



Radio Test Report

Maynetronics Ltd

Nomad Key

NRT302

47 CFR Part 15.225

Effective Date 1st October 2014

DXX: Part 15 Low Power Communication Device Transmitter

Test Date: 23rd July 2015 to 27th July 2015

Report Number: 07-8205-1-15 Issue 01

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Certificate of Test 8205-1

The equipment noted below has been partially 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:	Nomad Key
Model Number:	NRT302
Unique Serial Number:	8396
Manufacturer:	Maynetronics Ltd 782, Oak Cottage, Ashey Road Ashey Isle of Wight PO33 4BD
Full measurement results are detailed in Report Number:	07-8205-1-15 Issue 01
Test Standards:	47 CFR Part 15.225 Effective Date 1st October 2014 DXX: Part 15 Low Power Communication Device Transmitter

NOTE:

Certain tests were not performed as they are covered under RN Electronics test report: 09-7226-5-14 Issue 01. For details refer to section 3 of this report.

DEVIATIONS:

Deviations from the standards have been applied. For details refer to section 4.2 of this report. The following tests have not been performed as they are covered within RN Electronics test report: 09-7226-5-14 Issue 01:- AC power line conducted emissions, Radiated emissions - 30 MHz -1 GHz.

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: 23rd July 2015 to 27th July 2015

Test Engineer:

Approved By:
Technical Director

Customer
Representative:

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2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Maynetronics Ltd 782 Oak Cottage Ashey Road Ashey Isle of Wight PO33 4BD	
Manufacturer of EUT	Maynetronics Ltd	
Brand name of EUT	Nomad Key	
Model Number of EUT	NRT302	
Serial Number of EUT	8396	
Date Received	14th July 2015	
Date of Test:	23rd July 2015 to 27th July 2015	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Created	28th July 2015	
Visual Description	A small plastic enclosure designed to be hand-held. The unit features a membrane type numerical keypad with additional function buttons to navigate the menu system. A backlit LCD screen is recessed into the unit. The unit is powered by two 1.5V AA NiMh rechargeable batteries, and the unit is charged by placing it into a spare bay of the five-way docking / charging station. The docking / charging station is powered using a 110V 60Hz power supply.	
Main Function	A portable terminal to allow users to scan RFID tags using the built-in 13.56MHz reader/writer, and to make data entries. The EUT can be polled from a central location for data updates using the 915 MHz radio link.	
Information Specification	Height	120 mm
	Width	170 mm
	Depth	16 mm
	Weight	0.1 kg
	Voltage	2.2 - 15 VDC
	Current	0.03 A

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Handheld
Choice of model(s) for type tests	Production prototype
Antenna details	Integral
Antenna port	No
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	915 MHz
Lowest Signal generated in EUT	2 MHz
TX Parameters	
Alignment range – transmitter	13.56 MHz (fixed frequency equipment)
EUT Declared Modulation Parameters	As per ISO14443A requirements
EUT Declared Power level	1.5 A/m – 7.5 A/m
EUT Declared Signal Bandwidths	Not stated
EUT Declared Channel Spacing's	Not Applicable (Single frequency only)
EUT Declared Duty Cycle	Not stated
Unmodulated carrier available?	Yes
Declared frequency stability	13.56 MHz (± 7 kHz)
RX Parameters	
Alignment range – receiver	13.56 MHz (fixed frequency equipment)
EUT Declared RX Signal Bandwidth	Not stated
Receiver Signal Level (RSL)	Not stated
Method of Monitoring Receiver BER	Not Applicable

2.3 Functional description

The Nomad Key NRT302 incorporates two separate radio modules, a 915 MHz transceiver and a 13.56 MHz RFID reader / writer. In normal operation, the user scans RFID tags with the unit, and makes data entries using the keypad. The EUT can be polled from a central location using the 915 MHz radio link, for data updates.

The manufacturer states that the two radios operate asynchronously, and therefore only one radio will transmit at any point in time. This function is controlled in the EUT's firmware. Both of the EUT's antennas are integral and are etched into the printed circuit board. The unit features a backlit LCD screen to provide the user with status information and a sounder.

