



KTL EMC Test Report : 2H6191GUS1

Applicant : IML Ltd

Apparatus : IML Communicator

Authorised by

A handwritten signature in black ink, appearing to read 'McLender'.

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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:

IML Ltd
8 London Road
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Hants
GU30 7AN
United Kingdom

1.3 Manufacturer

As above.

1.4 Apparatus Assessed

The following apparatus was assessed between: 11/11/03 to 24/11/03:

IML Communicator

The above equipment was a wireless communications device for audience voting and audio feedback

1.5 Test Result Summary

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
REFE	Title 47 of the CFR :2002, Part 15 Subpart (c) 15.247	ANSI C63.4:2001	PASS
20dB Bandwidth	Title 47 of the CFR :2002, Part 15 Subpart (c) 15.247(a)(1)(i)	N/A	PASS
Maximum Peak Power	Title 47 of the CFR :2002, Part 15 Subpart (c) 15.247(b)(2)	N/A	PASS
Hopping Frequencies	Title 47 of the CFR :2002, Part 15 Subpart (c) 15.247(a)(1)	N/A	PASS
Channel Occupancy	Title 47 of the CFR :2002, Part 15 Subpart (c) 15.247(a)(1)(i)	N/A	PASS

Abbreviations used in the above table:

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

*See section 2.2 Note (c).

1.6 Notes Relating To The Assessment

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

- a) 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.
- b) The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only.
- c) Where relevant, the apparatus was only assessed using the monitoring methods and susceptibility criteria defined in this report.
- d) All testing with the exception of testing at the Open Area Test Site was performed under the following environmental conditions:

Temperature : 17 to 23 °C

Humidity : 45 to 75%

Barometric Pressure : 86 to 106 kPa

- e) All dates used in this report are in the format dd/mm/yy.
- f) This assessment has been performed in accordance with the requirements of ISO/IEC 17025.
- g) KTL Hull is a listed electromagnetic compatibility Conformance Assessment Body (CAB) for EC access to the US market. (Decision No 3/2000 of the Joint Committee established under the Agreement on Mutual Recognition between the European Community and the United States of America. This decision was effective from 16th January 2001).

KTL has submitted the information required by Section 2.948 of the FCC Rules for measuring specific types of intentionally radiating devices subject to the requirements in Part 15 of the FCC Rules. The FCC registration numbers for KTL's facilities are :

3m Alternative Test Sit: 90743

3m and 10m Open Area Test Site 90744

1.7 Deviations from Test Standards

There were no deviations from the standards tested to.

Section 2:**Measurement Uncertainty****2.1 Introduction**

The standard ISO/IEC 17025 used for laboratory accreditation requires laboratories to estimate measurement uncertainty using accepted methods of analysis.

Where required, the reported expanded uncertainty is based on a standard uncertainty providing a confidence level of approximately 95%.

Measurement uncertainty is calculated using the methods defined in the NAMAS document NIS81: May 1994.

KTL measurement uncertainty is recorded in the KTL document UNC/RFG/001 Issue 16.

2.2 Application of Measurement Uncertainty

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 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.

2.3 Measurement Uncertainty Values

All results were recorded in accordance with Section 2.2(i).

Section 3: Modifications

3.1 Modifications Performed During Assessment

No modifications were performed during the assessment:

Appendix A:**Formal Test Results**

Abbreviations used in the tables in this appendix:

Spec	: Specification	ALSR	: Absorber Lined Screened Room
Mod	: Modification	OATS	: Open Area Test Site
		ATS	: Alternative Test Site
EUT	: Equipment Under Test	Ref	: Reference
SE	: Support Equipment	Freq	: Frequency
L	: Live Power Line	MD	: Measurement Distance
N	: Neutral Power Line	SD	: Spec Distance
E	: Earth Power Line	Pol	: Polarisation
Pk	: Peak Detector	H	: Horizontal Polarisation
QP	: Quasi-Peak Detector	V	: Vertical Polarisation
Av	: Average Detector	CDN	: Coupling & decoupling network

A1 Radiated Electric Field Emissions

Preliminary radiated electric field emissions testing was performed using a peak detector in an absorber lined screened room.

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

10m open area test site :

3m alternative test site :

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

Test Details	
Regulation	Title 47 of the CFR :2002, Part 15 Subpart (c) Clause 15.247
Measurement standard	ANSI C63.4:2001
Frequency range	10 MHz to 25 GHz
EUT sample number	S26
Modification state	0
SE in test environment	S25
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix E)	Photograph

The worst case radiated emission measurements are listed below:

Ref No.	Freq (MHz)	Det.	Ang. Deg.	Height (cm)	Pol.	MD (m)	SD (m)	Result at SD (dB μ V/m)	Spec. Limit (dB μ V/m)	Margin (dB)	Result Summary
1	80.188	QP	140	91	V	3	3	34.4	97	62.6	Pass
2	1694.58	Av	150	360	V	3	3	46.2	97	50.8	Pass
3	4873.71	Av	100	0	V	3	3	64.7	97	32.3	Pass
4	7310.54	Av	100	155	V	3	3	62.8	97	34.2	Pass
5	9746.83	Av	100	260	V	3	3	55.5	97	41.5	Pass
6	12184.26	Av	140	50	V	3	3	56.6	97	40.4	Pass

Note: Testing below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.4:2001 section 8.2.1.

