Radio Test Report

Keymat Technology Ltd trading as Storm Interface

DS60

47 CFR Part 15.225 Effective Date 1st October 2015
& 47CFR Part 15C Effective Date 1st October 2015
DXX: Part 15 Low Power communication device transmitter
Test Date: 6th to 8th April 2016
Report Number: 04-8392-4-16 Issue 02

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Certificate of Test 8392-4

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

Equipment:	DS60
Model Number:	DS60
Unique Serial Numbers:	14503-0008 14503-0007 (Modified unit used for AC conducted emissions only)
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:	04-8392-4-16 Issue 02
Proposed FCC ID:	2AEEZ-DS60
Test Standards:	47 CFR Part 15.225 Effective Date 1st October 2015 47CFR Part 15C Effective Date 1st October 2015 DXX: Part 15 Low Power communication device transmitter

NOTE:
Certain tests were not performed based upon manufacturer's declarations. For details refer to section 3 of this report. This report covers both the 13.56MHz and the 125kHz RFID operation of the product

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:	6th to 8th April 2016
Test Engineer:	Digitally signed by: Graham Blake DN: CN = Graham Blake C = GB O = RN Electronics Ltd Date: 2016.06.15 12:38:09 +01'00'
Approved By: Radio Approvals Manager	Digitally signed by: Daniel Sims DN: CN = Daniel Sims C = GB O = RN Electronics Ltd Date: 2016.06.15 09:10:06 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	Keymat Technology Ltd trading as Storm Interface	
Full Name of EUT	DS60	
Model Number of EUT	DS60	
Serial Number of EUT	14503-0008 14503-0007 (Modified unit used for AC conducted emissions only)	
Date Received	6th April 2016	
Date of Test:	6th to 8th April 2016	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Created	25th April 2016	
Main Function	Contactless Card coupler with PIN for Access Control	
Information Specification	Height	200 mm
	Width	45 mm
	Depth	21 mm
	Weight	0.05 kg
	Voltage	10.8 - 13.8 VDC

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Wall mounted
Choice of model(s) for type tests	Production Sample
Antenna details	Integral
Antenna port	No
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	48 MHz
Lowest Signal generated in EUT	125 kHz
TX Parameters	
Alignment range – transmitter	13.56 MHz (Single frequency) 125 kHz (Single frequency)
EUT Declared Modulation Parameters	ASK
EUT Declared Power level	13.56 MHz - 0.4 Watt 125 kHz – Not declared
EUT Declared Signal Bandwidths	13.56 kHz - 14 kHz 125 kHz – 1.58 kHz / 2.42 kHz
EUT Declared Channel Spacing's	Single frequency only
EUT Declared Duty Cycle	13.56 MHz – 17.3% (CARD PRESENTED) 50% POLLING 125kHz – 16.0% (CARD PRESENTED) 50% POLLING
Unmodulated carrier available?	No
Declared frequency stability	<100 ppm
RX Parameters	
Alignment range – receiver	13.56 MHz (Single frequency) 125 kHz (Single frequency)
FCC Class	
DXX: Part 15 Low Power communication device transmitter	

2.3 Functional description

The EUT incorporates two separate card readers and is compatible with many types of 125kHz and 13.56MHz RFID cards. The device is normally idle, polling for a card. When a valid card is presented the card data is sent over the Wiegand interface to a remote controller. Optionally a PIN can be entered and the data sent to the remote controller.

2.4 Modes of operation

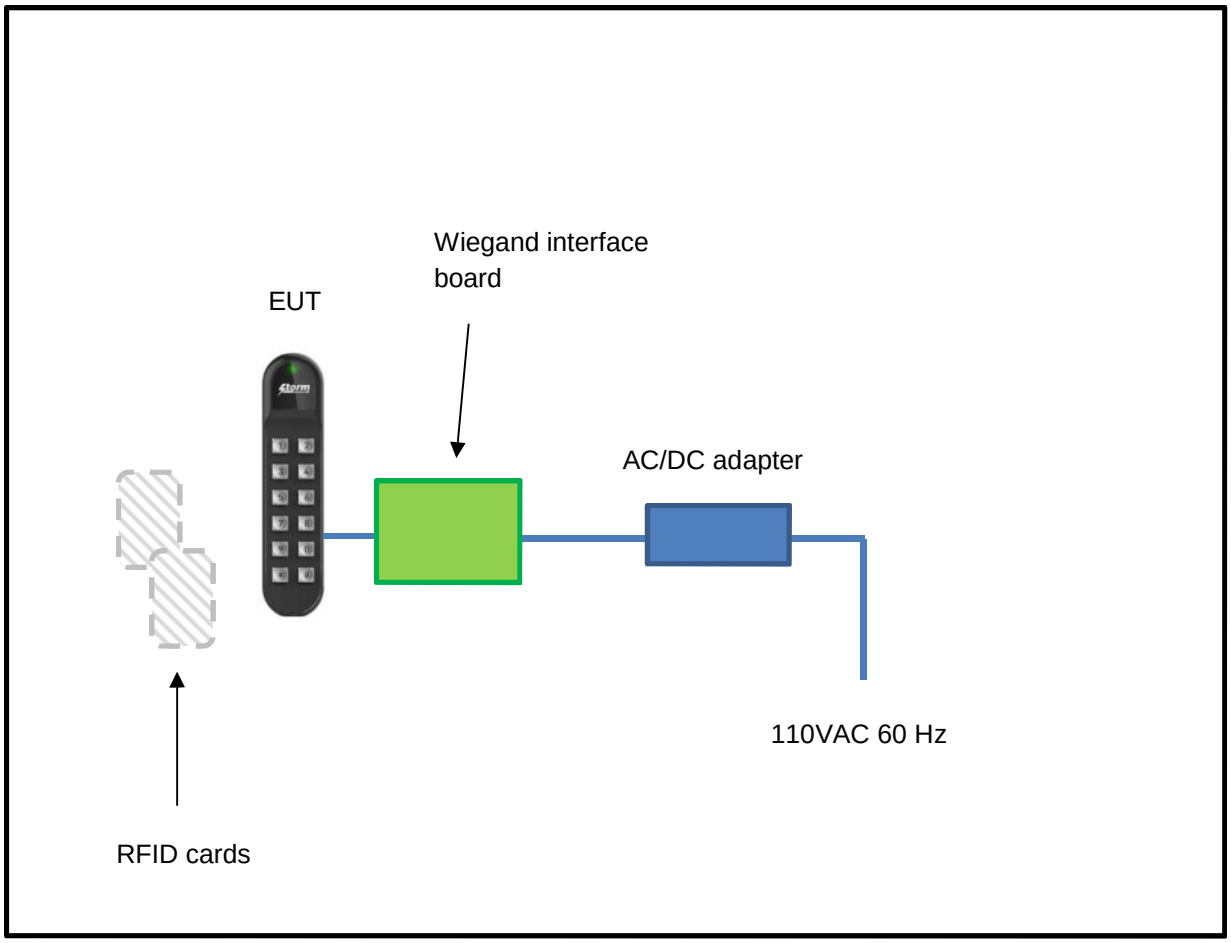
Mode Reference	Description	Used for testing
POLLING	The EUT is powered. The 13.56 MHz and 125 kHz readers are continuously polling and waiting to read a card. EUT is IDLE between transmissions.	YES
13.56MHz CARD PRESENTED	A 13.56 MHz card is presented and the card data is read repeatedly. EUT is IDLE between each card read.	YES
125kHz CARD PRESENTED	A 125 kHz card is presented and the card data is read repeatedly. EUT is IDLE between each card read.	YES
IDLE	The period of time between transmissions when the 13.56 MHz or the 125 kHz readers are not transmitting.	YES

Note: In operation both of the EUTs card readers transmit alternately with a short idle time between transmissions. During testing, it was not possible to disable the transmitters, and therefore not possible to assess the EUT in idle mode alone, as a consequence idle mode has effectively been assessed at the same time as the other modes.

In normal operation the EUT reads the data from a presented RFID card and then takes action (the sounder ‘beeps’ and the LED changes colour from red to green). In normal operation, if the card was held close to the EUT continuously, the EUT would initially respond, and then take no further action after the first event had been triggered (the EUT would read the card again however since the serial number was identical to the last read card, the EUT ‘ignored’ it). For the purposes of test, the manufacturer provided a modified unit where this function had been disabled so that the EUT would take action each time a card was read even if the same serial number was read repeatedly. The manufacturer considered this to be worst case approach as it exercised the full functionality of the EUT.

2.5 Emissions configuration

Test Area



The unit was powered from an AC/DC adapter via the Wiegand interface board. When no RFID card is present both readers are active and are both polling (waiting for a card to be read). When an RFID card was positioned in close proximity to the EUT, the unit would read the card data and the received data was sent to the Wiegand interface module. For the purposes of test, the EUT was programmed to allow the EUT to read the RFID card data continuously.

Prior to full test, a pre-test was performed to assess each test mode to determine worst-case emissions. To limit the size of this report only worst-case plots have been included.

The EUT is DC powered and the manufacturer states that the end-user would normally provide a suitable DC power source. The AC/DC adapter and interface board are only provided by the manufacturer for the purposes of test and are not supplied with the product.

For AC conducted emissions, a second test unit was provided which had been modified by disconnecting the integral 13.56 MHz antenna from the radio module and terminating the antenna port with a 50 ohm impedance load.

For field strength measurements max-held spectrum analyser plots were taken using peak detection.

Note: The DS60 is available with an option of metal or plastic keys. The DS60 is also available with the 125 kHz card reader functionality disabled. Prior to full-test an assessment was made to establish worst case emissions. A unit was tested with plastic keys and then the keys were replaced with metal keys. There was no significant difference between the two sets of measurements. A unit was tested with the 125 kHz reader disabled and compared to a unit with both 13.56 MHz and 125 kHz enabled. There was no significant difference between the two sets of measurements. For final tests a unit with plastic keys was selected for test which had both 125 kHz and 13.56 MHz readers enabled. This was considered as worst case configuration and exercised the full functionality of the EUT.

2.5.1 Signal leads

Port Name	Cable Type	Connected
Power +12V	Multi-core shielded cable	Yes
Power 0V	Multi-core shielded cable	Yes
Wiegand D0	Multi-core shielded cable	Yes
Wiegand D1	Multi-core shielded cable	Yes
Indicator input	Multi-core shielded cable	Yes
Beep input	Multi-core shielded cable	Yes
Tamper	Multi-core shielded cable	Yes

3 Summary of test results

The DS60 was tested for compliance to the following standards :

47 CFR Part 15.225 Effective Date 1st October 2015
47CFR Part 15C Effective Date 1st October 2015
DXX: Part 15 Low Power communication device transmitter

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. 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 or the essential requirements of the directive, particularly under different conditions to those during testing. 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%.

Title	References	Results
Transmitter Tests		
1. AC power line conducted emissions	47 CFR Part 15C Part 15.207	PASSED
2. Radiated emissions 9 - 150 kHz	47 CFR Part 15C Part 15.209	PASSED
3. Radiated emissions 150 kHz - 30 MHz	47 CFR Part 15C Part 15.209	PASSED
4. Radiated emissions 30 MHz -1 GHz	47 CFR Part 15C Part 15.225	PASSED[1]
5. Intentional radiator field strength	47 CFR Part 15C Part 15.225(a)	PASSED
6. Occupied bandwidth	47 CFR Part 15C Part 15.215	PASSED
7. Spectrum mask	47 CFR Part 15C Part 15.225	PASSED
8. Frequency stability	47 CFR Part 15C Part 15.225(e)	PASSED

[1] Spectrum investigated started at a frequency of 30MHz up to a frequency of 1 GHz based on 10 times the highest channel/ signal generated in equipment of 48 MHz.

Note: Results summary shown pertains to both the 13.56MHz and the 125kHz RF operation of the device.

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 15C	2014	Federal Communications Commission PART 15 – RADIO FREQUENCY DEVICES
4.1.2	ANSI C63.10	2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
4.1.3	ANSI C63.4	2014	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

4.2 Deviations

Deviations have not been 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 nominal	20 °C	V nominal	12V DC
T minimum	-20 °C	V minimum	10.8V DC
T maximum	50 °C	V maximum	13.8V DC

Extremes of voltage are as declared by the applicant.

Extremes of temperature are as listed in the standard.

The ambient test conditions of humidity and pressure in the laboratory were as follows: 50%; 101kPa.

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.

5 Tests, methods and results

5.1 AC power line conducted emissions

5.1.1 Test methods

Test Requirements: 47 CFR Part 15C 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 15C 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 and connected to a LISN via a 1m mains cable. Details of the Peripheral and Ancillary Equipment connected for this test is listed in section 10. No discernible difference was noted in emissions between card presented and not presented modes, therefore for full tests and to get both 13.56MHz and 125kHz transmitters operating, the EUT was operated in **POLLING** and **IDLE** modes.

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 and/or all signals within 10dB of the limit were investigated.

Tests were performed in Test Site F.

5.1.4 Test equipment

E010, E035, E150, E410, E411, E412, E465

See Section 9 for more details

5.1.5 Test results

Temperature of test environment	20°C
Humidity of test environment	40%
Pressure of test environment	100kPa

Band	13.11-14.01 MHz & 125kHz
Power Level declared	0.4 Watts
Channel Spacing	Single Channel
Mod Scheme	ASK
Single channel	13.56 MHz & 125kHz operation

Plot refs
8392-4 Cond 1 AC Live 150k-30M Average
8392-4 Cond 1 AC Live 150k-30M Quasi-Peak
8392-4 Cond 1 AC Neutral 150k-30M Average
8392-4 Cond 1 AC Neutral 150k-30M Quasi-Peak

Table of signals measured for Cond 1 AC Live 150kHz-30MHz

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)	AV Amp (dBuV)	AV Lim (dB)
1	0.153	51.0	48.6	-17.2	34.2	-21.6
2	0.184	47.2	43.4	-20.9	26.6	-27.7
3	0.208	44.9	41.3	-22.0	23.2	-30.1
4	0.232	40.5	38.0	-24.4	20.2	-32.2
5	**13.562**	**68.9**	**66.9**	**6.9***	**52.6**	**2.6***
6	13.604	51.2	42.9	-17.1	14.7	-35.3
7	13.647	43.2	35.0	-25.0	11.5	-38.5
8	13.693	45.9	35.8	-24.2	11.8	-38.2
9	26.997	37.0	34.9	-25.1	28.6	-21.4

Table of signals measured for Cond 1 AC Neutral 150kHz-30MHz

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)	AV Amp (dBuV)	AV Lim (dB)
1	0.153	50.9	48.7	-17.1	34.4	-21.4
2	0.176	50.9	46.6	-18.1	31.4	-23.3
3	0.213	45.9	42.3	-20.8	23.6	-29.5
4	13.487	44.1	33.9	-26.1	12.0	-38.0
5	**13.562**	**69.0**	**67.0**	**7.0***	**52.7**	**2.7***
6	13.611	51.3	43.0	-17.0	15.9	-34.1
7	13.611	51.3	43.1	-16.9	15.8	-34.2
8	26.622	34.2	31.4	-28.6	25.0	-25.0
9	26.747	36.9	34.9	-25.1	28.5	-21.5
10	27.247	36.4	34.7	-25.3	28.3	-21.7
11	27.497	36.3	34.4	-25.6	28.1	-21.9

*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.

