Report on the EMC Testing of:

Ocean Signal Limited
AIS Class B transponder ATB1

In accordance with IEC 60945

Prepared for: Ocean Signal Limited
Ocivan Way
Margate
CT9 4NN
United Kingdom

Product Service

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Document Number: 75936859-03 Issue: 01

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Authorised Signatory	Andy Lawson	09 October 2018	

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD Product Service document control rules.

EXECUTIVE SUMMARY
A sample of this product was tested and found to be compliant with IEC 60945: 2002 C1:2008.

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1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	09 October 2018

Table 1

1.2 Introduction

Applicant	Ocean Signal Limited
Manufacturer	Ocean Signal Limited
Model Number(s)	ATB1
Serial Number(s)	TA 003 (TUV Ref TSR0005)
Hardware Version(s)	Mod State 0: 0B.00 Mod State 1: 0B.01 Mod State 2: 0B.02 Mod State 3: 0B.03 Final Build Version: 01.00 (same as 0B.03)
Firmware Version(s)	0.1.03 0.1.14 01.00.00 (Final Version)
Number of Samples Tested	1
Test Specification/Issue/Date	IEC 60945: 2002 C1: 2008
Order Number Date	3122-00 reprint 03/1 03-November-2016
Date of Receipt of EUT	13-February-2018
Start of Test	29-June-2018
Finish of Test	23-August-2018
Name of Engineer(s)	Michael Mawby, Colin McKean and Jack Tuckwell
Related Document(s)	CISPR 16-1-4: 2007 CISPR 16-1-2: 2006 IEC 61000-4-6: 2006 IEC 61000-4-11: 2004 IEC 61000-4-2: 2001 ISO 694: 2000 IEC 61000-4-3: 2006

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with IEC 60945 is shown below.

Section	Specification Clause	Test Description	Result	Comments/Base Standard
Configuration and mode: Test Configuration 1, Transmitting and Receiving				
2.1	9.3	Radiated Emissions	Pass	CISPR 16-1-4: 2007
2.3	10.3	Immunity to Conducted Radio Frequency Disturbance	Pass	IEC 61000-4-6: 2006
2.4	10.8	Immunity to Power Supply Failure	Pass	IEC 61000-4-11: 2004
2.5	10.9	Immunity to Electrostatic Discharge	Pass	IEC 61000-4-2: 2001
2.6	11.2	Compass Safe Distance	Pass	ISO 694: 2000
2.7	10.4	Immunity to Radiated Radio Frequencies	Pass	IEC 61000-4-3: 2006
Configuration and mode: Test Configuration 2, Transmitting and Receiving				
2.2	9.2	Conducted Emissions	Pass	CISPR 16-1-2: 2006

Table 2

Product Service

1.4 Declaration of Build Status

EQUIPMENT DESCRIPTION	
Model Name/Number	ATB1
Part Number	760S-02700
Hardware Version	01.00
Software Version	01.00.00
Technical Description (Please provide a brief description of the intended use of the equipment)	Class B AIS transponder

EXTREME TEMPERATURE RANGE (over which equipment is to be type tested)
☐ Not Applicable (no extreme temperature testing required)
☒ Category I (General)
☐ Category II (Portable equipments)
☐ Other (please specify):

TYPE OF EQUIPMENT			
☐ Fixed Station	☐ Transmitter	☐ Simplex	☐ Integral Antenna
	☐ Receiver	☐ Duplex	☒ Single Antenna
☒ Mobile Station	☒ Transceiver		☐ Two Antenna Connector
			☐ Multiple Antenna Connectors No.
☐ Portable Station	☐		
☐ Transponder (Tag)	☒ Active	☐ Passive	

TRANSMITTER TECHNICAL CHARACTERISTICS		
FREQUENCY CHARACTERISTICS		
Transmitter frequency alignment range	to	MHz
Transmitter channel switching frequency range	156.025 to 162.025	MHz

Product Service

TRANSMITTER RF POWER CHARACTERISTICS		
Maximum rated transmitter output power as stated by manufacturer (if applicable)		
5	W	At transmitter permanent external 50 Ω RF output connector
and/or		
	W	Effective radiated power (for equipment with integral antenna)
Minimum rated transmitter output power as stated by manufacturer (if applicable)		
	W	At transmitter permanent external 50 Ω RF output connector
and/or		
	W	Effective radiated power (for equipment with integral antenna)

Is transmitter intended for :

