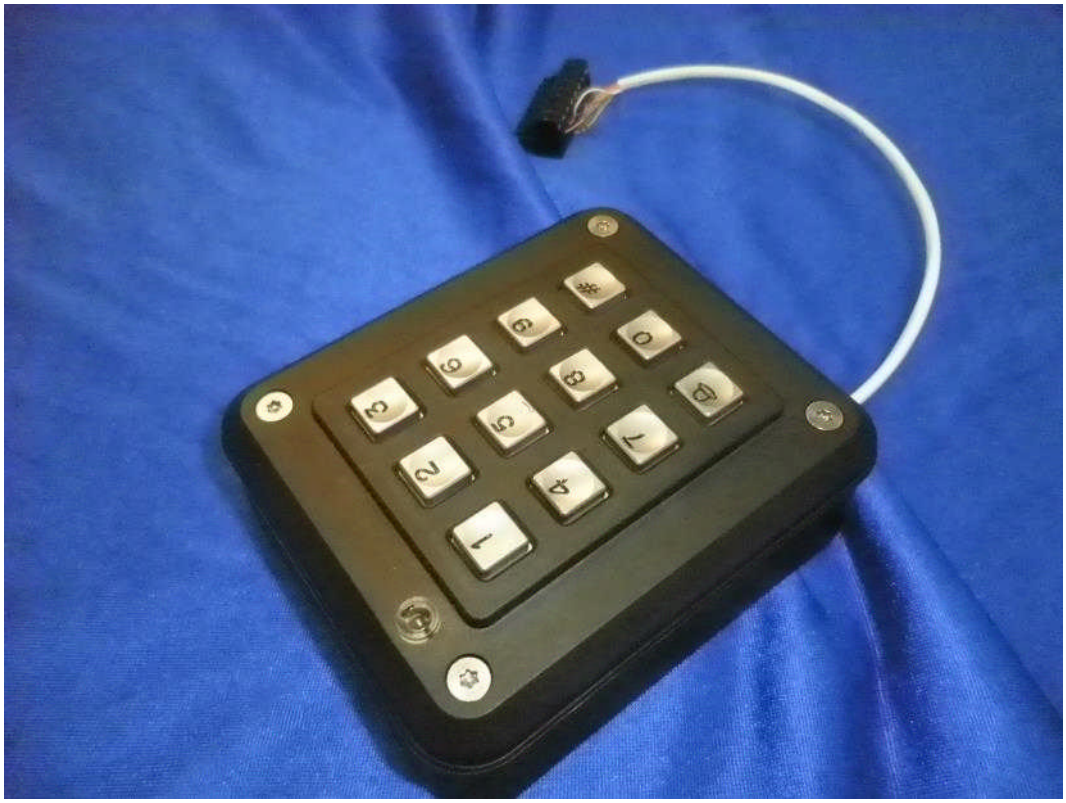
The limits given in the test standard are normally expressed as absolute values (e.g. in μV/m at a specified distance), whereas the measured values are expressed as peak, quasi peak or average values in dBμV/m referenced to the measuring instrument inputs. RN Electronics calibrate the test set-up to 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:

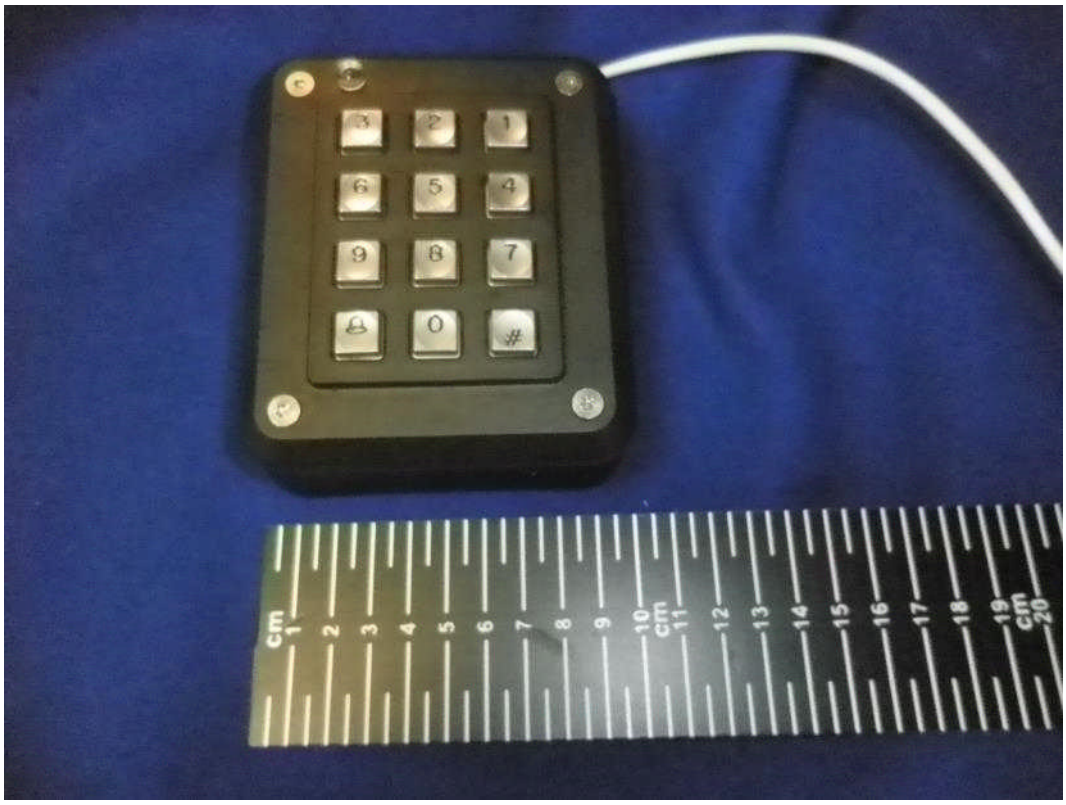
(a) limit of 500 μV/m equates to 20.log (500) = 54 dB μV/m.
(b) limit of 300 μV/m at 10m equates to 20.log (300 . 10/3) = 60 dB μV/m at 3m
(c) limit of 30 μV/m at 30m, but below 30MHz, equates to 20.log(30) + 40.log(30/3) = 69.5 dBμV/m at 3m, as extrapolation factor below 30MHz is 40dB/decade per 15.31(f)(2).

