TRaC Global Radio Test Report

FOR

Invisible Systems Ltd

ON

ISL024DB1

DOCUMENT NO. TRA-006915WUS3

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TRaC Wireless Test Report	**:** TRA-006915WUS3
Applicant	**:** Invisible Systems Ltd
Apparatus	**:** ISL024DB1
Specification(s)	**:** CFR47 Part 15 C July 2008 – 15.249
FCCID	**: ZWZISL024DB1**
Purpose of Test	**:** Certification
Authorised by	**:**
	: J Charters, Radio Product Manager
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Section 1: Introduction

1.1 General

This report contains an assessment of an apparatus against Electromagnetic Compatibility Standards based upon tests carried out on samples submitted to the Laboratory.

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1.2 Tests Requested By

This testing in this report was requested by:

Invisible Systems Ltd
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1.3 Manufacturer

As above.

1.4 Apparatus Assessed

The following apparatus was assessed between 17/08/11 and 22/08/11:

ISL024DB1

The ISL024DB1 is a battery powered single channel 925.78MHz radio transceiver with analogue, temperature, pulse and humidity inputs.

1.5 Test Result Summary

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

The statements relating to compliance with the standards below apply ONLY as qualified in the notes and deviations stated in sections 1.6 to 1.7 of this test report.

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

Test Type	Regulation	Measurement standard	Result
Spurious Emissions Radiated <1000MHz	Title 47 of the CFR: Part 15 Subpart (c) 15.209	ANSI C63.10	Pass
Spurious Emissions Radiated >1000MHz	Title 47 of the CFR: Part 15 Subpart (c) 15.209 Part 15 Subpart (c) 15.249 (a),(e)	ANSI C63.10	Pass
Intentional Emission Frequency	Title 47 of the CFR: Part 15 Subpart (c) 15.249 (a)	ANSI C63.10	Pass
Intentional Emission Field Strength	Title 47 of the CFR: Part 15 Subpart (c) 15.249 (a)	ANSI C63.10	Pass
Intentional Emission Band Occupancy	Title 47 of the CFR: Part 15 Subpart (c) 15.215	ANSI C63.10	Pass
Unintentional Radiated Spurious Emissions	Title 47 of the CFR: Part 15 Subpart (b) 15.109	ANSI C63.10	Pass
Antenna Arrangements Integral:	Title 47 of the CFR: Part 15 Subpart (c) 15.203	-	Pass
Antenna Arrangements External Connector	Title 47 of the CFR: Part 15 Subpart (c) 15.204	-	N/A
Restricted Bands	Title 47 of the CFR: Part 15 Subpart (c) 15.205	-	-
Maximum Frequency of Search	Title 47 of the CFR: Part 15 Subpart (c) 15.33	-	-
Extrapolation Factor	Title 47 of the CFR: Part 15 Subpart (c) 15.31(f)	-	-

Abbreviations used in the above table:

ANSI C 63.10:2009 is outside the scope of the laboratories UKAS accreditation.

Mod : Modification
CFR : Code of Federal Regulations
REFE : Radiated Electric Field Emissions
ANSI : American National Standards Institution
PLCE : Power Line Conducted Emissions

1.6 Notes Relating To The Assessment

With regard to this assessment, the following points should be noted:

The results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 1.7 of this test report (Deviations from Test Standards).

For emissions testing, throughout this test report, “Pass” indicates that the results for the sample as tested were below the specified limit (refer also to Section 2, Measurement Uncertainty).

Where relevant, the apparatus was only assessed using the monitoring methods and susceptibility criteria defined in this report.

All testing was performed under the following environmental conditions:

Temperature	: 17 to 23 °C
Humidity	: 45 to 75 %
Barometric Pressure	: 86 to 106 kPa

All dates used in this report are in the format dd/mm/yy.

This assessment has been performed in accordance with the requirements of ISO/IEC 17025.

1.7 Deviations from Test Standards

There were no deviations from the standards tested to.

Section 2: Measurement Uncertainty

2.1 Application of Measurement Uncertainty

The following table contains the measurement uncertainties for measurements

The following procedure is used when determining the result of a measurement:

(i) If specification limits are not exceeded by the measured result, extended by the positive component of the expanded uncertainty interval at a confidence level of 95%, then a pass result is recorded.

(ii) Where a specification limit is exceeded by the result even when the result is decreased by the negative component of the expanded uncertainty interval, a fail result is recorded.

(iii) Where a measured result is below a limit, but by a margin less than the positive measurement uncertainty component, it is not possible to record a pass based on a 95% confidence level. However, the result indicates that a pass result is more probable than a fail result.

(iv) Where a measured result is above a limit, but by a margin less than the negative measurement uncertainty component, it is not possible to record a fail based on a 95% confidence level. However the result indicates that a fail is more probable than a pass.

2.2 Measurement Uncertainty Values

For the test data recorded in accordance with note (iii) of Section 2.1 the following measurement uncertainty was calculated:

Radio Testing – General Uncertainty Schedule

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95% confidence where no required test level exists.

[1] Adjacent Channel Power

Uncertainty in test result = **1.86dB**

[2] Carrier Power

Uncertainty in test result = **0.9 dB**

[3] Effective Radiated Power

Uncertainty in test result = **4.1 dB**

[4] Spurious Emissions

Uncertainty in test result = **4.1dB**

[5] Maximum frequency error

Uncertainty in test result = **3.6 kHz**

[6] Frequency deviation

Uncertainty in test result = **3.6 kHz**

[7] Magnetic Field Emissions

Uncertainty in test result = **2.1 dB**

[8] Conducted Spurious

Uncertainty in test result = **0.9 dB**

[9] Channel Bandwidth

Uncertainty in test result = **3.6 kHz**

[10] Power Line Conduction

Uncertainty in test result = **3.5 dB**

[11] Spectrum Mask Measurements

Uncertainty in test result = **3.6 kHz (frequency)**
Uncertainty in test result = **0.9 dB (amplitude)**

[12] Transmission Time Measurement

Uncertainty in test result = **5.8% ± 10ns**

Section 3: Modifications

3.1 Modifications Performed During Assessment

No modifications were performed during the assessment

Appendix A: Formal Emission Test Results

Abbreviations used in the tables in this appendix:

Spec	: Specification
Mod	: Modification
EUT	: Equipment Under Test
SE	: Support Equipment
L	: Live Power Line
N	: Neutral Power Line
E	: Earth Power Line
Pk	: Peak Detector
QP	: Quasi-Peak Detector
Av	: Average Detector
CDN	: Coupling & decoupling network

ALSR	: Absorber Lined Screened Room
OATS	: Open Area Test Site
ATS	: Alternative Test Site
Ref	: Reference
Freq	: Frequency
MD	: Measurement Distance
SD	: Spec Distance
Pol	: Polarisation
H	: Horizontal Polarisation
V	: Vertical Polarisation

A1 Transmitter Intentional Emission Radiated

Test Details: Battery Powered	
Regulation	Title 47 of the CFR: Part15 Subpart (c) 15.249(a)
Measurement standard	ANSI C63.10:2003
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photographs 1 and 2