Band	13.11-14.01 MHz & 125kHz
Power Level	0.4 Watts
Channel Spacing	Single Channel
Mod Scheme	ASK
Single channel	13.56 MHz & 125kHz operation

Plot refs
8392-4 Cond 3 AC Live 150k-30M Average
8392-4 Cond 3 AC Live 150k-30M Quasi-Peak
8392-4 Cond 3 AC Neutral 150k-30M Average
8392-4 Cond 3 AC Neutral 150k-30M Quasi-Peak

Table of signals measured for Cond 1 AC Live 150kHz-30MHz (Integral antenna disconnected)

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)	AV Amp (dBuV)	AV Lim (dB)
1	0.170	47.5	44.7	-20.3	28.7	-26.3
2	0.199	43.6	41.0	-22.7	24.5	-29.2
3	0.242	38.7	35.2	-26.8	18.7	-33.3
4	13.560	34.0	31.6	-28.4	18.9	-31.1
5	27.051	25.1	21.4	-38.6	14.2	-35.8

Table of signals measured for Cond 1 AC Neutral 150kHz-30MHz (Integral antenna disconnected)

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)	AV Amp (dBuV)	AV Lim (dB)
1	0.153	50.0	46.3	-19.5	31.0	-24.8
2	0.171	47.1	44.5	-20.4	29.6	-25.3
3	0.224	40.5	37.8	-24.9	23.6	-29.1
4	13.560	34.4	31.8	-28.2	19.3	-30.7
5	27.899	30.2	27.8	-32.2	21.3	-28.7

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) 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.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
150kHz to 30MHz ±3.6dB

5.2 Radiated emissions 9 - 150 kHz

5.2.1 Test methods

Test Requirements:	47 CFR Part 15C 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 15C Part 15.225(d) [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 antenna was orientated in both Parallel and Perpendicular polarisations. The EUT was rotated in all three orthogonal planes. No discernible difference was noted in emissions between card presented and not presented modes, therefore for full tests and to get both 13.56MHz and 125kHz transmitters operating, the EUT was operated in **POLLING** and **IDLE** modes.

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 (pre-scan) with final measurements on an OATS without a ground plane. 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 H and OATS.

5.2.4 Test equipment

E533, E534, E535, TMS45, TMS81

See Section 9 for more details

5.2.5 Test results

Temperature of test environment	20°C
Humidity of test environment	40%
Pressure of test environment	101kPa

Band	13.11-14.01 MHz & 125kHz
Power Level	0.4 Watts
Channel Spacing	Single Channel
Mod Scheme	ASK
Single channel	13.56 MHz & 125kHz operation

Plot refs
8392-4 9-150k Parallel
8392-4 9-150k Perpendicular

No emissions were observed within 20 dB of the limit

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.

n.b. the general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
9kHz - 30MHz ±3.9dB

5.3 Radiated emissions 150 kHz - 30 MHz

5.3.1 Test methods

Test Requirements:	47 CFR Part 15C 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 15C Part 15.225(d) [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 antenna was orientated in both Parallel and Perpendicular polarisations. The EUT was rotated in all three orthogonal planes. No discernible difference was noted in emissions between card presented and not presented modes, therefore for full tests and to get both 13.56MHz and 125kHz transmitters operating, the EUT was operated in **POLLING** and **IDLE** modes.

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 (pre-scan) with final measurements on an OATS without a ground plane. 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 H and OATS.

5.3.4 Test equipment

E533, E534, E535, TMS45, TMS81

See Section 9 for more details

5.3.5 Test results

Temperature of test environment	21°C
Humidity of test environment	50%
Pressure of test environment	101kPa

Band	13.11-14.01 MHz & 125kHz
Power Level	0.4 Watts
Channel Spacing	Single Channel
Mod Scheme	ASK
Single channel	13.56 MHz & 125kHz operation

Plot refs
8392-4 150k-30M Parallel
8392-4 150k-30M Perpendicular

No emissions were observed within 20dB of the limit

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.
n.b. the general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
9kHz - 30MHz ±3.9dB

5.4 Radiated emissions 30 MHz -1 GHz

5.4.1 Test methods

Test Requirements: 47 CFR Part 15C 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 15C Part 15.225(d) [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. No discernible difference was noted in emissions between card presented and not presented modes, therefore for full tests and to get both 13.56MHz and 125kHz transmitters operating, the EUT was operated in **POLLING** and **IDLE** modes.

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. The measuring antenna was scanned 1 - 4m in both Horizontal and Vertical polarisations. The equipment and the antenna were rotated 360 degrees to record the worst case emissions. Tests were performed in Test Site H.

5.4.4 Test equipment

E533, E534, E535, LPE364, TMS45

See Section 9 for more details

5.4.5 Test results

Temperature of test environment	21°C
Humidity of test environment	50%
Pressure of test environment	101kPa

Band	13.11-14.01 MHz & 125kHz
Power Level	0.4 Watts
Channel Spacing	Single Channel
Mod Scheme	ASK
Single channel	13.56 MHz & 125kHz operation

Plot refs
8392-4 Rad 2 VHF Horiz
8392-4 Rad 2 VHF Vert
8392-4 Rad 2 UHF Horiz
8392-4 Rad 2 UHF Vert

Table of signals measured for Rad 2 Horizontal Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP Lim (dB)
1	203.420	34.0	31.6	-11.9
2	230.550	36.4	33.7	-12.3
3	257.640	33.6	28.9	-17.1
4	339.060	30.7	25.3	-20.7
5	352.560	31.0	25.7	-20.3
6	790.881	35.8	29.2	-16.8

Table of signals measured for Rad 2 Vertical Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP Lim (dB)
1	40.683	39.4	36.7	-3.3
2	59.010	28.7	23.5	-16.5
3	67.809	36.2	30.2	-9.8
4	108.480	24.3	25.6	-17.9
5	108.489	22.9	26.5	-17.0
6	339.031	27.2	25.2	-20.8
7	339.060	31.2	24.3	-21.7
8	393.240	30.8	24.1	-21.9

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.
n.b. the general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
30MHz - 1000MHz ±5.1dB

5.5 Intentional radiator field strength

5.5.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.225(a) [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 15C Part 15.225(a) [Reference 4.1.1 of this report]
47 CFR Part 15C Part 15.209 [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 antenna was orientated in both Parallel and Perpendicular polarisations. The EUT was rotated in all three orthogonal planes. The EUT was operated in **POLLING** mode.

5.5.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.
Pre-scan measurements were made at Site H & final measurements were made at site OATS.
This site is listed with the FCC.
Both the equipment and the antenna were rotated 360 degrees to record the maximised emission.

5.5.4 Test equipment

E285, E533, E534, E535, TMS45, TMS81

See Section 9 for more details

5.5.5 Test results

Temperature of test environment	21°C
Humidity of test environment	50%
Pressure of test environment	101kPa

13.56 MHz operation

Band	13.11-14.01 MHz
Power Level	0.4 Watts
Channel Spacing	Single Channel
Mod Scheme	ASK
Single channel	13.56 MHz

	13.56MHz channel
Peak Level (dBµV/m) @ 3m	74.5
Plot reference	8392-4 FS Parallel Upright
Antenna Polarisation	Parallel
EUT Polarisation	Upright

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

An extrapolation factor of 40dB/decade per ANSI C63.10:2013 clause 6.4 is applied to the 3m results to give the following field strengths at 30m for comparison to the limits:

Peak Level (dBµV/m) @ 30m	34.5

LIMITS: 13.56MHz operation:

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.

125 kHz operation

Band	110-490 kHz
Power Level	Not stated
Channel Spacing	Single Channel
Mod Scheme	ASK
Single channel	125 kHz

	Single
Peak Level (dBµV/m) @ 3m	83.5
Plot reference	8392-4 FS Parallel Side
Antenna Polarisation	Parallel
EUT Polarisation	Side

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

LIMITS: 125kHz operation

The intentional radiator field strength shall not exceed the general radiated emissions limits of 15.209.
0.009 – 0.490 MHz: 2400/F (kHz) uV/m @ 300 metres.

Therefore for 125 kHz the limit is 2400/125 = 19.2 uV/m @ 300m (or 25.7 dBuV/m)

Using an extrapolation factor of 40dB per decade as per FCC 15.31(2) gives a limit of 105.7 dBuV/m @ 3 meters.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 3.9 dB

5.6 Occupied bandwidth

5.6.1 Test methods

Test Requirements: 47 CFR Part 15C 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 15C Part 15.215 [Reference 4.1.1 of this report]

5.6.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable in a chamber and was positioned for maximised emissions. The EUT was operated in **13.56MHz CARD PRESENTED** and **125kHz CARD PRESENTED** modes.

5.6.3 Test procedure

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

5.6.4 Test equipment

E533, E534, E535, TMS81

See Section 9 for more details

5.6.5 Test results

Temperature of test environment	21°C
Humidity of test environment	50%
Pressure of test environment	101kPa

13.56 MHz

Band	13.11-14.01 MHz
Power Level	0.4 Watts
Channel Spacing	Single Channel
Mod Scheme	ASK
Single channel	13.56 MHz

	Single channel 13.56MHz
20dB Bandwidth (kHz)	363
Plot reference	8392-4 OBW 13.56MHz CARD PRESENT

125 kHz

Band	110-490 kHz
Power Level	Not stated
Channel Spacing	Single Channel
Mod Scheme	ASK
Single channel	125 kHz

	Single channel 125kHz
20dB Bandwidth (kHz)	4.884
Plot reference	8673-3 1k RBW

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.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1.9 %

5.7 Spectrum mask

5.7.1 Test methods

Test Requirements: 47 CFR Part 15C 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 15C Part 15.225(a)/(b)/(c)/(d) [Reference 4.1.1 of this report]

5.7.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The EUT was measured at a distance of 3 metres. The EUT and antenna were positioned for maximum field strength and referenced to the field strength measured on the OATS. The EUT was operated in **13.56MHz CARD PRESENTED** mode.

5.7.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.
Measurements were made at Site H. This site is listed with the FCC.
Max-held plots were taken and results were referenced to limits at 30m by using the extrapolation factor of 40dB/decade, per ANSI C63.10 clause 6.4

5.7.4 Test equipment

E533, E534, E535, TMS45, TMS81

See Section 9 for more details

5.7.5 Test results

Temperature of test environment	21°C
Humidity of test environment	50%
Pressure of test environment	101kPa

Band	13.11-14.01 MHz
Power Level	0.4 Watts
Channel Spacing	Single Channel
Mod Scheme	ASK
Single channel	13.56 MHz

	Single
Nominal, Maximised RF Output / field strength	34.5 dBuV/m
Nominal plot reference	8392-4 FCC15.225 Spectrum mask at 30metres

Analyser plots can be found in Section 6 of this report.
Note: 125kHz RFID operation has no specific mask limits, please refer to emissions results 9k-150kHz.

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.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 4.1 dB

5.8 Frequency stability

5.8.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.225(c) [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 15C Part 15.225(c) [Reference 4.1.1 of this report]

5.8.2 Configuration of EUT

The EUT's power port was connected to a variable power supply. This allowed the voltage end points to be set as declared by the manufacturer. 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 **POLLING** mode.

5.8.3 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. A frequency count was made on a CW signal. At nominal temperature the EUT supply was varied to the manufacturers stated end points. A max-held 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.
Tests were performed using Test Site A.

5.8.4 Test equipment

E227, E412, E434, E541, L264, TMS38, P266

See Section 9 for more details

5.8.5 Test results

Temperature of test environment 20°C
Humidity of test environment 50%
Pressure of test environment 101kPa

Band	13.11-14.01 MHz
Power Level	0.4 Watts
Channel Spacing	Single Channel
Mod Scheme	ASK
Single channel	13.56 MHz

Test conditions		Frequency Reading (MHz) Single
-20°C	Volts Nominal (12V)	13.561000
-10°C	Volts Nominal (12V)	13.560993
0°C	Volts Nominal (12V)	13.560999
10°C	Volts Nominal (12V)	13.560912
20°C	Volts Minimum (10.8V)	13.560918
	Volts Nominal (12V)	13.560918
	Volts Maximum (13.8V)	13.560918
30°C	Volts Nominal (12V)	13.560918
40°C	Volts Nominal (12V)	13.560893
50°C	Volts Nominal (12V)	13.560820
Max Frequency Error per chan (Hz)		+82 / -98
Max Frequency Error observed (MHz)		-0.000098

Maximum variation observed was +82 / -98 Hz

LIMITS: 15.225
+/- 0.01%. (+/- 1.356kHz)

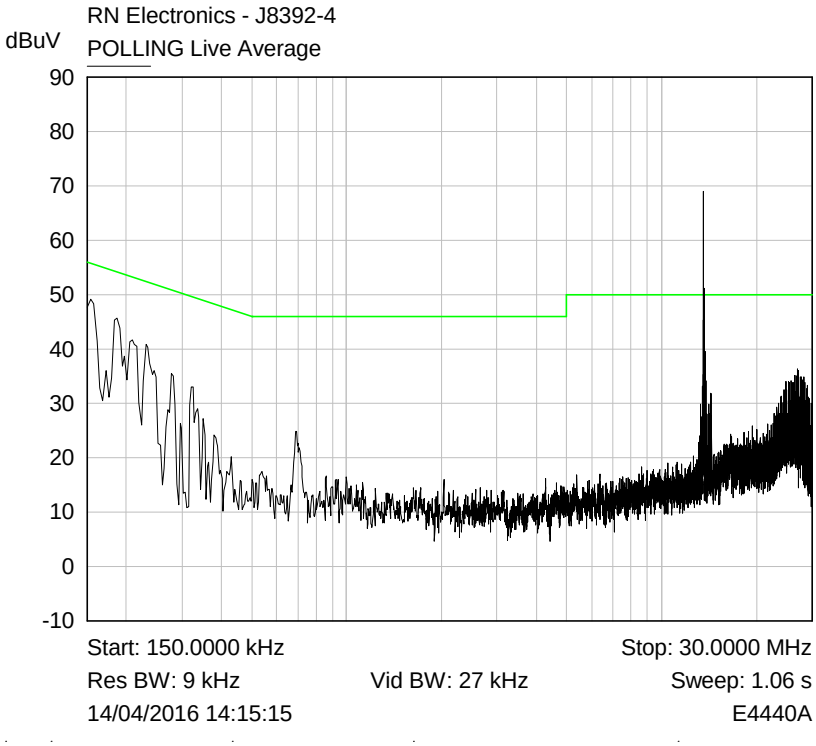
These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 0.7 ppm

6 Plots/Graphical results

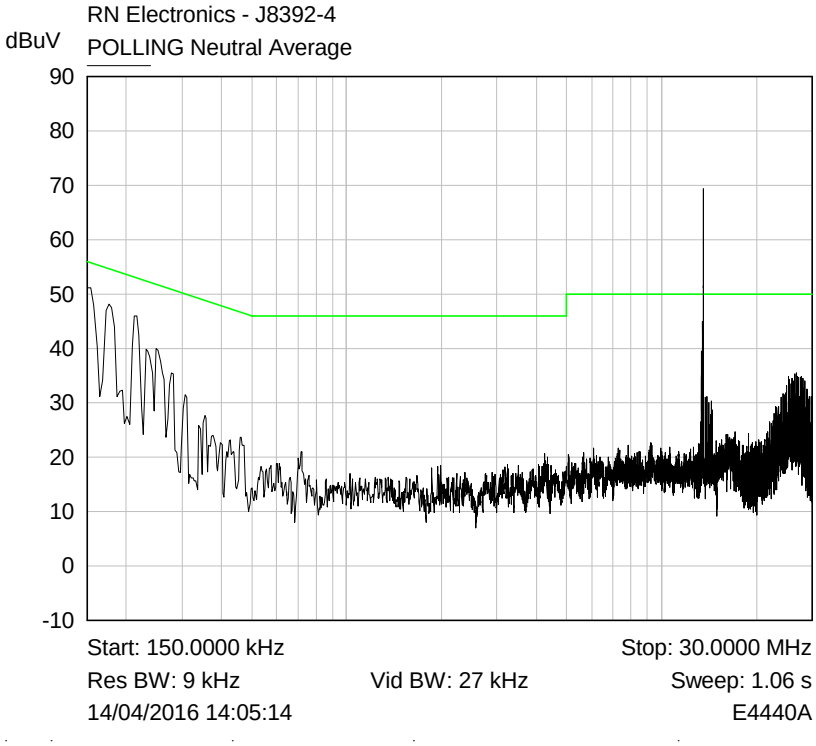
6.1 AC power line conducted emissions

RF Parameters: Band 13.11-14.01 MHz, Power 0.4 Watts, Single Channel, Modulation ASK, Channel 13.56 MHz



