



Radio Test Report

FEC Heliports Worldwide Limited

HEMS-Star

HP0678/6

47 CFR Part 15.249 Effective Date 1st October 2014

Test Date: 14th December 2015 to 29th January 2016
Report Number: 01-8311-2-16 Issue 01

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Arnolds Court, Arnolds Farm Lane, Mountnessing, Brentwood Essex, CM13 1UT
Certificate of Test 8311-2

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: HEMS-Star
Model Number: HP0678/6
Unique Serial Numbers: 609 (programmed to a single channel)
610 (programmed to use all channels consecutively)
Applicant: FEC Heliports Worldwide Limited
1 Mead Business Centre, 176-178 Berkhamstead Road
Chesham, Buckinghamshire
HP5 3EE
Proposed FCC/IC ID 2AFNN-HP0678-6-Z9
Full measurement results are detailed in Report Number: 01-8311-2-16 Issue 01
Test Standards: 47 CFR Part 15.249 Effective Date 1st October 2014
DXT: Low power Transceiver, RX verified

NOTE:

Certain requirements are subject to manufacturer declaration only and have not been tested/verified. For details refer to section 3 of this report.

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: 14th December 2015 to 29th January 2016

Test Engineer:

Approved By:

Radio Approvals Manager

Customer

Representative:

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2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	FEC Heliports Worldwide Limited 1 Mead Business Centre 176-178 Berkhamstead Road Chesham Buckinghamshire HP5 3EE	
Manufacturer of EUT	Interleader Limited	
Brand name of EUT	HEMS-Star	
Model Number of EUT	HP0678/6	
Serial Number of EUT	609 (programmed to a single channel) 610 (programmed to use all channels consecutively)	
Date Received	19th November 2015	
Date of Test:	14th December 2015 to 29th January 2016	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Created	5th February 2016	
Main Function	Portable Battery LED Helipad Lights.	
Information Specification	Height Width Depth Weight Voltage Current	65 mm 84 mm 83 mm 0.73 kg 6 - 8.4 VDC <1 Amp

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Deployed directly on the ground.
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	915.27 MHz
Lowest Signal generated in EUT	16 MHz
TX Parameters	
Alignment range – transmitter	915 - 915.27 MHz
EUT Declared Modulation Parameters	FSK
EUT Declared Power level	Power level 3 (+8 dBm)
EUT Declared Signal Bandwidths	100 kHz
EUT Declared Channel Spacing's	90 kHz
EUT Declared Duty Cycle	Not stated
Unmodulated carrier available?	No
Declared frequency stability	10 ppm
RX Parameters	
Alignment range – receiver	915 - 915.27 MHz
EUT Declared RX Signal Bandwidth	100 kHz

2.3 Functional description

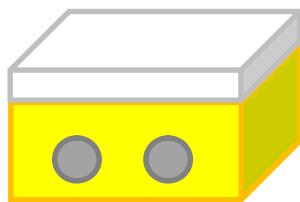
HEMS-Star battery LED Helipad lights are designed to mark temporary helicopter landing areas either at designated or ad-hoc locations. The lights are deployed by ground operators (typically coast guards or designated staff) to support night-time helicopter (most often air ambulance) movements. The lights are capable of showing, at programmable intensities, white, green, blue, red and infra-red or a combination of a visible colour and infra-red to support pilots wearing Night Vision Goggles (NVGs). The lights are also capable of flashing warning or Morse code and have the ability to detect light levels for automatic sunset and sunrise switching. The units are fitted with an 868MHz (915MHz in USA) UHF transceiver and can be setup, interrogated and controlled by wireless commands. The HEMS-Stars can be controlled by Remote Lighting Controllers (RLCs), Key Fob Controllers (KFC) and using a PC fitted with a Zulu 'dongle' transceiver.

2.4 Modes of operation

Mode Reference	Description	Used for testing
TX 915.18	Continuous transmissions at 915.18 MHz, with normal modulation	Yes
TX all channels	Transmitting with modulation across all 4 channels consecutively	Yes

2.5 Emissions configuration

Test Area



The unit was powered from a fully charged battery. For the purposes of testing the manufacturer provided a modified unit, pre-configured to allow continuous transmission at 915.18 MHz with normal modulation. The EUT was supplied with a simple on/off power switch soldered to the PCB of the EUT to enable this test mode (**TX 915.18 MHz** mode). Prior to test the manufacturer set the RF output power to 'Level 3 (+8dBm)' in the engineering software and this power level was used throughout the tests detailed in this report. No other power levels were investigated.

For band edge compliance tests, a second EUT was provided which transmitted across all four channels consecutively (normal use configuration). To enable this test mode a Zulu 'dongle' transceiver was connected to a laptop PC, and using engineering software the EUT was configured into **TX all channels** mode.

The transmit mode was 100% continuous with normal system modulation.

2.5.1 Signal leads

Port Name	Cable Type	Connected
Power charging studs	None	No

The manufacturer states that operation of the EUT is inhibited whilst docked in the charger and therefore the EUT has only been investigated whilst powered from the internal battery.

3 Summary of test results

The HEMS-Star, HP0678/6 was tested for compliance to the following standard :

47 CFR Part 15.249 Effective Date 1st October 2014
DXT: Low power Transceiver, RX verified

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	-	NOT APPLICABLE 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 & 15.249(a)(d)	PASSED
5. Radiated emissions - Above 1 GHz	47 CFR Part 15C Part 15.209 & 15.249(a)(d)	PASSED
6. Intentional radiator field strength	47 CFR Part 15C Part 15.249(a)	PASSED
7. Band Edge Compliance	47 CFR Part 15C Part 15.215 & 15.249(d)	PASSED
8. Occupied bandwidth	47 CFR Part 15C Part 15.215	PASSED
9. Duty cycle	-	NOT APPLICABLE ²
10. Frequency stability	-	NOT APPLICABLE ³

¹ EUT does not operate from the AC power lines nor contain provisions for operation while connected to AC power lines.

² No limits apply, however duty cycle measurement performed to verify any possible correction factors for average emissions. EUT Duty was confirmed as operating at 100% constant transmit state for tests.

³ Test only applies to equipment intended for fixed, point-to-point 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	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

No deviations to the standards have been applied.

5 Tests, methods and results

5.1 AC power line conducted emissions

NOT APPLICABLE: EUT does not operate from the AC power lines nor contain provisions for operation while connected to AC power lines.

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 & 6.6 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.209/15.249(d) [Reference 4.1.1 of this report]

5.2.2 Configuration of EUT

The EUT was placed on a 0.8 metre 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 fully charged battery. The EUT was operated in **TX 915.18** mode.

5.2.3 Test procedure

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

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

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

Radiated emissions 9kHz-150kHz – Tests were performed using Test Site M and OATS.

5.2.4 Test equipment

E410, E411, E412, 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	902-928 MHz
Power Level	Power level 3 (8 dBm)
Channel Spacing	90 kHz
Mod Scheme	FSK
Mid channel	915.18 MHz

Plot refs
8311-2 9-150kHz Parallel
8311-2 9-150kHz Perpendicular

Peak detector "Max held" Analyser plots against the Quasi-Peak / Average limit lines 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.

15.249(d) other emissions, outside the intentional band, must be attenuated by at least 50dB from the level of the fundamental or meet the general limits of 15.209, whichever is the lesser attenuation.

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 $\pm 3.9\text{dB}$

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 & 6.6 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.209/15.249(d) [Reference 4.1.1 of this report]

5.3.2 Configuration of EUT

The EUT was placed on a 0.8 metre 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 fully charged battery. The EUT was operated in **TX 915.18** mode.

5.3.3 Test procedure

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

Measurements were made in a semi-anechoic chamber (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.

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

Tests were performed using Test Site M and OATS.

5.3.4 Test equipment

E410, E411, E412, TMS81

See Section 9 for more details

5.3.5 Test results

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

Band	902-928 MHz
Power Level	Power level 3 (8 dBm)
Channel Spacing	90 kHz
Mod Scheme	FSK
Mid channel	915.18 MHz

Plot refs
8311-2 150kHz-30MHz Parallel
8311-2 150kHz-30MHz Perpendicular

Peak detector "Max held" Analyser plots against the Quasi-Peak / Average limit lines 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.

15.249(d) other emissions, outside the intentional band, must be attenuated by at least 50dB from the level of the fundamental or meet the general limits of 15.209, whichever is the lesser attenuation.

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 ± 3.9 dB

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 6.3-6.5 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.209/15.249(d) [Reference 4.1.1 of this report]

5.4.2 Configuration of EUT

The EUT was placed on a 0.8 metre 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 fully charged battery. The EUT was operated in **TX 915.18** mode.

5.4.3 Test procedure

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

Measurements were made on a site listed with the FCC. The equipment was rotated 360° and the antenna scanned 1 – 4 metres in both horizontal and vertical polarisations to record the worst case emissions. At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.

Tests were performed using Test Site M.

5.4.4 Test equipment

E410, E411, E412, TMS933

See Section 9 for more details

5.4.5 Test results

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

Band	902-928 MHz
Power Level	Power level 3 (8 dBm)
Channel Spacing	90 kHz
Mod Scheme	FSK
Mid channel	915.18 MHz

Plot refs
8311-2 Rad 1 VHF Horiz
8311-2 Rad 1 VHF Vert
8311-2 Rad 1 UHF Horiz
8311-2 Rad 1 UHF Vert

Peak detector "Max held" Analyser plots against the Quasi-Peak / Average limit lines can be found in Section 6 of this report.