8 Photographs

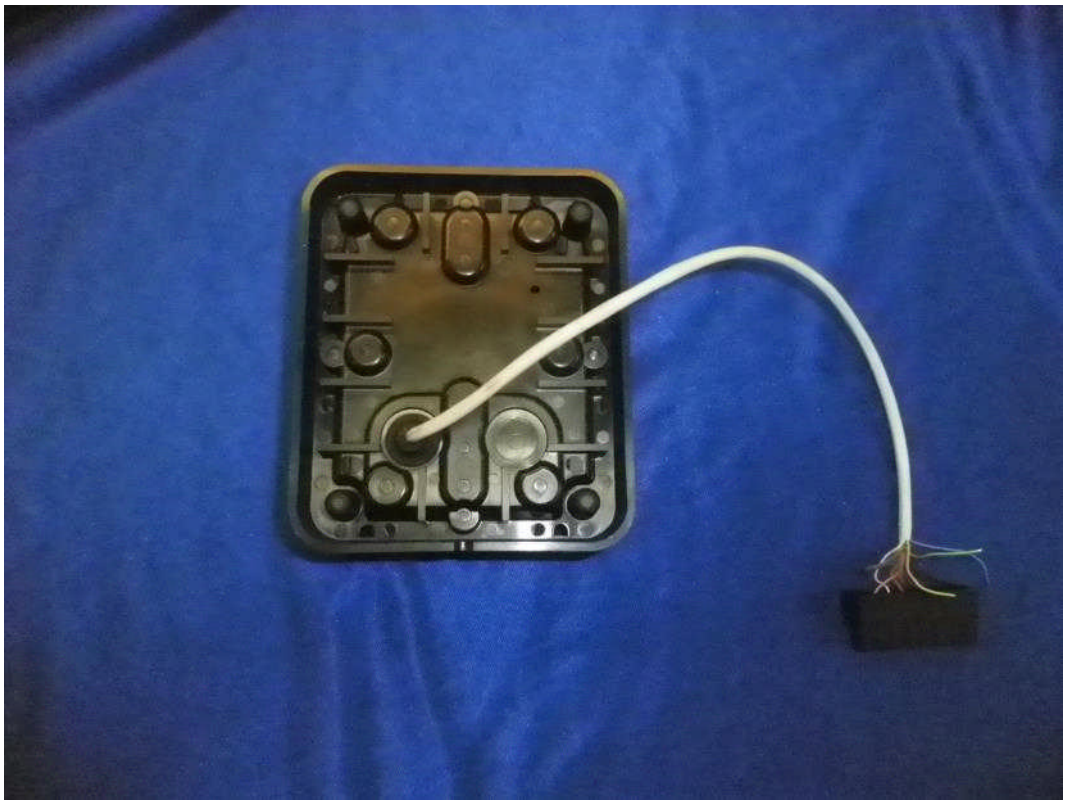
8.1 EUT Front View

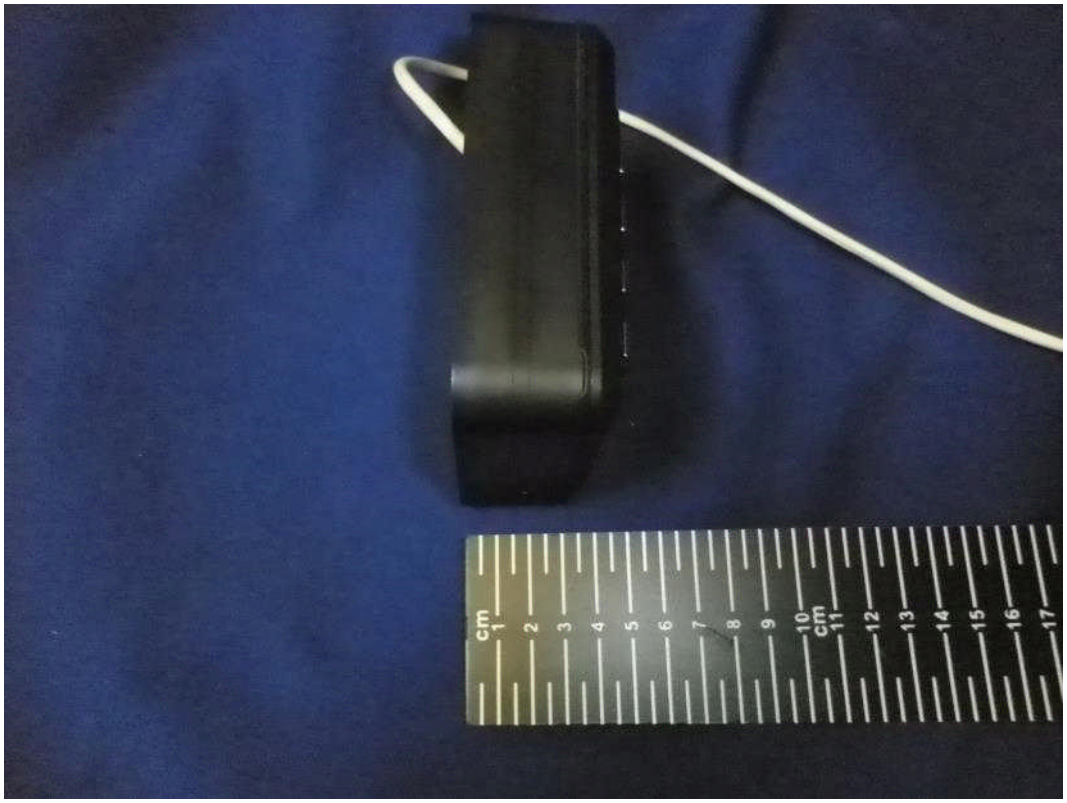


