



TEST REPORT

Test Report No. : UL-RPT-RP88980JD05A V5.0

Manufacturer : J.J MacKay Canada Limited / MacKay Meters, Inc.
Model No. : Mackay Guardian SOLO
FCC ID : ZPZ0213MGSOLO
IC Certification No. : 9753A-MGSOLO
Test Standard(s) : FCC Parts 15.209(a),15.225 & RSS-Gen 4.6.1, 4.7, 4.8, 4.9 & RSS-210 A2.6

1. This test report shall not be reproduced in full or partial, without the written approval of UL VS LTD.
2. The results in this report apply only to the sample(s) tested.
3. This 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 5.0 supersedes all previous versions

Date of Issue: 31 July 2015

Checked by:

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Issued by :

pp

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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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1. Manufacturer

Company Name:	J.J MacKay Canada Limited / MacKay Meters, Inc.
Address:	1342 Abercrombie Road New Glasgow Nova Scotia Canada B2H 5E3

2. Summary of Testing

2.1. General Information

Specification Reference:	47CFR15.225
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications) 2012: Part 15 Subpart C (Radio Frequency Devices) - Section 15.225
Specification Reference:	47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications) 2012: Part 15 Subpart C (Intentional Radiators) - Section 15.209
Specification Reference:	RSS-Gen Issue 3 December 2010
Specification Title:	General Requirements and Information for the Certification of Radio Apparatus
Specification Reference:	RSS-210 Issue 8 December 2010
Specification Title:	Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment.
Site Registration:	FCC: 209735; Industry Canada: 3245B-2
Location of Testing:	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	11 December 2012 to 19 December 2012

2.2. Summary of Test Results

FCC Reference (47CFR)	IC Reference	Measurement	Result
Part 15.225(a)(b)(c)(d)	RSS-Gen 4.8 RSS-210 A2.6	Transmitter Fundamental Field Strength	✓
Part 15.209(a)/ 15.225(d)	RSS-Gen 4.9 RSS-210 A2.6	Transmitter Radiated Emissions	✓
Part 15.209(a)/ 15.225(c)(d)	RSS-Gen 4.9 RSS-210 A2.6	Transmitter Band Edge Radiated Emissions	✓
Part 2.1049	RSS-Gen 4.6.3	Transmitter 20 dB Bandwidth	✓
N/A	RSS-Gen 4.6.1	Transmitter 99% Occupied Bandwidth	✓
Part 15.225(e)	RSS-Gen 4.7 RSS-210 A2.6	Transmitter Frequency Stability (Temperature & Voltage Variation)	✓

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:	Mackay Meters
Model Name or Number:	Mackay Guardian SOLO
Serial Number:	9000002
Hardware Version Number:	002
Software Version Number:	001
FCC ID:	ZPZ0213MGSOLO
IC Certification Number:	9753A-MGSOLO

3.2. Description of EUT

The equipment under test was a parking meter fitted with an RFID module transmitting at 127 kHz and 13.56 MHz.

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:	RFID	
Category of Equipment:	Transceiver	
Channel Spacing:	Single channel device	
Transmit Frequency Range:	13.56 MHz	
Power Supply Requirement:	Nominal	9.0 VDC
	Minimum	7.65 VDC
	Maximum	10.35 VDC
Tested Temperature Range:	Minimum	-20°C
	Maximum	50°C

3.5. Support Equipment

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

Description:	Diagnosis Card
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	Battery
Brand Name:	House of Batteries
Model Name or Number:	PN1300-L23C
Serial Number:	Not marked or stated

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 full power with a modulated carrier in test mode.

4.2. Configuration and Peripherals

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

- The test mode was enabled by inserting a Diagnosis Card into the EUT and pressing a sequence of buttons to active the transmitter. The Customer supplied instructions on how to configure the EUT for test purposes.
- A fully charged battery was fitted before the testing commenced and the voltage levels were monitored during testing.

