



**KTL EMC Test Report** : 2H6191GUS1

**Applicant** : IML Ltd

**Apparatus** : IML Communicator

**Authorised by**

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

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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.

Test performed by: KTL  
Saxon Way  
Priory Park West  
Hull HU13 9PB  
United Kingdom  
  
Telephone: +44 (0) 1482 801801  
Fax: +44 (0) 1482 801806  
Email: [ktl@ktl.com](mailto:ktl@ktl.com)  
Web site: [www.ktl.com](http://www.ktl.com)

A handwritten signature in black ink, reading "K J Anderson". The signature is written in a cursive style with a vertical line to the left of the text.

Tests performed by: K J Anderson, Senior EMC Engineer

Report author: As above.

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## **1.2 Tests Requested By**

This testing in this report was requested by:

IML Ltd  
8 London Road  
Liphook  
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                      | ANSI | : American National Standards Institution |
| CFR  | : Code of Federal Regulations       | PLCE | : Power Line Conducted Emissions          |
| REFE | : Radiated Electric Field 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 16<sup>th</sup> 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           |
| EUT  | : Equipment Under Test | ATS  | : Alternative Test Site         |
| SE   | : Support Equipment    |      |                                 |
|      |                        | Ref  | : Reference                     |
|      |                        | Freq | : Frequency                     |
|      |                        | MD   | : Measurement Distance          |
| L    | : Live Power Line      | SD   | : Spec Distance                 |
| N    | : Neutral Power Line   |      |                                 |
| E    | : Earth Power Line     | Pol  | : Polarisation                  |
|      |                        | H    | : Horizontal Polarisation       |
| Pk   | : Peak Detector        | V    | : Vertical Polarisation         |
| QP   | : Quasi-Peak Detector  |      |                                 |
| 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 $\mu$ V/m) | Spec. Limit (dB $\mu$ 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 $\mu$ 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  | ✓       |          |           |          |
| (i) Parameter defined by standard and / or single possible, refer to Appendix D<br>(ii) Parameter defined by client and / or single possible, refer to Appendix D<br>(iii) Parameter had a negligible effect on emission levels, refer to Appendix D<br>(iv) Worst case determined by initial measurement, refer to Appendix D |         |          |           |          |

**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.

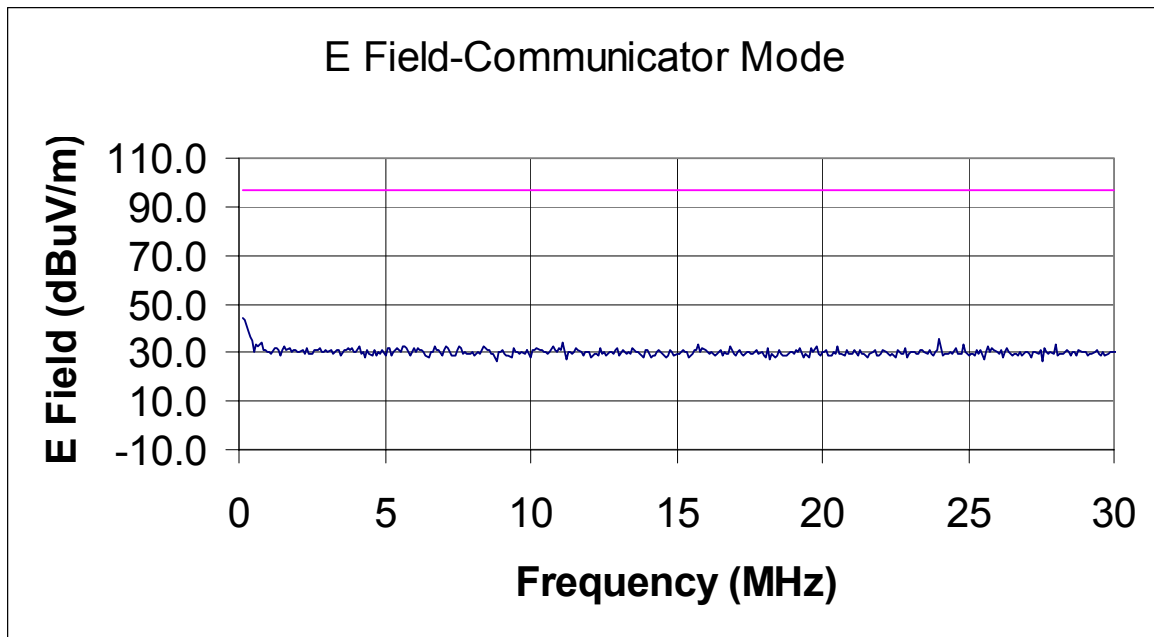
| Test Details           |   |
|------------------------|---|
| Regulation             | Title 47 of the CFR2002, Part15 Subpart (c) 15.247(a)(1)(i) |
| EUT sample number      | S26   |
| Modification state     | 0   |
| SE in test environment | S24   |
| SE isolated from EUT   | None  |
| EUT set up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

