



HURSLEY  
**EMC**  
SERVICES

# EMC TEST REPORT

No. 15R174 CR

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UKAS Accredited  
EU Notified Body  
FCC & VCCI Registered  
BSMI Lab ID: SL2-IN-E-3008  
KC Lab ID: EU0184

## EMC Test Report for the SRT Marine Technology Ltd Apollo Class A Transceiver

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## 1.0 OVERVIEW

### 1.1 Introduction

The Equipment Under Test (EUT), as described within this document, was submitted for EMC testing as agreed with the customer.

### 1.2 Objective

The purpose of the test was to measure and report the EUT against limits and methods of the emissions and immunity standards, as requested for and listed in section **2.0 Test Summary**.

### 1.3 Product Modifications

To meet the requirements the following modifications were carried out:

1. For Radiated Emissions a minor layout change to separate clock GND from GND beneath power connector.
2. For Radiated Immunity a ferrite was added to the interconnect between Radio and Display boards.

### 1.4 Conclusion

The EUT, as modified, met the emission limits and immunity requirements of the tests defined in section **2.0 Test Summary**.

This report relates to the sample tested and may not represent the entire population. It is valid only for the product identified, either in part or in full, to the relevant electromagnetic requirements necessary for compliance with the EMC Directive 2004/108/EC.

## 2.0 TEST SUMMARY

### 2.1 Summary

The EUT was tested to the EN 60945 (Parts 9 and 10) test standard for maritime navigation and radio communication equipment.

The EUT met the **emission** test requirements of the following standards:

Description	General Standard	Referenced Standard
Radiated disturbance	EN 60945:2002	CISPR 16-1:1999 & EN 55022:2010
Radiated disturbance, H-Field		
Conducted disturbance, AC port		

The EUT met the **immunity** test requirements of the following standards:

Description	General Standard	Referenced Standard
Electrostatic discharge	EN 60945:2002, ETSI EN 301 489-1:V1.9.2 <sup>†</sup> & ETSI EN 301 489-17:V2.2.1 <sup>†</sup>	IEC 61000-4-2:1995
Radiated RF interference		IEC 61000-4-3:1995
Fast transient bursts		IEC 61000-4-4:1995
Conducted RF Interference		IEC 61000-4-6:1996
Power interrupts		IEC 61000-4-11:1994

The uncertainty of measurement for each test has been included to support a level of confidence of approximately 95%.

<sup>†</sup>These test standards are not currently included in the UKAS Accreditation Schedule for Hursley EMC Services.

### 2.2 Test Deviations

None.

### 2.3 EMC Test Lab Reference

Hursley EMC Services files: 15R174, 15R539 & 16R004.

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## 3.0 EQUIPMENT & TEST DETAILS

### 3.1 General

<b>EUT:</b>	Apollo Class A Transceiver  Make: SRT Marine Technology Ltd Model: Apollo Serial number: 002
<b>EUT powered by:</b>	24V Lead Acid Battery
<b>EUT manufacturer:</b>	SRT Marine Technology Ltd
<b>EUT build level:</b>	Production sample
<b>Customer:</b>	SRT Marine Technology Ltd Wireless House Westfield Industrial Estate Midsomer Norton Bath BA3 4BS United Kingdom  Tel: +44 (0) 1761 409 500
<b>Test commissioned by:</b>	Mr Richard McMahon
<b>Date EUT received:</b>	2 <sup>nd</sup> April 2015
<b>Test date(s):</b>	2 <sup>nd</sup> to the 8 <sup>th</sup> April, 7 <sup>th</sup> December 2015 and 6 <sup>th</sup> January 2016
<b>EMC measurement site:</b>	Hursley EMC Services Limited Trafalgar House, Trafalgar Close, Chandlers Ford, Hampshire

Note: Between test dates the EUT was taken away and returned by the customer.

### 3.2 EUT Description

The EUT is an AIS Transceiver for maritime use. The AIS Transceiver transmits and receives position, bearing and other key data from surrounding shipping fitted with a similar AIS Transceiver. The AIS Transceiver is also fitted with a GPS receiver to give its own position. The AIS data is transposed into electronic nautical charts to provide key information on surrounding shipping

### 3.3 EUT Support

- SRT Apollo, s/n 004
- 30dB attenuators
- HEMCS 3115 Horn Antenna, s/n 85 & 430
- HEMCS Samsung N150 Laptop, s/n 65G
- GPS Antenna (x2)

### 3.4 EUT Test Exerciser

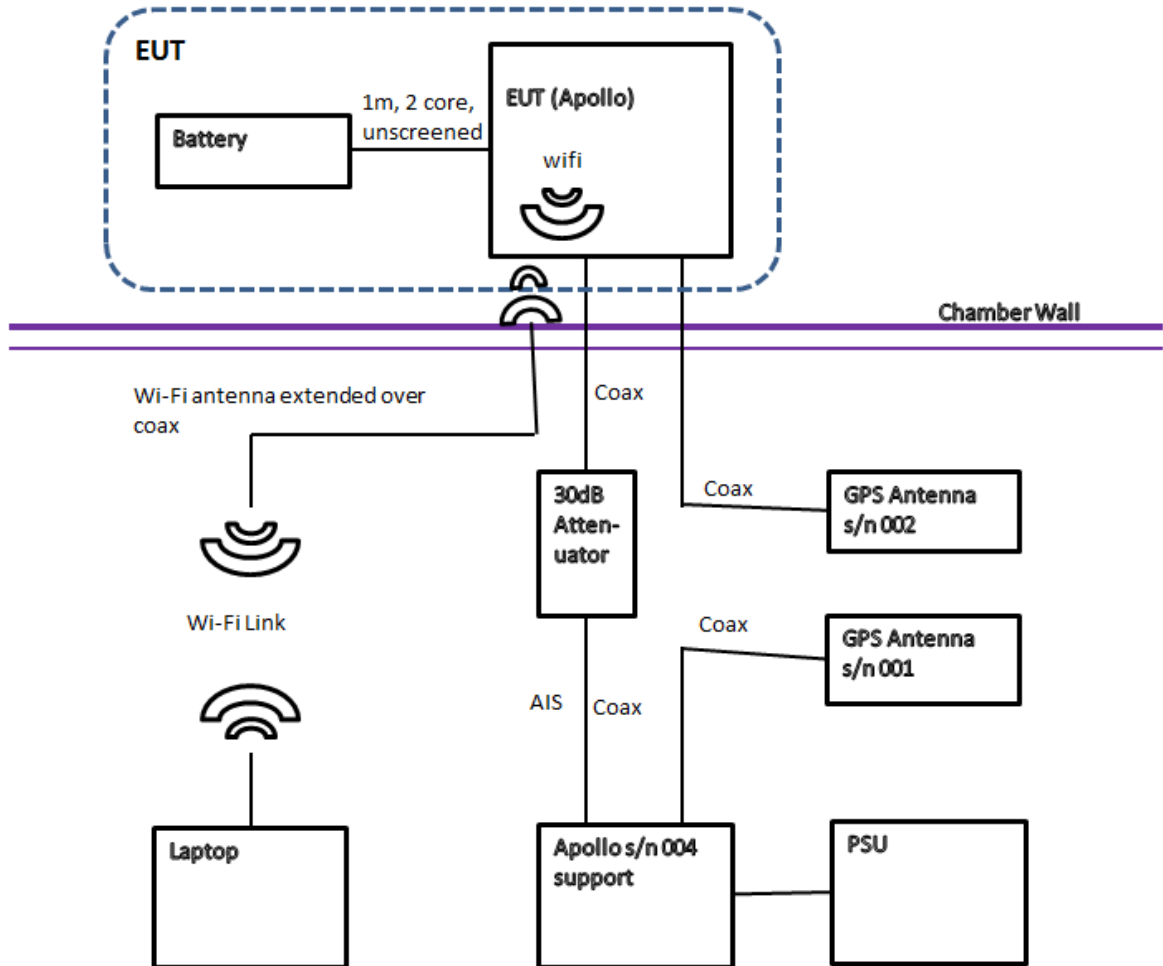
The EUT was set to transmit its position every 10 seconds alternating from channel A and channel B, this was displayed on the second support Apollo Transceiver. The logging is time-stamped in order to check that these transmissions are occurring on time throughout the testing.

