



TEST REPORT

Test Report No. : UL-RPT-RP10816619JD06A V2.0

Manufacturer : Torquing Robotics Ltd
Model No. : ZANO1
FCC ID : 2AE23-ZANO1
Test Standard(s) : FCC Parts 15.209(a) & 15.249

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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 2.0 supersedes all previous versions.

Date of Issue: 10 September 2015

Checked by:

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Engineer, Radio Laboratory

Issued by :

pp

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Quality Manager,
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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	6
3.6. Antenna	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 Fundamental Field Strength	10
5.2.2. Transmitter 20 dB Bandwidth	11
5.2.3. Transmitter Radiated Emissions	13
5.2.4. Transmitter Band Edge Radiated Emissions	17
6. Measurement Uncertainty	19
7. Report Revision History	20

1. Customer Information

Company Name:	Torquing Robotics Ltd
Address:	Unit 13 Pembrokeshire Science & Technology Park Pembroke Dock Pembrokeshire SA72 6UN United Kingdom

2. Summary of Testing

2.1. General Information

Specification Reference:	47CFR15.249
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.249
Specification Reference:	47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.209
Site Registration:	209735
Location of Testing:	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	22 June 2015 to 25 June 2015

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.249(a)(e)	Transmitter Fundamental Field Strength	✓
Part 2.1049	Transmitter 20 dB Bandwidth	✓
Part 15.249(a)(d)(e)/ 15.209(a)	Transmitter Radiated Emissions	✓
Part 15.249(d)/ 15.209(a)	Transmitter Band Edge Radiated Emissions	✓
Key to Results		
✓ = Complied	✗ = Did not comply	

2.3. Methods and Procedures

Reference:	ANSI C63.4 (2009)
Title:	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
Reference:	ANSI C63.10 (2009)
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:	Torquing Robotics
Model Name or Number:	ZANO1
Hardware Version Identification Number:	1.0
Firmware Version Identification Number:	1.0
Test Sample Serial Number:	ZANO1_915
FCC ID:	2AE23-ZANO1

3.2. Description of EUT

The Equipment Under Test was a drone containing WiFi and SRD radios.

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:	Low Power Transceiver	
Power Supply Requirement:	Nominal	3.7 VDC
Type of Unit:	Transceiver	
Modulation:	FSK	
Transmit Frequency Range:	902 MHz to 928 MHz	
Transmit Channel Tested:	Channel ID	Channel Frequency (MHz)
	Single channel	915

3.5. Support Equipment

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

Description:	WiFi Router
Brand Name:	Belkin
Model Name or Number:	N600 DB
Serial Number:	121142GF101099

Description:	Test Laptop
Brand Name:	ASUS
Model Name or Number:	S200E
Serial Number:	D3N0BC0735526118

3.6. Antenna

The table below lists the antenna that the manufacturer intends to use with this product when operating in the 902 to 928 MHz band:

Antenna Type	Stated Gain	Manufacturer	Part Number
SMD	-1.0 dBi	Johanson Technology	0915AT43A0026

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

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

- Transmitting a modulated signal continuously on a single channel.

4.2. Configuration and Peripherals

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

- The EUT was powered by 3.7 VDC battery, which is charged via a USB port. A fully charged battery was used for all tests.
- The EUT was configured wirelessly via a WiFi router using a set of software commands on the customer's test laptop. Once the EUT's SRD radio was put into test mode, the connection with the router was broken and the WiFi radio was switched off.
- Radiated tests were performed with the USB port unterminated, as any connection to this port would place the EUT into a receive/idle mode.

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 Fundamental Field Strength

Test Summary:

Test Engineer:	Sandeep Bharat	Test Date:	22 June 2015
Test Sample Serial Number:	ZANO1_915		

FCC Reference:	Part 15.249(a)
Test Method Used:	As detailed in ANSI C63.10 Section 6.5

Environmental Conditions:

Temperature (°C):	25
Relative Humidity (%):	36

Note(s):

1. The final measured value in the table below incorporates the calibrated antenna factor and cable loss.

Results: Quasi-Peak

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
915.055	Horizontal	73.9	94.0	20.1	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
G0543	Amplifier	Sonoma	310N	230801	05 Jul 2015	3
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	19 Mar 2016	12
A259	Antenna	Chase	CBL6111	1513	08 Apr 2016	12
A1834	Attenuator	Hewlett Packard	8491B	10444	05 Mar 2016	12