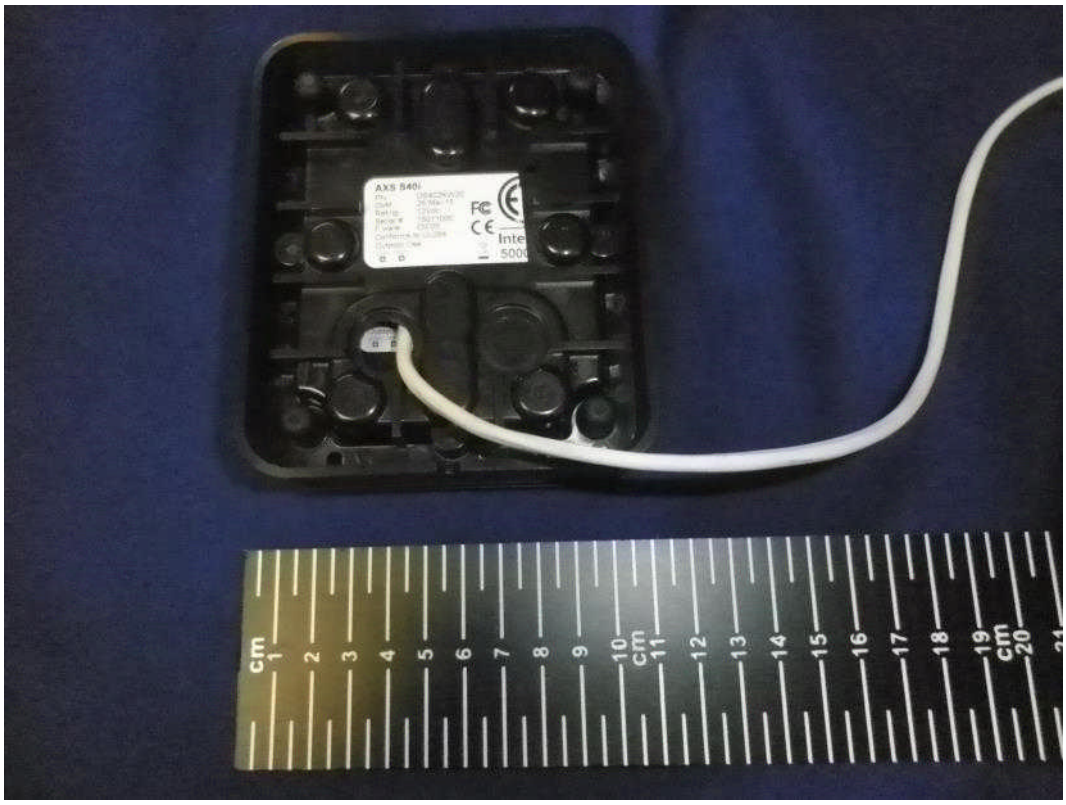




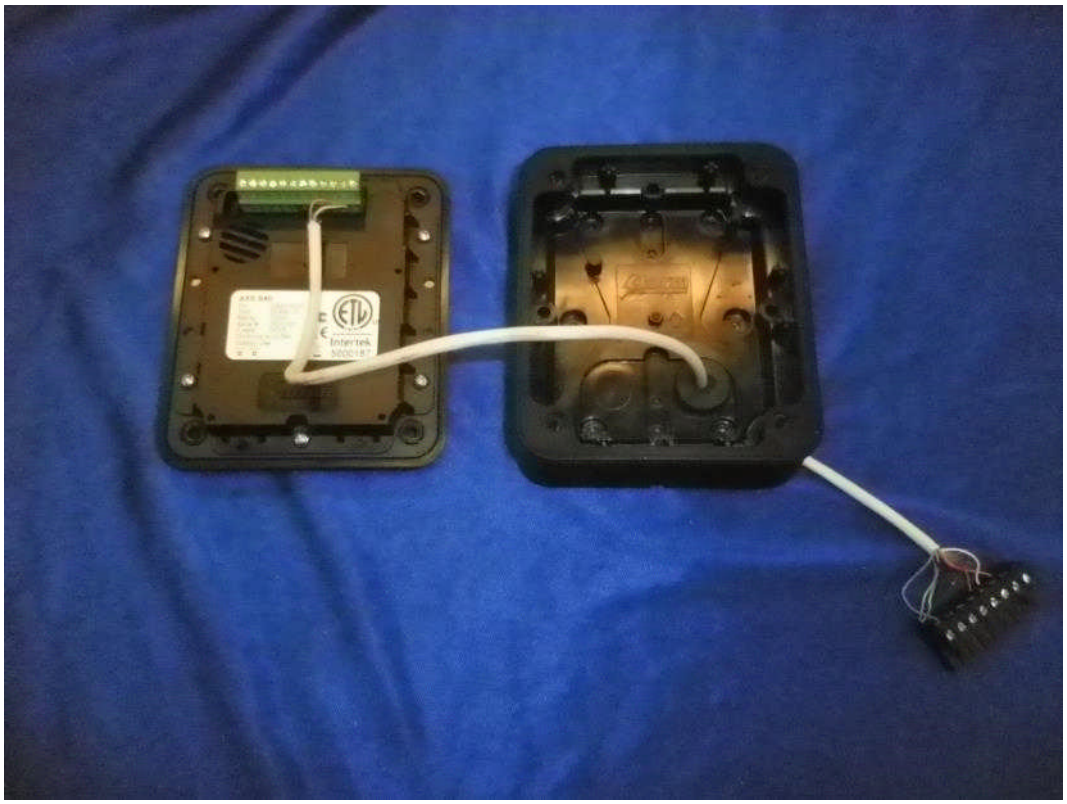
8.2 EUT Reverse Angle

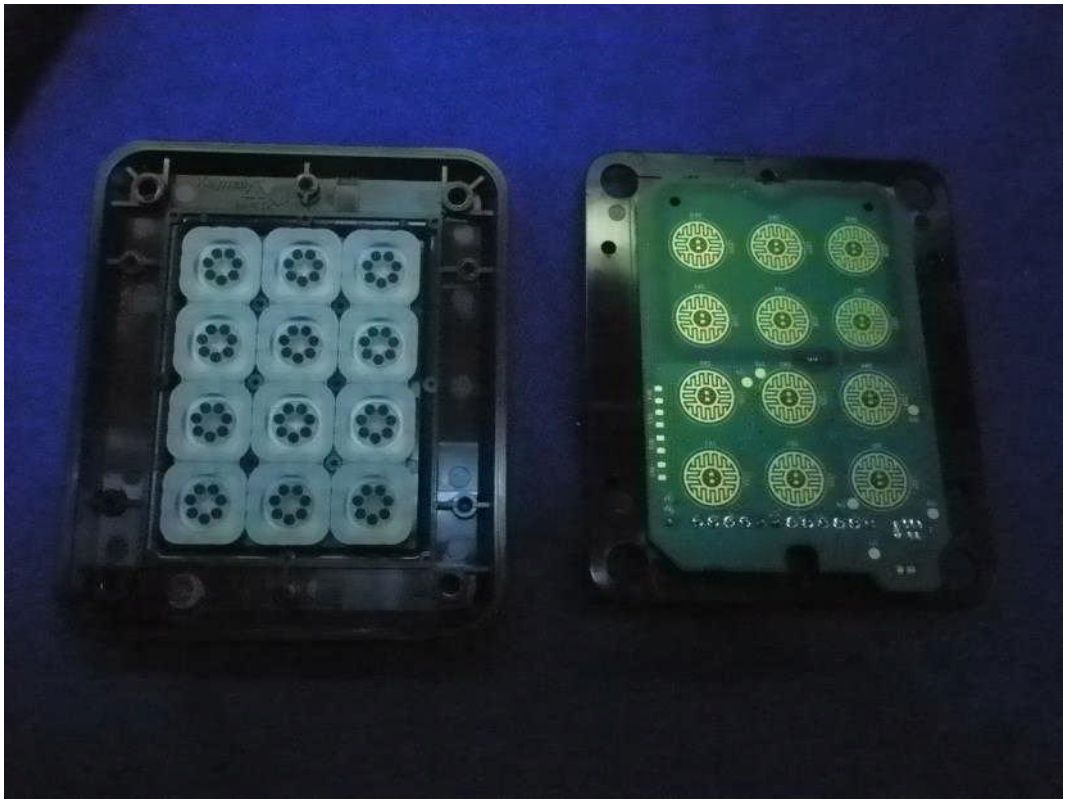


