TEST REPORT
FROM
RFI GLOBAL SERVICES LTD

Partial Test of: Lojack Vehicle Location Unit

To: FCC Part 90: 2009 Subpart B

Test Report Serial No:
RFI-RPT-RP78050JD05A

Version 3.0 Supersedes All Previous Versions

This Test Report Is Issued Under The Authority Of Scott D'Adamo, Operations Manager Global Approvals:	
Checked By:	Ian Watch
Signature:	
Date of Issue:	22 September 2010

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1. Customer Information

Company Name:	Plextek Ltd on behalf of Lojack Corporation
Address:	London Road Great Chesterford Essex CB10 1NY United Kingdom

2. Summary of Testing

2.1. General Information

Specification Reference:	47CFR90
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications) 2009: Part 90: Public Safety Radio Pool
Site Registration:	FCC: 209735
Location of Testing:	RFI Global Services Ltd, Wade Road, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	23 July 2010 to 10 August 2010

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Port Type	Result
Part 15.109	Receiver Mode Radiated Spurious Emissions	Enclosure	✓
Part 90.209 / 90.20(e)(6) / 2.1049	Transmitter Occupied Bandwidth (Bandwidth Limitations)	Antenna	✓
Part 90.210	Transmitter Radiated Emissions Masks	Antenna	✓
Part 90.210	Transmitter Radiated Emissions (Out of Band)	Antenna	✓
Part 90.213 / 2.1055	Transmitter Frequency Stability (Temperature & Voltage Variation)	Antenna	✓
Part 90.214	Transmitter Transient Frequency Behaviour	Antenna	✓
Part 90.20(e)(6)	Transmitter Duty Cycle	Antenna	✓

Key to Results

✓ = Complied ✗ = Did not comply

2.3. Methods and Procedures

Reference:	ANSI/TIA-603-C-2004
Title:	Land Mobile FM or PM - Measurement and Performance Standards
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.

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)

Description:	Vehicle Location Unit
Brand Name:	Lojack
Model Name or Number:	VLU5 W US 4600-1101-01
Serial Number:	01320878706602 (without modulation) 01470925900470 (with modulation)
Hardware Version Number:	Revision 1.3.0
Software Version Number:	1.0.3
FCC ID Number:	IDIVLU-05

3.2. Description of EUT

The equipment under test was a vehicle location unit.

3.3. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.4. Additional Information Related to Testing

Category of Equipment:	Private Mobile Radio (PMR)	
Type of Equipment	Transceiver	
Intended Operating Environment:	Vehicle	
Highest Internally Generated Clock or Oscillator Frequency:	173.075 MHz	
Modulation Type:	FM MSK	
Channel Spacing:	25 kHz	
Antenna Type:	External captive wire type	
Antenna Gain:	-6 dBi but dependant on the vehicle installation	
Power Supply Requirement:	Nominal	12.0 V
	Minimum	10.2 V
	Maximum	13.8 V
Tested Temperature Range:	Minimum	-30°C
	Maximum	50°C
Transmit Frequency Range:	Single Channel 173.075 MHz	
Receive Frequency Range:	Single Channel 173.075 MHz	
Occupied Bandwidth:	11.663 kHz	

3.5. Support Equipment

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

Description:	RF Signal Generator (not directly connected to EUT)
Brand Name:	Marconi Instruments
Model Name or Number:	2022C
Serial Number:	811125/004
Cable Length and Type:	Not Applicable
Connected to Port:	Not Applicable

Description:	“Bleep Box” Diecast box unit for custom carrier modulation (not directly connected to EUT)
Brand Name:	Plextek
Model Name or Number:	Not Applicable
Serial Number:	Not Applicable
Cable Length and Type:	1m Coax, 1m serial communication 12V power and ground
Connected to Port:	Laptop / Signal Generator

Description:	VHF receiver to check 1 second transmission rate of VLU5 unit in “track mode”
Brand Name:	Yaesu
Model Name or Number:	FRG 9600
Serial Number:	021582
Cable Length and Type:	Not Applicable
Connected to Port:	Not Applicable

Description:	Laptop PC (not directly connected to EUT)
Brand Name:	HP Compaq nx7010
Model Name or Number:	Compaq nx7010
Serial Number:	CND445017B
Cable Length and Type:	Not Applicable
Connected to Port:	Not Applicable