5.2.2. Transmitter 20 dB Bandwidth

Test Summary:

Test Engineer:	Sandeep Bharat	Test Date:	25 June 2015
Test Sample Serial Number:	ZANO1_915		

FCC Reference:	Part 2.1049
Test Method Used:	As detailed in ANSI C63.10 Section 6.9.1

Environmental Conditions:

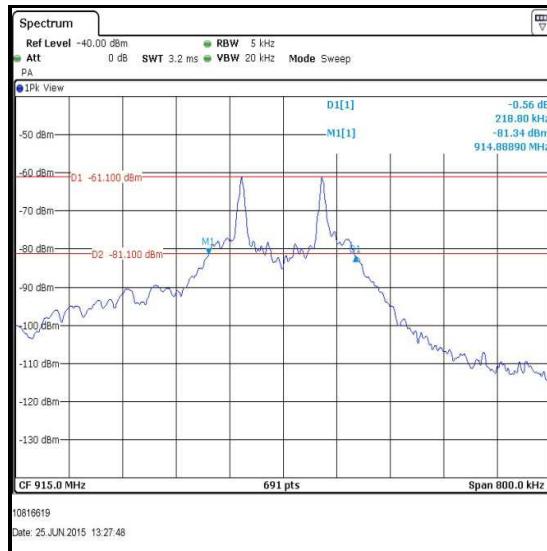
Temperature (°C):	25
Relative Humidity (%):	39

Note(s):

1. The test receiver resolution bandwidth was set to 5 kHz and video bandwidth 20 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 800 kHz. Normal and delta markers were placed 20 dB down from the peak of the carrier. The result is recorded in the table below.
2. The EUT was connected to the signal analyser using a test fixture.

Results:

Transmitter Frequency	20 dB Bandwidth (kHz)
915 MHz	218.800



Transmitter 20 dB Bandwidth (continued)**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohygrometer	JM Handelpunkt	30.5015.13	None stated	23 Apr 2016	12
M1835	Test Receiver	Rohde & Schwarz	FSV30	103050	18 Feb 2016	12
A1395	Attenuator	Huber & Suhner	6806.17.B	753459	Calibrated before use	-

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

Test Engineer:	Sandeep Bharat	Test Date:	22 June 2015
Test Sample Serial Number:	ZANO1_915		

FCC Reference:	Parts 15.249(a)(d)(e) & 15.209(a)
Test Method Used:	As detailed in ANSI C63.10 Sections 6.3 and 6.5 referencing ANSI C63.4
Frequency Range	30 MHz to 1000 MHz

Environmental Conditions:

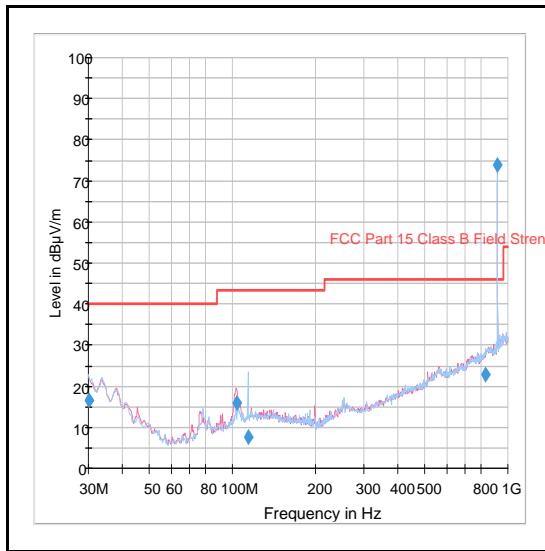
Temperature (°C):	25
Relative Humidity (%):	36

Note(s):

1. The emission at 915 MHz shown on the 30 MHz to 1 GHz plot 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. 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.
4. 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.
5. 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.
6. Final measurements were performed on the marker frequencies and the results entered into the table below. The test receiver resolution bandwidth was set to 120 kHz. A CISPR quasi-peak detector was used.

Results:

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
831.563	Horizontal	22.9	46.0	23.1	Complied

Transmitter Radiated Emissions (continued)

Note: This plot is a pre-scan and for indication purposes only. For final measurements, see accompanying table.

