



Radio Test Report

FEC Heliports Worldwide Limited

FEC Remote Lighting Controller V2

HP0656

47 CFR Part 15.249 Effective Date 1st October 2015
FCC|DXX: Part 15 Low Power Communication Device Transmitter
Test Date: 4th February 2016 to 5th February 2016
Report Number: 02-8564-2-16 Issue 01

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Certificate of Test 8564-2

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:	FEC Remote Lighting Controller V2
Model Number:	HP0656
Unique Serial Number:	78
Applicant:	FEC Heliports Worldwide Limited 1 Mead Business Centre 176-178 Berkhamstead Road Chesham Buckinghamshire HP5 3EE
Proposed FCC ID	2AFNN-HP0656-7-8-Z9
Full measurement results are detailed in Report Number:	02-8564-2-16 Issue 01
Test Standards:	47 CFR Part 15.249 Effective Date 1st October 2015 FCC DXX: Part 15 Low Power Communication Device Transmitter

NOTE:

Certain tests were not performed based upon manufacturer's declarations. Certain other 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: 4th February 2016 to 5th February 2016

Test Engineer:

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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	
Full Name of EUT	FEC Remote Lighting Controller V2	
Model Number of EUT	HP0656	
Serial Number of EUT	78	
Date Received	2nd February 2016	
Date of Test:	4th February 2016 to 5th February 2016	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Created	26th February 2016	
Main Function	Remotely control helipad landing lights	
Information Specification	Height	280 mm
	Width	180 mm
	Depth	160 mm
	Weight	2.5 kg
	Voltage	100 VAC - 240 VAC
	Current	<1 Amp

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Pole mounted or other suitable location
Choice of model(s) for type tests	Prototype
Antenna details	VHF: Normally supplied by the end-user GSM: RF Solutions ANT-GSM5WM 5dB gain UHF: RF Solutions OUTSIDE-WFME 3dB gain
Antenna port	VHF: BNC Connector GSM: SMA socket UHF: Reverse SMA Socket
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	915.27 MHz
Lowest Signal generated in EUT	32.768 kHz
TX Parameters	
Alignment range – transmitter	915 - 915.27 MHz
EUT Declared Modulation Parameters	FSK
EUT Declared Power level	2dBm (1.6mW)
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

2.3 Functional description

The RLC turns on up to three circuits of lights in response to:

- 1) A correct sequence of VHF (Airband) Carrier Wave detects, or
- 2) SMS commands (either from a phone or dedicated 'mimic' panel), or
- 3) Direct input via the unit's keypad, or
- 4) Direct input from the 'auxiliary channel', or
- 5) Any combination of the above

Once activated, each circuit remains live for a predetermined timeout period and then turns off. Status information is displayed on the LCD display and, if configured, sent to up to 4 SMS devices for reporting and monitoring. Internal faults (and external circuit faults if the circuit current sensors are fitted) are presented as BMS relay outputs and also sent to SMS devices. If the optional 868MHz (915MHz in USA) UHF transceiver link is fitted, the RLC will also control 'Groups' of wireless battery helipad lights.

If an optional weather station is fitted (Gill Instruments MetPak), abbreviated weather reports are sent via SMS either on demand or automatically at the time of circuit activation/de-activation. All SMS commands are password protected and actioned in an hierarchical order depending on the class of 'User'. The 'Operator' has the ability to locally (via the keypad) or remotely (via SMS) control many aspects of the system including remote status reporting, resetting and changing configuration settings.

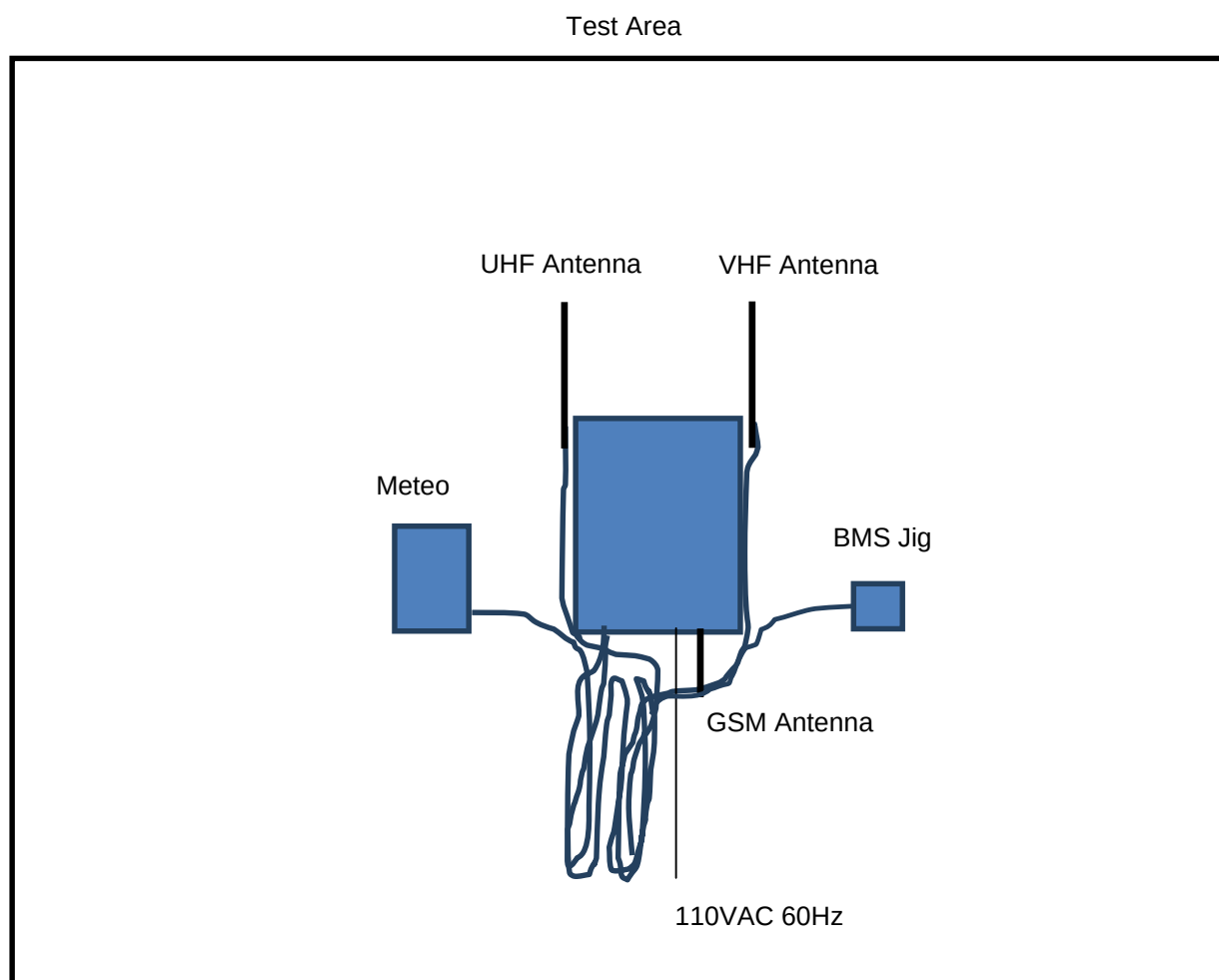
2.4 Modes of operation

Mode Reference	Description	Used for testing
TX 1	The EUT is transmitting across each channel consecutively with normal modulation (normal operation).	Yes
TX 2	Continuous transmissions at 915.18 MHz, with normal modulation	Yes
RX 118 MHz	VHF receiver tuned to 118 MHz	No
RX 127.5 MHz	VHF receiver tuned to 127.5 MHz	No
RX 136.975 MHz	VHF receiver tuned to 136.975 MHz	No
GSM	The EUT is powered. The GSM radio is enabled but not active	No

During the tests detailed in this report, the UHF transmitter was assessed whilst the VHF receiver was powered as per normal operation. During a pre-scan the receiver was set to top, middle and bottom channels however no significant difference was observed and therefore for full test the receiver was set to middle channel (RX 127.5 MHz mode).

In normal use the manufacturer states that the GSM radio cannot transmit at the same time as the UHF transmitter and therefore for the tests detailed in this report the GSM radio was powered, however it was not transmitting.

2.5 Emissions configuration



The unit was powered from a 110VAC 60Hz supply. The unit was tested with the UHF, VHF and GSM antenna connected to the equipment under test. Any excess of cables were bundled. All ports were populated with typical peripheral equipment supplied by the manufacturer.

The unit was configured with engineering menus in software to allow transmit modes of the device as stated within section 2.4 of this report. A test mode was used where the EUT transmitted on each channel consecutively using modulation. This mode is the normal transmit mode of the EUT. The power level was programmed/set to Level 1 (+2dBm).

Note: This power setting was used throughout the test detailed in this test report. No other power levels have been investigated. The manufacturer states that the on final product the end-user will not be able to adjust the RF power level.

For occupied bandwidth measurements a single test mode was used in which the EUT transmitted on a single channel.

2.5.1 Signal leads

Port Name	Cable Type	Connected
Mains Input	3-core cable	Yes
Mains Output	3-core cable	No
VHF Input	RG58 / RG213	Yes
UHF Input/output	RG174, SMA Socket	Yes
GSM Input/output	RG174, SMA Socket	Yes
Meteo	Belden 9503, 9 way 'D' Socket (Meteorological Unit Simulator connected for test)	Yes
Aux / BMS	Belden 9503, 9 way 'D' Socket (BMS jig connected for test)	Yes
USB	Type B Socket	No

The mains output port is purely a screw terminal block in line with the incoming mains supply and is therefore not likely to produce any emissions.

The manufacturer states that the USB port is only used for firmware upgrade and that the EUT will not transmit during programming mode. The USB port has been assessed under 47CFR Part 15B. Please refer to RN Electronics test report 02-8564-2-16 for further details.

3 Summary of test results

The FEC Remote Lighting Controller V2, HP0656 was tested for compliance to the following standards :

47 CFR Part 15.249 Effective Date 1st October 2015
FCC|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 15.209	PASSED
5. Radiated emissions above 1 GHz	47 CFR Part 15C Part 15.209	PASSED ¹
6. Intentional radiator field strength	47 CFR Part 15C Part 15.249a	PASSED
7. Band Edge Compliance	47 CFR Part 15C Part (15.215 and 15.249)	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 Spectrum investigated up to a frequency of 10GHz based on 10 times the highest channel of 915MHz

² Duty cycle has not been measured. The EUT complies with the requirements of the standard without the need to apply duty cycle correction to the average measurements.

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	2015	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 have been applied to the standards listed above.

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. The EUT was powered using a 110VAC 60Hz mains supply.

Details of the Peripheral and Ancillary Equipment connected for this test are listed in section 10.

The EUT was operated in **TX 1** mode as this was the EUTs' normal transmit mode.

5.1.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed 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 K.

5.1.4 Test equipment

E035, E150, E410, E411, E412, E465

See Section 9 for more details

5.1.5 Test results

Temperature of test environment	22°C
Humidity of test environment	40%
Pressure of test environment	101kPa

Band	902-928 MHz
Power Level (set in software)	Power Level 1 (2 dBm)
Channel Spacing	90 kHz
Mod Scheme	FSK
Channel	915-915.27 MHz

Plot refs
8564-2 Cond 1 AC Live 150k-30M Average
8564-2 Cond 1 AC Live 150k-30M Quasi-Peak
8564-2 Cond 1 AC Neutral 150k-30M Average
8564-2 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	0.297	52.8	52.4	-7.9	49.7	-0.6
2	0.594	48.4	47.8	-8.2	45.3	-0.7
3	0.890	42.3	41.4	-14.6	39.1	-6.9
4	7.159	54.2	53.0	-7.0	37.4	-12.6
5	8.304	56.1	54.7	-5.3	41.1	-8.9
6	8.332	56.3	54.8	-5.2	38.5	-11.5
7	8.842	56.6	48.1	-11.9	21.6	-28.4
8	8.842	56.7	47.4	-12.6	20.8	-29.2
9	8.930	56.5	55.0	-5.0	38.4	-11.6
10	9.009	55.8	50.3	-9.7	22.3	-27.7
11	10.103	55.2	53.9	-6.1	40.3	-9.7
12	10.132	55.3	53.4	-6.6	35.7	-14.3
13	10.670	53.1	52.0	-8.0	38.0	-12.0
14	18.410	51.4	47.5	-12.5	23.3	-26.7
15	18.780	51.6	49.2	-10.8	26.1	-23.9

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	0.297	52.8	52.6	-7.7	49.4	-0.9
2	0.890	42.5	42.1	-13.9	39.9	-6.1
3	1.188	48.6	48.3	-7.7	45.2	-0.8
4	2.088	48.7	47.2	-8.8	33.6	-12.4
5	7.111	54.6	53.5	-6.5	41.2	-8.8
6	8.291	56.2	54.4	-5.6	39.0	-11.0
7	8.849	56.6	53.2	-6.8	26.4	-23.6
8	8.882	56.5	54.7	-5.3	38.9	-11.1
9	8.882	56.6	54.9	-5.1	38.6	-11.4
10	8.899	56.6	55.1	-4.9	40.7	-9.3
11	8.940	56.3	53.4	-6.6	32.4	-17.6
12	9.009	55.8	50.2	-9.8	20.8	-29.2
13	10.652	52.7	50.0	-10.0	39.7	-10.3
14	16.350	50.9	48.2	-11.8	28.7	-21.3
15	16.980	53.2	49.9	-10.1	28.8	-21.2

Peak detector "Max held" Analyser plots against the Quasi-Peak / Average limit lines 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 ± 3.6 dB

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 & 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 metres high turntable. The EUT was powered using a 110VAC 60Hz mains supply. 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 assessed in normal use position. The EUT was operated in **TX 1** mode as this was the EUTs' normal transmit mode.