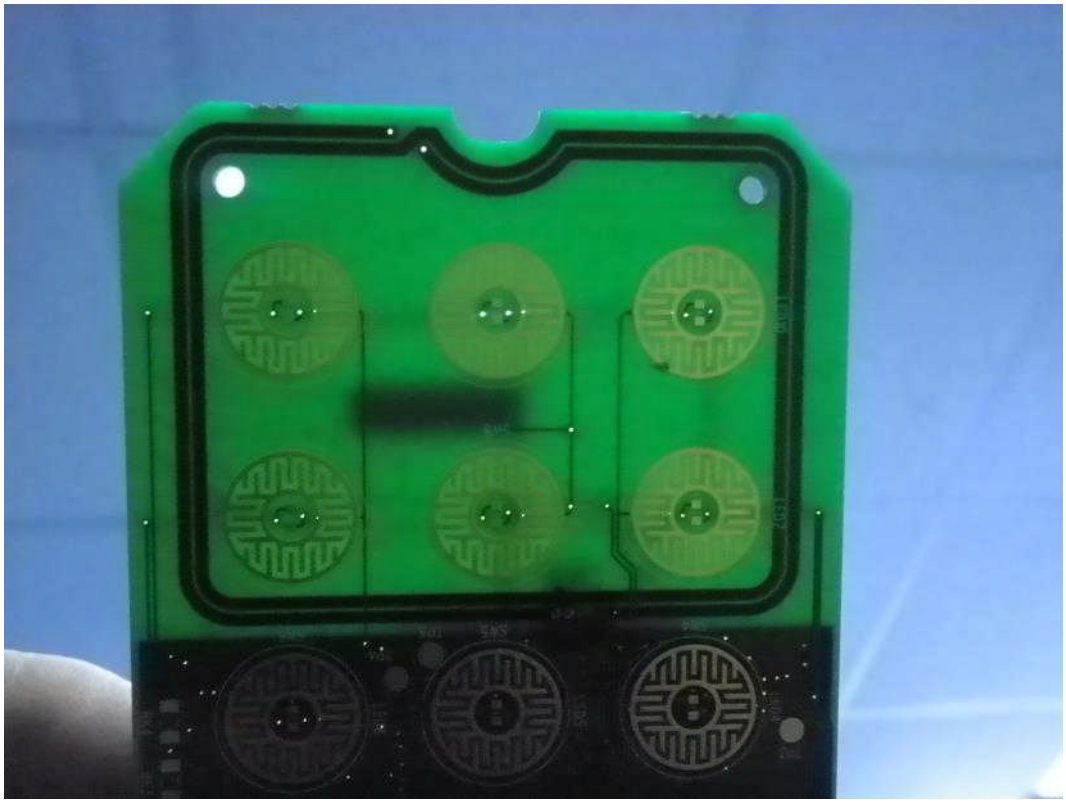




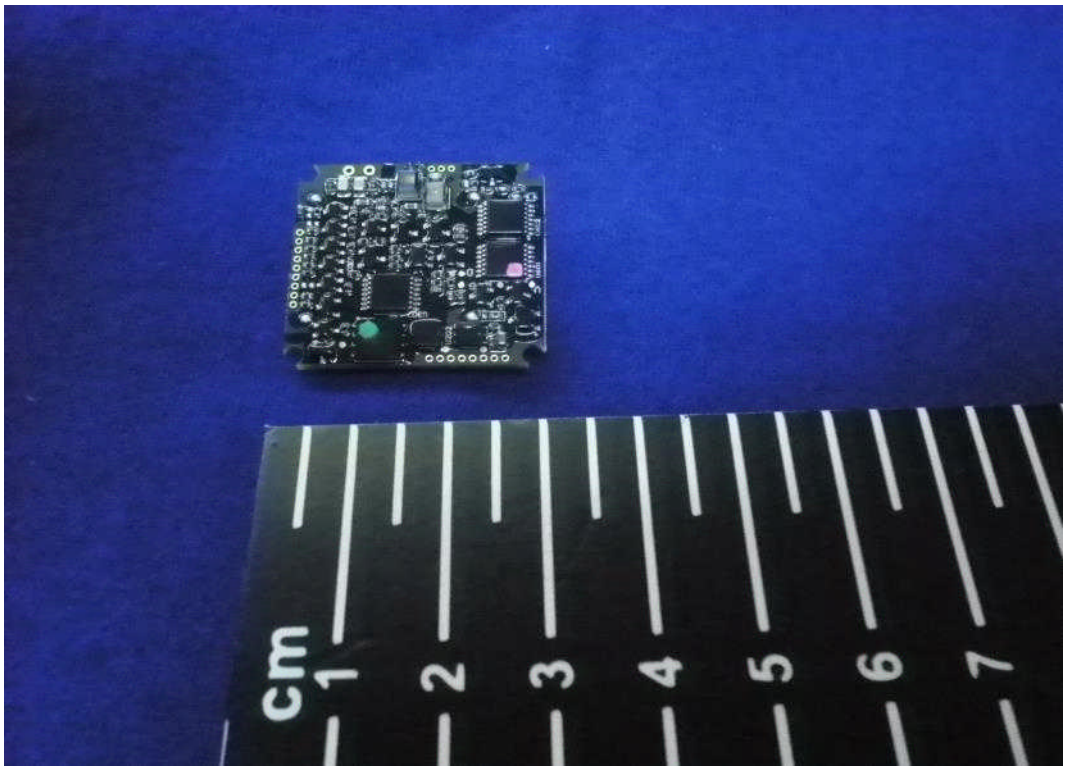
8.3 EUT Internal photos







