



TEST REPORT

Test Report No. : UL-RPT-RP10665836JD01A

Manufacturer : Harvard Engineering Ltd
Model No. : LN-DRA-G3-915
FCC ID : 2AGAA- WMLNDRA915
Test Standard(s) : FCC Parts 15.209(a) & 15.247(d)

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2. The results in this report apply only to the sample(s) tested.
3. The sample tested is in compliance with the above standard(s).
4. The test results in this report are traceable to the national or international standards.
5. Version 1.0

Date of Issue: 18 November 2015

Checked by:

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Engineer, Radio Laboratory

Company Signatory:

Steven White
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This laboratory is accredited by UKAS.
The tests reported herein have been
performed in accordance with its' terms
of accreditation.

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Table of Contents

1. Customer Information.....	4
2. Summary of Testing.....	5
2.1. General Information	5
2.2. Summary of Test Results	5
2.3. Methods and Procedures	5
2.4. Deviations from the Test Specification	5
3. Equipment Under Test (EUT)	6
3.1. Identification of Equipment Under Test (EUT)	6
3.2. Description of EUT	6
3.3. Modifications Incorporated in the EUT	6
3.4. Additional Information Related to Testing	6
3.5. Support Equipment	7
4. Operation and Monitoring of the EUT during Testing	8
4.1. Operating Modes	8
4.2. Configuration and Peripherals	8
5. Measurements, Examinations and Derived Results.....	9
5.1. General Comments	9
5.2. Test Results	10
5.2.1. Transmitter Radiated Emissions	10
5.2.2. Transmitter Radiated Emissions	13
5.2.3. Transmitter Band Edge Radiated Emissions	17
6. Measurement Uncertainty	19
7. Report Revision History	20

1. Customer Information

Company Name:	Harvard Engineering Ltd
Address:	Tyler Close Normanton Wakefield WF6 1RL United Kingdom

2. Summary of Testing

2.1. General Information

Specification Reference:	47CFR15.247
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
Specification Reference:	47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.209
Site Registration:	FCC: 209735
Location of Testing:	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	12 October 2015 to 09 November 2015

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.247(d)/15.209(a)	Transmitter Radiated Emissions	✓
Part 15.247(d)/15.209(a)	Transmitter Band Edge Radiated Emissions	✓
Key to Results		
✓ = Complied		✗ = Did not comply

2.3. Methods and Procedures

Reference:	ANSI C63.10 (2013)
Title:	American National Standard for Testing Unlicensed Wireless Devices

2.4. Deviations from the Test Specification

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specification identified above.

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	Venture
Model Name or Number:	LN-DRA-G3-915
Test Sample Serial Number:	17478097
Hardware Version:	Top Level Assembly: rev 2 , Internal LeafNode Radio: rev 3
Software Version:	Internal LeafNode Radio: Rev 34
FCC ID:	2AGAA- WMLNDRA915

3.2. Description of EUT

The equipment under test was a WiMAC Leaf Node Dual Relay Adaptor for HID Lighting control gear control. A LeafNode was fitted inside the EUT to transmit on the required frequency or mode.

3.3. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.4. Additional Information Related to Testing

Tested Technology:	FHSS		
Power Supply Requirement:	Nominal	120 VAC	
Type of Unit:	Transceiver		
Channel Spacing:	170 kHz		
Modulation:	GFSK		
Data Rate	2400 bps		
Transmit Frequency Range:	902 MHz to 928 MHz		
Transmit Channels Tested:	Channel ID	Channel No.	Channel Frequency (MHz)
	Bottom	0	905.20
	Middle	31	910.47
	Top	63	915.91

3.5. Support Equipment

The following support equipment was used to exercise the EUT during testing:

Description:	LeafNode
Brand Name:	Venture
Model Name or Number:	WMLN-915USA-OFF
Serial Number:	17472261 (<i>Bottom Channel</i>)

Description:	LeafNode
Brand Name:	Venture
Model Name or Number:	WMLN-915USA-OFF
Serial Number:	17450153 (<i>Middle Channel</i>)

Description:	LeafNode
Brand Name:	Venture
Model Name or Number:	WMLN-915USA-OFF
Serial Number:	17478024 (<i>Top Channel</i>)

Description:	LeafNode
Brand Name:	Venture
Model Name or Number:	WMLN-915A
Serial Number:	17450183 (<i>Hopping mode</i>)

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

The EUT was tested in the following operating mode(s):

- Constantly transmitting at maximum power in fixed frequencies.
- Constantly transmitting at maximum power in hopping mode.