FREQ. (MHz)	MEASUREMENT Rx. READING (dBµV)	CABLE LOSS (dB)	ANT FACTOR (dB/m)	PRE AMP (dB)	FIELD STRENGTH (dBµV/m)	FIELD STRENGTH (mV/m)
925.788	67.5	3.1	22.5	0.0	93.1	45.1
Limit value @ fc			**50 mV/m**			
Band occupancy @ -20 dBc			f lower		f higher	
			925.72325MHz		925.83175MHz	
			108.5kHz			

Notes:

Radiated Measurement:

Notes:
1 Results quoted are extrapolated as indicated
2 Receiver detector @ fc = Quasi Peak 120kHz bandwidth.
3 When battery powered the EUT was powered with new batteries

Test Method:
1 As per Radio – Noise Emissions, ANSI C63.10
2 Measuring distances 3m
3 EUT 0.8 metre above ground plane
4 Emissions maximised by rotation of EUT, on an automatic turntable.
Raising and lowering the receiver antenna between 1m & 4m.
Horizontal and vertical polarisations, of the receive antenna.
EUT orientation in three orthogonal planes.
Maximum results recorded

A2 Radiated Electric Field Emissions

Preliminary scans were performed using a peak detector with the RBW = 100 kHz. The radiated electric filed emission test applies to all spurious emissions and harmonics emissions. The maximum permitted field strength is listed in Section 15.209. The EUT was set to transmit as required.

The following test site was used for final measurements as specified by the standard tested to:

3m alternative test site : [X]

The effect of the EUT set-up on the measurements is summarised in note (c) below.

Test Details: Battery Powered	
Regulation	Title 47 of the CFR, Part 15 Subpart (c) Clause 15.209
Measurement standard	ANSI C63.10:2003
Frequency range	30MHz – 10GHz
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photographs 1 and 2

The worst case radiated emission measurements for spurious emissions and harmonics that fall within the restricted bands are listed below:

Ref No.	FREQ. (MHz)	Det.	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (dBµV/m)	LIMIT (dBµV/m)	Margin (dB)
1	902.000	Pk	29.3	3.5	22.3	30.3	24.8	0.0	24.8	73.1	-48.3
2	902.000	QP	22.1	3.5	22.3	30.3	17.6	0.0	17.6	53.1	-35.5
3	928.000	Pk	31.0	3.5	22.6	30.1	27.0	0.0	27.0	73.1	-46.1
4	928.000	QP	24.6	3.5	22.6	30.1	20.6	0.0	20.6	53.1	-32.5
5	1851.555	Pk	49.9	4.2	27.4	35.3	46.2	0.0	46.2	74.0	-27.8
6	1851.555	AV	48.0	4.2	27.4	35.3	44.3	0.0	44.3	54.0	-9.7

Notes:

1 Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.10: section 4.5, Table 1
2 In accordance with 15.35(b), above 1 GHz, emissions measured using a peak detector shall not exceed a level 20 dB above the average limit.
3 Measurements at 902 & 928 MHz were made to ensure band edge compliance.
4 Testing was performed with the EUT orientated in three orthogonal planes and the maximum emissions level recorded. In addition, the EUT antenna was varied within its range of motion in order to maximise emissions.
5 For Frequencies below 1 GHz, RBW= 100 kHz, testing was performed with CISPR16 compliant test receiver with QP detector. Above 1 GHz tests were performed using a spectrum analyser using the following settings:

Peak RBW=VBW= 1MHz
Average RBW= 1MHz, VBW= 30Hz

These settings as per ANSI C63.10

The upper and lower frequency of the measurement range was decided according to CFR 47 Part 15:2008 Clause 15.33(a) and 15.33(a)(1).

Radiated emission limits (CFR 47 Part 15: Clause 15.209) for emissions falling within the restricted bands defined in 15.205(a):

Frequency of emission (MHz)	Field strength μV/m	Measurement Distance m	Field strength dBμV/m
0.009-0.490	2400/F(kHz)	300	67.6/F (kHz)
0.490-1.705	24000/F(kHz)	30	87.6/F (kHz)
1.705-30	30	30	29.5
30-88	100	3	40.0
88-216	150	3	43.5
216-960	200	3	46.0
Above 960	500	3	54.0

Notes:

(a) Where results have been measured at one distance, and a signal level displayed at another, the results have been extrapolated using the following formula:

$$\text{Extrapolation}\,(\text{dB}) = 20\log_{10}\left(\frac{\text{measurement distance}}{\text{specification distance}}\right)$$

The results displayed take into account applicable antenna factors and cable losses.

(b) The levels may have been rounded for display purposes.

(c) The following table summarises the effect of the EUT operating mode, internal configuration and arrangement of cables / samples on the measured emission levels:

	See (i)	See (ii)	See (iii)	See (iv)
Effect of EUT operating mode on emission levels		✓		
Effect of EUT internal configuration on emission levels		✓		
Effect of Position of EUT cables & samples on emission levels				✓

(i) Parameter defined by standard and / or single possible, refer to Appendix D
(ii) Parameter defined by client and / or single possible, refer to Appendix D
(iii) Parameter had a negligible effect on emission levels, refer to Appendix D
(iv) Worst case determined by initial measurement, refer to Appendix D

A3 Unintentional Radiated Spurious Emissions

Preliminary scans were performed using a peak detector with the RBW = 100 kHz. The maximum permitted field strength is listed in Section 15.109. The EUT was set to receive mode only.

The following test site was used for final measurements as specified by the standard tested to:

3m alternative test site : [X]

Test Details: Battery Powered	
Regulation	Title 47 of the CFR: Part 15 Subpart (b) Clause 15.109
Measurement standard	ANSI C63.10
Frequency range	30MHz to 10 GHz
EUT sample number	S03
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photographs 1 and 2

The worst case radiated emission measurements for spurious emissions:

Ref No.	FREQ. (MHz)	Det.	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (dBµV/m)	LIMIT (dBµV/m)	Margin (dB)
No significant emissions within 20dB of the limit											

Specification limits:

The upper frequency of the measurement range was decided according to CFR 47 Part 15:2008 Clause 15.33.

Radiated emission limits (CFR 47 Part 15:2008 Clause 15.109):

Except for a Class A digital device, the field strength of radiated emissions from unintentional radiators at a distance of 3m shall not exceed the following values:

Frequency of emission (MHz)	Field strength μV/m	Field strength dBμV/m
30-88	100	40.0 (quasi-peak)
88-216	150	43.5 (quasi-peak)
216-960	200	46.0 (quasi-peak)
960-1000	500	54.0 (quasi-peak)
Above 1000	500	54.0 (average)
Above 1000	-	74.0 (peak)

Notes:

(a) Where results have been measured at one distance, and a signal level displayed at another, the results have been extrapolated using the following formula:

$$\text{Extrapolation}\,(\text{dB}) = 20\log_{10}\left(\frac{\text{measurement distance}}{\text{specification distance}}\right)$$

The results displayed take into account applicable antenna factors and cable losses.

(b) The levels may have been rounded for display purposes.

(c) The following table summarises the effect of the EUT operating mode, internal configuration and arrangement of cables / samples on the measured emission levels:

	See 1)	See 2)	See 3)	See 4)
Effect of EUT operating mode on emission levels		✓		
Effect of EUT internal configuration on emission levels		✓		
Effect of Position of EUT cables & samples on emission levels		✓		
1) Parameter defined by standard and / or single possible. 2) Parameter defined by client and / or single possible. 3) Parameter had a negligible effect on emission levels. 4) Worst case determined by initial measurement.				