5.2.3 Test procedure

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

Measurements were made in a semi-anechoic chamber (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 H and Site OATS.

5.2.4 Test equipment

E533, E534, E535, TMS81, TMS46, LPE351

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	102kPa

Band	902-928 MHz
Power Level (set in software)	Power Level 1 (2 dBm)
Channel Spacing	90 kHz
Mod Scheme	FSK
Channel	915-915.27 MHz

Plot refs
8564-2 9kHz-150kHz Parallel
8564-2 9kHz-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 ± 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 & 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 metres high turntable. The EUT was powered using a 110VAC 60Hz mains supply. 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 assessed in normal use position. The EUT was operated in **TX 1** mode as this was the EUTs' normal transmit 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 H and OATS.

5.3.4 Test equipment

E533, E534, E535, TMS81, TMS46, LPE351

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	102kPa

Band	902-928 MHz
Power Level (set in software)	Power Level 1 (2 dBm)
Channel Spacing	90 kHz
Mod Scheme	FSK
Channel	915-915.27 MHz

Plot refs
8564-2 150kHz-30MHz Parallel
8564-2 150kHz-30MHz Perpendicular

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.

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 ±3.9dB

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 6.3 & 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 metres high turntable. The EUT was powered using a 110VAC 60Hz mains supply. 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 assessed in normal use position. The EUT was operated in **TX 1** mode as this was the EUTs' normal transmit mode.

5.4.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed 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 H.

5.4.4 Test equipment

E533, E534, E535, LPE364, TMS46, LPE351

See Section 9 for more details

5.4.5 Test results

Temperature of test environment	22°C
Humidity of test environment	40%
Pressure of test environment	102kPa

Band	902-928 MHz
Power Level (set in software)	Power Level 1 (2 dBm)
Channel Spacing	90 kHz
Mod Scheme	FSK
Channel	915-915.27 MHz

Plot refs
8564-2 Rad 1 UHF Horiz
8564-2 Rad 1 UHF Vert
8564-2 Rad 1 VHF Horiz
8564-2 Rad 1 VHF Vert

Table of signals measured for Rad 1 Horizontal Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP Lim (dB)
1	135.480	22.2	14.9	-28.6
2	143.883	22.1	16.0	-27.5
3	156.740	20.6	13.8	-29.7

Table of signals measured for Rad 1 Vertical Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP Lim (dB)
1	56.148	28.0	25.5	-14.5
2	77.742	24.7	17.6	-22.4
3	78.418	18.4	11.4	-28.6
4	78.851	16.9	14.1	-25.9
5	422.980	30.2	23.6	-22.4

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:

30MHz - 1000MHz ± 5.1 dB

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 metres high turntable. The EUT was powered using a 110VAC 60Hz mains supply. 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 assessed in normal use position.

The EUT was operated in **TX 1** mode as this was the EUTs' normal transmit mode.

5.5.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed 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 - 6GHz, 1.2m was used in the test range 6 - 10GHz.

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

Tests were performed using test Site H.

5.5.4 Test equipment

LPE261, LPE333, E533, E534, E535, LPE351

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	102kPa

Setup Table

Band	902-928 MHz
Power Level (set in software)	Power Level 1 (2 dBm)
Channel Spacing	90 kHz
Mod Scheme	FSK
Channels	915-915.27 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBμV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBμV/m)	Difference to Average Limit (dB)	Antenna Polarisation	EUT Polarisation
5248.57	46.8	-27.2	34.3	-19.7	Horizontal	Normal use position
1830.36	48.3	-25.7	44.7	-9.3	Horizontal	Normal use position
3660.72	53.2	-20.8	46.5	-7.5	Horizontal	Normal use position
5491.08	48.3	-25.7	35.9	-18.1	Horizontal	Normal use position
1830.36	50	-24	46.7	-7.3	Vertical	Normal use position
2745.54	47.4	-26.6	40.5	-13.5	Vertical	Normal use position
3660.72	52.3	-21.7	45.5	-8.5	Vertical	Normal use position

Plot reference
8564-2 Rad 1 1-2GHz Horiz
8564-2 Rad 1 1-2GHz Vert
8564-2 Rad 1 2-5GHz Horiz
8564-2 Rad 1 2-5GHz Vert
8564-2 Rad 1 5-6GHz Horiz
8564-2 Rad 1 5-6GHz Vert
8564-2 Rad 1 6upto10GHz Horiz
8564-2 Rad 1 6upto10GHz Vert

Note: Only signals that measured within 20dB of limits have been reported.

Peak detector "Max held" Analyser plots against the Average limit line 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:

1 – 10 GHz ±3.5dB

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 [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 assessed in normal use position. The EUT was operated in **TX 1** mode as this was the EUTs' normal transmit mode.

5.6.3 Test procedure

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

Maximum field strength was measured using a spectrum analyser set with the appropriate RBW/span in conjunction with a PK detector.

Measurements were made in a semi-anechoic chamber listed with the FCC. Measurements were made at site H.

5.6.4 Test equipment

E533, E534, E535, LPE364, LPE351

See Section 9 for more details

5.6.5 Test results

Temperature of test environment	20°C
Humidity of test environment	40%
Pressure of test environment	102kPa

Band	902-928 MHz
Power Level (set in software)	Power Level 1 (2 dBm)
Channel Spacing	90 kHz
Mod Scheme	FSK
Channel	915-915.27 MHz

Peak Level (dBµV/m)	90.70
Plot reference	8564-2 Field Strength Vert Upright
Antenna Polarisation	Horiz
EUT Polarisation	Upright

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

LIMITS:

15.249(a) 50 @ 3m (94 dBµV/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 and 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 1** mode as this was the EUTs' normal transmit mode.

5.7.3 Test procedure

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

Tests were performed using Test Site H.

5.7.4 Test equipment

E533, E534, E535, LPE364, LPE351

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 102kPa

Band	902-928 MHz
Power Level (set in software)	Power Level 1 (2 dBm)
Channel Spacing	90 kHz
Mod Scheme	FSK
Channel	915-915.274 MHz

Peak Level (dBµV/m) Low	33.8
Peak Level (dBµV/m) High	33.8

Band Edge Plot reference	8564-2 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:
≤± 5.1 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 operated in **TX 2** mode.

5.8.3 Test procedure

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

Tests were performed using test Site A.

5.8.4 Test equipment

E624

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	102kPa

Band	902-928 MHz
Power Level (set in software)	Power Level 1 (2 dBm)
Channel Spacing	90 kHz
Mod Scheme	FSK
Mid channel	915.18 MHz

20dB Bandwidth (MHz) Plot reference	Mid
	0.1303
	8564-2 OBW

Analyser plots for the 20dB 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: Duty cycle has not been measured. The EUT complies with the requirements of the standard without the need to apply duty cycle correction to the average measurements.

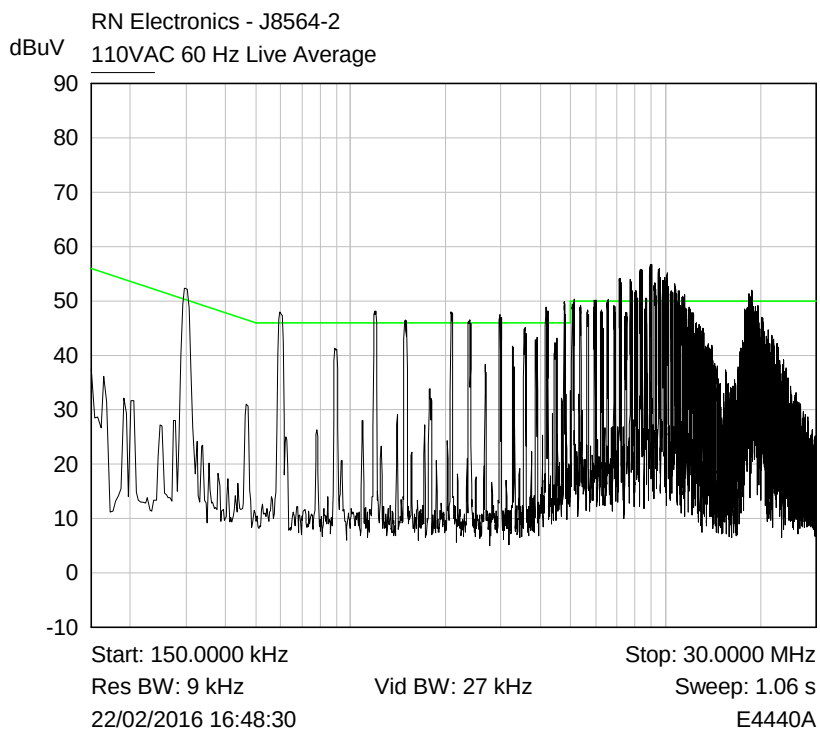
5.10 Frequency stability

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

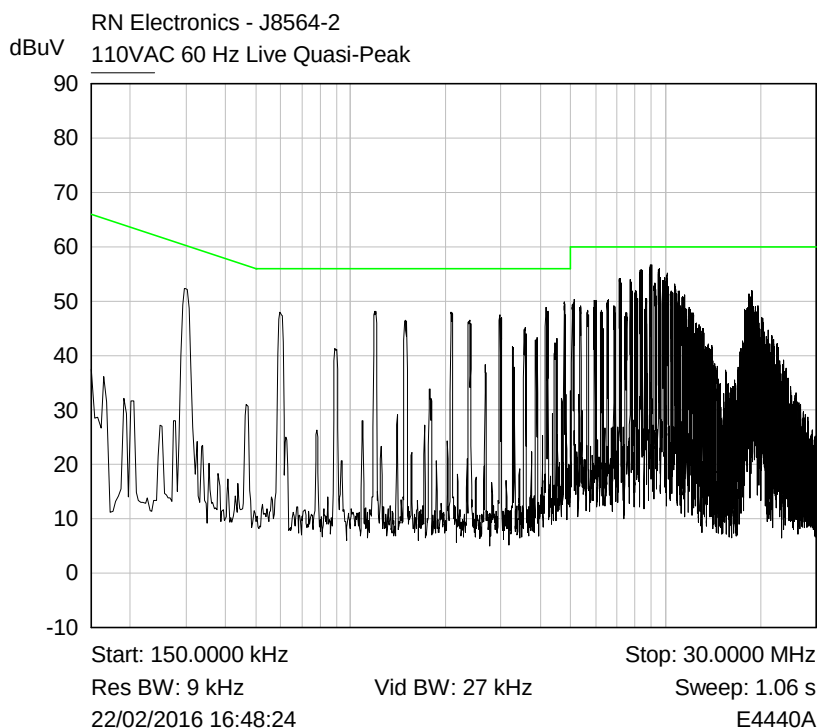
6 Plots/Graphical results

6.1 AC power line conducted emissions

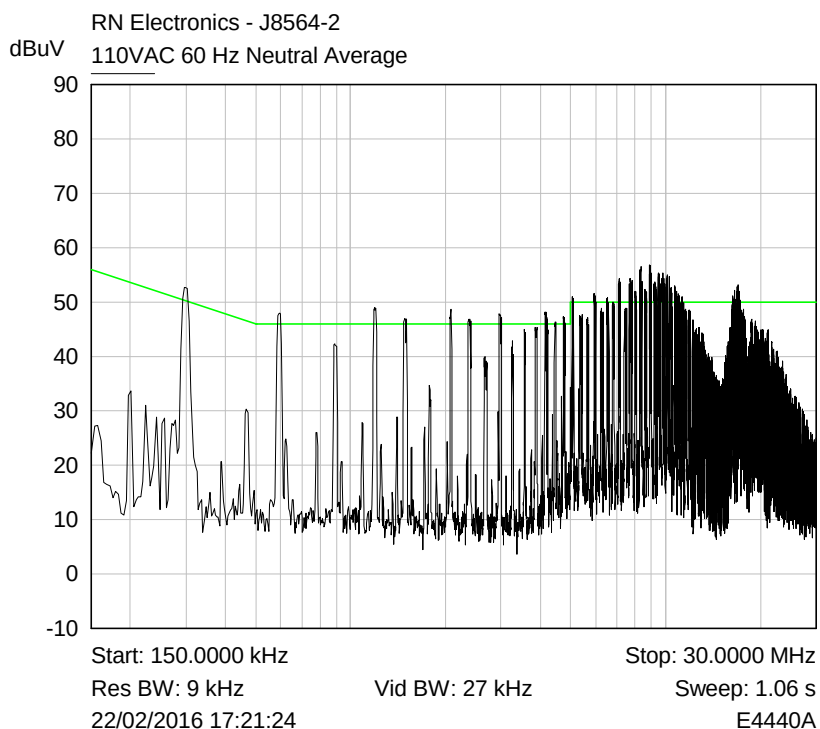
RF Parameters: Band 902-928 MHz, Power Level 1 (2 dBm), Channel Spacing 90 kHz,
Modulation FSK, Channel 915-915.27 MHz