4.2. Configuration and Peripherals

The EUT was tested in the following configuration(s):

- The relevant LeafNode was integrated into the EUT (Dual Relay Adaptor) dependant on the test. Four LeafNodes were provided by the customer, three were fixed frequency and one in normal hopping mode. The fixed frequency LeafNodes were supplied for testing purposes only. For normal operation, the EUT operates in a hopping mode.
- The EUT was connected to a 120 VAC single phase supply. Once power was applied to the EUT, it started transmitting immediately.
- The EUT was only tested in the one orientation (antenna vertical), as this is representative of the orientation in its operational mode.
- Transmitter Radiated Emissions <1 GHz testing was performed with DRA serial number 17478097 and Middle channel LeafNode serial number 17450153.
- Transmitter Radiated Emissions >1 GHz testing was performed with DRA serial number 17478097 and all four LeafNodes.
- Transmitter Band Edge Radiated Emissions testing was performed with DRA serial number 17478097, Bottom channel LeafNode serial number 17472261, Top channel LeafNode serial number 17478024 and Hopping mode LeafNode 17450183.

5. Measurements, Examinations and Derived Results

5.1. General Comments

Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to *Section 6. Measurement Uncertainty* for details.

In accordance with UKAS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period on the date of testing.

5.2. Test Results

5.2.1. Transmitter Radiated Emissions

Test Summary:

Test Engineer:	David Doyle	Test Date:	14 October 2015
Test Sample Serial Numbers:	17478097 & 17450153		

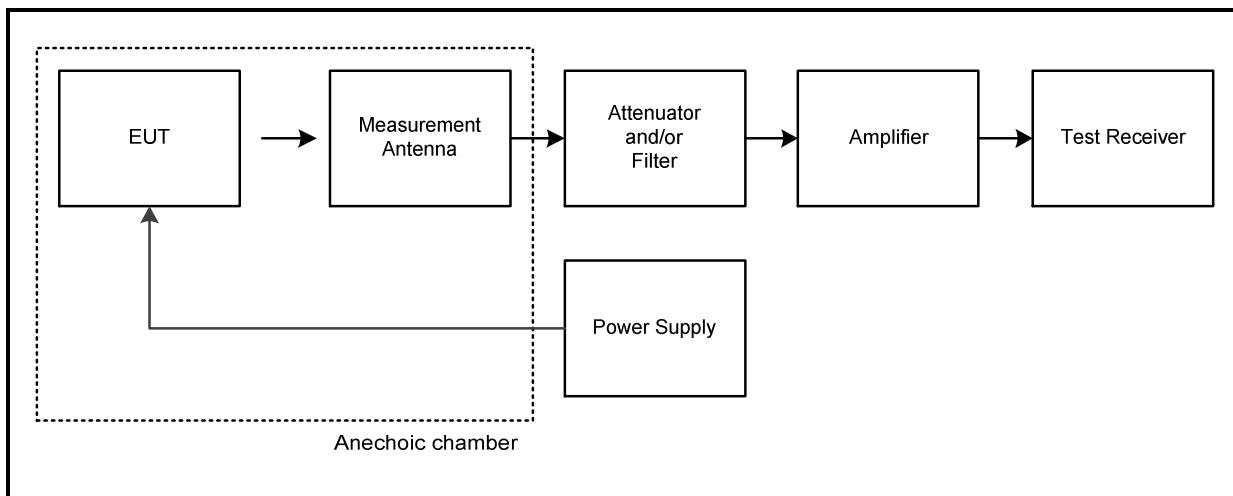
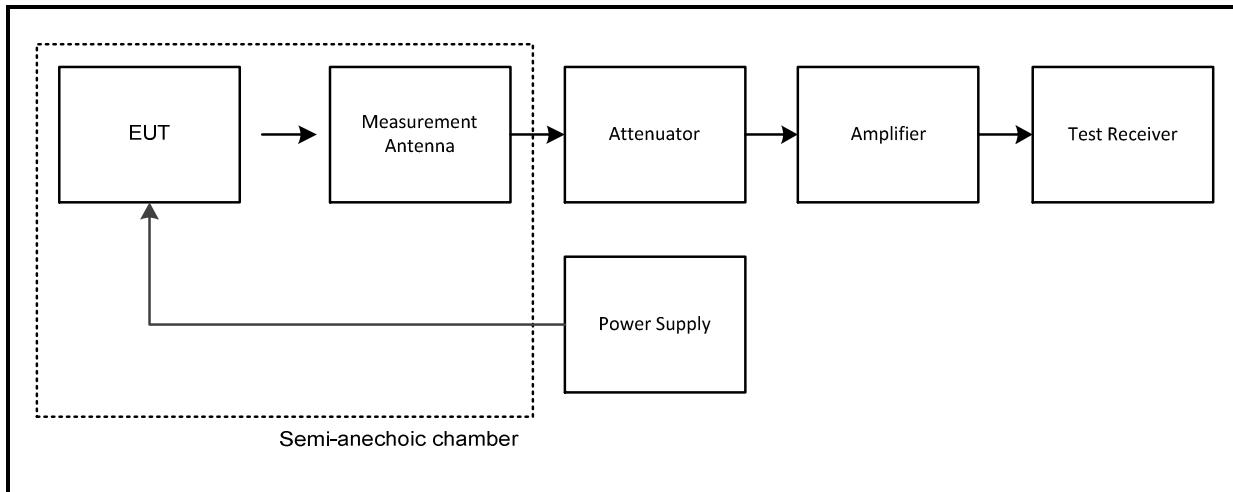
FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3 and 6.5
Frequency Range	30 MHz to 1000 MHz