No discernible difference was noted in emissions between channels (exploratory measurements), therefore final measurements are presented for 915.18 MHz channel only for these test ranges.

LIMITS:

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

15.249(d) other emissions, outside the intentional band, must be attenuated by at least 50dB from the level of the fundamental or meet the general limits of 15.209, whichever is the lesser attenuation.

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 \pm 5.1dB

5.5 Radiated emissions - Above 1 GHz

5.5.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.209 [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.3 & 6.6 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.209/15.249(d) [Reference 4.1.1 of this report]

5.5.2 Configuration of EUT

The EUT was placed on a 1.5 metre 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 fully charged battery.

The EUT was operated in **TX 915.18** mode.

5.5.3 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 with appropriate absorbing material for use in this range. Horn antennas were used at heights where the whole of the EUT was contained within the main beam. The EUT was rotated through 360° to record the worst case emissions. A measurement distance of 3m was used between the test range 1 - 10GHz.

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

Tests were performed using Test Site M.

5.5.4 Test equipment

E410, E411, E412, E428, TMS82

See Section 9 for more details

5.5.5 Test results

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

Setup Table

Band	902-928 MHz
Power Level	Power level 3 (8 dBm)
Channel Spacing	90 kHz
Mod Scheme	FSK
Single channel	915.18 MHz

Horizontal signal list

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	Pk Lim (dB)	AV Amp (dBuV/m)	AV Lim (dB)
1	1131.849	32.8	-41.2	20.8	-33.2
2	1830.356	49.0	-25.0	47.3	-6.7
3	2745.536	44.8	-29.2	41.1	-12.9
4	3660.718	47.6	-26.4	44.2	-9.8
5	5248.440	42.2	-31.8	28.9	-25.1
6	6943.001	35.4	-38.6	22.9	-31.1

Vertical signal list

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	Pk Lim (dB)	AV Amp (dBuV/m)	AV Lim (dB)
1	1830.357	49.3	-24.7	47.6	-6.4
2	2745.537	43.3	-30.7	38.6	-15.4
3	3660.706	46.1	-27.9	41.7	-12.3
4	5248.570	41.0	-33.0	28.8	-25.2
5	6943.000	36.1	-37.9	22.9	-31.1

Plot References

8311-2 Rad 1 1-2GHz Horiz

8311-2 Rad 1 1-2GHz Vert

8311-2 Rad 1 2-5GHz Horiz

8311-2 Rad 1 2-5GHz Vert

8311-2 Rad 1 5-6GHz Horiz

8311-2 Rad 1 5-6GHz Vert

8311-2 Rad 1 6upto10GHz Horiz

8311-2 Rad 1 6upto10GHz Vert

Peak detector "Max held" Analyser plots against the Average limit line can be found in Section 6 of this report.

Note: No discernible difference was noted in emissions between channels (exploratory measurements), therefore final measurements are presented for 915.18 MHz channel only for these test ranges.

LIMITS:

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

15.249(d) other emissions, outside the intentional band, must be attenuated by at least 50dB from the level of the fundamental or meet the general limits of 15.209, whichever is the lesser attenuation.

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:
1 – 10 GHz $\pm 3.5\text{dB}$

5.6 Intentional radiator field strength

5.6.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.249a [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.3 & 6.5 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.249a [Reference 4.1.1 of this report]

5.6.2 Configuration of EUT

The EUT was placed on a 0.8 metre 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 scanned 1-4m in height in both Horizontal and Vertical polarisations. The EUT was rotated in all three orthogonal planes. The EUT was operated in **TX 915.18** mode.

5.6.3 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 at test site M. This site is listed with the FCC.

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

5.6.4 Test equipment

E410, E411, E412, TMS933

See Section 9 for more details

5.6.5 Test results

Temperature of test environment	18°C
Humidity of test environment	40%
Pressure of test environment	101kPa

Band	902-928 MHz
Power Level	Power level 3 (8 dBm)
Channel Spacing	90 kHz
Mod Scheme	FSK
Single channel	915.18 MHz

	Single
Duty Cycle (%)	100
Duty Cycle correction	0

	Single
Peak Level (dB μ V/m) @3m	85.70
Plot reference	8311-2 Rad power
Antenna Polarisation	Horiz
EUT Polarisation	Upright

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

LIMITS:

15.249(a) 50 mV/m @ 3m (94 dB μ V/m @ 3m).

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:
 ± 5.1 dB

5.7 Band Edge Compliance

5.7.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.215 & 15.249 [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.10 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.209 [Reference 4.1.1 of this report]

5.7.2 Configuration of EUT

The EUT was placed on a 0.8 metre 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 all channels** mode.

5.7.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. The emission from the EUT was maximised before taking the plots.

Tests were performed using Test Site M.

5.7.4 Test equipment

E410, E411, E412, TMS933

See Section 9 for more details

5.7.5 Test results

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

Band	902-928 MHz
Power Level	Power level 3 (8 dBm)
Channel Spacing	90 kHz
Mod Scheme	FSK
Channels	915.0 – 915.27 MHz

	Single Channel
Peak Level (dB μ V/m) Low edge	32.7
Peak Level (dB μ V/m) High edge	33.1

	Single Channel
Band Edge Plot reference	8311-2 Radiated band edge

Analyser plots for the Band Edge Compliance can be found in Section 6 of this report. These show the 50dBc requirement of 15.249(d) are met at the band edges of 902 and 928 MHz.

LIMITS:

Emissions radiated outside of the specified frequency bands, shall be attenuated by 50dB below the level of the fundamental field strength or to the general emissions limits of 15.209, whichever is the lesser attenuation.

The restricted band edges closest to the EUT frequency of 902-928MHz are 614 & 960MHz are covered under radiated emissions 30 MHz – 1GHz (refer to section 5.4).

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

5.8 Occupied bandwidth

5.8.1 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(c)/15.209 [Reference 4.1.1 of this report]

5.8.2 Configuration of EUT

The EUT was placed on a 0.8 metre 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 tested using a fully charged battery. The EUT was operated in **TX 915.18** mode.

5.8.3 Test procedure

Tests were performed using Test Site M.

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

5.8.4 Test equipment

E410, E411, E412, TMS933

See Section 9 for more details

5.8.5 Test results

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

Band	902-928 MHz
Power Level	Power level 3 (14 dBm)
Channel Spacing	90 kHz
Mod Scheme	FSK
Mid channel	915.18 MHz

20dB Bandwidth (MHz)	Mid
Plot reference	0.1329

Analyser plots for the 20 bandwidth can be found in Section 6 of this report.

LIMITS:

15.215(c) The 20dB bandwidth of the emission must be contained within the designated frequency band.

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 %

5.9 Duty cycle

NOT APPLICABLE: No limits apply, however duty cycle measurement performed to verify any possible correction factors for average emissions. EUT Duty was confirmed as operating at 100% constant transmit state for tests.

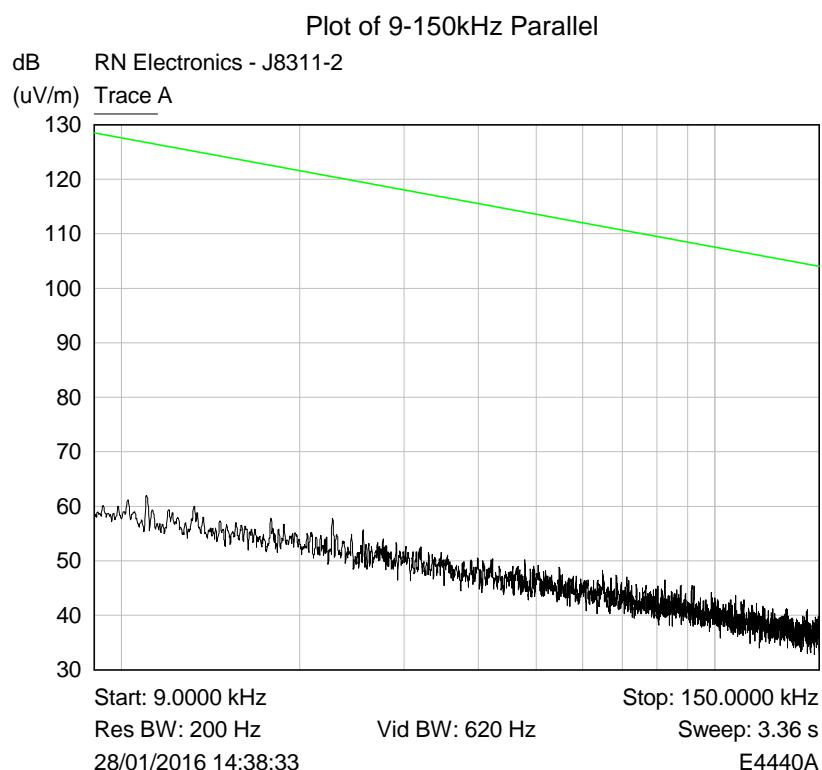
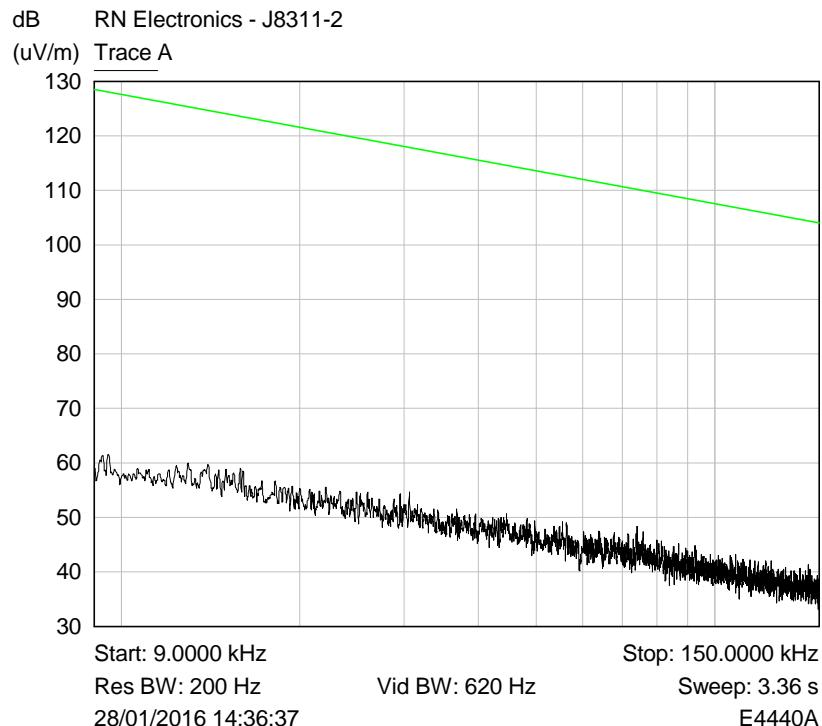
5.10 Frequency stability