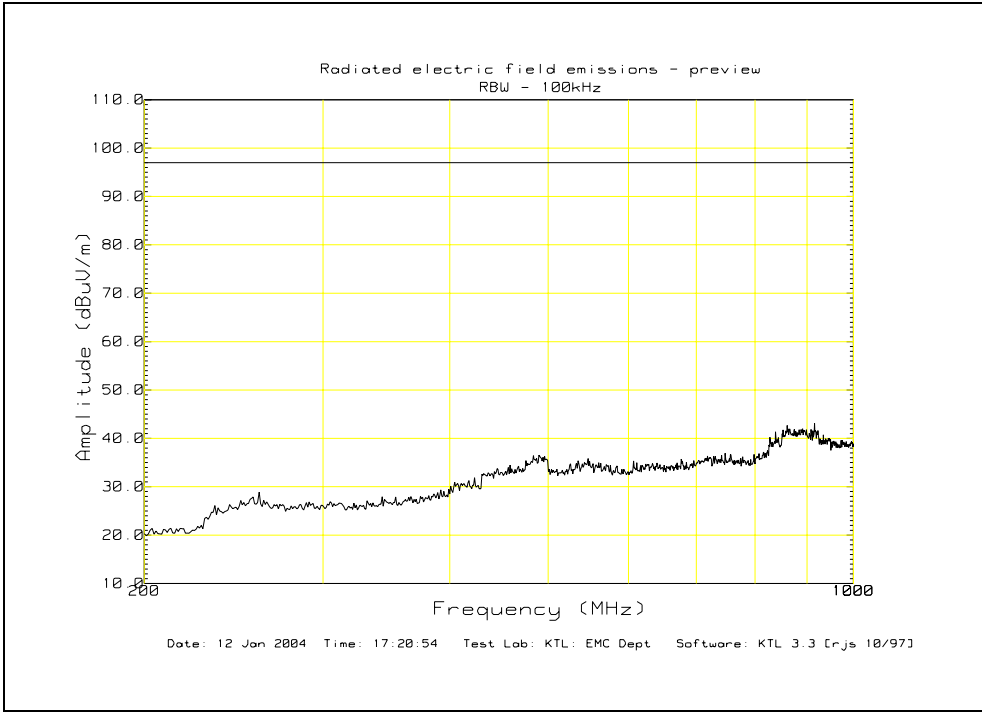
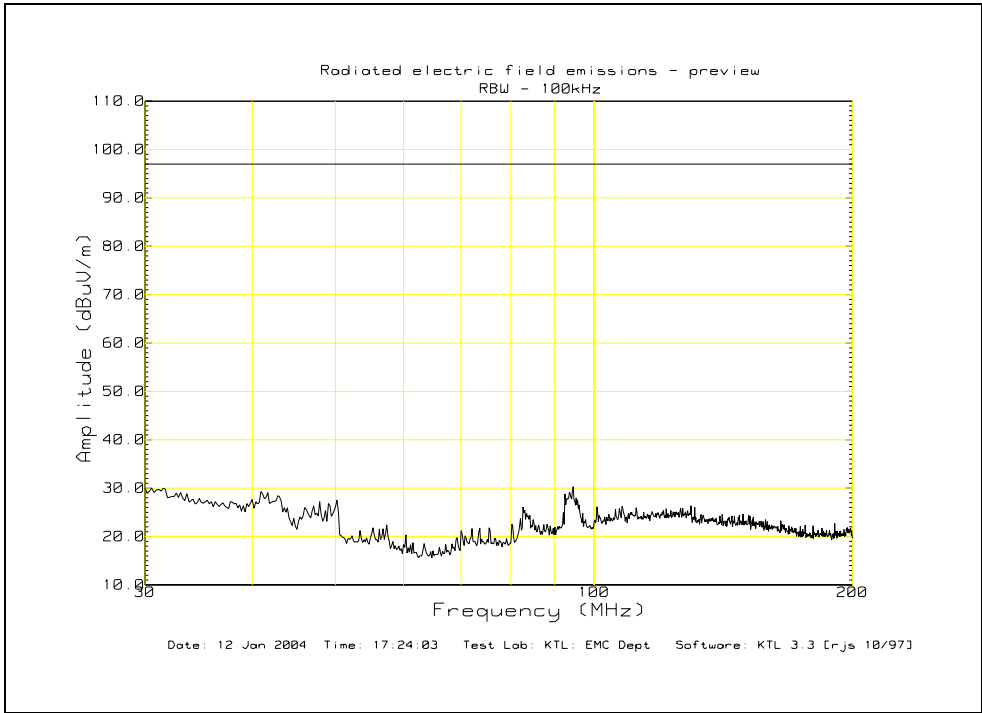
| Measured Channel Occupancy Time | Limit  |
|---------------------------------|--------|
| 1.24 ms                         | 400 ms |