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	41

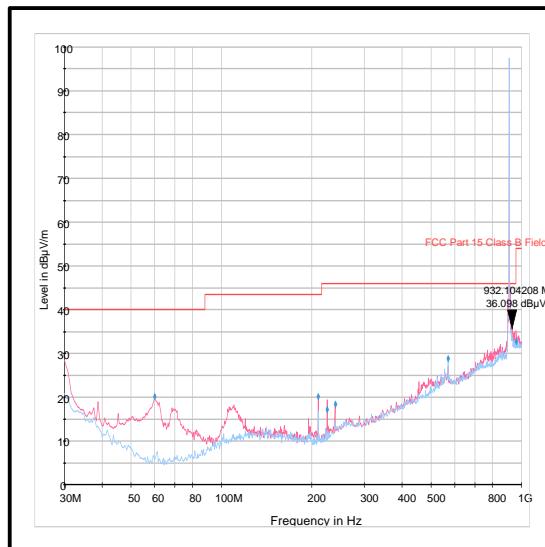
Note(s):

1. The emission shown on the 30 MHz to 1 GHz plot at approximately 910 MHz is the EUT fundamental.
2. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
3. The preliminary scans showed similar emission levels below 1 GHz, for each channel of operation. Therefore final radiated emissions measurements were performed with the EUT set to the middle channel only.
4. All emissions shown on the pre-scan plot were investigated and found to be ambient or >20 dB below the applicable limit or below the measurement system noise floor, therefore the highest peak noise floor reading of the measuring receiver was recorded in the table below.
5. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
6. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. The sweep time was set to auto. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.

Transmitter Radiated Emissions (continued)**Test setups for Radiated measurements:**

Transmitter Radiated Emissions (continued)**Results: Middle Channel**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
932.104	Vertical	36.1	46.0	9.9	Complied

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1945	Thermohygrometer	JM Handelpunkt	30.5015.01	0112	23 Apr 2016	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	19 Mar 2016	12
M1273	Test Receiver	Rohde & Schwarz	ESIB26	100275	19 Mar 2016	12
A490	Antenna	Chase	CBL6111A	1590	30 Apr 2016	12
G0543	Amplifier	Sonoma	310N	230801	06 Nov 2015	3
A1834	Attenuator	Hewlett Packard	8491B	10444	05 Mar 2016	12
A088	Variable Transformer	Zenith	Y20-HM	9029	Calibrated before use	-
M122	Multimeter	Fluke	77	64910017	22 Apr 2016	12

5.2.2. Transmitter Radiated Emissions

Test Summary:

Test Engineer:	David Doyle	Test Dates:	12 October 2015 & 19 October 2015
Test Sample Serial Numbers:	17478097, 17472261, 17450153, 17478024 & 17450183		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3 and 6.6
Frequency Range	1 GHz to 9.3 GHz

Environmental Conditions:

Temperature (°C):	22 to 23
Relative Humidity (%):	39 to 41

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. All other emissions shown on the pre-scan plot were investigated and found to be ambient or >20 dB below the applicable limit or below the measurement system noise floor.
3. * In accordance with ANSI C63.10 Section 6.6.4.3 (Note 1), if the peak measured value complies with the average limit, it is unnecessary to perform an average measurement.
4. Pre-scans above 1 GHz were performed in a fully anechoic chamber (Asset Number K0002) at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the test chamber floor in the centre of the chamber turntable. All measurement antennas were placed at a fixed height of 1.5 metres above the test chamber floor, in line with the EUT. Final measurements above 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
5. Pre-scans were performed and markers were placed on the highest measured levels of the appropriate plot. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. The sweep time was set to auto. Peak and average measurements were performed with their own appropriate detectors during the pre-scan measurements.