A4 ac Power Line Conducted Emissions

Not applicable the EUT is battery power.

Appendix B: Supporting Graphical Data

This appendix contains graphical data obtained during testing.

Notes:

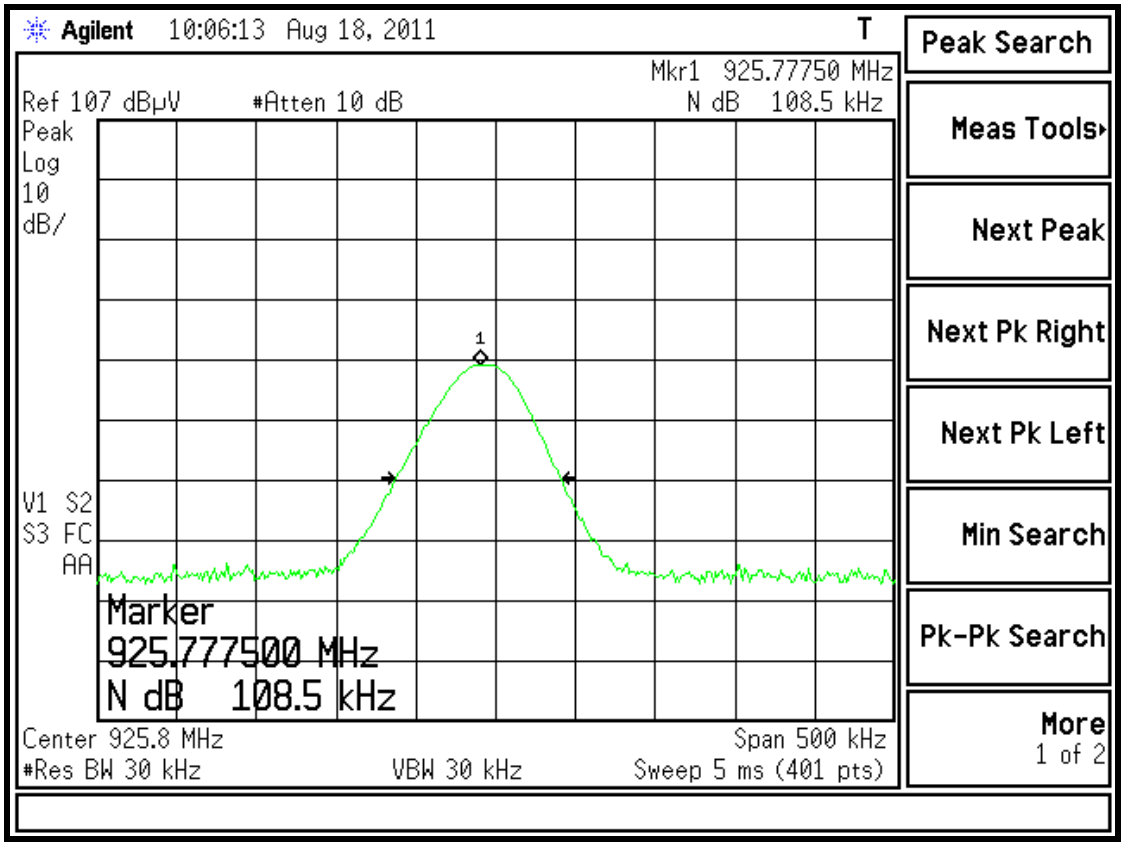
(a) The radiated electric field emissions and conducted emissions graphical data in this appendix is preview data. For details of formal results, refer to Appendix A and Appendix B.

(b) The time and date on the plots do not necessarily equate to the time of the test.

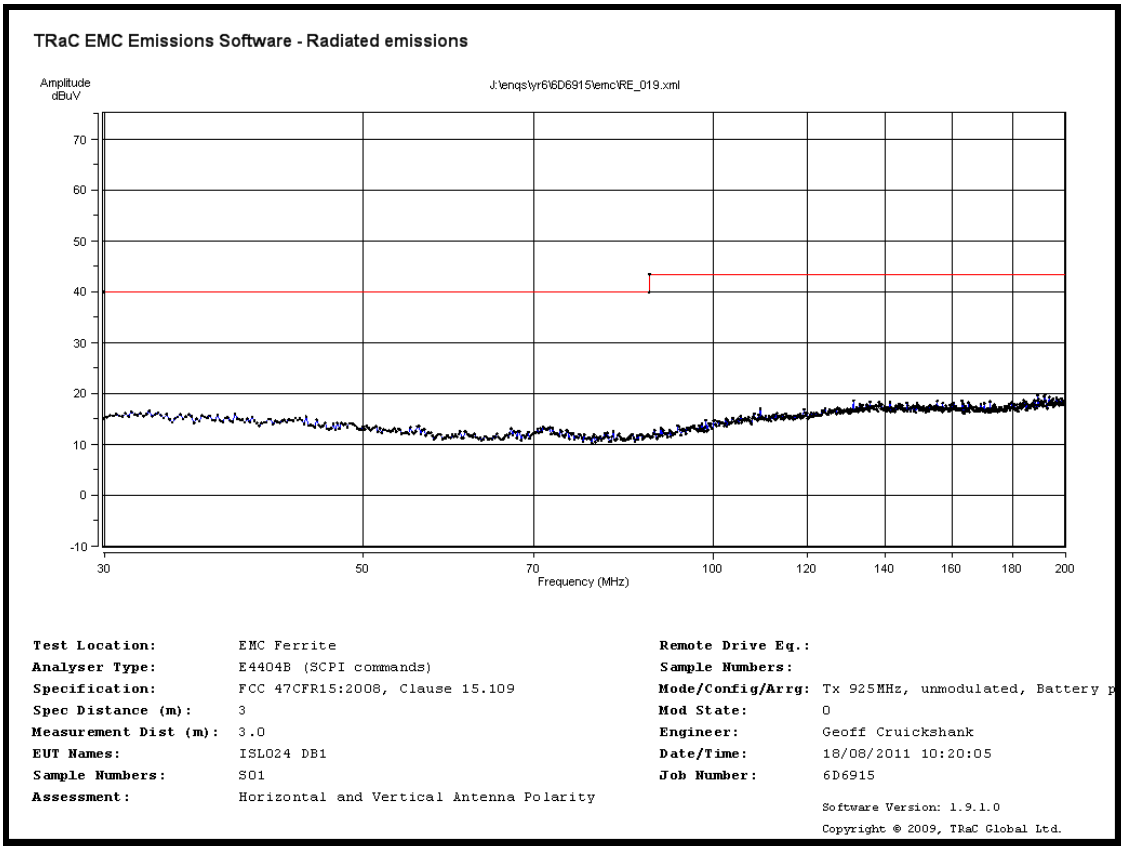
(c) Where relevant, on power line conducted emission plots, the limit displayed is the average limit, which is stricter than the quasi peak limit.

(d) Appendix C details the numbering system used to identify the sample and its modification state.