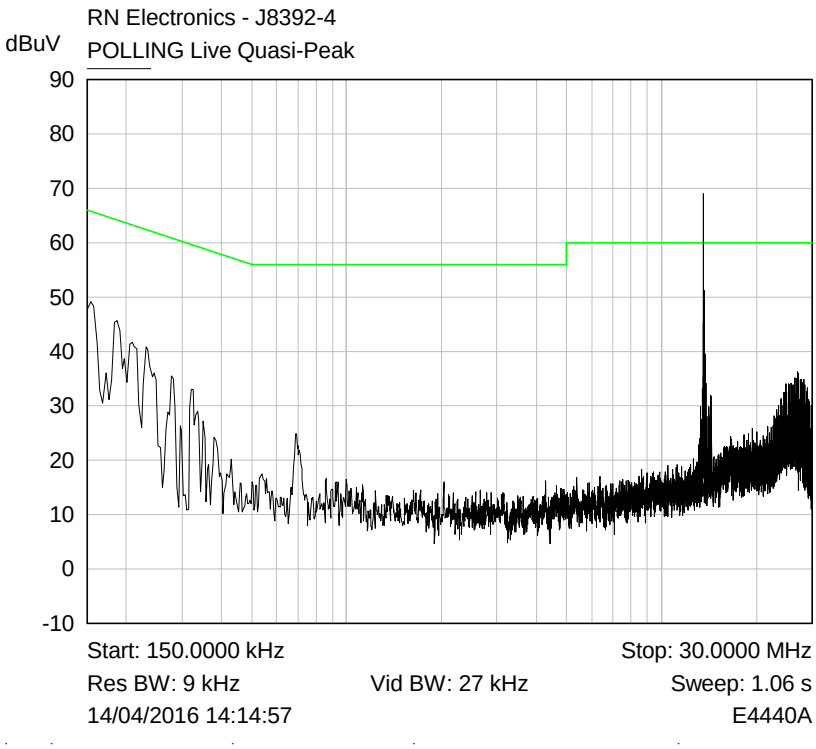
Plot of Live 150kHz-30MHz Average

Note: The emission that exceeds the limit line is the fundamental carrier of the 13.56 MHz transmitter radiating on to the mains lead



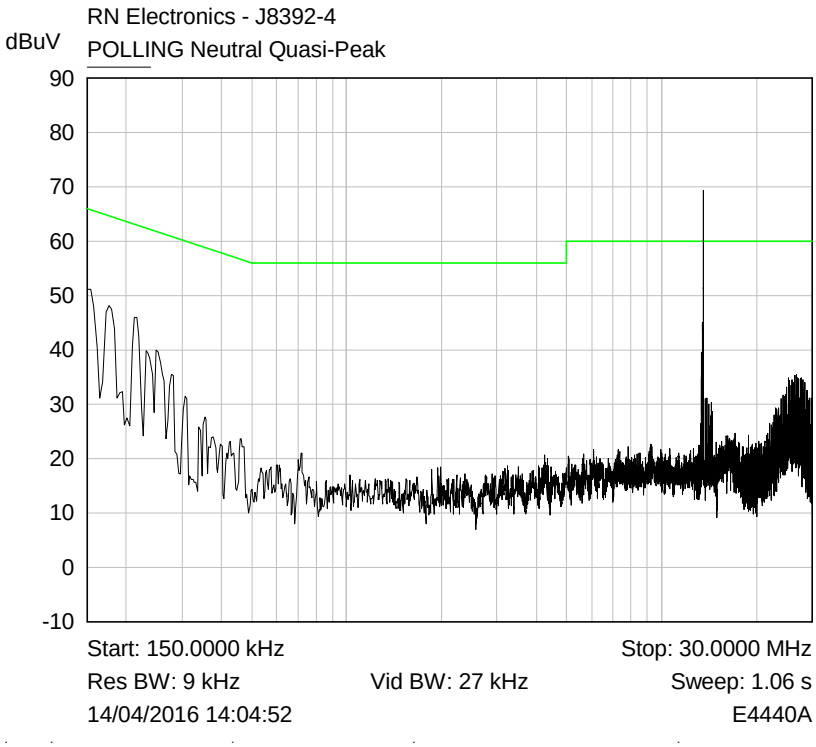
Plot of Neutral 150kHz-30MHz Average

Note: The emission that exceeds the limit line is the fundamental carrier of the 13.56 MHz transmitter radiating on to the mains lead



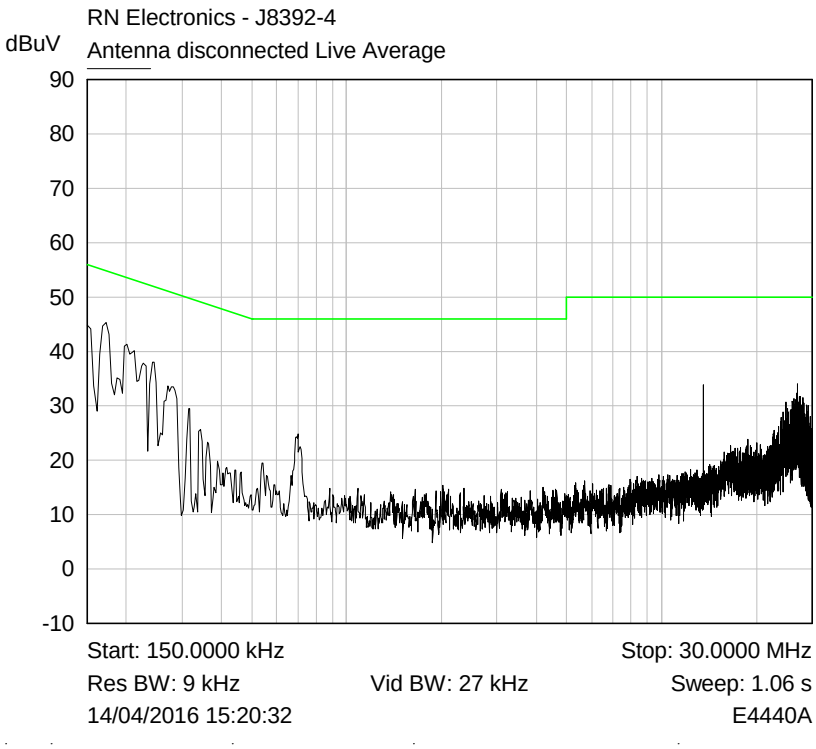
Plot of Live 150kHz-30MHz Quasi-Peak

Note: The emission that exceeds the limit line is the fundamental carrier of the 13.56 MHz transmitter radiating on to the mains lead

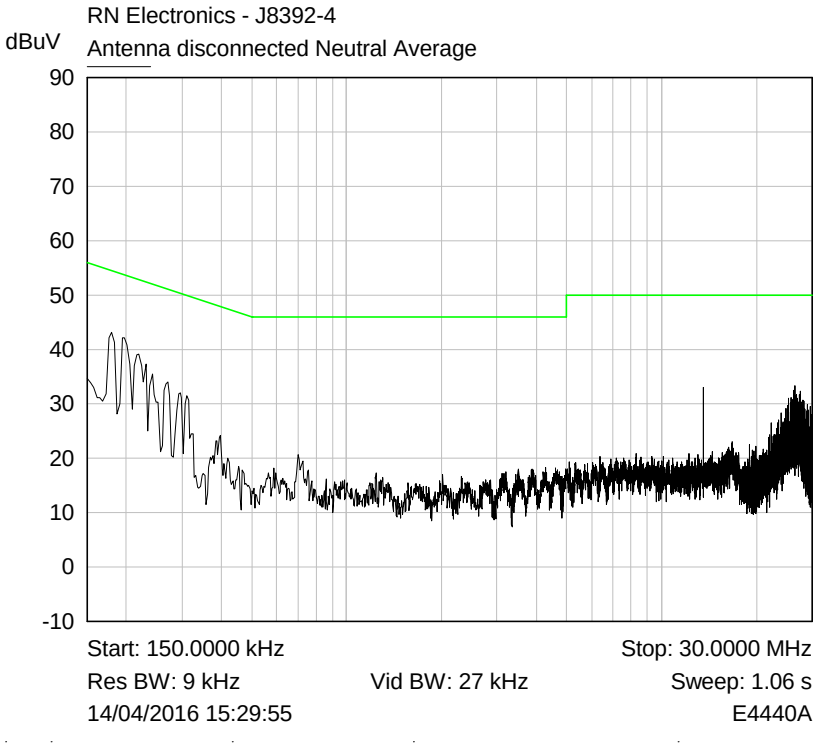


Plot of Neutral 150kHz-30MHz Quasi-Peak

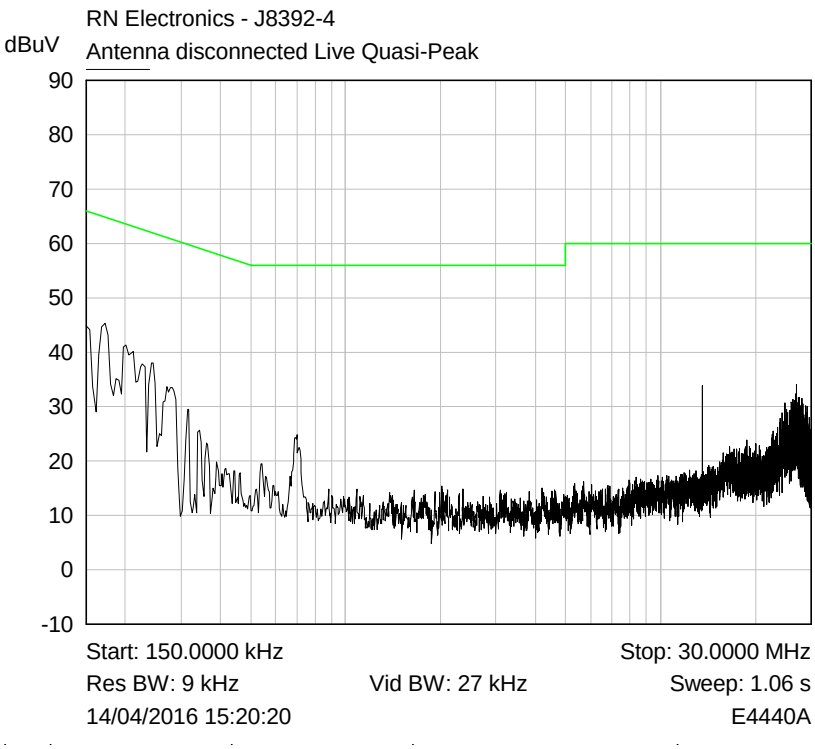
Note: The emission that exceeds the limit line is the fundamental carrier of the 13.56 MHz transmitter radiating on to the mains lead



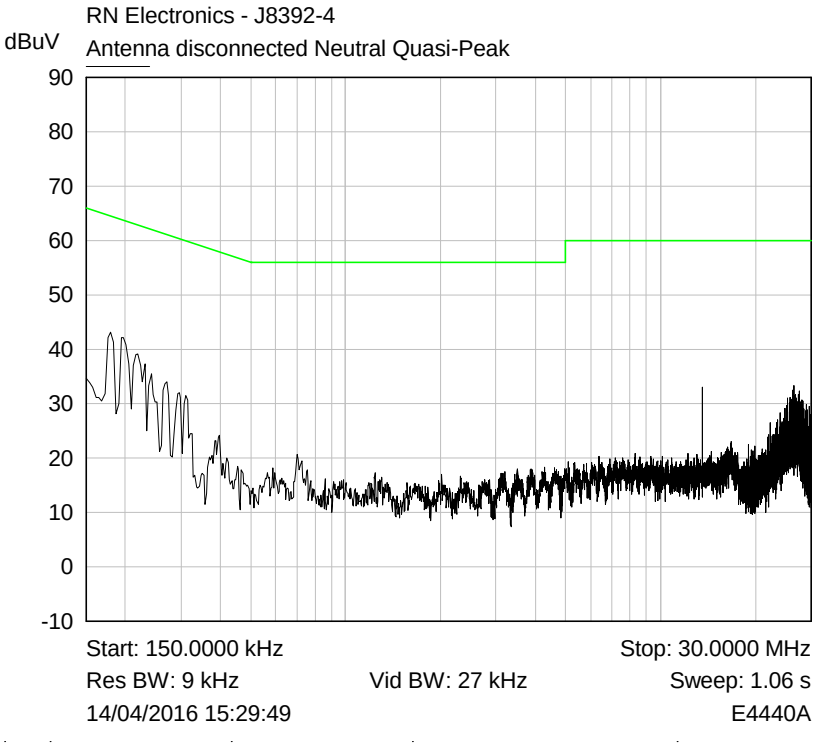
Plot of Live 150kHz-30MHz Average (Integral antenna disconnected)



Plot of Neutral 150kHz-30MHz Average (Integral antenna disconnected)



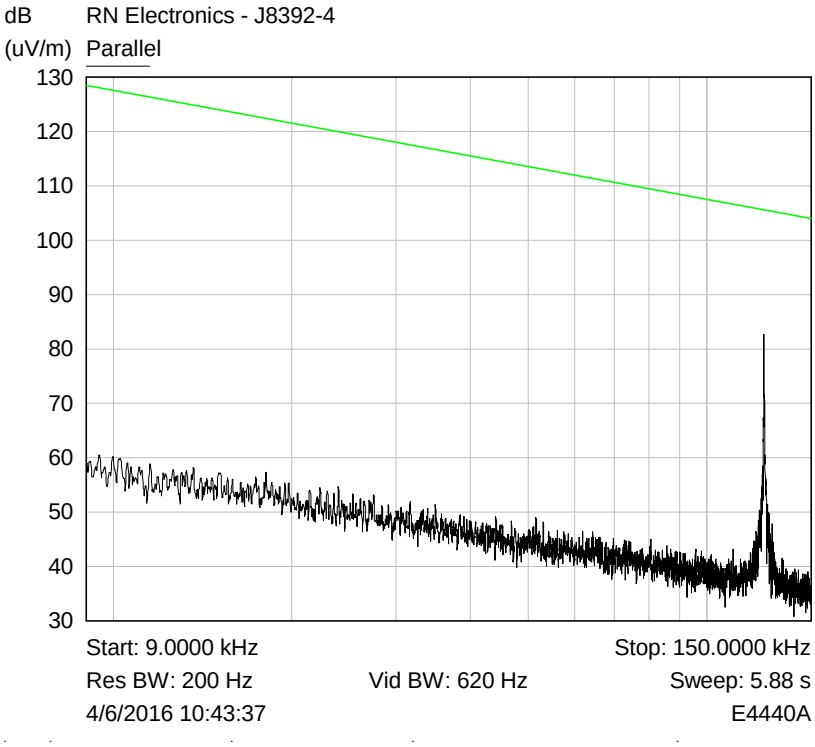
Plot of Live 150kHz-30MHz Quasi-Peak (Integral antenna disconnected)



Plot of Neutral 150kHz-30MHz Quasi-Peak (Integral antenna disconnected)

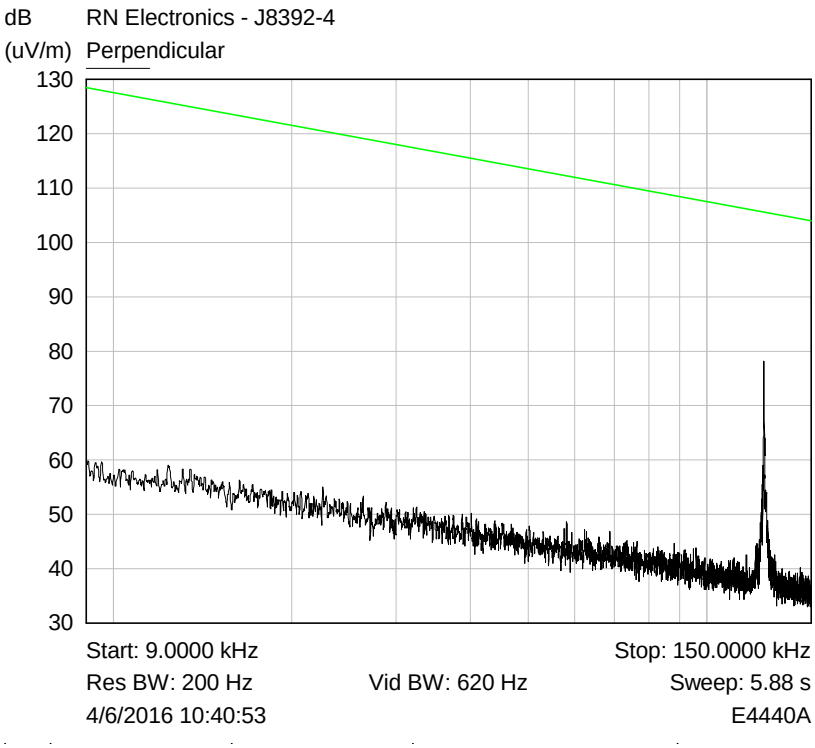
6.2 Radiated emissions 9 – 150 kHz

RF Parameters: Band 13.11-14.01 MHz, Power 0.4 Watts, Modulation ASK, Channels 13.56 MHz and 125 kHz