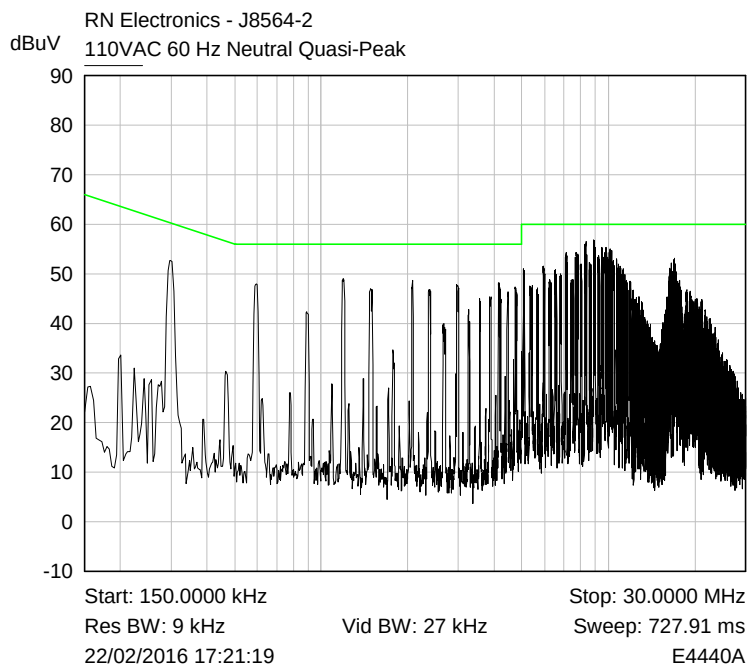
Plot of Live 150kHz-30MHz Average



Plot of Live 150kHz-30MHz Quasi-Peak



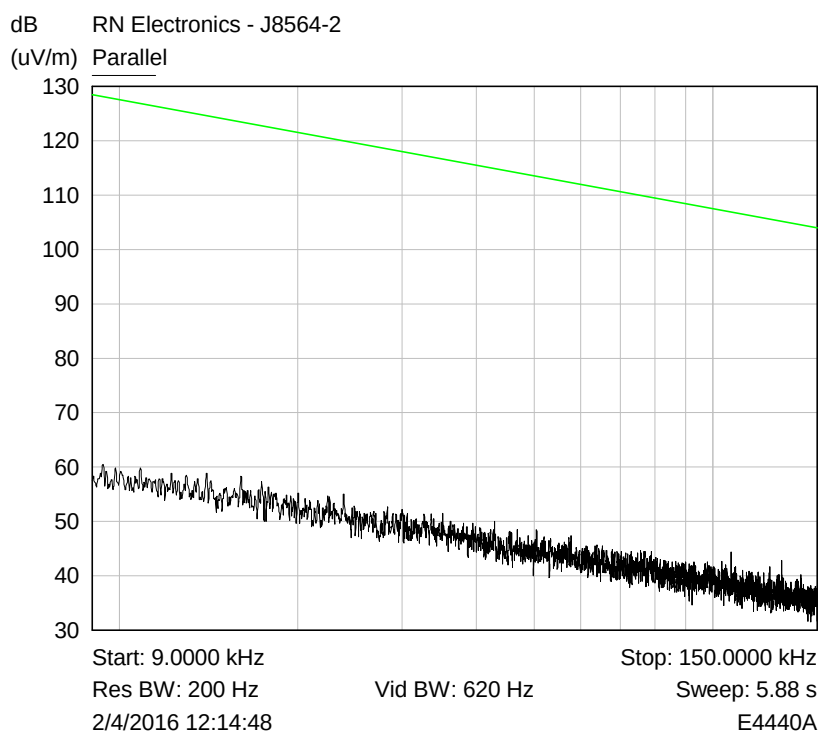
Plot of Neutral 150kHz-30MHz Average



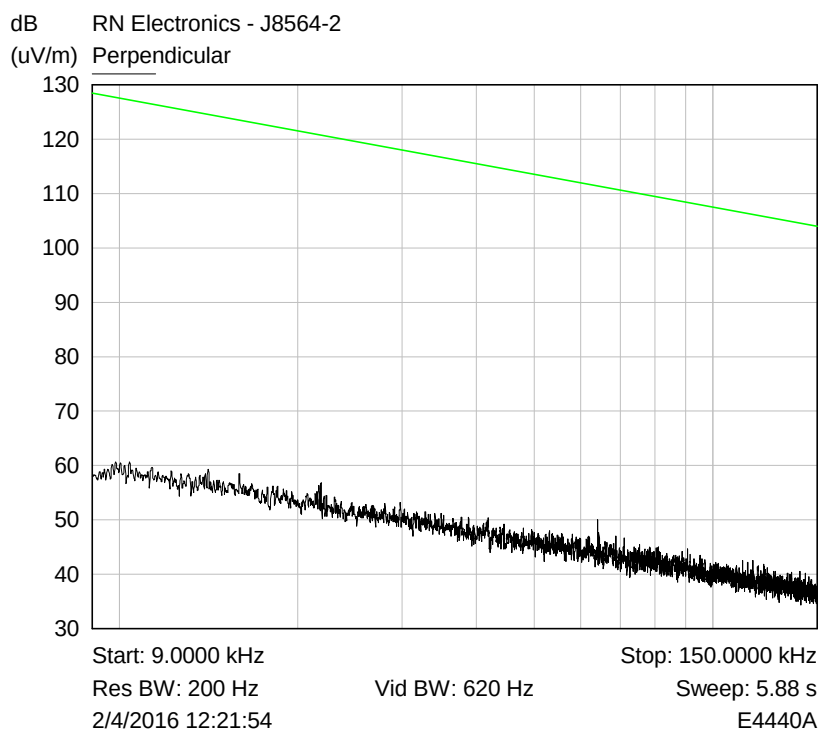
Plot of Neutral 150kHz-30MHz Quasi-Peak

6.2 Radiated emissions 9 - 150 kHz

RF Parameters: Band 902-928 MHz, Power Level 1 (2 dBm), Channel Spacing 90 kHz,
Modulation FSK, 915-915.27 MHz



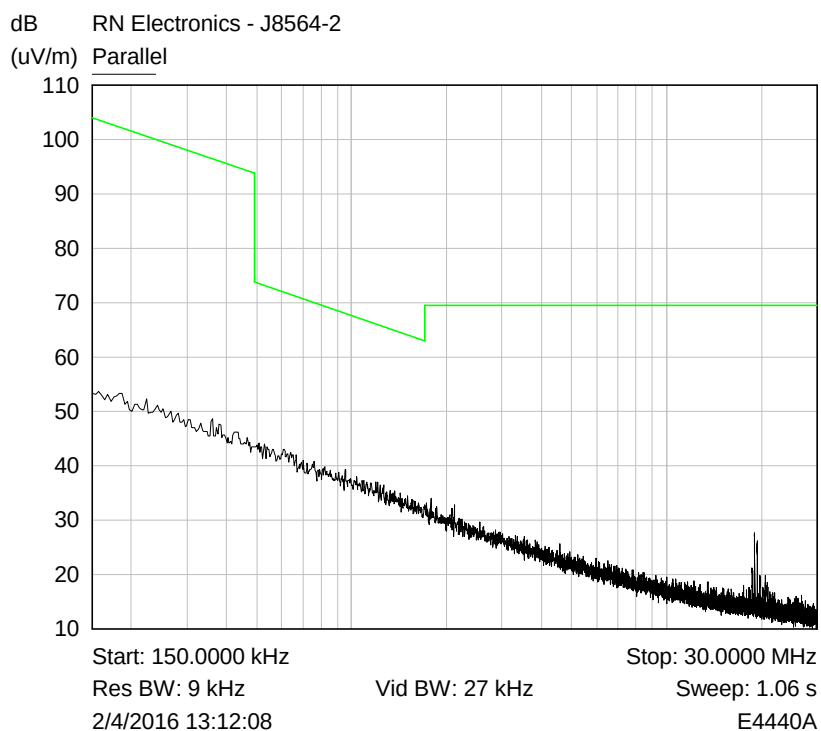
Plot of 9-150kHz Parallel



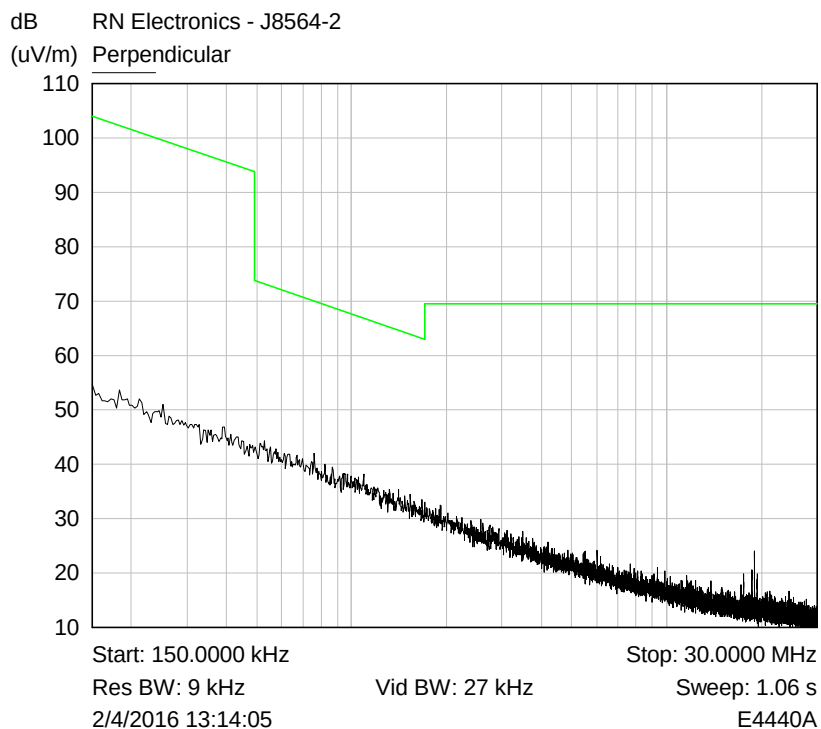
Plot of 9-150kHz Perpendicular

6.3 Radiated emissions 150 kHz - 30 MHz

RF Parameters: Band 902-928 MHz, Power Level 1 (2 dBm), Channel Spacing 90 kHz,
Modulation FSK, 915-915.27 MHz