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
G0543	Amplifier	Sonoma	310N	230801	05 Jul 2015	3
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	19 Mar 2016	12
A259	Antenna	Chase	CBL6111	1513	08 Apr 2016	12
A1834	Attenuator	Hewlett Packard	8491B	10444	05 Mar 2016	12

Transmitter Radiated Emissions (continued)**Test Summary:**

Test Engineer:	Sandeep Bharat	Test Date:	22 June 2015
Test Sample Serial Number:	ZANO1_915		

FCC Reference:	Parts 15.249(a)(d)(e) & 15.209(a)
Test Method Used:	As detailed in ANSI C63.10 Sections 6.3 and 6.6 referencing ANSI C63.4
Frequency Range	1 GHz to 10 GHz

Environmental Conditions:

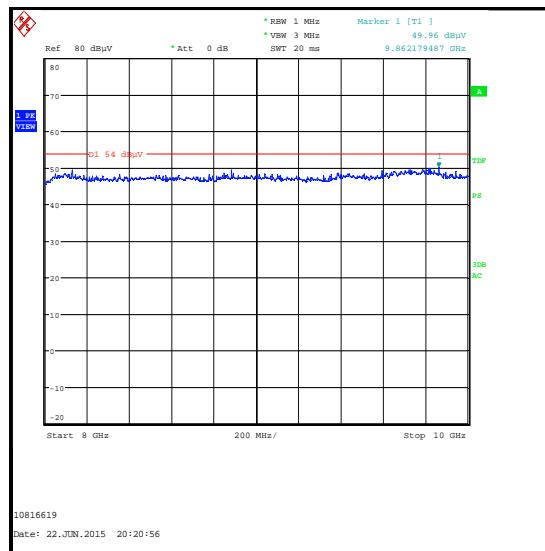
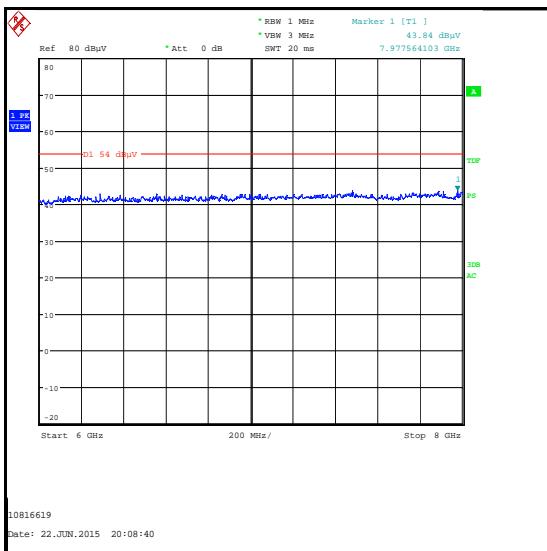
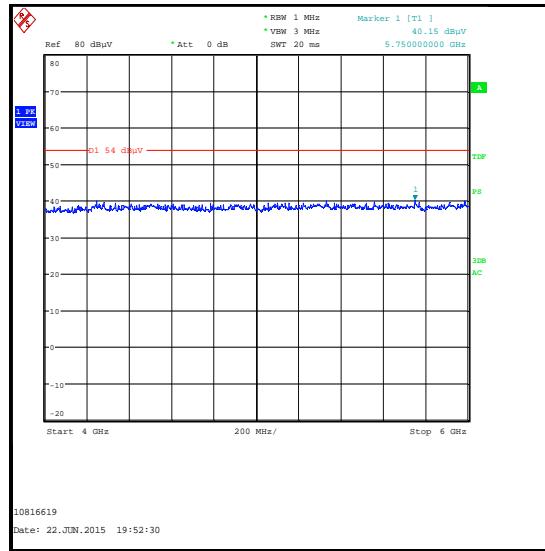
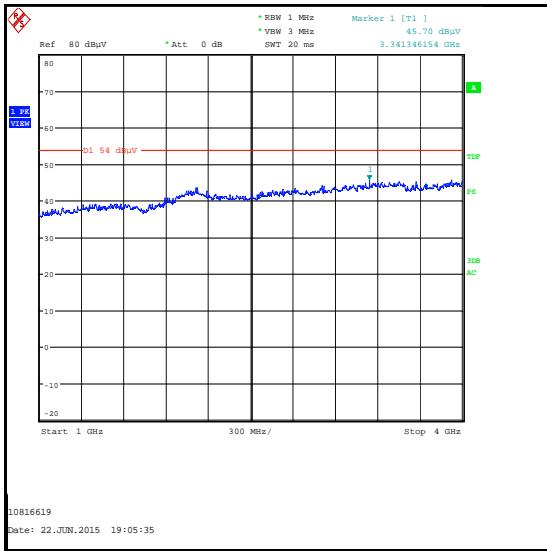
Temperature (°C):	24
Relative Humidity (%):	39

