

TEST REPORT NO: EU2464/6865  
COPY NO: 1 (pdf)  
ISSUE NO: 1

**REPORT ON THE EMC TESTING OF A  
Cambridge Consultants Ltd  
Iridium S1c L-Band Satellite Transceiver  
WITH RESPECT TO  
ETSI EN 301 489- 20 V1.2.1 (2002-11)**

TEST DATE: 9<sup>th</sup> – 17<sup>th</sup> February 2006

REPORT COMPILED BY:..... T Lowry

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EMC Product Manager

DATE .....13<sup>th</sup> March 2006.....

Distribution:

Copy Nos: 1 Cambridge Consultants Ltd  
2 TRL Compliance Ltd

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## SUMMARY

TEST REPORT NO: EU2464/6865

TRL WO: EU2464

PURPOSE OF TEST: Electromagnetic Compatibility - CERTIFICATION

TEST SPECIFICATION: ETSI EN 301 489-20V1.2.1 (2002-11)

EQUIPMENT UNDER TEST: Iridium S1c L-Band Satellite Transceiver

EQUIPMENT BUILD LEVEL: Production, C7484-DL-001 V1.2 rev b

EQUIPMENT SERIAL No: 7023T0 (C7478-GR-037)

TEST RESULT: Measured as Compliant  
Given the modifications (if any) described in Section 6  
(Note uncertainty values in Appendix B)

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DATE OF TEST: 9<sup>th</sup> – 17<sup>th</sup> February 2006

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## **1 INTRODUCTION**

This report EU2464/6865 presents the results of the EMC testing on a Cambridge Consultants Ltd, Iridium S1c L-Band Satellite Transceiver to specification ETSI EN 301 489-20 V1.2.1 (2002-11).

The testing was carried out for Cambridge Consultants Ltd by TRL Compliance Ltd, an independent test house, at their EMC test facility located at Up Holland, West Lancashire, England.

The test methods used were in accordance with the specifications cited in the references of ETSI EN 301 489-20 V1.2.1 (2002-11)

This report also details the configuration of the equipment under test, the test methods used and any relevant modifications where appropriate.

## **2 SYSTEM UNDER TEST**

### **2.1 Equipment Under Test (EUT)**

|                     |  |
|---------------------|--|
| Manufacturer:       | Cambridge Consultant Ltd                         |
| Name:               | Iridium S1c L-Band Satellite Transceiver         |
| Model:              | 9522A (replacing previous 9522A)                 |
| Supply Voltage:     | 4.4Vdc +/- 0.4Vdc                                |
| Build Level:        | Production, C7484-DL-001 V1.2 rev b              |
| Serial Number:      | 7023T0 (C7478-GR-037)                            |
| Software Revision:  | MDC0003  |
| Description of EUT: | Satellite Transceiver (MES Mobile Earth Station) |

### **2.2 Essential Function**

To provide a voice or data communications link via satellite.

### **2.3 Support Equipment**

1. Racal Instruments 6108B Digital Radio Test Set (Ser. No. 2455)
2. Monaco BER Test Software V3.00, operating on desktop PC.
3. Monaco DPL adaptor Box (Mambo) Model C7032-GA-002 v1.0 #120

### **2.4 Modes of Operation of EUT During Testing**

The Iridium S1c L-Band Satellite Transceiver was tested in two modes of operation (dependant on the test being performed):-

1. Powered via the DPL Adapter box with the phone in idle (not transmitting) mode.
2. Powered via the DPL Adapter box with the phone in transmit / receive mode monitoring for bit and frame errors.

- Notes:
1. For the active, transmit / receive mode, channel 1 was selected operating at a frequency of 1.616GHz.
  2. During Conducted Emissions testing the phone was powered directly from the power source via the LISN (i.e. not via the DPL Adapter box).

## 2.5 Performance Criteria

### 2.5.1 Mobile Earth Station Equipment Classification

| CLASS OF MES EQUIPMENT | RESULT OF TOO LOW PERFORMANCE  |
|------------------------|--|
| 1                      | Vehicle mounted MES (V-MES) Intended to be powered by the vehicle main battery |
| 2                      | Portable MES (P-MES) powered by a stand alone battery                          |
| 3                      | Fixed MES (F-MES) powered either by a DC or AC mains                           |

The Iridium S1c L-Band Satellite Transceiver been designated as equipment class 3.

### 2.5.2 Performance Criteria for Continuous Phenomena applied to Transmitters & Receivers (CT/CR)

During and after test, the apparatus shall continue to operate as intended. No degradation of performance or loss of function is allowed below a permissible performance level specified by the manufacturer when the apparatus is used as intended. In some cases this permissible performance level may be replaced by permissible loss of performance.

During the test the EUT shall not unintentionally transmit or change its actual operating state or stored data.

### 2.5.3 Performance Criteria for Transient Phenomena applied to Transmitters & Receivers (TT/TR)

After test, the apparatus shall continue to operate as intended. No degradation of performance or loss of function is allowed below a permissible performance level specified by the manufacturer when the apparatus is used as intended. In some cases this permissible performance level may be replaced by permissible loss of performance.

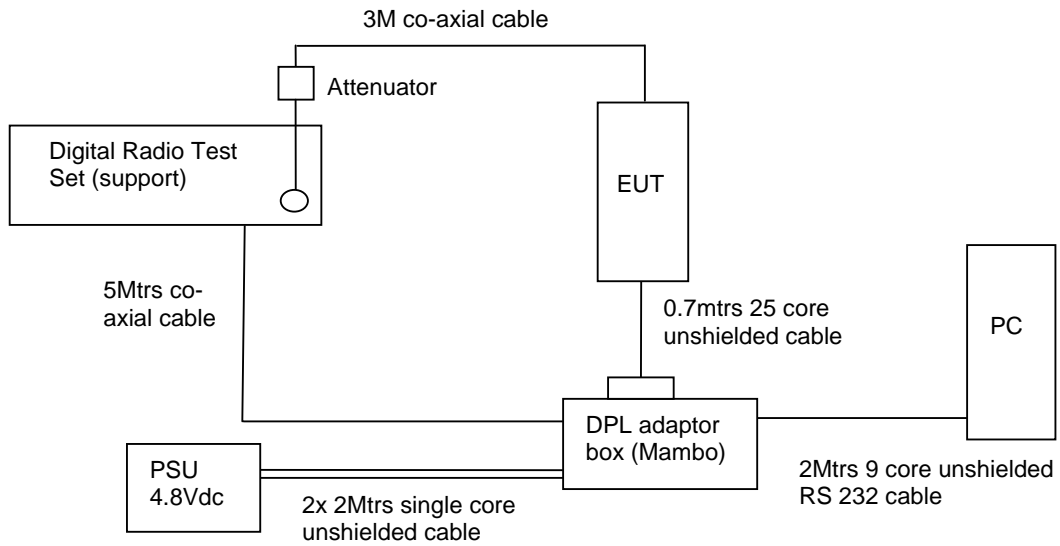
During transient type testing (electrostatic discharge, fast burst transients, etc.) a change of the frame error rate (FER), as monitored by the Racal Instruments 6108B Digital Radio Test Set, was deemed acceptable by the manufacturer, however loss of function or loss of established link was deemed unacceptable.

During the test, a degradation of performance is, however, allowed. No change of actual mode of operation (e.g. unintended transmission) or stored data is allowed.

## 2.6 Monitoring of Performance

During the idle mode of operation the EUT was connected to the spectrum analyser with the peak hold function on to monitor for unintentional transmissions. During the transmit/receive mode the EUT was connected via the antenna port to the Racal Instruments 6108B Digital Radio Test Set. The PC with the Monaco BER Test Software was used to put the EUT into a transmit/receive test mode and it was monitored for a continuous communications link, the Bit Error Rate (BER) and Frame Error Rate (FER) were also monitored for degradation via the test software.

## 2.7 Block Diagram (Transmit / Receive BER testing)



NOTE:

1. All cables are un-screened unless otherwise stated.
2. Cable lengths are as shown in diagram.

### 3 TEST SPECIFICATION, METHODS AND PROCEDURES

#### 3.1 Test Specification

ETSI EN 301 489-20 V1.2.1 (2002-11)

Title:

Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 20: Specific conditions for Mobile Earth Stations (MES) used in the Mobile Satellite Services (MSS).

#### 3.2 Clauses and Applicability

##### 3.2.1 EMC Emissions

| PHENOMENON                       | APPLICATION                       | TEST REQUIREMENT | NOTE |
|----------------------------------|-----------------------------------|------------------|------|
| Radiated emissions               | Enclosures of ancillary equipment | Not applicable   | 1    |
| Conducted emissions              | DC power input/output port        | Applicable       |      |
| Conducted emissions              | AC power input/output port        | Not applicable   | 2    |
| Harmonic current emissions       | AC mains input port               | Not applicable   | 2    |
| Voltage fluctuations and flicker | AC mains power port               | Not applicable   | 2    |
| Conducted emissions              | Telecommunication port            | Not applicable   | 3    |

Note 1: Not applicable, no ancillary equipment. Radiated emissions will be carried out under radio approval and detailed under TRL report no. RU1221/6892.

Note 2: Not applicable as the EUT had no AC mains power port.

Note 3: Not applicable as the EUT had no telecommunication port.

##### 3.2.2 EMC Immunity

| PHENOMENON                     | APPLICATION   | TEST REQUIREMENT | NOTE  |
|--------------------------------|---|------------------|-------|
| RF electromagnetic field       | Enclosure   | Applicable       |       |
| Electrostatic discharge        | Enclosure   | Applicable       |       |
| Fast transients common mode    | Signal, telecommunication and control ports, AC & DC power port | Applicable       |       |
| RF common mode                 | Signal, telecommunication and control ports, AC & DC power port | Applicable       |       |
| Transients and surges          | DC power input ports  | Not applicable   | 1     |
| Voltage Dips and interruptions | AC mains input port   | Not applicable   | 2     |
| Surges                         | AC mains power ports and telecommunication ports                | Not applicable   | 2 & 3 |

Note 1: Not applicable as the Iridium S1c L-Band Satellite Transceiver is not intended to be connected directly to a vehicles supply.