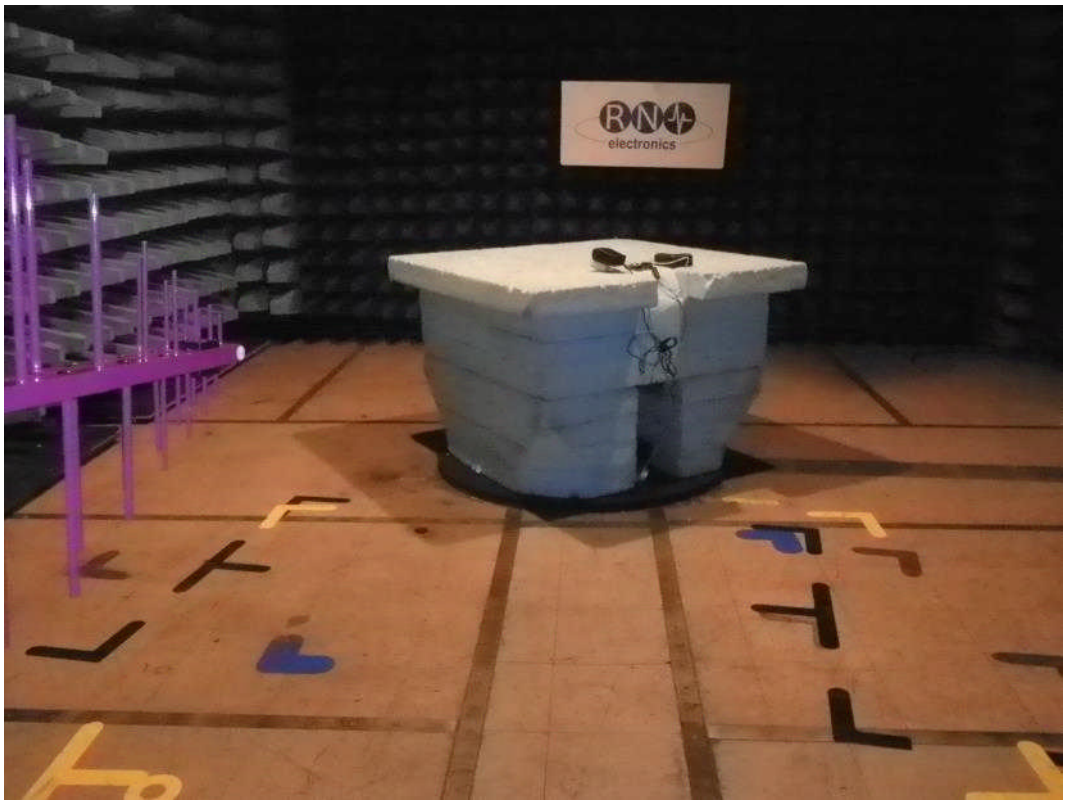
Photograph shows the EUTs integral antenna etched into the PCB material.