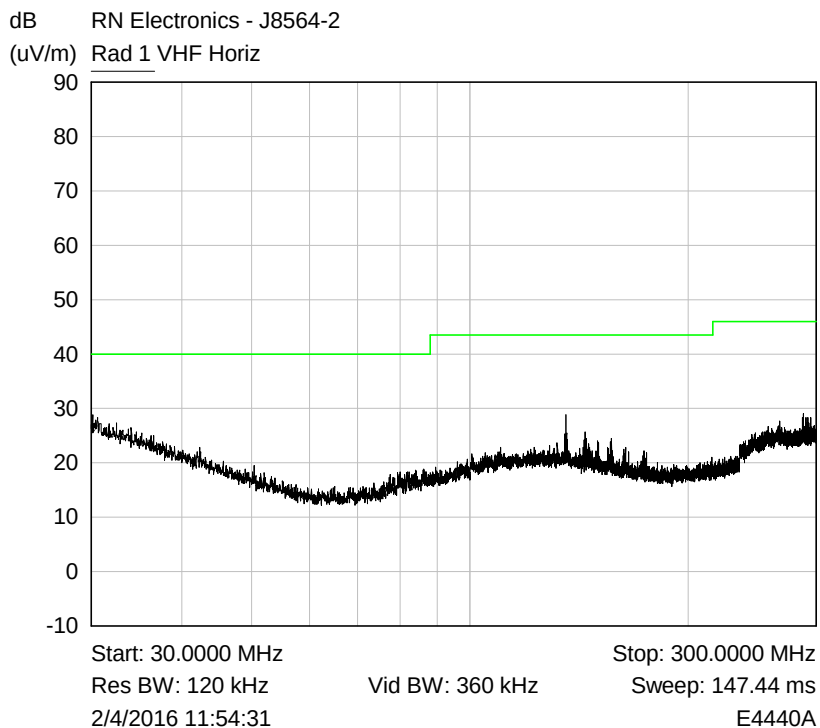
Plot of 150kHz-30MHz Parallel



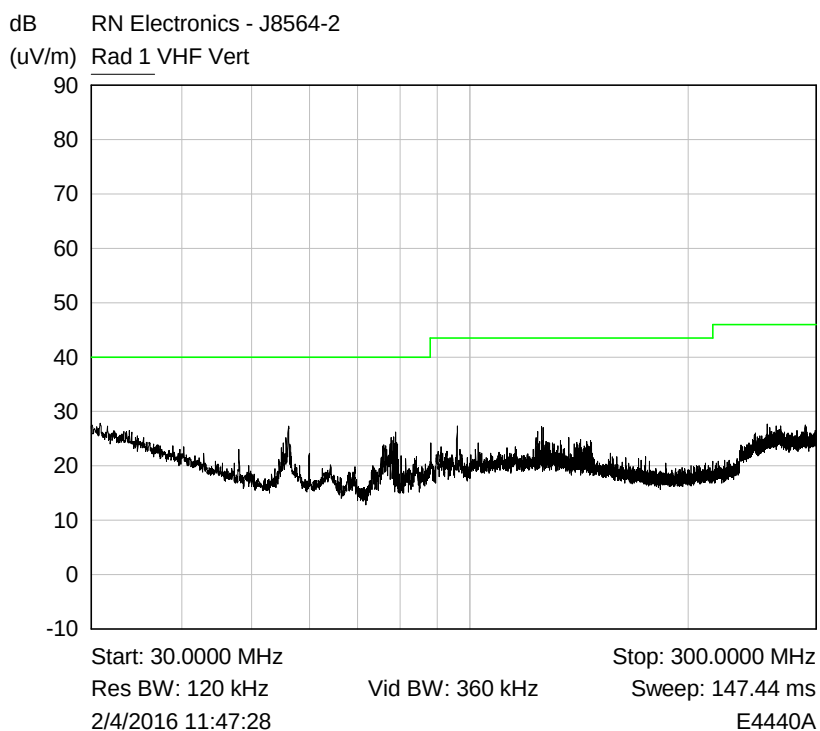
Plot of 150kHz-30MHz Perpendicular

6.4 Radiated emissions 30 MHz -1 GHz

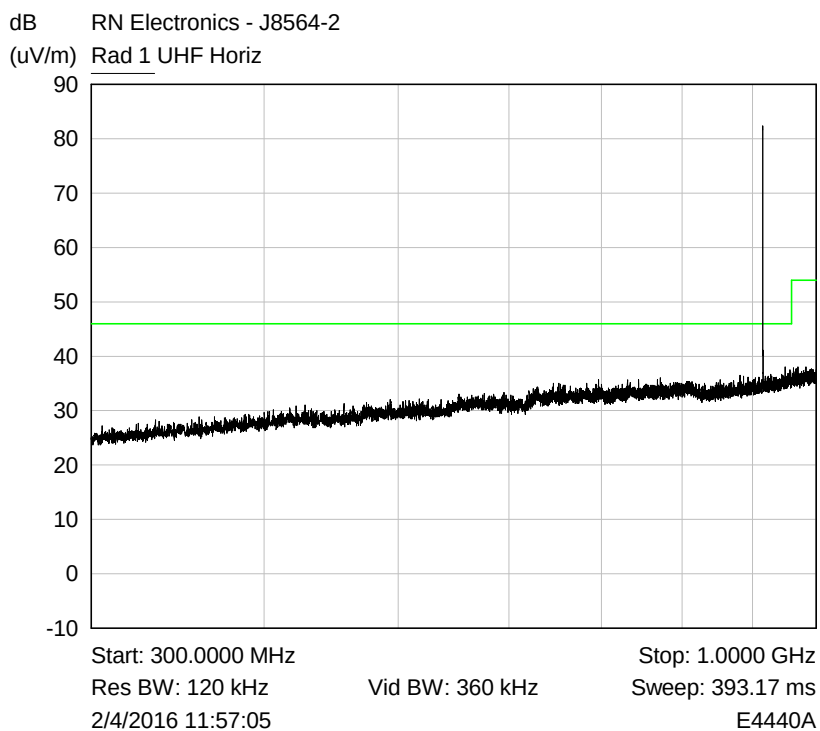
RF Parameters: Band 902-928 MHz, Power Level 1 (2 dBm), Channel Spacing 90 kHz,
Modulation FSK, 915-915.27 MHz



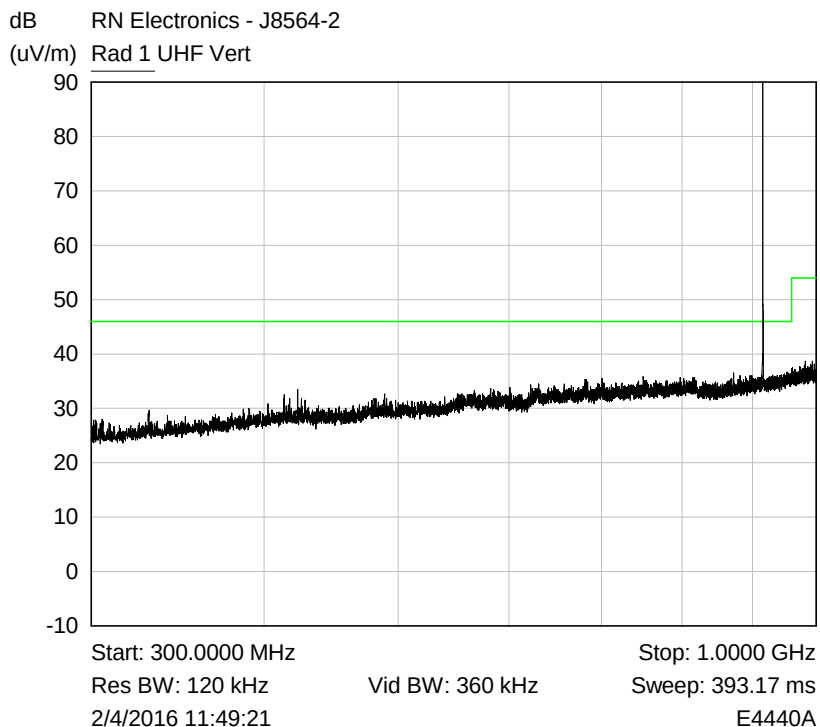
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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



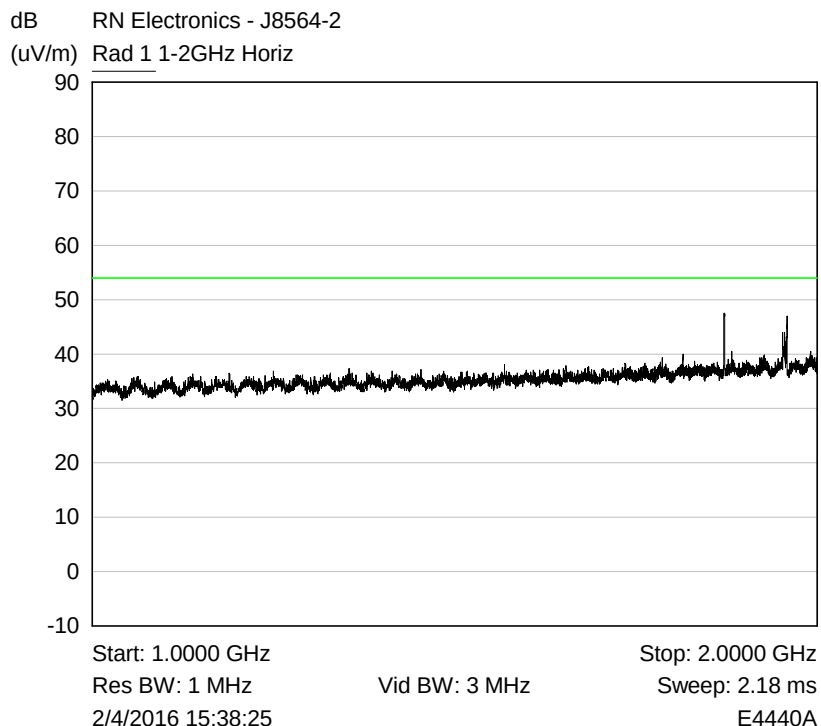
Plot of Peak emissions for UHF Horizontal against the QP limit line.
Note: The emission that exceeds the limit is the fundamental carrier frequency of the EUT.



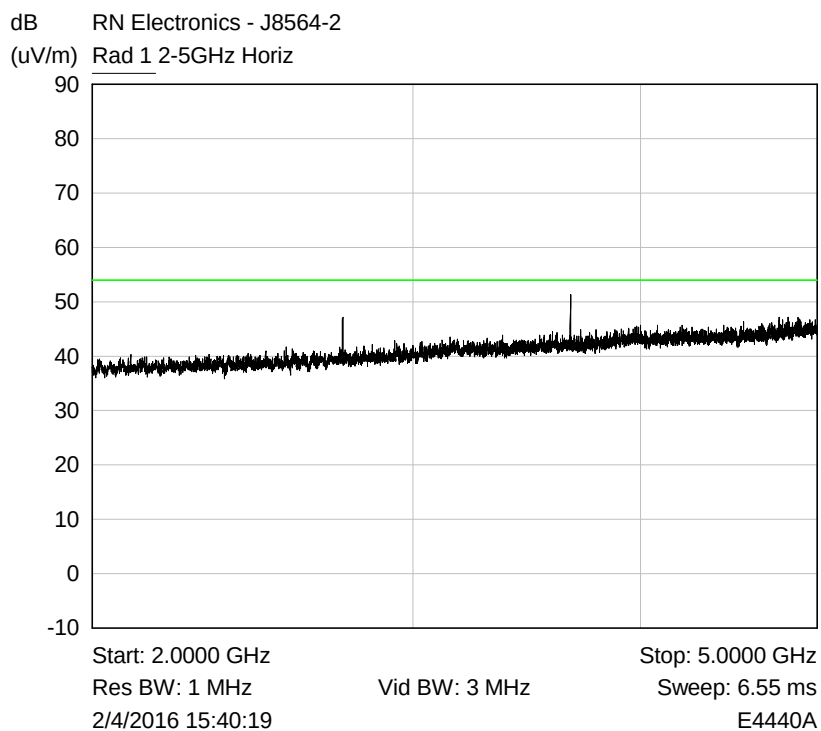
Plot of Peak emissions for UHF Vertical against the QP limit line.
Note: The emission that exceeds the limit is the fundamental carrier frequency of the EUT.

6.5 Radiated emissions above 1 GHz

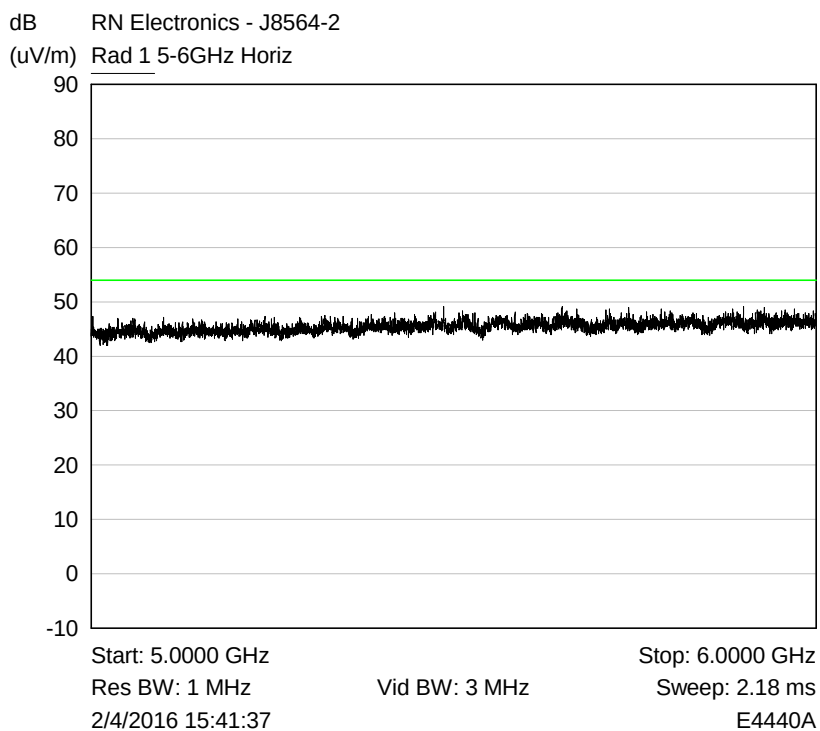
RF Parameters: Band 902-928 MHz, Power Level 1 (2 dBm), Channel Spacing 90 kHz,
Modulation FSK, 915-915.27 MHz



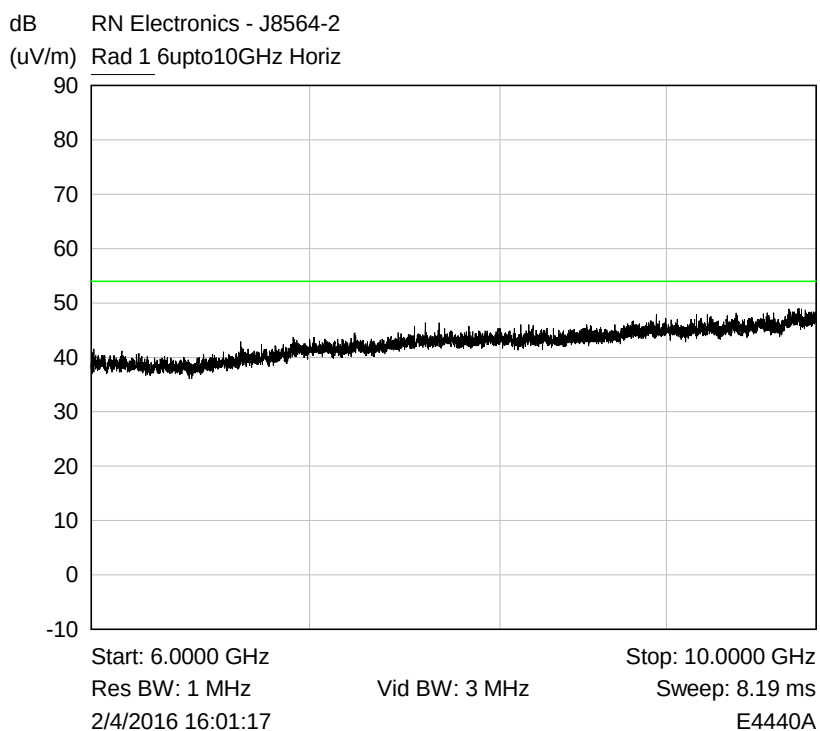
Plot of Peak emissions for Horizontal against the average limit line.



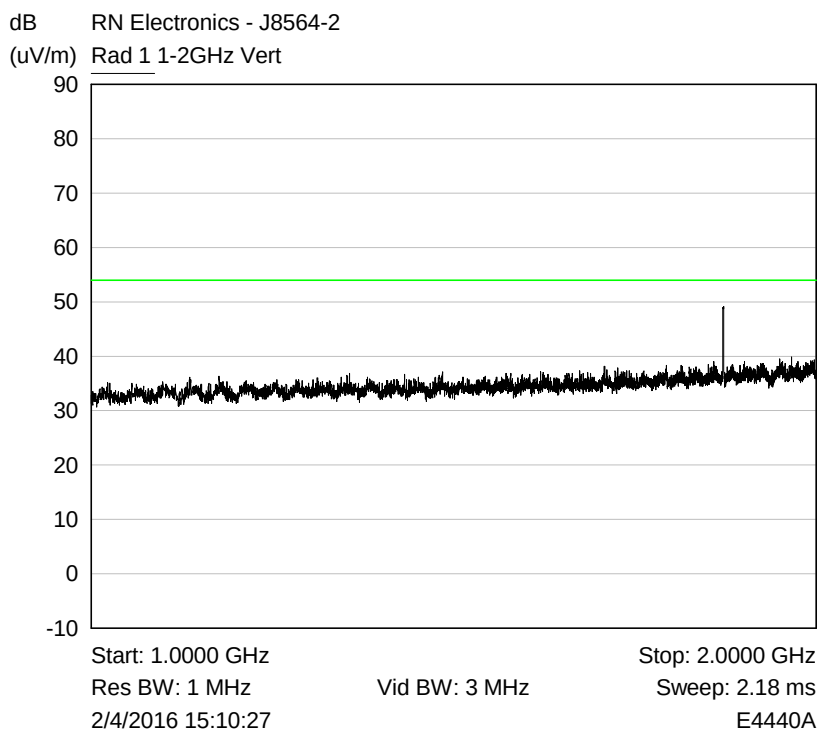
Plot of Peak emissions for Horizontal against the average limit line.



