EMC Test Report

for the

Raymarine AIS500
Class B
AIS Transceiver

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

EMC Test Report

for the

Raymarine AIS500
Class B
AIS Transceiver

Project Engineer: R. P. St John James

Approval Signatory

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The above named are authorised Hursley EMC Services engineers.

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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 immunity requirements the following product modifications were applied:

- Increased the overvoltage sensitivity threshold from 33.5v to 36v and the windows setting from 100ns to 10ms

1.4 Conclusion

The EUT, with modification applied, 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 test standard for maritime navigation and radio communication equipment. The EUT was also tested to the ETSI EN 301 843-1 test standard for marine radio equipment and services.

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

Description	General Standard	Referenced Standard
Radiated disturbance	EN 60945:2002 † & ETSI EN 301 843-1:2004 †	CISPR 16-1:1999
Radiated H-Field		CISPR 16-1:1999
Conducted disturbance, DC port		CISPR 16-1:1999

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

Description	General Standard	Referenced Standard
Electrostatic discharge	EN 60945:2002 † & ETSI EN 301 843-1:2004 †	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%.

† The 2004 version of ETSI EN 301 843-1 and the 2002 version of EN 60945 are not currently included in the UKAS Accreditation Schedule for Hursley EMC Services but the reference standards are included in the schedule.

2.2 Test Deviations

None.

2.3 EMC Test Lab Reference

Hursley EMC Services file: 08R532.

3.0 EQUIPMENT & TEST DETAILS

3.1 General

EUT:	Class B Automatic Identification System (AIS) Transceiver Make: Raymarine Model: AIS500 Serial number: EP2-08
EUT build level:	Production sample
EUT manufacturer:	Raymarine
Customer:	SRT Marine Technology Ltd Wireless House Westfield Industrial Estate Midsomer Norton Bath BA3 4BS United Kingdom Tel: +44 (0) 1761 409 500
Test commissioned by:	Mr Matt Clarke
Date EUT received:	1st December 2008
Test date(s):	1st to 14th December 2008 and the 8th January 2009
EMC measurement site(s):	Hursley EMC Services Limited • Unit 16, Brickfield Lane, Chandlers Ford, Hampshire • Hursley Park, Winchester, Hampshire

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

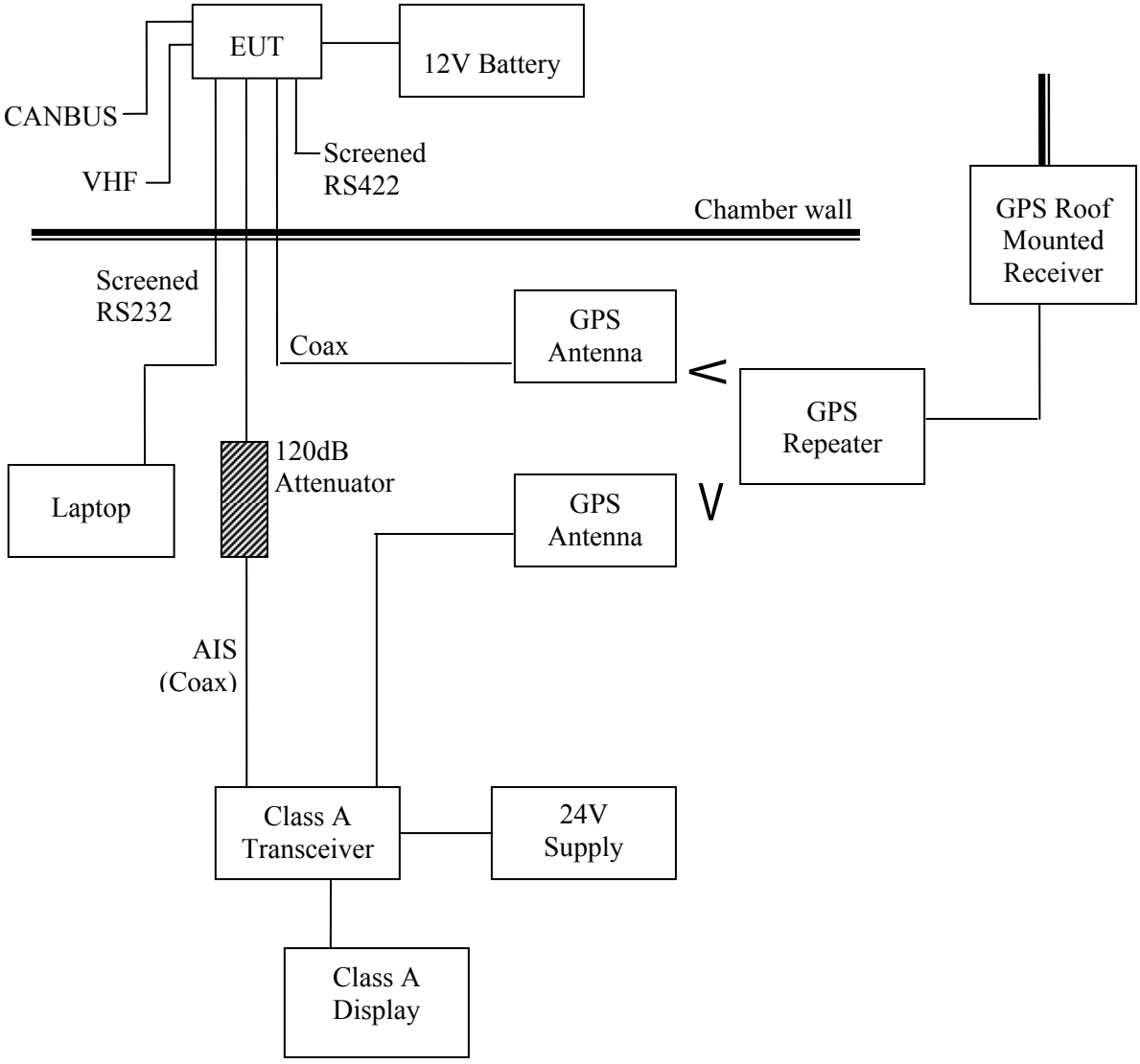
- 12V lead acid battery
- 2x GPS antennae
- 24V power supply H2 Power Model PS3003L, s/n 10010
- Samyung SI-300-E Display (VDU) , s/n 6400030
- Samyung SI-30 Class A Transceiver, s/n 7A01901
- IBM Laptop 2647, s/n 55R7X0X204 (HEMCS)
- 120dB attenuator
- HEMCS GPS receiver & repeater