The frequency measurement range was decided according to 47 CFR 15:2002 Clause 15.33.

Radiated emission limits are derived from 47 CFR 15:2002 Clause 15.247(c). These are based on a measured radiated field strength of the carrier of 117 dB μ V/m

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:

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

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	✓			
<p>(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</p>				

A2 20 dB Bandwidth

Title 47 of the CFR :2002, Part 15 Subpart (c) 15.247(a)(1)(i) requires the measurement of the bandwidth of the transmission between the -20 dB points on the transmitted spectrum. The results of this test determine the limits for other tests. The formal measurements are detailed below:

Test Details	
Regulation	Title 47 of the CFR :2002, Part 15 Subpart (c) 15.247(a)(1)(i)
EUT sample number	S26
Modification state	0
SE in test environment	S25
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Measured 20 dB Bandwidth	Limit
863.7 kHz	864 KHz

A3 Maximum Peak Power (EIRP)

Peak carrier EIRP was carried out at an ANSI 63.4 test site using the antenna substitution method with the EUT transmitting at a carrier frequency of 2.43688 GHz.

Test Details	
Regulation	Title 47 of the CFR2002, Part15 Subpart (c) 15.247(b)(2)
EUT sample number	S26
Modification state	0
SE in test environment	S25
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Measured Peak Carrier EIRP (W) at 2.43688 GHz	Limit (W)
0.135	1

A4 Hopping frequencies

Hopping frequencies were verified using a spectrum analyser in zero span mode, centred on each declared frequency in turn, while the EUT was operating in its normal frequency hopping mode.

Test Details	
Regulation	Title 47 of the CFR :2002, Part 15 Subpart (c) 15.247(a)(1)(i)
EUT sample number	S26
Modification state	0
SE in test environment	S24
SE isolated from EUT	None
EUT set up	Refer to Appendix C

No. of Hopping Channels	Requirement
93	For 1W EIRP Limit, greater than 75

A5 Channel Occupancy

Channel occupancy time was verified using a spectrum analyser in zero span mode, centred on the middle hopping channel frequency, while the EUT was operating in its normal frequency hopping mode. The other channels were then verified to ensure that the channel occupancy was identical for all channels.

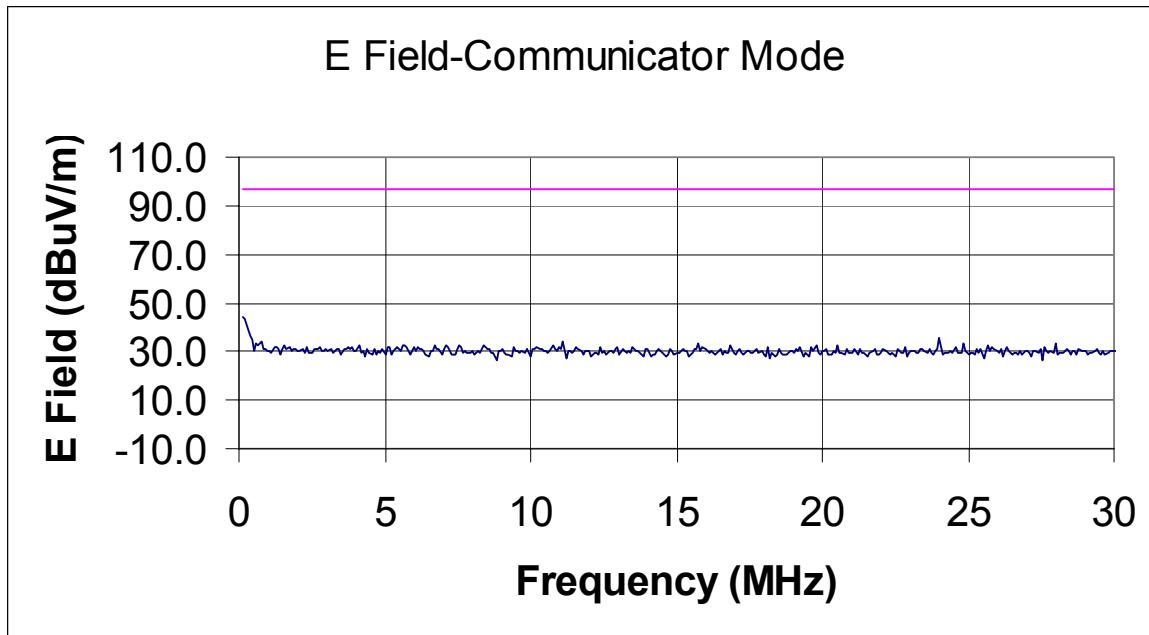
Test Details	
Regulation	Title 47 of the CFR2002, Part15 Subpart (c) 15.247(a)(1)(i)
EUT sample number	S26
Modification state	0
SE in test environment	S24
SE isolated from EUT	None
EUT set up	Refer to Appendix C