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 Uncertainties* 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:	Andrew Edwards	Test Date:	11 December 2012
Test Sample Serial Number:	9000002		

FCC Reference:	Parts 15.225(a)(b)(c)(d)
Industry Canada Reference:	RSS-Gen 4.8 & RSS-210 A2.6
Test Method Used:	As detailed in ANSI C63.10 Section 6.4

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	28

Note(s):

1. The limit is specified at a test distance of 30 metres. However, as specified by FCC Section 15.31 (f)(2), measurements may be performed at a closer distance and the measured level corrected to the specified measurement distance by using the square of an inverse linear distance extrapolation factor (40 dB/decade).
2. A transducer factor on the measuring instrument was used to extrapolate the results at 3 metres to a distance of 30 metres. A distance extrapolation factor of 40 dB was used.

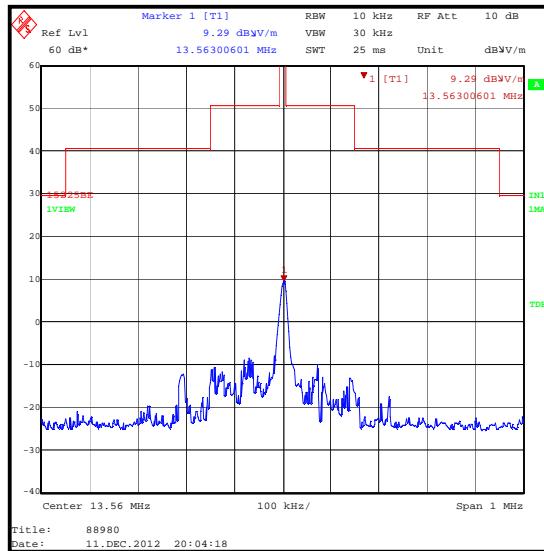
Note: An additional 20 dB has been added to attain the final value shown in the table; this is to account for a transducer factor that was not included during the original measurement.

$$i.e.: 9.4 \text{ dBuV/m} + 20 \text{ dB} = 29.4 \text{ dBuV/m}$$

Results: Quasi Peak

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit at 30 m (dB μ V/m)	Margin (dB)	Result
13.56	90° to EUT	29.4	84.0	54.6	Complied

Transmitter Fundamental Field Strength (continued)



Test Equipment Used:

UL No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	24 Oct 2013	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	03 Feb 2013	12
M1536	Magnetic Loop Antenna	Rohde & Schwarz	HFH2-Z2	879284/2	27 Jan 2013	12

5.2.2. Transmitter Radiated Spurious Emissions

Test Summary:

Test Engineers:	Andrew Edwards & Nick Steele	Test Dates:	11 December 2012 & 12 December 2012
Test Sample Serial Number:	9000002		

FCC Reference:	Parts 15.225(d) & 15.209(a)
Industry Canada Reference:	RSS-Gen 4.9 & RSS-210 A2.6
Test Method Used:	As detailed in ANSI C63.10 Sections 6.3, 6.4 and 6.5 referencing ANSI C63.4
Frequency Range:	9 kHz to 1000 MHz

Environmental Conditions:

Temperature (°C):	23 to 25
Relative Humidity (%):	27 to 28

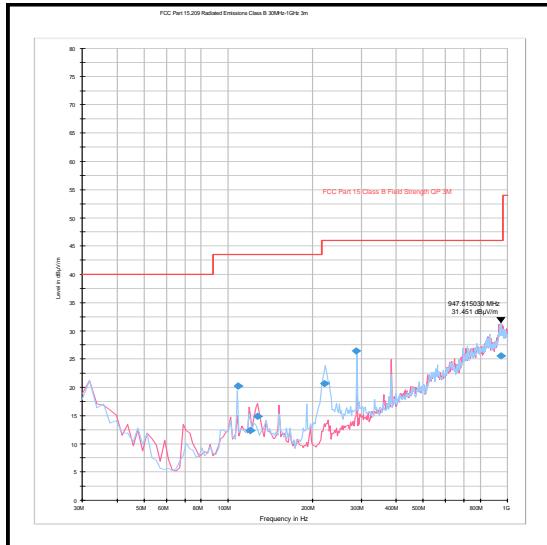
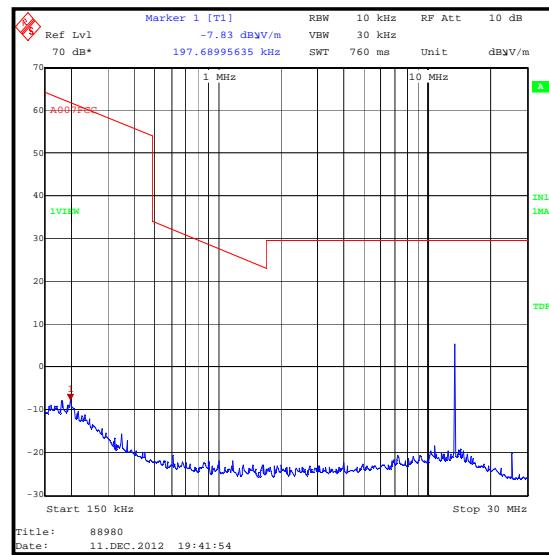
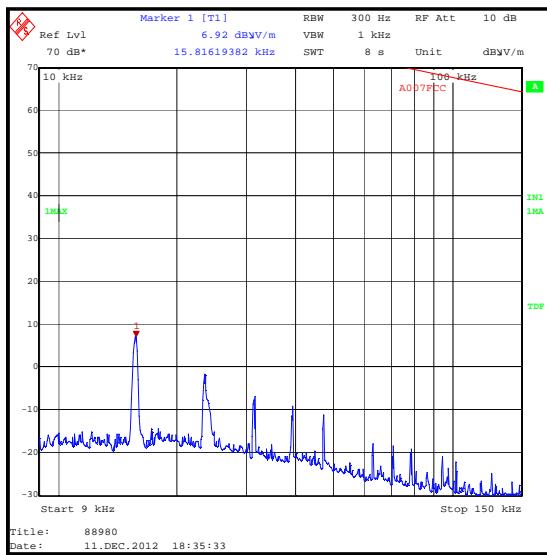
Note(s):

1. Limits below 30 MHz are specified at a test distance of 30 metres, whilst below 0.49 MHz they are specified at a test distance of 300 metres. However, as specified by FCC Section 15.31 (f)(2), measurements may be performed at a closer distance and the measured level corrected to the specified measurement distance by using the square of an inverse linear distance extrapolation factor (40dB/decade).
2. A transducer factor on the measuring instrument was used to extrapolate the results at 3 metres to a distance of 30 metres where required. A distance extrapolation factor of 40 dB was used.
3. Final measurement values include corrections for antenna factor and cable losses.
4. The emission shown at approximately 13.56 MHz is the fundamental.
5. All emissions on the 9 kHz to 150 kHz plot were investigated and found to be radiating from the test site turntable.
6. All other emissions shown on the pre-scan plots were investigated and found to be >20 dB below the applicable limit or below the measurement system noise floor.
7. Measurements in the range 30 MHz to 1 GHz were performed in a semi-anechoic chamber (UL 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: Quasi Peak

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
108.491	Horizontal	20.2	43.5	23.3	Complied

Transmitter Radiated Spurious Emissions (continued)



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

Test Equipment Used:

UL No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
A1834	Attenuator	Hewlett Packard	8491B	10444	29 Jan 2013	12
A553	Antenna	Chase	CBL6111A	1593	15 Feb 2013	12
G0543	Amplifier	Sonoma	310N	230801	02 Jan 2013	3
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	24 Oct 2013	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	03 Feb 2013	12
M1536	Magnetic Loop Antenna	Rohde & Schwarz	HFH2-Z2	879284/2	27 Jan 2013	12

5.2.3. Transmitter Band Edge Radiated Emissions

Test Summary:

Test Engineer:	Andrew Edwards	Test Date:	11 December 2012
Test Sample Serial Number:	9000002		

FCC Reference:	Parts 15.225(d) & 15.209(a)
Industry Canada Reference:	RSS-Gen 4.9 & RSS-210 A2.6
Test Method Used:	As detailed in ANSI C63.10 Section 6.9.2

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	38

Note(s):