2.4 Modes of operation

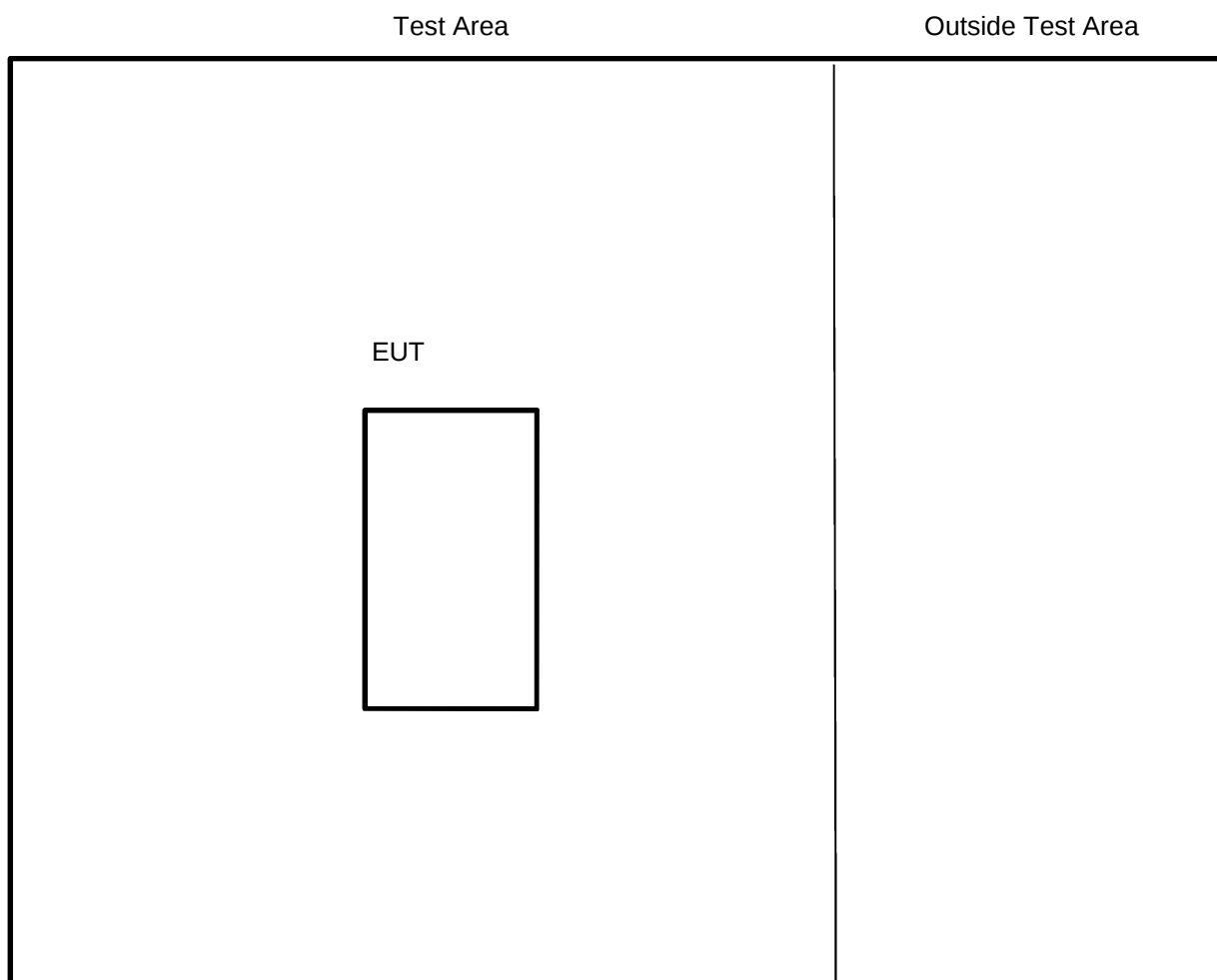
Mode Reference	Description	Used for testing
TX 13.56 MOD (Docked)	Transmitting for 38ms every 480ms with modulation, On charge (docked) in the docking station	No
TX 13.56 MOD (Undocked)	Transmitting for 38ms every 480ms with modulation, standalone (undocked) configuration	Yes
TX 13.56 RFID TAG (Docked)	Scanning RFID tag. EUT Transmits a single burst for 85ms, On charge (docked) in the docking station	No
TX 13.56 RFID TAG (Undocked)	Scanning RFID tag. EUT Transmits a single burst for 85ms, standalone (undocked) configuration	Yes
TX 915 MOD (Docked)	Transmitting continuously at 915 MHz with modulation, On charge (docked) in the docking station	No
TX 915 MOD (Undocked)	Transmitting continuously at 915 MHz with modulation, standalone (undocked) configuration	No
RX 915 (Docked)	Receiving continuously at 915 MHz, On charge (docked) in the docking station	No
RX 915 (Undocked)	Receiving continuously at 915 MHz standalone (undocked) configuration	No

The Nomad Key NRT302 incorporates two separate radio modules, a 915 MHz transceiver and a 13.56 MHz RFID reader / writer. This test report pertains to the 13.56 MHz radio only, and as such, **TX 915 MOD** and **RX 915** test modes have not been used for testing. Please refer to RN Electronics test report 09-7226-2-14 Issue 01 for test results for the 915MHz radio.

Pre-tests performed within RN Electronics report: 09-7226-5-14 Issue 01 showed no discernible difference in results for the tests contained within this report, and as such all testing was performed with the EUT not docked in a charger. Refer to specific test results sections (section 5) for details on test modes used for tests. A special engineering menu was provided on the unit and this allowed the EUT to be set to transmit using either of the two radios. The 915 MHz radio could be set to transmit continuously with modulation, and the 13.56MHz radio could be set to transmit in bursts of 38ms every 480ms. **TX 13.56 RFID TAG** modes were not used for test, because the EUT would require resetting manually before another transmission could be triggered, which made testing impractical; however, pre-tests showed no difference in results between **TX 13.56 RFID TAG** and **TX 13.56 MOD** modes.

All modes were verified using a spectrum analyser tuned to the fundamental frequency. The manufacturer has stated that this engineering menu will not be available to the end-user in the final product.

2.5 Emissions configuration



For all tests within this report there was no discernible difference in emissions with the unit docked in a charger or not docked in the charger (standalone), therefore full tests were performed with the EUT in a stand-alone configuration.

For testing purposes, the manufacturer supplied two identical RFID tags. When a tag was placed in close proximity to the EUT the 13.56 MHz carrier signal modulated in amplitude.

For frequency stability measurements the internal battery was removed and a bench top supply connected in its place. This allowed the battery end points to be set as declared by the manufacturer.

2.5.1 Signal leads

Port Name	Cable Type	Connected
Charging pins	N/A, 1 contact pin either side of unit to contact with a docking charger	Yes

3 Summary of test results

The Nomad Key, NRT302 was tested for compliance to the following standard(s) :

47 CFR Part 15.225, Effective Date 1st October 2014
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	NOT TESTED ¹
2. Radiated emissions - 9 kHz - 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 15.209	NOT TESTED 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 ²
7. Spectrum mask	47 CFR Part 15C Part 15.225(a)(b)(c)(d)	PASSED
8. Frequency stability	47 CFR Part 15C Part 15.225(e)	PASSED

¹ Test has been performed under RN Electronics report number: 09-7226-5-14 Issue 01.

² 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 15C	2014	Federal Communications Commission PART 15 – RADIO FREQUENCY DEVICES
4.1.2	ANSI C63.10	2014	American National Standard for Testing Unlicensed Wireless Devices
4.1.3	ANSI C63.4	2013	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

Deviations have been applied on the following:

The following tests have not been performed as they have been covered within RN Electronics test report number 09-7226-5-14 Issue 01:-

AC power line conducted emissions.