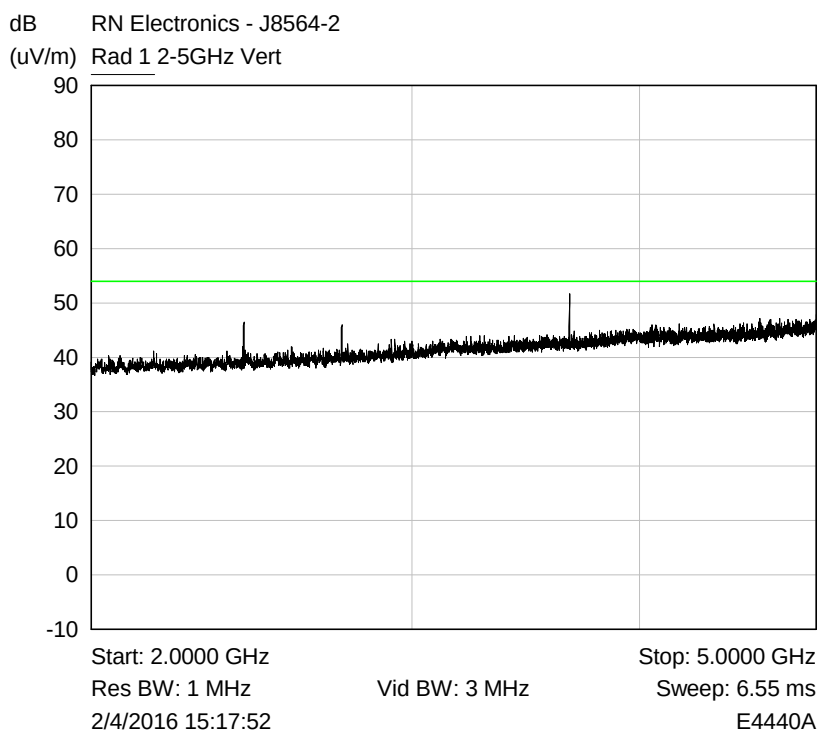
Plot of Peak emissions for Horizontal against the average limit line.



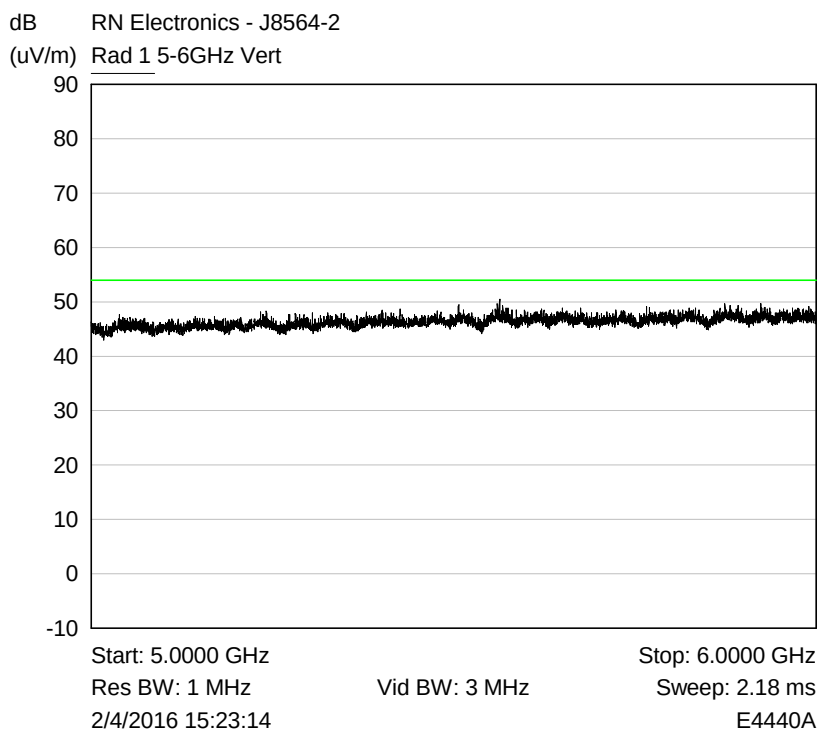
Plot of Peak emissions for Horizontal against the average limit line.



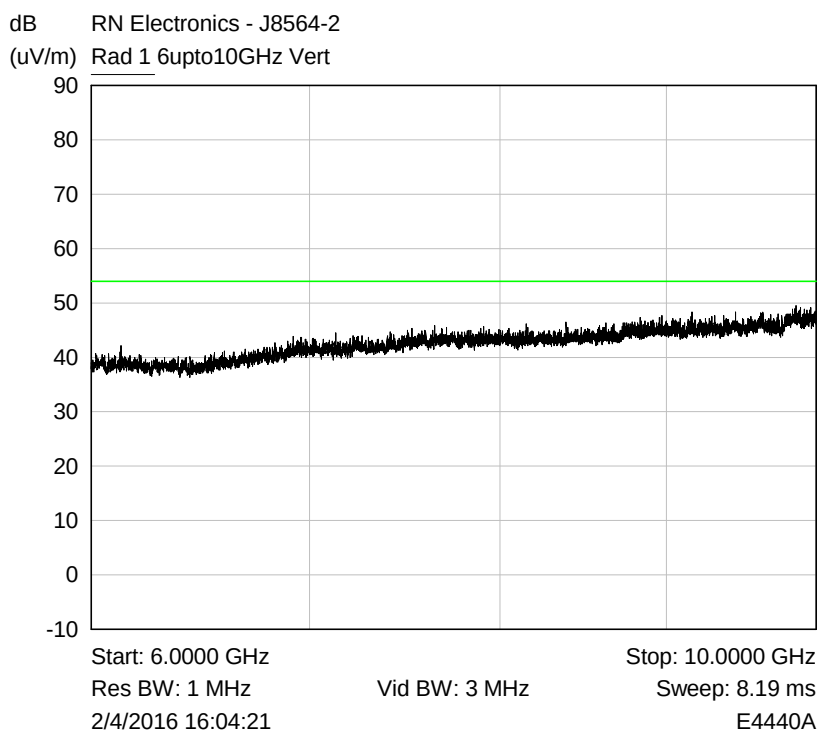
Plot of Peak emissions for Vertical against the average limit line.



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



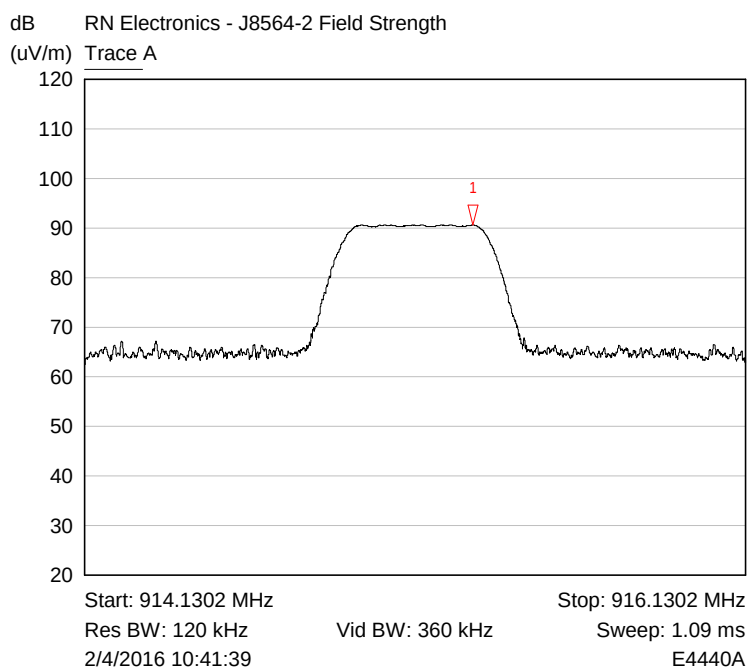
Plot of Peak emissions for Vertical against the average limit line.



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

6.6 Intentional radiator field strength

RF Parameters: Band 902-928 MHz, Power Level 1 (2 dBm), Channel Spacing 90 kHz,
Modulation FSK, 915-915.27 MHz

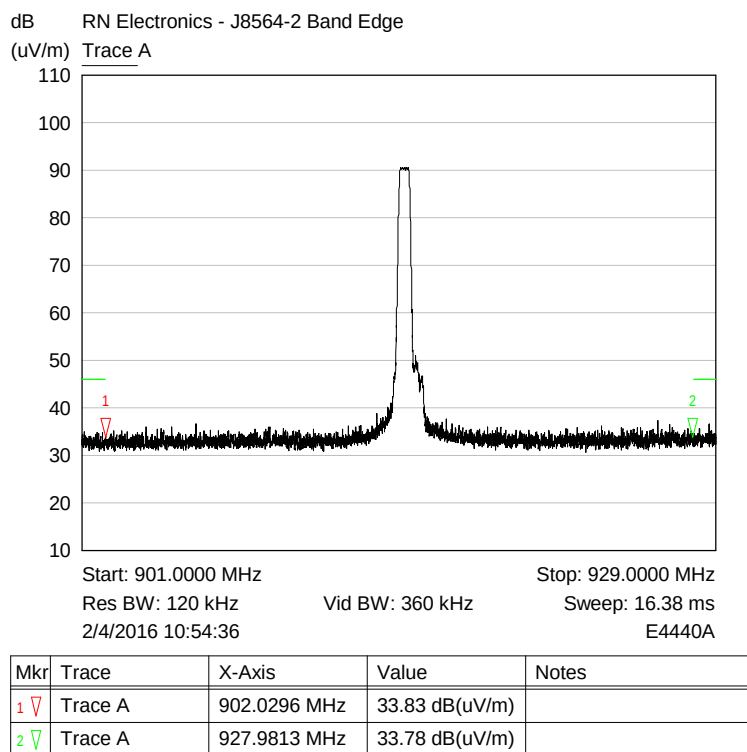


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	915.3051 MHz	90.68 dB(uV/m)	

Plot of Horiz polarisation and EUT in Upright position

6.7 Band Edge Compliance

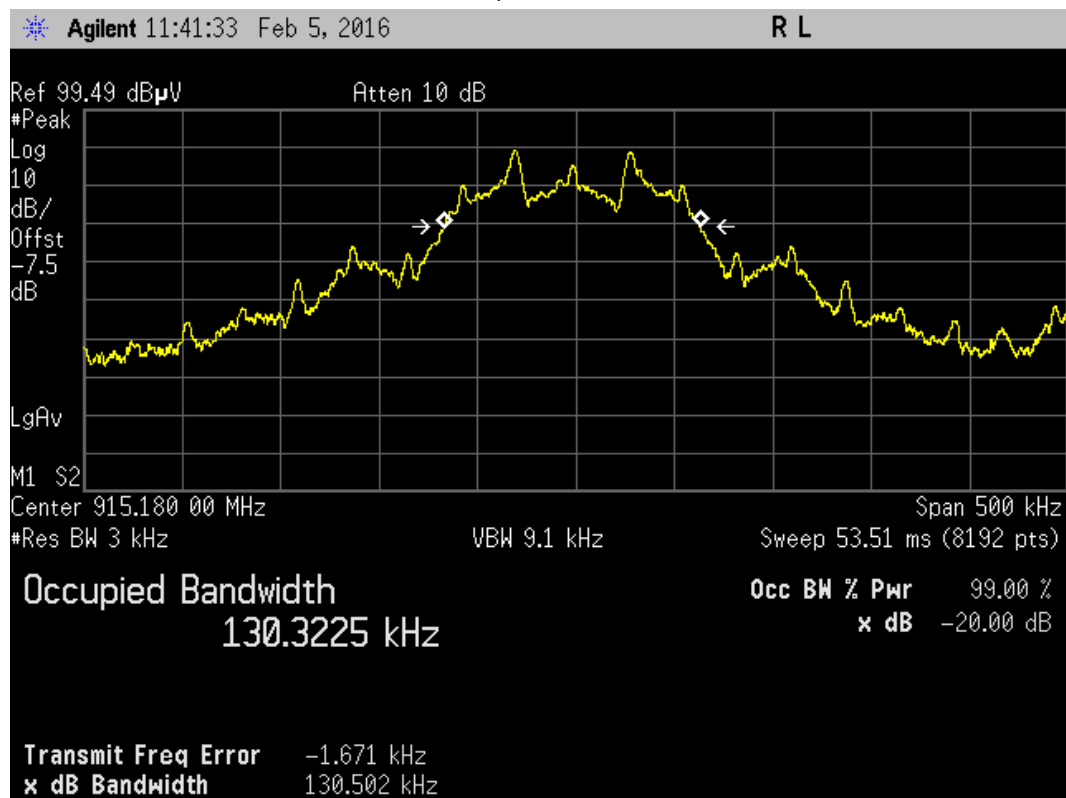
RF Parameters: Band 902-928 MHz, Power Level 1 (2 dBm), Channel Spacing 90 kHz,
Modulation FSK, 915-915.27 MHz



Band Edge Plot

6.8 Occupied bandwidth

RF Parameters: Band 902-928 MHz, Power Level 1 (2 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 (dBμV)	Pk – Lim 1 (dB)	QP Amp (dBμV)	QP - Lim1 (dB)	Av Amp (dBμV)	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 $\mu\text{V/m}$ 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 $15.31(f)(2)$.