Description:	DC Power Suppply
Brand Name:	Thurlby Thundar Instruments
Model Name or Number:	PL320MQD
Serial Number:	135105
Cable Length and Type:	Not Applicable
Connected to Port:	Not Applicable

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

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

- Tracking Mode – The EUT transmits a 200 ms burst every second
- Receive Mode – The EUT is in constant receive mode
- Activate Mode – The EUT transmits a 200 ms burst every 15 seconds

4.2. Configuration and Peripherals

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

- The EUT was tested standalone and connected to a DC Power supply with antenna mounted vertically
- The EUT antenna was expanded to full length and attached to a non-metallic support for the duration of the test
- The EUT was programmed remotely (wireless), using command from the support computer, modulation box and signal generator.

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.

5.2. Test Results

5.2.1. Receiver Mode Radiated Spurious Emissions

Test Summary:

Test Engineer:	Fara Razally	**Test Date:**	23 July 2010
Test Sample Serial No:	01320878706602		

FCC Part:	FCC 15.109
Test Method:	As detailed in ANSI C63.4 Section 8 and relevant annexes
Frequency Range:	30 MHz to 1000 MHz

Environmental Conditions:

Temperature (°C):	27
Relative Humidity (%):	31

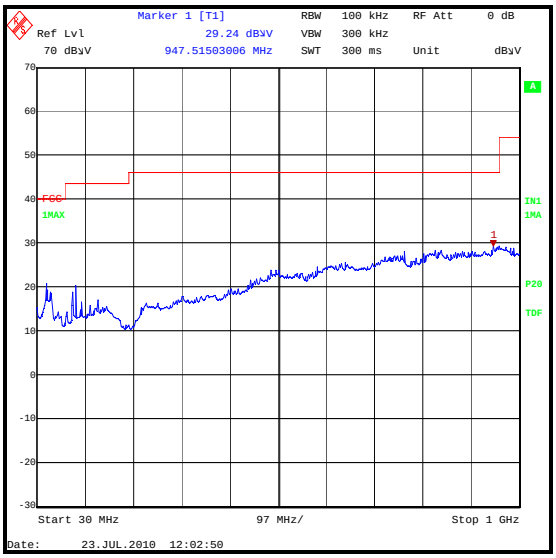
Results:

Frequency (MHz)	Antenna Polarity	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
947.515	Horizontal	29.2	46.0	16.8	Complied

Note(s):

1. All emissions were investigated and found to be at least 20 dB below the specified limit; therefore the highest emission level was recorded as shown in the table above.

Receiver Mode Radiated Spurious Emissions



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

5.2.2. Transmitter Occupied Bandwidth (Bandwidth Limitations)

Test Summary:

Test Engineer:	Andrew Edwards	**Test Date:**	2 August 2010
Test Sample Serial No:	01470925900470		

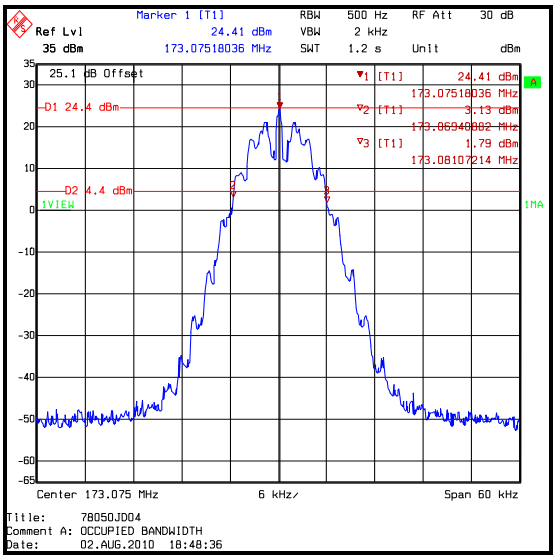
FCC Part:	90.209(b)(5) / 90.20(e)(6)(iii) / 2.1049
Test Method:	C63.4 Section 13.7

Environmental Conditions:

Temperature (°C):	29
Relative Humidity (%):	28

Results:

Frequency (MHz)	Occupied Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
173.075	11.663	20.0	8.337	Complied



5.2.3. Transmitter Radiated Emissions Mask

Test Summary:

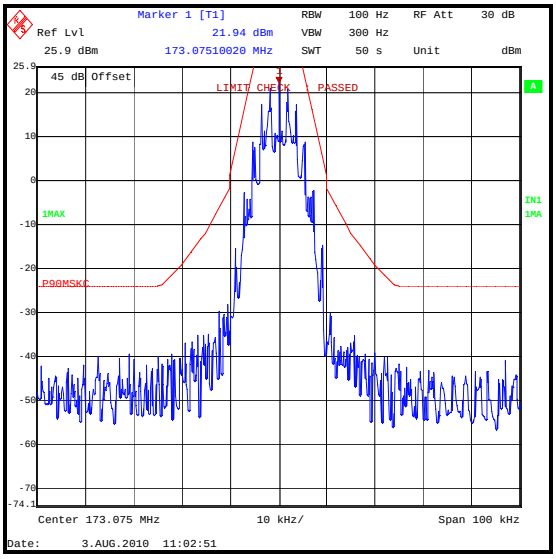
Test Engineer:	Fara Razally	**Test Date:**	3 August 2010
Test Sample Serial No:	01470925900470		

FCC Part:	90.210(c)
Test Method:	TIA-603-C Section 2.2.12

Environmental Conditions:

Temperature (°C):	26
Relative Humidity (%):	31

Results:



Note(s):

1. A reduced measurement bandwidth of approximately 1% of the occupied bandwidth was used to perform the measurement.
2. The top of the mask was referenced to the previously measured ERP of 25.9 dBm.

5.2.4. Transmitter Radiated Emissions (Out of Band)

Test Summary:

Test Engineer:	Fara Razally	**Test Date:**	23 July 2010
Test Sample Serial No:	01320878706602		

FCC Part:	90.210(c)(3)
Test Method:	TIA-603-C Section 2.2.12

Environmental Conditions:

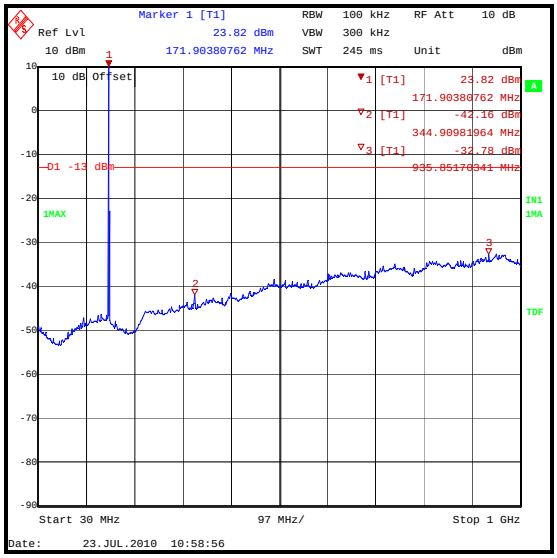
Temperature (°C):	26
Relative Humidity (%):	30

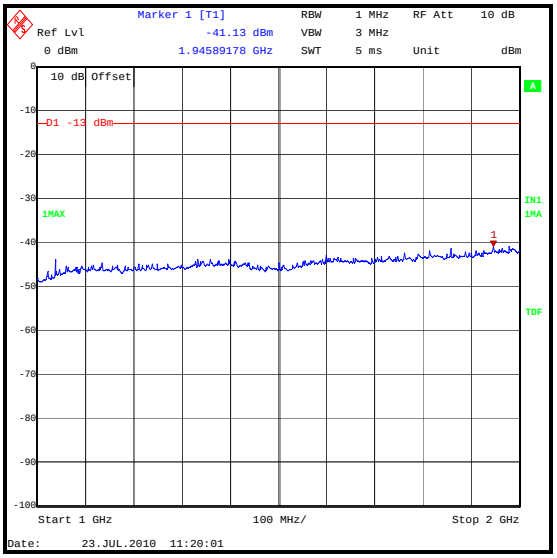
Results:

Frequency (MHz)	Peak Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
935.852	-32.8	-13.0	19.8	Complied

Note(s):

1. The carrier is shown at approximately 171 MHz on the 30 MHz to 1 GHz plot.
2. All emissions were investigated and found to be at least 20 dB below the specified limit; therefore the highest emission level was recorded as shown in the table above.