Radiated emissions - 30 MHz -1 GHz.

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	3.0 V DC
T minimum	-30 °C	V minimum	2.2 V DC
T maximum	50 °C	V maximum	3.0 V DC

Extremes of voltage are based on manufacturer's end point declaration for the internal battery operation.
Extremes of temperature are based upon 15.225 requirements.

The ambient test conditions of humidity and pressure in the laboratory were as follows:
45 %; 102 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.

5 Tests, methods and results

5.1 AC power line conducted emissions

NOT TESTED: Test has been performed under RN Electronics report: 09-7226-5-14 Issue 01.

5.2 Radiated emissions - 9 kHz - 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 15.209 [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. Radiated Emissions testing was performed with a charged battery. The EUT was operated in TX 13.56 MOD (Undocked) and TX 13.56 RFID TAG (Undocked) mode with no discernible difference seen in emissions, therefore the unit was operated in TX 13.56 MOD mode for full test.

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 & OATS.

5.2.4 Test equipment

TMS81, E533, E534, E535

See Section 9 for more details

5.2.5 Test results

Temperature of test environment	21°C
Humidity of test environment	40%
Pressure of test environment	101kPa

Band	13.11-14.01 MHz
Power Level	Maximum
Channel Spacing	Single frequency
Mod Scheme	ISO14443A
Mid channel	13.56 MHz

Plot refs
8205-1 Rad 1 9-150 kHz Para
8205-1 Rad 1 9-150 kHz Perp

Analyser plots for the Quasi-Peak / Average values as applicable 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:
9 kHz – 30 MHz ± 3.9 dB

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 15.209 [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 antenna was orientated in both Parallel and Perpendicular polarisations. Radiated Emissions testing was performed with a new battery. The EUT was operated in TX 13.56 MOD (Undocked) and TX 13.56 RFID TAG (Undocked) mode with no discernible difference seen in emissions, therefore the unit was operated in TX 13.56 MOD mode for full test.

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 & OATS.

5.3.4 Test equipment

TMS81, E533, E534, E535

See Section 9 for more details

5.3.5 Test results

Temperature of test environment	21°C
Humidity of test environment	40%
Pressure of test environment	101kPa

Band	13.11-14.01 MHz
Power Level	Maximum
Channel Spacing	Single frequency
Mod Scheme	ISO14443A
Mid channel	13.56 MHz

Plot refs
8205-1 Rad 1 150k-30MHz Para
8205-1 Rad 1 150k-30MHz Perp

Analyser plots for the Quasi-Peak / Average values as applicable 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:
9 kHz – 30 MHz ± 3.9 dB

5.4 Radiated emissions - 30 MHz -1 GHz

NOT TESTED: Test has been performed under RN Electronics report: 09-7226-5-14 Issue 01.

5.5 Intentional radiator field strength

5.5.1 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) [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 TX 13.56 MOD (Undocked) and TX 13.56 RFID TAG (Undocked) mode with no discernible difference seen in emissions, therefore the unit was operated in TX 13.56 MOD mode for full test.

5.5.3 Test procedure

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

Measurements were made at Site OATS. 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.

5.5.4 Test equipment

TMS81, E285

See Section 9 for more details

5.5.5 Test results

Temperature of test environment	21°C
Humidity of test environment	43%
Pressure of test environment	101kPa

Band	13.11-14.01 MHz
Power Level	Maximum
Channel Spacing	Single frequency
Mod Scheme	ISO14443A
Single channel	13.56 MHz

	Single
Peak Level (dBµV/m) @ 3metres	43.10
Plot reference	J8205-1, 3m parallel upright field strength
Antenna Polarisation	Parallel
EUT Polarisation	Upright

Highest field strength was measured with EUT in its upright position and the loop antenna in the parallel position. 3 metre distance was used. A 40 dB extrapolation factor as per FCC was used to convert the field strength to 30 metres. This gave a field strength result at 30 metres of 3.1dBuV/m. Any analyser plots can be found in Section 6 of this report.

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.

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:
<± 3.5 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. 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 13.56 MOD (Undocked) and TX 13.56 RFID TAG (Undocked) mode with no discernible difference seen in emissions, therefore the unit was operated in TX 13.56 MOD mode for full test.

5.6.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. A 10kHz RBW, 3x VBW, auto sweep time and max hold settings were used for the 20 dB bandwidth. Tests were performed in Test Site H.

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	41%
Pressure of test environment	101kPa

Band	13.11-14.01 MHz
Power Level	Maximum
Channel Spacing	Single frequency
Mod Scheme	ISO14443A
Mid channel	13.56 MHz

20dB Bandwidth (kHz) Plot reference	Single channel
	231.5 8205-1 20dB & 99% BW

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 TX 13.56 MOD (Undocked) and TX 13.56 RFID TAG (Undocked) mode with no discernible difference seen in emissions, therefore the unit was operated in TX 13.56 MOD mode for full test.

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.

5.7.4 Test equipment

E533, E534, E535, TMS81

See Section 9 for more details

5.7.5 Test results

Temperature of test environment	21°C
Humidity of test environment	41%
Pressure of test environment	101kPa

Band	13.11-14.01 MHz
Power Level	Maximum
Channel Spacing	Single frequency
Mod Scheme	ISO14443A
#Channel# channel	13.56 MHz

	Single
Maximised RF field strength referenced to 30m (dBuV/m)	3.1
Plot reference	8205-2 Spectrum mask

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 $\mu\text{V/m}$ @ 30m = 84 dB $\mu\text{V/m}$ @ 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 $\mu\text{V/m}$ @ 30m = 50.5 dB $\mu\text{V/m}$ @ 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 $\mu\text{V/m}$ @ 30m = 40.5 dB $\mu\text{V/m}$ @ 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:
< $\pm$ 4.1 dB

5.8 Frequency stability

5.8.1 Test methods

Test Requirements:	47 CFR Part 15C Part15.225(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 15C Part15.225(e) [Reference 4.1.1 of this report]

5.8.2 Configuration of EUT

The EUTs' internal batteries were removed and a bench top supply was connected directly to the battery terminals. This allowed the battery 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 **TX 13.56 MOD (Undocked)** mode for this test.