Transmitter Radiated Emissions (continued)**Results: Bottom Channel**

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
2715.449	Vertical	49.4	54.0*	4.6	Complied
3620.769	Vertical	49.9	54.0*	4.1	Complied
4526.010	Vertical	49.8	54.0*	4.2	Complied
5431.178	Vertical	47.0	54.0*	7.0	Complied

Results: Peak / Middle Channel

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2731.119	Vertical	48.3	54.0*	5.7	Complied
3641.912	Vertical	55.3	74.0	18.7	Complied
4552.585	Vertical	44.3	54.0*	9.7	Complied

Results: Average / Middle Channel

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
3641.928	Vertical	53.0	54.0	1.0	Complied

Results: Top Channel

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
2747.668	Vertical	48.4	54.0*	5.6	Complied
3663.493	Vertical	50.8	54.0*	3.2	Complied
4579.631	Vertical	47.2	54.0*	6.8	Complied
7327.376	Vertical	39.0	54.0*	15.0	Complied

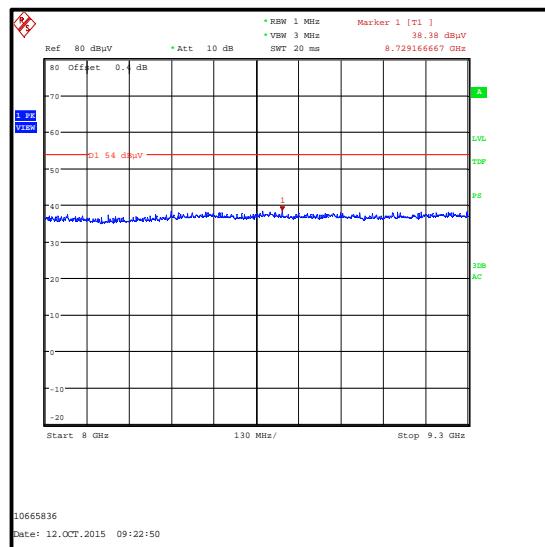
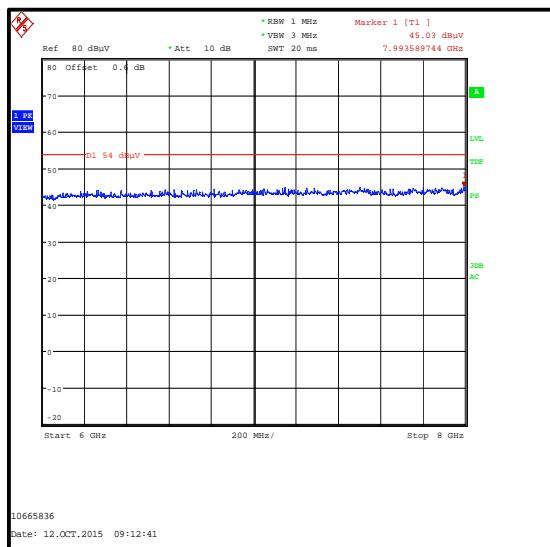
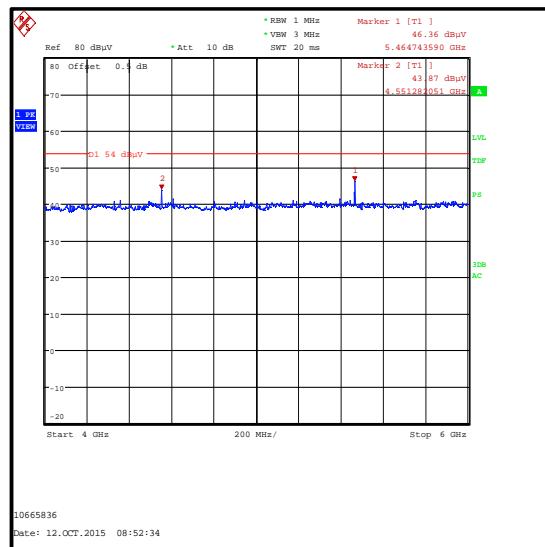
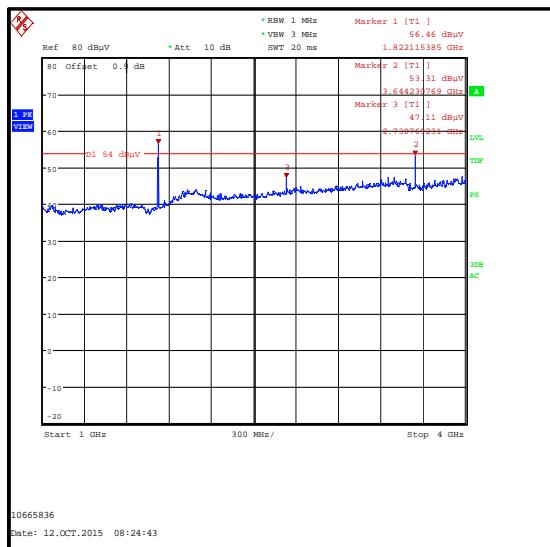
Results: Peak / Hopping Mode