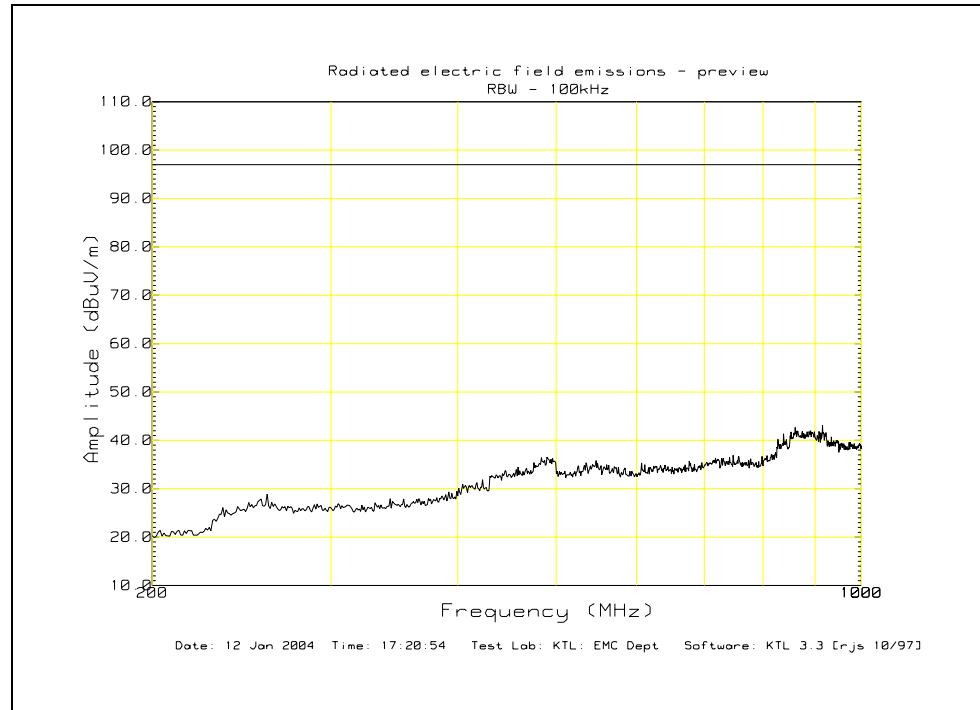
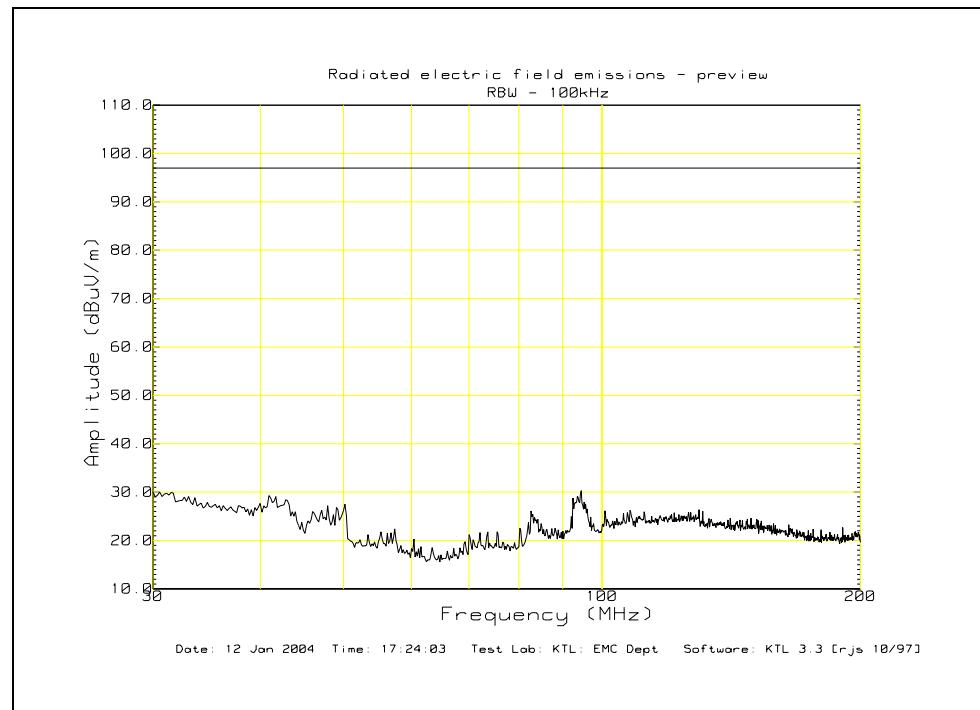
Measured Channel Occupancy Time	Limit
1.24 ms	400 ms

Note: The transmitter is on during 3 time slots of a possible 24 which can give a maximum occupancy of 10 ms.