3.4 EUT Test Exerciser

The laptop continuously monitored the activity of the Class B AIS Transceiver over the RS232 RS422 interface. Once every 180 seconds the message changed to indicate a transmission had occurred. The McMurdo MT-1 VDU displayed a message that had been received from the Class B AIS Transceiver and displayed a counter in seconds for the time to the next message; the count between each message was 180 seconds.

The RS232 activity was recorded in a Tera Term Windows on the Laptop. Both the Tera Term Windows and the MT-1 VDU were monitored for data interruption or unintended transmissions.

3.5 EUT Test Configuration



Note:

- Cables connecting to the EUT were 20m long.
- A screened RS232 cable was used for all testing.
- A screened RS422 cable was also connected to the EUT.
- A terminated CANBUS cable was connected.
- A terminated VHF cable was also attached to the EUT

3.6 Environmental Test Conditions

Temperature	17.5 to 24º Celsius
Relative Humidity	33 to 41%
Atmospheric Pressure	990 to 1029 millibars

3.7 EMC Test Equipment

#ID	CP	Manufacturer	Type	Serial Nø	Description	Calibration due date
004	1	Rohde Schwarz	ESH-3	893607/002	Test receiver (9kHz-30MHz)	03/12/2009
008	1	HP	8568B	2517A01791	Spectrum analyser	11/01/2009
009	1	HP	8447D	1937A01808	Pre-amplifier (30-1000MHz)	09/07/2009
014	0	Rohde Schwarz	HL223*	831465/005	Logperiod; 1m ARP958, F/Space	Internal
026	LAB	Chase	CBL6140	1036	Antenna X-wing (20-2000MHz)	Internal
030	1	KeyTek	MZ-15/EC	0406216	ESD Minizap /pink	14/10/2009
034	1	Rohde Schwarz	SMT06	830004/0012	Signal generator (6GHz)	25/02/2009
043	2	IFI	M5580	0790-3820	M5580 amplifier (ref 44)	29/02/2009
044	2	IFI	M406	1288-3509	M406 amplifier (1kW)	29/02/2009
065	1	Schaffner	CDN125	158 9137	Capacitive coupling clamp	09/10/2009
070	1	HP+short cable	8449B	3008A00481	Pre-amplifier (1.0-26.5GHz) + 1m cable	13/10/2009
073	1+	Schwarzbeck	BBHA9120B	237	Horn antenna (1-10GHz)	15/01/2009
079a	1.5	Bird	4022	5933	Probe for [079]	02/07/2009
099	1	HP	8596-EM	3911A00146	Spectrum analyser (9kHz-12.8GHz)	03/01/2009
102	LAB	Amp research	AT4002A	310154	Horn antenna (0.8-5.0GHz)	Internal
115	1	KeyTek	CE Master	9703374	Immunity simulator	08/04/2009
116	1	Rohde Schwarz	ESH-3 Z2	M458	Pulse limiter BNC type	08/07/2009
121	1	EM	CWS500A	0898-02	Conducted immunity simulator	03/11/2009
122	1	Sucoflex	106	25156/6	Cable SMA (18GHz)	15/12/2009
129	0	Rohde Schwarz	HK116	835291/001	Bicon; ARP958 1m + F/space	Internal
135	1	KeyTek	EMC Pro	9806258	Immunity tester	Internal
147	1	Rohde Schwarz	ESH3 Z5	846695/011	AMN - single phase	*01/11/2008
152	1	Fischer	801-M2-16	9867	CDN mains 2xwire	10/03/2009
200	1	Fischer	F-203I	121	EM Injection clamp (10k-1GHz)	Internal
218	1.5	Boonton	4230	26603	Power meter/probe(a) (18GHz)	21/04/2009
241	1	Rohde Schwarz	ESVP	879962/049	Test receiver (30-1300MHz)	11/02/2009
248	1	Sucoflex	104	6776/4B	RES cable, armoured (12m 6GHz)	10/09/2009

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
'*' denotes that the calibration, as defined by Hursley EMC Services quality system, remains valid whilst within three calendar months of due date

4.0 EMISSION RESULTS

4.1 Radiated Disturbance

4.1.1 Data, 30 to 156 MHz & 165 to 2000 MHz

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 data obtained from the chamber profile-scan as an engineering guide, the EUT was then transferred onto the turntable in the Open Area Test Site. The antenna was positioned at a distance of three metres from the periphery of the EUT. Radiated emissions were then systematically maximised by revolving the EUT and adjusting the antenna in polarity and height. The highest emissions are presented here.