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2731.619	Vertical	45.1	54.0*	8.9	Complied
3624.865	Vertical	54.9	74.0	19.1	Complied
4536.212	Vertical	46.0	54.0*	8.0	Complied

Results: Average / Hopping Mode

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
3624.936	Vertical	52.5	54.0	1.5	Complied

Transmitter Radiated Emissions (continued)



Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Radiated Emissions (continued)**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1656	Thermohygrometer	JM Handelspunkt	30.5015.13	Not stated	23 Apr 2016	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	01 May 2016	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	12 Jun 2016	12
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	21 Dec 2015	12
A1818	Antenna	EMCO	3115	00075692	20 Dec 2015	12
A253	Antenna	Flann Microwave	12240-20	128	20 Dec 2015	12
A254	Antenna	Flann Microwave	14240-20	139	20 Dec 2015	12
A255	Antenna	Flann Microwave	16240-20	519	20 Dec 2015	12
A2467	High Pass Filter	Wainwright Instruments GmbH	WHJE5-920-1000-4000-60EE	2	13 Feb 2016	12
A1975	High Pass Filter	AtlanTecRF	AFH-03000	090424010	17 Apr 2016	12
A088	Variable Transformer	Zenith	Y20-HM	9029	Calibrated before use	-
M122	Multimeter	Fluke	77	64910017	22 Apr 2016	12

5.2.3. Transmitter Band Edge Radiated Emissions**Test Summary:**

Test Engineer:	David Doyle	Test Date:	09 November 2015
Test Sample Serial Numbers:	17478097, 17472261, 17450183 & 17478024		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Section 6.10.4

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	49

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. As both band edges fall within the non-restricted band, only peak measurements are required. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The test receiver was left to sweep for a sufficient length of time in order to maximise the carrier level and out-of-band emissions. A marker and corresponding reference level line were placed on the peak of the carrier. A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent band (where a higher level emission was present). Marker frequencies and levels were recorded.
3. The spectrum analyser reference level was set to 120 dB μ V/m in order to obtain sufficient headroom on the result plots.

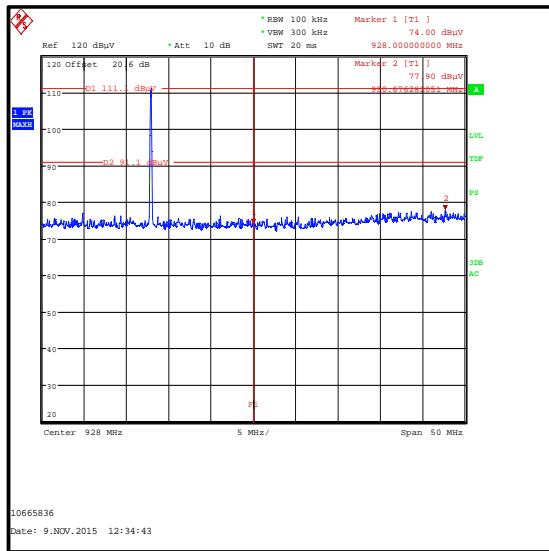
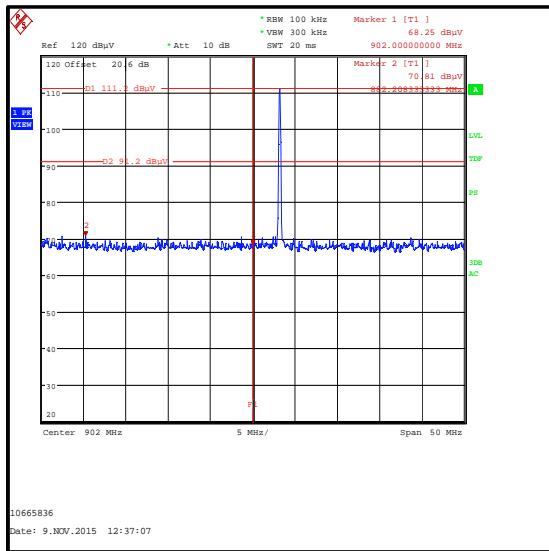
Results: Static Mode