Note 2: Not applicable as the EUT had no AC mains power port.

Note 3: Not applicable as the EUT had no telecommunications port.



### 3.3 References

ETSI EN 301 489-1: Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements.

ETSI EN 301 489-20: Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 20: Specific conditions for Mobile Earth Stations (MES) used in the Mobile Satellite Services (MSS)

1999/5/EC: Council Directive on the approximation of the laws of the Member States relating to radio equipment and telecommunication terminal equipment and the mutual recognition of their conformity.

89/336/EEC: Council Directive on the approximation of the laws of the Member States relating to electromagnetic compatibility.

Directive 98/34/EC of the European Parliament and of the Council of 22 June 1998 laying down a procedure for the provisions of information in the field of technical standards and regulations

## 4 TEST CONDITIONS

### 4.1 Radiated Electromagnetic Emissions

|                                    |   |
|------------------------------------|---|
| Measurement Frequency Range        | 30MHz - 1000MHz   |
| Measurement Distance               | N/A   |
| Antenna Height                     | 1-4 metres  |
| Antenna Polarisation               | Vertical and Horizontal   |
| Receiver<br>bandwidth<br>detectors | 120kHz<br>Quasi-peak (CISPR Time constants)   |
| Ambient Conditions                 | N/A   |
| EUT Height                         | N/A   |
| Remarks                            | All recorded emissions are the maximum value observed by:<br>a) Rotating the EUT<br>b) Elevating antenna<br>c) Polarising antenna Horizontal and Vertical<br>d) Manipulation and placement of system and power cables |
| Measurement Uncertainty            | See Appendix B  |

**Note:** Not applicable, radiated emissions will be carried out under radio approval and detailed under TRL report no. RU1221/6892.

#### 4.2 Conducted Emissions – DC Power input/output Port

|  |   |
|--|---|
| Measurement Freq Range                   | 150kHz - 30MHz  |
| Line Voltage                             | 4.4V  |
| Line Frequency                           | DC  |
| Artificial Mains Network (AMN) Impedance | 50 ohm/50μH   |
| Receiver<br>bandwidth<br>detectors       | 9kHz<br>Quasi-Peak (CISPR Time Constants) and Average   |
| Configuration                            | Conforming to CISPR 16  |
| EUT Height                               | Mounted on a 0.8m high, non-conductive table  |
| Remarks                                  | Where the average limit values are met using the Quasi-peak detector, both limits were deemed to be met. Where the product had load and other power terminals, conduction at those terminals was also measured and compared with the appropriate limit. |
| Measurement Uncertainty                  | See Appendix B  |

Test equipment used for this measurement was:

| TYPE OF EQUIPMENT | MAKER/ SUPPLIER | MODEL No | SERIAL No  | TRL No | ACTUAL EQUIPMENT USED |
|-------------------|-----------------|----------|------------|--------|-----------------------|
| LISN/AMN          | R & S           | ESH3-Z5  | 863906/018 | UH05   | X                     |
| RECEIVER          | R & S           | ESHS 10  | 841429/012 | UH187  | X                     |
| SOFTWARE          | CHASE           | CIS9942  | V4.31      | N/A    | X                     |

Note: During Conducted Emissions testing a NAL Research Corporation breakout-box was fitted in-line to the power / signal connector on the EUT.

#### 4.3 Conducted Emissions – AC Power input/output Port

|  |   |
|--|---|
| Measurement Freq Range                   | 150kHz - 30MHz  |
| Line Voltage                             | N/A   |
| Line Frequency                           | N/A   |
| Artificial Mains Network (AMN) Impedance | 50 ohm/50μH   |
| Receiver                                 |   |
| Bandwidth                                | 9kHz  |
| Detectors                                | Quasi-Peak (CISPR Time Constants) and Average   |
| Configuration                            | Conforming to CISPR 16  |
| EUT Height                               | N/A   |
| Remarks                                  | Where the average limit values are met using the Quasi-peak detector, both limits were deemed to be met. Where the product had load and other power terminals, conduction at those terminals was also measured and compared with the appropriate limit. |
| Measurement Uncertainty                  | See Appendix B  |

**Note:** Not applicable as the EUT had no AC Power input/output Port.

Test equipment used for this measurement was:

| TYPE OF EQUIPMENT | MAKER/SUPPLIER | MODEL No | SERIAL No   | TRL No | ACTUAL EQUIPMENT USED |
|-------------------|----------------|----------|-------------|--------|-----------------------|
| LISN/AMN          | R & S          | ESH3-Z5  | 8407 31/015 | UH195  |                       |
| RECEIVER          | R & S          | ESHS 10  | 830051/01   | UH003  |                       |
| SOFTWARE          | R&S            | 1082     | 2.03        | N/A    |                       |

#### 4.4 Harmonic Current Emissions

Not applicable as the EUT had no AC mains Power input Port.

#### 4.5 Voltage Fluctuations and Flicker

Not applicable as the EUT had no AC mains Power input Port.

##### 4.5.1 Description

- A. The equipment is jointly manufactured by 'Spitzenberger and Spies GmbH' and 'Bioconsult Ingegneria Dei Sistemi S.P.A'. The type description of our analyser is 'B10'.
- B. For class D equipment the limits for harmonic currents are calculated for each 320ms time window (for a 50Hz voltage). Both the input voltage are measured continuously and simultaneously, allowing calculation of the input power and thus the setting of dynamic class D harmonic current limits against this input power.
- C. For class B equipment, the B10 uses the value 2.25 (being  $1.5 \times 1.5$ ) in evaluating compliance to EN61000-3-2.

Test equipment for this test was:

| TYPE OF EQUIPMENT | MAKER/SUPPLIER | MODEL No | SERIAL No | TRL No | ACTUAL EQUIPMENT USED |
|-------------------|----------------|----------|-----------|--------|-----------------------|
| FLICKER UNIT      | SCHAFFNER      | INA2151  | 71976     | UH152  |                       |
| PROFLINE          | SCHAFFNER      | 2105     | 54544     | UH151  |                       |

#### 4.6 RF Electro-magnetic Field

|                                  |                                       |
|----------------------------------|---------------------------------------|
| Frequency Range                  | 80MHz to 1000MHz & 1400MHz to 2000MHz |
| Test Level                       | 3 V/m (unmodulated level)             |
| Modulation Type                  | Amplitude                             |
| Modulation Depth                 | 80% (with 1 kHz sinewave)             |
| Reference Standard               | ETSI EN 301 489-1                     |
| Test Method                      | EN61000-4-3                           |
| Antenna to EUT Distance          | 3 metres                              |
| Antenna Type                     | Log Periodic                          |
| Antenna Polarisation             | Vertical and Horizontal               |
| Dwell Time                       | 2.5 seconds                           |
| Frequency Step                   | 1% of momentary frequency             |
| Acceptable Performance Criterion | CT/CR (see section 2.5)               |
| EUT Test Height                  | 0.8 metres                            |
| Temperature during Test          | 22°C                                  |
| Relative Humidity during Test    | 34% Humidity                          |

##### 4.6.1 Test Method

Compliance tests were carried out using a Log Periodic transmitting antenna. The forward power from a calibration file was called up and used in a computer controlled closed loop system to generate the required RF field of 3 V/m (unmodulated level) across the frequency range by setting the output level from the signal generator. The interfering signal was amplitude modulated to a depth of 80% with a 1 kHz sinewave.

##### 4.6.2 Conditions of Test

The EUT was tested on 4 axes with the antenna both vertically and horizontally polarised with the support equipment outside the Electromagnetic Field.

The test equipment used for this test was:

| TYPE OF EQUIPMENT        | MAKER/<br>SUPPLIER   | MODEL No     | SERIAL No   | TRL No | ACTUAL<br>EQUIPMENT<br>USED |
|--------------------------|----------------------|--------------|-------------|--------|-----------------------------|
| POWER AMP                | AR                   | 100W 1000M1A | 18816       | UH103  | X                           |
| V. PROBE                 | AR                   | FP1000       | 12386       | UH20   |                             |
| FIELD MONITOR            | AR                   | FM1000       | 12379       | UH13   |                             |
| SIGNAL GEN               | MARCONI              | 2042         | 119562/021  | TRL254 | X                           |
| SIGNAL GEN.              | MARCONI              | 2023         | 119224/040  | UH105  | X                           |
| SIGNAL GEN.              | MARCONI              | 2022D        | 119215/058  | UH75   |                             |
| SIGNAL GEN               | MARCONI              | 6920         | 112224/040  | UH105  | X                           |
| FUNCTION GEN.            | THURLBY              | TG210        | 018504      | UH33   |                             |
| RF AMPLIFIER             | AR                   | 50S1G4A      | 303825      | UH167  | X                           |
| HORN ANTENNA             | AR                   | AT4002A      | 303850      | UH169  |                             |
| MAC ROOM                 | MA                   | MAC4         | 1008/1024   | UH106  | X                           |
| ISOTROPIC<br>FIELD PROBE | AR                   | FP6001       | 305347      | UH164  | X                           |
| DIR. COUPLER             | AR                   | DC 7144      | 303761      | UH165  |                             |
| DIR. COUPLER             | AR                   | DC6180       | 1006444-501 | UH125  | X                           |
| RF POWER<br>METER        | ROHDE AND<br>SCHWARZ | NRP-Z11      | 100002      | UH260  | X                           |
| RF POWER<br>SENSOR       | ROHDE AND<br>SCHWARZ | NRP          | 100511      | UH259  | X                           |
| SPECTRUM<br>ANALYSER     | HEWLETT<br>PACKARD   | 8563A        | 3147A01298  | U256   | X                           |
| HORN ANTENNA             | EATON /<br>AILTECH   | 96001        | 2623        | U223   | X                           |

#### 4.7 Electrostatic Discharge

|                                  |  |
|----------------------------------|--|
| Test Voltage Level               | ± 4kV Contact Discharge<br>± 8kV Air Discharge |
| Reference Standard               | ETSI EN 301 489-1                              |
| Test Method                      | EN61000-4-2                                    |
| Acceptable Performance Criterion | TT/TR (see section 2.5)                        |
| Temperature during Test          | 20°C   |
| Relative Humidity during Test    | 38%  |
| Atmospheric Pressure during Test | 969mb  |

##### 4.7.1 Contact Discharge

1. Horizontal coupling plane
2. Vertical coupling plane
3. EUT casing
4. Casing cover
5. Antenna TNC connector

10 discharges were applied to the pre-selected points in both positive and negative polarity.