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. No spurious emissions were detected above the noise floor of the measuring receiver therefore the highest peak noise floor reading of the measuring receiver was recorded and compared to the 15.209 limit as shown in the table below.
3. 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 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.

Results:

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
9862.179	Vertical	50.0	54.0	4.0	Complied

Transmitter Radiated Emissions (continued)

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

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1656	Thermohygrometer	JM Handelpunkt	30.5015.13	None 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	10 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	12240-20	128	20 Dec 2015	12
A254	Antenna	Flann	14240-20	139	20 Dec 2015	12
A255	Antenna	Flann	16240-20	519	20 Dec 2015	12

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

Test Engineer:	Sandeep Bharat	Test Date:	22 June 2015
Test Sample Serial Number:	ZANO1_915		

FCC Reference:	Parts 15.249(d) & 15.209
Test Method Used:	As detailed in ANSI C63.10 Section 6.9.2

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	39

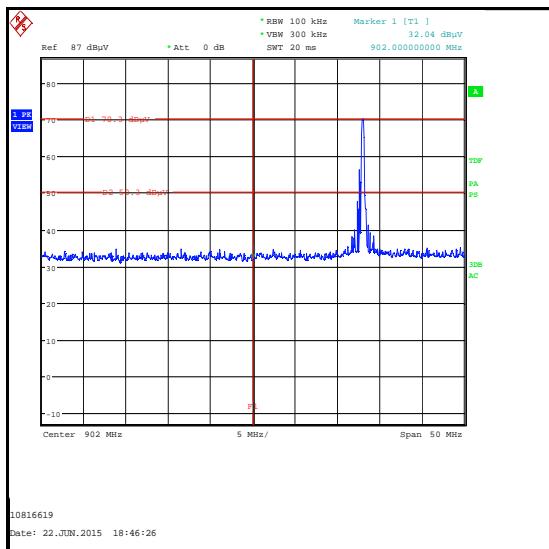
Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.

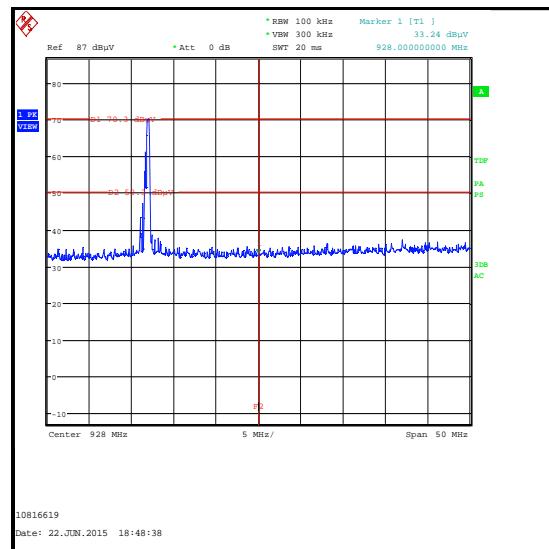
Results:

Frequency (MHz)	Antenna Polarity	Peak Level (dBμV/m)	-20 dBc Limit (dBμV/m)	Margin (dB)	Result
902	Horizontal	32.0	50.3	18.3	Complied
928	Horizontal	33.2	50.3	17.1	Complied

Transmitter Band Edge Radiated Emissions (continued)



Lower Band Edge Peak Measurement



Upper Band Edge Peak Measurement

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1656	Thermohygrometer	JM Handelpunkt	30.5015.13	None 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	10 Jun 2016	12
A288	Antenna	Chase	CBL6111A	1589	21 Aug 2015	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
Fundamental Field Strength	902 MHz to 928 MHz	95%	±5.65 dB
20 dB Bandwidth	902 MHz to 928 MHz	95%	±3.92%
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
2.0	-	-	Model name updated

---END OF REPORT---