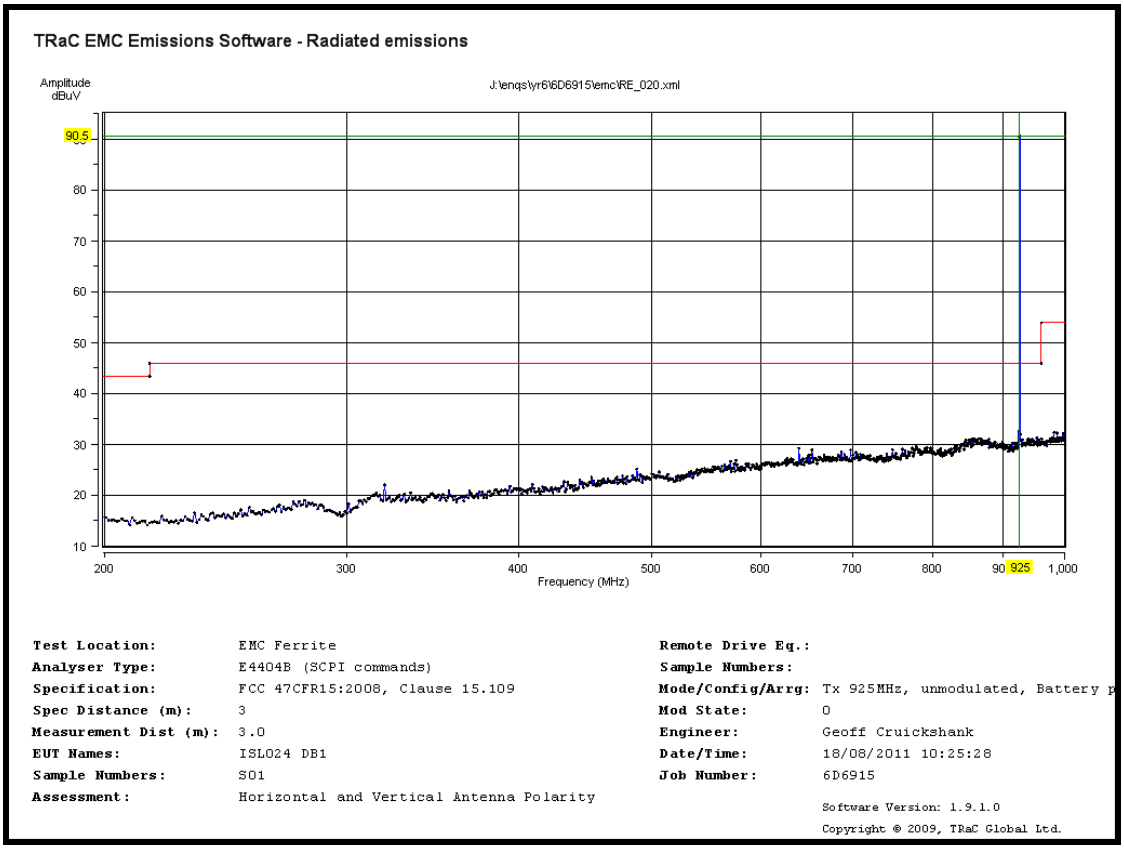
(e) The plots presented in this appendix may not be a complete record of the measurements performed, but are a representative sample, relative to the final assessment.