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 manufacturer's end points. A 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

E412, E227, E434, TMS80, TMS38

See Section 9 for more details

5.8.5 Test results

Temperature of test environment	20°C
Humidity of test environment	45%
Pressure of test environment	102kPa

Band	13.11-14.01 MHz
Power Level	Maximum
Channel Spacing	Single frequency
Mod Scheme	ISO14443A
Single channel	13.56 MHz

Test conditions		Frequency Reading (MHz)
-30°C	Volts Nominal	-0.000089
-20°C	Volts Nominal	-0.000079
-10°C	Volts Nominal	-0.000058
0°C	Volts Nominal	-0.000030
10°C	Volts Nominal	0.000003
Temp Ambient	Volts Minimum	0.000000
	Volts Nominal	0.000000
	Volts Maximum	0.000000
30°C	Volts Nominal	0.000011
40°C	Volts Nominal	-0.000004
50°C	Volts Nominal	-0.000013
Max Frequency Error per chan (Hz)		+11 / -89
Max Frequency Error observed (MHz)		-0.000089

Maximum variation observed was -89Hz at a temperature of -30°C.

LIMITS:

15.225(e), +/- 0.01%. (+/- 1.356 kHz)

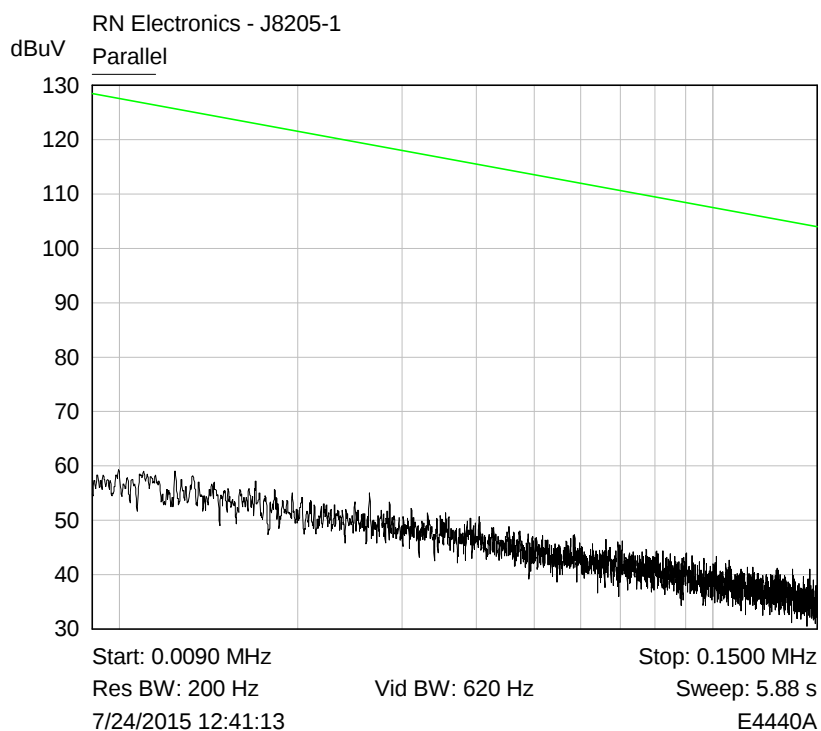
These results show that the EUT has PASSED this test.

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

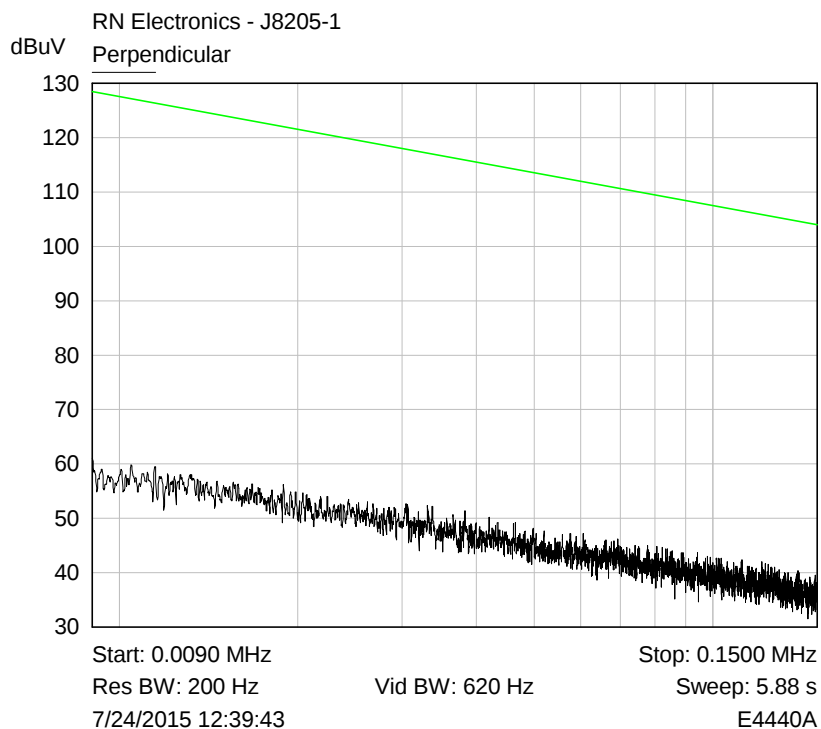
6 Plots/Graphical results

6.1 Radiated emissions - 9 kHz - 150 kHz

RF Parameters: Band 13.11-14.01 MHz, Power Maximum, Channel Spacing Single frequency, Modulation ISO14443A, Channel 13.56 MHz