##### 4.7.2 Air Discharge

1. 25 way D-Type connector

10 discharges were applied to the pre-selected points in both positive and negative polarity.

Test equipment used for this test was:

| TYPE OF EQUIPMENT | MAKER/SUPPLIER  | MODEL No | SERIAL No  | TRL No | ACTUAL EQUIPMENT USED |
|-------------------|-----------------|----------|------------|--------|-----------------------|
| ESD GUN           | SCHAFFNER       | NSG 435  | 1622       | UH85   | X                     |
| ESD PLUG-IN       | SCHAFFNER       | NSG 435  | 258        | UH01   |                       |
| SPECTRUM ANALYSER | HEWLETT PACKARD | 8563A    | 3147A01298 | U256   | X                     |
| HORN ANTENNA      | EATON / AILTECH | 96001    | 2623       | U223   | X                     |



#### 4.8 Fast Burst Transients Common Mode

##### 4.8.1 AC Power Ports

|                                  |                         |
|----------------------------------|-------------------------|
| Test Voltage Level               | N/A                     |
| Injection Method                 | Direct Injection        |
| Reference Standard               | ETSI EN 301 489-1       |
| Test Method                      | EN61000-4-4             |
| Duration of Test                 | 60 seconds              |
| Acceptable Performance Criterion | TT/TR (see section 2.5) |
| Temperature during Test          | N/A                     |
| Relative Humidity during Test    | N/A                     |
| Atmospheric Pressure during Test | N/A                     |
| Cables under Test                | No applicable cables    |

##### 4.8.2 DC Power Ports

|                                  |                         |
|----------------------------------|-------------------------|
| Test Voltage Level               | $\pm 0.5\text{kV}$      |
| Injection Method                 | Direct Injection        |
| Reference Standard               | ETSI EN 301 489-1       |
| Test Method                      | EN61000-4-4             |
| Duration of Test                 | 60 seconds              |
| Acceptable Performance Criterion | TT/TR (see section 2.5) |
| Temperature during Test          | 20°C                    |
| Relative Humidity during Test    | 35%                     |
| Atmospheric Pressure during Test | 967mb                   |
| Cables under Test                | 4.4Vdc supply cables    |

#### 4.8.3 Signal, Telecommunication and Control Ports

|                                  |   |
|----------------------------------|---|
| Test Voltage Level               | ± 0.5kV   |
| Injection Method                 | Capactive Coupling Clamp  |
| Reference Standard               | ETSI EN 301 489-1   |
| Test Method                      | EN61000-4-4   |
| Duration of Test                 | 60 seconds  |
| Acceptable Performance Criterion | TT/TR (see section 2.5)   |
| Temperature during Test          | 20°C  |
| Relative Humidity during Test    | 35%   |
| Atmospheric Pressure during Test | 967mb   |
| Cables under Test                | <ol style="list-style-type: none"><li>1. Antenna cable</li><li>2. 25 way D-Type connector cable</li></ol> |

#### 4.8.3 Test Method

The EUT was supplied with DC power via the interference simulator. The interference simulator introduced common mode interference to the specified level with positive and negative polarity onto the DC and signal lines for a period of 60 seconds.

The test equipment used for this testing was:

| TYPE OF EQUIPMENT | MAKER/SUPPLIER  | MODEL No    | SERIAL No    | TRL No | ACTUAL EQUIPMENT USED |
|-------------------|-----------------|-------------|--------------|--------|-----------------------|
| COUPLING CLAMP    | SCHAFFNER       | CDN 125     | 691          | UH98   | X                     |
| FBT SIMULATOR     | SCHAFFNER       | PNW2225     | 200140-042SC | UH161  | X                     |
| MAIN FRAME        | SCHAFFNER       | 400213NSG20 | 200130/556AR | UH170  | X                     |
| FBT SIMULATOR     | SCHAFFNER       | NSG 625     | 3040         | UH83   |                       |
| MAIN FRAME        | SCHAFFNER       | NSG600      | 3508         | UH82   |                       |
| SPECTRUM ANALYSER | HEWLETT PACKARD | 8563A       | 3147A01298   | U256   | X                     |
| HORN ANTENNA      | EATON / AILTECH | 96001       | 2623         | U223   | X                     |

#### 4.9 RF Common Mode

|                                  |   |
|----------------------------------|---|
| Frequency Range                  | 0.15 - 80 MHz   |
| Test Level                       | 3 V (rms) - unmodulated level (defined as the equivalent current into a 150Ω load)                                |
| Modulation Type                  | Amplitude   |
| Modulation Depth                 | 80% (with 1 kHz sinewave)   |
| Reference Standard               | ETSI EN 301 489-1   |
| Test Method                      | EN 61000-4-6  |
| Injection Method                 | CDN / Injection Clamp   |
| Dwell Time                       | 2.5 seconds   |
| Frequency Step                   | 1% of momentary frequency   |
| Acceptable Performance Criterion | CT/CR (see section 2.5)   |
| Temperature during Test          | 20°C  |
| Relative Humidity during Test    | 35% Humidity  |
| Cables under Test                | <ol style="list-style-type: none"><li>1. Antenna cable</li><li>2. All cables to 25 way D-Type connector</li></ol> |

##### 4.9.1 Test Method

The EUT was powered via a CDN/Injection clamp. The interfering signal was applied to the line under test whilst incrementally sweeping the frequency range.

The test equipment used for this test was:

| TYPE OF EQUIPMENT       | MAKER/SUPPLIER  | MODEL No | SERIAL No  | TRL No | ACTUAL EQUIPMENT USED |
|-------------------------|-----------------|----------|------------|--------|-----------------------|
| POWER AMP               | AR              | 75A250   | 18951      | UH104  | X                     |
| CDN (2 wire)            | MEB             | M2       | 12109      | UH135  |                       |
| CDN (25 way D)          | MEB             | S-25     | 12397      | UH113  |                       |
| SIGNAL GEN.             | MARCONI         | 2022D    | 119224/035 | UH89   | X                     |
| CURRENT INJECTION PROBE | SOLAR           | 9120-IN  | 956419     | UH86   |                       |
| CURRENT INJECTION PROBE | SOLAR           | 9108-IN  | 972531     | UH148  | X                     |
| SPECTRUM ANALYSER       | HEWLETT PACKARD | 8563A    | 3147A01298 | U256   | X                     |
| HORN ANTENNA            | EATON / AILTECH | 96001    | 2623       | U223   | X                     |

#### 4.10 Transients and Surges

|                                  |   |
|----------------------------------|---|
| Pulses Tested                    | Pulse 1<br>Pulse 2<br>Pulse 3a<br>Pulse 3b<br>Pulse 4<br>Pulse 5<br>Pulse 7               |
| Pulse severity Level             | II  |
| Reference Standard               | ETSI EN 301 489-1   |
| Test Method Setup                | ISO 7637-1  |
| Acceptable Performance Criterion | Pulse 3a and 3b = CP (see section 2.5)<br>Pulse 1a, 1b, 2, 4 and 5 = TP (see section 2.5) |
| Temperature during Test          | N/A   |
| Relative Humidity during Test    | N/A   |
| Atmospheric Pressure during Test | N/A   |
| Cables under Test                | N/A   |

**Note:** Not applicable as the EUT is not intended to be directly connected to a vehicles supply.

##### 4.12.1 Test Method

The EUT was supplied with DC power via the pulse simulator, which introduced transients and surges to the specified level with positive and/or negative polarity on to the DC lines.

Test equipment used for this test was:

| TYPE OF EQUIPMENT      | MAKER/SUPPLIER | MODEL No | SERIAL No  | TRL No | ACTUAL EQUIPMENT USED |
|------------------------|----------------|----------|------------|--------|-----------------------|
| TEST SYSTEM MAIN FRAME | SCHAFFNER      | NSG 5000 | IN5094-086 | 386    |                       |
| TRANSIENT GENERATOR    | SCHAFFNER      | NSG 5001 | AR5094-097 | 387    |                       |
| BURST GENERATOR        | SCHAFFNER      | NSG 5003 | AR5194-143 | 388    |                       |
| HIGH ENERGY GENERATOR  | SCHAFFNER      | NSG 5005 | AR5194-026 | 389    |                       |
| BATTERY SIMULATOR      | SCHAFFNER      | NSG 5004 | IN0995-021 | 390    |                       |

#### 4.11 Voltage Dips and Interruptions

|                                  |  |
|----------------------------------|--|
| Voltage Reductions               | 30%, 60% and >95%  |
| Reduction Duration               | 10ms for 30% reduction<br>100ms for 60% reduction<br>5000ms for >95% reduction |
| Number of Reductions             | 3  |
| Repetition rate                  | 10 second intervals  |
| Acceptable Performance Criterion | 30% and 60% = CT/CR (see section 2.5)<br>>95% = 30% = TT/TR (see section 2.5)  |
| Reference Standard               | ETSI EN 301 489-1  |
| Test Method                      | EN61000-4-11   |
| Temperature during Test          | N/A  |
| Relative Humidity during Test    | N/A  |
| Atmospheric Pressure during test | N/A  |
| Cables under Test                | No applicable cables   |

**Note:** Not applicable as the EUT had no AC power port.

##### 4.11.1 Test Method

The EUT was supplied with AC power via the test generator. The Voltage Dips and Interruptions were applied to the AC lines for the duration times shown above.