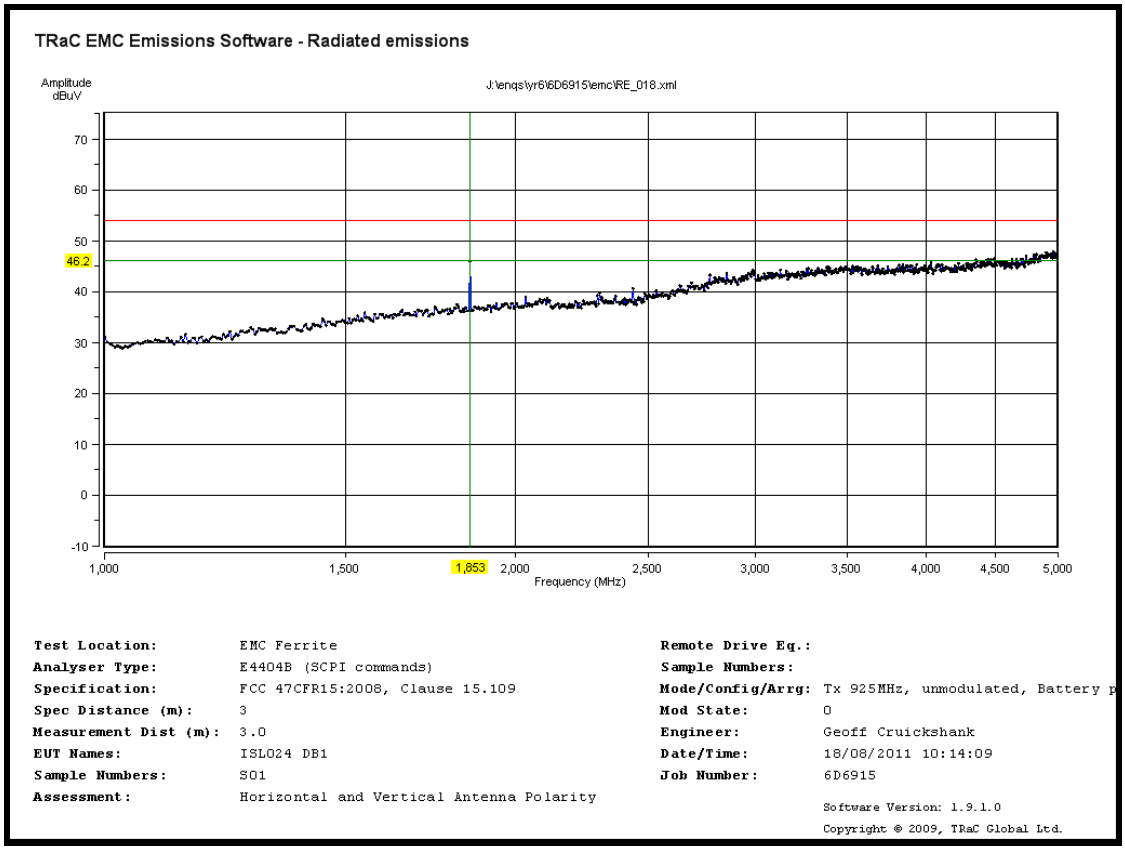
20 dB Bandwidth – Battery powered



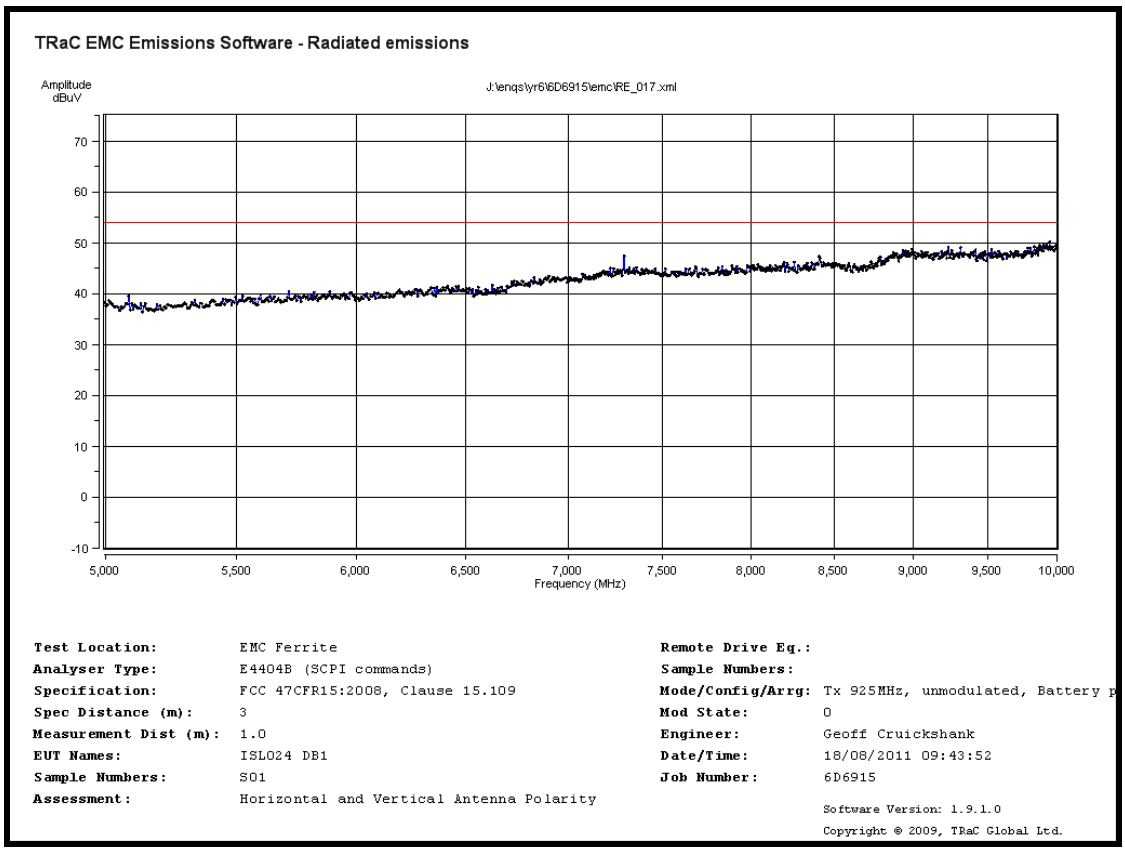
Radiated Spurious emissions 30 MHz to 200 MHz – Tx mode battery powered