Emission frequency (MHz)	Measured quasi-peak value (dBµV/m)	Specified quasi-peak limit (dBµV/m)	Status
98.303	34.1	54	Pass
123.120	35.8	54	Pass
135.970	36.1	54	Pass
154.475	32.1	54	Pass
479.228	40.3	54	Pass
540.668	31.5	54	Pass
679.850	40.3	54	Pass
815.819	37.1	54	Pass

Uncertainty of measurement: ± 4.2dBµV for a 95% confidence level.

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

TEST ENGINEER: Rob St John James

4.1.2 Data, 156 to 165 MHz

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.

Using the data obtained from the chamber profile-scan as an engineering guide, the EUT was then transferred onto the turntable in the Open Area Test Site. The antenna was positioned at a distance of three metres from the periphery of the EUT. Radiated emissions were then systematically maximised by revolving the EUT and adjusting the antenna in polarity and height. The highest emissions measured with a 9kHz quasi-peak detector, are presented here.

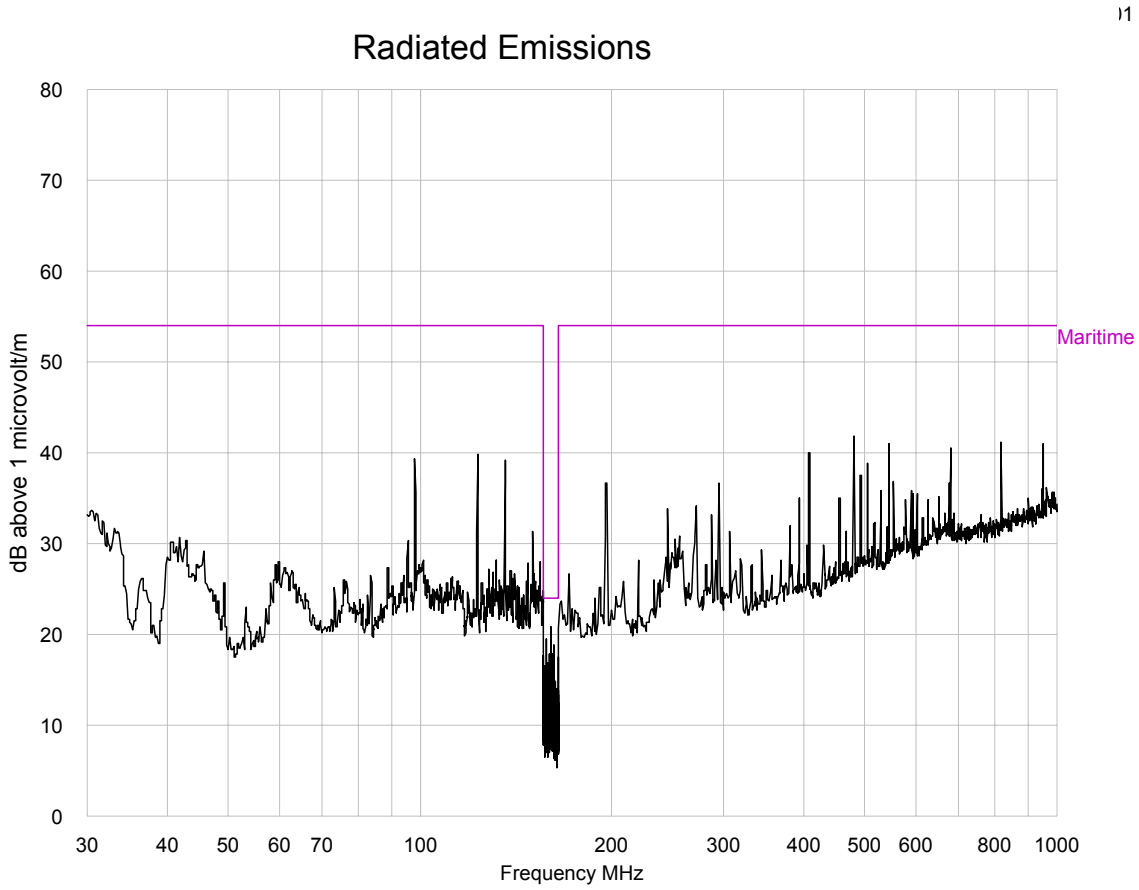
Emission frequency (MHz)	Measured quasi-peak value (dBµV/m)	Specified quasi-peak limit (dBµV/m)	Status
160.245	15.8	24	Pass

Uncertainty of measurement: ± 4.2dBµV for a 95% confidence level.