Plot of 9-150kHz Parallel

Note: The emission that is shown on the plot is the fundamental carrier of the 125 kHz transmitter

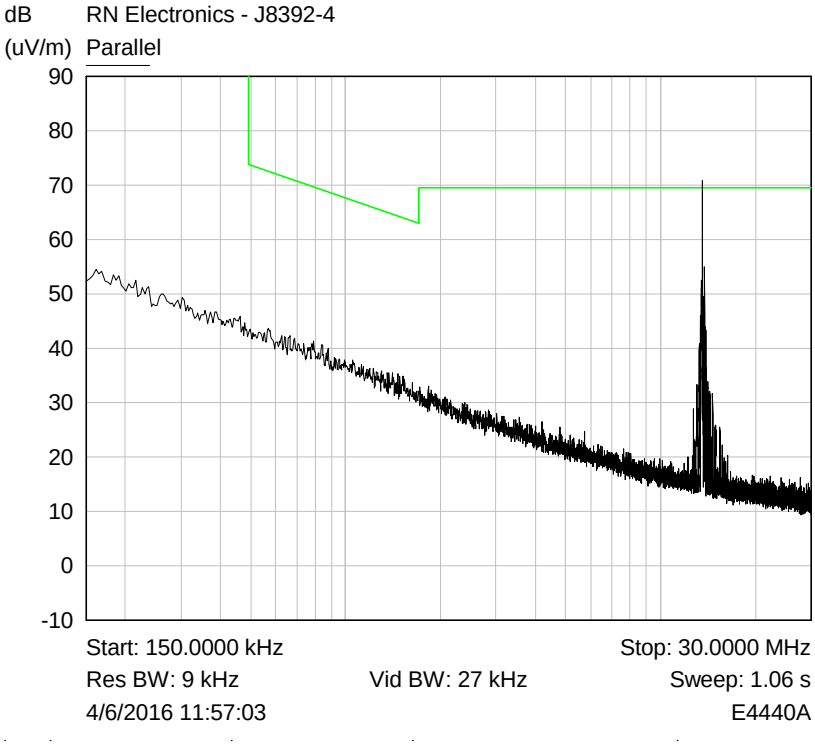


Plot of 9-150kHz Perpendicular

Note: The emission that is shown on the plot is the fundamental carrier of the 125 kHz transmitter

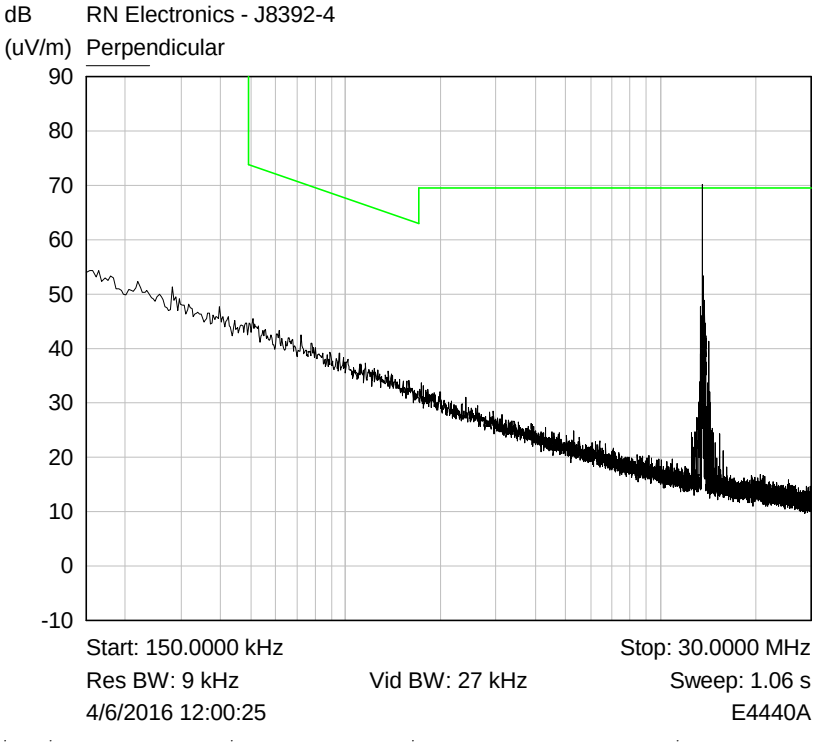
6.3 Radiated emissions 150 kHz – 30 MHz

RF Parameters: Band 13.11-14.01 MHz, Power 0.4 Watts, Modulation ASK, Channels 13.56 MHz and 125 kHz



Plot of 150kHz-30MHz Parallel

Note: The emission that exceeds the limit line is the fundamental carrier of the 13.56 MHz transmitter

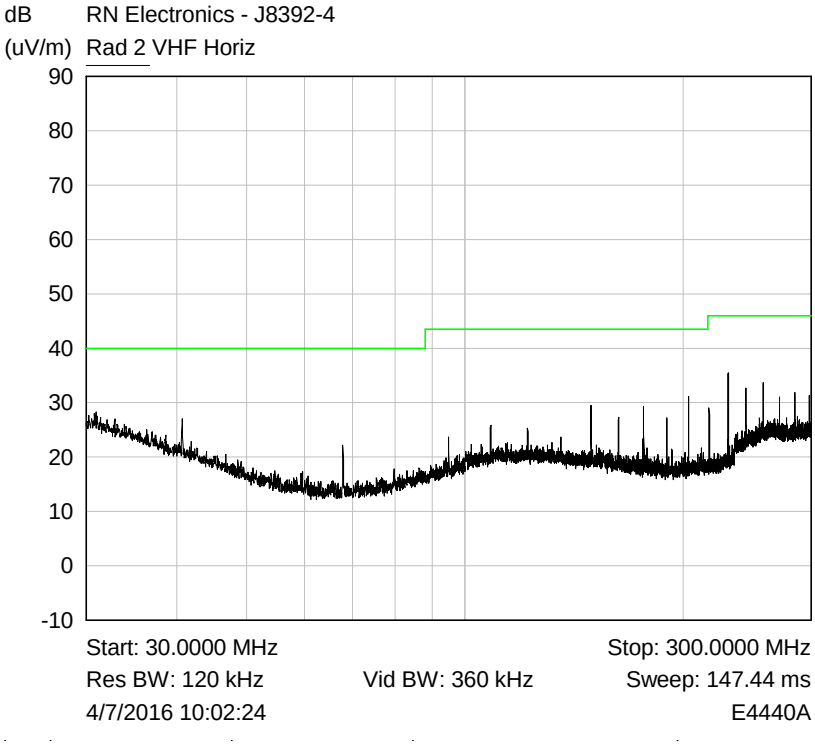


Plot of 150kHz-30MHz Perpendicular

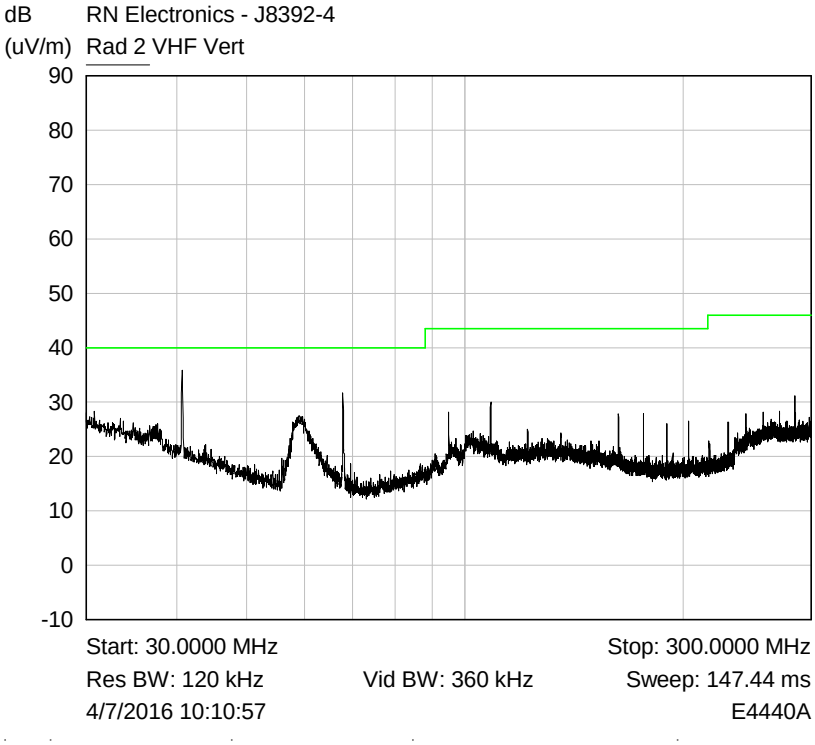
Note: The emission that exceeds the limit line is the fundamental carrier of the 13.56 MHz transmitter

6.4 Radiated emissions 30 MHz -1 GHz

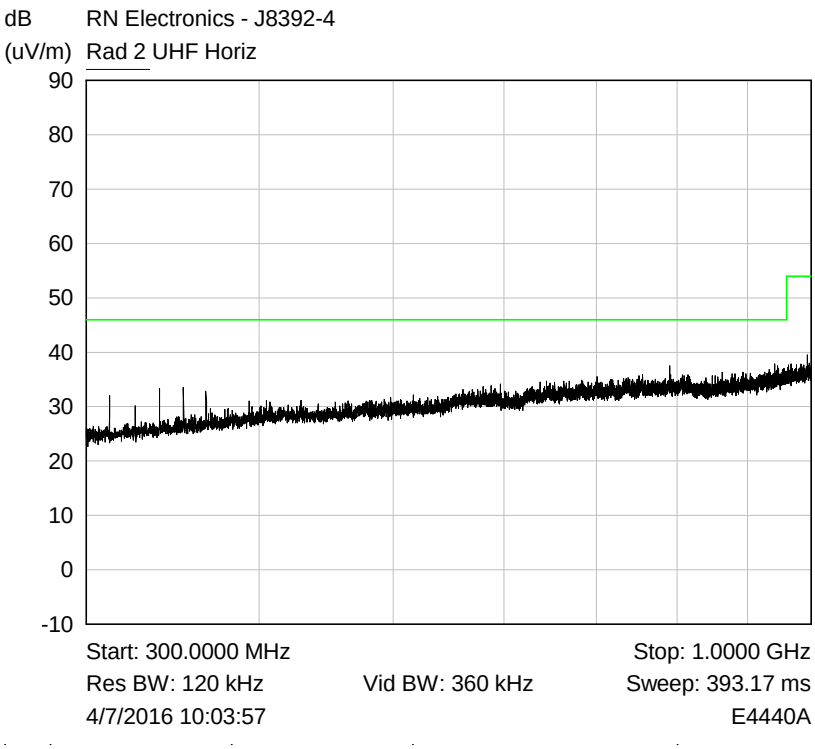
RF Parameters: Band 13.11-14.01 MHz, Power 0.4 Watts, Modulation ASK, Channel 13.56 MHz and 125 kHz



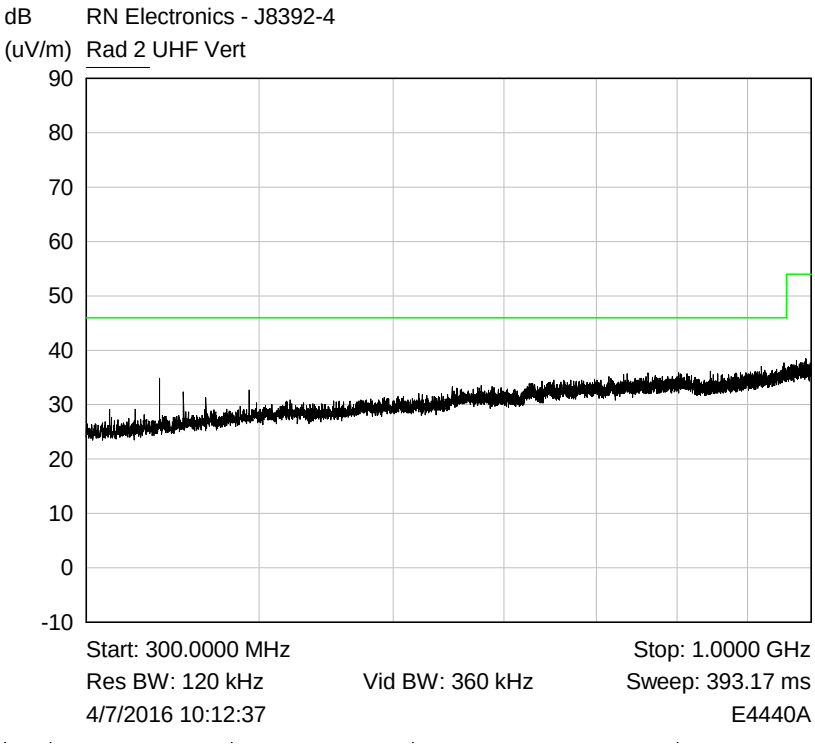
Plot of Peak emissions for VHF Horizontal against the QP limit line.



Plot of Peak emissions for UHF Horizontal against the QP limit line.



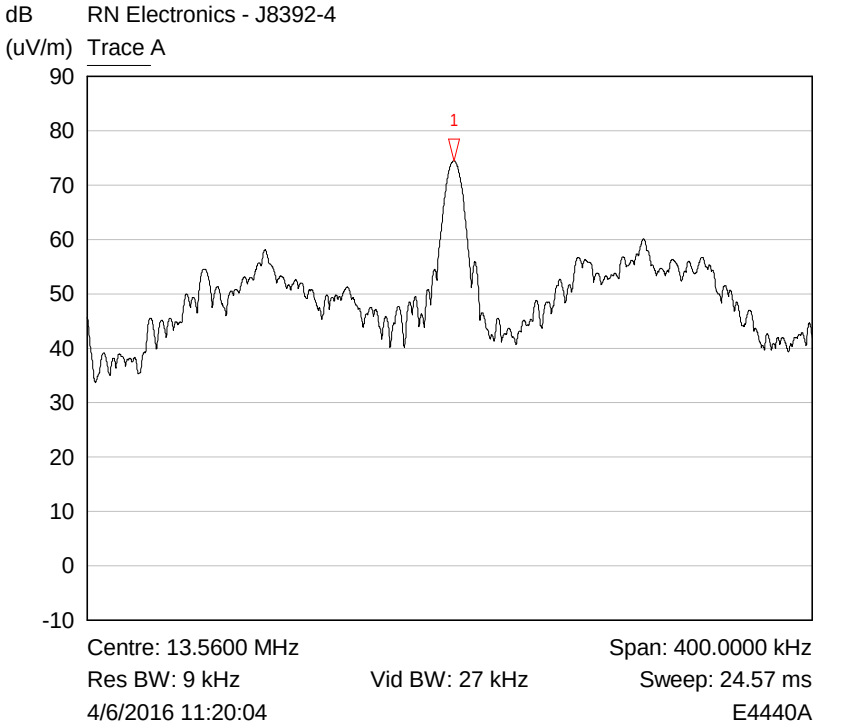
Plot of Peak emissions for VHF Vertical against the QP limit line.



Plot of Peak emissions for UHF Vertical against the QP limit line.