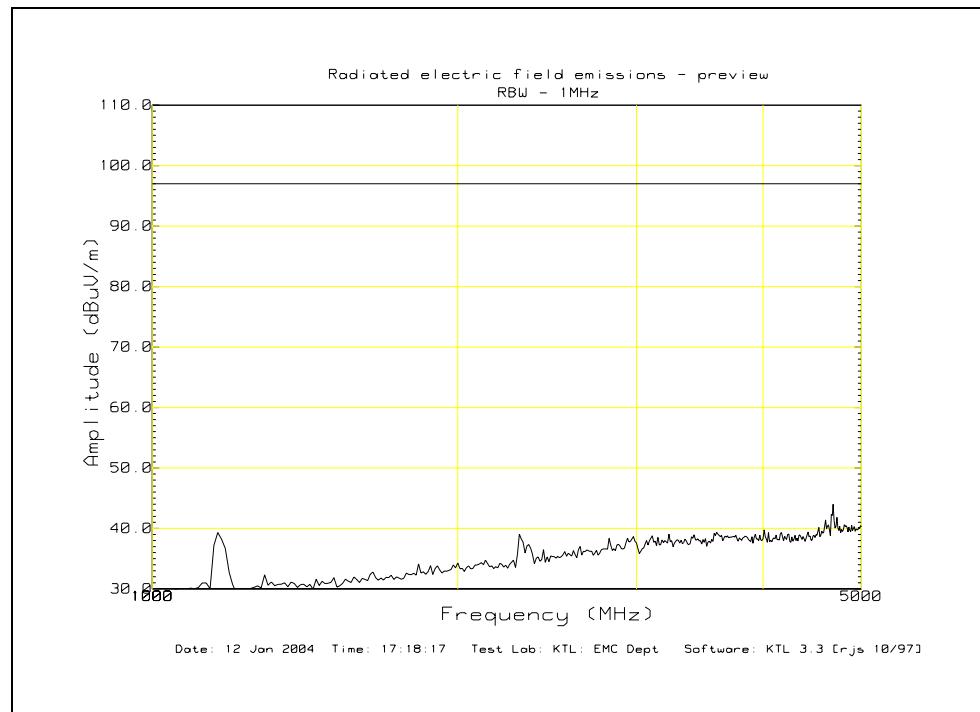
Appendix B:

Supporting Graphical Data

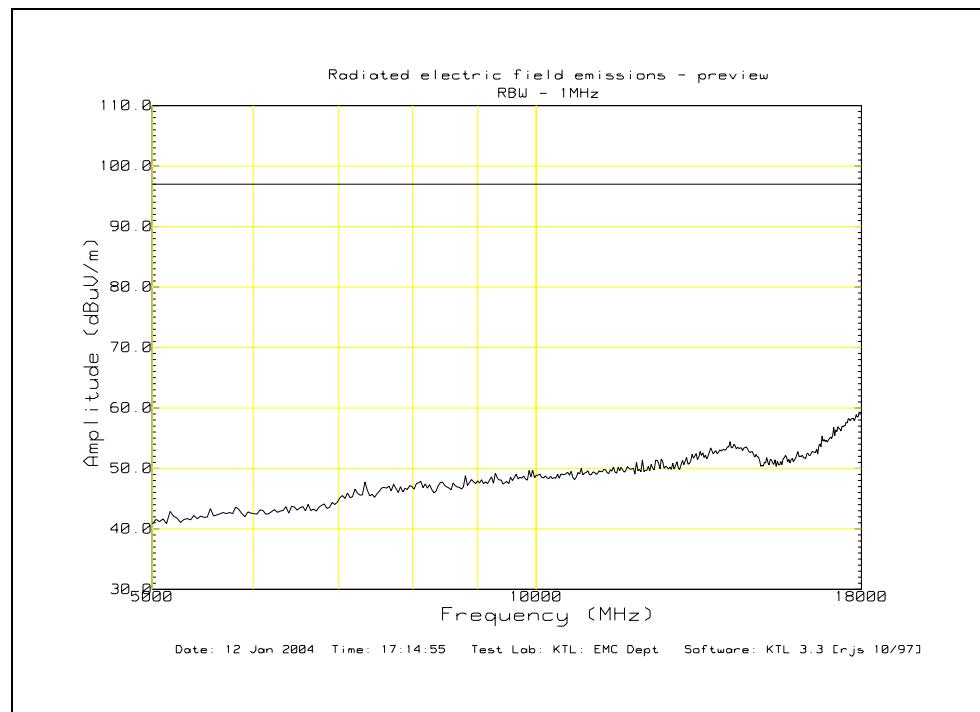




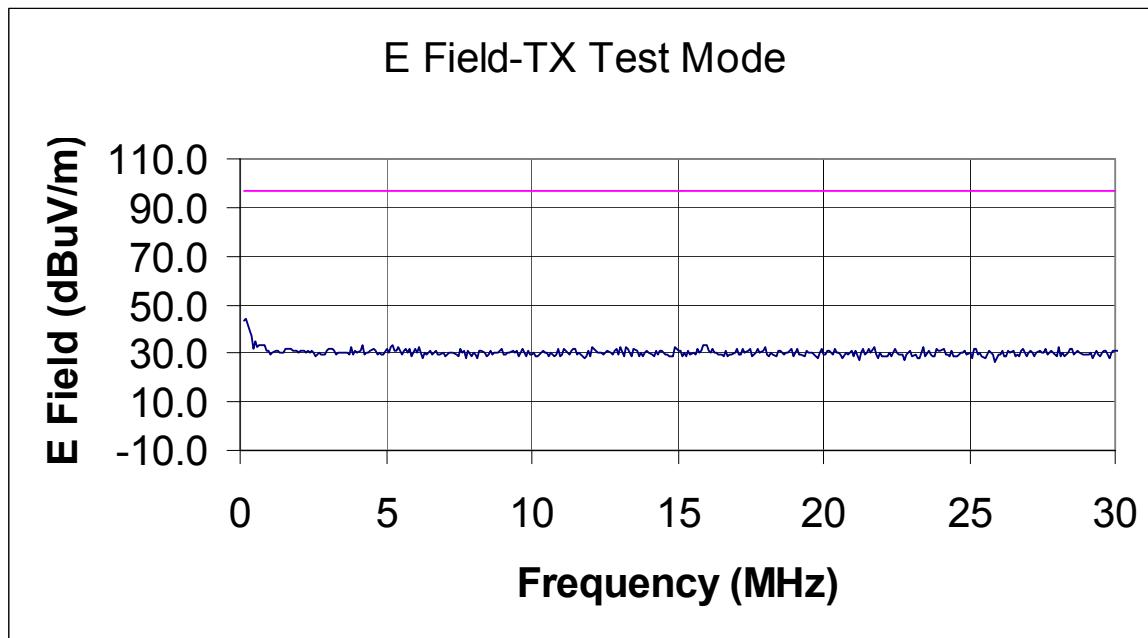
Communicator (Standby) Mode

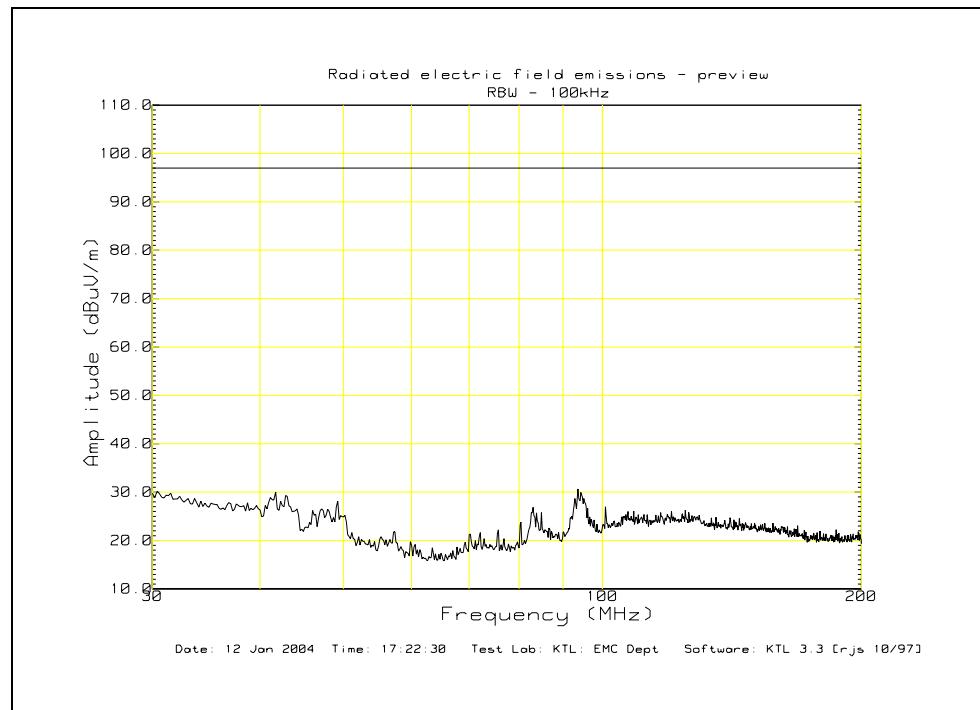


Communicator (Standby) Mode

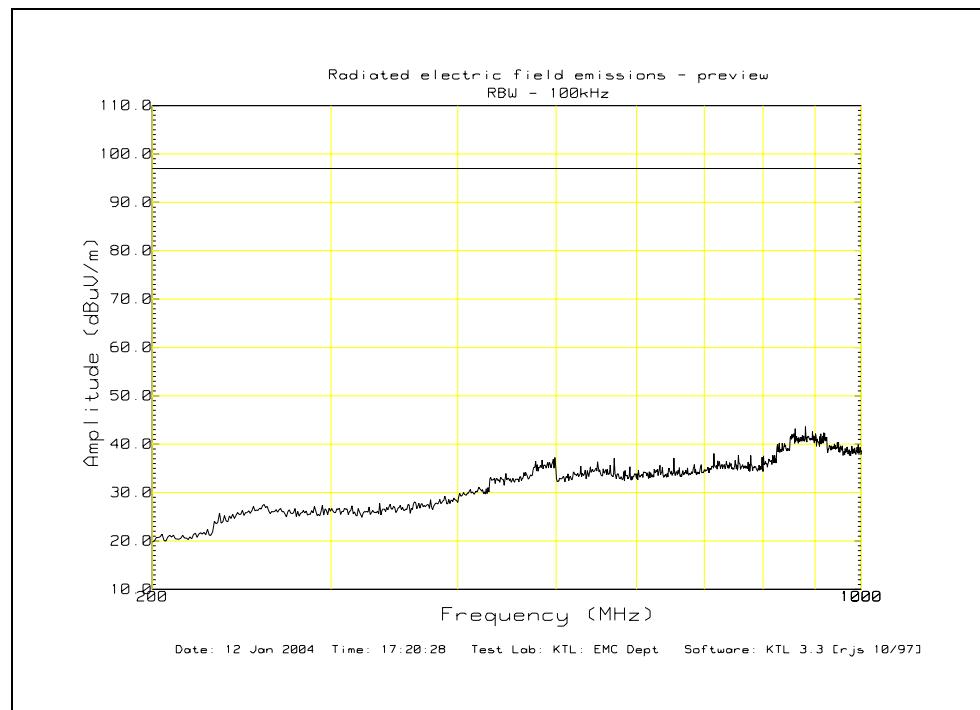


Communicator (Standby) Mode

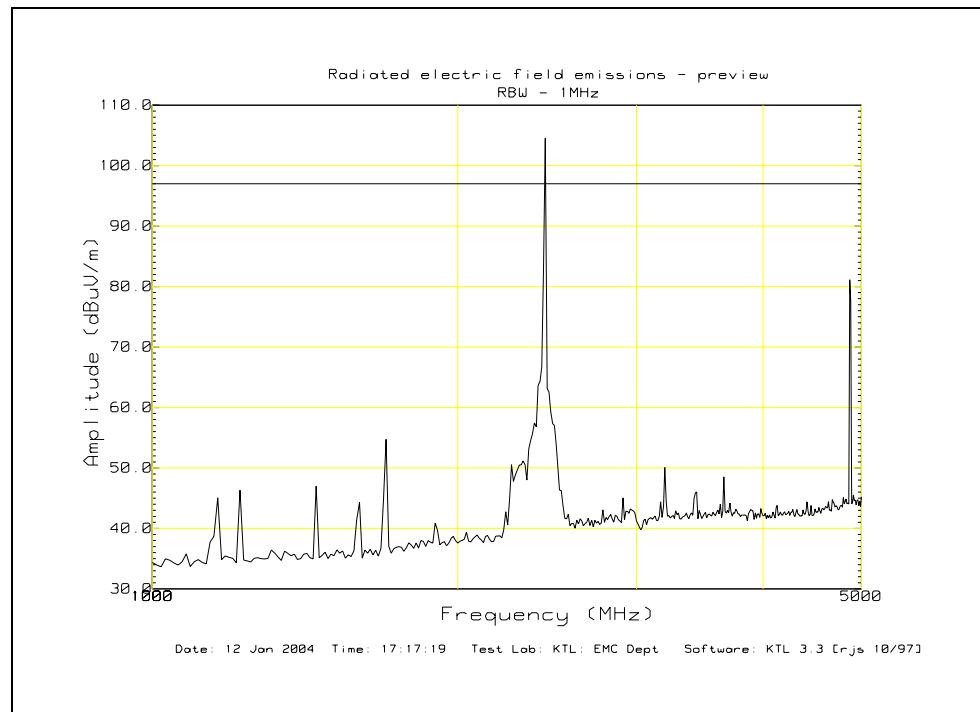




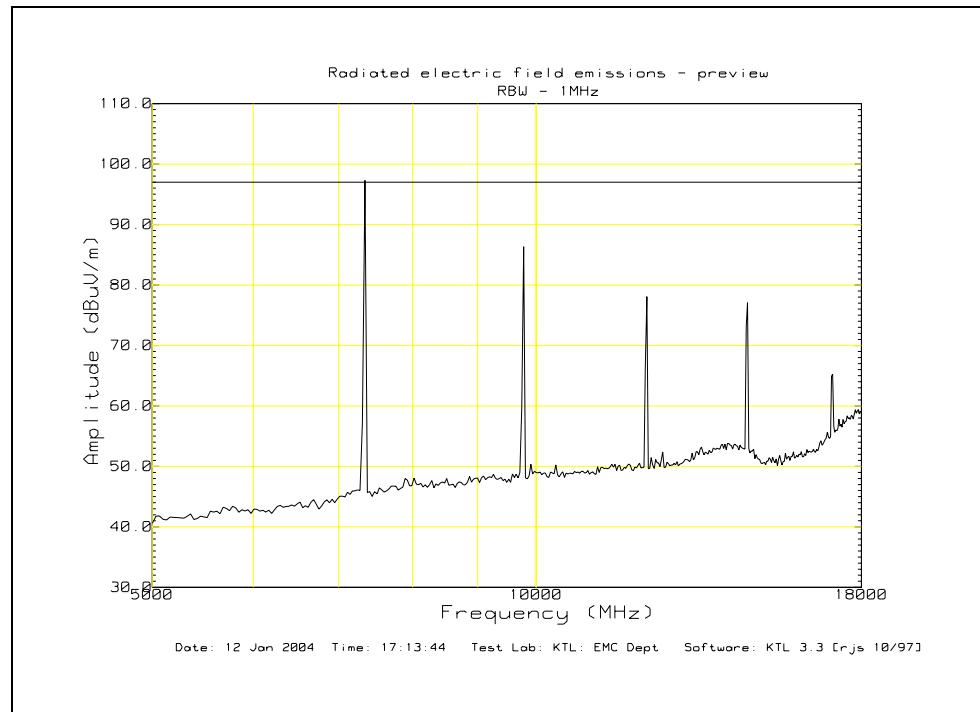
TX Test (Transmit) Mode



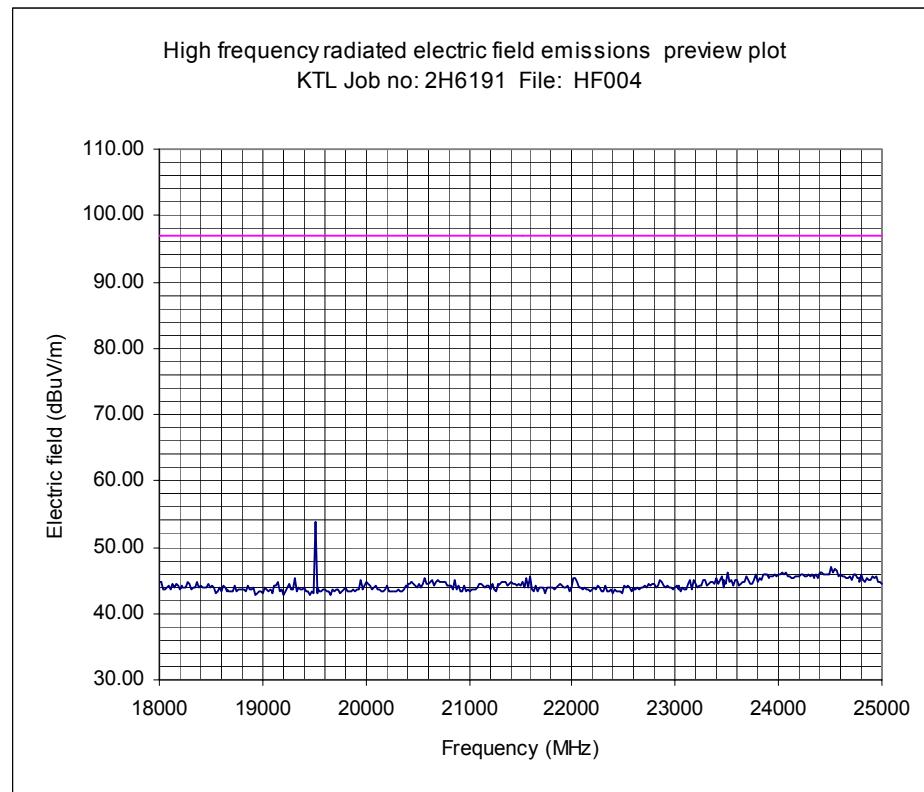
TX Test (Transmit) Mode



TX Test (Transmit) Mode



TX Test (Transmit) Mode



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 its modification state:

Sample No: Sxx Mod w

where:

xx	= sample number	eg. S01
w	= modification number	eg. 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 KTL upon request.

C1) Test Samples

The following samples of the apparatus were submitted for testing:

Sample No.	Description	Identification
S26	IML Communicator	Serial No 0010006733
S29	2.4 GHz RF module with antenna connector	Serial No 0020006520