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.

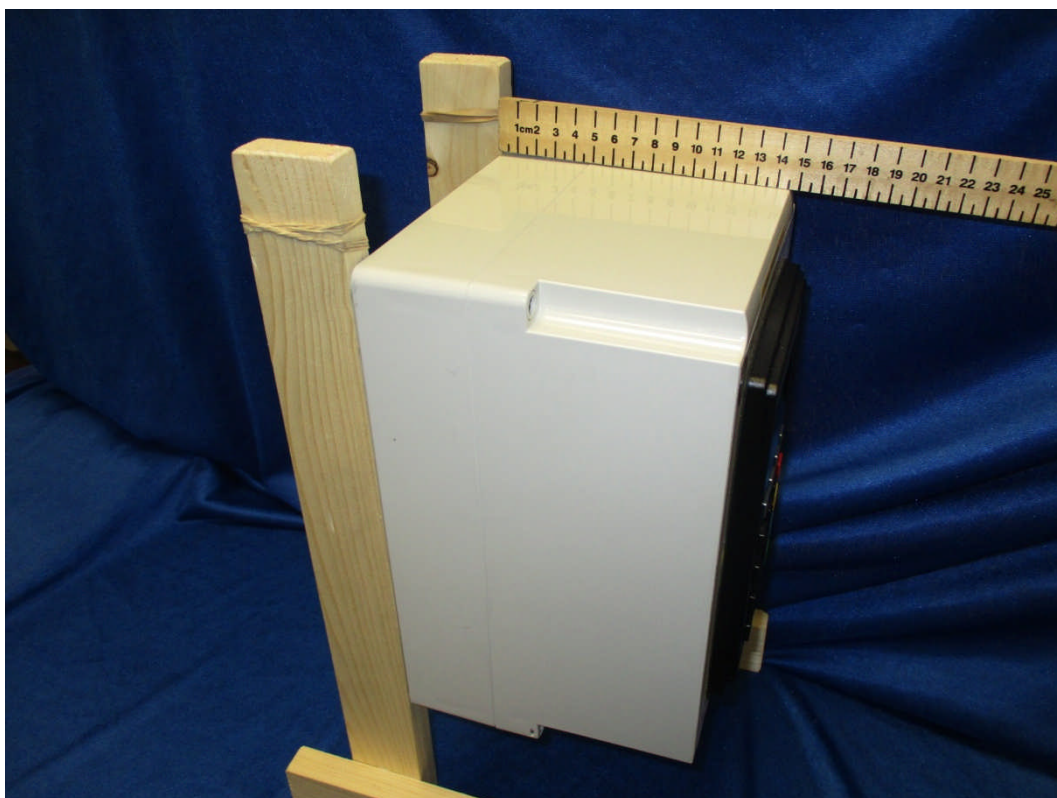
Example calculation: - $\text{FS} = \text{RA} + \text{AF} + \text{CL}$.

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





8.2 EUT Antenna Port

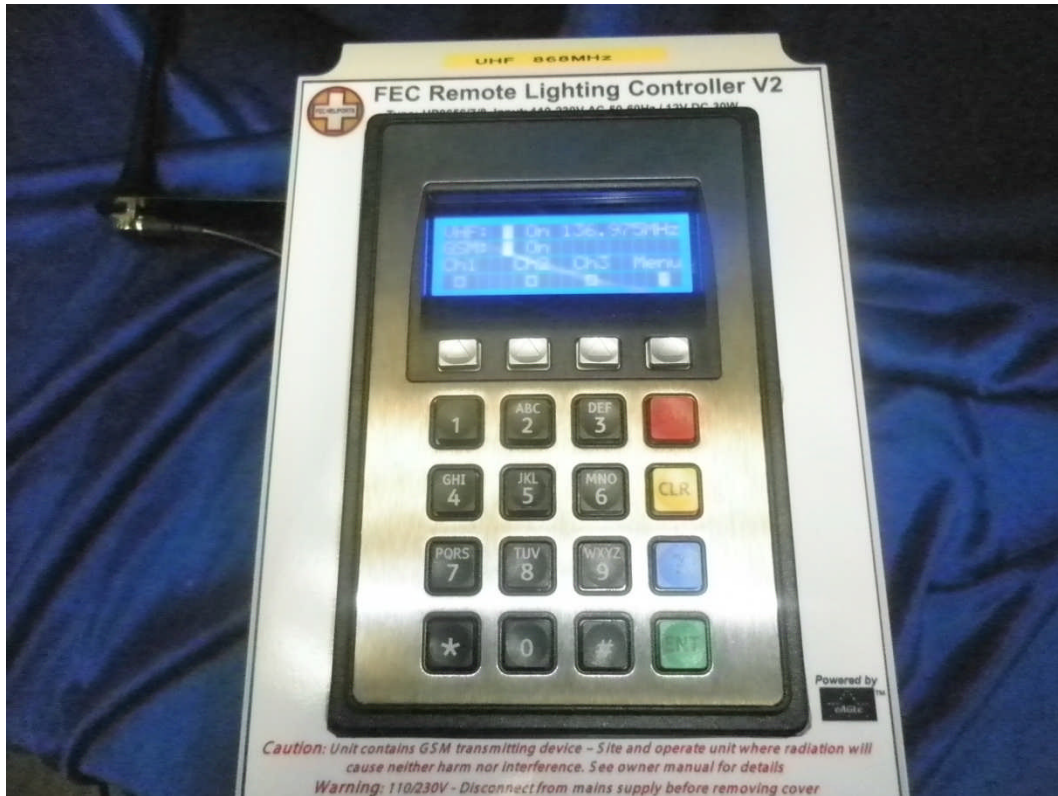


8.3 Antenna



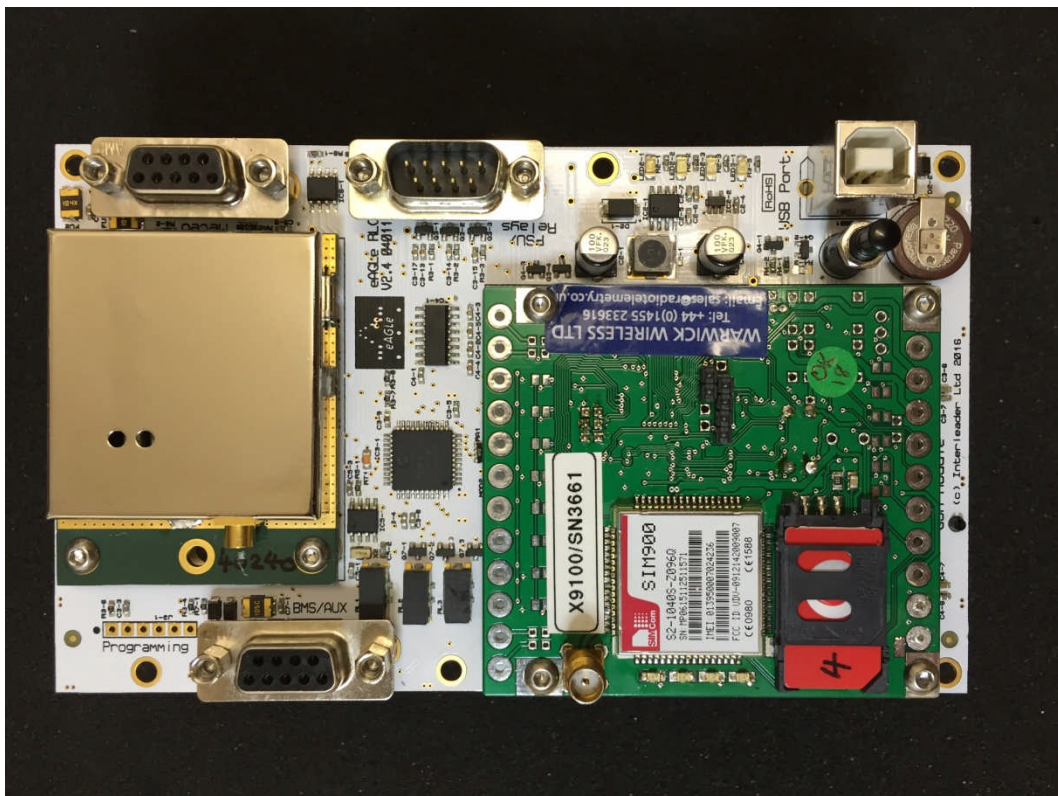
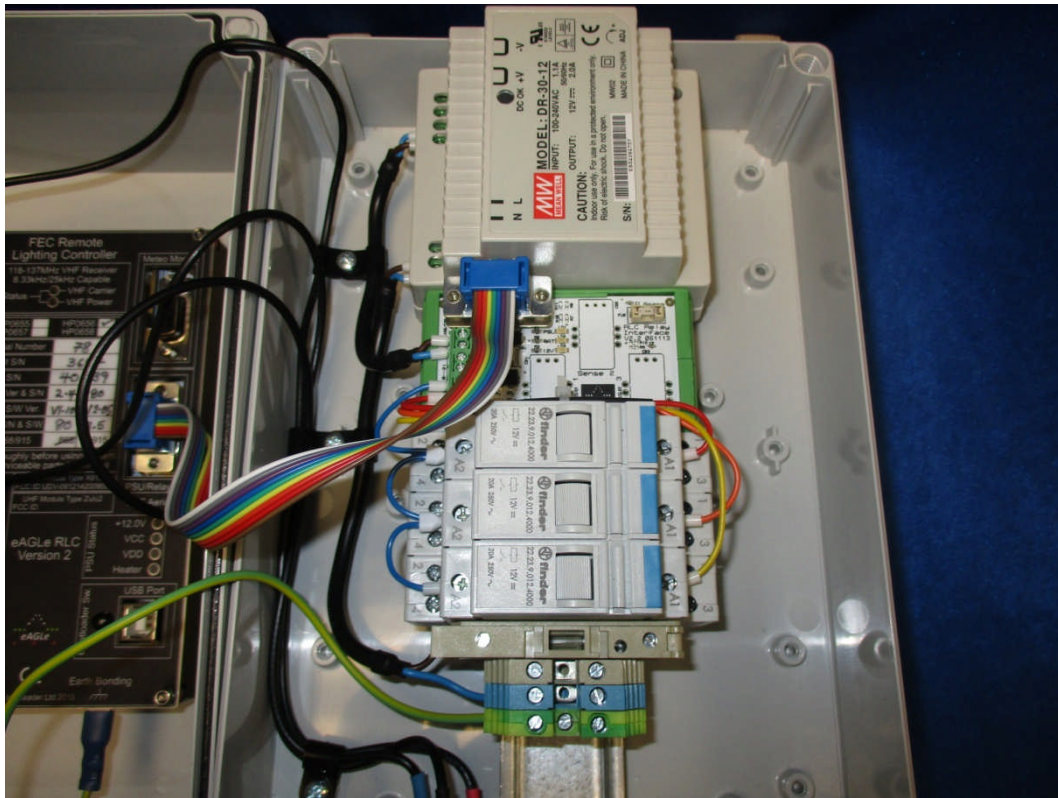
Photograph shows the 915MHz UHF antenna

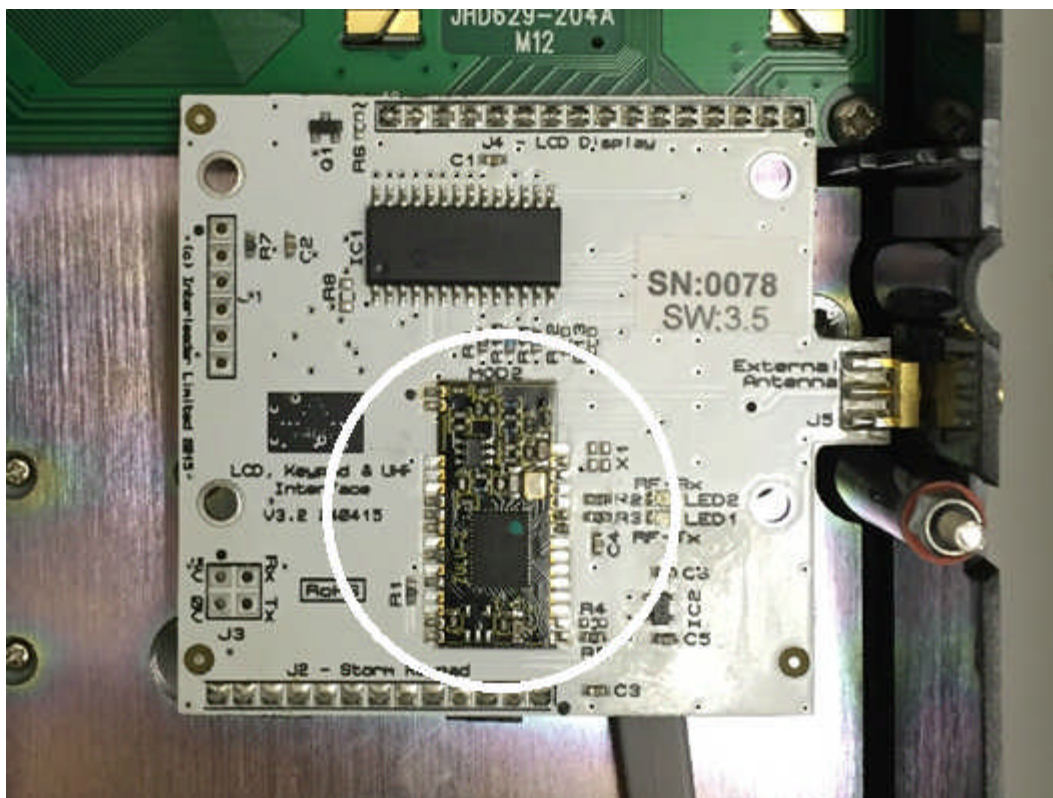
8.4 EUT Display & Controls



8.5 EUT Internal photos







Photograph shows the 915 MHz radio module (circled)