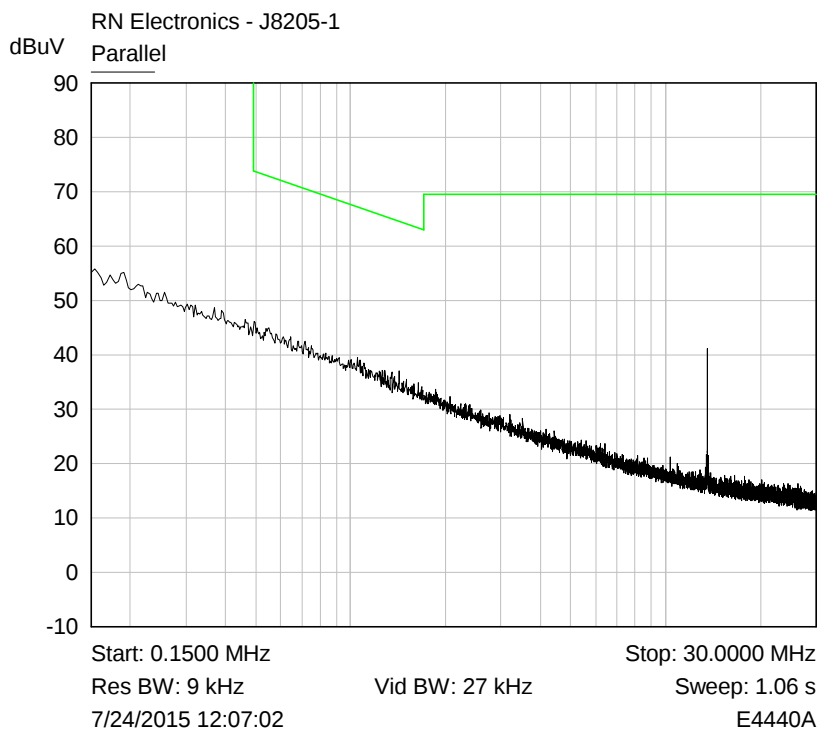
Plot of 9-150 kHz Parallel



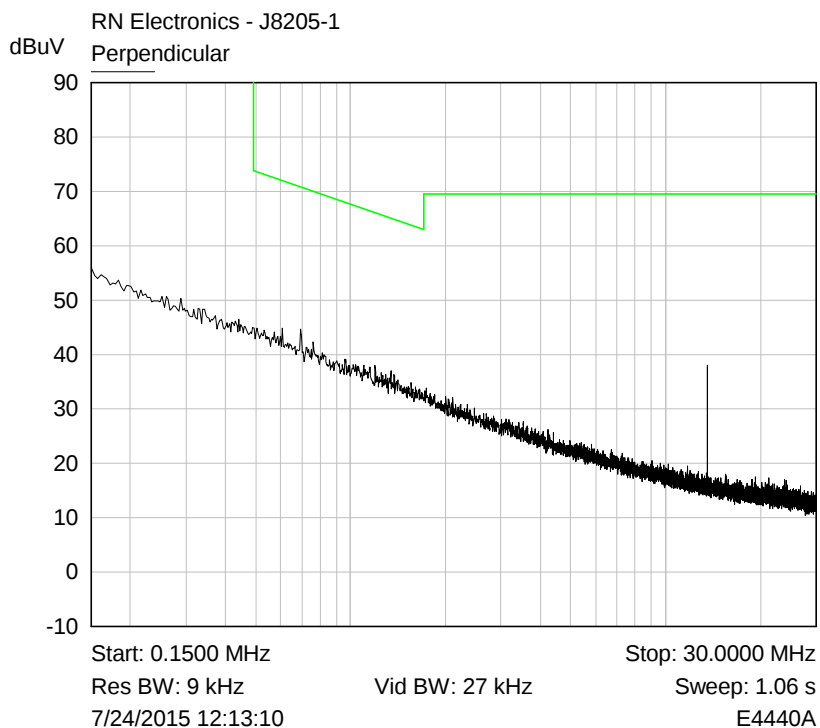
Plot of 9-150 kHz Perpendicular

6.2 Radiated emissions - 150 kHz - 30 MHz

RF Parameters: Band 13.11-14.01 MHz, Power Maximum, Channel Spacing Single frequency, Modulation ISO14443A, Channel 13.56 MHz



Plot of 150k-30 MHz Parallel



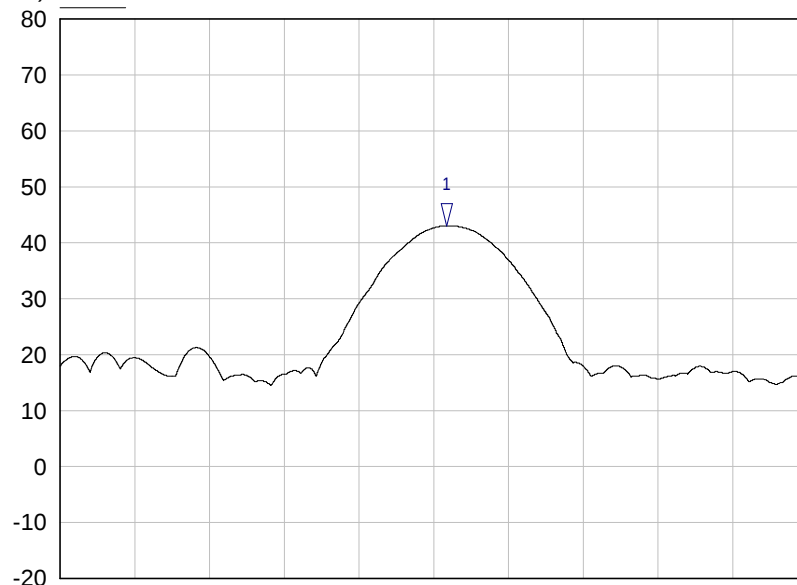
Plot of 150k-30 MHz Perpendicular

6.3 Intentional radiator field strength

RF Parameters: Band 13.11-14.01 MHz, Power Maximum, Channel Spacing Single frequency, Modulation ISO14443A, Channel 13.56 MHz