6.5 Intentional radiator field strength

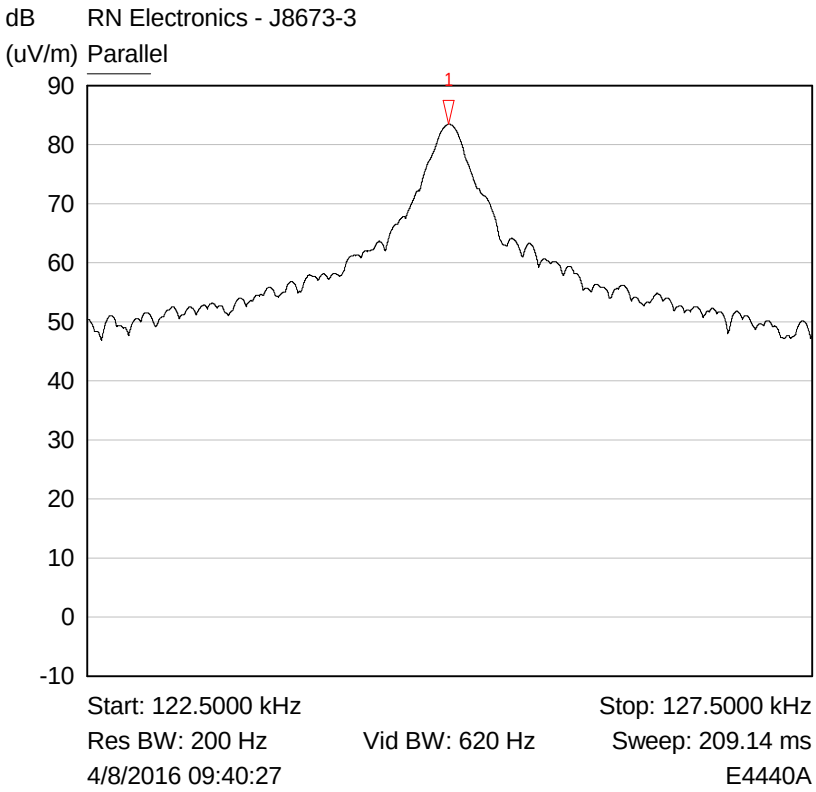
RF Parameters: Band 13.11-14.01 MHz, Power 0.4 Watts, Single Channel, Modulation ASK, Channel 13.56 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	13.5608 MHz	74.49 dB(uV/m)	

Plot of Parallel polarisation and EUT in Upright position

RF Parameters: Band 0.009 – 0.490 kHz, Single Channel, Modulation ASK, Channel 125 kHz

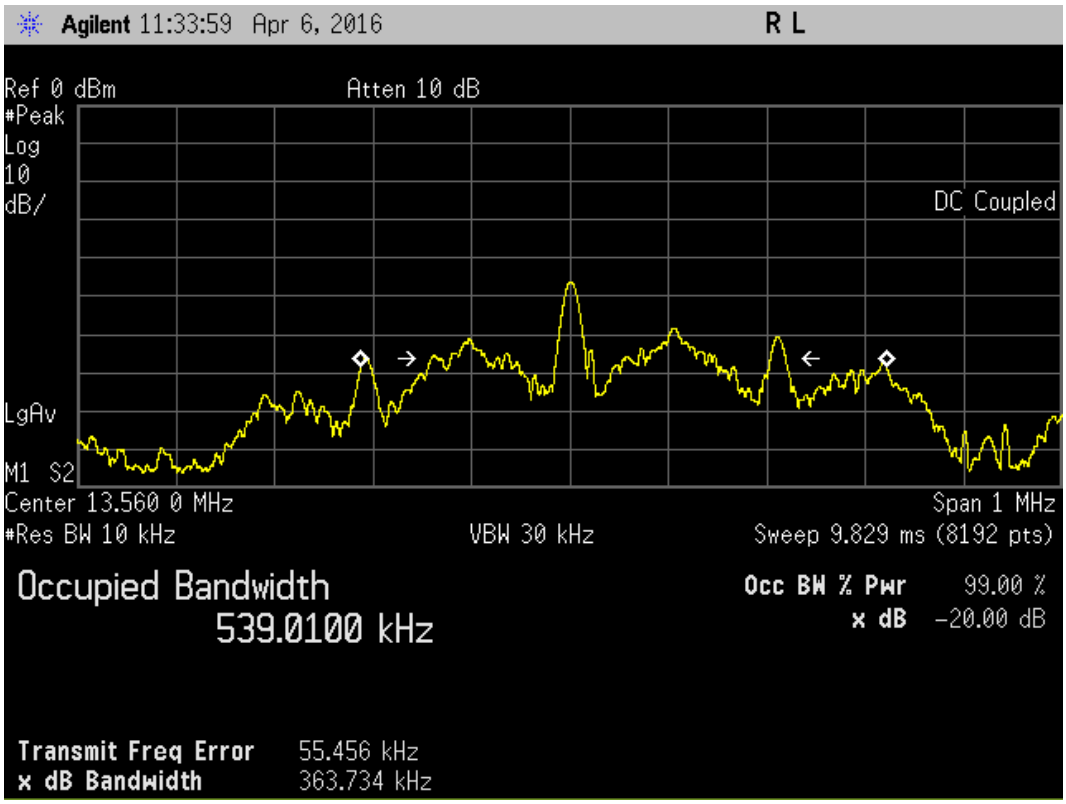


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Parallel	124.9698 kHz	83.48 dB(uV/m)	

Plot of Parallel polarisation and EUT in Side position

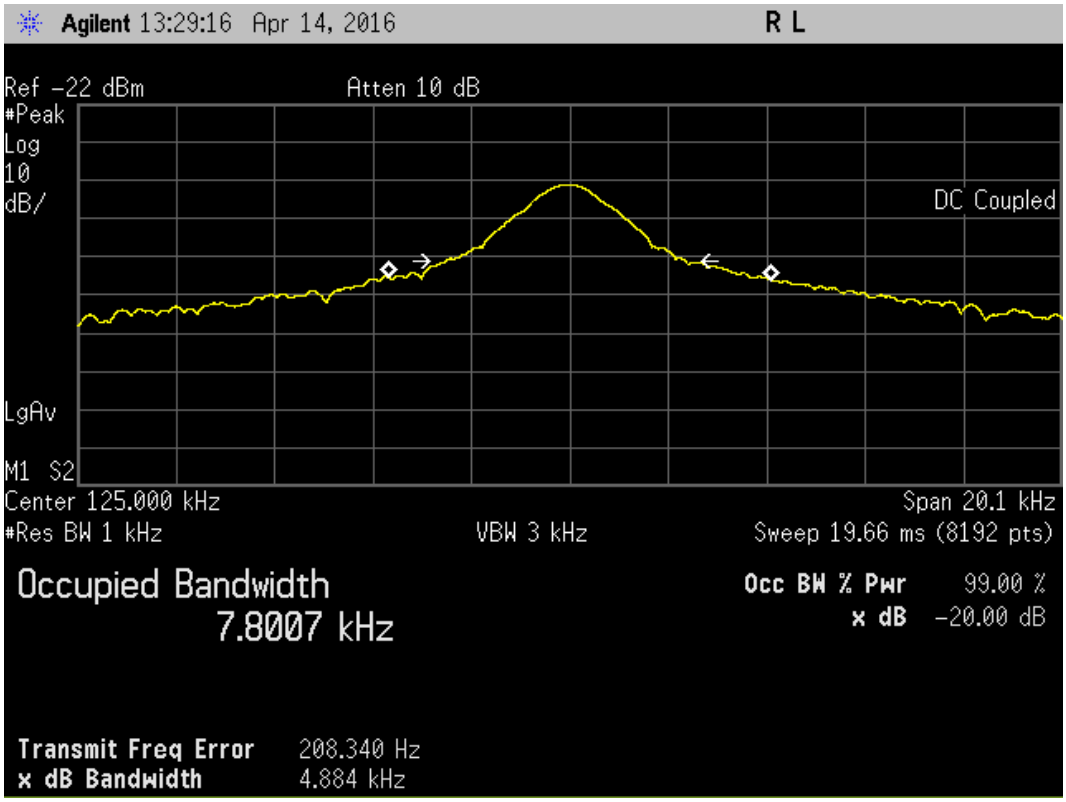
6.6 Occupied bandwidth

RF Parameters: Band 13.11-14.01 MHz, Power 0.4 Watts, Single Channel, Modulation ASK, Channel 13.56 MHz



Plot for 20dB Bandwidth 13.56 MHz

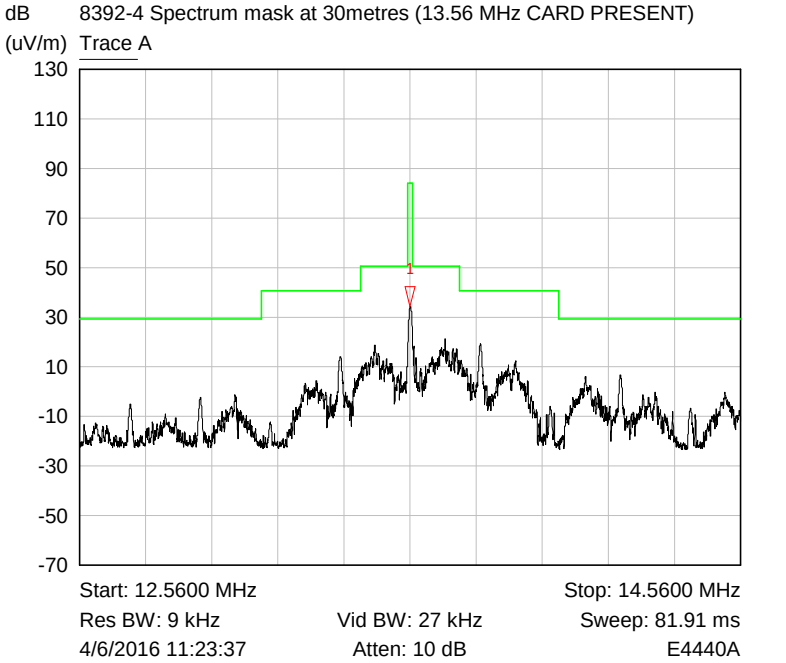
RF Parameters: Band 0.009 – 0.490 kHz, Single Channel, Modulation ASK, Channel 125 kHz



Plot for 20dB Bandwidth 125 kHz

6.7 Spectrum mask

RF Parameters: Band 13.11-14.01 MHz, Power 0.4 Watts, Single Channel, Modulation ASK, Channel 13.56 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	13.5606 MHz	34.49 dB(uV/m)	

Nominal Temperature, Nominal Voltage

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	-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

© 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).

The measurement receiver used for emissions testing, performs the field strength (FS) calculations automatically. The receiver combines the signal amplitude (RA), Antenna Factor (AF) and Cable Loss (CL) factors for the frequency to be measured.

Example calculation: - FS = RA + AF + CL.

Receiver amplitude (RA)	Antenna factor (3m) (AF)	Cable loss (CL)	Field strength result (3m) (FS)
20dBuV	25 dB	3 dB	48dBuV/m

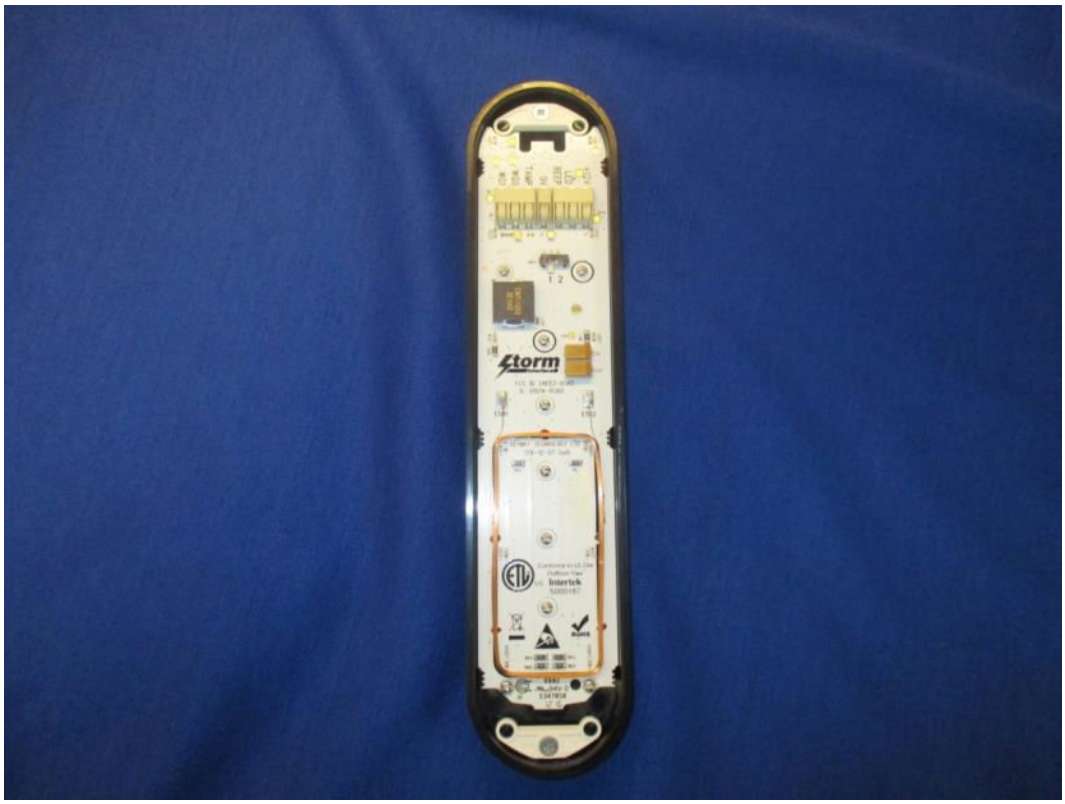
8 Photographs

8.1 EUT Front View

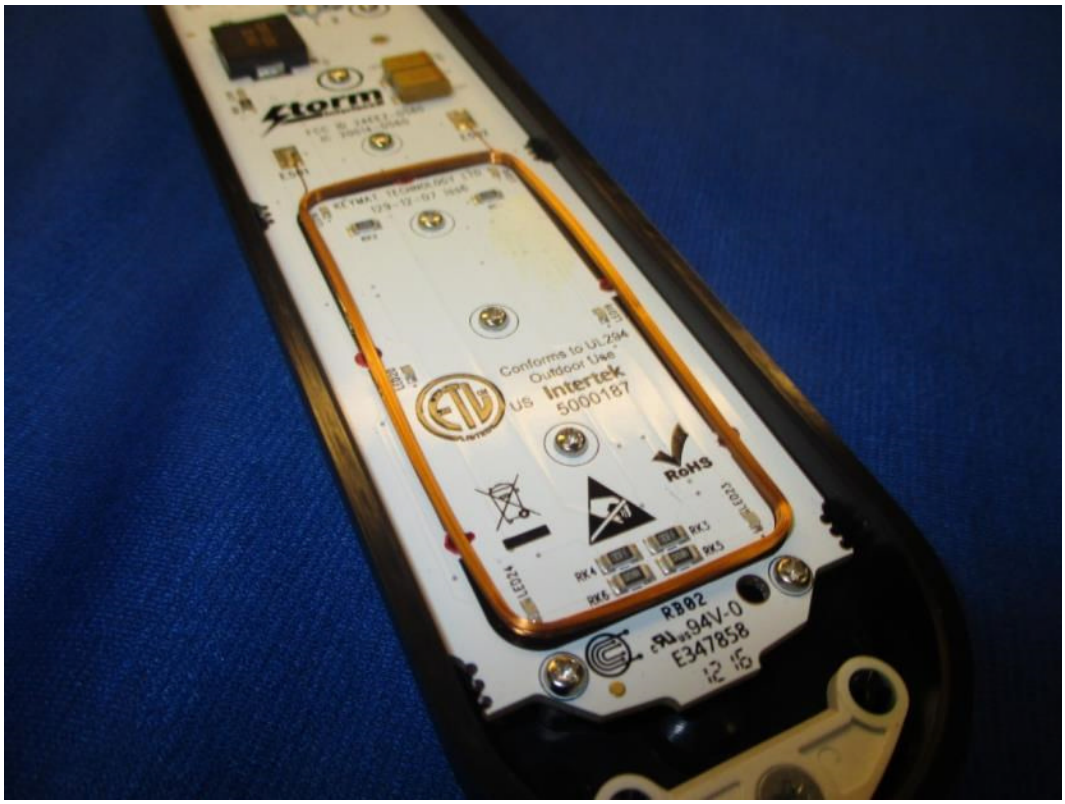
EUT fitted with plastic keys

EUT fitted with metal keys.