The test equipment used for this test was:

| TYPE OF EQUIPMENT    | MAKER/SUPPLIER  | MODEL No     | SERIAL No     | TRL No | ACTUAL EQUIPMENT USED |
|----------------------|-----------------|--------------|---------------|--------|-----------------------|
| NSG2050 MAIN FRAME   | SCHAFFNER       | 400213NSG 20 | 200130/556 AR | UH170  |                       |
| 2050 V. DIPS UNIT    | SCHAFFNER       | PNW2003      | 200138-005SC  | UH160  |                       |
| TEMP/HUMID BAROMETER | RS              | N/A          | N/A           | UH110  |                       |
| SPECTRUM ANALYSER    | HEWLETT PACKARD | 8563A        | 3147A0129 8   | U256   |                       |
| HORN ANTENNA         | EATON / AILTECH | 96001        | 2623          | U223   |                       |

#### 4.12 Surges

|                                  |  |
|----------------------------------|--|
| Test Voltage Level               | ±0.5 kV – line to line<br>±1.0 kV – line to ground |
| Injection Method                 | Line to Line<br>Line to Ground                     |
| Reference Standard               | ETSI EN 301 489-1                                  |
| Test Method Set-up               | EN61000-4-5  |
| Number of Discharges             | 5 per Voltage Polarity                             |
| Repetition rate                  | Minimum of 1 Discharge per minute                  |
| Phase angles                     | 0°, 90°, 180°, 270°                                |
| Acceptable Performance Criterion | TT/TR (see section 2.5)                            |
| Temperature during Test          | N/A  |
| Relative Humidity during Test    | N/A  |
| Atmospheric Pressure during Test | N/A  |
| Cables under Test                | No applicable cables                               |

**Note:** Not applicable as the EUT had no AC mains or telecommunications ports.

##### 4.12.1 Test Method

The EUT was supplied with AC power via the surge generator, which introduced a pulse of differential or common mode interference to the specified level with positive and negative polarity on to the AC lines.

Test equipment used for this test was:

| TYPE OF EQUIPMENT   | MAKER/SUPPLIER | MODEL No     | SERIAL No     | TRL No | ACTUAL EQUIPMENT USED |
|---------------------|----------------|--------------|---------------|--------|-----------------------|
| NSG2050 MAIN FRAME  | SCHAFFNER      | 400213NSG 20 | 200130/556 AR | UH170  |                       |
| 2050 SURGE UNIT     | SCHAFFNER      | PNW 2050     | 200130-556AR  | UH159  |                       |
| TEMP/HUMIDITY METER | RS             | NONE         | NONE          | UH110  |                       |

## 5 RESULTS OF TEST

### 5.1 Radiated Electromagnetic Emissions

Test not applicable, no ancillary equipment (see section 4.1)

### 5.2 Conducted Emissions – DC Power input/output Port

| MEASUREMENT  | FREQUENCY | EMISSION        | LIMIT           |
|--|-----------|-----------------|-----------------|
| Power Line Conduction<br>Quasi-Peak Detector<br>Graph A1 | 0.265MHz  | 56.33dB $\mu$ V | 61.27dB $\mu$ V |
| Power Line Conduction<br>Average Detector<br>Graph A1    | 0.3MHz    | 46.54dB $\mu$ V | 50.24dB $\mu$ V |

### 5.3 Conducted Emissions – AC Power input/output Port

| MEASUREMENT  | FREQUENCY | EMISSION | LIMIT |
|--|-----------|----------|-------|
| Power Line Conduction<br>Quasi-Peak Detector<br>Graph A2 | N/A       |          |       |
| Power Line Conduction<br>Average Detector<br>Graph A2    | N/A       |          |       |

**Note:** Not applicable as the EUT had no AC power input/output port.

### 5.4 Conducted Emissions – Telecommunication Port

| MEASUREMENT  | FREQUENCY | EMISSION | LIMIT |
|--|-----------|----------|-------|
| Power Line Conduction<br>Quasi-Peak Detector<br>Graph A3 | N/A       |          |       |
| Power Line Conduction<br>Average Detector<br>Graph A3    | N/A       |          |       |

**Note:** Not applicable as the EUT had no telecommunication port.

### 5.5 Harmonic Current Emissions

Not applicable as the EUT had no AC power input port.

### 5.6 Voltage Fluctuations and Flicker

Not applicable as the EUT had no AC power input port.

## 5.7 RF Electromagnetic Field

| LEVEL<br>(V/m) | PERFORMANCE CRITERIA |          |
|----------------|----------------------|----------|
|                | ACTUAL               | REQUIRED |
| 3              | CT/CR                | CT/CR    |

The actual frequencies (in MHz) used for this test were:

|         |   |         |   |         |   |         |   |         |   |         |   |          |   |
|---------|---|---------|---|---------|---|---------|---|---------|---|---------|---|----------|---|
| 80.000  | P | 115.606 | P | 167.060 | P | 241.414 | P | 348.862 | P | 504.132 | P | 728.509  | P |
| 80.800  | P | 116.762 | P | 168.730 | P | 243.828 | P | 352.350 | P | 509.173 | P | 735.794  | P |
| 81.608  | P | 117.930 | P | 170.418 | P | 246.266 | P | 355.874 | P | 514.265 | P | 743.152  | P |
| 82.424  | P | 119.109 | P | 172.122 | P | 248.729 | P | 359.433 | P | 519.408 | P | 750.584  | P |
| 83.248  | P | 120.300 | P | 173.843 | P | 251.216 | P | 363.027 | P | 524.602 | P | 758.089  | P |
| 84.081  | P | 121.503 | P | 175.581 | P | 253.729 | P | 366.657 | P | 529.848 | P | 765.670  | P |
| 84.922  | P | 122.718 | P | 177.337 | P | 256.266 | P | 370.324 | P | 535.146 | P | 773.327  | P |
| 85.771  | P | 123.945 | P | 179.111 | P | 258.828 | P | 374.027 | P | 540.498 | P | 781.060  | P |
| 86.629  | P | 125.185 | P | 180.902 | P | 261.417 | P | 377.767 | P | 545.903 | P | 788.871  | P |
| 87.495  | P | 126.437 | P | 182.711 | P | 264.031 | P | 381.545 | P | 551.362 | P | 796.760  | P |
| 88.370  | P | 127.701 | P | 184.538 | P | 266.671 | P | 385.360 | P | 556.875 | P | 804.727  | P |
| 89.253  | P | 128.978 | P | 186.383 | P | 269.338 | P | 389.214 | P | 562.444 | P | 812.775  | P |
| 90.146  | P | 130.268 | P | 188.247 | P | 272.031 | P | 393.106 | P | 568.068 | P | 820.902  | P |
| 91.047  | P | 131.571 | P | 190.129 | P | 274.752 | P | 397.037 | P | 573.749 | P | 829.111  | P |
| 91.958  | P | 132.886 | P | 192.031 | P | 277.499 | P | 401.008 | P | 579.487 | P | 837.402  | P |
| 92.878  | P | 134.215 | P | 193.951 | P | 280.274 | P | 405.018 | P | 585.281 | P | 845.776  | P |
| 93.806  | P | 135.557 | P | 195.891 | P | 283.077 | P | 409.068 | P | 591.134 | P | 854.234  | P |
| 94.744  | P | 136.913 | P | 197.850 | P | 285.908 | P | 413.158 | P | 597.046 | P | 862.777  | P |
| 95.692  | P | 138.282 | P | 199.828 | P | 288.767 | P | 417.290 | P | 603.016 | P | 871.404  | P |
| 96.649  | P | 139.665 | P | 201.826 | P | 291.654 | P | 421.463 | P | 609.046 | P | 880.118  | P |
| 97.615  | P | 141.061 | P | 203.845 | P | 294.571 | P | 425.678 | P | 615.137 | P | 888.920  | P |
| 98.591  | P | 142.472 | P | 205.883 | P | 297.517 | P | 429.934 | P | 621.288 | P | 897.809  | P |
| 99.577  | P | 143.897 | P | 207.942 | P | 300.492 | P | 434.234 | P | 627.501 | P | 906.787  | P |
| 100.573 | P | 145.336 | P | 210.021 | P | 303.497 | P | 438.576 | P | 633.776 | P | 915.855  | P |
| 101.579 | P | 146.789 | P | 212.121 | P | 306.532 | P | 442.962 | P | 640.114 | P | 925.013  | P |
| 102.595 | P | 148.257 | P | 214.243 | P | 309.597 | P | 447.391 | P | 646.515 | P | 934.263  | P |
| 103.621 | P | 149.740 | P | 216.385 | P | 312.693 | P | 451.865 | P | 652.980 | P | 943.606  | P |
| 104.657 | P | 151.237 | P | 218.549 | P | 315.820 | P | 456.384 | P | 659.510 | P | 953.042  | P |
| 105.703 | P | 152.749 | P | 220.734 | P | 318.978 | P | 460.948 | P | 666.105 | P | 962.572  | P |
| 106.760 | P | 154.277 | P | 222.942 | P | 322.168 | P | 465.557 | P | 672.766 | P | 972.198  | P |
| 107.828 | P | 155.820 | P | 225.171 | P | 325.390 | P | 470.213 | P | 679.494 | P | 981.920  | P |
| 108.906 | P | 157.378 | P | 227.423 | P | 328.644 | P | 474.915 | P | 686.289 | P | 991.739  | P |
| 109.995 | P | 158.952 | P | 229.697 | P | 331.930 | P | 479.664 | P | 693.151 | P | 1000.000 | P |
| 111.095 | P | 160.541 | P | 231.994 | P | 335.249 | P | 484.461 | P | 700.083 | P |          |   |
| 112.206 | P | 162.146 | P | 234.314 | P | 338.602 | P | 489.305 | P | 707.084 | P |          |   |
| 113.328 | P | 163.768 | P | 236.657 | P | 341.988 | P | 494.198 | P | 714.155 | P |          |   |
| 114.462 | P | 165.406 | P | 239.024 | P | 345.408 | P | 499.140 | P | 721.296 | P |          |   |

The letter in the adjacent column to the frequency identifies,  
P = EUT passes at this frequency  
F = EUT fails at this frequency  
E = EUT exclusion band