NOT APPLICABLE: Test only applies to equipment intended for fixed, point-to-point operation.

6 Plots/Graphical results

6.1 Radiated emissions - 9 kHz - 150 kHz

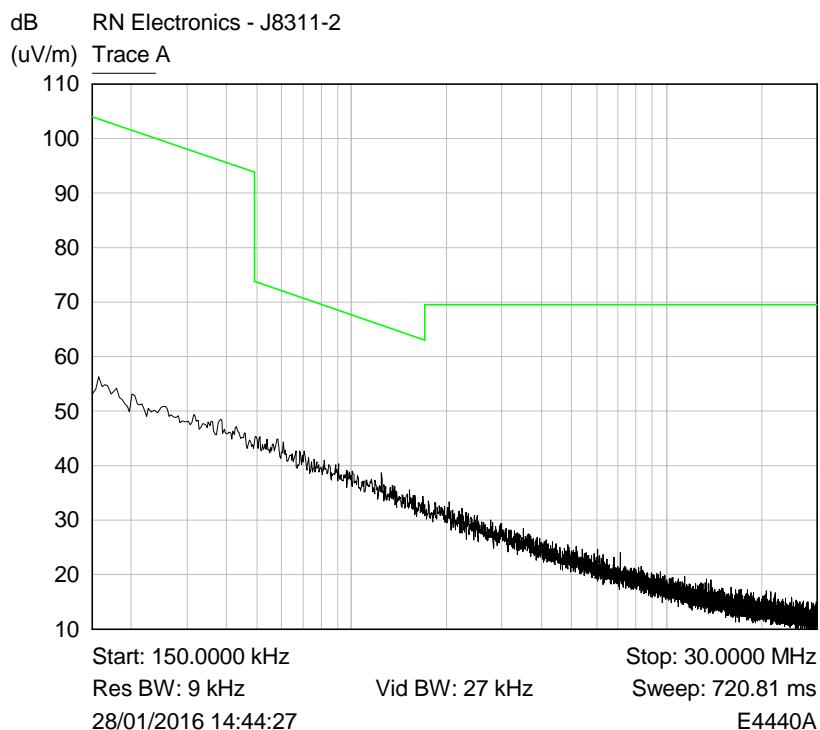
RF Parameters: Band 902-928 MHz, Power level 3 (8 dBm), Channel Spacing 90 kHz,
Modulation FSK, Channel 915.18 MHz



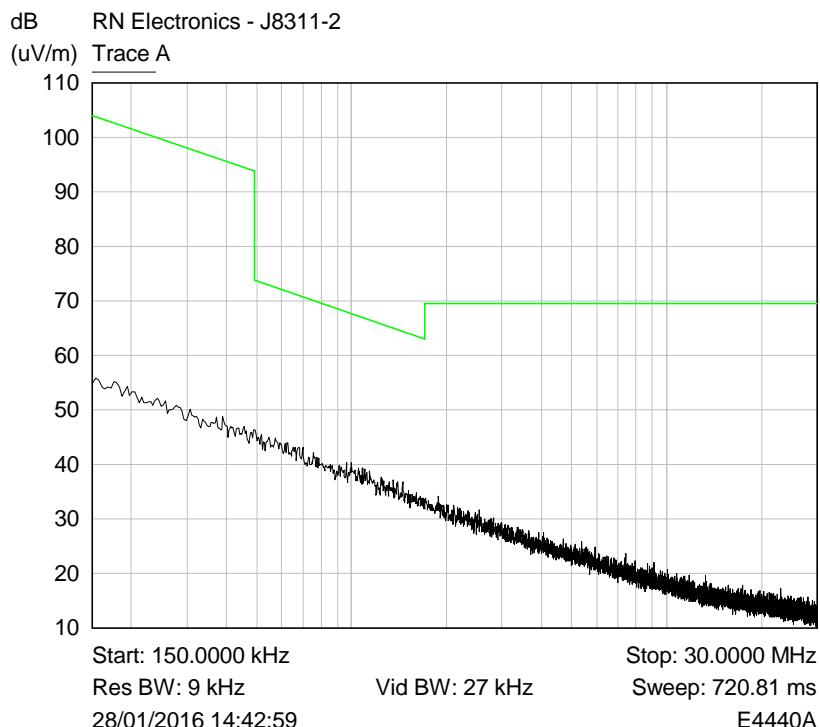
Plot of 9-150kHz Perpendicular

6.2 Radiated emissions - 150 kHz - 30 MHz

RF Parameters: Band 902-928 MHz, Power level 3 (8 dBm), Channel Spacing 90 kHz,
Modulation FSK, Channel 915.18 MHz