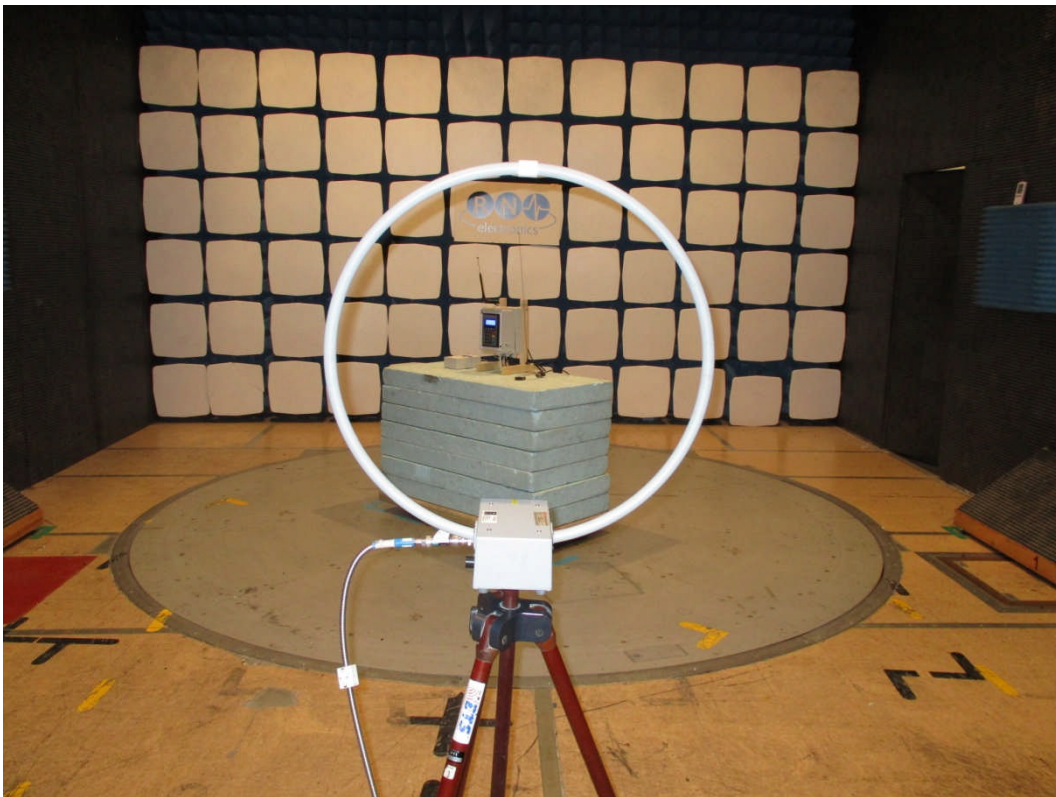
8.6 EUT ID Label

No label provided at time of test.