dB J8205-1, upright parallel field strength 3m

(uV/m) Trace A



Start: 13.5100 MHz

Stop: 13.6100 MHz

Res BW: 10 kHz

Vid BW: 30 kHz

Sweep: 1.07 ms

27/07/2015 15:32:20

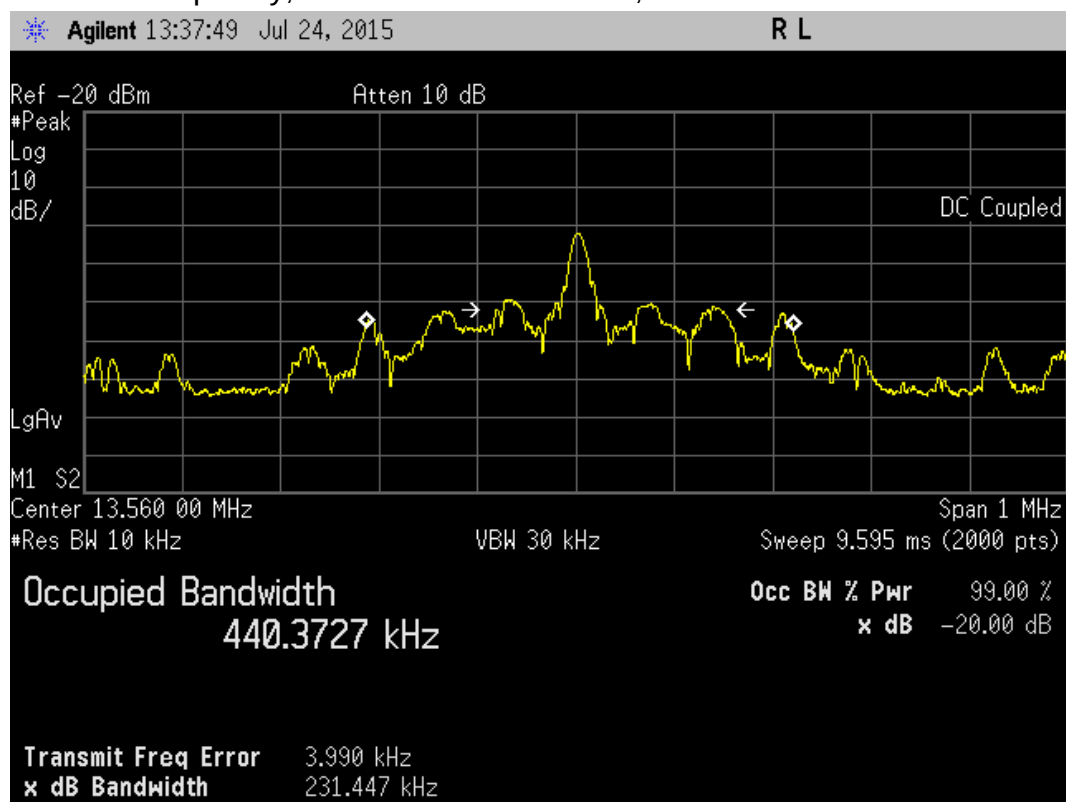
E4440A

Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	13.5618 MHz	43.05 dB(uV/m)	

Plot of maximised field strength @ 3m.

6.4 Occupied bandwidth

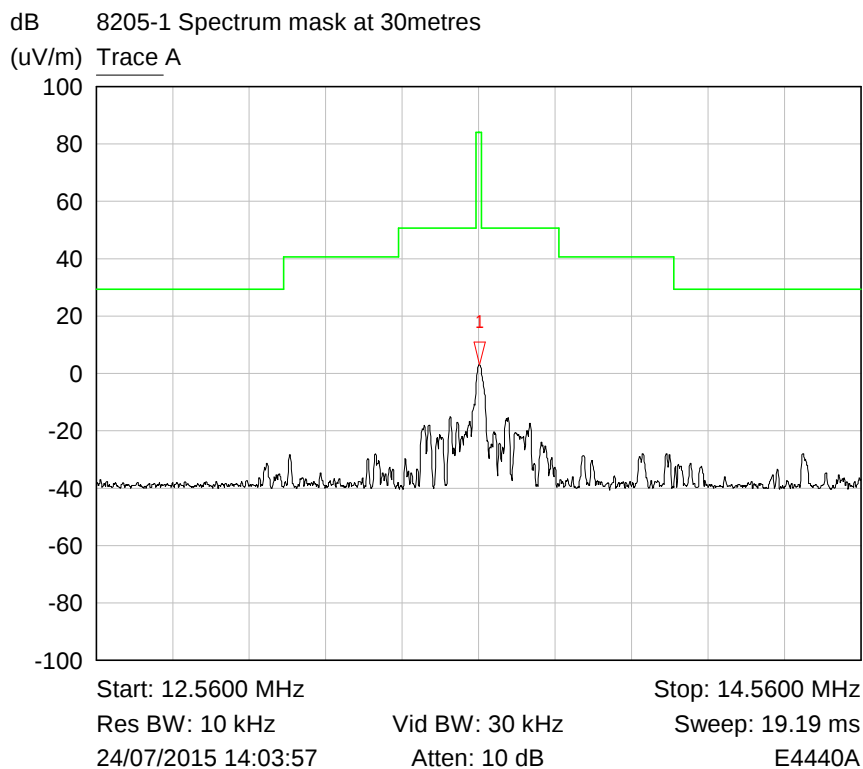
RF Parameters: Band 13.11-14.01 MHz, Power Maximum, Channel Spacing Single frequency, Modulation ISO14443A, Channel 13.56 MHz