Continuous duty	☐ Yes	☒ No
Intermittent duty only	☒ Yes	☐ No

If intermittent duty state DUTY CYCLE

Transmitter ON	0.026	Seconds	Transmitter OFF	Seconds

TRANSMITTER - MODULATION			
Amplitude	☐	Other	☒
Frequency	☐	Details :	GMSK
Phase	☐	Channel Spacing	25kHz
Can the transmitter be operated without modulation? * See definition below		☐ Yes	☒ No

RECEIVER TECHNICAL CHARACTERISTICS	
FREQUENCY CHARACTERISTICS	
Receiver frequency alignment range	to
Receiver channel switching frequency range	156.025 to 162.025
Channel Separation (if applicable)	25kHz
State the maximum number of channels over which the equipment can operate:	

Product Service

POWER SOURCE	
☐ AC mains	State voltage
AC supply frequency (Hz)	
VAC	
Max Current	
Hz	
☐ Single phase	☐ Three phase
And / Or	
☒ External DC supply	
Nominal voltage V	Max Current 6 A
Extreme upper voltage 31.2 V	
Extreme lower voltage 10.8 V	
Battery	
☐ Nickel Cadmium	☐ Lead acid (Vehicle regulated)
☐ Alkaline	☐ Leclanche
☐ Lithium	☐ Other Details :
Volts nominal.	
End point voltage as quoted by equipment manufacturer 10.8 V	

AUTOMATIC EQUIPMENT SWITCH OFF	
If the equipment is designed to automatically switch off at a predetermined voltage level which is higher or lower in value than the battery minimum and minimum calculated values this shall be clearly stated.	
☐ Applies	V cut-off voltage
☒ Does not apply	

Product Service

AUTOMATIC EQUIPMENT SWITCH OFF	
If the equipment is designed to automatically switch off at a predetermined voltage level which is higher or lower in value than the battery minimum and minimum calculated values this shall be clearly stated.	
☐ Applies	V cut-off voltage
☒ Does not apply	

CHANNEL IDENTIFICATION			
Each equipment, whether one or more submitted for tests shall carry clear identification (such as a serial number), together with the frequencies associated with the channel identification displayed on the equipment.			
Equipment Identification eg Serial Number	Channel No.	Transmit Nominal Freq MHz	Receive Nominal Freq MHz

I hereby declare that that the information supplied is correct and complete.

Name: David Sheekey Position held: Type Approval Manager

Date: 28/3/2018

1.5 Product Information

1.5.1 Technical Description

The Equipment Under Test (EUT) was an Ocean Signal, AIS Transceiver Class B.

The primary function of the EUT is to provide Automatic Identification data. Additionally, the EUT has functionality to receive GPS data.

A full description and detailed product specification details are available from the manufacturer.

Figure 1 - General View

Figure 2 - Rear View

1.5.2 EUT Port/Cable Identification

Port	Max Cable Length specified	Usage	Type	Screened
Configuration and Mode: Test Configuration 1 and 2, Transmitting and Receiving				
Antenna	>2m	Connection to AIS	Coax	Yes
Power / Data	>2m	12 V DC / USB	Multicore	Yes
GPS	>2m	GPS Rx	Coax	Yes
NMEA	>2m	Connection to NMEA	Multicore	Yes

Table 3

1.5.3 Test Configuration

Configuration	Description
Test Configuration 1	The EUT was powered from a 12V DC PSU and a GPS simulator provided GPS signals. An external Class A AIS, FTDI NMEA to USB Convertor and PC with data logging were used to monitor the transmissions to and from the EUT.
Test Configuration 2	The EUT was powered from a 12V DC Battery and a GPS simulator provided GPS signals. An external Class A AIS, Brainbox NMEA to USB Convertor and PC with data logging was used to monitor the EUT.

Table 4

1.5.4 Modes of Operation

Mode	Description
Transmitting and Receiving	Transmitting and receiving AIS data.

Table 5

1.5.5 Monitoring of Performance

Software monitored for corruption of recorded data.

1.5.6 Performance Criteria

Performance Criteria A

The apparatus shall continue to operate as intended during and 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. The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended.

The manufacturers specified performance level is detailed as:

No corruption of recorded data during test

Performance Criteria 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. 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 performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended.

The manufacturers specified performance level is detailed as:

Some corruption of recorded data during test, no change of performance.

Performance Criteria C

Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of the controls.