8.2 EUT Reverse Angle



8.3 EUT Antenna Port

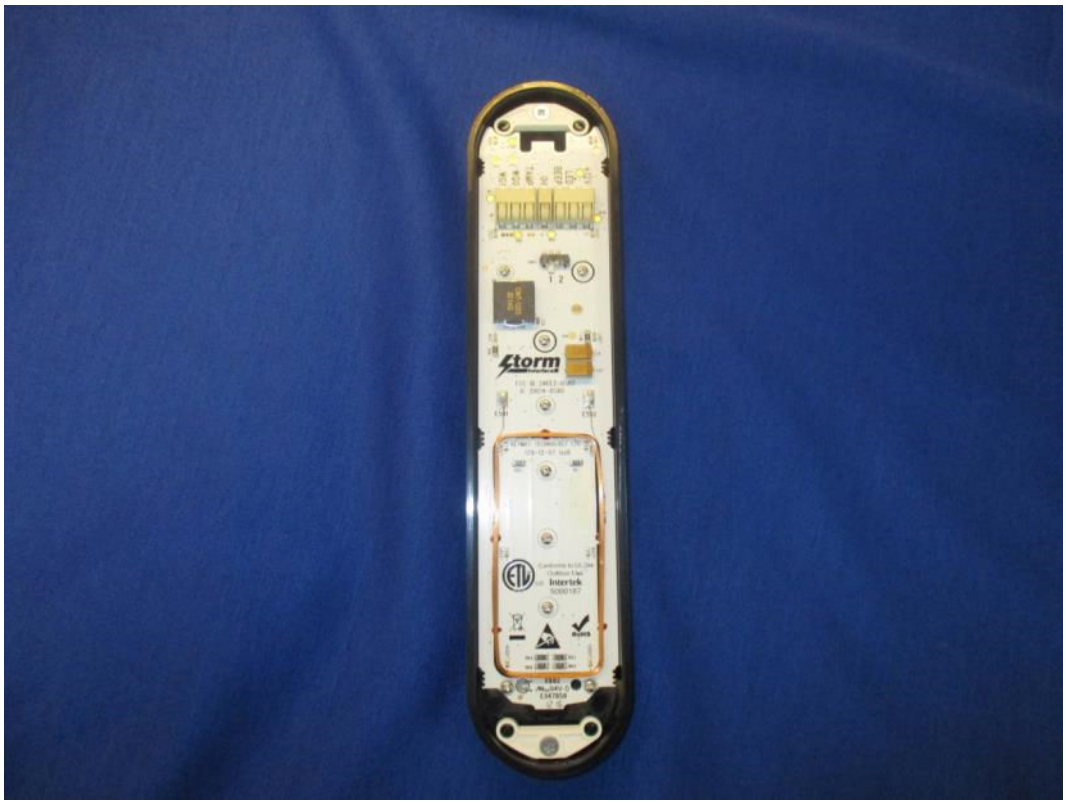


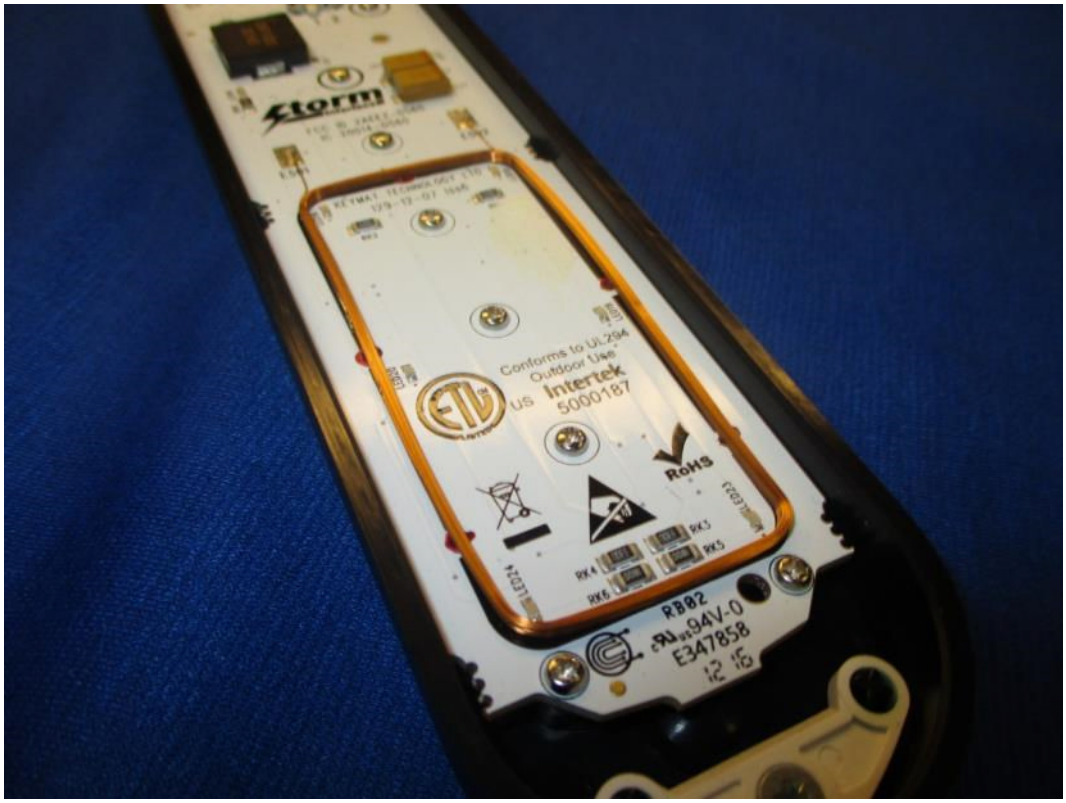
Photograph shows the EUTs 125 kHz loop antenna

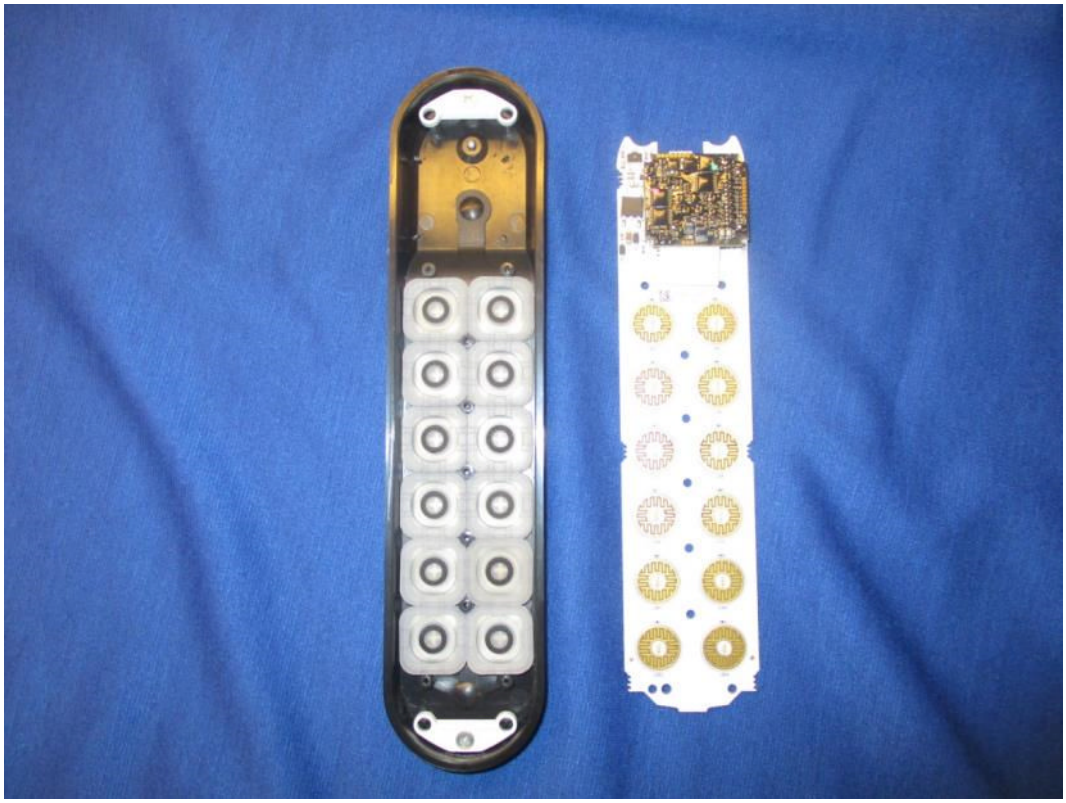
Note: It is not possible to show the 13.56 MHz antenna as it is etched into the PCB material on an internal layer.