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

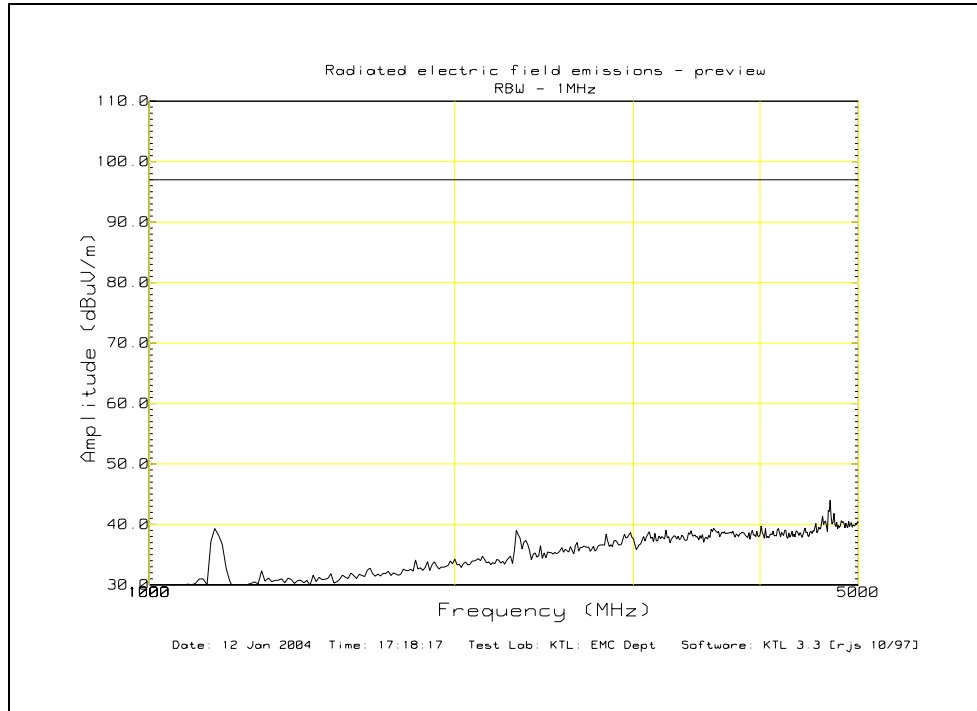
## Appendix B:

## Supporting Graphical Data

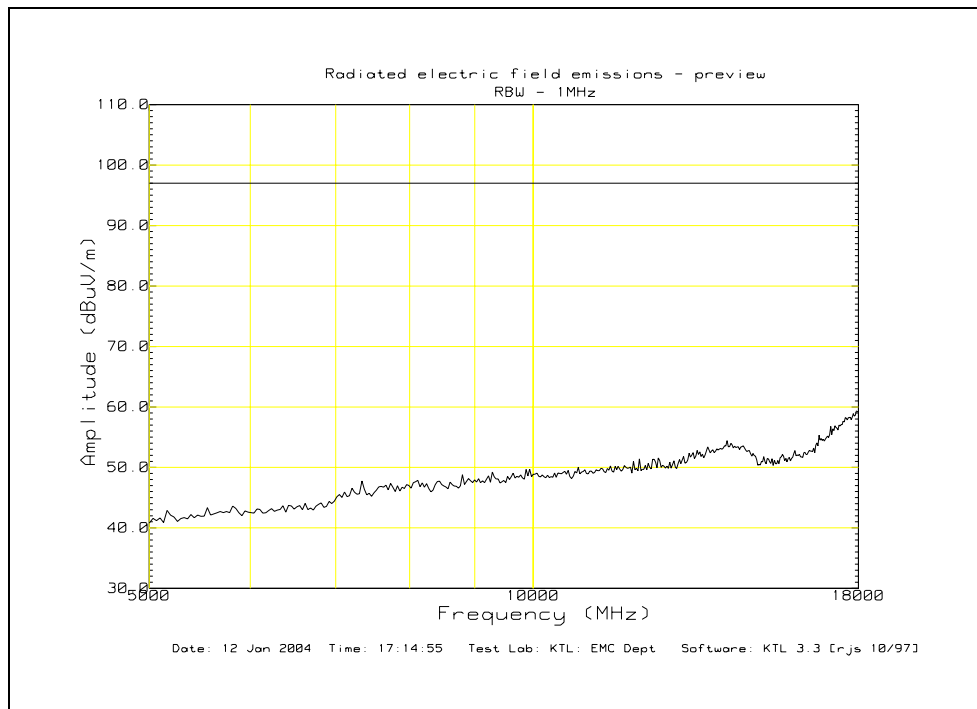




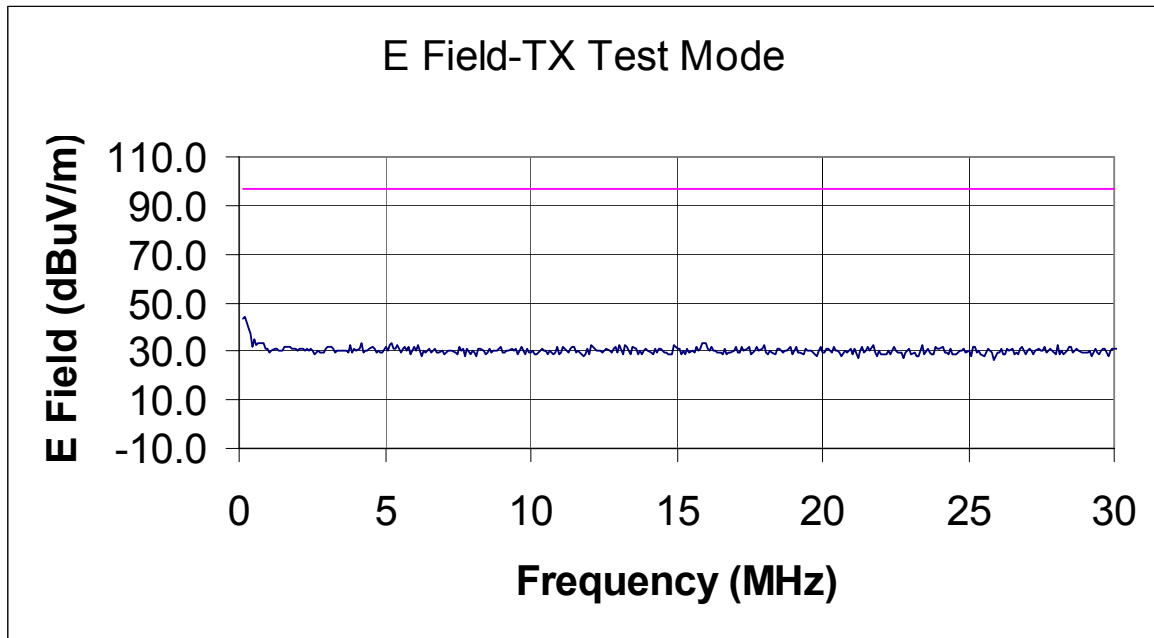
Communicator (Standby) Mode

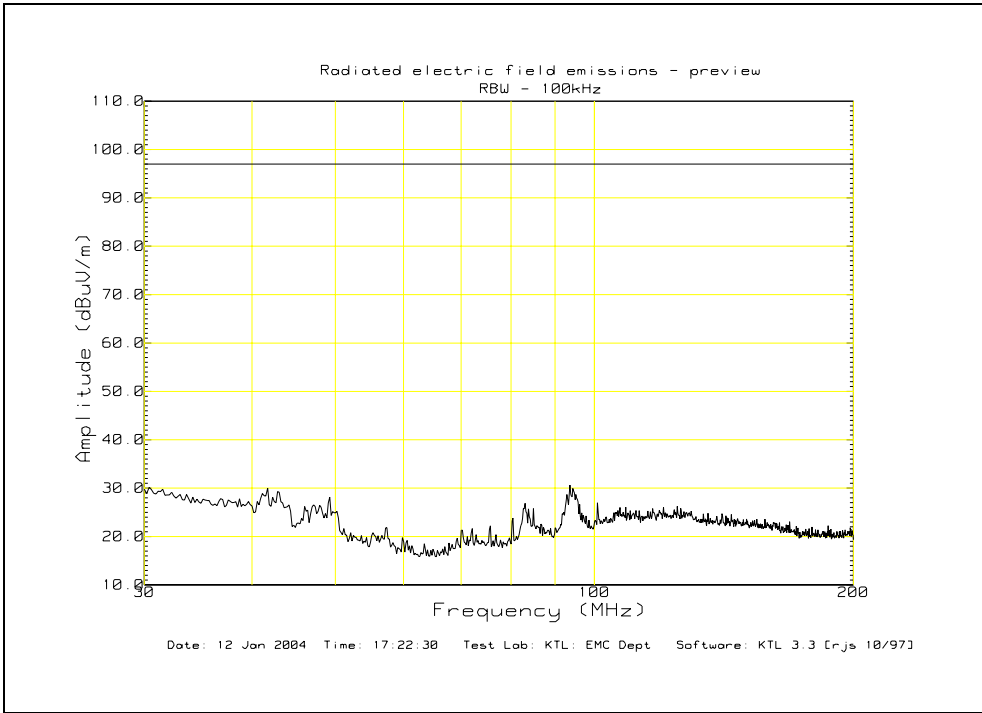


Communicator (Standby) Mode