Frequency (MHz)	Peak Level (dB μ V/m)	-20 dBc Limit (dB μ V/m)	Margin (dB)	Result
882.208	70.8	91.2	20.4	Complied
902	68.3	91.2	22.9	Complied
928	74.0	91.1	17.1	Complied
950.676	77.9	91.1	13.2	Complied

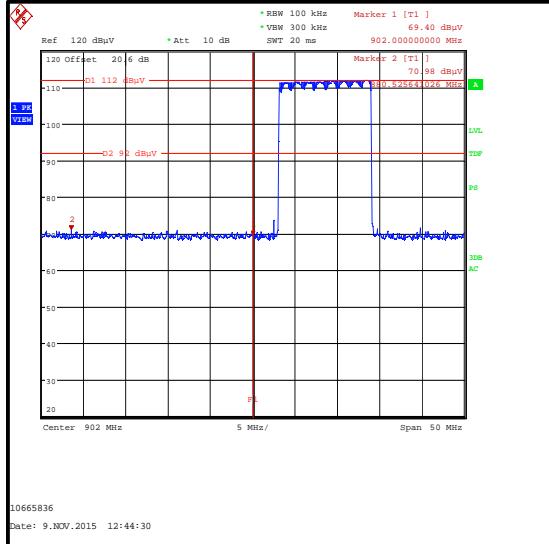
Results: Hopping Mode

Frequency (MHz)	Peak Level (dB μ V/m)	-20 dBc Limit (dB μ V/m)	Margin (dB)	Result
880.526	71.0	92.0	21.0	Complied
902	69.4	92.0	22.6	Complied
928	69.2	91.6	22.4	Complied
952.119	73.1	91.6	18.5	Complied

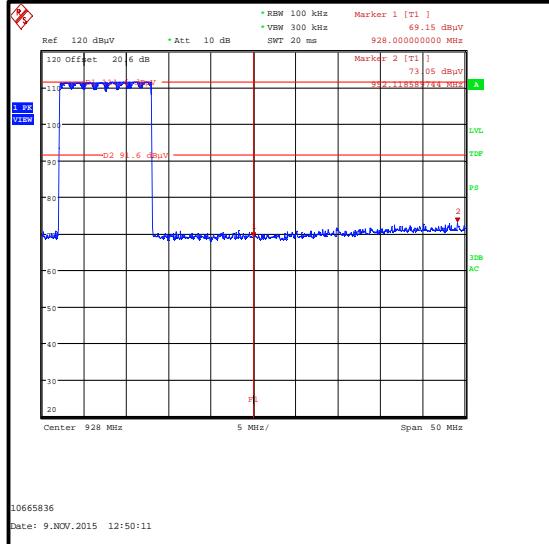
Transmitter Band Edge Radiated Emissions (continued)



Lower Band Edge / Static Mode



Upper Band Edge / Static Mode



Lower Band Edge / Hopping Mode

Upper Band Edge / Hopping Mode

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1656	Thermohygrometer	JM Handelspunkt	30.5015.13	Not stated	23 Apr 2016	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	01 May 2016	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	12 Jun 2016	12
A288	Antenna	Chase	CBL6111A	1589	27 Aug 2016	12
A1393	Attenuator	Huber & Suhner	6820.17.B	757456	05 May 2016	12
A088	Variable Transformer	Zenith	Y20-HM	9029	Calibrated before use	-
M122	Multimeter	Fluke	77	64910017	22 Apr 2016	12

6. Measurement Uncertainty

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor such that a confidence level of approximately 95% is maintained. For the purposes of this document "approximately" is interpreted as meaning "effectively" or "for most practical purposes".

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±5.65 dB
Radiated Spurious Emissions	1 GHz to 10 GHz	95%	±2.94 dB

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty the published guidance of the appropriate accreditation body is followed.

7. Report Revision History

Version Number	Revision Details		
	Page No(s)	Clause	Details
1.0	-	-	Initial Version