Radiated Spurious emissions 200 MHz to 1 GHz – Tx mode battery powered

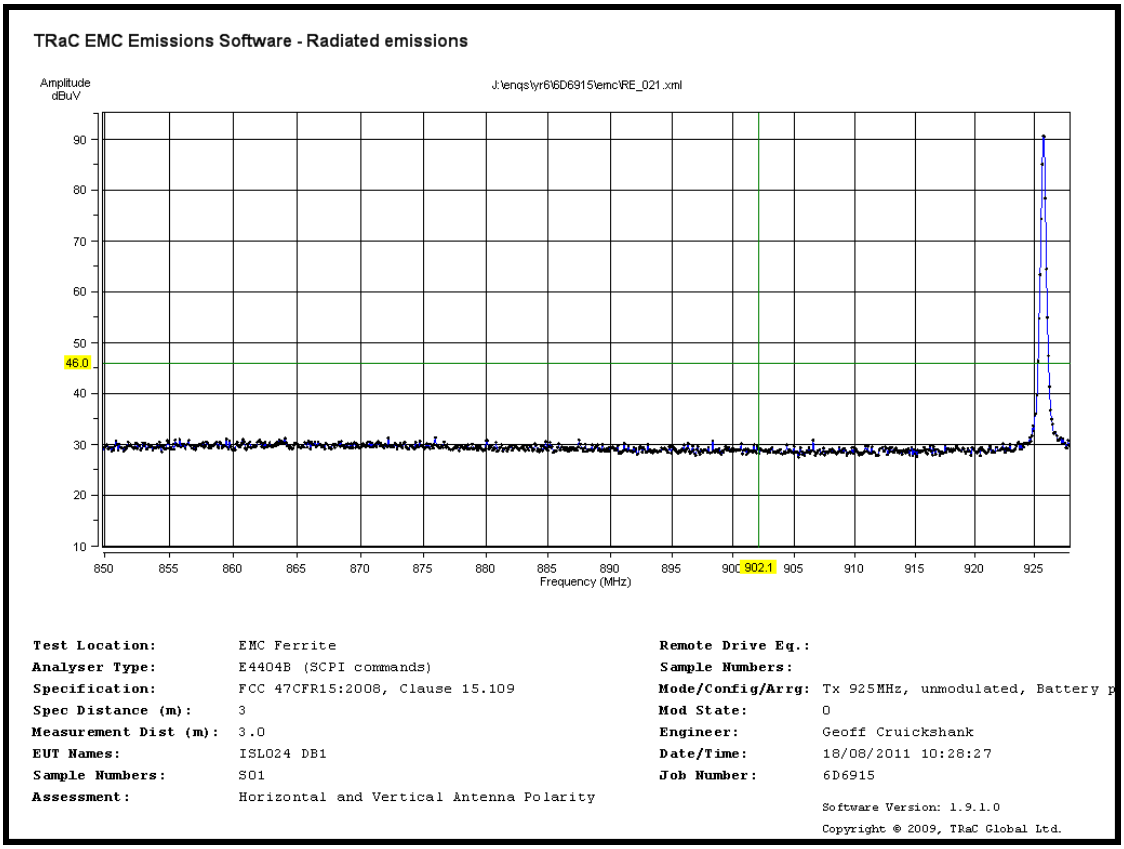


Radiated Spurious emissions 1 GHz to 5 GHz – Tx mode battery powered

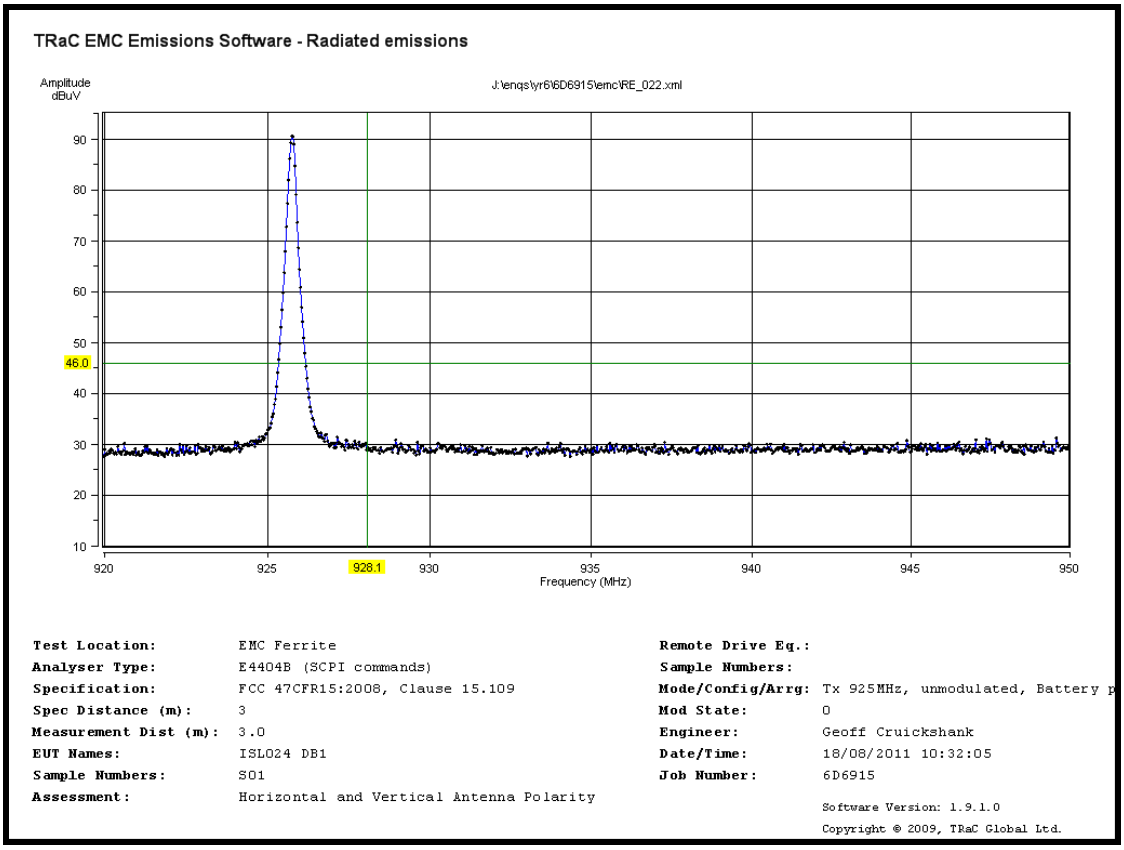


Radiated Spurious emissions 5 GHz to 10 GHz – Tx mode battery powered

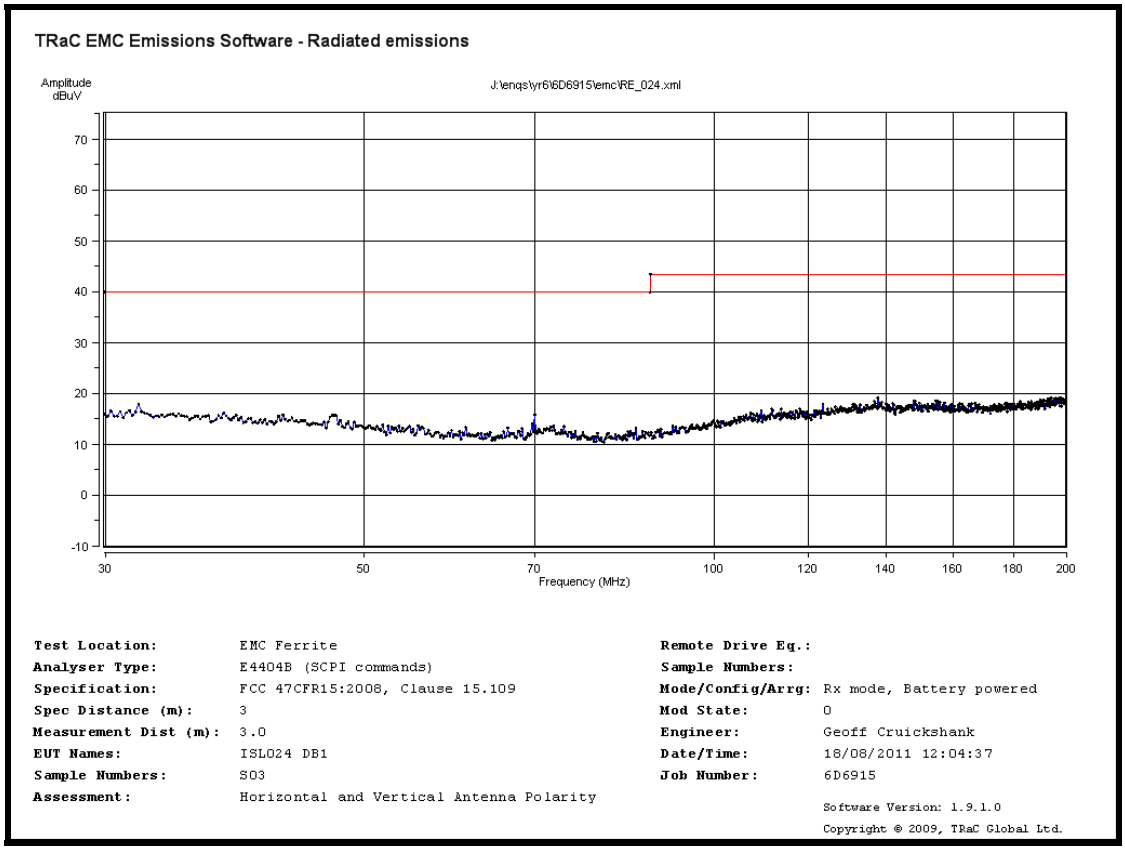
Radiated Bandedge Compliance – Battery Powered