The following samples of apparatus were submitted (or supplied by KTL) as host, support or drive equipment (auxiliary equipment):

Sample No.	Description	Identification
S24	Base Station test mode smart card	None
S25	Transmitter test mode smart card	None

C2) EUT Operating Mode During Testing.

During testing, the EUTs were exercised as described in the following tables :

Test	Description of Operating Mode
Carrier power, 20 dB bandwidth and Radiated Emissions	Transmitter in transmitter test mode transmitting a FSK modulated carrier at an aggregate bit rate of 1152 kb/s on a fixed frequency of 2.43688 GHz.
All other tests	Transmitter in base station mode transmitting with frequency hopping enabled using all available channels.

C3) EUT Configuration Information.

Radiated Test

Sample	Internal Configuration Details
S26	EUT fitted with standard RF module with integral antenna

All other Test

Sample	Internal Configuration Details
S26	EUT fitted with modified RF module with antenna connector (S29)

C4) Termination of EUT Ports.

The EUT is a battery-powered device with an integral antenna and therefore has no external ports for the purpose of the tests performed.

C5) Details of test equipment used

For Radiated Electric Field Emissions 9kHz to 1GHz:

RFG No	Type	Description	Manufacturer	Date Calibrated.
274	ATS	Ferrite Lined Chamber	KTL	16/09/02
023	HFH-Z2	Screened magnetic loop antenna 9 kHz to 30 MHz	R & S	02/04/02
231	CBL6111	Blue BILOG Antenna 30 MHz to 1GHz	Chase	02/05/00
214	ESAI	Spec Analyser/Test Receiver (LF/HF)	R & S	20/06/03

For Radiated Electric Field Emissions 1GHz to 18GHz

RFG No	Type	Description	Manufacturer	Date Calibrated
274	ATS	Ferrite Lined Chamber	KTL	16/09/02
129	3115	Horn Antennas	EMCO	29/07/98
307	HP8449B	Microwave Pre-Amp (1-26.5GHz)	HP	01/02/02
311	-	Sucoflex uW Adapter Cable 1m	Suhner	10/11/02
312	-	Sucoflex uW Adapter Cable 1m	Suhner	10/11/02
137	N-104	Sucoflex uW Cable 2m	Suhner	01/11/02
138	N-104	Sucoflex uW Cable 2m	Suhner	01/11/02
158	N-106	Sucoflex uW Cable 6m	Suhner	10/11/02
404	E4407B	Spectrum Analyser	Agilent	21/11/02