5.2.5. Transmitter Frequency Stability (Temperature Variation)

Test Summary:

Test Engineer:	Grant Mason	**Test Date:**	2 August 2010
Test Sample Serial No:	01320878706602		

FCC Part:	90.213/2.1055(a)(1)
Test Method:	TIA-603-C Section 2.2.2

Environmental Conditions:

Ambient Temperature (°C):	30
Ambient Relative Humidity (%):	26

Results: Single Channel (173.075 MHz)

Temperature (°C)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (ppm)	Limit (ppm)	Margin (ppm)	Result
-30	173.075146	146	0.84	±5.0	4.16	Complied
-20	173.075190	190	1.10	±5.0	3.90	Complied
-10	173.075216	216	1.25	±5.0	3.75	Complied
0	173.075143	143	0.83	±5.0	4.17	Complied
10	173.075042	42	0.24	±5.0	4.76	Complied
20	173.075037	37	0.21	±5.0	4.79	Complied
30	173.075079	79	0.46	±5.0	4.54	Complied
40	173.075093	93	0.54	±5.0	4.46	Complied
50	173.075106	106	0.61	±5.0	4.39	Complied

5.2.6. Transmitter Frequency Stability (Voltage Variation)

Test Summary:

Test Engineer:	Grant Mason	**Test Date:**	2 August 2010
Test Sample Serial No:	01320878706602		

FCC Part:	90.213/2.1055(d)(1)
Test Method:	TIA-603-C Section 2.2.2

Environmental Conditions:

Temperature (°C):	20
Relative Humidity (%):	69

Results: Single Channel (173.075 MHz)

Supply Voltage (V)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (ppm)	Limit (ppm)	Margin (ppm)	Result
10.2	173.075076	76	0.44	±5.0	4.56	Complied
12.0	173.075037	37	0.21	±5.0	4.79	Complied
13.8	173.075076	76	0.44	±5.0	4.56	Complied

5.2.7. Transmitter Transient Frequency Behaviour

Test Summary:

Test Engineer:	Fara Razally	**Test Date:**	5 August 2010
Test Sample Serial No:	01320878706602		

FCC Part:	90.214
Test Method:	TIA-603-C Section 2.2.19

Environmental Conditions:

Temperature (°C):	27
Relative Humidity (%):	29

Results:

Time Intervals	**FREQUENCY DIFFERENCE (kHz)**
	Single Channel
t1	17.083
t2	2.083
t3	4.167

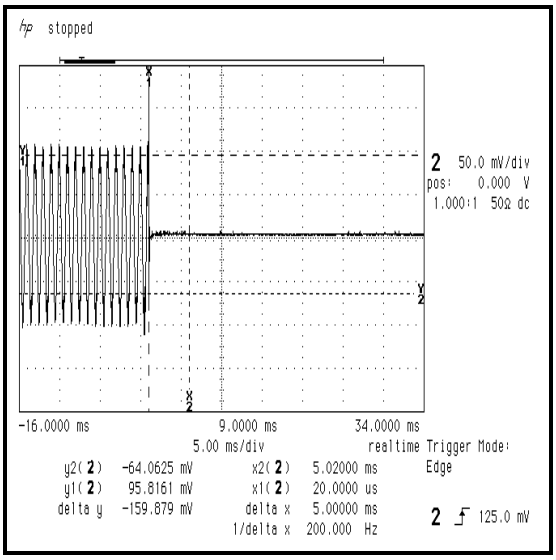
Limits:

Time Intervals	**Maximum frequency difference**	**Frequency Range**
		150 to 174 MHz
t1	+/- 25.0 kHz	<5.0 mS
t2	+/- 12.5 kHz	<20.0 mS
t3	+/- 25.0 kHz	<5.0 mS

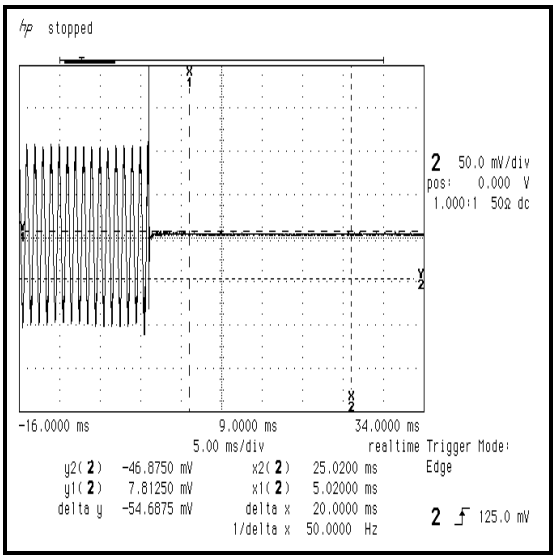
Note(s):

During the period from the end of t2 to the beginning of t3, the frequency difference did not exceed 5 ppm (865 Hz) of the carrier frequency.