The EUT was also connected to the laptop via Wi-Fi. The laptop had a second Tera Term window open connected via TCP/IP directly logging the EUT serial data. Again this logging was time-stamped in order to check for connection drop-outs.

During immunity testing inside the anechoic chamber the Wi-Fi was connected to the support equipment via a pair of 3115 horn antennae connected via a coax, one inside the chamber pointing at the EUT and the other outside chamber pointing at the laptop.

### 3.5 EUT Test Configuration

Radiated immunity – Ethernet mode



### 3.6 Environmental Test Conditions

Temperature	20 to 21° Celsius
Relative Humidity	38 to 60%
Atmospheric Pressure	979 to 1030 millibars

### 3.7 EMC Test Equipment

#ID	CP	Manufacturer	Type	Serial Nø	Description	Calibration due date
006	1	HP	8568B	2841A04350	Spectrum analyser	Internal
030a	1		TPC-2	1407181	Omnitip probe for #30 Zap	01/09/2016
033	1	HP	8593EM	3726U00203	Spectrum analyser (9kHz-26.5GHz)	22/09/2016
034	1	Rohde & Schwarz	SMT06	830004/0012	Signal generator (6GHz)	24/07/2016
047	3	Rohde & Schwarz	HFH2-Z2	879021/22	Loop antenna (9kHz-30MHz)	05/08/2017
050	1	HP	8447D	1937A02341	Pre-amplifier (30-1000MHz)	Internal
068	1	EM	CWS500C	1001-07	Conducted immunity simulator	23/02/2016
135	1	KeyTek	EMC Pro	9806258	Immunity tester	05/03/2016
152	1	Fischer	801-M2-16	9867	CDN mains 2xwire	03/12/2016
170	1	Fischer	FCC150-50	336	Adapter (100Ω)	Internal
200	1	Fischer	F-203I-32MM	09849	EM Injection clamp (10k-1GHz)	26/02/2016
218	1	Boonton	4230	26603	Power meter/probe(a) (18GHz)	18/09/2016
218c	1	Boonton	51075	36264	Power Sensor	19/09/2016
250	1	HP	8449B	3008A01077	Pre-amplifier (1.0-26.5GHz)	02/07/2016
289	1	Rohde & Schwarz	ESCI 7	100765	CISPR 7GHz Receiver	12/06/2016
390	0	Schwarzbeck	STLP9128D	9128D-060	RES antenna Saturn	Internal
415	1	AR	DC6080	20263	Directional Coupler	Internal
449	1	Narda	3022	60259	Directional Coupler	Internal
452	3	CHASE	CBL 6141	4013	Pink 30M-2G Antenna	01/10/2018
466	3	Schwarzbeck	BBHA 9120 571	571	1-10GHz Horn	29/01/2016
538	1	HP	8593EM	3710A00204	Spectrum analyser	05/12/2015
541	1	HP	8491B	819	Attenuator 30dB	Internal
549	1	Boonton	4231A	103602	Boonton Power meter	24/04/2016
549a	1	Boonton	51075A Sensor	33000	500kHz to 18GHz	Internal
552	1	Rohde & Schwarz	ESCI7	1166595007	7GHz Receiver	17/04/2016
555	1	Milmega	500W Amp	0	80-1000 MHz	Internal
639	1	VectaWave	VBA3100-180	0	800-3100MHz	Internal
642	2	Fischer	F33-2	141414	1kHz to 250MHz current clamp	08/01/2016

CP = Interval period [year] prescribed for external calibrations

**Note:** 'Calibration due date' means that the instrument is certified with a UKAS or traceable calibration certificate.  
'Internal' means internally calibrated using HEMCS procedures



## 4.0 EMISSION RESULTS

### 4.1 Radiated Disturbance

A profile scan was taken at a distance of three metres on eight azimuths of the EUT in both the vertical and horizontal polarities of the antenna in a semi-anechoic chamber. Tests were carried out with the transmitter ready to transmit but not transmitting.

Using the pre-scan results as a guide, each emission from the EUT was maximised. Measurements were carried out a distance of three metres in a CISPR 16-1-4 compliant semi-anechoic chamber. Cable positions were then finally adjusted to produce the maximum emission levels. The worst-case CISPR quasi-peak results are recorded below.

#### 4.1.1 Data, 30 to 2000 MHz

Emission frequency (MHz)	Measured quasi-peak value (dB $\mu$ V/m)	Measured quasi-peak value including uncertainty budget	Specified quasi-peak limit (dB $\mu$ V/m)	Status
39.990	Vertical	28.46	54.0	Pass
119.028	Vertical	37.47	54.0	Pass
158.121	Horizontal	12.50	24.0	Pass
161.977	Vertical	22.84	24.0	Pass
161.977	Vertical	23.13	24.0	Pass
238.106	Horizontal	47.77	54.0	Pass
249.614	Horizontal	41.44	54.0	Pass
251.202	Horizontal	48.74	54.0	Pass
359.910	Horizontal	53.14	54.0	Pass
359.990	Horizontal	53.18	54.0	Pass
660.062	Horizontal	40.23	54.0	Pass
722.710	Horizontal	42.37	54.0	Pass
792.040	Horizontal	47.80	54.0	Pass
1012.006	Horizontal	47.30	54.0	Pass
1026.173	Horizontal	36.10	54.0	Pass
1080.140	Horizontal	47.74	54.0	Pass
1451.990	Vertical	50.33	54.0	Pass
1584.060	Vertical	44.71	54.0	Pass
1980.110	Vertical	38.63	54.0	Pass