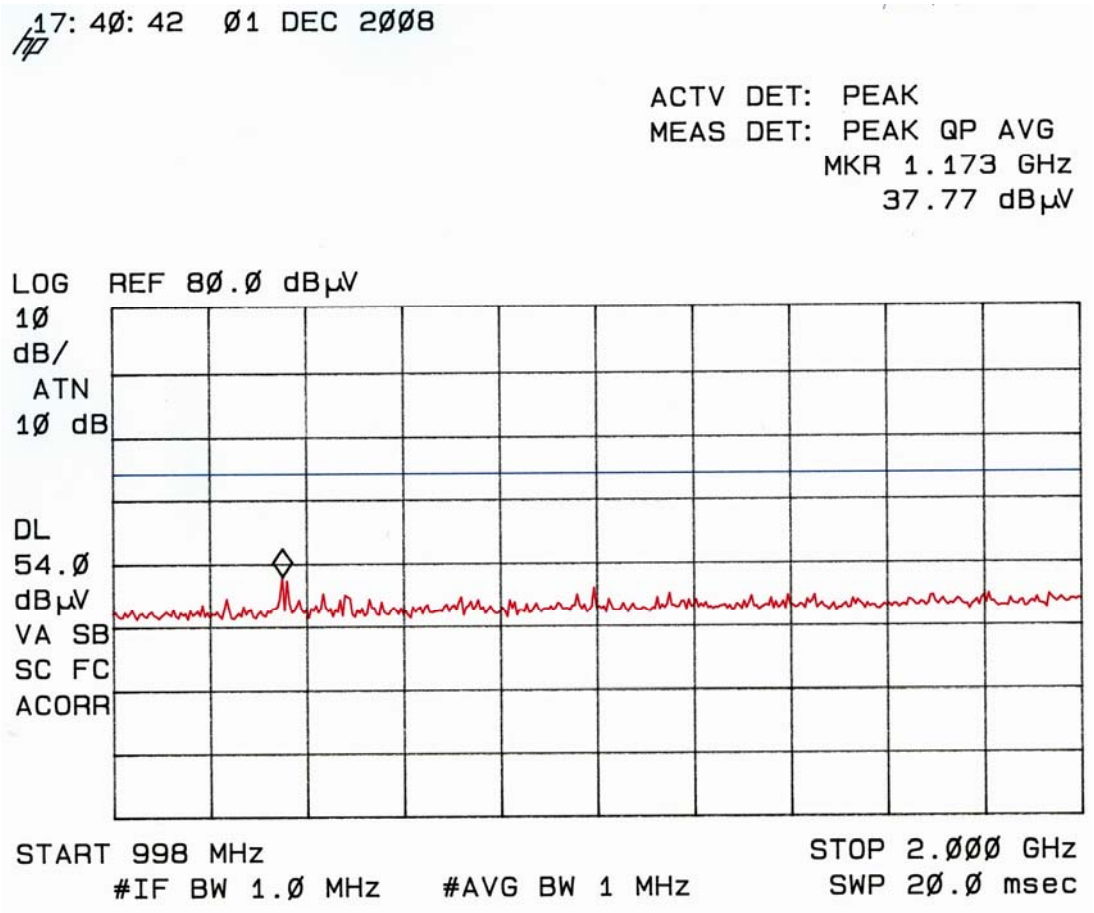
The measurements reported are the highest emissions relative to the EN 60945 limit and take into account the antenna and cable loss factors. Measurements made according to the EN 60945 test standard and Hursley EMC Services test procedure RAD-01.

TEST ENGINEER: Rob St John James

4.1.3 Radiated Emission Plot, 30 MHz to 1.0 GHz



4.1.4 Radiated Emission Plot, 1.0 to 2.0 GHz



4.1.5 Radiated H-Field, 150 kHz to 30 MHz

4.1.6 Data

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

The highest emission was then measured at 3m on an open area test site these are recorded below:

X-AXIS (worst-case)

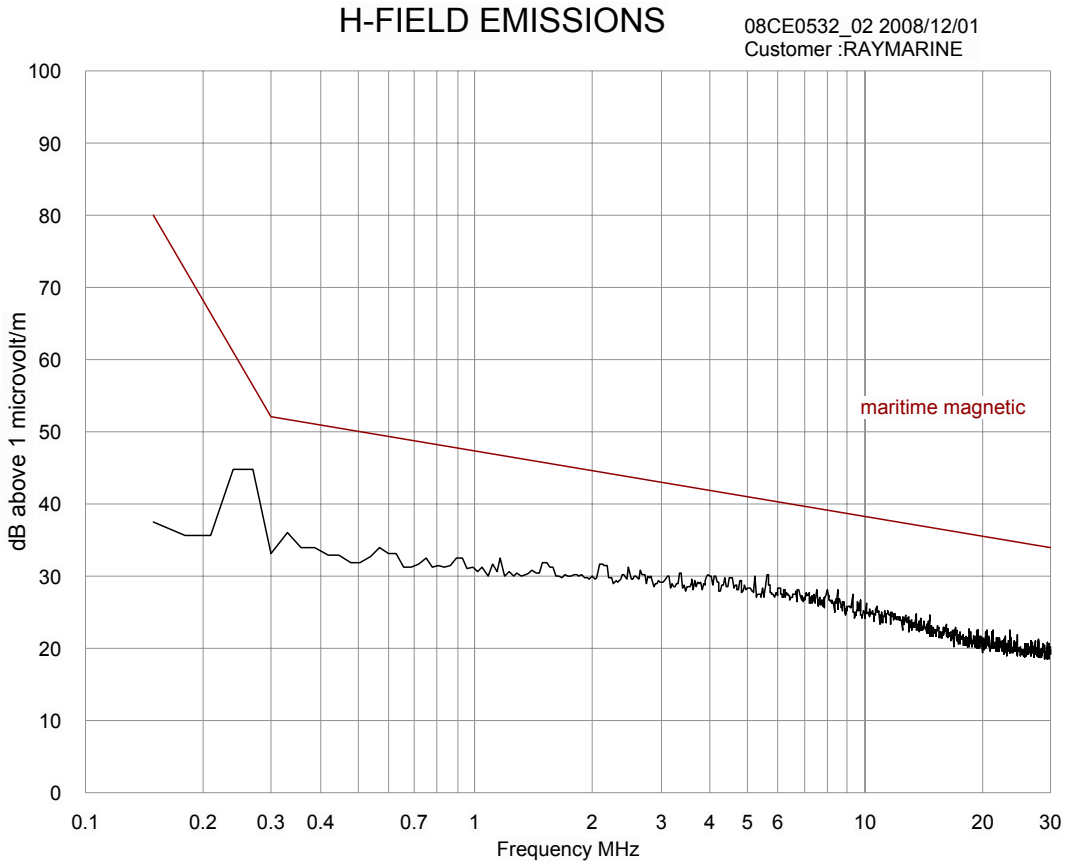
Emission frequency (MHz)	Measured quasi-peak value (dBµV/m)	Specified quasi-peak limit (dBµV/m)	Status
0.307	42.3	51.9	Pass

Uncertainty of measurement: ± 4.2dBµV for a 95% confidence level.