Plot of 20 dB Bandwidth (includes 99% bandwidth)

6.5 Spectrum mask

RF Parameters: Band 13.11-14.01 MHz, Power Maximum, Channel Spacing Single frequency, Modulation ISO14443A, Channel 13.56 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	13.5625 MHz	3.10 dB(uV/m)	

Mask at 30m, 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 (dB μ V)	Pk – Lim 1 (dB)	QP Amp (dB μ V)	QP - Lim1 (dB)	Av Amp (dB μ V)	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 (dB μ V) is the level of received signal that was measured in dB above 1 μ V 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 (dB μ V) is the level of received signal that was measured in dB above 1 μ V 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 (dB μ V) is the level of received signal that was measured in dB above 1 μ V 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 $\mu\text{V/m}$ at a specified distance), whereas the measured values are expressed as peak, quasi peak or average values in $\text{dB}\mu\text{V/m}$ 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 $500 \mu\text{V/m}$ equates to $20.\log(500) = 54 \text{ dB } \mu\text{V/m}$.

(b) limit of $300 \mu\text{V/m}$ at 10m equates to $20.\log(300 \cdot 10/3) = 60 \text{ dB } \mu\text{V/m}$ at 3m

(c) limit of $30 \mu\text{V/m}$ at 30m, but below 30MHz, equates to $20.\log(30) + 40.\log(30/3) = 69.5 \text{ dB}\mu\text{V/m}$ at 3m, as extrapolation factor below 30MHz is 40dB/decade per 15.31(f)(2).

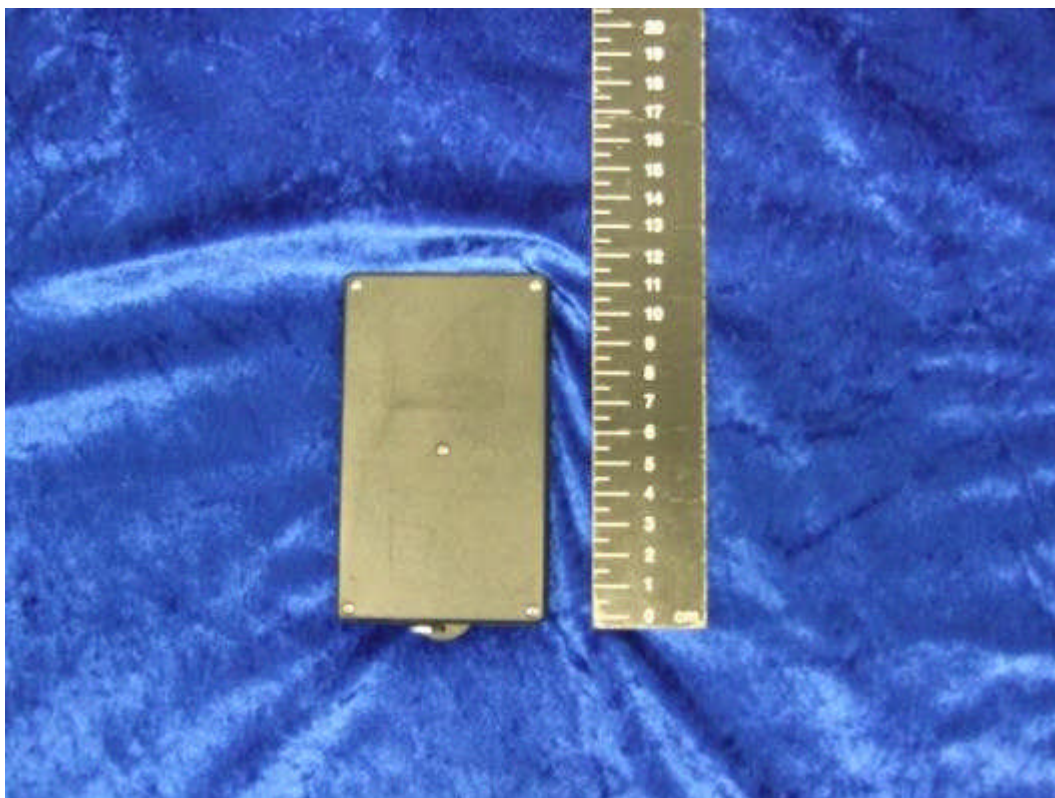
8 Photographs

Note: All other photos including internal and antenna photos are included in RN Electronics report:
09-7226-5-14 Issue 01