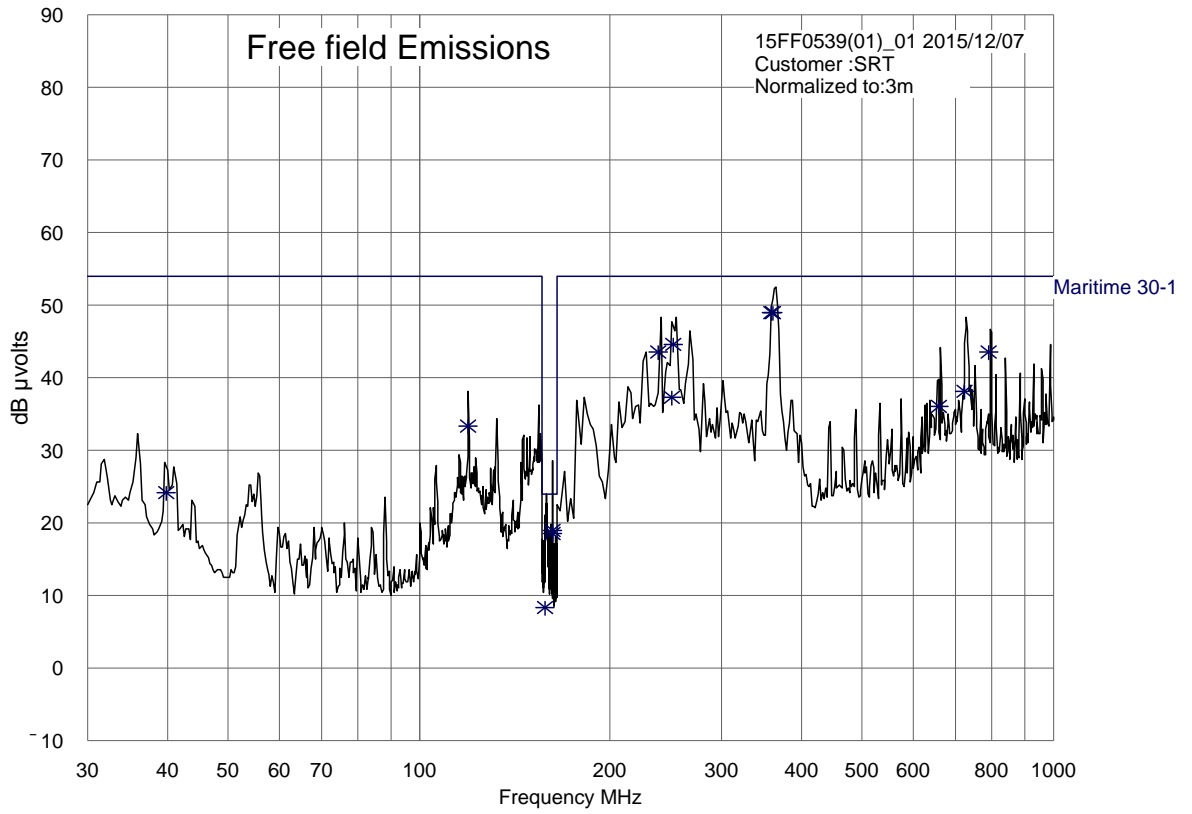
The uncertainty of measurement:  $\pm 4.2\text{dB}\mu\text{V}$  for a 95% confidence level has been added to the measured result.

The measurements reported are the highest emissions relative to the EN 60945 limit and take into account the antenna, cable loss factors and uncertainty budget. Measurements made according to the EN 60945 test standard and Hursley EMC Services test procedure RAD-01.

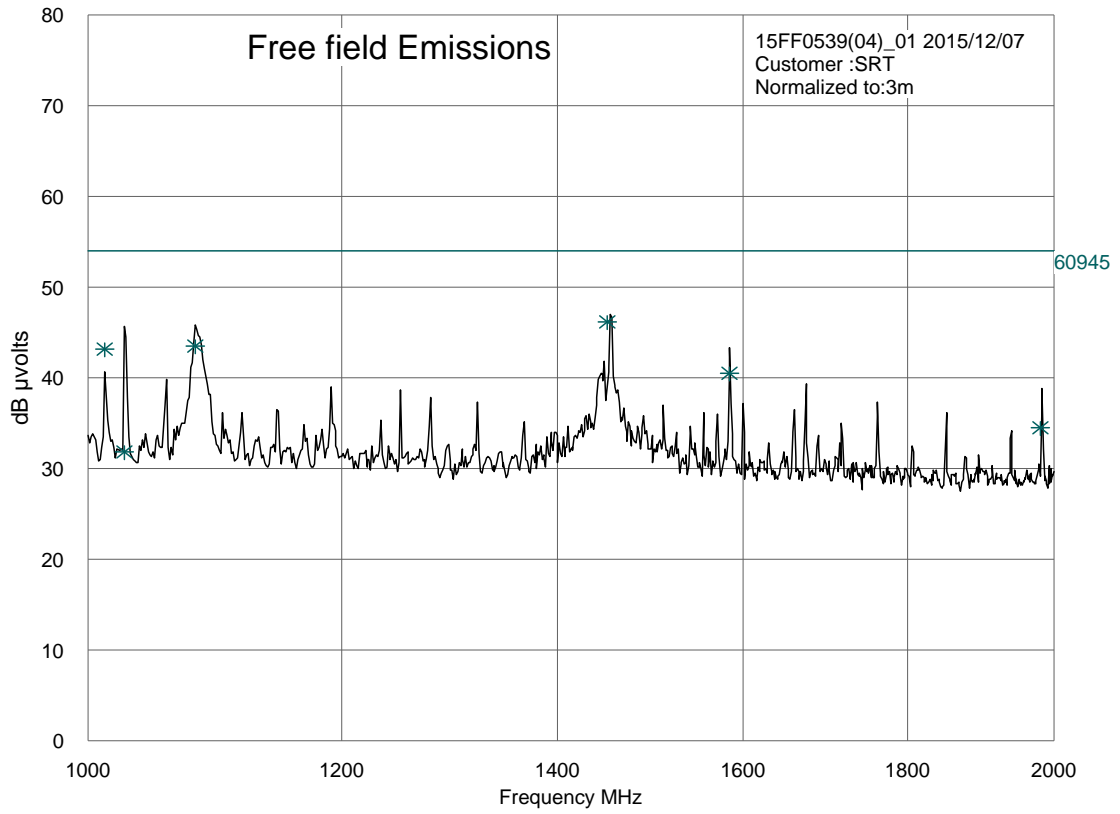
Note: Apollo sample, s/n 002, was replaced by sample s/n EP4 (with modification applied) for this test.

TEST ENGINEER: Daniel Tiroke

4.1.2 Radiated Emission Plot, 30 to 1000 MHz



4.1.3 Radiated Emission Plot, 1.0 to 2.0 GHz



#### 4.1.4 Radiated H-Field, 150 kHz to 30 MHz

A profile scan was taken at a distance of three metres with a 360° azimuth scan of the EUT in a semi-anechoic chamber. The tests were repeated for three orientations of the loop antenna.

The sample was then re-measured in an anechoic chamber; the pre-scan results were used as a guide at three metre.