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

TEST ENGINEER: Rob St John James

4.1.7 Profile


H-FIELD EMISSIONS
08CE0532_02 2008/12/01
Customer :RAYMARINE
dB above 1 microvolt/m
100
90
80
70
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.7
1
2
3
4
5
6
10
20
30
Frequency MHz
maritime magnetic

4.2 Conducted Disturbance

4.2.1 Data

A filtered 24V DC 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 an average and/or 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.

0V DC

Frequency (MHz)	Quasi-peak value (dBµV)		Status
	Measured	Limit	
0.087	25.8	59.3	Pass
0.092	29.8	58.3	Pass
0.306	41.9	51.6	Pass
24.576	45.9	50.0	Pass
27.648	33.8	50.0	Pass

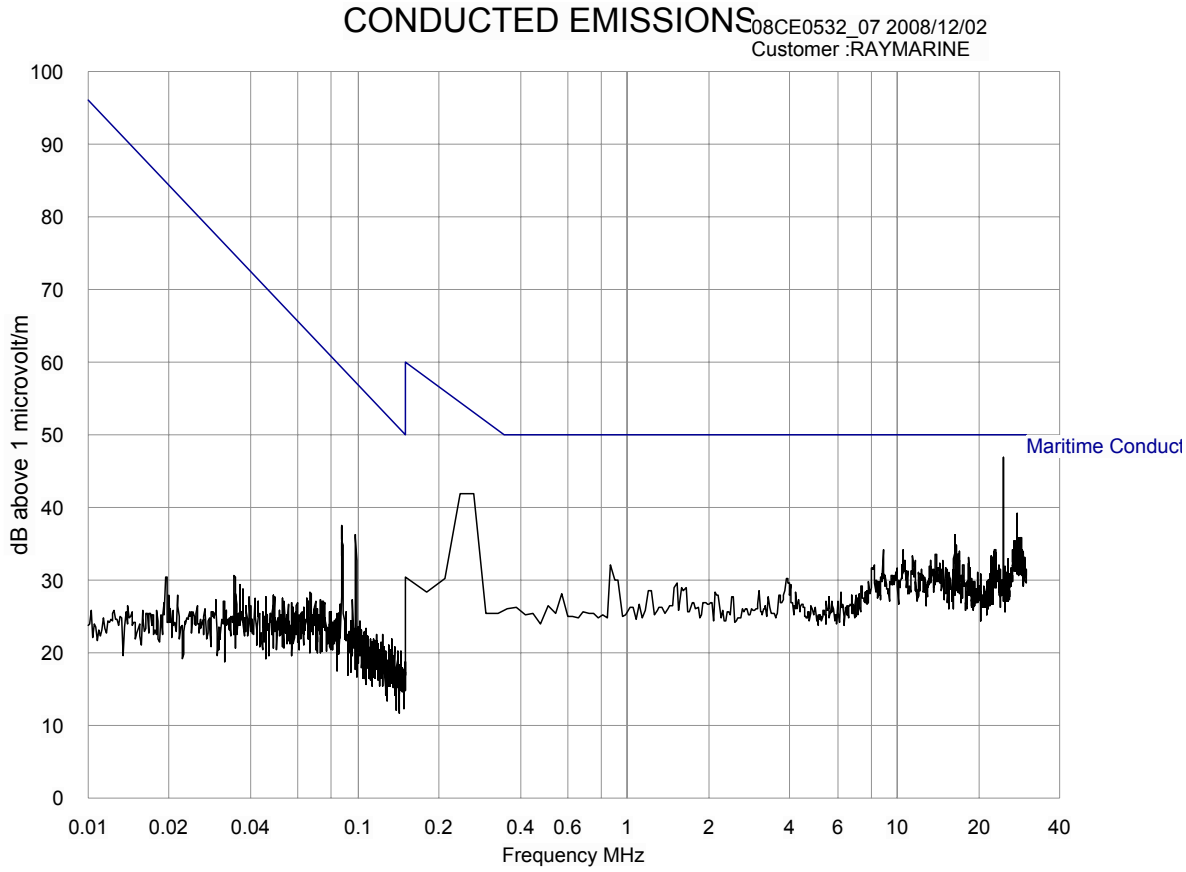
24V DC

Frequency (MHz)	Quasi-peak value (dBµV)		Status
	Measured	Limit	
0.307	39.3	51.5	Pass
24.576	45.2	50.0	Pass
24.577	45.2	50.0	Pass
27.646	33.6	50.0	Pass