**Note:** 1.4GHz – 2GHz continued overleaf...



The actual frequencies used for 1.4GHz – 2GHz were:

|          |   |          |   |          |   |          |   |
|----------|---|----------|---|----------|---|----------|---|
| 1400.000 | P | 1561.936 | P | 1742.602 | P | 1944.166 | P |
| 1414.000 | P | 1577.555 | P | 1760.028 | P | 1963.608 | P |
| 1428.140 | P | 1593.331 | P | 1777.629 | P | 1983.244 | P |
| 1442.421 | P | 1609.264 | P | 1795.405 | P | 2000.000 | P |
| 1456.846 | P | 1625.357 | P | 1813.359 | P |          |   |
| 1471.414 | P | 1641.610 | P | 1831.492 | P |          |   |
| 1486.128 | P | 1658.026 | P | 1849.807 | P |          |   |
| 1500.989 | P | 1674.606 | P | 1868.305 | P |          |   |
| 1515.999 | P | 1691.353 | P | 1886.988 | P |          |   |
| 1531.159 | P | 1708.266 | P | 1905.858 | P |          |   |
| 1546.471 | P | 1725.349 | P | 1924.917 | P |          |   |

The letter in the adjacent column to the frequency identifies,  
P = EUT passes at this frequency  
F = EUT fails at this frequency  
E = EUT exclusion band

## 5.8 Electrostatic Discharge

| TEST POINTS | LEVEL<br>(kV) | PERFORMANCE CRITERIA |          |
|-------------|---------------|----------------------|----------|
|             |               | ACTUAL               | REQUIRED |
| See 4.7.1   | $\pm 4$       | TT/TR                | TT/TR    |
| See 4.7.2   | $\pm 8$       | TT/TR                | TT/TR    |

**Note:** During electrostatic discharge testing, when applied to the casing and antenna connector, a small increase in FER (rate and event) occurred, however this was deemed acceptable and the rate decrease after the phenomena was removed.

## 5.9 Fast Transients Common Mode

| TEST POINTS               | LEVEL<br>(kV) | PERFORMANCE CRITERIA |          |
|---------------------------|---------------|----------------------|----------|
|                           |               | ACTUAL               | REQUIRED |
| DC input                  | $\pm 0.5$     | CT/CR                | TT/TR    |
| 25 way input/output cable | $\pm 0.5$     | CT/CR                | TT/TR    |
| Antenna cable             | $\pm 0.5$     | CT/CR                | TT/TR    |

## 5.10 RF Common Mode

| LEVEL<br>(Vrms) | PERFORMANCE CRITERIA |          |
|-----------------|----------------------|----------|
|                 | ACTUAL               | REQUIRED |
| 3               | CT/CR                | CT/CR    |

The actual frequencies (in MHz) used for this test were:

|       |   |       |   |       |   |        |   |        |   |        |   |        |   |        |   |        |   |
|-------|---|-------|---|-------|---|--------|---|--------|---|--------|---|--------|---|--------|---|--------|---|
| 0.150 | P | 2.250 | P | 4.350 | P | 6.673  | P | 10.134 | P | 15.392 | P | 23.377 | P | 35.504 | P | 53.924 | P |
| 0.200 | P | 2.300 | P | 4.400 | P | 6.739  | P | 10.235 | P | 15.546 | P | 23.610 | P | 35.859 | P | 54.463 | P |
| 0.250 | P | 2.350 | P | 4.450 | P | 6.807  | P | 10.338 | P | 15.701 | P | 23.847 | P | 36.218 | P | 55.007 | P |
| 0.300 | P | 2.400 | P | 4.500 | P | 6.875  | P | 10.441 | P | 15.858 | P | 24.085 | P | 36.580 | P | 55.557 | P |
| 0.350 | P | 2.450 | P | 4.550 | P | 6.943  | P | 10.546 | P | 16.017 | P | 24.326 | P | 36.946 | P | 56.113 | P |
| 0.400 | P | 2.500 | P | 4.600 | P | 7.013  | P | 10.651 | P | 16.177 | P | 24.569 | P | 37.315 | P | 56.674 | P |
| 0.450 | P | 2.550 | P | 4.650 | P | 7.083  | P | 10.758 | P | 16.339 | P | 24.815 | P | 37.689 | P | 57.241 | P |
| 0.500 | P | 2.600 | P | 4.700 | P | 7.154  | P | 10.865 | P | 16.502 | P | 25.063 | P | 38.065 | P | 57.813 | P |
| 0.550 | P | 2.650 | P | 4.750 | P | 7.225  | P | 10.974 | P | 16.667 | P | 25.314 | P | 38.446 | P | 58.391 | P |
| 0.600 | P | 2.700 | P | 4.800 | P | 7.298  | P | 11.084 | P | 16.834 | P | 25.567 | P | 38.831 | P | 58.975 | P |
| 0.650 | P | 2.750 | P | 4.850 | P | 7.371  | P | 11.194 | P | 17.002 | P | 25.822 | P | 39.219 | P | 59.565 | P |
| 0.700 | P | 2.800 | P | 4.900 | P | 7.444  | P | 11.306 | P | 17.172 | P | 26.081 | P | 39.611 | P | 60.161 | P |
| 0.750 | P | 2.850 | P | 4.950 | P | 7.519  | P | 11.419 | P | 17.344 | P | 26.341 | P | 40.007 | P | 60.762 | P |
| 0.800 | P | 2.900 | P | 5.000 | P | 7.594  | P | 11.534 | P | 17.517 | P | 26.605 | P | 40.407 | P | 61.370 | P |
| 0.850 | P | 2.950 | P | 5.050 | P | 7.670  | P | 11.649 | P | 17.692 | P | 26.871 | P | 40.811 | P | 61.984 | P |
| 0.900 | P | 3.000 | P | 5.101 | P | 7.747  | P | 11.765 | P | 17.869 | P | 27.140 | P | 41.219 | P | 62.604 | P |
| 0.950 | P | 3.050 | P | 5.152 | P | 7.824  | P | 11.883 | P | 18.048 | P | 27.411 | P | 41.632 | P | 63.230 | P |
| 1.000 | P | 3.100 | P | 5.203 | P | 7.902  | P | 12.002 | P | 18.228 | P | 27.685 | P | 42.048 | P | 63.862 | P |
| 1.050 | P | 3.150 | P | 5.255 | P | 7.981  | P | 12.122 | P | 18.411 | P | 27.962 | P | 42.468 | P | 64.500 | P |
| 1.100 | P | 3.200 | P | 5.308 | P | 8.061  | P | 12.243 | P | 18.595 | P | 28.242 | P | 42.893 | P | 65.146 | P |
| 1.150 | P | 3.250 | P | 5.361 | P | 8.142  | P | 12.366 | P | 18.781 | P | 28.524 | P | 43.322 | P | 65.797 | P |
| 1.200 | P | 3.300 | P | 5.414 | P | 8.223  | P | 12.489 | P | 18.969 | P | 28.809 | P | 43.755 | P | 66.455 | P |
| 1.250 | P | 3.350 | P | 5.468 | P | 8.305  | P | 12.614 | P | 19.158 | P | 29.097 | P | 44.193 | P | 67.119 | P |
| 1.300 | P | 3.400 | P | 5.523 | P | 8.388  | P | 12.740 | P | 19.350 | P | 29.388 | P | 44.635 | P | 67.791 | P |
| 1.350 | P | 3.450 | P | 5.578 | P | 8.472  | P | 12.868 | P | 19.543 | P | 29.682 | P | 45.081 | P | 68.469 | P |
| 1.400 | P | 3.500 | P | 5.634 | P | 8.557  | P | 12.996 | P | 19.739 | P | 29.979 | P | 45.532 | P | 69.153 | P |
| 1.450 | P | 3.550 | P | 5.690 | P | 8.643  | P | 13.126 | P | 19.936 | P | 30.279 | P | 45.987 | P | 69.845 | P |
| 1.500 | P | 3.600 | P | 5.747 | P | 8.729  | P | 13.258 | P | 20.135 | P | 30.582 | P | 46.447 | P | 70.543 | P |
| 1.550 | P | 3.650 | P | 5.805 | P | 8.816  | P | 13.390 | P | 20.337 | P | 30.887 | P | 46.911 | P | 71.249 | P |
| 1.600 | P | 3.700 | P | 5.863 | P | 8.905  | P | 13.524 | P | 20.540 | P | 31.196 | P | 47.381 | P | 71.961 | P |
| 1.650 | P | 3.750 | P | 5.922 | P | 8.994  | P | 13.659 | P | 20.746 | P | 31.508 | P | 47.854 | P | 72.681 | P |
| 1.700 | P | 3.800 | P | 5.981 | P | 9.083  | P | 13.796 | P | 20.953 | P | 31.823 | P | 48.333 | P | 73.408 | P |
| 1.750 | P | 3.850 | P | 6.041 | P | 9.174  | P | 13.934 | P | 21.163 | P | 32.142 | P | 48.816 | P | 74.142 | P |
| 1.800 | P | 3.900 | P | 6.101 | P | 9.266  | P | 14.073 | P | 21.374 | P | 32.463 | P | 49.304 | P | 74.883 | P |
| 1.850 | P | 3.950 | P | 6.162 | P | 9.359  | P | 14.214 | P | 21.588 | P | 32.788 | P | 49.797 | P | 75.632 | P |
| 1.900 | P | 4.000 | P | 6.224 | P | 9.452  | P | 14.356 | P | 21.804 | P | 33.115 | P | 50.295 | P | 76.388 | P |
| 1.950 | P | 4.050 | P | 6.286 | P | 9.547  | P | 14.500 | P | 22.022 | P | 33.447 | P | 50.798 | P | 77.152 | P |
| 2.000 | P | 4.100 | P | 6.349 | P | 9.642  | P | 14.645 | P | 22.242 | P | 33.781 | P | 51.306 | P | 77.924 | P |
| 2.050 | P | 4.150 | P | 6.412 | P | 9.739  | P | 14.791 | P | 22.465 | P | 34.119 | P | 51.819 | P | 78.703 | P |
| 2.100 | P | 4.200 | P | 6.476 | P | 9.836  | P | 14.939 | P | 22.689 | P | 34.460 | P | 52.338 | P | 79.490 | P |
| 2.150 | P | 4.250 | P | 6.541 | P | 9.934  | P | 15.088 | P | 22.916 | P | 34.805 | P | 52.861 | P | 80.000 | P |
| 2.200 | P | 4.300 | P | 6.606 | P | 10.034 | P | 15.239 | P | 23.145 | P | 35.153 | P | 53.390 | P |        |   |