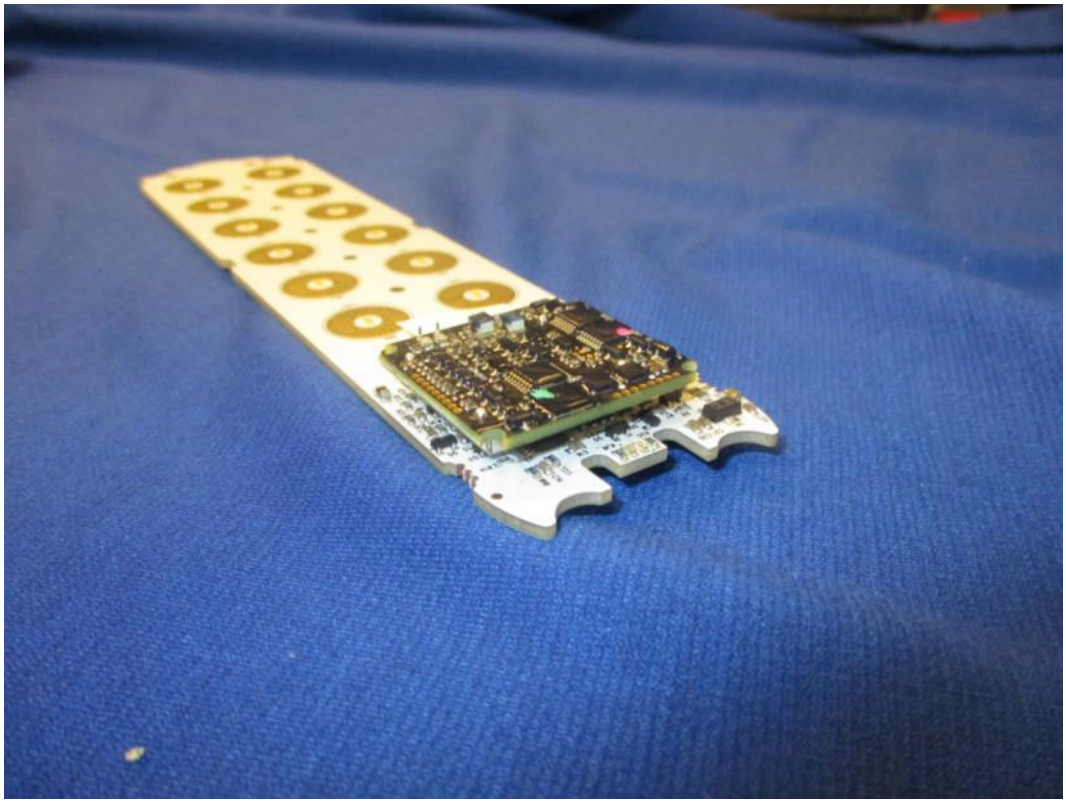
8.4 EUT Display & Controls

8.5 EUT Internal photos

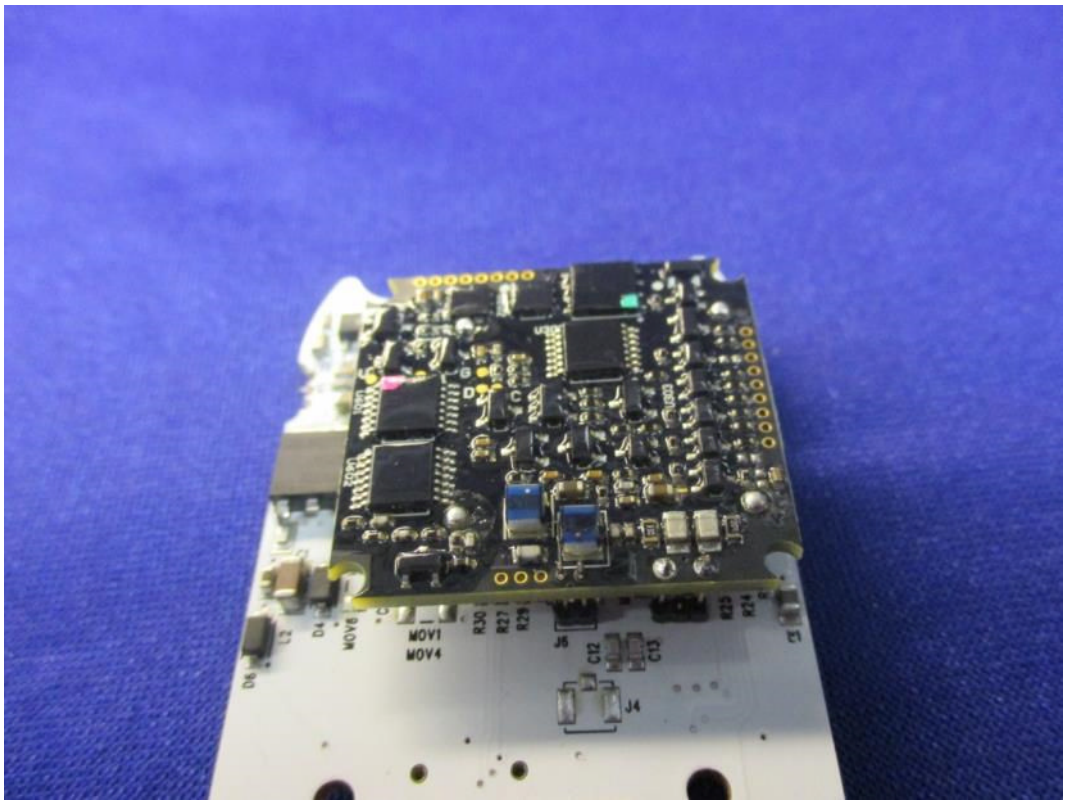


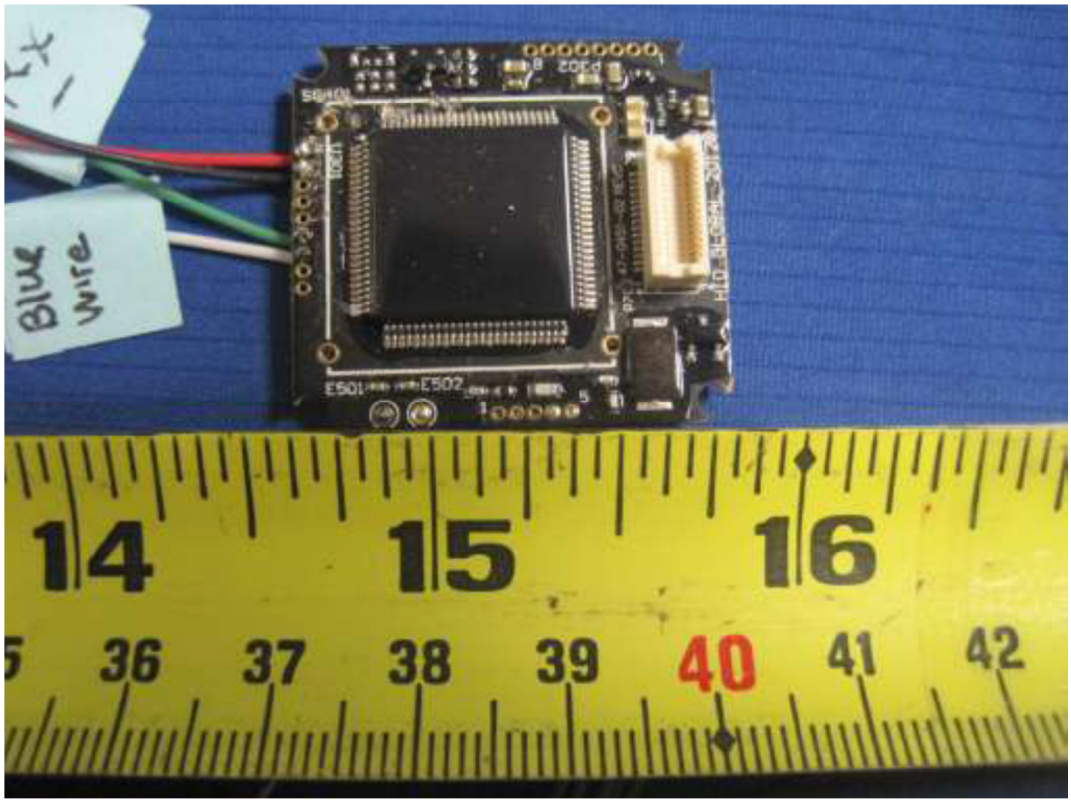


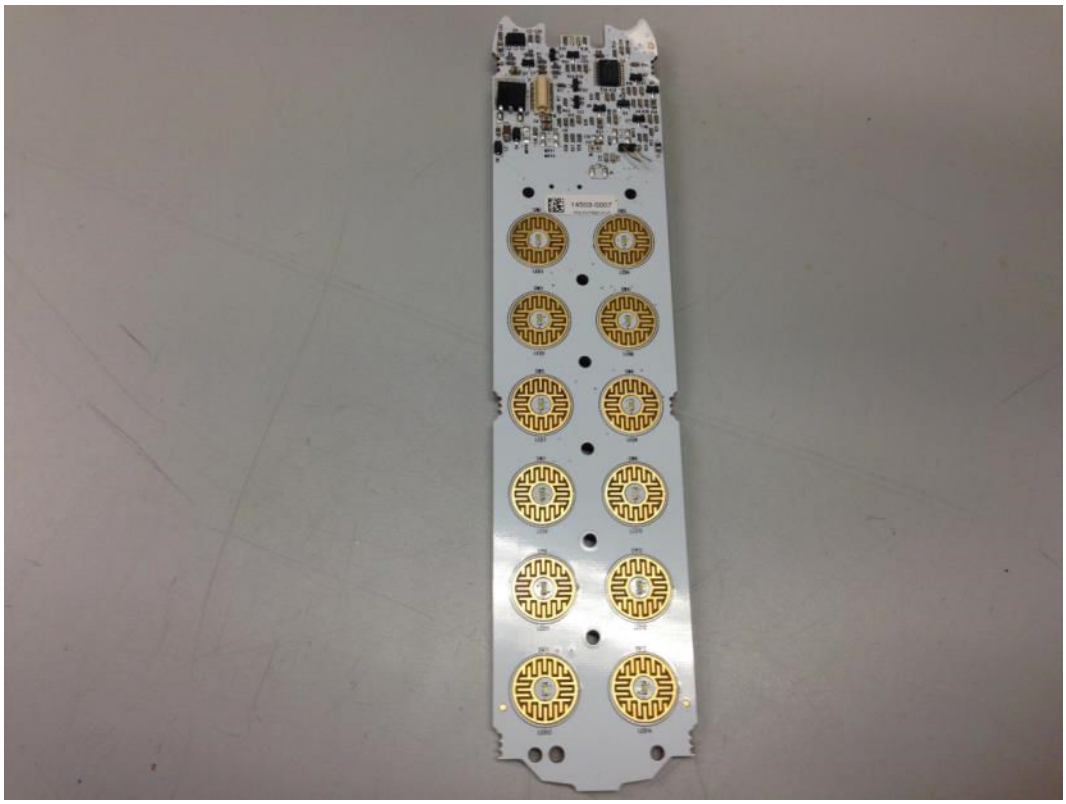




Photograph shows the card-reader radio module fitted to the PCB







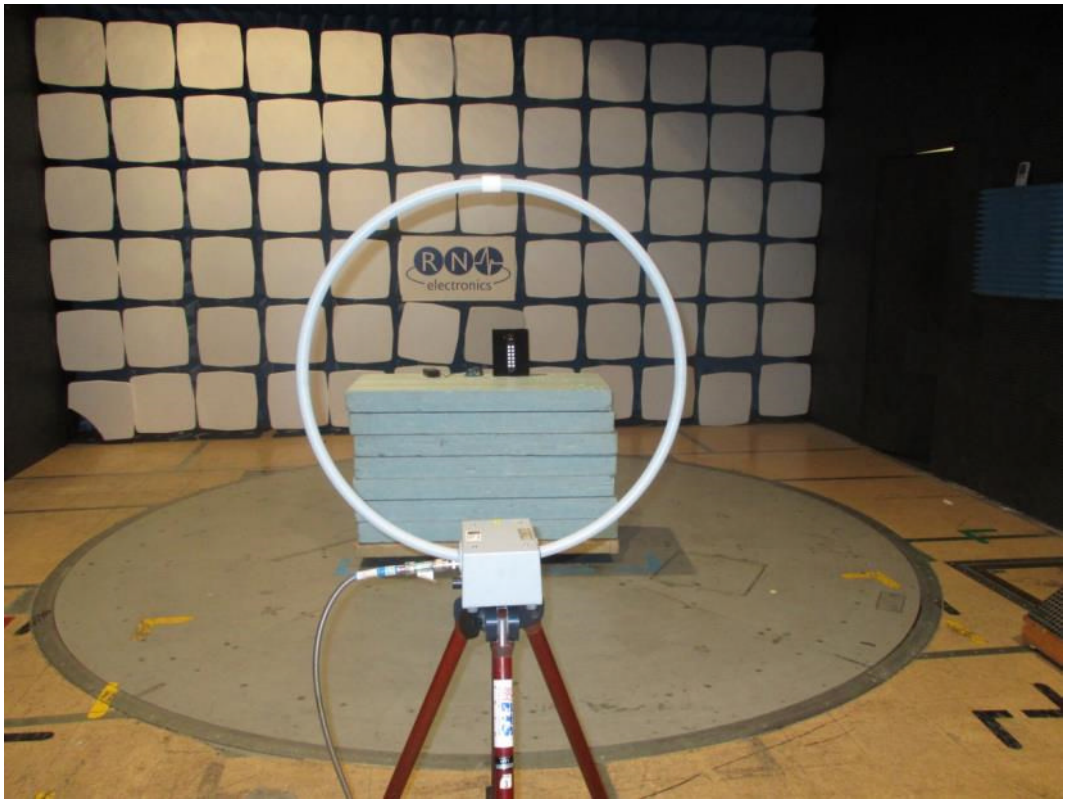
8.6 EUT ID Label

8.7 EUT Chassis

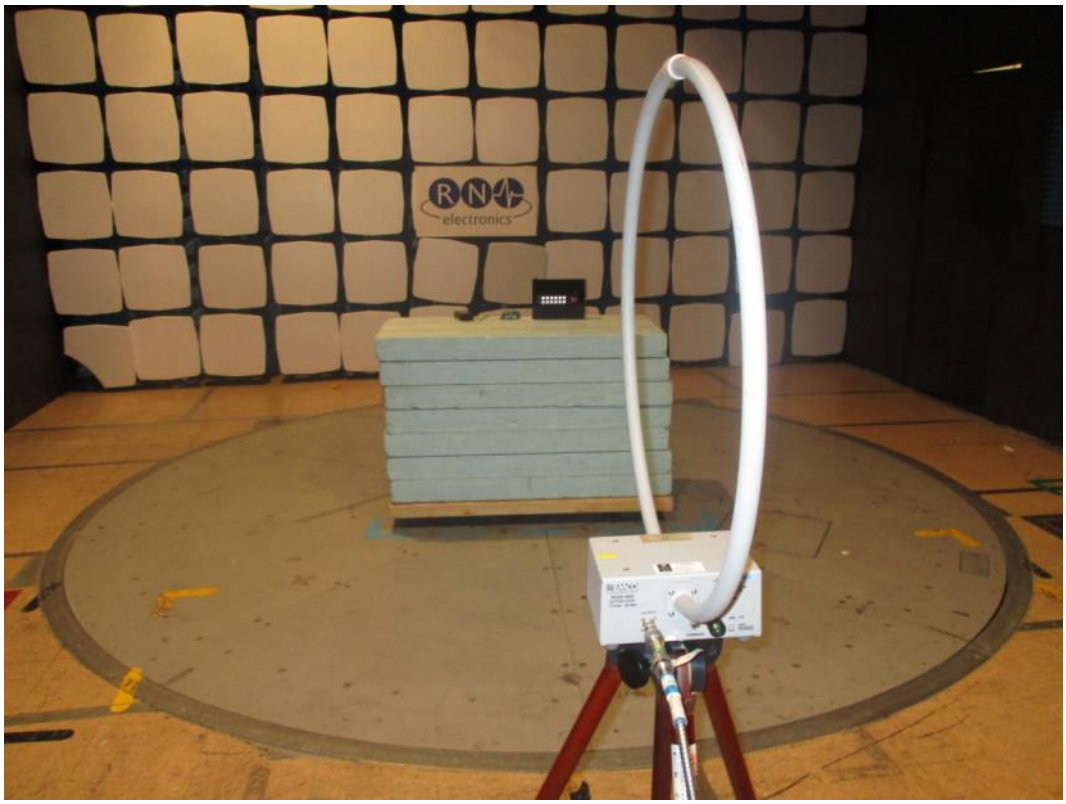
No chassis

8.8 AC power line conducted emissions

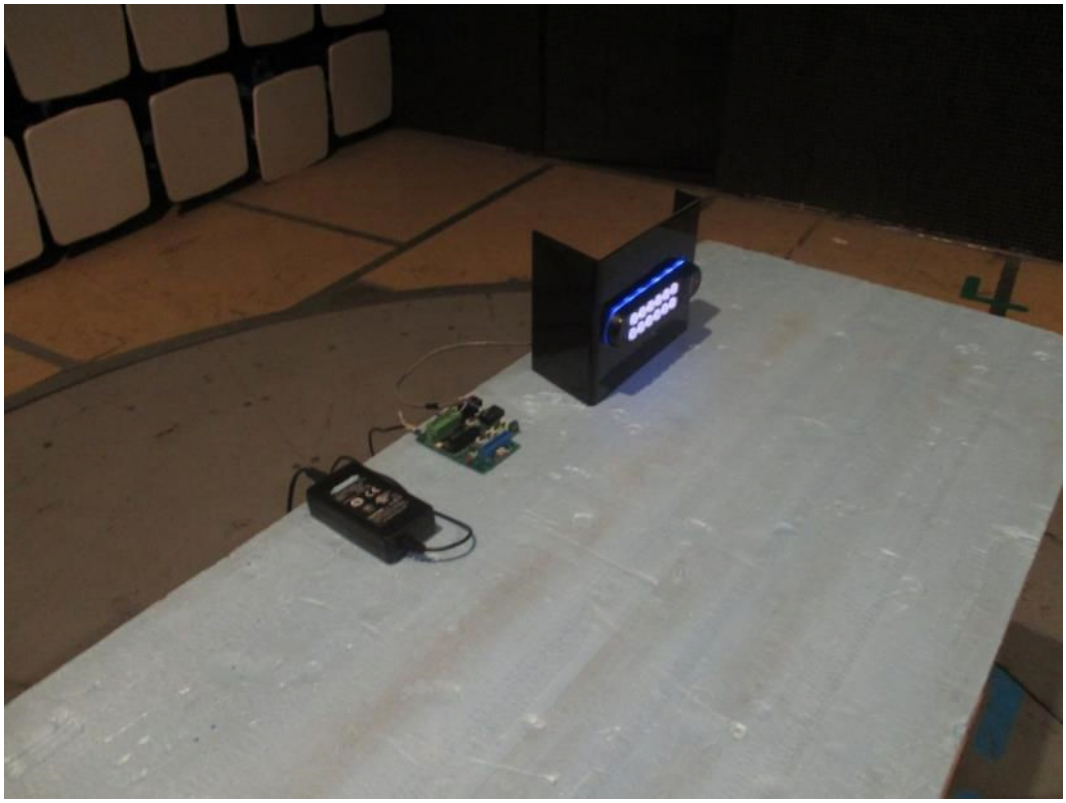
8.9 Radiated emissions 9 kHz – 150 kHz



Site H



Site H

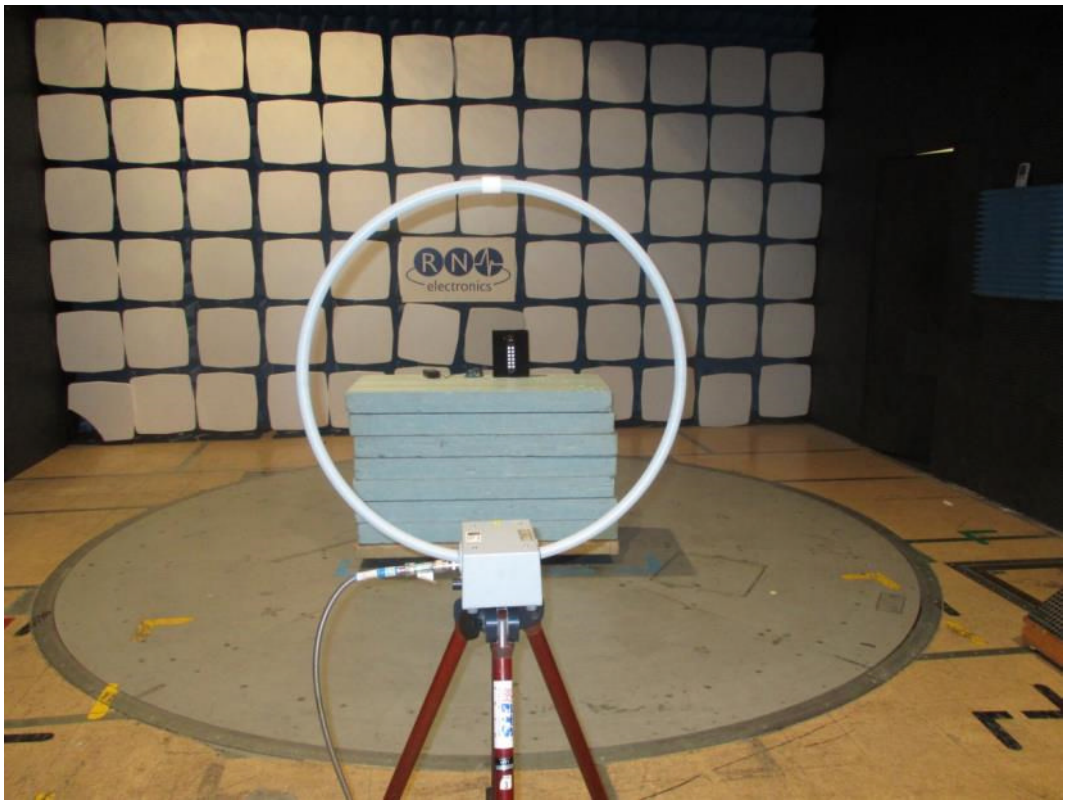


Site H

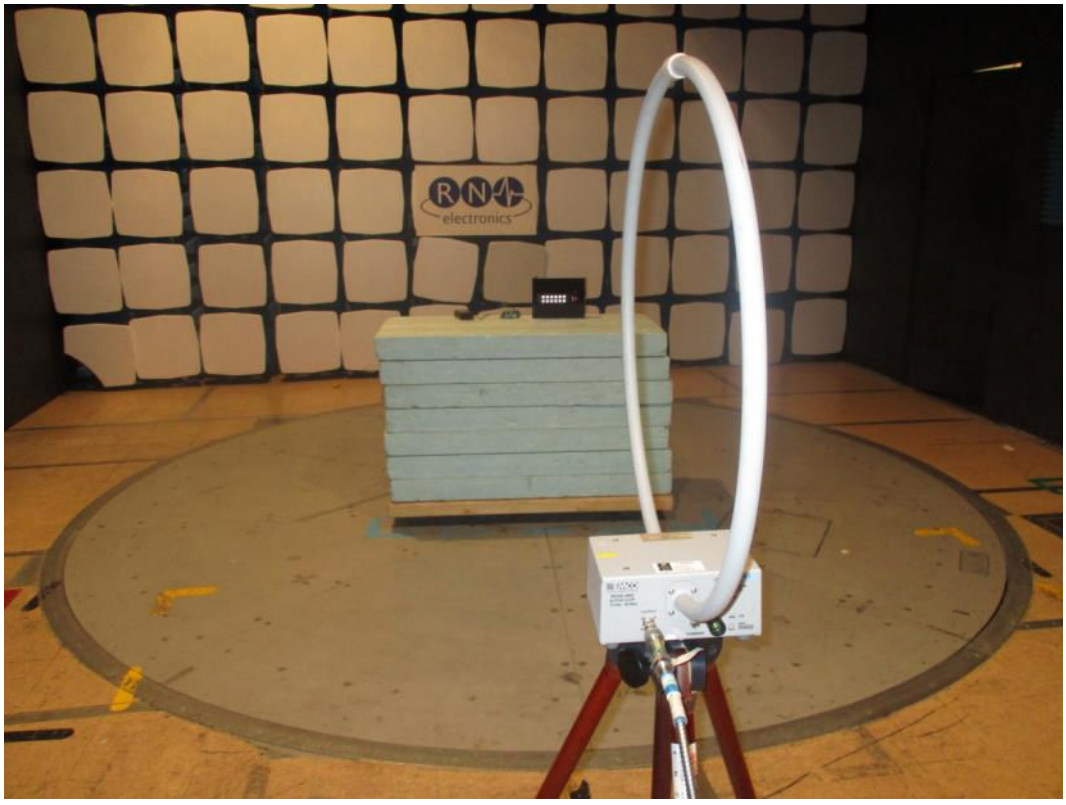
Site OATS

Site OATS

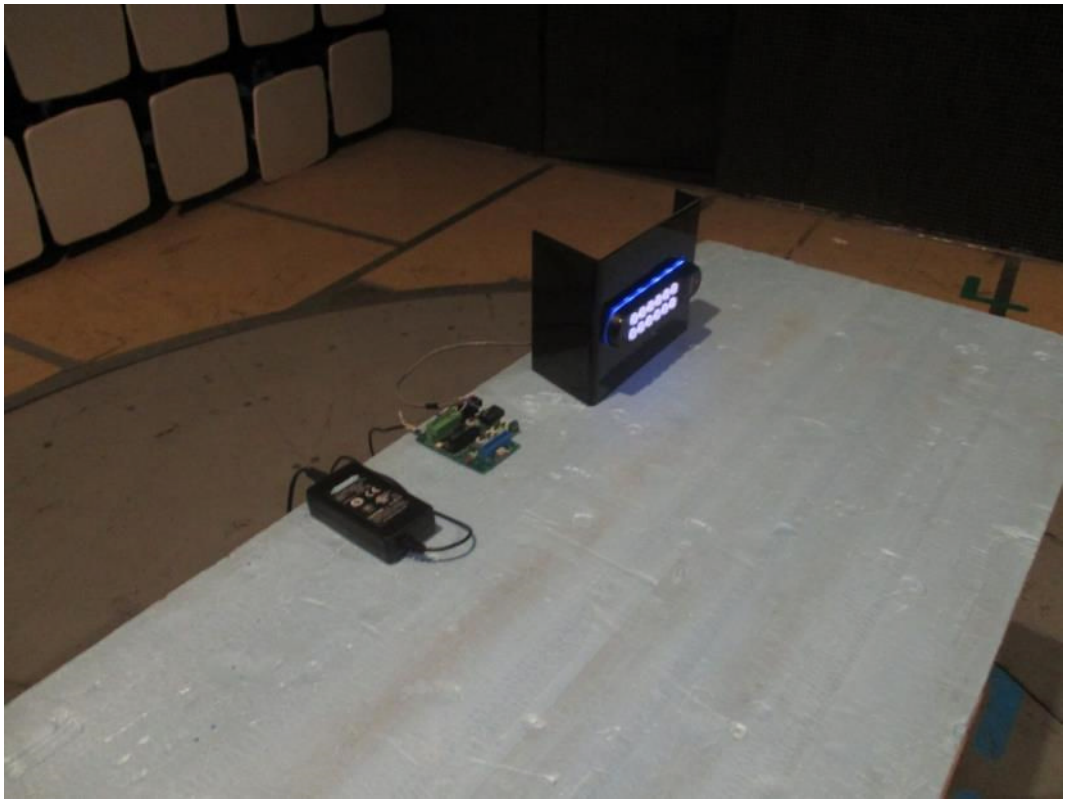
8.10 Radiated emissions 150 kHz – 30 MHz



Site H



Site H

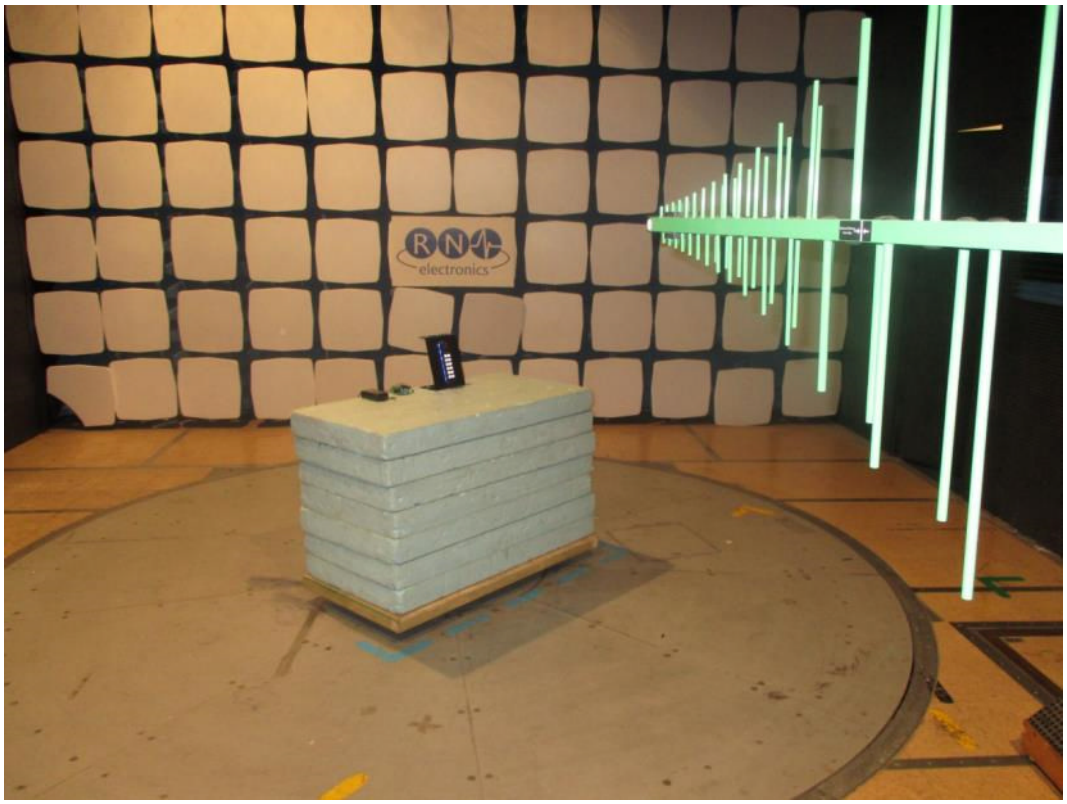


Site H

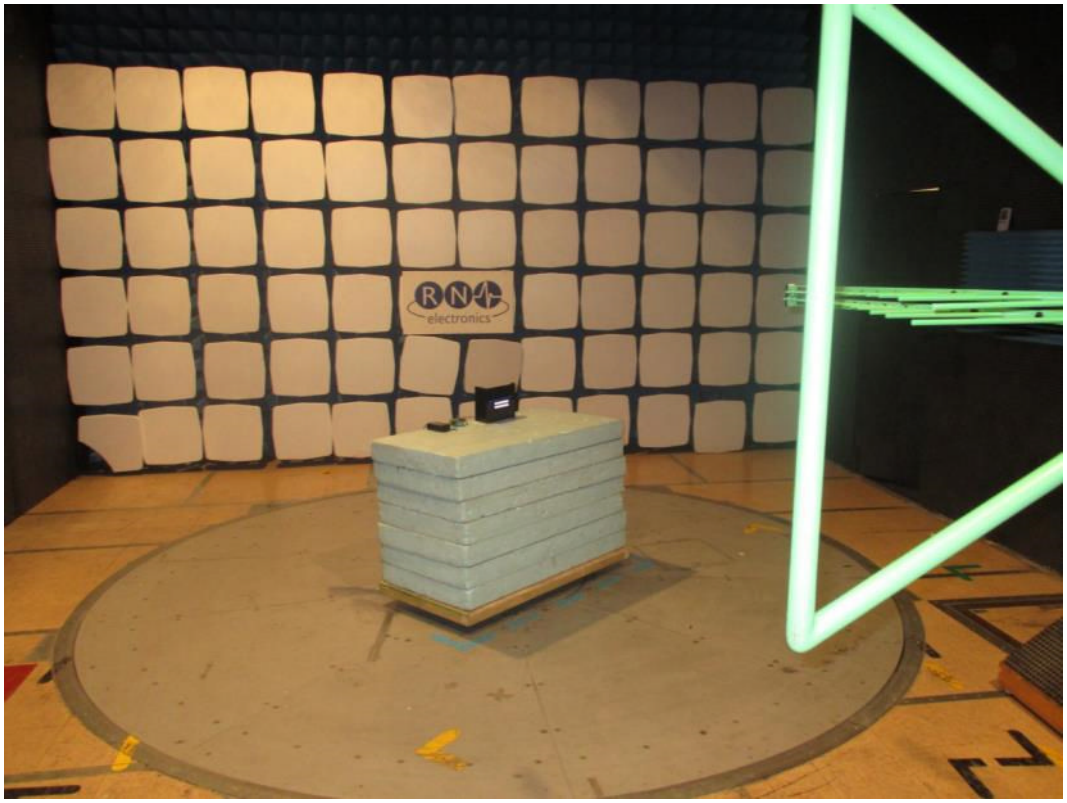
Site OATS

Site OATS

8.11 Radiated emissions 30 MHz -1 GHz



Site H



Site H

8.11 Radiated emission diagram

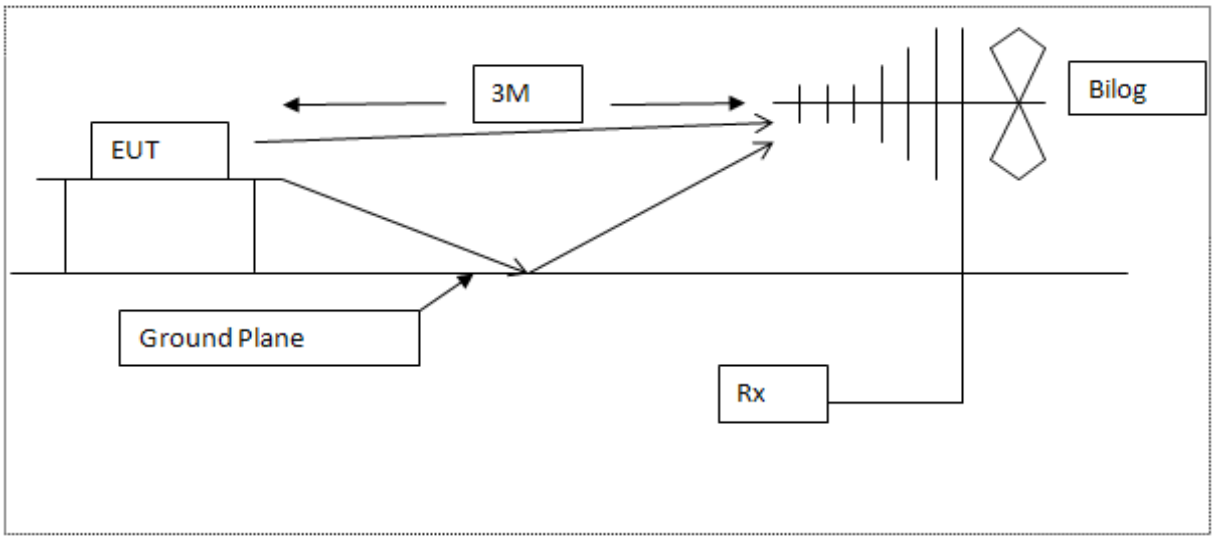


Diagram of the radiated emissions test setup 30 – 1000 MHz

8.12 AC powerline conducted emission diagram

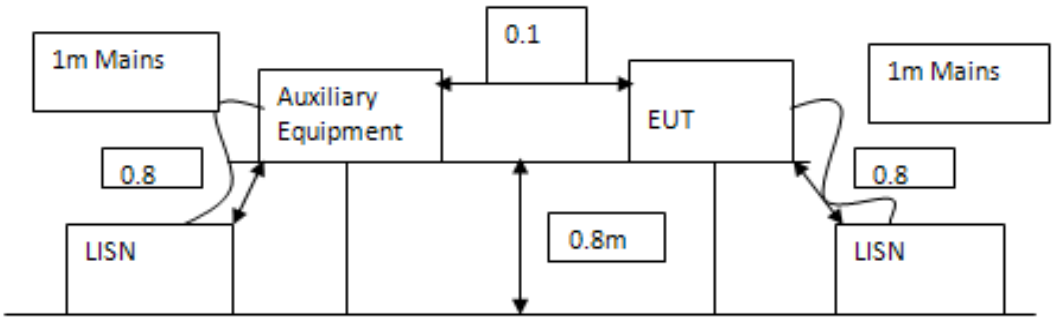


Diagram of the AC conducted emissions test setup

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
E010	MN2050	LISN 13A	Chase	08-Oct-2015	12 months
E035	11947A	Transient Limiter + 10dB Atten.	Hewlett Packard	14-Dec-2015	6 months
E150	MN2050	LISN 13A	Chase	08-Oct-2015	12 months
E227	6632A	System DC Power Supply	Hewlett Packard	16-Mar-2016	12 months
E285	8546A	EMI Receiver	Hewlett Packard	29-Jul-2015	12 months