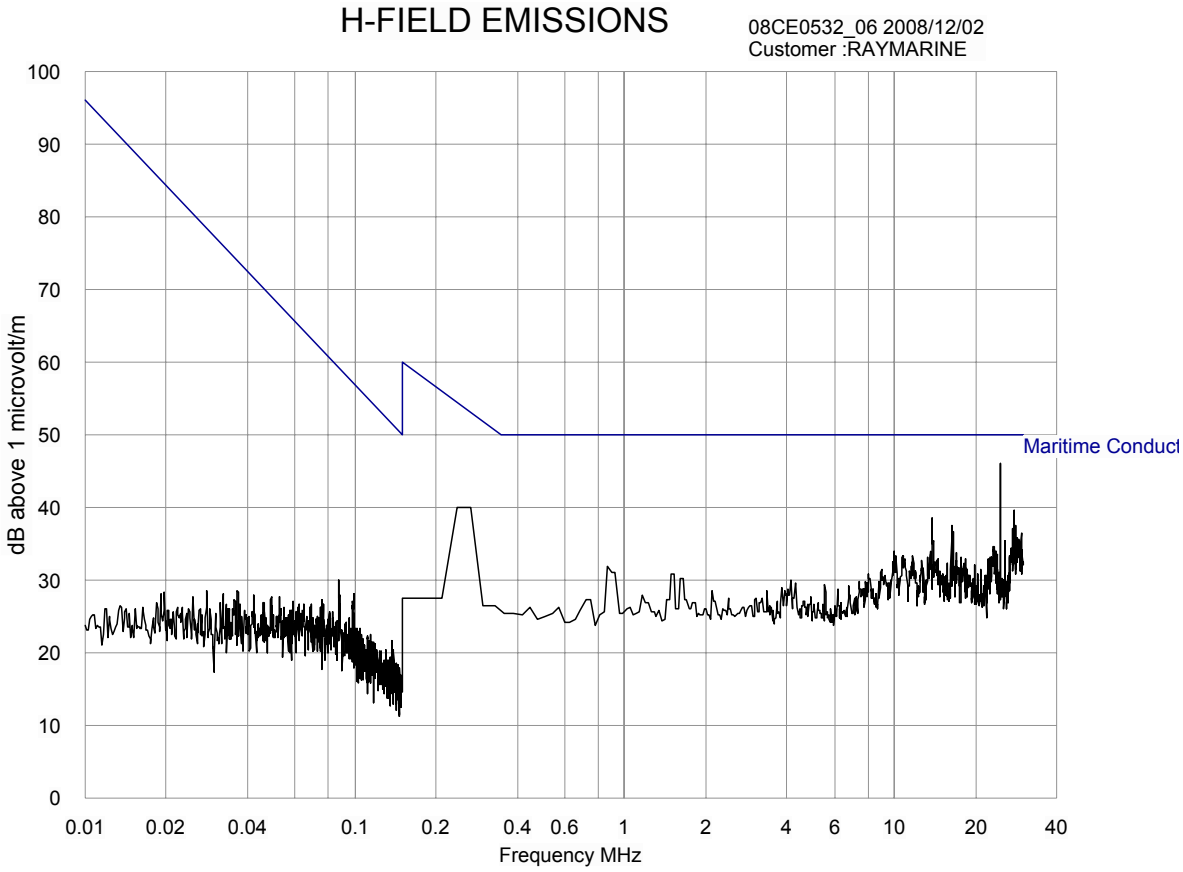
Uncertainty of measurement: ± 3.22 dBµV for a 95% confidence level.

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:	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.
Criterion B:	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.
Criterion C:	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.

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

5.2 Electrostatic Discharge

TEST METHOD	IEC 61000-4-2 REFERENCING PROCEDURE: ESD-03

TEST DETAILS

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

RESULTS

Contact, Indirect

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

Contact, Direct To EUT

SPECIFIED VOLTS	TEST POINTS	STATUS
± 2.0 kV	See test points on next page	PASS
± 4.0 kV		PASS
± 6.0 kV		PASS

Air Discharge (Insulating, Slots & Apertures)

SPECIFIED VOLTS	TEST POINTS	STATUS
± 2.0 kV	See test points on next page	PASS
± 4.0 kV		PASS
± 8.0 kV		PASS

UNCERTAINTY: It has been demonstrated that the ESD simulator met the specified requirements in the standard with at least a 95% confidence.

COMMENT: No performance degradation was observed. The EUT met the specified test criterion.

TEST ENGINEER: Allan Wheelan

5.2.1 Electrostatic discharge – Test points

Arrows indicate discharge points

Contact Discharge →
Air Discharge —●

5.3 Radiated RF Interference

TEST METHOD	IEC 61000-4-3 REFERENCING PROCEDURE: RES-02

TEST DETAILS

Test severity levels, 80 to 2000 MHz swept frequency	• **10.0 V/m** • **80% amplitude modulation 400 Hz** • **1% increment, 3 seconds dwell time and 9 seconds dwell time from 1.0 GHz**
Exerciser program during test	**Referencing section 3.4**
Specified test criterion	**Criterion 'A'**
EUT performance criterion	**Criterion 'A'**

RESULTS

TEST POINTS	ANTENNA POLARITIES	FIELD LEVEL SPOT FREQUENCY	STATUS
Front	**Horizontal & vertical**	**10.0 V/m**	**PASS**
Side, left	**Horizontal & vertical**	**10.0 V/m**	**PASS**
Side, right	**Horizontal & vertical**	**10.0 V/m**	**PASS**
Rear	**Horizontal & vertical**	**10.0 V/m**	**PASS**

UNCERTAINTY: The field level has been applied at level higher than that specified to give a greater confidence that the EUT meets the specified level.

COMMENT: The exclusion band was ±5% of the GPS frequency (1570 MHz) and ±5% of the AIS frequency band (156.025 to 162.025 MHz). In test no exclusion bands were used. The EUT met the specified test criterion.