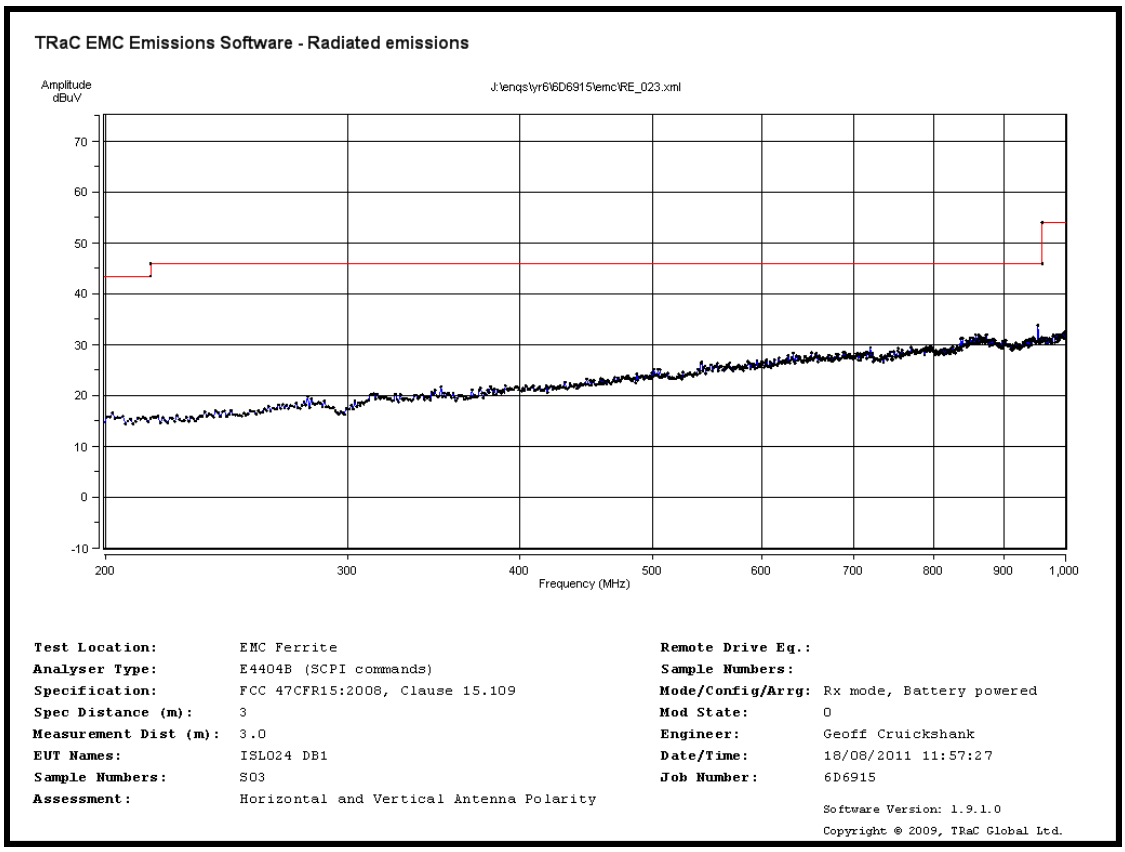
Lower Bandedge



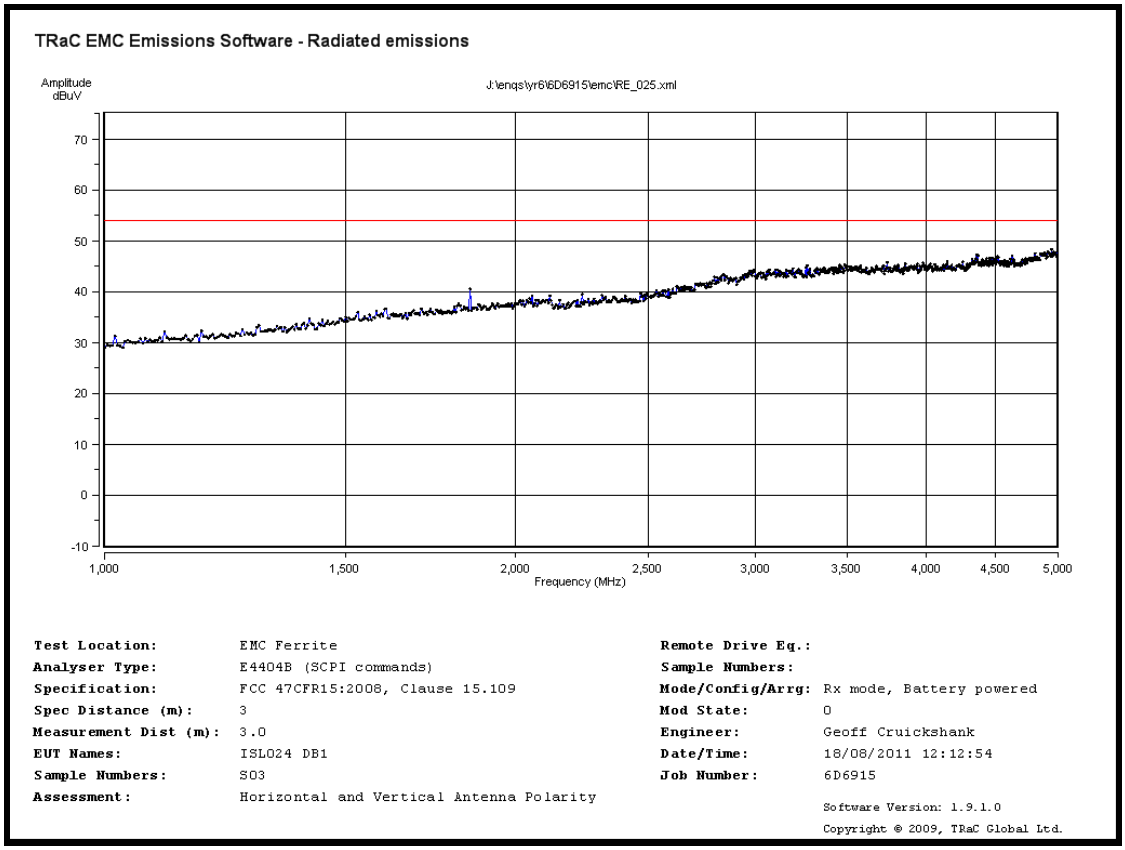
Upper Bandedge



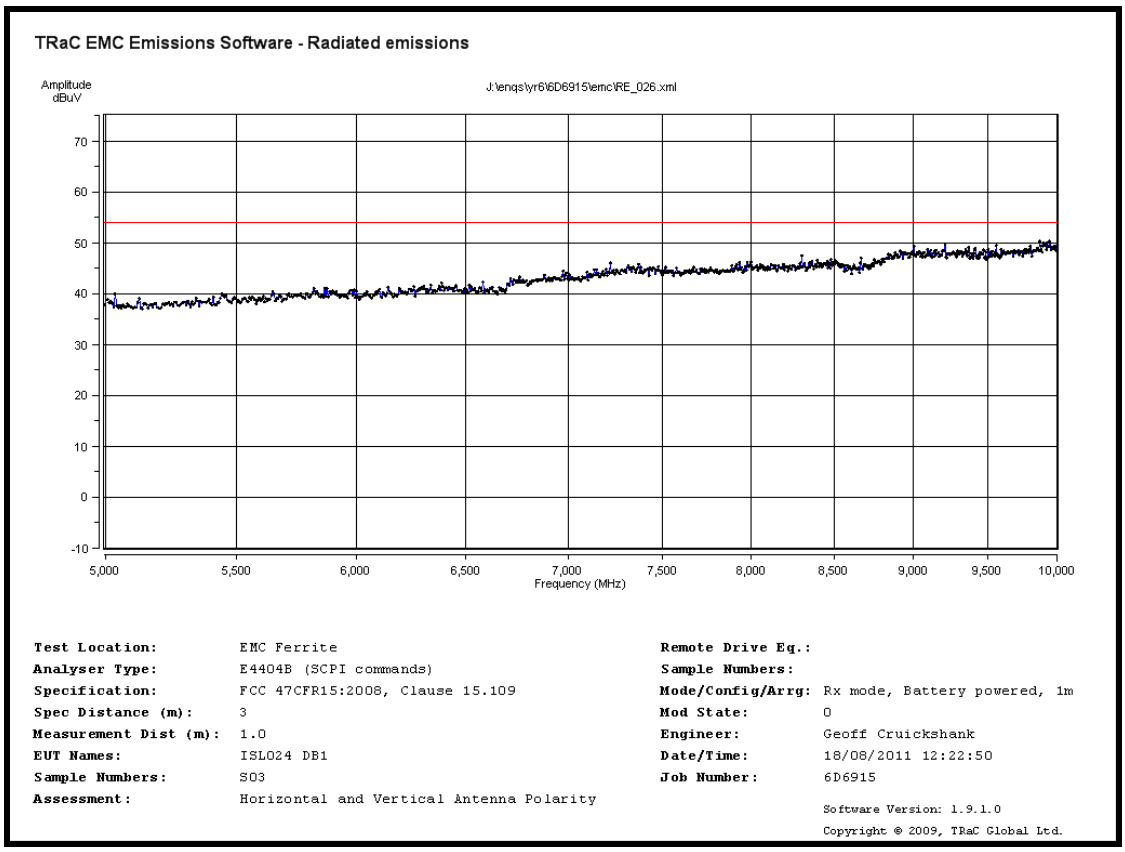
Radiated Spurious emissions 30 MHz to 200 MHz – Rx mode battery powered



Radiated Spurious emissions 200 MHz to 1 GHz – Rx mode battery powered



Radiated Spurious emissions 1 GHz to 5 GHz – Rx mode battery powered



Radiated Spurious emissions 5 GHz to 10 GHz – Rx mode battery powered

Appendix C: Additional Test and Sample Details

This appendix contains details of:

1. The samples submitted for testing.
2. Details of EUT operating mode(s)
3. Details of EUT configuration(s) (see below).
4. EUT arrangement (see below).