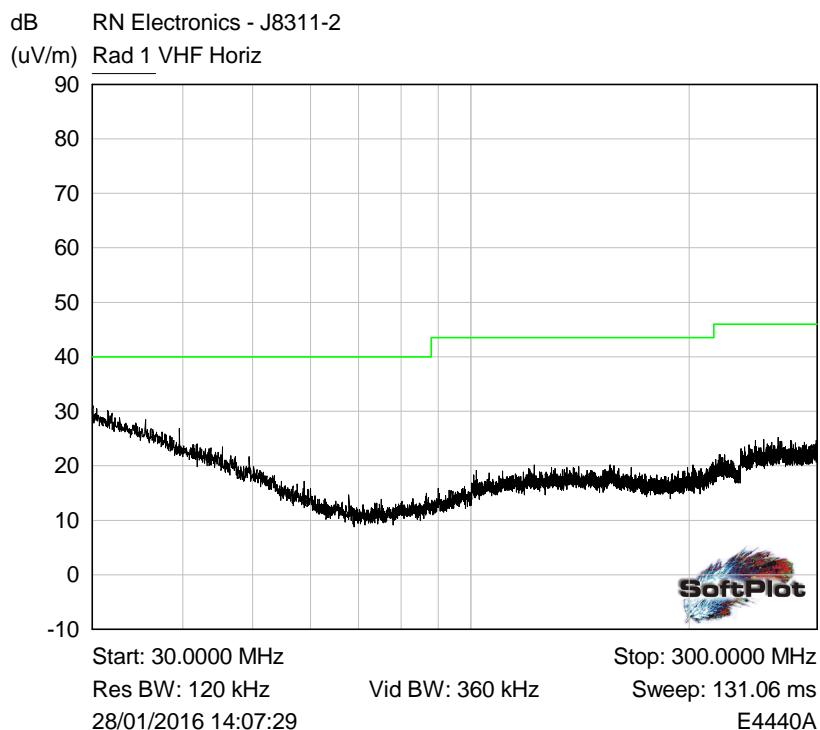
Plot of 150kHz-30MHz Parallel



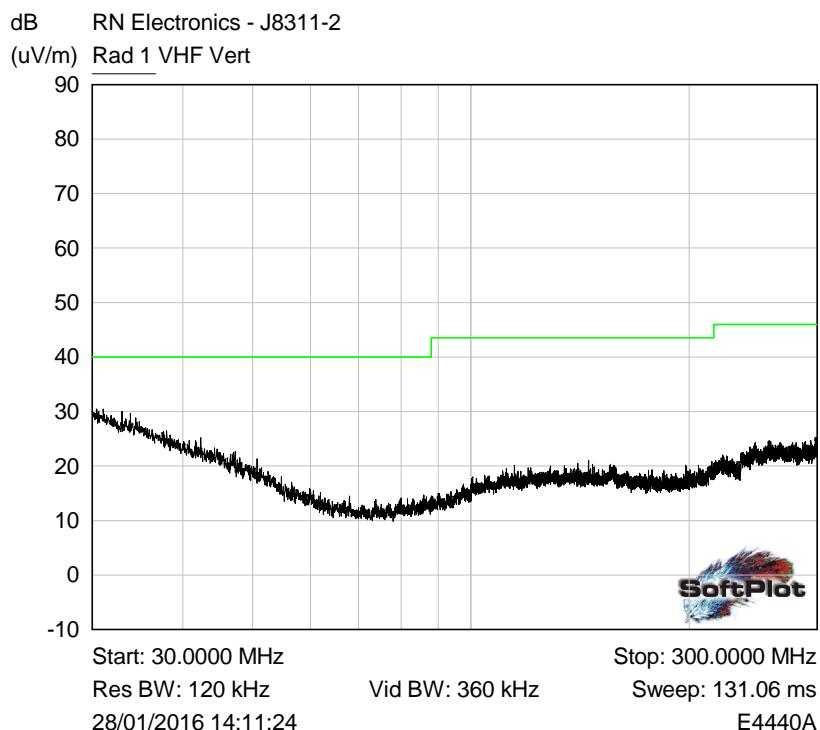
Plot of 150kHz-30MHz Perpendicular

6.3 Radiated emissions - 30 MHz -1 GHz

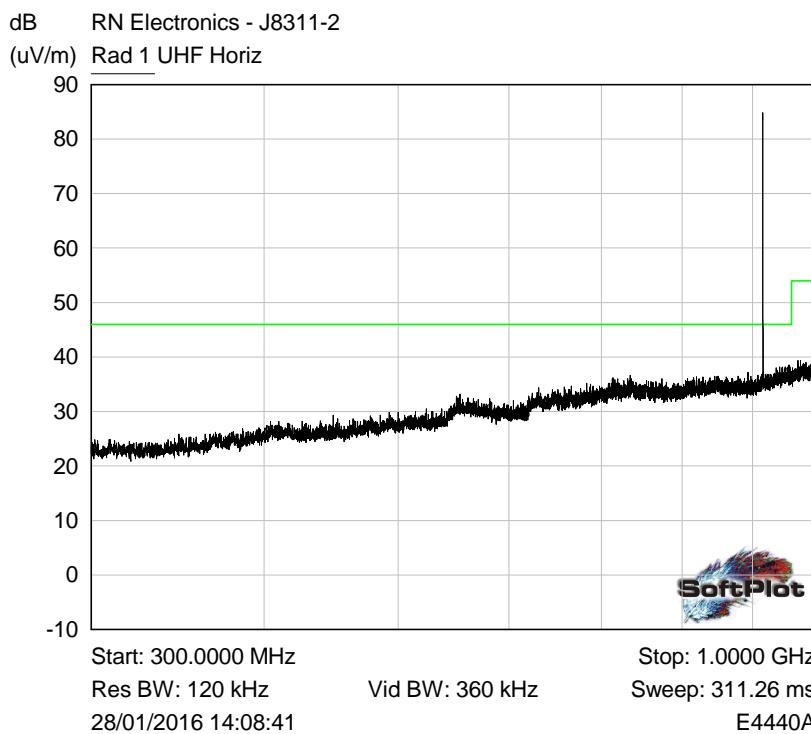
RF Parameters: Band 902-928 MHz, Power level 3 (8 dBm), Channel Spacing 90 kHz,
Modulation FSK, Channel 915.18 MHz



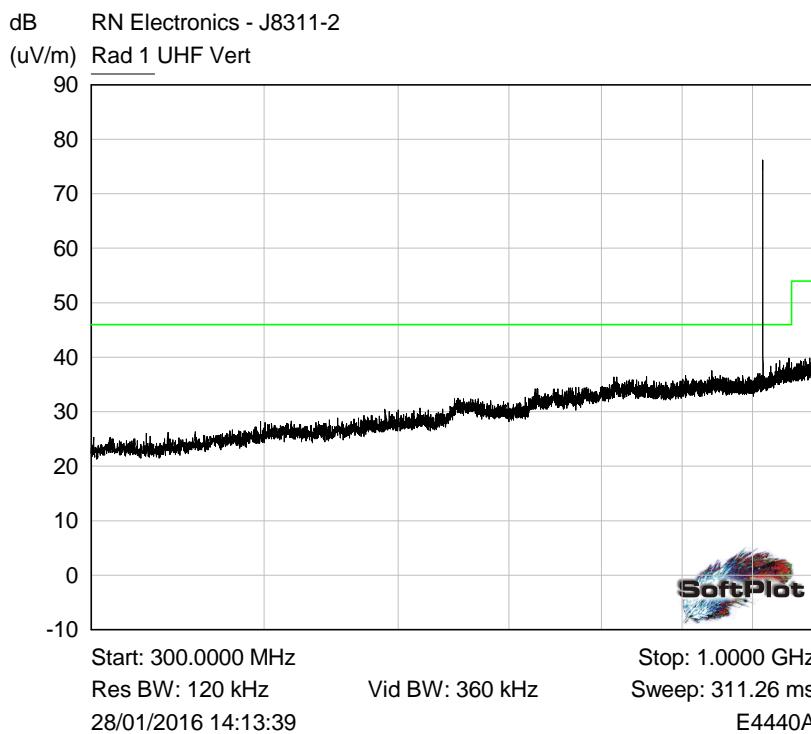
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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



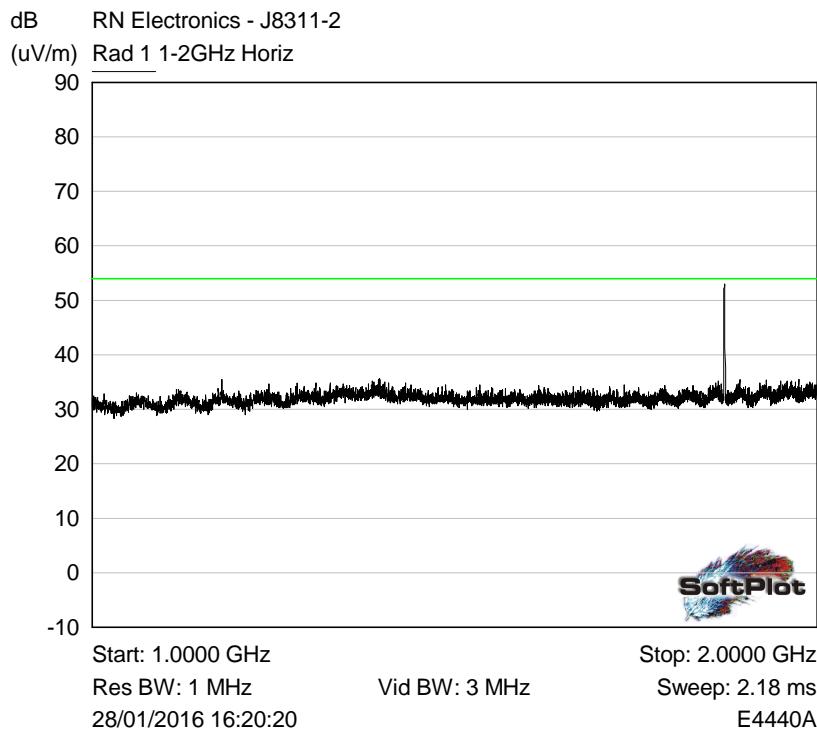
Plot of Peak emissions for UHF Horizontal against the QP limit line.
Note: Plot shows the fundamental transmit carrier at 915.18MHz



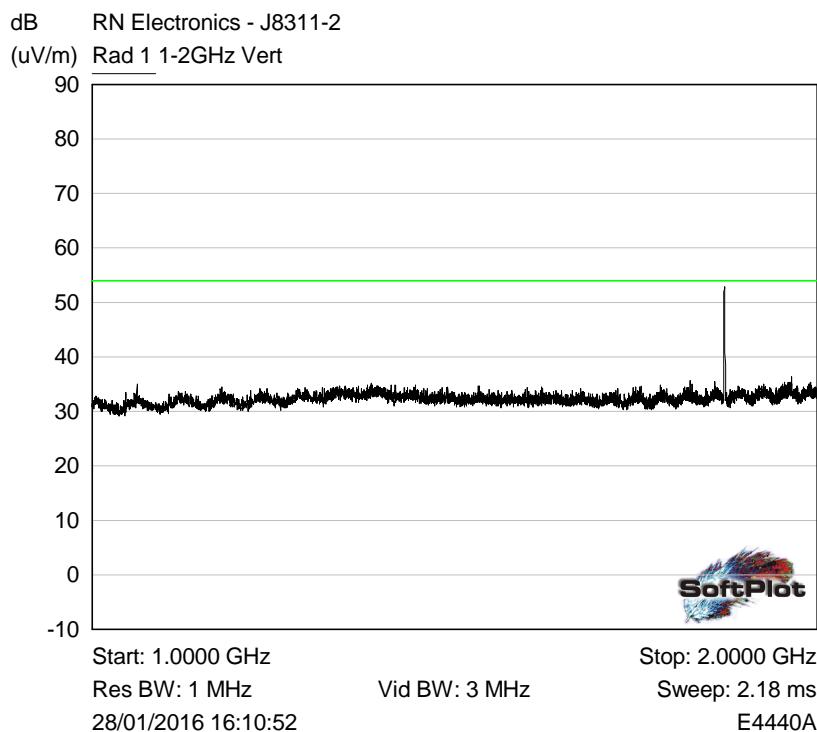
Plot of Peak emissions for UHF Vertical against the QP limit line.
Note: Plot shows the fundamental transmit carrier at 915.18MHz