TEST ENGINEERS: Rob St John James and Allan Wheelan

5.4 Fast Transient Bursts

TEST METHOD	IEC 61000-4-4 REFERENCING PROCEDURE: FTB-01

TEST DETAILS

Test severity	• ± 1.0 kV Signal Ports • ± 1.0 kV DC Port 5/50ns Tr/Td 5kHz Repetition Rate
Exerciser program during test	**Referencing section 3.4**
Specified test criterion	**Criterion 'B'**
EUT performance criterion	**Criterion 'A'**

RESULTS

Direct Injection

PORT	TEST VOLTAGE	STATUS
DC Power Port	**± 1.0 kV**	**PASS**

Injection Via Clamp

PORT	TEST VOLTAGE	STATUS
Antenna coax leads & RS232/422	**± 1.0 kV**	**PASS**

UNCERTAINTY: It has been demonstrated that the transient simulator met the specified requirements in the standard with at least a 95% confidence.

COMMENT: The EUT met the specified test criterion.

TEST ENGINEER: Rob St John James

5.5 Conducted RF Field

TEST METHOD	IEC 61000-4-6 REFERENCING PROCEDURE: CES-02

TEST DETAILS

Test severity level	• **3.0V rms, 80% amplitude modulation 400 Hz 0.15 to 80 MHz** • **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.**
Exerciser program during test	**Referencing section 3.4**
Specified test criterion	**Criterion 'A'**
EUT performance criterion	**Criterion 'A'**

RESULTS

TEST VOLTAGE	TEST POINTS	COUPLING METHOD	STATUS
3.0V & 10.0V	**DC Port**	**CDN**	**PASS**

RESULTS – Signal Port

TEST VOLTAGE	TEST POINTS	COUPLING METHOD	STATUS
3.0V & 10.0V	**Coax ports**	**100 ohm resistor to screen**	**PASS**
3.0V & 10.0V	**RS232/422**	**100 ohm resistor to screen**	**PASS**

UNCERTAINTY: It has been demonstrated that the conducted immunity simulator met the specified requirements in the standard with at least a 95% confidence.

COMMENT: The EUT when powered by 24v DC, turned off during testing at 22MHz. A modification to increase the overvoltage threshold from 33.5v to 36v and windows settings from 100ns to 10ms, resolved this problem.

TEST ENGINEER: Rob St John James

5.6 Power Line Disturbance

TEST METHOD	**IEC 61000-4-11** **REFERENCING PROCEDURE: PLD-01**

TEST DETAILS

Test severity level	**Interrupt >95% for 60s**
Exerciser program during test	**Referencing section 3.4**
Specified test criterion for –100% x 60s	**Criterion 'C'**
EUT performance criterion	**Criterion 'C'**

RESULTS – RF COMMON MODE

TEST POINTS	LEVEL	STATUS
12V DC input	**-100% x 60s**	**PASS**

UNCERTAINTY: It has been demonstrated that the power line disturbance simulator met the specified requirements in the standard with at least a 95% confidence.

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

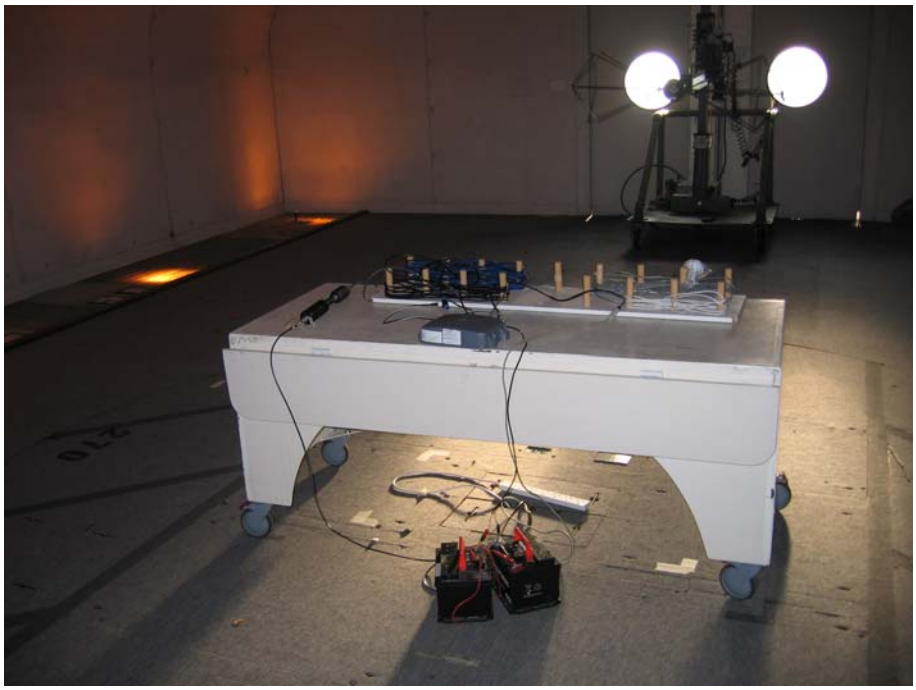


Photo Log (continued)

Emissions:

Conducted disturbance

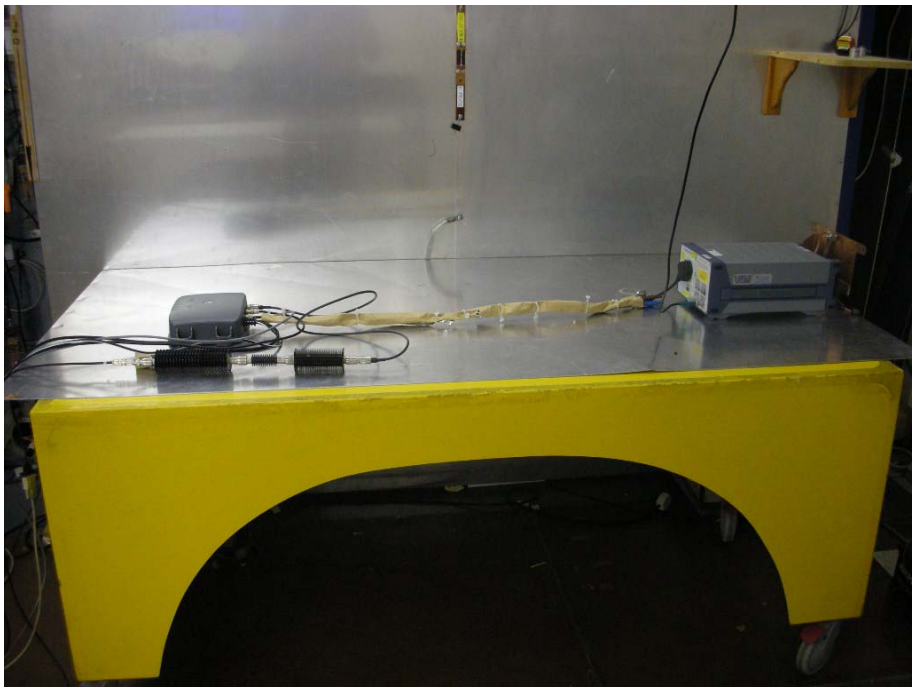
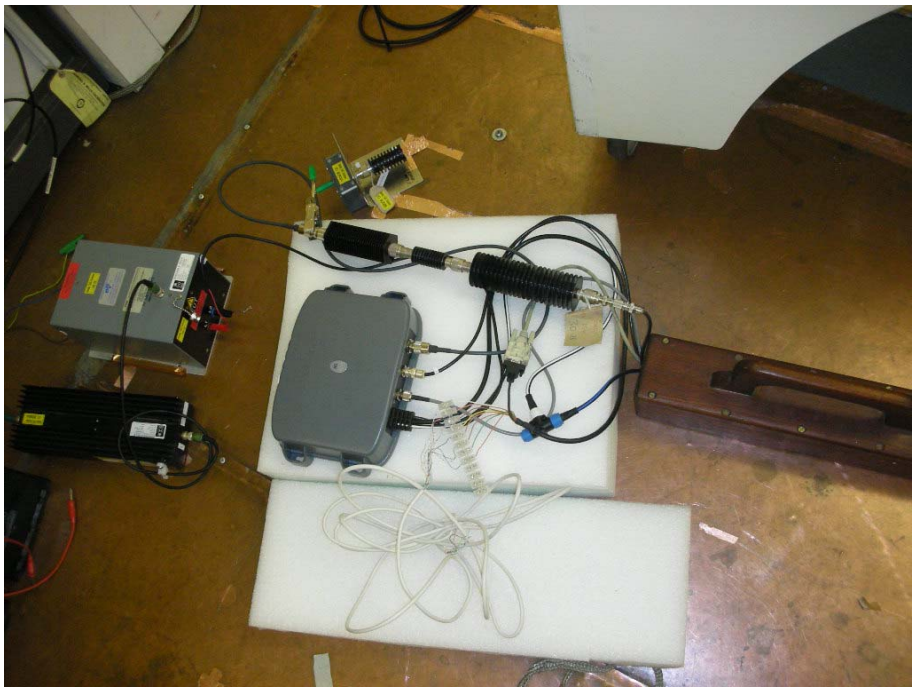


Photo Log (continued)

Immunity:

Conducted RF field



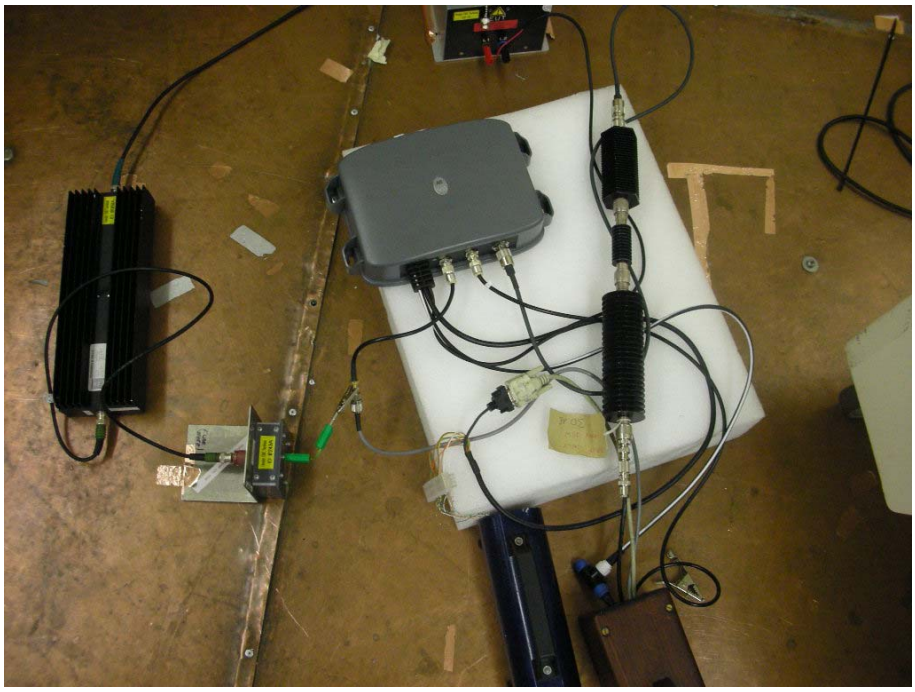


Photo Log (continued)

Immunity:

Radiated RF field

Photo Log (continued)

Immunity:

Fast burst transients