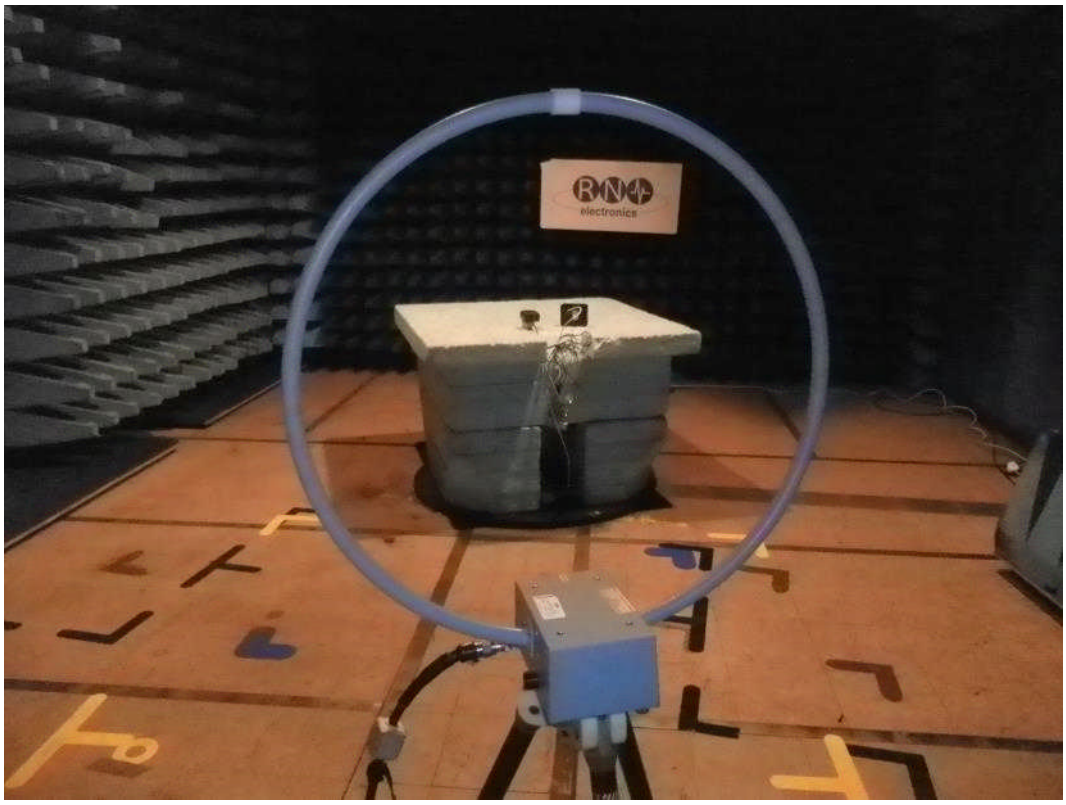

cm
1
2
3
4
5
6
7

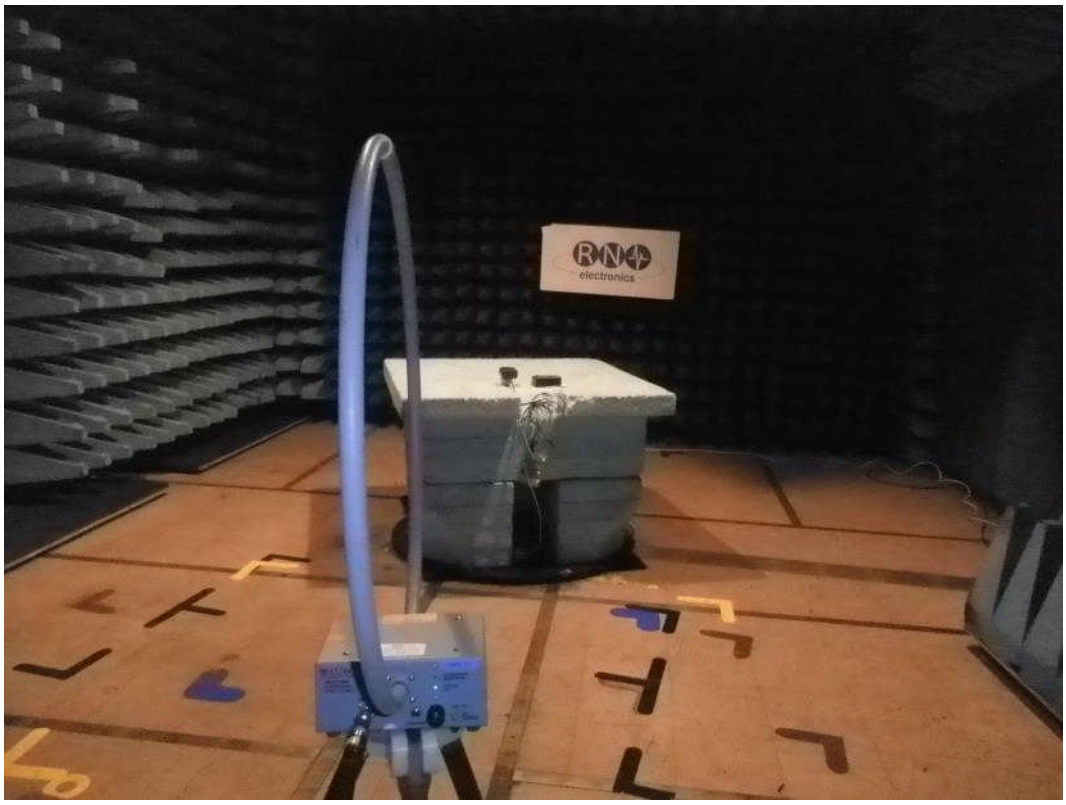
8.4 EUT ID Label

Not available at time of test.