6.4 Radiated emissions - Above 1 GHz

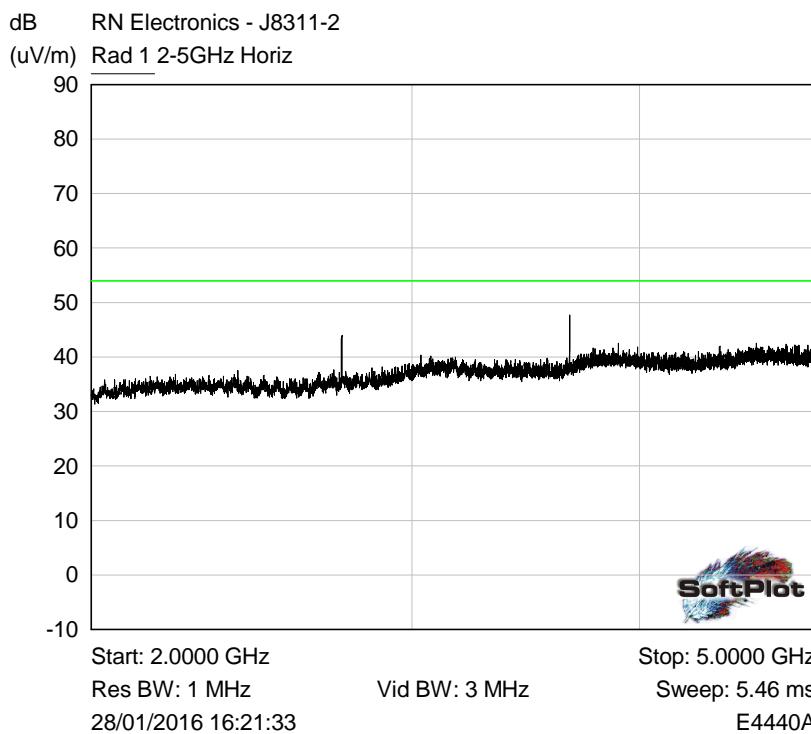
RF Parameters: Band 902-928 MHz, Power level 3 (8 dBm), Channel Spacing 90 kHz,
Modulation FSK, Channel 915.18 MHz



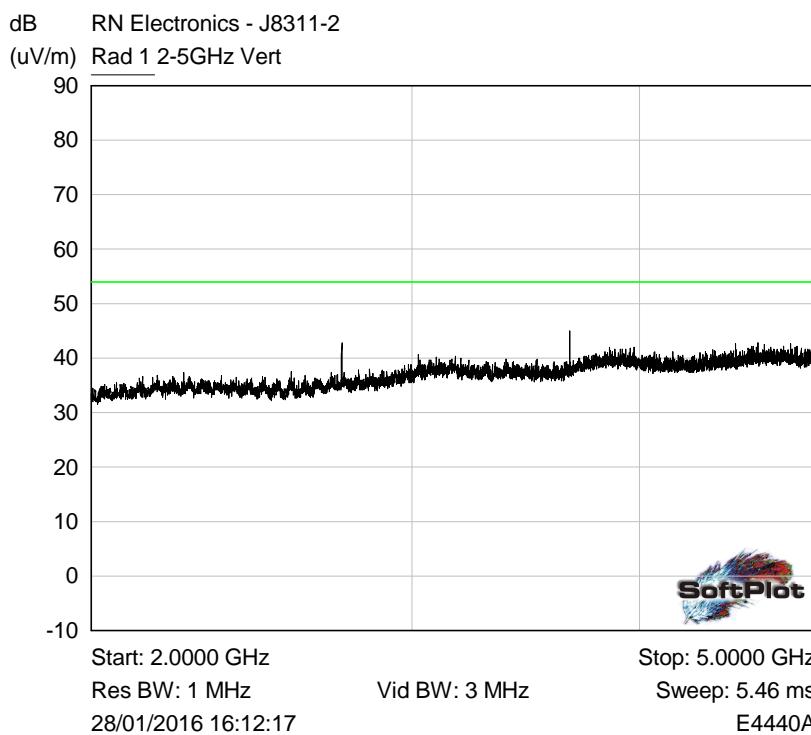
Plot of Peak emissions for Horizontal against the average limit line.



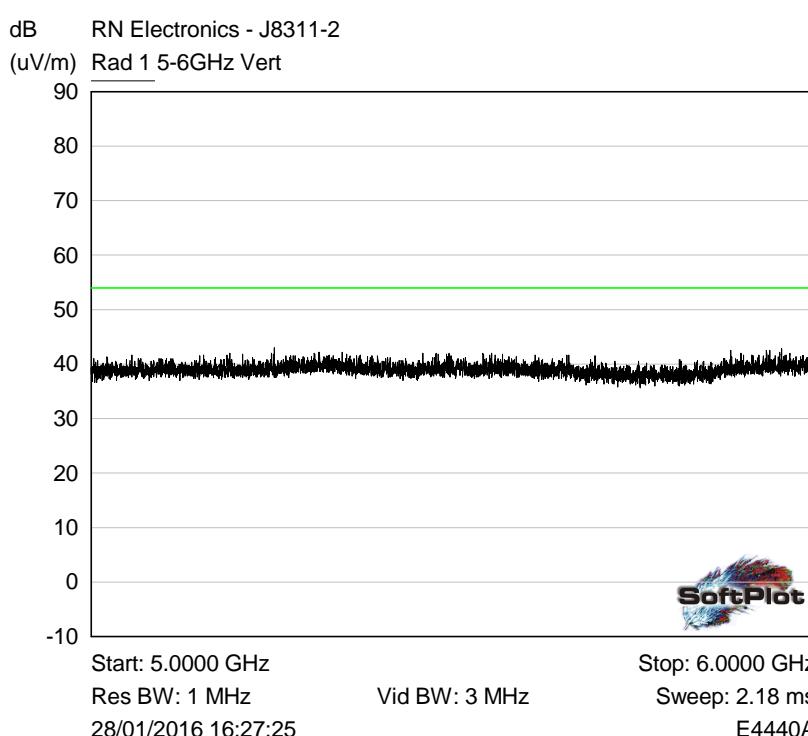
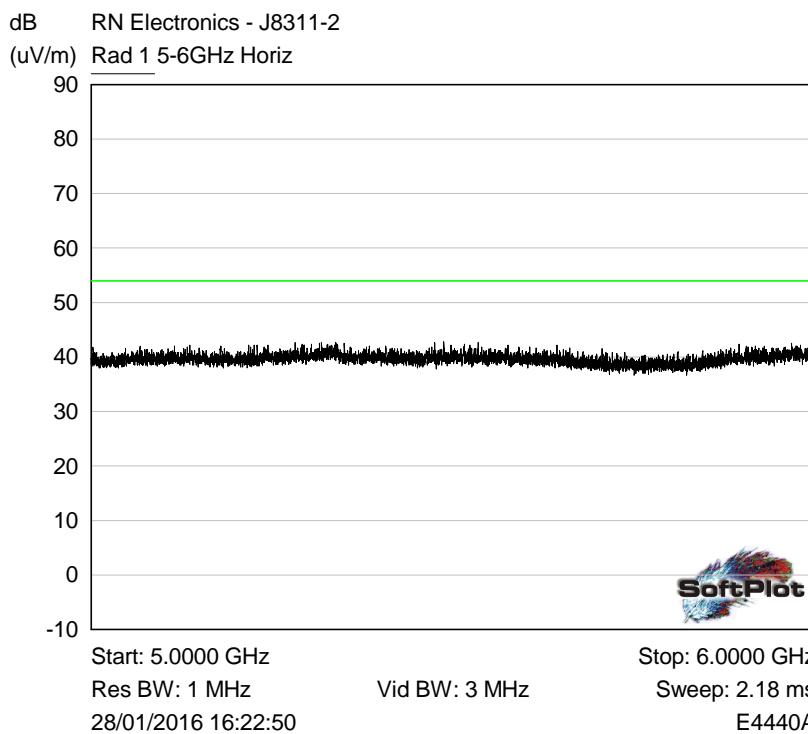
Plot of Peak emissions for Vertical against the average limit line.

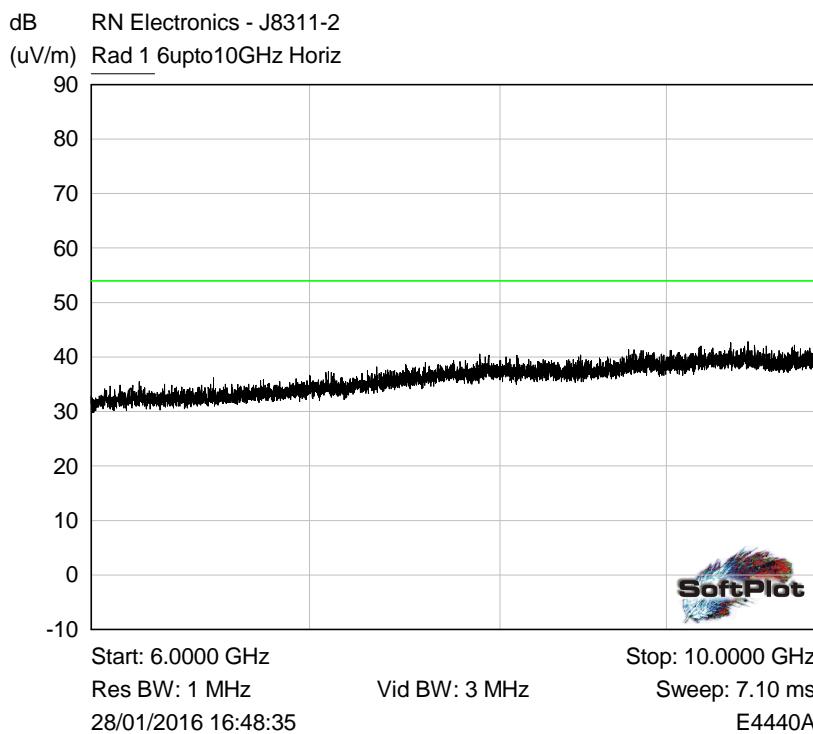


Plot of Peak emissions for Horizontal against the average limit line.