8.1 EUT Front View



8.2 EUT Reverse Angle

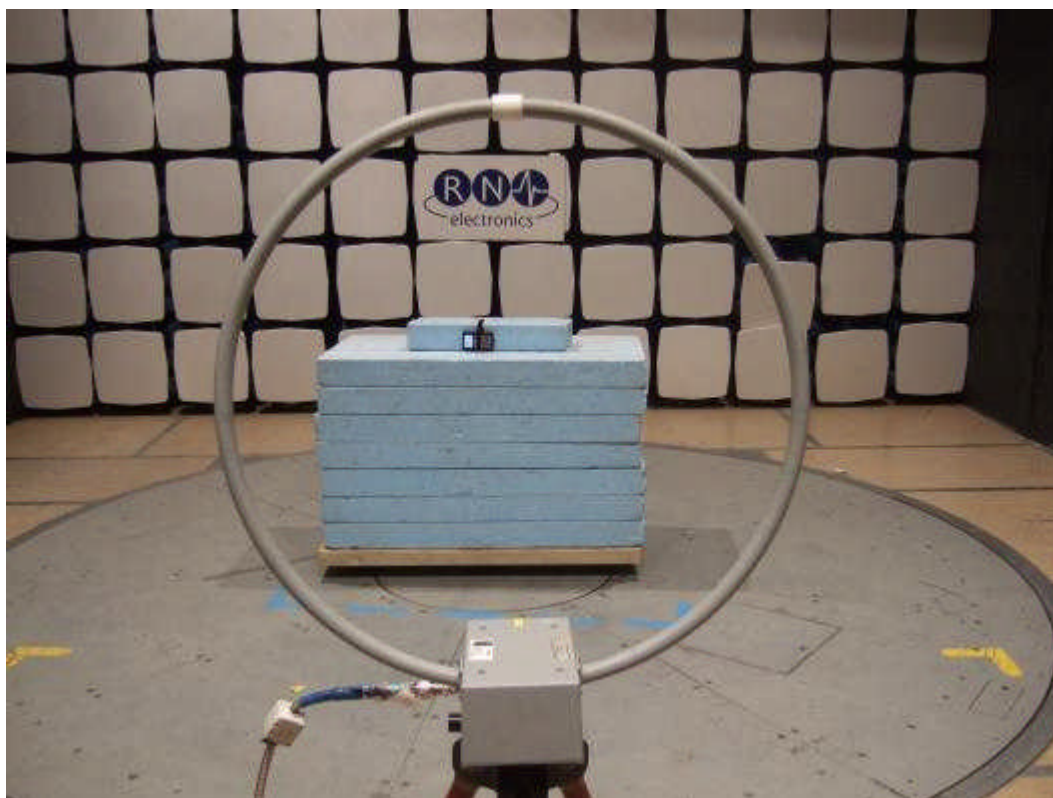


8.3 EUT Display & Controls



8.4 Radiated emissions - 150 kHz - 30 MHz





8.5 Set-up diagrams

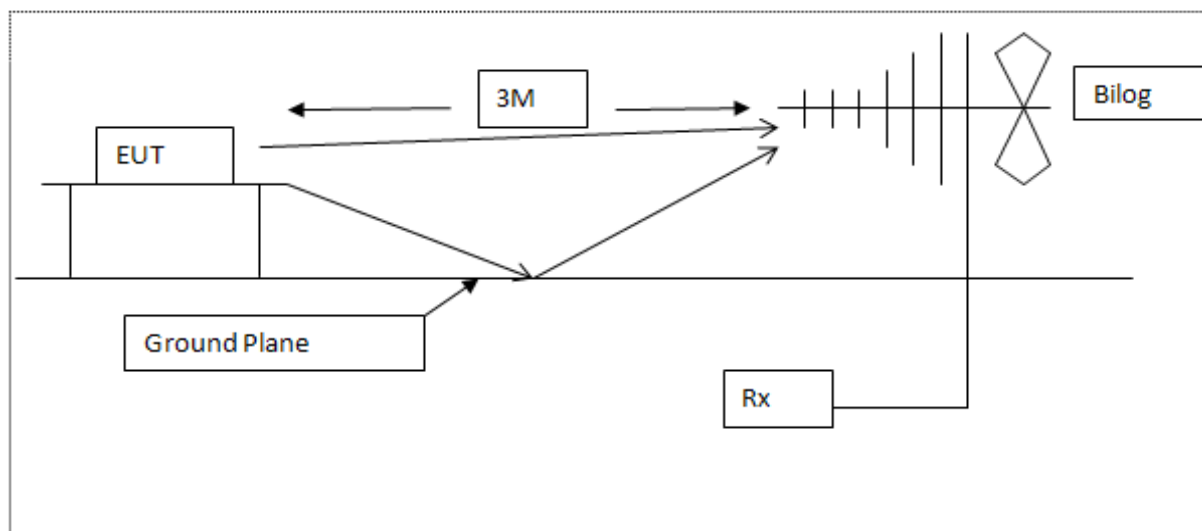


Diagram of the radiated emissions test setup 30 – 1000MHz

8.6 Set-up diagrams

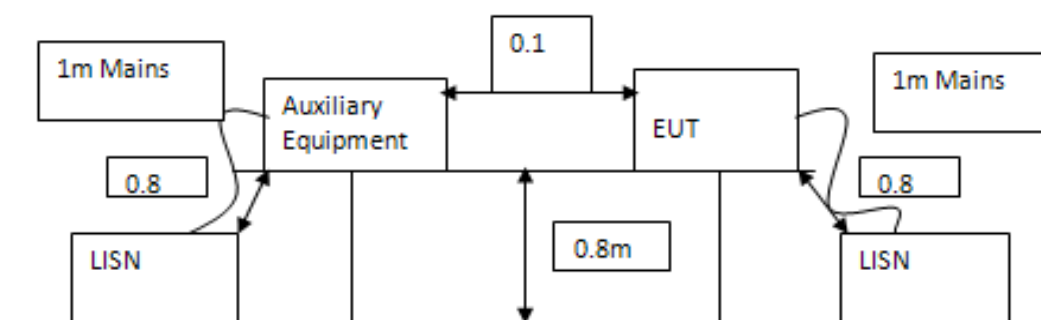


Diagram of the AC conducted emissions test setup

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
E227	6632A	System DC Power Supply	Hewlett Packard	19-Mar-15	12 months
E285	8546A	EMI Receiver	Hewlett Packard	*29-Jul-2015	12 months
E412	E4440A	3 Hz - 26.5 GHz PSA	Agilent Technologies	29-Apr-15	24 months
E434	G3RUH	10 MHz GPS Oscillator	James Miller	N/A	N/A
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-Feb-15	24 months
E535	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	26-Jan-2015	12 months
TMS38	VMT04/140	Environmental Oven	Heraeus Votsch	N/A	N/A
TMS80	206-3722	Digital Thermometer & K Probe	RS Components Ltd	07-Nov-2014	12 months
TMS81	6502	Active Loop Antenna	EMCO	27-Apr-2015	24 months

* Equipment was within calibration dates for tests and has been re-calibrated since date of tests.

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	-	2 RFID Tags	-	-

10.2 RN Electronics supplied equipment

RN No.	Model No.	Description	Manufacturer
E541	-	Magnetic Loop test fixture	RN Electronics Ltd

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.

13 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

14 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
°C	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		