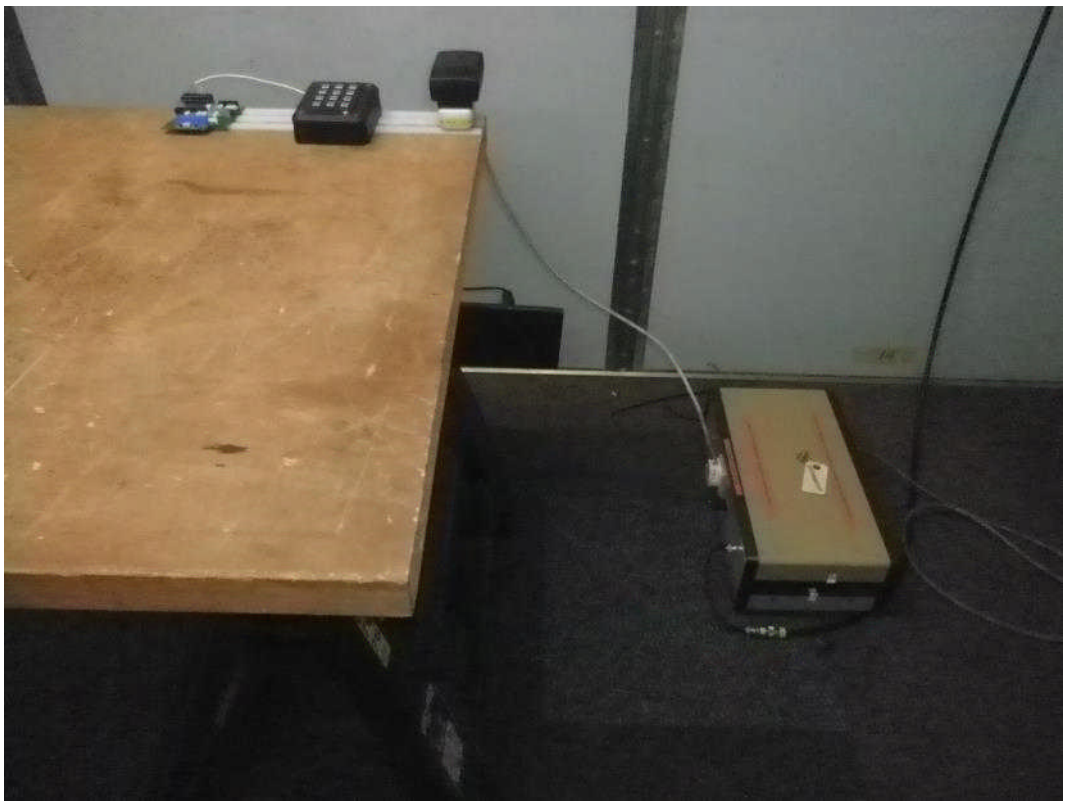
8.5 Spurious emissions test set-up







8.6 AC power line conducted emissions



8.7 Set-up diagrams

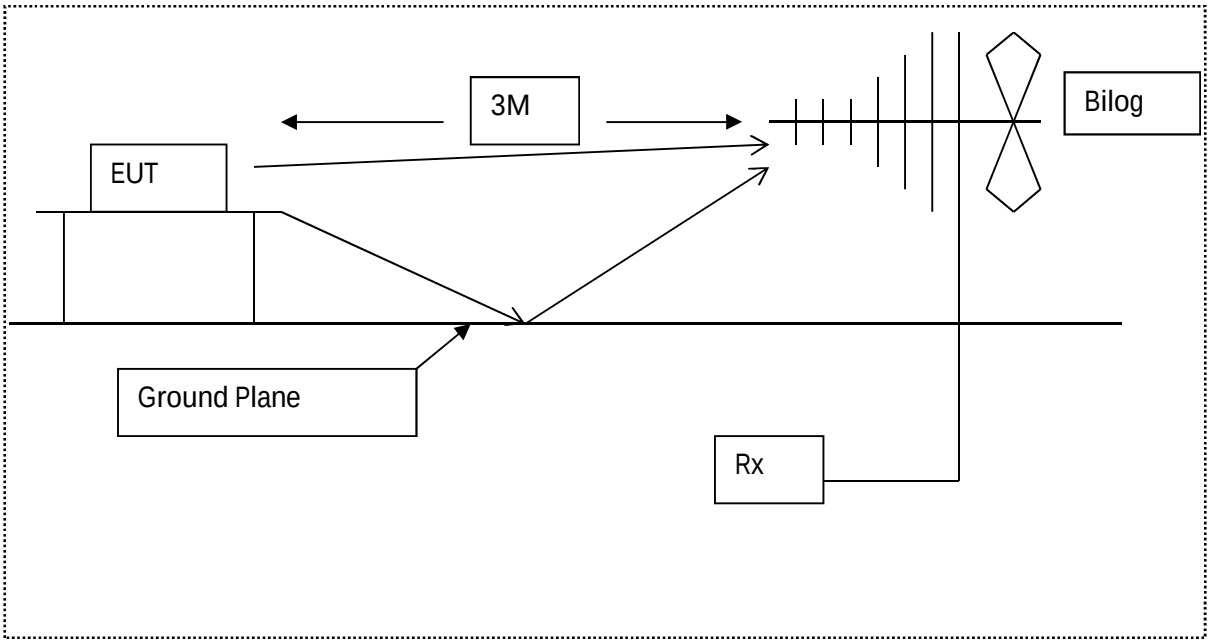


Diagram of the radiated emissions test setup 30-1000MHz.