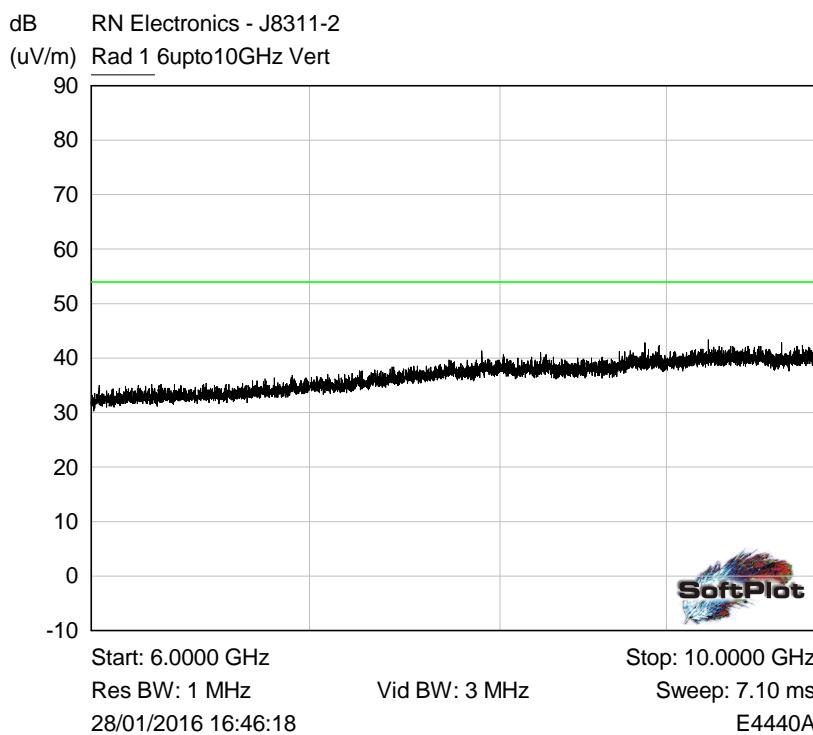


Plot of Peak emissions for Vertical against the average limit line.





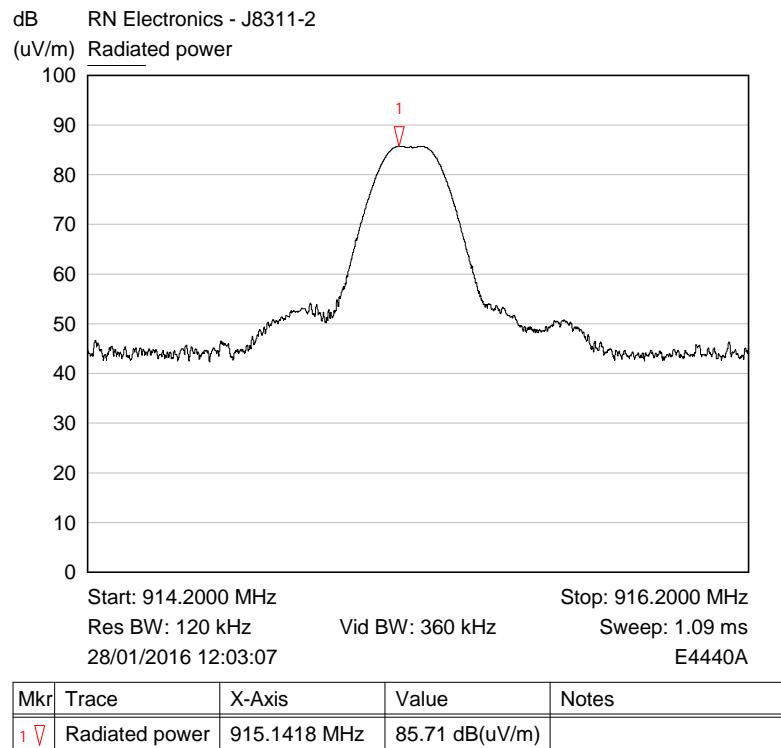
Plot of Peak emissions for Horizontal against the average limit line



Plot of Peak emissions for Vertical against the average limit line

6.5 Intentional radiator field strength

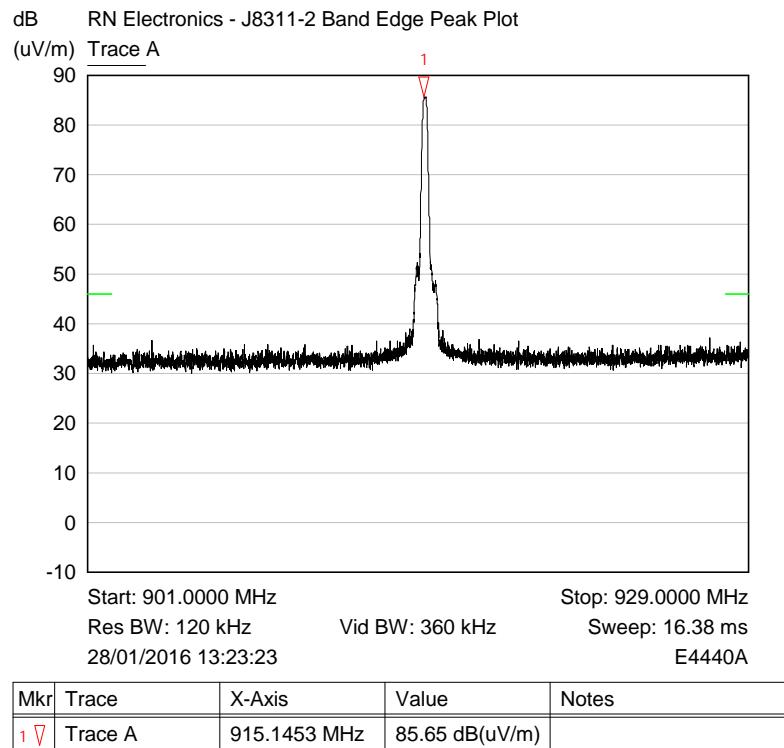
RF Parameters: Band 902-928 MHz, Power level 3 (8 dBm), Channel Spacing 90 kHz,
Modulation FSK, Channel 915.18 MHz



Plot of Horiz polarisation and EUT in Upright position

6.6 Band Edge Compliance

RF Parameters: Band 902-928 MHz, Power level 3 (8 dBm), Channel Spacing 90 kHz,
Modulation FSK, Channel 915.18 MHz



Band Edge Plot

6.7 Occupied bandwidth

RF Parameters: Band 902-928 MHz, Power level 3 (8 dBm), Channel Spacing 90 kHz,
Modulation FSK, Channel 915.18 MHz



Plot for 20dB Bandwidth

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/m)	Pk - Lim 1 (dB)	QP Amp (dB μ V/m)	QP - Lim1 (dB)	Av Amp (dB μ V/m)	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.