Transmitter Transient Frequency Behaviour (continued)

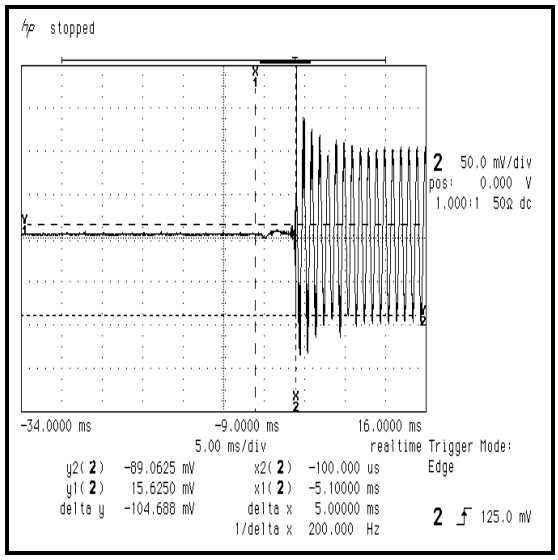


t1



t2

Transmitter Transient Frequency Behaviour (continued)



t3

5.2.8. Transmitter Duty Cycle

Test Summary:

Test Engineer:	Fara Razally	**Test Dates:**	2 August 2010 and 10 August 2010
Test Sample Serial No:	01320878706602		

FCC Part:	90.20(e)(6)(v)

Environmental Conditions:

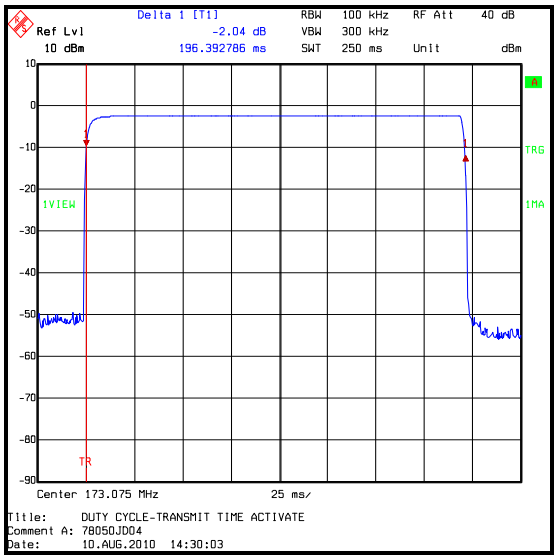
Temperature (°C):	29
Relative Humidity (%):	28

Results:

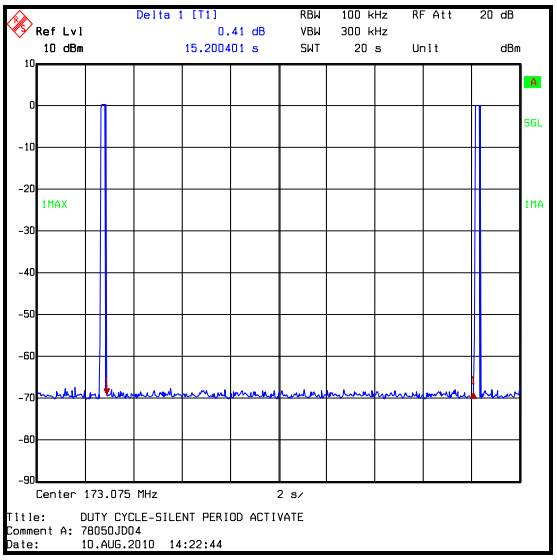
Operating Mode	Transmit Duration Time (milliseconds)	Limit (milliseconds)
Activate	196.393	≤ 400
Tracking	195.391	≤ 400