E410	N5181A	Signal Generator 3 GHz MXG	Agilent Technologies	30-Apr-2015	36 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	29-Apr-2015	12 months
E412	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	29-Apr-2015	24 months
E434	G3RUH	10MHz GPS Disciplined Oscillator	James Miller	N/A	N/A
E465	PCR2000LA	AC Power Supply	Kikusui	*10-May-2016	12 months
E533	N5182A	Signal Generator 6 GHz MXG	Agilent Technologies	26-Feb-2016	36 months
E534	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	26-Feb-2015	24 months
E535	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	25-Feb-2016	12 months
E541	-	Magnetic Loop test fixture	RN Electronics Ltd	N/A	N/A
L264	DT75	Digital Thermometer	Instrotech Ltd	02-Dec-2015	24 months
LPE364	CBL6112A	30MHz - 2GHz Bilog Antenna	Chase Electronics Ltd	22-Jan-2016	24 months
P266	9480	Distribution System	Racal Instruments Ltd	N/A	N/A
TMS38	VMT04/140	Environmental Oven	Heraeus Votsch	N/A	N/A
TMS45	Model1	Attenuator	Weinschel	07-Jul-2015	12 months
TMS81	6502	Active Loop Antenna	EMCO	27-Apr-2015	24 months

* Equipment was in calibration date for tests and has been re-calibrated during/since test dates.

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	UP03061120	Power supply	Hypercom	Not stated
2	DTX-00-07	Wiegand Interface Board	Not stated	13012-0019
3	Not stated	13.56 MHz RFID card	Not stated	j72579204l
4	Not stated	125 kHz RFID card	Not stated	i01004ck

10.2 RN Electronics supplied equipment

No RN Electronics Ltd supplied equipment was used.

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 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

13 Abbreviations and units

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