#### 4.1.5 Data

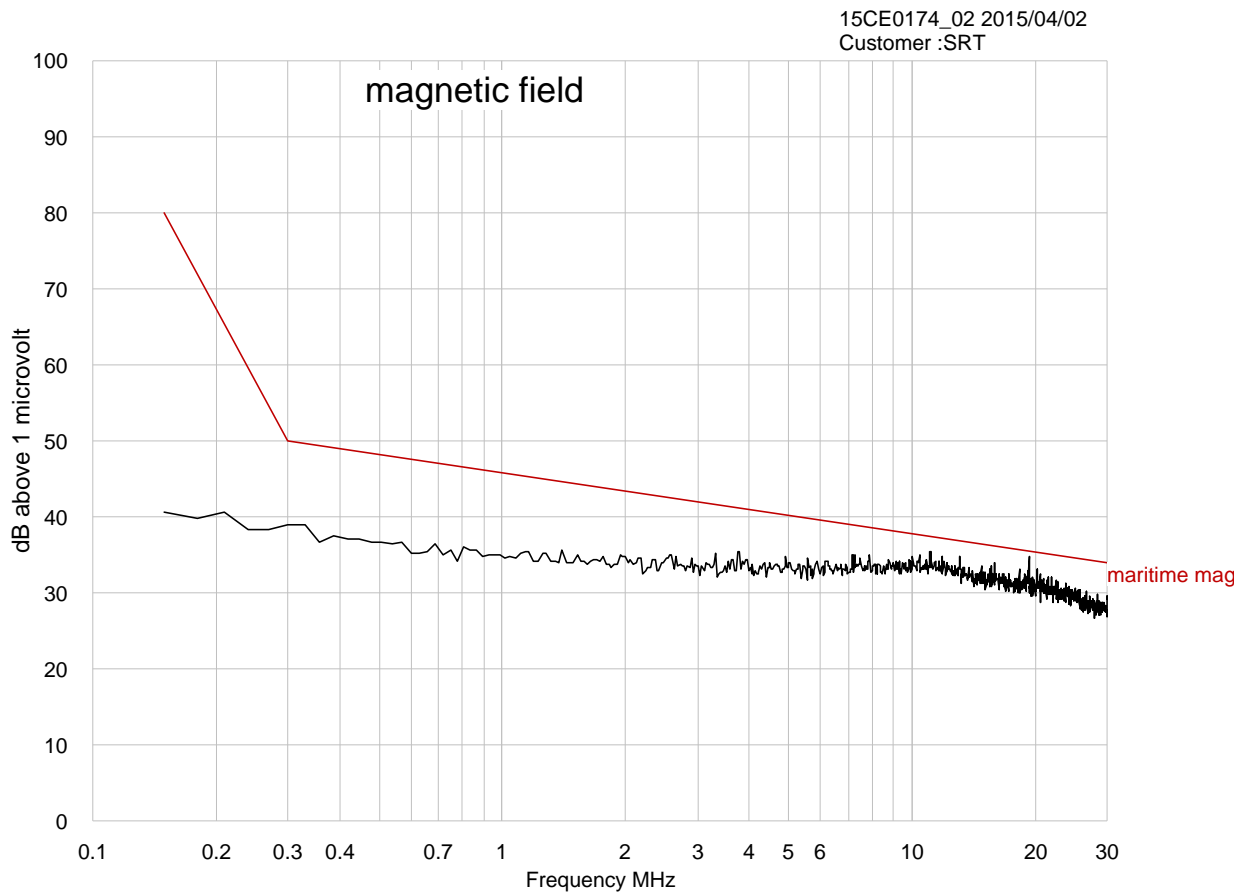
Emission frequency (MHz)	Measured quasi-peak value (dB $\mu$ V/m)	Measured quasi-peak value including uncertainty budget	Specified quasi-peak limit (dB $\mu$ V/m)	Status
No significant peaks found within the specified limit.				Pass

The uncertainty of measurement:  $\pm 4.2$ dB $\mu$ V for a 95% confidence level has been added to the measured result.

The measurements reported are the highest emissions relative to the EN 60945 limit and take into account the antenna, cable loss factors and uncertainty budget. Measurements made according to the EN 60945 test standard and Hursley EMC Services test procedure MAR-01.

TEST ENGINEER: Rob St John James

4.1.6 Profile



## 4.2 Conducted Disturbance

A filtered 24V DC mains supply was fed to the EUT via a 50Ω/50μH Artificial Mains Network (AMN). The AMN was bonded to a conductive ground plane. Line and neutral phases were measured separately.

A spectrum analyser was set to scan between 10 kHz and 30 MHz to record the peak emission profiles. The worst-case peaks were then measured using a quasi-peak receiver and compared to the EN 60945 limit. Measurements made according the EN 60945 test standard and Hursley EMC Services test procedure CON-02. The worst-case results are shown here.

### 4.2.1 Data

0V

Frequency (MHz)	Quasi-peak value (dBμV)			
	Measured	Measured quasi-peak value including uncertainty budget	Limit	Status
0.1573	46.7	49.9	59.4	Pass
0.3422	27.8	28.0	50.3	Pass
0.8063	23.2	26.4	50.0	Pass
19.200	31.1	34.3	50.0	Pass