For Radiated Electric Field Emissions 18GHz to 25GHz

RFG No	Type	Description	Manufacturer	Date Calibrated
274	ATS	Ferrite Lined Chamber	KTL	16/09/02
N/A	EM3160-09	Horn Antennas	Electrometrics	17/08/02
307	HP8449B	Microwave Pre-Amp (1-26.5GHz)	HP	01/02/02
311	-	Sucoflex uW Adapter Cable 1m	Suhner	10/11/02
312	-	Sucoflex uW Adapter Cable 1m	Suhner	10/11/02
N/A	UFA-147A	uW Cable 2m	Rosenberger	16/07/03
404	E4407B	Spectrum Analyser	Agilent	21/11/02

All other tests

RFG No	Type	Description	Manufacturer	Date Calibrated
404	E4407B	Spectrum Analyser	Agilent	21/11/02

Appendix D:

Additional Information

No additional information is included.

Appendix E:

Photographs and Figures

The following photographs were taken of the test samples:

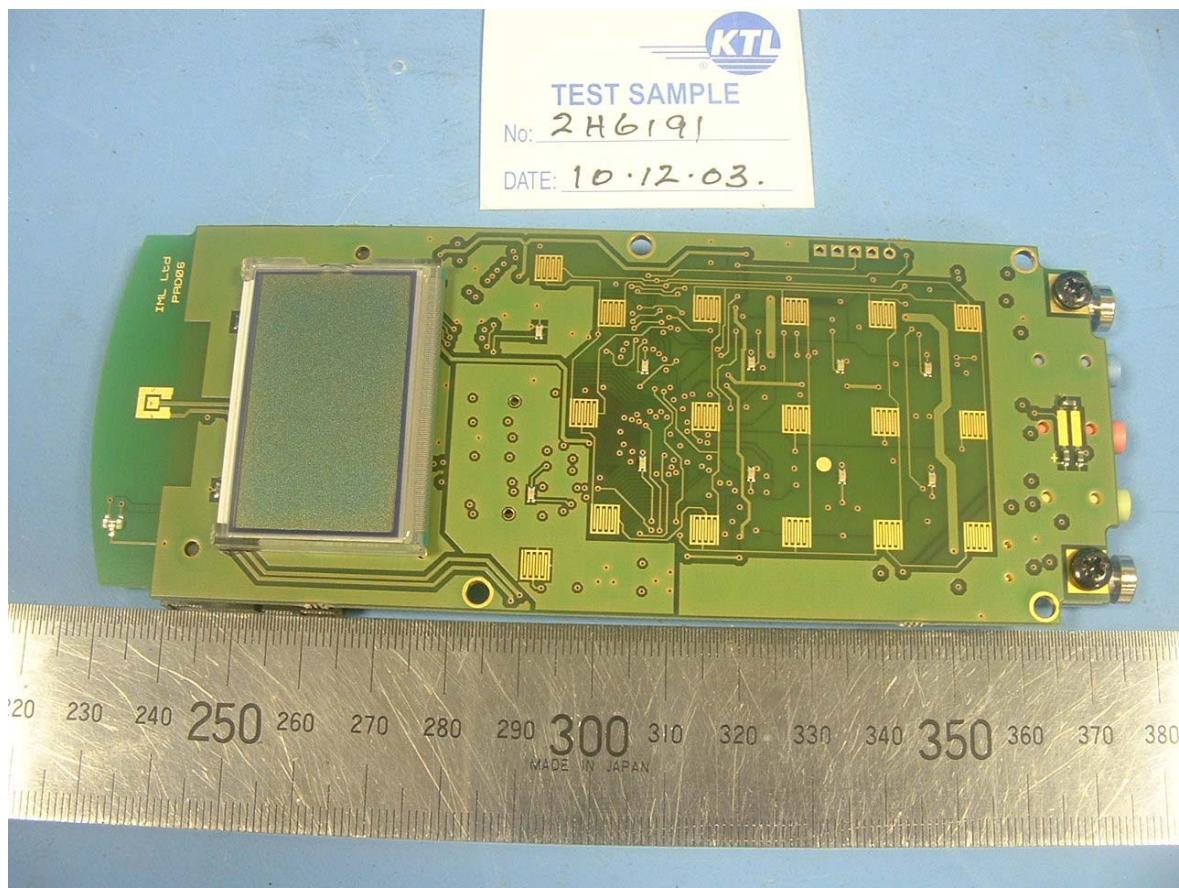
- 1 Radiated electric field emissions arrangement
- 2 Internal View: Communicator – Top side
- 3 Internal View: Communicator – Bottom side
- 4 Internal View: RF Module – Top side
- 5 Internal View: RF Module – Bottom side



Photograph 1



Photograph 2



Photograph 3



Photograph 4



Photograph 5