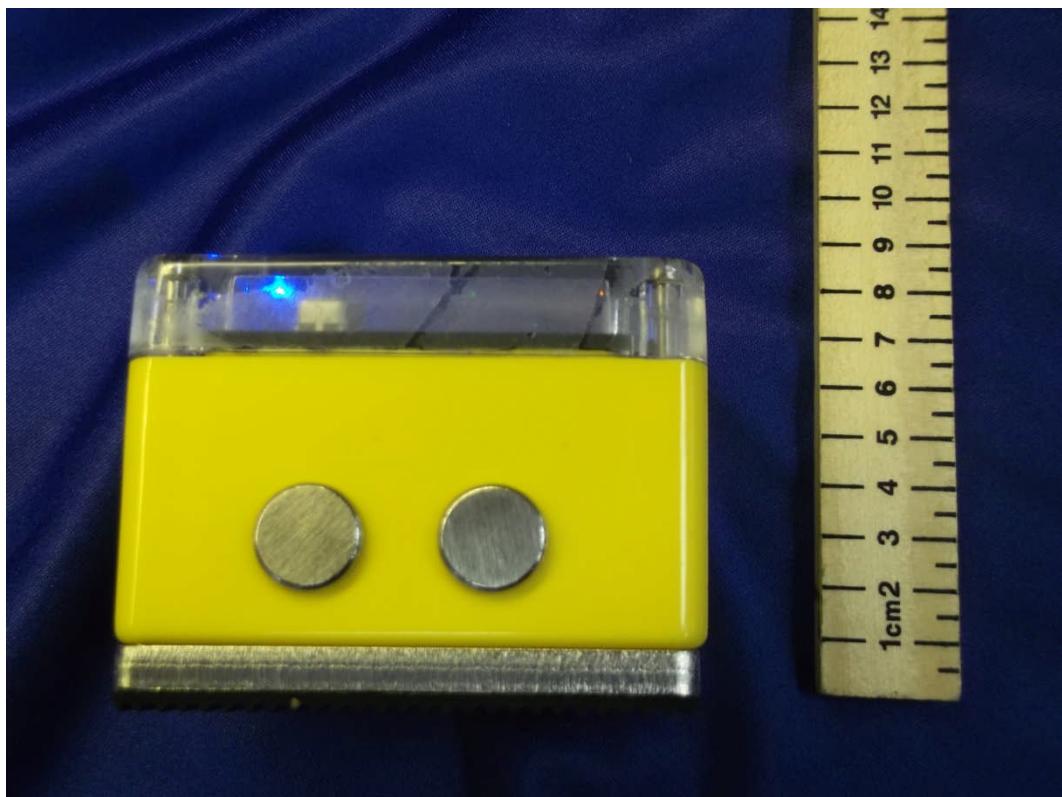
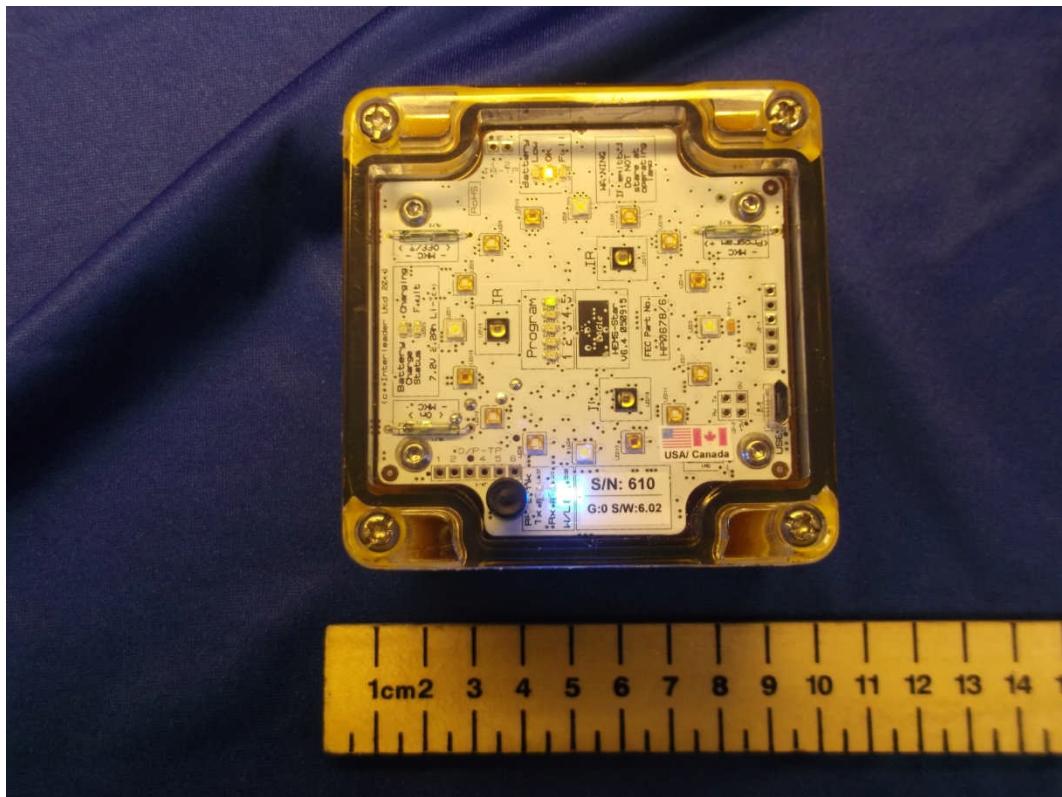
7.2 Explanation of limit line calculations for radiated measurements

The limits given in the test standard are normally expressed as absolute values (e.g. in $\mu\text{V}/\text{m}$ at a specified distance), whereas the measured values are expressed as peak, quasi peak or average values in $\text{dB}\mu\text{V}/\text{m}$ 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:

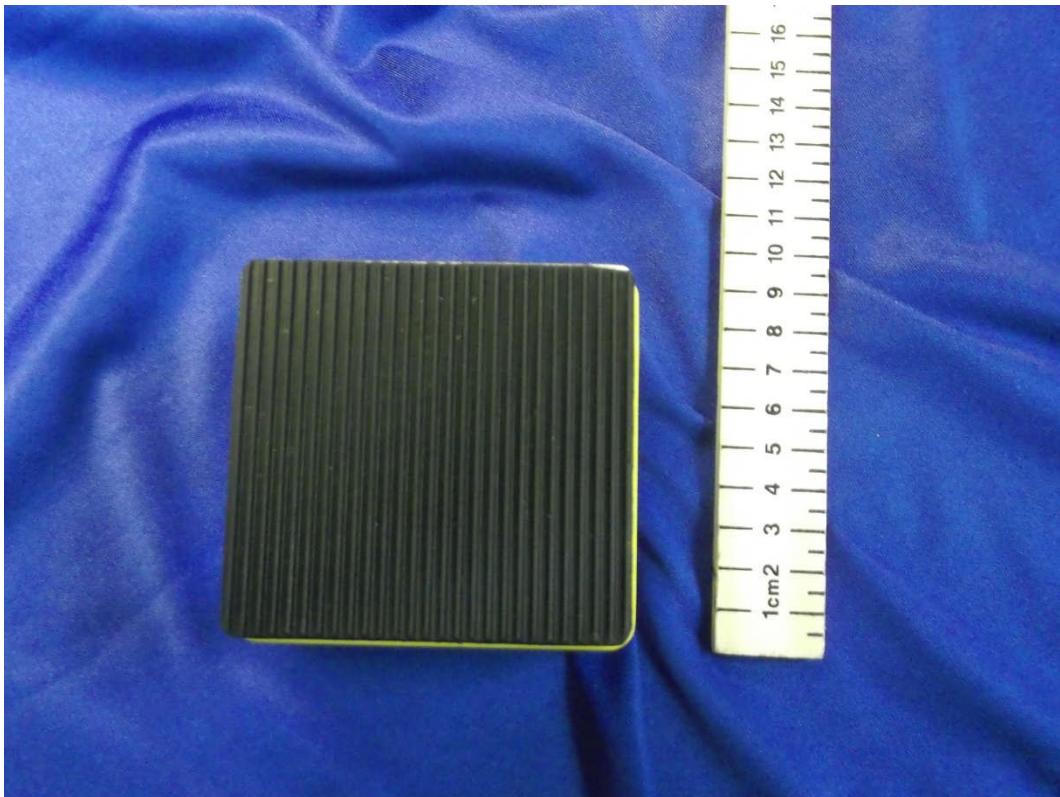
- (a) limit of 500 $\mu\text{V}/\text{m}$ equates to $20.\log(500) = 54 \text{ dB } \mu\text{V}/\text{m}$.
- (b) limit of 300 $\mu\text{V}/\text{m}$ at 10m equates to $20.\log(300 \cdot 10/3) = 60 \text{ dB } \mu\text{V}/\text{m}$ at 3m
- (c) limit of 30 $\mu\text{V}/\text{m}$ at 30m, but below 30MHz, equates to $20.\log(30) + 40.\log(30/3) = 69.5 \text{ dB}\mu\text{V}/\text{m}$ at 3m, as extrapolation factor below 30MHz is 40dB/decade per 15.31(f)(2).