The letter in the adjacent column to the frequency identifies,

P = EUT passes at this frequency

F = EUT fails at this frequency

E = EUT exclusion band

## 5.11 Transients and Surges

### 5.11.1 Test Pulse 1

| SEVERITY LEVEL | Vs  | Ri       | td | tr       | t1  | t2  | t3         | PERFORMANCE CRITERIA |          |
|----------------|-----|----------|----|----------|-----|-----|------------|----------------------|----------|
|                | V   | $\Omega$ | ms | $\mu$ s  | s   | ms  | $\mu$ s    | ACTUAL               | REQUIRED |
| II             | -50 | 10       | 2  | $\leq 1$ | 2.5 | 200 | $\leq 100$ | N/A                  | N/A      |

### 5.11.2 Test Pulse 2

| SEVERITY<br>LEVEL | Vs  | Ri | td   | tr  | t1  | t2  | PERFORMANCE CRITERIA |          |
|-------------------|-----|----|------|-----|-----|-----|----------------------|----------|
|                   | V   | Ω  | ms   | μs  | s   | ms  | ACTUAL               | REQUIRED |
| II                | +50 | 10 | 0.05 | ≤ 1 | 2.5 | 200 | N/A                  | N/A      |

### 5.11.3 Test Pulse 3a

| SEVERITY LEVEL | Vs  | Ri       | td      | tr       | t1      | t4 | t5 | PERFORMANCE CRITERIA |          |
|----------------|-----|----------|---------|----------|---------|----|----|----------------------|----------|
|                | V   | $\Omega$ | $\mu$ s | ns       | $\mu$ s | ms | Ms | ACTUAL               | REQUIRED |
| II             | -50 | 50       | 0.1     | $\leq 5$ | 100     | 10 | 90 | N/A                  | N/A      |

### 5.11.4 Test Pulse 3b

| SEVERITY LEVEL | Vs  | Ri       | td      | tr       | t1      | t4 | t5 | PERFORMANCE CRITERIA |          |
|----------------|-----|----------|---------|----------|---------|----|----|----------------------|----------|
|                | V   | $\Omega$ | $\mu$ s | ns       | $\mu$ s | ms | Ms | ACTUAL               | REQUIRED |
| II             | +50 | 50       | 0.1     | $\leq 5$ | 100     | 10 | 90 | N/A                  | N/A      |

### 5.11.5 Test Pulse 4

| SEVERITY LEVEL | Vs | Va   | Ri       | t6 | t7        | t8 | tf | tr       | PERFORMANCE CRITERIA |          |
|----------------|----|------|----------|----|-----------|----|----|----------|----------------------|----------|
|                | V  | V    | $\Omega$ | ms | ms        | s  | ms | ms       | ACTUAL               | REQUIRED |
| II             | -5 | -2.5 | 0.01     | 25 | $\leq 50$ | 5  | 5  | $\leq 5$ | N/A                  | N/A      |

### 5.11.6 Test Pulse 5

| SEVERITY LEVEL | Vs    | Ri       | td  | tr | PERFORMANCE CRITERIA |          |
|----------------|-------|----------|-----|----|----------------------|----------|
|                | V     | $\Omega$ | ms  | ms | ACTUAL               | REQUIRED |
| II             | +46.5 | 4        | 100 | 5  | N/A                  | N/A      |

### 5.11.7 Test Pulse 7

| SEVERITY LEVEL | Vs  | Ri       | td  | tr | t3         | PERFORMANCE CRITERIA |          |
|----------------|-----|----------|-----|----|------------|----------------------|----------|
|                | V   | $\Omega$ | ms  | ms | $\mu$ s    | ACTUAL               | REQUIRED |
| II             | -40 | 10       | 100 | 5  | $\leq 100$ | N/A                  | N/A      |

### 5.12 Voltage Dips and Interruptions

| LEVEL            | PERFORMANCE CRITERIA |          |
|------------------|----------------------|----------|
|                  | ACTUAL               | REQUIRED |
| 30% dip, 10ms    | N/A                  |          |
| 60% dip, 100ms   | N/A                  |          |
| >95% dip, 5000ms | N/A                  |          |

### 5.13 Surges

| TEST POINT     | LEVEL (kV)<br>WORST CASE | PERFORMANCE CRITERIA |          |
|----------------|--------------------------|----------------------|----------|
|                |                          | ACTUAL               | REQUIRED |
| Line to line   | $\pm 0.5$                | N/A                  |          |
| Line to ground | $\pm 1.0$                | N/A                  |          |

## **6 EMC MODIFICATIONS**

The following modifications were incorporated during testing:

1. The support, conductive paint covered, 25-way D type connector supplied for the testing was changed to a moulded plastic plug as discharges directly to the connector caused the software to stop refreshing. It was not established whether a EUT failure occurred or the support equipment was susceptible to the discharges. After the software application was closed and restarted the EUT operate as intended.

## 7 CONCLUSIONS

### 7.1 Emission Tests

The Iridium S1c L-Band Satellite Transceiver meets the requirements of ETSI EN 301 489-20 V1.2.1 (2002-11) in the configuration tested.

### 7.2 Immunity Tests

| TEST                           | SEVERITY LEVEL   | PERFORMANCE CRITERIA |          |
|--------------------------------|------------------|----------------------|----------|
|                                |                  | ACTUAL               | REQUIRED |
| Radio Field Susceptibility     | 3V/m 80% AM      | CT/CR                | CT/CR    |
| Electrostatic Discharge        | ± 8kV AIR        | TT/TR                | TT/TR    |
|                                | ± 4kV CONTACT    |                      |          |
| Fast Transients Common Mode    | ± 0.5kV          | CT/CR                | TT/TR    |
| RF Common Mode                 | 3Vrms 80% AM     | CT/CR                | CT/CR    |
| Transients and Surges          | N/A              | N/A                  | N/A      |
| Voltage Surges                 | ± 1kV / ± 0.5kV  | N/A                  | N/A      |
| Voltage Dips and Interruptions | 30% Dip, 10ms    | N/A                  | N/A      |
|                                | 60% Dip, 100ms   | N/A                  | N/A      |
|                                | >95% Dip, 5000ms | N/A                  | N/A      |

Note should be taken of modifications (if any) as described in section 6 of this report.

### 7.3 Conformity in Production

TRL EMC has based this test report on results from the equipment sample(s) provided.

The manufacturer is advised that they may have an obligation to demonstrate that production samples are in conformity with the Standards noted.

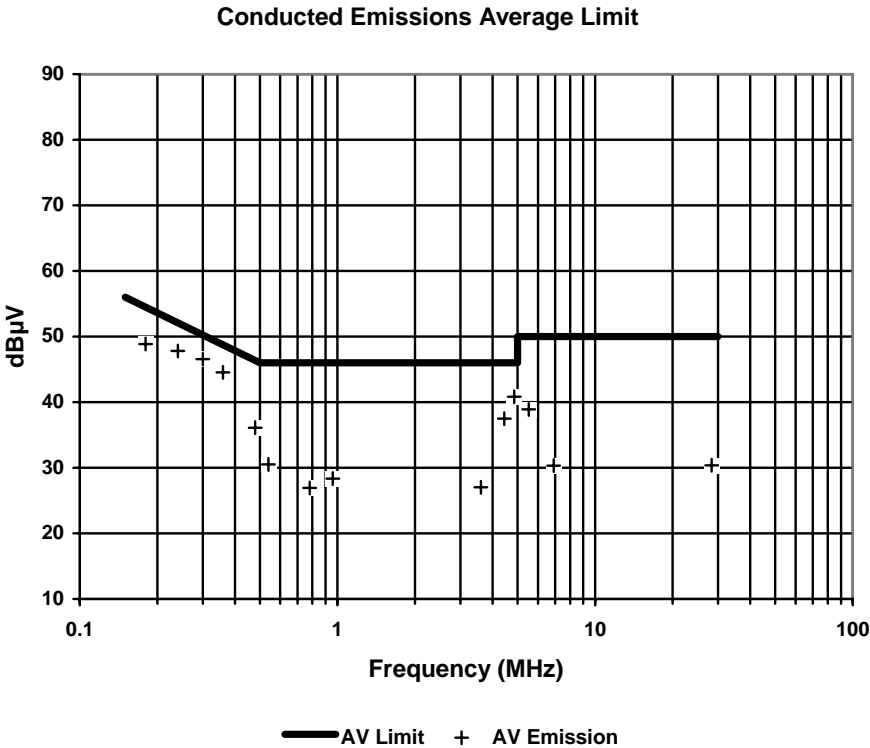
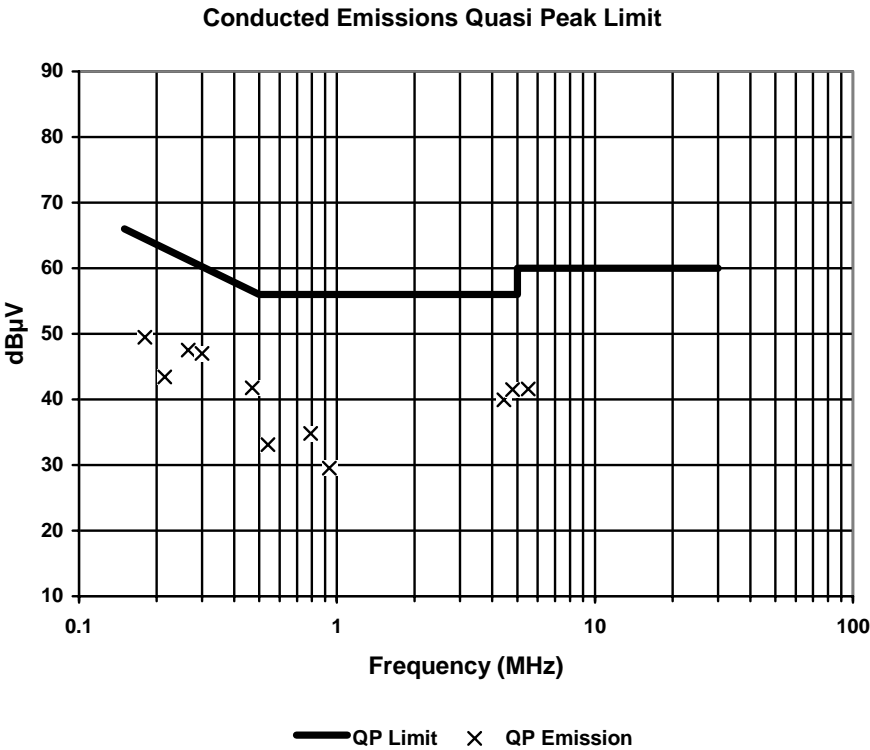
The EMC performance reported above was achieved after incorporation of any modifications as detailed in section 6 of this report.