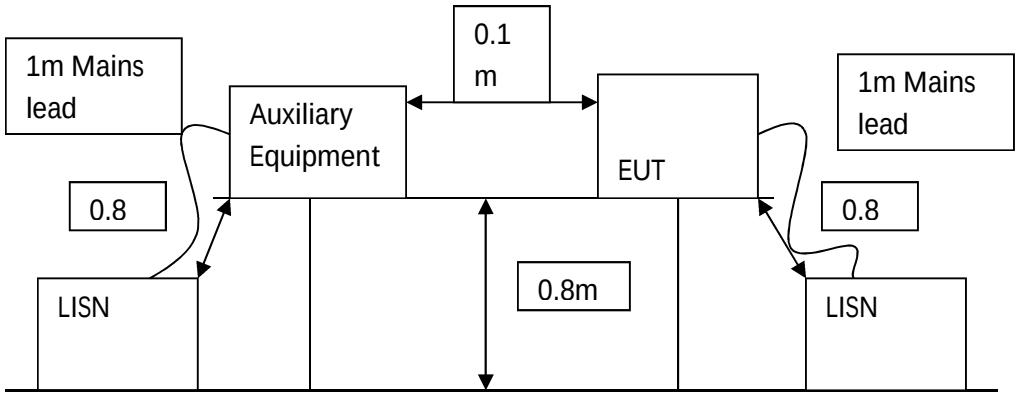


Diagram of the AC power line conducted emissions test setup.

9 Test equipment calibration list

The following is a list of the test equipment used by R.N. Electronics Ltd to test the unit detailed within this report. In line with our procedures, the equipment was within calibration for the period during which testing was carried out.

RN No.	Model No.	Description	Manufacturer	Calibration date	Cal period
E035	HP11947A	Transient Limiter + 10dB Atten.	Hewlett Packard	15-Dec-14	6 months
E150	MN2050	LISN 13A	Chase	06-Oct-14	12 months
E226	8546A	EMI Receiver	Hewlett Packard	18-Jun-14	12 months
E227	6632A	System DC Power Supply	Hewlett Packard	19-Mar-15	12 months
E410	N5181A	3 GHz MXG Signal Generator	Agilent Technologies	*30-Apr-15	36 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	*29-Apr-15	12 months
E412	E4440A	3 Hz - 26.5 GHz PSA	Agilent Technologies	*29-Apr-15	24 months
E465	PCR2000LA	AC Power Supply	KIKUSUI	*15-May-15	12 months
E533	N5182A	6 GHz MXG Signal Generator	Agilent Technologies	26-Feb-13	36 months
E534	E4440A	3 Hz - 26.5 GHz PSA	Agilent Technologies	26-Jan-15	24 months
E535	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	26-Jan-15	12 months
E570	K050120400F	3 Phase Power Supply	Harmer & Simmons	05-Jan-15	12 months
L264	DT75	Digital Thermometer	Instrotech Ltd	06-Dec-13	24 months
TMS80	206-3722	Digital Thermometer & K Probe	RS Components Ltd	07-Nov-14	12 months
TMS81	6502	Active Loop Antenna	EMCO	10-Dec-14	24 months
TMS933	CBL6141A	Bilog Antenna 30MHz - 2GHz	York EMC	29-Sep-14	24 months

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

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No
1	DTX	DTX Interface Board	Storm Interface	13012-0001

10.2 RN Electronics supplied equipment

RN No.	Model No.	Description	Manufacturer	Serial No
E541	n/a	Magnetic Loop	RN Electronics Ltd	n/a

11 Condition of the equipment tested

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

11 .1 Modifications before test

No modifications were made before test by RN Electronics Ltd.

11 .2 Modifications during test

No modifications were made during test by RN Electronics Ltd.

12 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:

Certified equipment – DoC not required.

11 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. 293246
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

12 Abbreviations and units

%	Percent	LBT	Listen Before Talk
µA/m	microAmps per metre	LO	Local Oscillator
µV	microVolts	mA	milliAmps
µW	microWatts	max	maximum
AC	Alternating Current	kPa	Kilopascal
ALSE	Absorber Lined Screened Enclosure	Mbit/s	MegaBits per second
AM	Amplitude Modulation	MHz	MegaHertz
Amb	Ambient	mic	Microphone
ATPC	Automatic Transmit Power Control	min	minimum
BER	Bit Error Rate	mm	milliMetres
ºC	Degrees Celsius	ms	milliSeconds
C/I	Carrier / Interferer	mW	milliWatts
CEPT	European Conference of Postal and Telecommunications Administrations	NA	Not Applicable
COFDM	Coherent OFDM	nom	Nominal
CS	Channel Spacing	nW	nanoWatt
CW	Continuous Wave	OATS	Open Area Test Site
dB	deciBels	OFDM	Orthogonal Frequency Division Multiplexing
dBµA/m	deciBels relative to 1µA/m	ppm	Parts per million
dBµV	deciBels relative to 1µV	PRBS	Pseudo Random Bit Sequence
dBc	deciBels relative to Carrier	QAM	Quadrature Amplitude Modulation
dBm	deciBels relative to 1mW	QPSK	Quadrature Phase Shift Keying
DC	Direct Current	R&TTE	Radio and Telecommunication Terminal Equipment
DTA	Digital Transmission Analyser	Ref	Reference
EIRP	Equivalent Isotropic Radiated Power	RF	Radio Frequency
ERP	Effective Radiated Power	RFC	Remote Frequency Control
EU	European Union	RSL	Received Signal Level
EUT	Equipment Under Test	RTP	Room Temperature and Pressure
FM	Frequency Modulation	RTPC	Remote Transmit Power Control
FSK	Frequency Shift Keying	Rx	Receiver
g	Grams	s	Seconds
GHz	GigaHertz	SINAD	Signal to Noise And Distortion
Hz	Hertz	Tx	Transmitter
IF	Intermediate Frequency	V	Volts
kHz	kiloHertz		