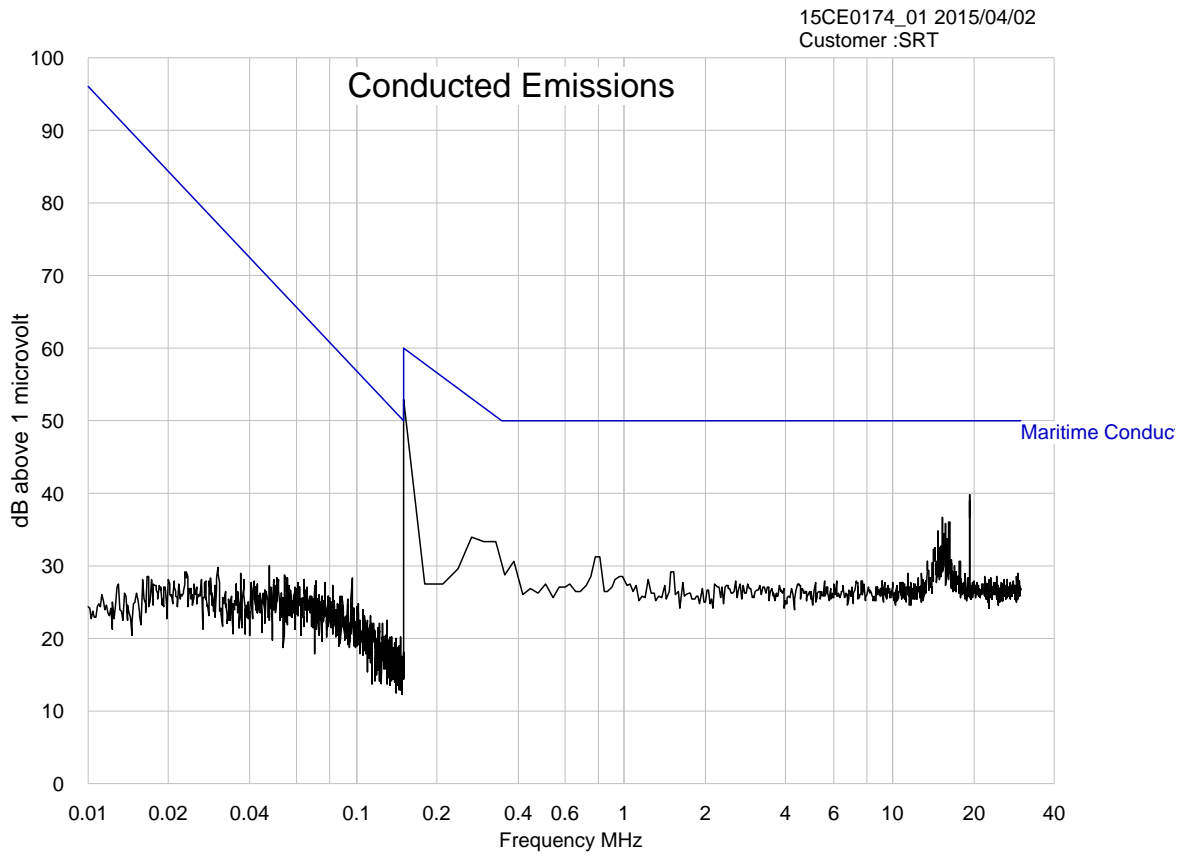
24V

Frequency (MHz)	Quasi-peak value (dBμV)			
	Measured	Measured quasi-peak value including uncertainty budget	Limit	Status
0.1573	48.1	51.3	59.4	Pass
0.2230	31.5	34.7	53.5	Pass
0.7936	25.6	28.9	50.0	Pass
19.2000	31.0	34.2	50.0	Pass

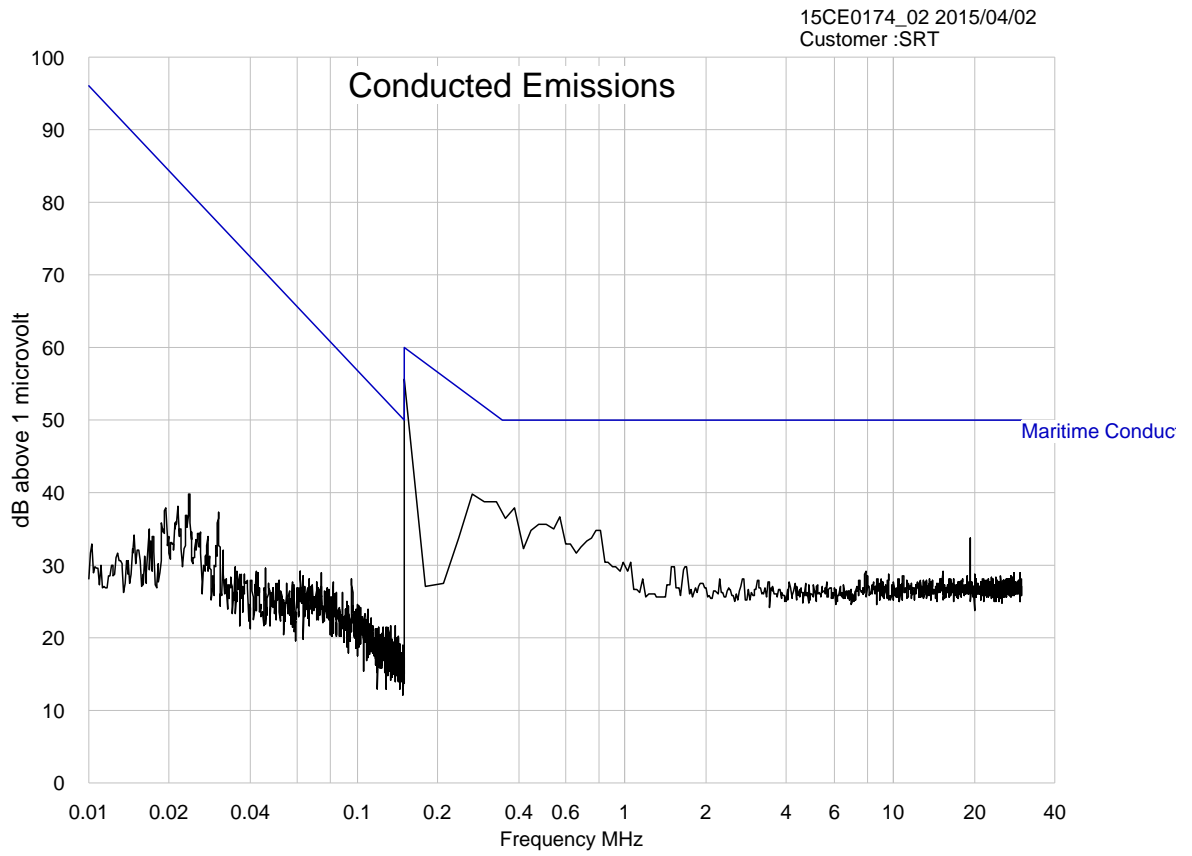
Uncertainty of measurement: ± 3.22 dBμV for a 95% confidence level has been added to the measured result.

TEST ENGINEER: Rob St John James

4.2.2 Profile; 0V



4.2.3 Profile; 24V





## 5.0 IMMUNITY RESULTS

### 5.1 Performance Criteria

General performance criteria for immunity testing are defined below:-

Criterion A:	<p>The apparatus shall continue to operate as intended. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the apparatus is used as intended. In some cases the performance level may be replaced by a permissible loss of performance. If the performance level or the permissible level is not specified by the manufacturer then either of these may be derived from the EUT description and documentation and what the user may reasonably expect from the apparatus if used as intended.</p> <p>Wi-Fi: No unintended transmissions, no loss of communication.</p>
Criterion B:	<p>The apparatus shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the apparatus is used as intended. In some cases the performance level may be replaced by a permissible loss of performance. During the test degradation of performance is however allowed. No change of actual operating state or stored data is allowed. If the minimum performance level or the permissible level is not specified by the manufacturer then either of these may be derived from the EUT description and documentation and what the user may reasonably expect from the apparatus if used as intended.</p> <p>Wi-Fi: No unintended transmissions, any loss of communication shall automatically recover.</p>
Criterion C:	<p>Temporary loss of function is allowed provided the loss of function is self-recoverable or can be restored by the operation of the controls, or by any operation specified in the instructions for use.</p>

Note: All immunity tests were applied above the specification level to include the uncertainty attributed to each test.