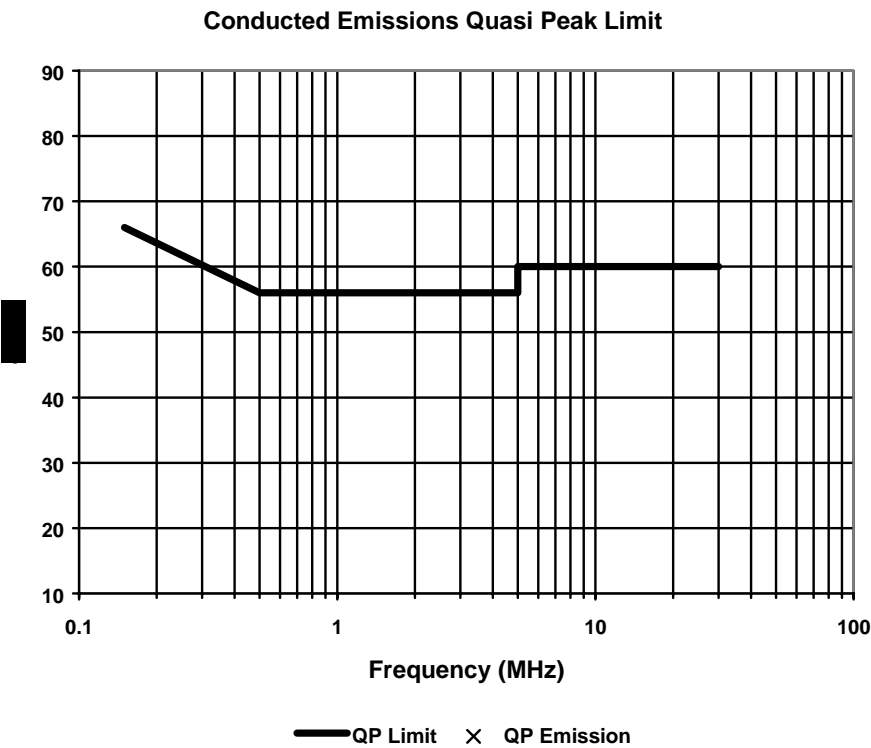
**APPENDIX A**  
**GRAPHS**



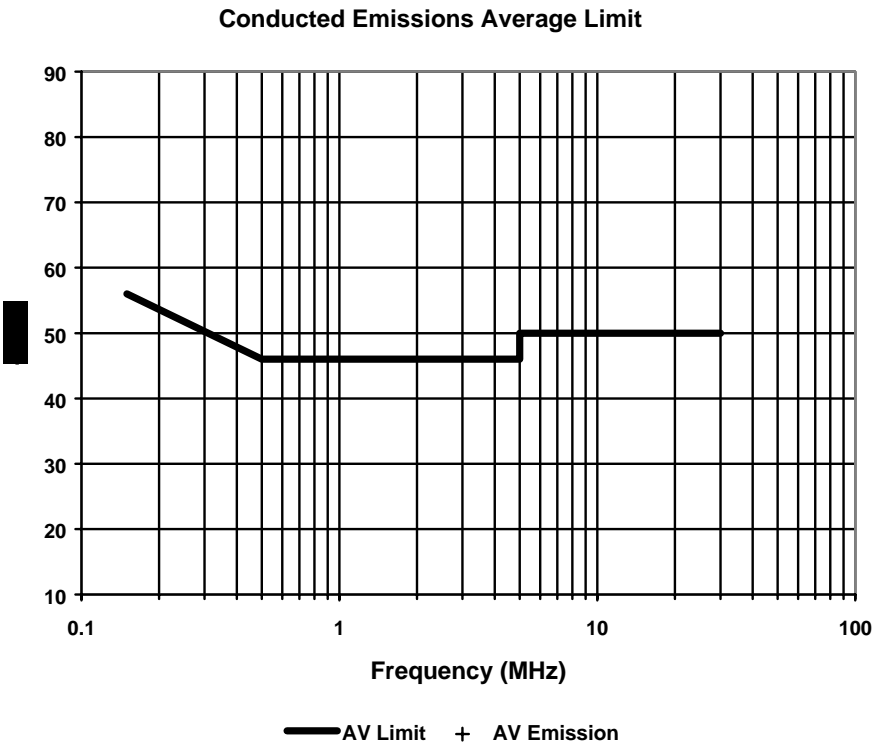
Graph A1

Conducted Emissions – DC Power Input / Output Port



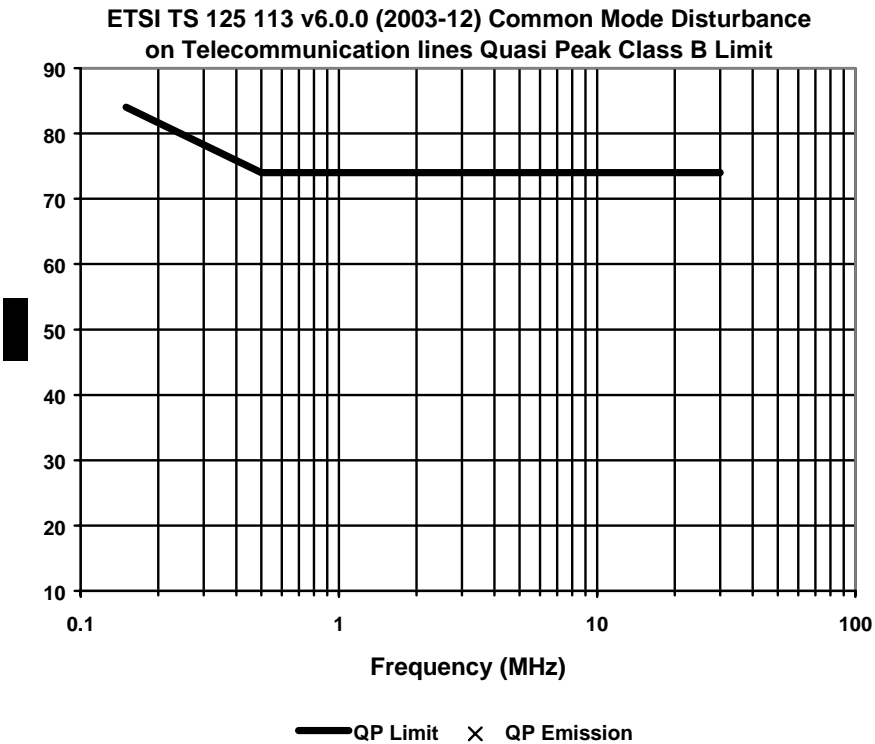


**Note:** Not applicable (see note 2 in section 3.2.1)

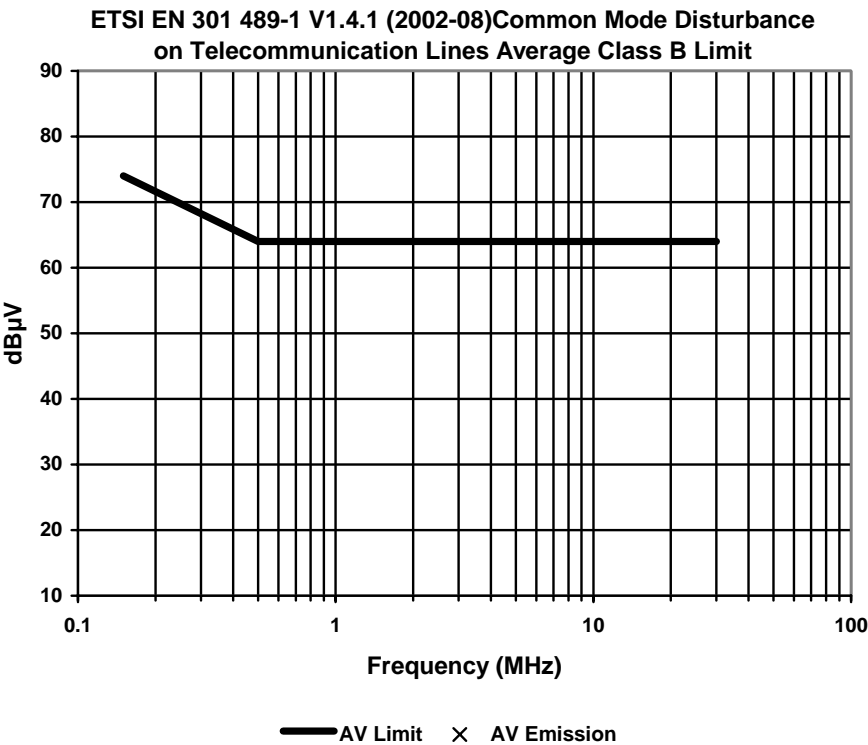


**Note:** Not applicable (see note 2 in section 3.2.1)

Graph A3: **Conducted Emissions – Telecommunication Port**



**Note:** Not applicable (see note 3 in section 3.2.1)



**Note:** Not applicable (see note 3 in section 3.2.1)

**APPENDIX B**  
**MEASUREMENT UNCERTAINTY**

## SCHEDULE A - EMC MEASUREMENT UNCERTAINTY

### Static Discharge

| Tolerance Parameter               | TRLUH 01 | TRLUH 85 | TRL 252 / 212 | Specification Tolerance |
|-----------------------------------|----------|----------|---------------|-------------------------|
| Negative Discharge Current at 2kV | 10.25%   | 21.80%   | 19.70%        | 30%                     |
| Negative Discharge Current at 8kV | 27.31%   | 25.34%   | 28.63%        | 30%                     |
| Negative Discharge Voltage        | 3.33%    | 4.73%    | 5.11%         | 10%                     |
| Negative Rise Time at 2kV         | 11.81%   | 5.93%    | 7.10%         | 17.7%                   |
| Negative Rise Time at 8kV         | 11.81%   | 2.20%    | 5.93%         | 17.7%                   |
| Positive Discharge Current at 2kV | 6.90%    | 14.45%   | 19.70%        | 30%                     |
| Positive Discharge Current at 8kV | 18.13%   | 27.31%   | 22.06%        | 30%                     |
| Positive Discharge Voltage        | 5.87%    | 5.36%    | 5.87%         | 10%                     |
| Positive Rise Time at 2kV         | 14.16%   | 3.58%    | 7.10%         | 17.7%                   |
| Positive Rise Time at 8kV         | 11.81%   | 3.58%    | 5.93%         | 17.7%                   |

### Voltage Surge (1.2/50µs)

| Tolerance Parameter | TRLUH 42         | TRL 444          | TRLUH 159        | TRL 177           | Specification Tolerance |
|---------------------|------------------|------------------|------------------|-------------------|-------------------------|
| Positive Voltage    | 4.49%            | 8.05%            | 8.85%            | 8.05%             | 10%                     |
| Negative Voltage    | 4.49%            | 8.36%            | 9.03%            | 6.30%             | 10%                     |
| Positive Duration   | 10.40%           | 5.72%            | 6.89%            | 10.66%            | 20%                     |
| Negative Duration   | 10.81%           | 6.29%            | 6.11%            | 9.99%             | 20%                     |
| Positive Front Time | 23.30%           | 18.57%           | 28.51%           | 24.17%            | 30%                     |
| Negative Front Time | 22.44%           | 18.57%           | 28.51%           | 25.04%            | 30%                     |
| Peak Current        | 7.84%            | 9.76%            | 9.76%            | 12.37%            | 10%                     |
| Duration (8/20µs)   | 6.39%            | 12.64%           | 12.64%           | 7.17%             | 10%                     |