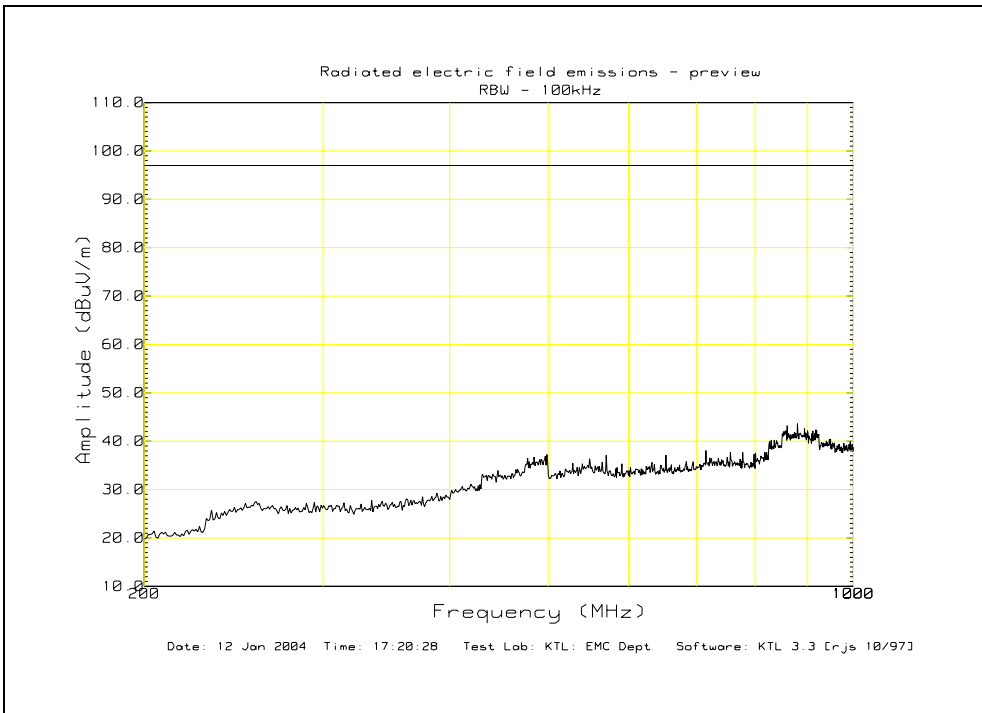


Communicator (Standby) Mode

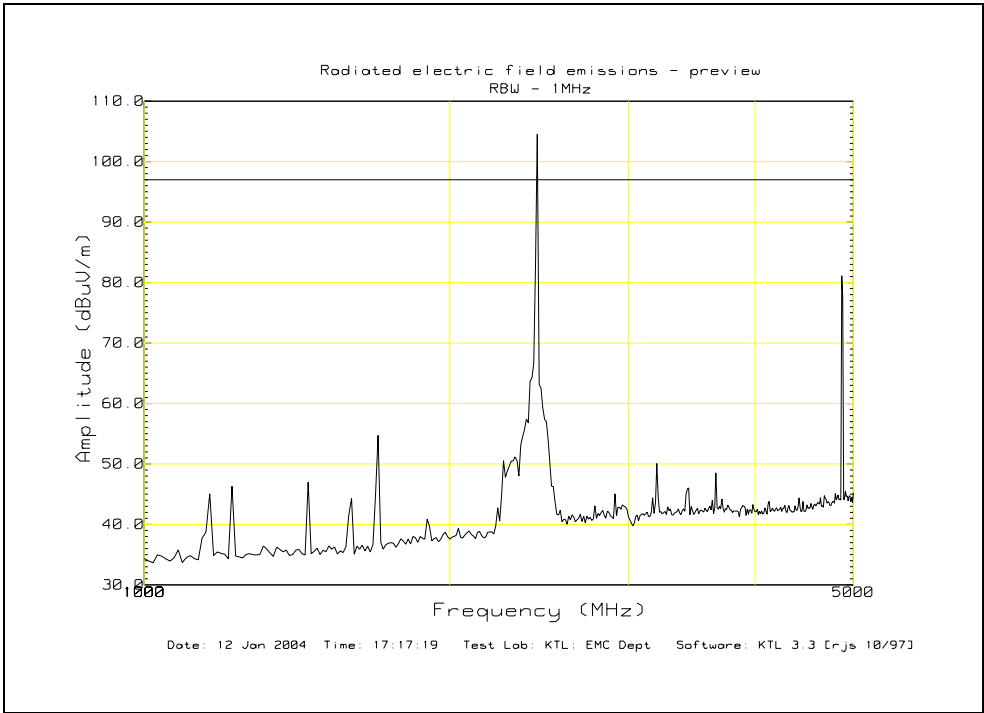




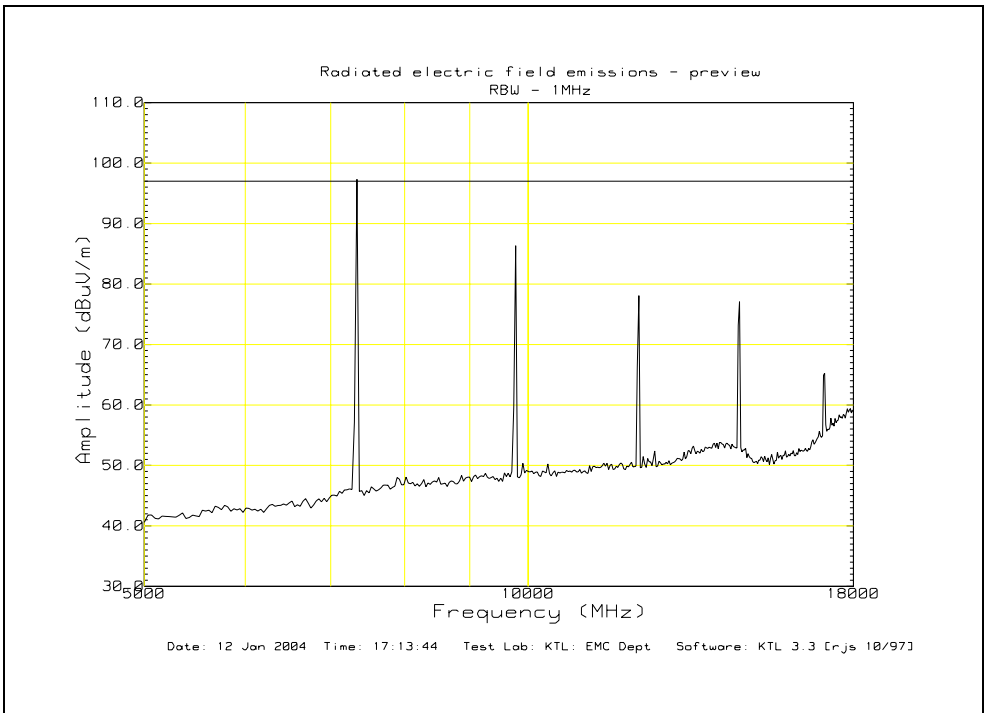
TX Test (Transmit) Mode



TX Test (Transmit) Mode

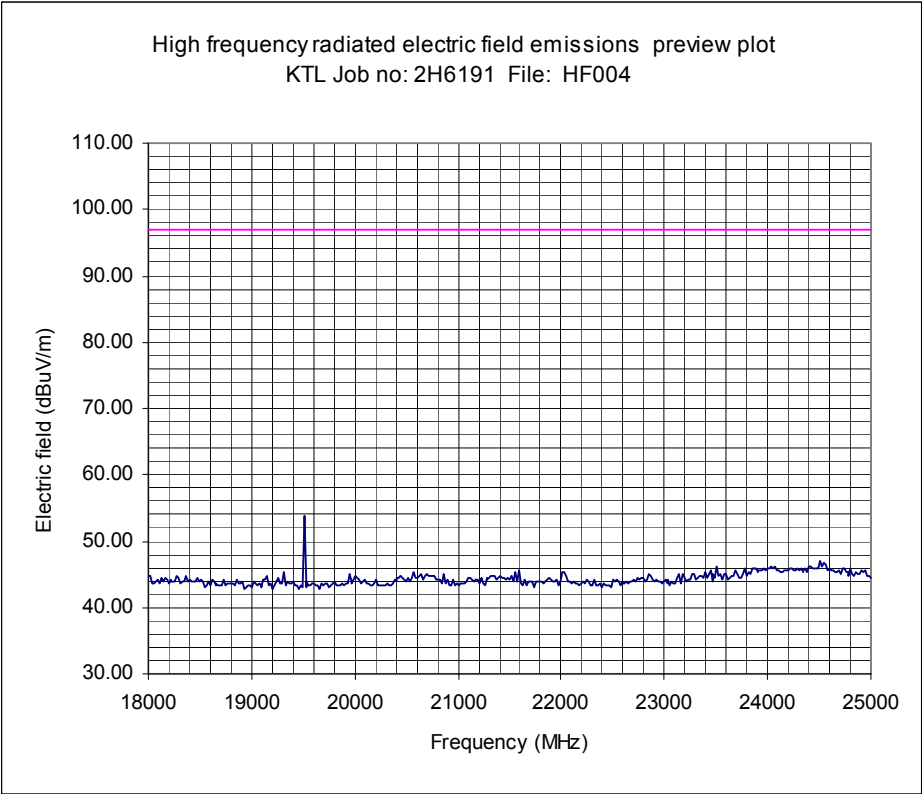


TX Test (Transmit) Mode



TX Test (Transmit) Mode





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 it's 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<br>9 kHz to 30 MHz | R & S        | 02/04/02         |
| 231    | CBL6111 | Blue BILOG Antenna<br>30 MHz to 1GHz              | Chase        | 02/05/00         |
| 214    | ESAI    | Spec Analyser/Test Receiver<br>(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