## 5.2 Electrostatic Discharge

<b>TEST METHOD</b>	<b>IEC 61000-4-2</b> <b>REFERENCING PROCEDURE: ESD-03</b>
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### TEST DETAILS

<b>Test severity, <u>contact discharge</u></b>	<b>± 6.0 kV, 50 strikes per point. Total of 200 strikes (minimum).</b>
<b>Test severity, <u>air discharge</u></b>	<b>± 8.0 kV, 10 strikes for each selected point</b>
<b>Exerciser program during test</b>	<b>Referencing section 3.4</b>
<b>Specified test criterion</b>	<b>Criterion 'B'</b>
<b>EUT performance criterion</b>	<b>Criterion 'A'</b>

### RESULTS

#### Contact, Indirect

<b>SPECIFIED VOLTS</b>	<b>REFERENCE PLANE @ 10cm</b>	<b>STATUS</b>
<b>± 4.0 kV</b>	<b>Horizontal and vertical; front, rear and sides</b>	<b>PASS</b>
<b>± 6.0 kV</b>	<b>Horizontal and vertical; front, rear and sides</b>	<b>PASS</b>

#### Contact, Direct To EUT

<b>SPECIFIED VOLTS</b>	<b>TEST POINTS</b>	<b>STATUS</b>
<b>± 2.0 kV</b>	<b>Case and connector shells; see illustration on next page</b>	<b>PASS</b>
<b>± 4.0 kV</b>		<b>PASS</b>
<b>± 6.0 kV</b>		<b>PASS</b>

#### Air Discharge (Insulating, Slots & Apertures)

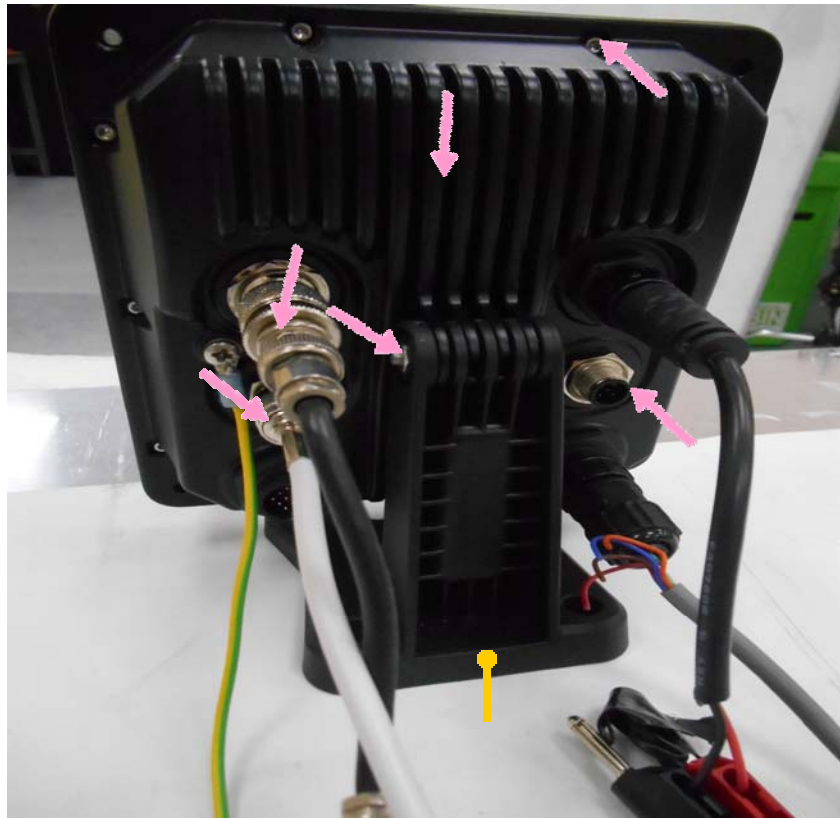
<b>SPECIFIED VOLTS</b>	<b>TEST POINTS</b>	<b>STATUS</b>
<b>± 2.0 kV</b>	<b>See illustration on next page</b>	<b>PASS</b>
<b>± 4.0 kV</b>		<b>PASS</b>
<b>± 8.0 kV</b>		<b>PASS</b>

UNCERTAINTY: Specified as less than 5%. The level applied was 5% higher than the upper levels stated above to take into account the uncertainty for this test.

COMMENT: The EUT met the specified test criterion.

TEST ENGINEER: Rob St John James

### 5.2.1 Electrostatic Discharge Test Points



Arrow indicates Contact Discharge  /  Air discharge

### 5.3 Radiated RF Interference

<b>TEST METHOD</b>	<b>IEC 61000-4-3</b> <b>REFERENCING PROCEDURE: RES-02</b>
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#### TEST DETAILS

<b>Test severity levels,</b>	<ul style="list-style-type: none"> <li>• <b>10.0 V/m; 80 to 2000 MHz swept frequency</b></li> <li>• <b>3.0 V/m; 2.0 to 2.7 GHz</b></li> <li>• <b>80% amplitude modulation 400 Hz</b></li> <li>• <b>1% increment, 3 seconds dwell time and 9 seconds dwell time from 1.0 GHz</b></li> </ul>
<b>Exerciser program during test</b>	<b>Referencing section 3.4</b>
<b>Specified test criterion</b>	<b>Criterion 'A'</b>
<b>EUT performance criterion</b>	<b>Criterion 'A'</b>

#### RESULTS

<b>TEST POINTS</b>	<b>ANTENNA POLARITIES</b>	<b>FIELD LEVEL SPOT FREQUENCY</b>	<b>STATUS</b>
<b>Front</b>	<b>Horizontal &amp; vertical</b>	<b>10.0 &amp; 3.0 V/m</b>	<b>PASS</b>
<b>Side, left</b>	<b>Horizontal &amp; vertical</b>	<b>10.0 &amp; 3.0 V/m</b>	<b>PASS</b>
<b>Side, right</b>	<b>Horizontal &amp; vertical</b>	<b>10.0 &amp; 3.0 V/m</b>	<b>PASS</b>
<b>Rear</b>	<b>Horizontal &amp; vertical</b>	<b>10.0 &amp; 3.0 V/m</b>	<b>PASS</b>

**UNCERTAINTY:** Estimated uncertainty is 20%. The field level has been applied at level higher of 12 V/m to take into account uncertainties.

**COMMENT:** The exclusion band was  $\pm 5\%$  of the GPS frequency (1570 MHz), Wi-Fi Band (2.45 - 2.485GHz)  $\pm 10\text{MHz}$  and  $\pm 5\%$  of the AIS frequency band (156.025 to 162.025 MHz). In test no exclusion bands were used. With modifications applied, the EUT met the specified test criterion.

TEST ENGINEERS: Andy Jones & Daniel Tiroke

## 5.4 Fast Transient Bursts

<b>TEST METHOD</b>	<b>IEC 61000-4-4 REFERENCING PROCEDURE: FTB-01</b>
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### TEST DETAILS

<b>Test severity</b>	<ul style="list-style-type: none"> <li>• <math>\pm 1.0</math> kV All Ports</li> </ul> <b>5/50ns Tr/Td 5kHz Repetition Rate</b>
<b>Exerciser program during test</b>	<b>Referencing section 3.4</b>
<b>Specified test criterion</b>	<b>Criterion 'B'</b>
<b>EUT performance criterion</b>	<b>Criterion 'A'</b>

### RESULTS

#### Injection Via Clamp

<b>PORT</b>	<b>TEST VOLTAGE</b>	<b>STATUS</b>
<b>All ports</b>	<b><math>\pm 1.0</math> kV</b>	<b>PASS</b>

**UNCERTAINTY:** Specified as less than 10% but estimated as less than 5%. The level applied was 5% higher than the levels stated above to take into account the uncertainty for this test.