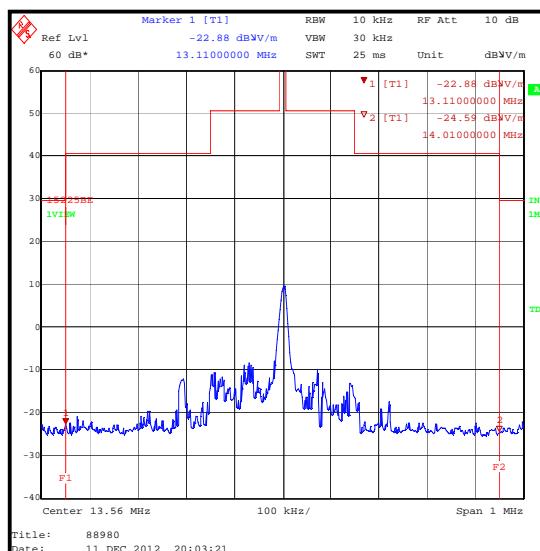
1. A transducer factor on the measuring instrument was used to extrapolate the results at 3 metres to a distance of 30 metres where required. A distance extrapolation factor of 40 dB was used.
2. The band edge emission plot shown below is low by a factor of 20 dB, due to the absence of a transducer factor at the time of measurement. An additional 20 dB was subsequently added to any band edge measurements, for comparisons with the limit, when determining compliance.

Results: Quasi Peak Lower Band Edge

Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
13.11	-11.4	29.5	40.9	Complied

Results: Quasi Peak Upper Band Edge

Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
14.01	-12.2	29.5	41.7	Complied



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

UL No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	24 Oct 2013	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	03 Feb 2013	12
M1536	Magnetic Loop Antenna	Rohde & Schwarz	HFH2-Z2	879284/2	27 Jan 2013	12

5.2.4. Transmitter 20 dB Bandwidth

Test Summary:

Test Engineer:	Sarah Williams	Test Date:	19 December 2012
Test Sample Serial Number:	9000002		

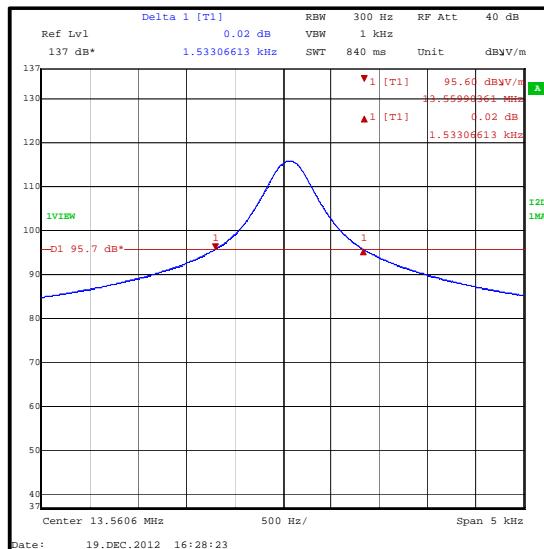
FCC Reference:	Part 2.1049
Industry Canada Reference:	RSS-Gen 4.6.3
Test Method Used:	As detailed in ANSI C63.10 Section 6.9.1

Environmental Conditions:

Temperature (°C):	27
Relative Humidity (%):	30

Results:

20 dB Bandwidth (kHz)	
	1.533



Test Equipment Used:

UL No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1379	Test Receiver	Rohde & Schwarz	ESIB 7	100330	15 Oct 2013	12
M1536	Magnetic Loop Antenna	Rohde & Schwarz	HFH2-Z2	879284/2	27 Jan 2013	12

5.2.5. Transmitter 99% Occupied Bandwidth

Test Summary:

Test Engineer:	Sarah Williams	Test Date:	19 December 2012
Test Sample Serial Number:	9000002		