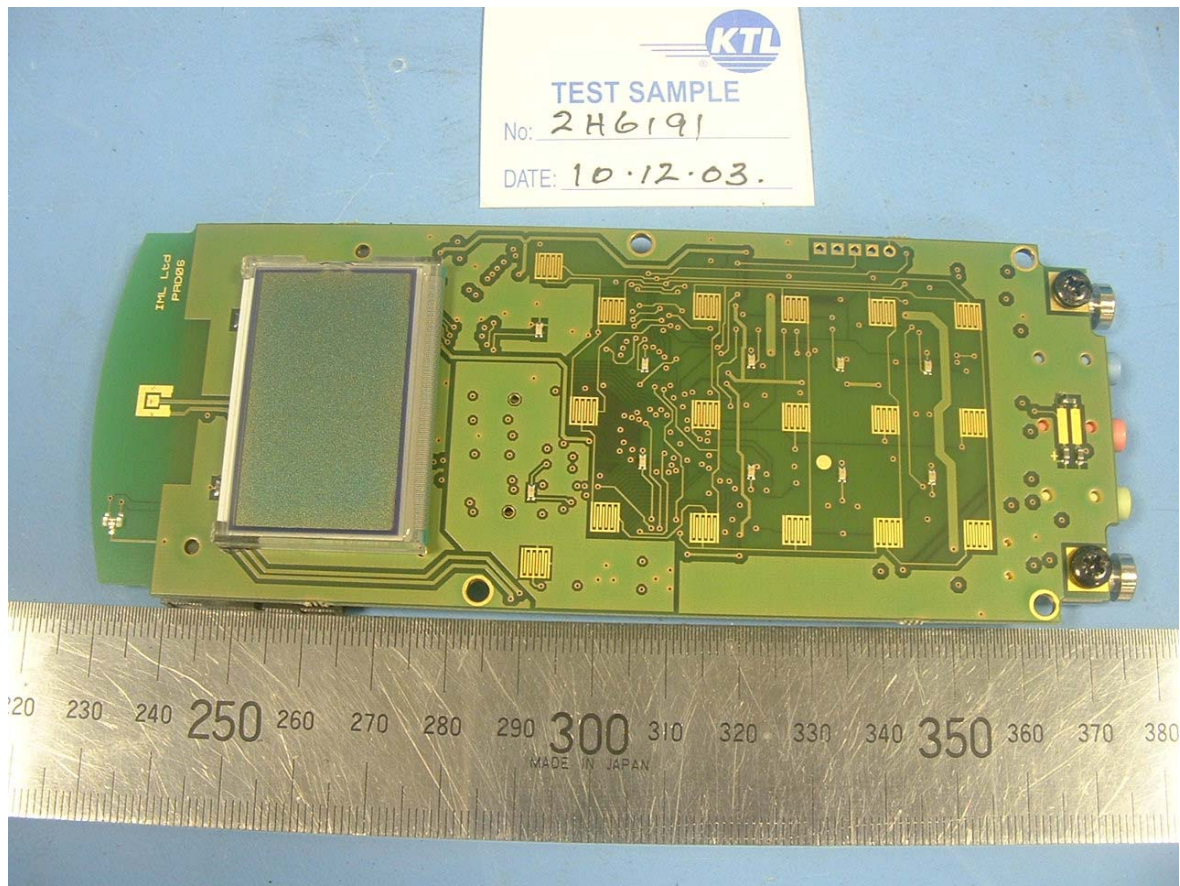


Photograph 1





Photograph 2



Photograph 3



Photograph 4





Photograph 5