**COMMENT:** The EUT met the specified test criterion.

TEST ENGINEER: Rob St John James

## 5.5 Conducted RF Field

<b>TEST METHOD</b>	<b>IEC 61000-4-6</b> <b>REFERENCING PROCEDURE: CES-02</b>
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### TEST DETAILS

<b>Test severity level</b>	<ul style="list-style-type: none"> <li>• <b>3.0V rms, 80% amplitude modulation 400 Hz 0.15 to 80 MHz</b></li> <li>• <b>10V rms spot frequencies at: 2, 3, 4, 6.2, 8.2, 12.2, 12.6, 16.5, 18.8, 22, 25 MHz, the dwell at each frequency was 60 seconds.</b></li> </ul>
<b>Exerciser program during test</b>	<b>Referencing section 3.4</b>
<b>Specified test criterion</b>	<b>Criterion 'A'</b>
<b>EUT performance criterion</b>	<b>Criterion 'A'</b>

### RESULTS

<b>TEST VOLTAGE</b>	<b>TEST POINTS</b>	<b>COUPLING METHOD</b>	<b>STATUS</b>
<b>3.0V &amp; 10.0V</b>	<b>DC Input</b>	<b>CDN</b>	<b>PASS</b>

### RESULTS – Signal Port

<b>TEST VOLTAGE</b>	<b>TEST POINTS</b>	<b>COUPLING METHOD</b>	<b>STATUS</b>
<b>3.0V &amp; 10.0V</b>	<b>AIS &amp; GPS</b>	<b>150-50 ohm Adapter</b>	<b>PASS</b>
<b>3.0V &amp; 10.0V</b>	<b>All other signal ports</b>	<b>EM-Clamp</b>	<b>PASS</b>

**UNCERTAINTY:** Estimated uncertainty is < 5%. The applied voltage has been applied at higher level of 4 or 12V to take into account uncertainties.

**COMMENT:** The EUT met the performance criterion.

TEST ENGINEER: Rob St John James

## 5.6 Power Line Disturbance

<b>TEST METHOD</b>	<b>IEC 61000-4-11</b> <b>REFERENCING PROCEDURE: PLD-01</b>
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<b>TEST DETAILS</b>	<b>Specified test types &amp; levels</b> (voltage shift @ zero phase crossing)	<b>Specified criteria</b>
	<b>Interrupt: 100% reduction for 60s</b>	<b>C</b>
<b>Exerciser program during test</b>	<b>Referencing section 3.4</b>	

### RESULTS

<b>Applied test types &amp; levels</b>	<b>Test point</b>	<b>Nominal operation frequency / voltage</b>	<b>Performed criteria</b>	<b>Status</b>
<b>-100% x 60s</b>	<b>DC Input</b>	<b>24V DC</b>	<b>C</b>	<b>PASS</b>

UNCERTAINTY: Specification level is 5% but estimated as less than 1%.

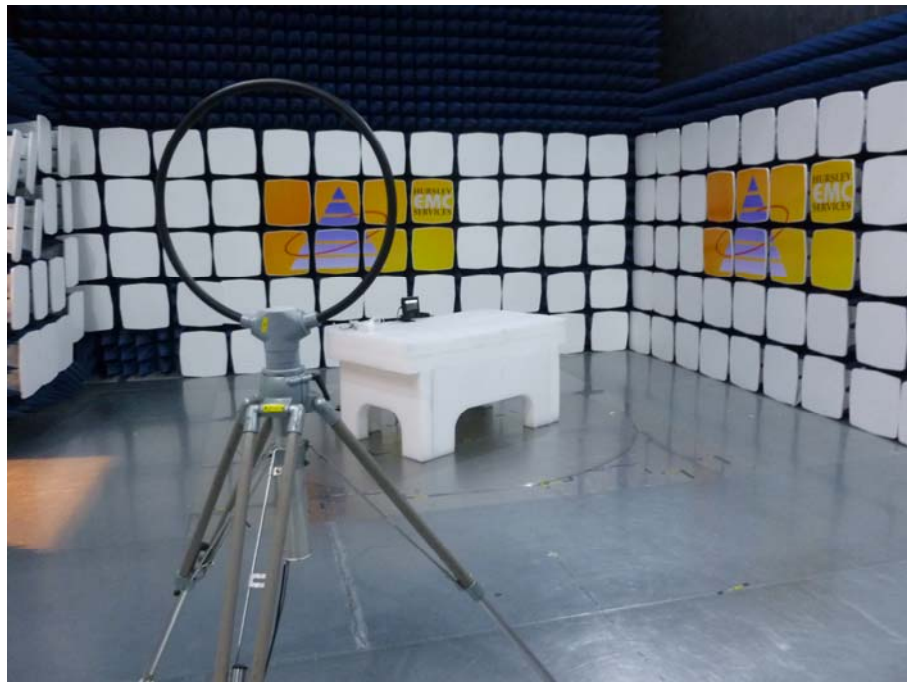
COMMENT: The EUT reset and continued after the test. The EUT met the performance criteria.

TEST ENGINEER: Rob St John James

## 6.0 PHOTO LOG (TYPICAL)

Emissions:

Radiated disturbance





**Photo Log (continued)**

**Immunity:**

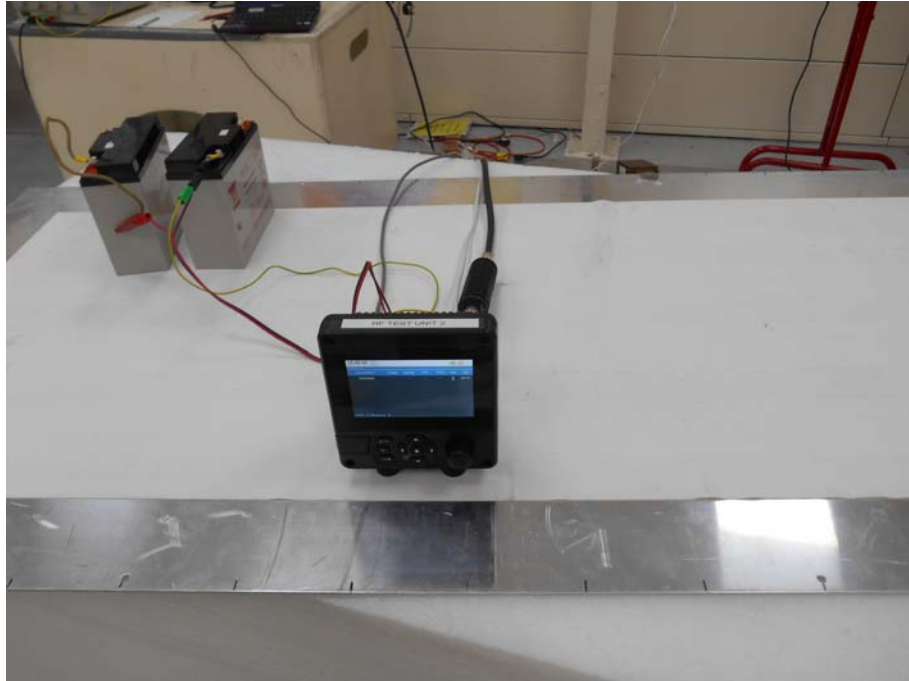
**Conducted disturbance**



**Photo Log (continued)**

**Immunity:**

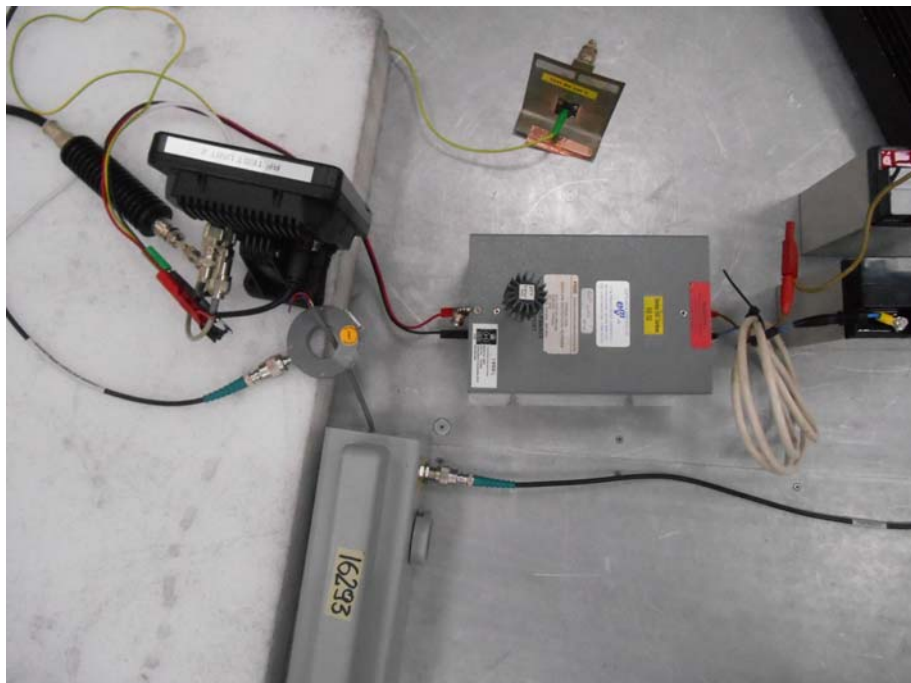
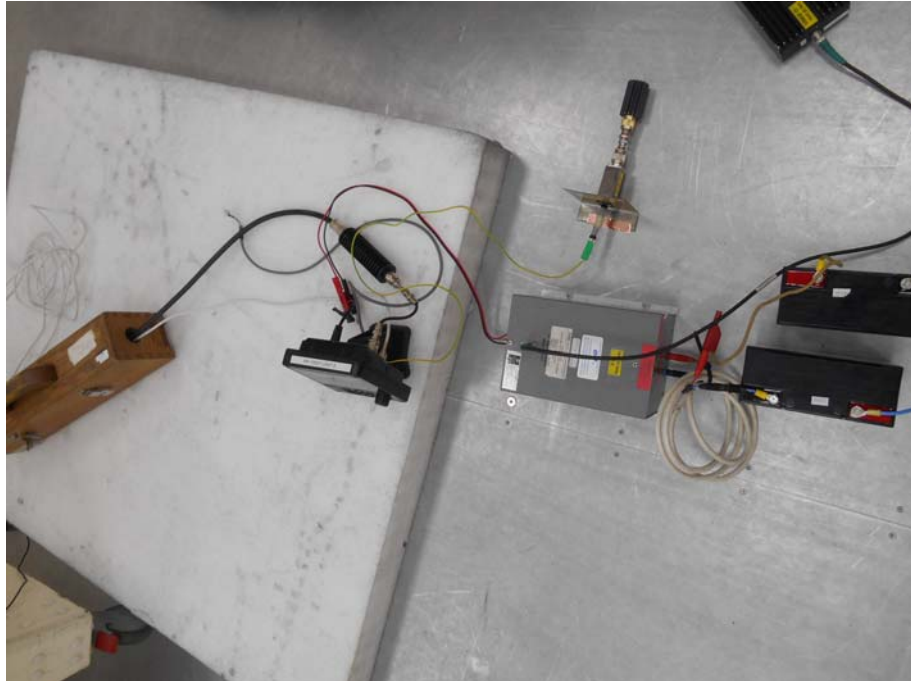
**Electrostatic discharge (set-up)**



**Photo Log (continued)**

**Immunity:**

**Conducted RF field**



**Photo Log (continued)**

**Immunity:**

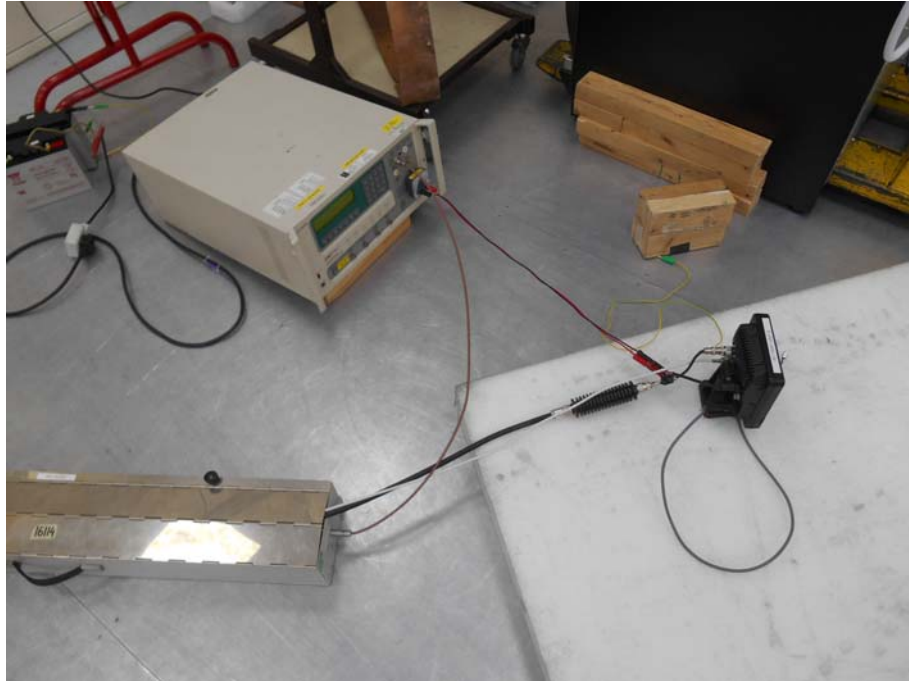
**Radiated RF field**



**Photo Log (continued)**

**Immunity:**

**Fast burst transients**



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