| Front Time (8/20µs) | 8.20%            | 10.00%           | 14.20%           | 11.80%            | 10%                     |
| Current Undershoot  | Inside Tolerance | Inside Tolerance | Inside Tolerance | Outside Tolerance | 30% of Peak Current     |

### Transients (5/50ns)

| Tolerance Parameter                  | LG LAB | UH LAB | BEST   | NSG1025 | Specification Tolerance |
|--------------------------------------|--------|--------|--------|---------|-------------------------|
| Positive Voltage                     | 2.60%  | 2.60%  | 5.81%  | 4.59%   | 10%                     |
| Negative Voltage                     | 2.99%  | 2.99%  | 5.81%  | 5.92%   | 10%                     |
| Source impedance (positive waveform) | 9.69%  | 9.69%  | 11.71% | 10.29%  | 20%                     |
| Source impedance (negative waveform) | N/A    | N/A    | N/A    | N/A     | 20%                     |
| Pulse Parameters (positive waveform) | 4.87%  | 4.87%  | 18.93% | 5.56%   | 30%                     |
| Pulse Parameters (negative waveform) | 6.50%  | 6.50%  | 14.21% | 26.01%  | 30%                     |
| Burst Parameters                     | 1.00%  | 1.00%  | 1.00%  | 1.00%   | 10%                     |

### Voltage Dips and Short Interruptions

| Tolerance Parameter           | 2050 System (UH) | 2050 System (LG) | BEST System (LG) | Specification Tolerance |
|-------------------------------|------------------|------------------|------------------|-------------------------|
| Event Duration                | 1.00%            | 1.00%            | 1.00%            | 10%                     |
| Repetition Time               | 1.00%            | 1.00%            | 1.00%            | 10%                     |
| Supply Regulation             | <5µs             | <5µs             | <5µs             | <5µs                    |
| Phase Delay                   | 2.98%            | 2.98%            | 2.98%            | 10%                     |
| Switching time at 90 degrees  | 1.2µs            | 2.95µs           | 2.42µs           | 1-5µs                   |
| Switching time at 270 degrees | 3.8µs            | 3.04µs           | 2.12µs           | 1-5µs                   |

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## **SCHEDULE A - EMC MEASUREMENT UNCERTAINTY**

### **Conducted Emissions**

- [1] Conducted Emissions 9kHz to 150kHz = **3.7dB**
- [2] Conducted Emissions 150kHz to 30MHz = **3.4dB**

### **Radiated Emissions**

- [1] Radiated Emissions 30MHz to 1GHz using Bilog CBL6112 Antenna = **5.8dB**

### **Conducted Immunity**

- [1] Re-establishment of pre-calibrated field = **1.9dB**
- [2] Limiting of injected level using monitor coil = **2.6dB**

### **Radiated Immunity**

- [1] Re-establishment of pre-calibrated field level = **2.17dB**
- [2] Dynamic feedback calibrated field level = **2.21dB**

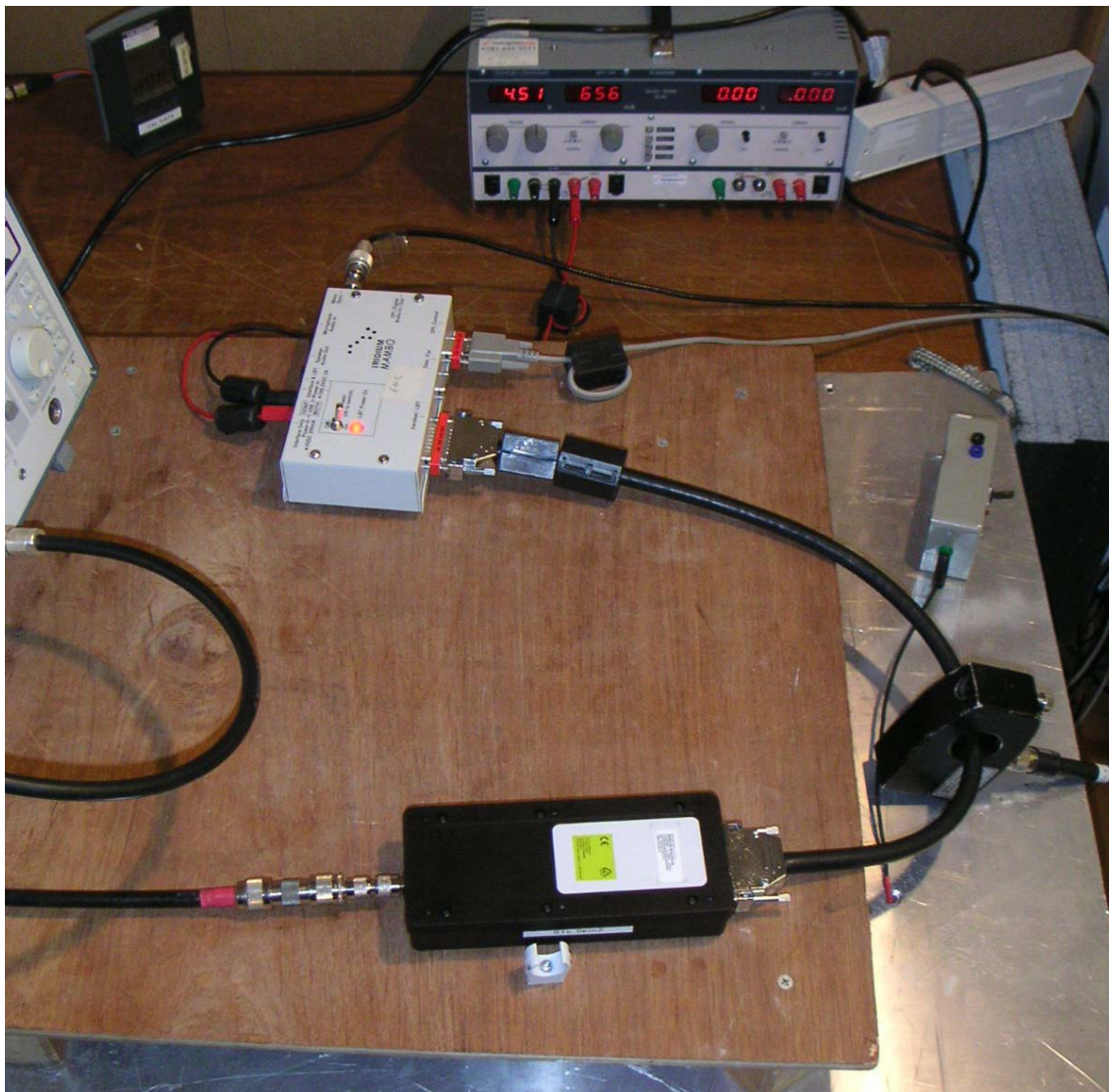
### **Power Frequency magnetic Field**

- [1] Magnetic field immunity up to 1000A/m DC-400Hz = **1.7dB**

**APPENDIX C**  
**PHOTOGRAPHS**















**APPENDIX D**  
**ADDITIONAL INFORMATION**

## **ADDITIONAL INFORMATION**

NB: The contents of this page and subsequent page(s) are not covered by the scope of the laboratories UKAS accreditation.

Not applicable.