8.7 Radiated emissions 9 - 150 kHz



Site OATS

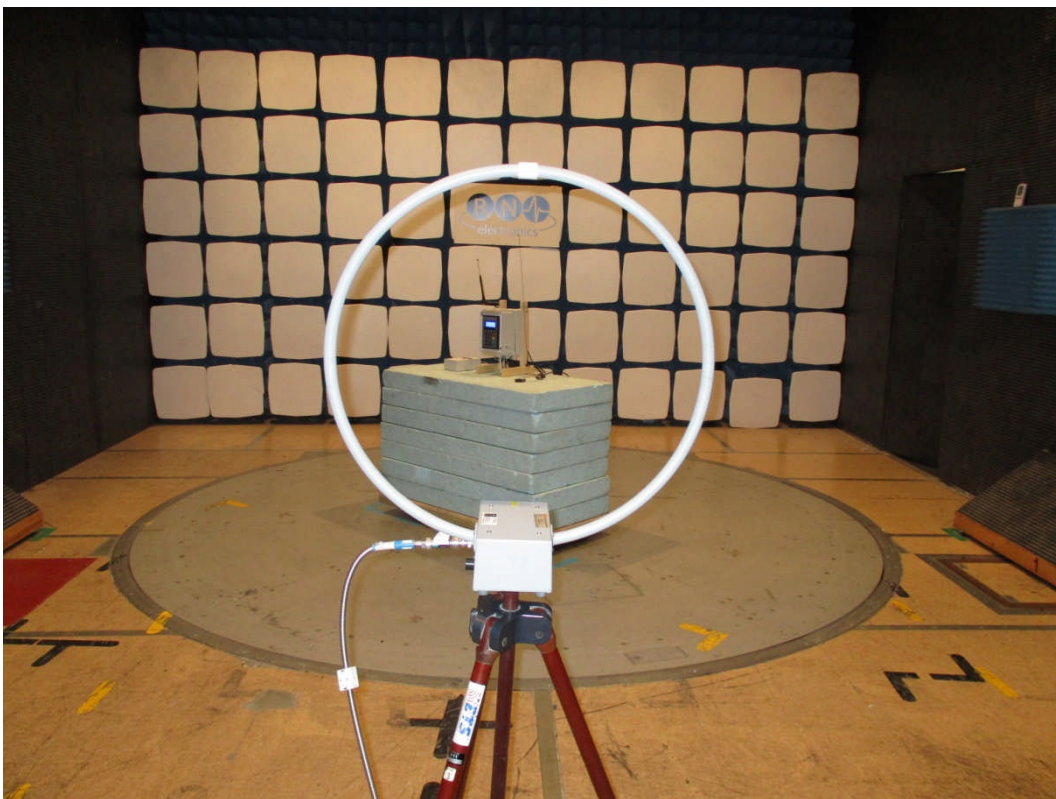


Site H

8.8 Radiated emissions 150 kHz - 30 MHz

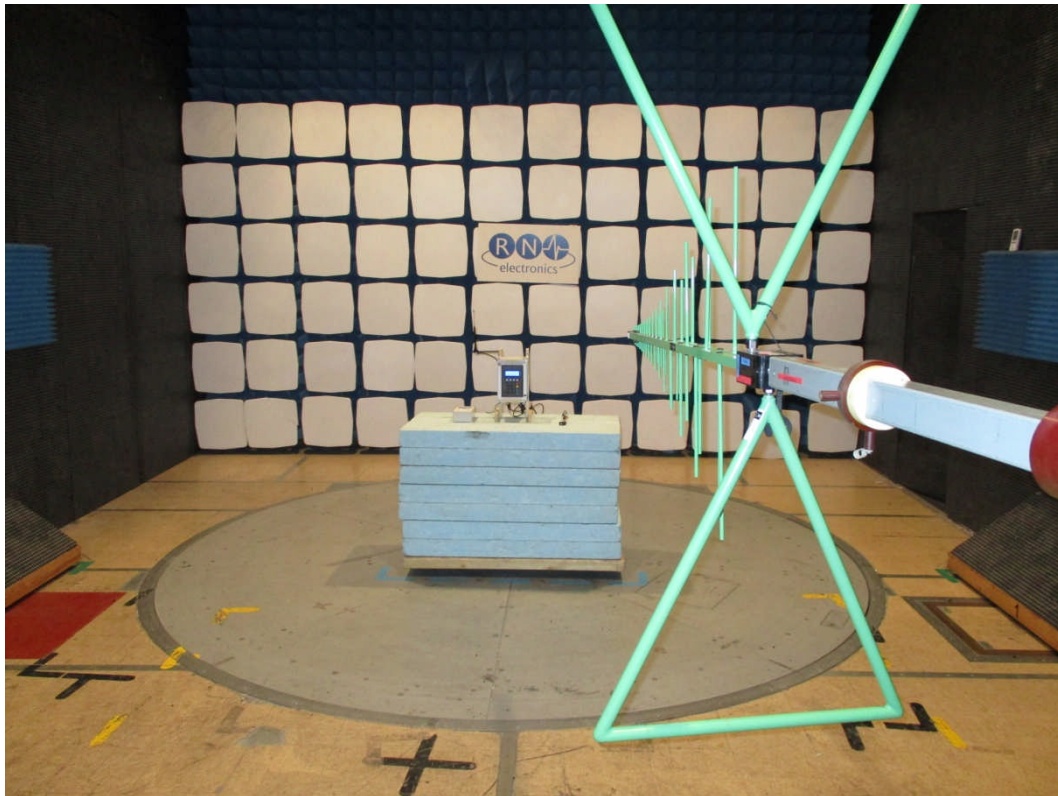


Site OATS

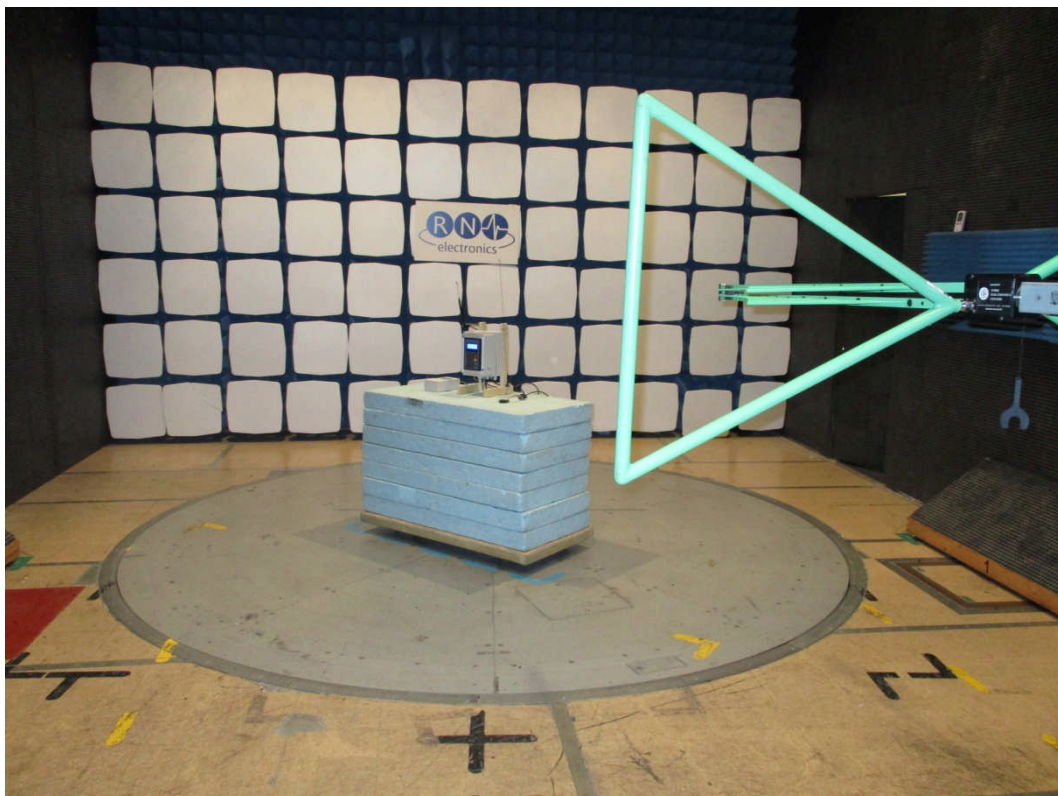


Site H

8.9 Radiated emissions 30 MHz -1 GHz

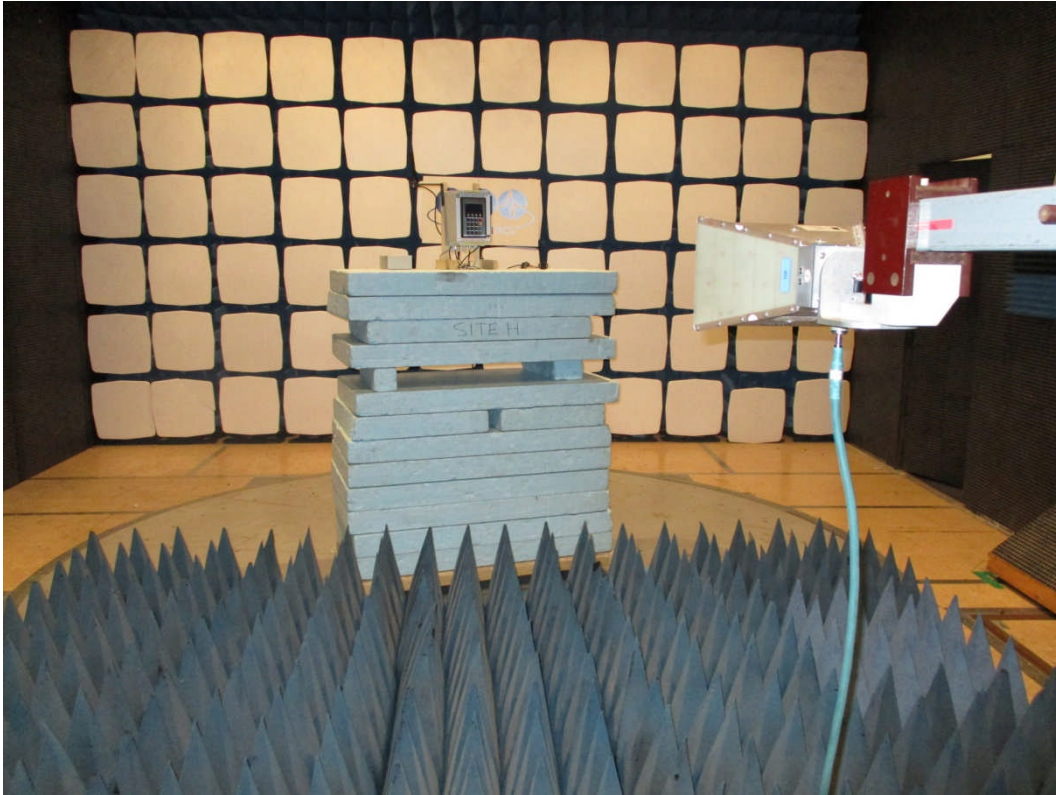


Site H

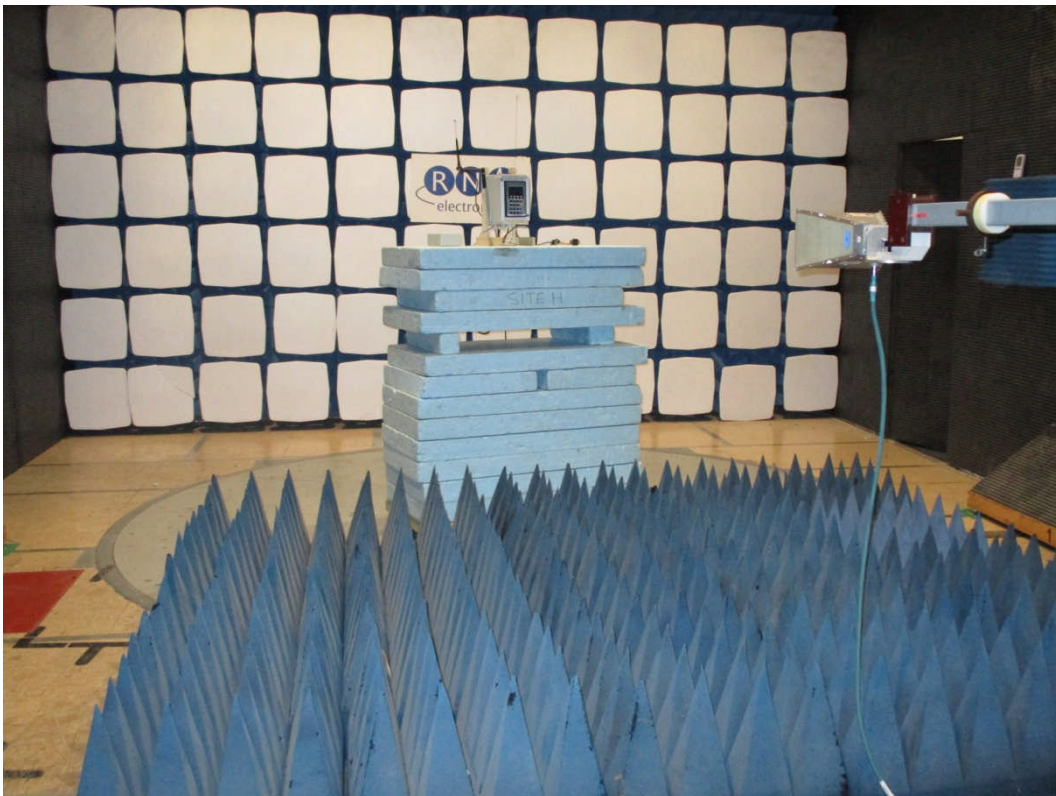


Site H

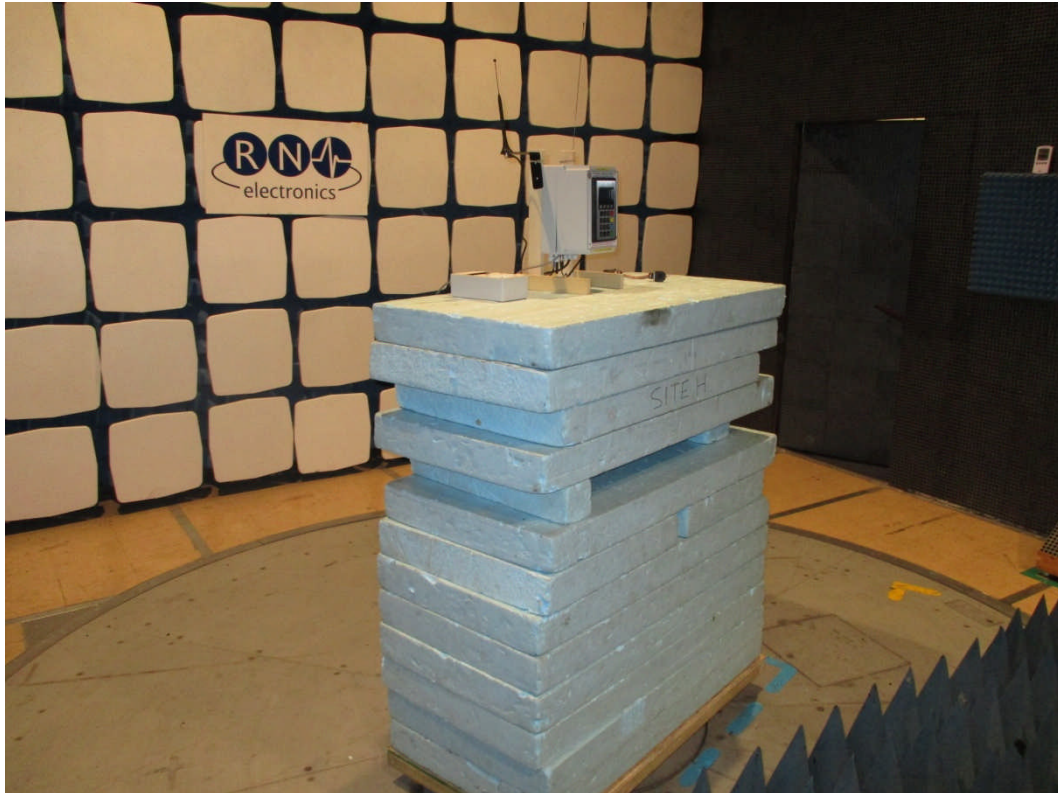
8.10 Radiated emissions above 1 GHz



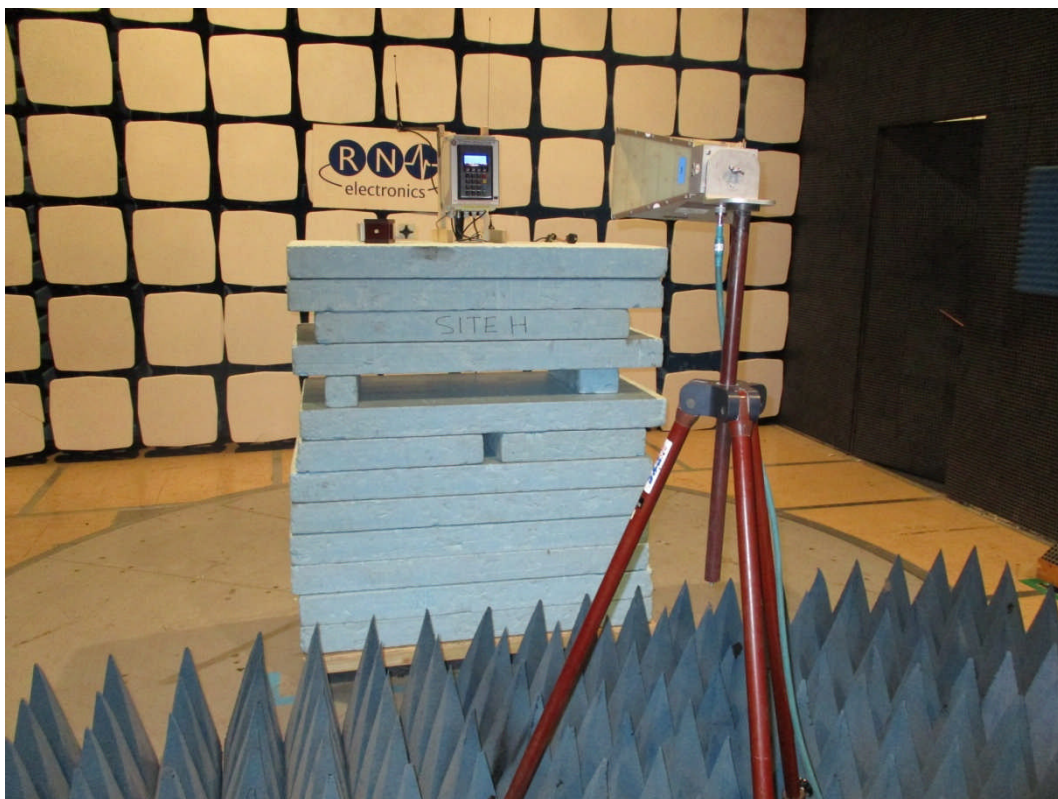
Site H



Site H



Site H



Site H



Site H

8.11 Radiated emission diagram

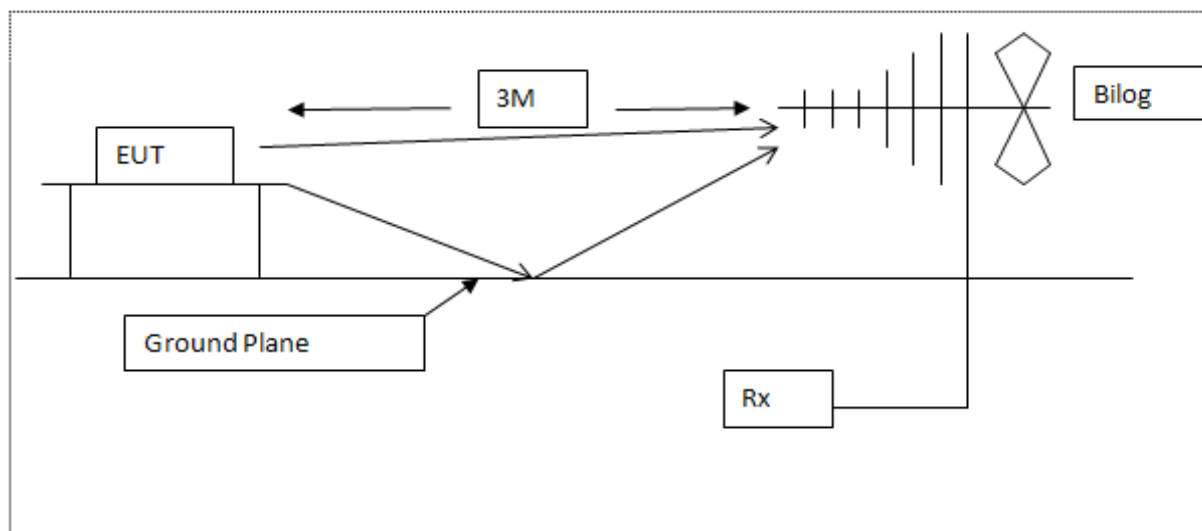


Diagram of the radiated emissions test setup 30 - 1000 MHz

8.12 AC powerline conducted emission diagram

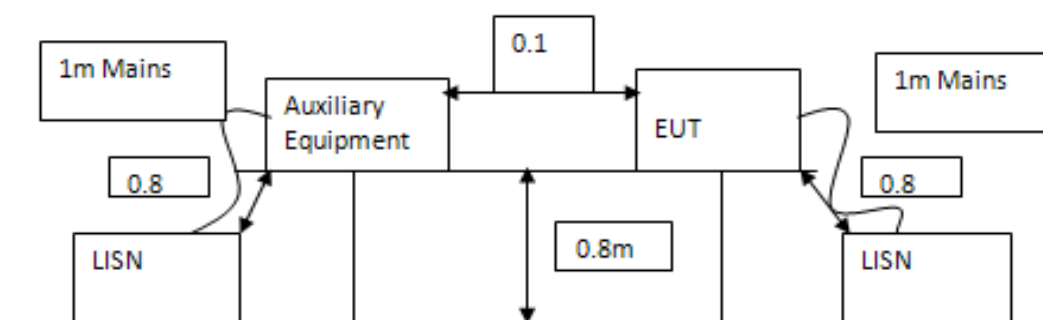


Diagram of the AC conducted emissions test setup

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
E035	11947A	Transient Limiter + 10dB Atten.	Hewlett Packard	14-Dec-2015	6 months
E150	MN2050	LISN 13A	Chase	08-Oct-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
E465	PCR2000LA	AC Power Supply	KIKUSUI	15-May-2015	12 months
E533	N5182A	Signal Generator 6 GHz MXG	Agilent Technologies	26-Feb-2013	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
E624	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	22-Dec-2015	24 months
LPE261	3115	1-18GHz Horn	EMCO	18-Feb-2014	24 months
LPE333	8449B	Pre-amplifier 1GHz - 26.5GHz	Hewlett Packard	29-Jan-2015	24 months
LPE351	PAS 5000	5kV Power Source	SPITZENBERGER + SPIES	08-Apr-2015	12 months
LPE364	CBL6112A	30MHz - 2GHz Bilog Antenna	Chase Electronics Ltd	22-Jan-2016	24 months
TMS46	Model1	Attenuator	Weinschel	07-Jul-2015	12 months
TMS81	6502	Active Loop Antenna	EMCO	27-Apr-2015	24 months

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	EAGLE	Meteorological Unit Simulator	Interleader Limited	Not stated
2	Not stated	BMS output jig	Interleader Limited	Not stated

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

Test	Modification	Time of modification	Photo Reference
TX ERP Field Strength	Power setting programmed was reduced to 'Level 1 (2dB)' to meet radiated field strength limit.	Before testing	No

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
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		