8 Photographs

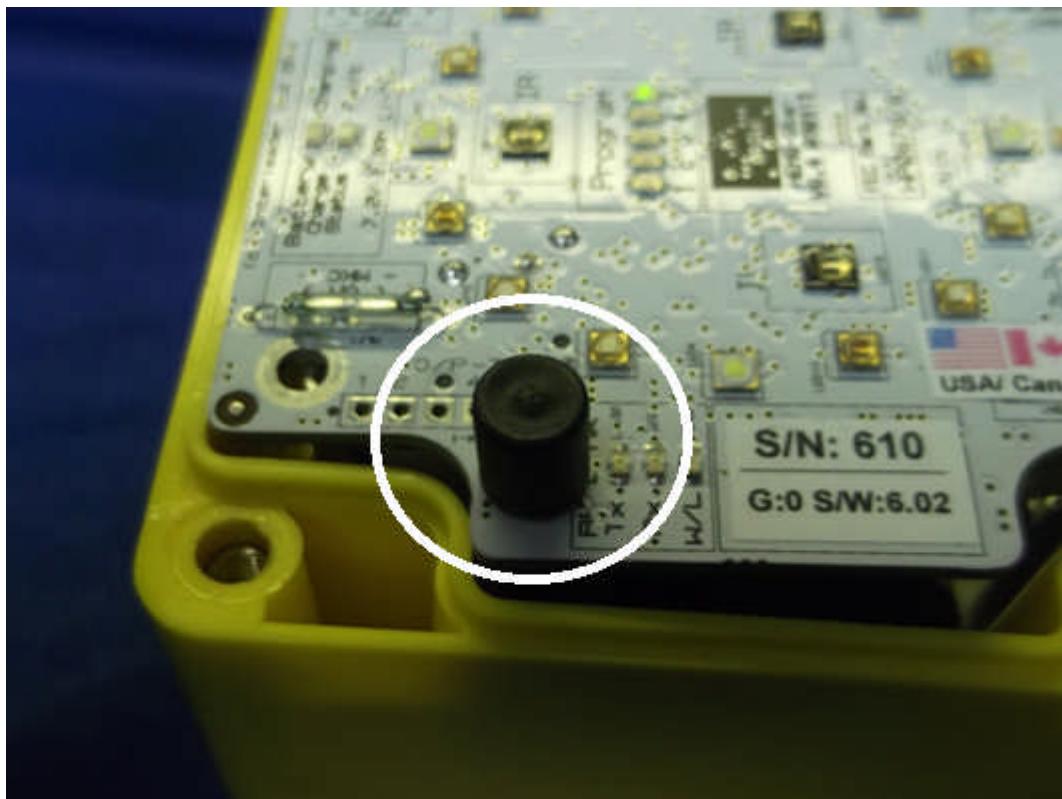
8.1 EUT Front View



8.2 EUT Reverse Angle



8.3 EUT Antenna



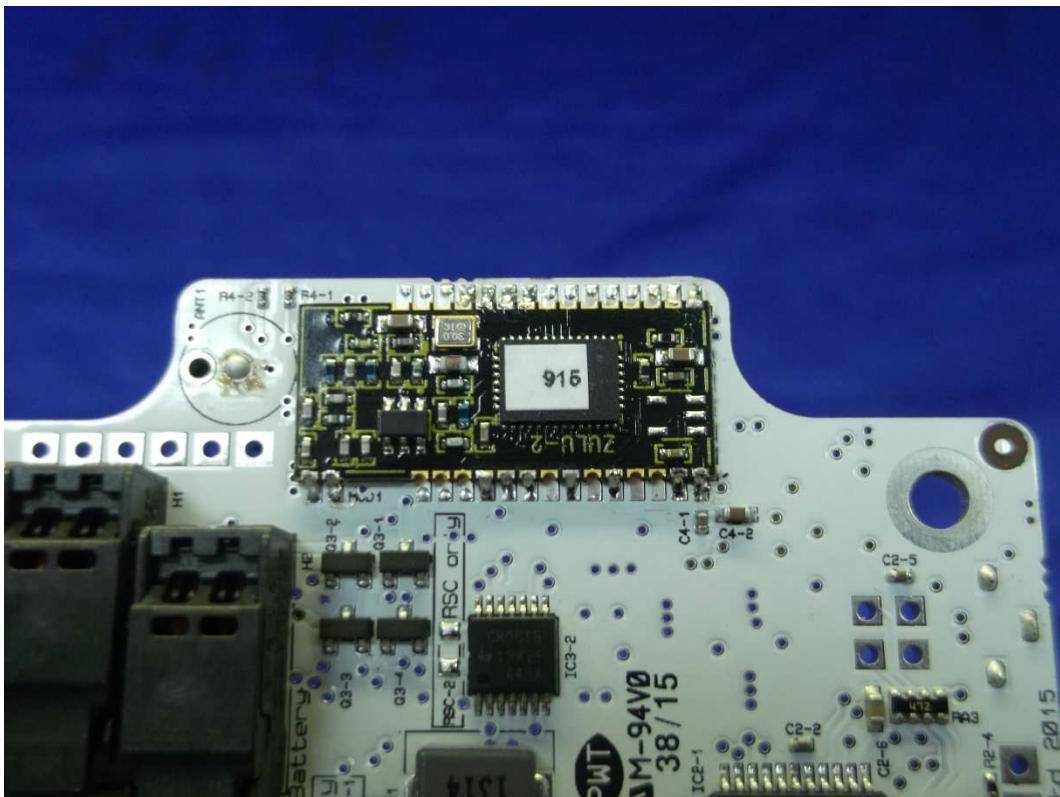
Photograph shows the EUT integral antenna (circled)

8.4 EUT Display & Controls

The EUT has no displays or controls.

8.5 EUT Internal photos





8.6 EUT ID Label

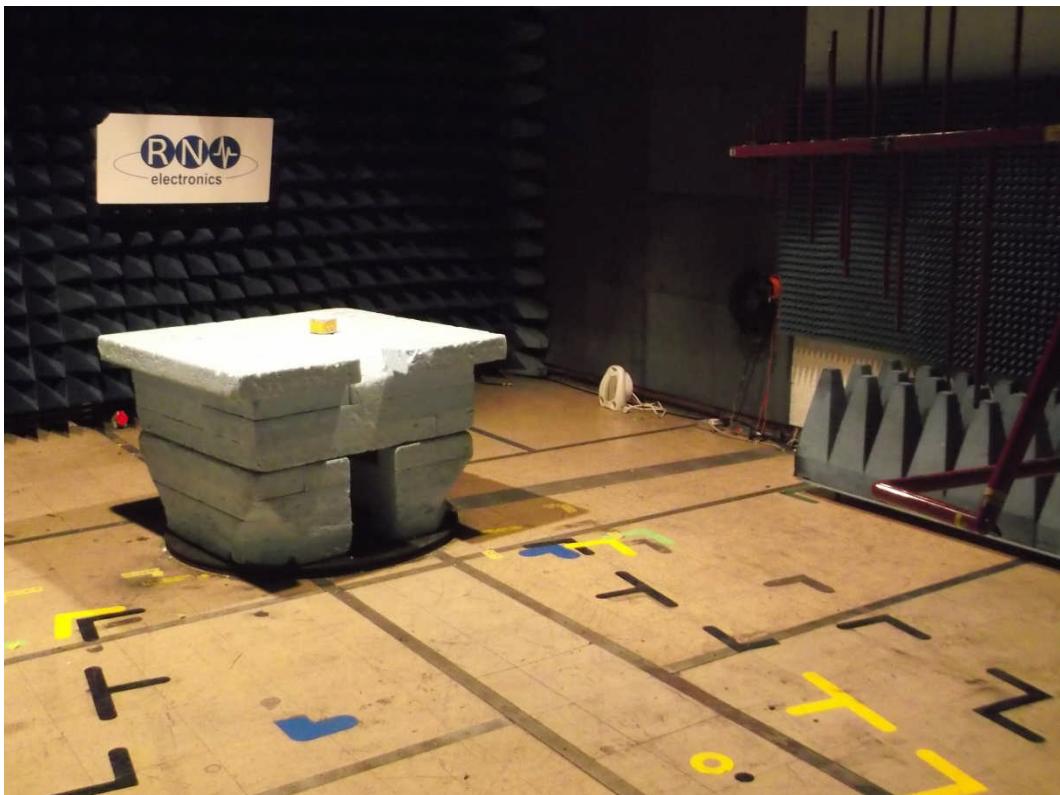
At the time of test there was no ID label attached to the EUT.

8.7 Radiated emissions - 9 kHz - 150 kHz



Site OATS

8.8 Radiated emissions - 30 MHz -1 GHz



Site M

8.9 Radiated emissions - Above 1 GHz



Site M



Site M

8.10 Radiated emission diagram

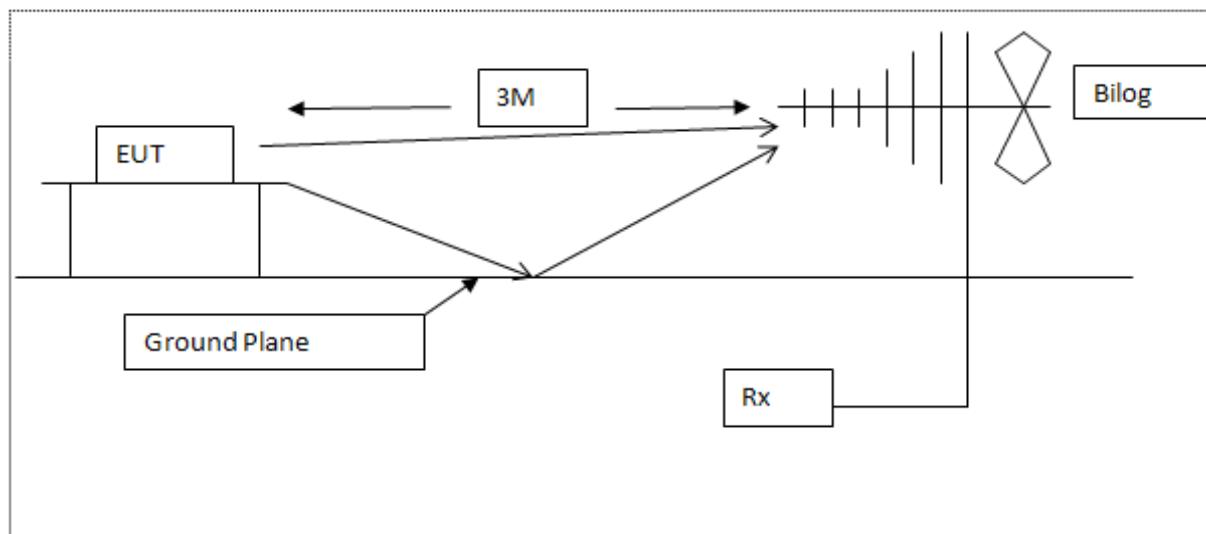


Diagram of the radiated emissions test setup 30 - 1000 MHz

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
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 3Hz - 26.5 GHz	Agilent Technologies	29-Apr-2015	24 months
E428	HF906	1-18 GHz Horn Antenna	Rohde & Schwarz	28-Jan-2014	24 months
TMS81	6502	Active Loop Antenna	EMCO	27-Apr-2015	24 months
TMS82	8449B	Pre Amplifier 1 - 26 GHz	Agilent	17-Dec-2015	12 months
TMS933	CBL6141A	Bilog Antenna 30MHz - 2GHz	York EMC	29-Sep-2014	24 months

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	N/A	Terminal software v1.96	Not stated	N/A
2	Not stated	Zulu USB dongle transceiver	RF Solutions	14

10.2 RN Electronics supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	Inspiron 5150	Laptop PC	DELL	CN-0W0940-12961-44J-2047

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

Test	Modification	Time of modification
TX ERP Field Strength	The EUTs power level was reduced to 'Level 3' in the software control engineering menu by the applicant.	Before testing

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	LBT	Listen Before Talk
$\mu\text{A}/\text{m}$	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
$^{\circ}\text{C}$	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
$\text{dB}\mu\text{A}/\text{m}$	deciBels relative to $1\mu\text{A}/\text{m}$	ppm	Parts per million
$\text{dB}\mu\text{V}$	deciBels relative to $1\mu\text{V}$	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		