Throughout testing, the following numbering system is used to identify the sample and it's modification state:

Sample No: Sxx Mod w

where:

xx = sample number e.g. S01
w = modification number e.g. Mod 2

The following terminology is used throughout the test report:

Support Equipment (SE) is any additional equipment required to exercise the EUT in the applicable operating mode. Where relevant SE is divided into two categories:

SE in test environment: The SE is positioned in the test environment and is not isolated from the EUT (e.g. on the table top during REFE testing).

SE isolated from the EUT: The SE is isolated via filtering from the EUT. (e.g. equipment placed externally to the ALSR during REFE testing).

EUT configuration refers to the internal set-up of the EUT. It may include for example:

Positioning of cards in a chassis.
Setting of any internal switches.
Circuit board jumper settings.
Alternative internal power supplies.

Where no change in EUT configuration is **possible**, the configuration is described as “single possible configuration”.

EUT arrangement refers to the termination of EUT ports / connection of support equipment, and where relevant, the relative positioning of samples (EUT and SE) in the test environment.

For further details of the test procedures and general test set ups used during testing please refer to the related document "EMC Test Methods - An Overview", which can be supplied by TRaC Global upon request.

C1 Test samples

The following samples of the apparatus were submitted by the client for testing :

Sample No.	Description	Identification
S01	ISL024DB1	None
S03	ISL024DB1	None

C2 EUT Operating Mode During Testing.

During testing, the EUT was exercised as described in the following tables :

Test	Description of Operating Mode
Transmitter intentional, transmitter radiated spurious emissions and transmitter power line conducted emissions	EUT Transmitting Modulated carrier at 925MHz using normal modulation rate.

Test	Description of Operating Mode:
Receiver radiated spurious emissions and receiver power line conducted emissions	EUT active but non-transmitting.

C3 EUT Configuration Information.

The EUT was submitted for testing in one single possible configuration.

C4 List of EUT Ports

The tables below describe the termination of EUT ports:

Sample : S01
Tests : All transmitter tests

Port	Description of Cable Attached	Cable length	Equipment Connected
Temperature Sensor	3 Core Unscreened	2m	Unterminated

Sample : S03
Tests : All receiver tests

Port	Description of Cable Attached	Cable length	Equipment Connected
External antenna connector	HF Co-Axial	0.5m	S06 and S07

C5 Details of Equipment Used

For Radiated Measurements:

For Radiated TX and Standby/RX emissions 30MHz to 1GHz

RFG No	Type	Description	Manufacturer	Date Calibrated.
REF886	Lab 16	Large Anechoic Chamber	TRaC	27/07/11
095	96002	Bicon Antenna (30-200MHz)	Eaton	12/05/10
191	3146	Log Periodic Antenna (200-1000MHz)	EMCO	12/05/10
673	310	Pre-Amp (9kHz-1GHz)	Sonoma	14/09/10
404	E4407B	Spectrum Analyser	Agilent	17/05/11
450		HF RF coaxial cable	Teledyne Reynolds	25/05/11
REF881		HF RF coaxial cable	Teledyne Reynolds	06/06/11
REF882		HF RF coaxial cable	Teledyne Reynolds	06/06/11
REF884		HF RF coaxial cable	Teledyne Reynolds	06/06/11
REF885		HF RF coaxial cable	Teledyne Reynolds	06/06/11

Radiated TX and Standby/RX spurious emissions (e.r.p) 1GHz to 10GHz

RFG No	Type	Description	Manufacturer	Date Calibrated
REF886	Lab 16	Large Anechoic Chamber	TRaC	27/07/11
REF880	HL050	Log Periodic Antenna (1-26.5GHz)	R&S	14/05/10
REF913	HP8449B	Microwave Pre-Amp (1-26.5GHz)	HP	07/01/11
404	E4407B	Spectrum Analyser	Agilent	17/05/11
450		HF RF coaxial cable	Teledyne Reynolds	25/05/11
REF881		HF RF coaxial cable	Teledyne Reynolds	06/06/11
REF882		HF RF coaxial cable	Teledyne Reynolds	06/06/11
REF884		HF RF coaxial cable	Teledyne Reynolds	06/06/11
REF885		HF RF coaxial cable	Teledyne Reynolds	06/06/11

ac Power line conducted emissions

RFG No	Type	Description	Manufacturer	Date Calibrated
N/A	Lab 7	Screened Room 1	TRaC	N/A
189	ESH3-Z5	LISN Two Line V-Network 9kHz – 30MHz	R & S	09/06/11
674	ESH3-Z2	LF Pulse Limiter 9kHz to 30MHz	R & S	20/05/11
657	E4404B	Spectrum Analyser	Agilent	17/05/11
125	ESHS-10	Test Receiver	R & S	19/05/11
295	K0017F	BNC Type 3m RF Cable	TRaC	17/09/10
296	K0017F	BNC Type 3m RF Cable	TRaC	17/09/10
109	8559	230/110Vac Power Supply	IR Group	N/A

Appendix D: Additional Information

No additional information is included within this test report.

Appendix E: Calculation of the duty cycle correction factor

Due to the nature of the transmission frequency having a pulse train greater than 100ms, no duty cycle correction factor can be applied.

Appendix F: Photographs and Figures

The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement: front view battery powered.
2. Radiated electric field emissions arrangement: rear view battery powered.

Photograph 1

Photograph 2

Appendix G: MPE Calculation

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47 CFR §§1.1307 and 2.1091

2.1091 Radio frequency radiation exposure evaluation: mobile devices.

For purposes of these requirements mobile devices are defined by the FCC as transmitters designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimetres is normally maintained between radiating structures and the body of the user or nearby persons. These devices are normally evaluated for exposure potential with relation to the MPE limits. As the 20cm separation specified under FCC rules may not be achievable under normal operation of the EUT, an RF exposure calculation is needed to show the minimum distance required to be less than 1mW/cm^2 power density limit, as required under FCC rules.

Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{EIRP}{4\pi R^2} \quad \text{re - arranged} \qquad R = \sqrt{\frac{EIRP}{S\ 4\pi}}$$

where:

S = power density
R = distance to the centre of radiation of the antenna
EIRP = EUT Maximum power

Note:

The EIRP was calculated using the following formula.

Formula:

EIRP = (E*D)²/30*G

E = Field Strength (V/m)
D = Test Distance
G= Gain of antenna
EIRP = Radiated power (dBm)

Results

Prediction Frequency (MHz)	Field Strength V/m	Maximum EIRP	Power density limit (S) (mW/cm^2)	Distance (R) cm required to be less than 0.6.mW/cm^2
925.788 (Battery Powered)	45.13mV/m	0.611mW	f(MHz) / 1500 = 0.617	0.281

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