Operating Mode	Silent Period (seconds)	Limit (seconds)
Activate	15.200	≥ 9.6
Tracking	0.984	≥ 0.6

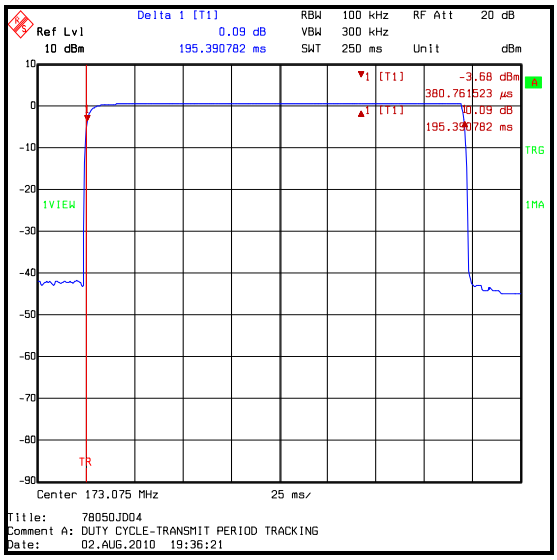
Transmitter Duty Cycle (continued)



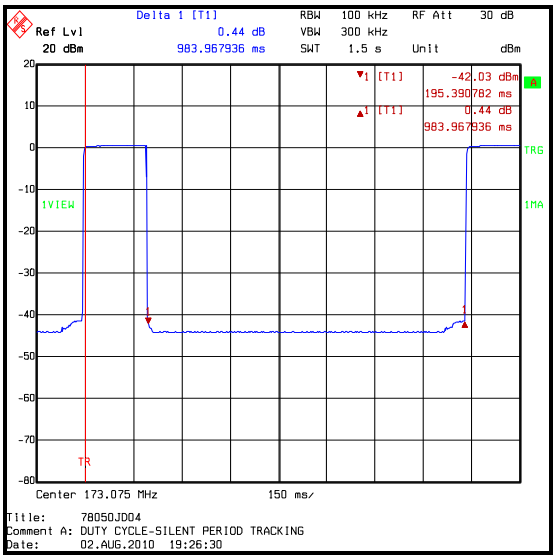
Activate Mode / Transmitter on period



Activate Mode / Silent period



Tracking Mode / Transmitter on period



Tracking Mode / Silent period

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 1000 MHz	95%	±5.26 dB
Radiated Spurious Emissions	1 GHz to 40 GHz	95%	±2.94 dB
Occupied Bandwidth	Not applicable	95%	+/- 24.3 Hz
Frequency Stability	Not applicable	95%	+/- 24.3 Hz
Transient Frequency Behaviour	Not applicable	95%	+/- 0.32% (Amplitude) +/- 3.53nS (Time)
Duty Cycle	Not applicable	95%	+/- 0.29 mS

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.

Appendix 1. Test Equipment Used

RFI No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
A1396	Attenuator	Huber & Suhner	757987	6810.17.B	Calibrated before use	-
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	Calibrated before use	-
A1818	Antenna	EMCO	3115	00075692	27 Nov 2010	12
A228	Power Divider	Suhner Electronics	4901/01/A	none	Calibrated before use	-
A288	Antenna	Chase	CBL6111 A	1589	16 Mar 2011	12
A296	Attenuator	Narda	766-20	167	Calibrated before use	-
E013	Environmental Chamber	Sanyo	ATMOS	None	Calibration not required	-
G013	Signal Generator	Rohde & Schwarz	SMHU	894 055/003	13 May 2011	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	01 Sep 2010	12
M015	Communications Analyser	Rohde & Schwarz	CMTA	883 574/003	28 April 2011	12
M093	Oscilloscope	Hewlett Packard	54520A	US34360744	Calibrated before use	-
M1124	Spectrum Analyser	Rohde & Schwarz	ESI26	100046K	22 Apr 2011	12
M1229	Digital Multimeter	Fluke	179	87640015	15 Jul 2011	12
M1242	Spectrum Analyser	Rohde & Schwarz	FSEM30	845986/022	08 Mar 2011	12
M1273	Test Receiver	Rhode & Schwarz	ESIB 26	100275	08 Apr 2011	12

NB In accordance with UKAS requirements all the measurement equipment is on a calibration schedule.