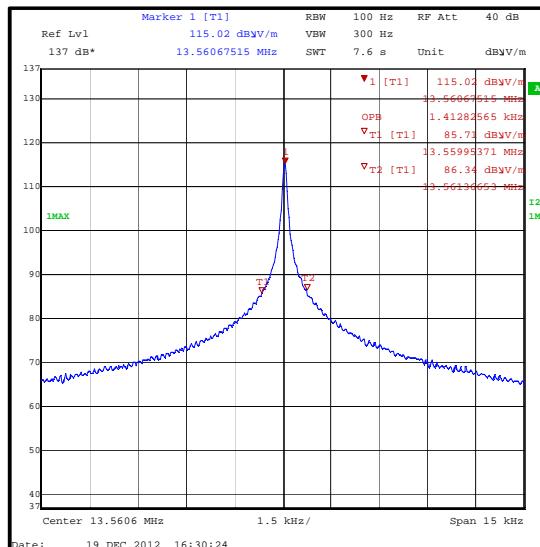
FCC Reference:	N/A
Industry Canada Reference:	RSS-Gen 4.6.1
Test Method Used:	Test receiver 99% occupied bandwidth function

Environmental Conditions:

Temperature (°C):	27
Relative Humidity (%):	30

Results:

99% Emission Bandwidth (kHz)	
	1.413



Test Equipment Used:

UL No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1379	Test Receiver	Rohde & Schwarz	ESIB 7	100330	15 Oct 2013	12
M1536	Magnetic Loop Antenna	Rohde & Schwarz	HFH2-Z2	879284/2	27 Jan 2013	12

5.2.6. Transmitter Frequency Stability (Temperature & Voltage Variation)**Test Summary:**

Test Engineer:	Andrew Edwards	Test Date:	12 December 2012
Test Sample Serial Number:	9000002		

FCC Reference:	Part 15.225(e)
Industry Canada Reference:	RSS-Gen 4.7 & RSS-210 A2.6
Test Method Used:	As detailed in ANSI C63.10 Section 6.8.1 and 6.8.2

Environmental Conditions:

Temperature (°C):	25
Relative Humidity (%):	26

Results: Maximum frequency error of the EUT with variations in ambient temperature

Temperature (°C)	Time after Start-up			
	0 minutes	2 minutes	5 minutes	10 minutes
-20	13.560574 MHz	13.560608 MHz	13.560612 MHz	13.560611 MHz
20	13.560645 MHz	13.560642 MHz	13.560641 MHz	13.560641 MHz
50	13.560702 MHz	13.560703 MHz	13.560704 MHz	13.560704 MHz

Frequency with Worst Case Deviation (MHz)	Frequency Error (Hz)	Frequency Error (%)	Limit (%)	Margin (%)	Result
13.560704	704	0.0052	0.01	0.0048	Complied

Results: Maximum frequency error of the EUT with variations in nominal operating voltage at an ambient temperature of 20°C

Supply Voltage (V)	Nominal Frequency (MHz)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (%)	Limit (%)	Margin (%)	Result
7.65	13.56	13.560643	643	0.0047	0.01	0.0053	Complied
9.0	13.56	13.560645	645	0.0048	0.01	0.0052	Complied
10.35	13.56	13.560642	642	0.0047	0.01	0.0053	Complied

Transmitter Frequency Stability (Temperature & Voltage Variation) (continued)**Test Equipment Used:**

UL No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
E013	Environmental Chamber	Sanyo	MTH-4200PR	None	Calibrated before use	-
M1269	Multimeter	Fluke	179	90250210	30 Jul 2013	12
M1630	Test Receiver	Rohde & Schwarz	ESU 40	100233	06 Feb 2013	12
M1642	Thermometer	Fluke	52II	18890119	21 Feb 2013	12
S021	Dual DC power supply	Thurlby Thandar Instruments	CPX200	061034	Calibrated before use	-

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 measured (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
20 dB Bandwidth	13 MHz to 14 MHz	95%	±0.92 ppm
99% Occupied Bandwidth	13 MHz to 14 MHz	95%	±0.92 ppm
Frequency Stability	13 MHz to 14 MHz	95%	±0.92 ppm
Radiated Spurious Emissions	9 kHz to 30 MHz	95%	±3.53 dB
Radiated Spurious Emissions	30 MHz to 1000 MHz	95%	±2.94 dB
Transmitter Fundamental Field Strength	13 MHz to 14 MHz	95%	±3.53 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	-	-	Update to Manufacturers name
3.0	-	-	FCC ID updated
4.0	-	-	Update of model name and address of location of testing
5.0	11 & 15	-	Corrected previously reported emissions levels by +20 dB

--- END OF REPORT ---