The manufacturers specified performance level is detailed as:

Some corruption of recorded data during test so long as equipment function can be restored

1.6 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

1.7 EUT Modification Record

The table below details modifications made to the EUT during the test programme.
The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Hardware			
0	As supplied by the Manufacturer	Not Applicable	Not Applicable
1	Add 22pf decoupling capacitor from IC 42 Pin 42 to 0V - SPI data line (Signal RF_MOSI). Add 22pf decoupling capacitor from IC 42 Pin 43 to 0V - SPI data line (Signal RF_MISO). Change C299 from 1nF to 4n7 – TX Power control loop BW reduction.	Manufacturer	15 May 2018
2	Add M95512 non -volatile memory IC to SPI Bus (IC50).	Manufacturer	12 June 2018
3	Add 4A SM Fuse “F2” to Supply +V between J1 and D2 (TA001 only). Not applicable to this document.	Manufacturer	17 September 2018
Firmware: all testing was carried out with firmware 0.1.03 unless indicated otherwise.			
0.1.03	As supplied by the Manufacturer	Manufacturer	As supplied
0.1.14	Fixed issue with channel management in message 22. Fixed problem with SOG error in message 27. Fixed problem with TX malfunction alarm not clearing.	TUV	21 August 2018
Manufacturer notes the following: Further firmware revisions were applied to the EUT within the test dates. This was to maintain all of the supplied test samples at the same firmware revision. The revisions made were to resolve non-compliances identified during network testing and had no effect on the EUT transceiver performance or the operation of the serial data ports.			

Table 6

1.8 Test Location

TÜV SÜD Product Service conducted the following tests at our Fareham Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Test Configuration 1		
Radiated Emissions	Michael Mawby	UKAS
Immunity to Conducted Radio Frequency Disturbance	Michael Mawby and Colin McKean	UKAS
Immunity to Power Supply Failure	Michael Mawby	UKAS
Immunity to Electrostatic Discharge	Colin McKean	UKAS
Compass Safe Distance	Michael Mawby	UKAS
Immunity to Radiated Radio Frequencies	Michael Mawby, Colin McKean and Jack Tuckwell	UKAS
Test Configuration 2		
Conducted Emissions	Michael Mawby	UKAS

Table 7

Office Address:

Octagon House
Concorde Way
Segensworth North, Fareham
Hampshire
PO15 5RL
United Kingdom

2 Test Details

2.1 Radiated Emissions

2.1.1 Specification Reference

IEC 60945, Clause 9.3

2.1.2 Equipment Under Test and Modification State

ATB1, S/N: TA 003 - Modification State 2

2.1.3 Date of Test

01-August-2018 – Electric Field Emissions (firmware 0.1.03)
23-August-2018 – magnetic emissions (firmware 0.1.14)

2.1.4 Test Method

The EUT was set up in a semi-anechoic chamber on a remotely controlled turntable and placed on a non-conductive table 0.8 m above a reference ground plane.

A pre-scan of the EUT emissions profile was made while varying the antennae-to-EUT azimuth and antennae-to-EUT polarization using a peak detector; measurements were taken at a 3m distance. Using the pre-scan list of the highest emissions detected, their bearing and associated antenna polarisation, the EUT was then formally measured using Quasi-Peak and Average detectors, as appropriate. The readings were maximised by adjusting the antenna height, polarisation and turntable azimuth, in accordance with the specification.

2.1.5 Environmental Conditions

Ambient Temperature	20.8 - 22.0 °C
Relative Humidity	46.0 - 62.0 %

2.1.6 Specification Limits

<u>150 kHz to 30 MHz</u>

Required Specification Limits (@ 3m)	
Frequency Range (MHz)	Quasi-peak (dBµV/m)
0.15 to 0.3	80 - 52*
0.3 to 30	52 - 34*
Supplementary Information: The measured test results shall be compared with the corresponding acceptable performance limits, and the EUT shall pass the test only if the measured performance margin is favourable and greater than the test measurement uncertainty. *As detailed in specification clause 5.3 Test results, the EUT shall pass the test only if the measured performance margin is favourable and greater than the test measurement uncertainty.	

Table 8

30 MHz to 2 GHz

Required Specification Limits (@ 3m)		
Frequency Range (MHz)	Quasi-peak (dBµV/m)	Peak (dBµV/m)
30 to 2000(1)	54*	N/A
156 to 165(2)	24*	30*

Supplementary Information:
*As detailed in specification clause 5.3 Test results, the EUT shall pass the test only if the measured performance margin is favourable and greater than the test measurement uncertainty.
(1) In addition, for the frequency band 156 MHz to 165 MHz, the measurement shall be repeated with a receiver bandwidth of 9 kHz, all other conditions hereinbefore remaining unchanged.
(2) Alternatively, for the frequency band 156 MHz to165 MHz, a peak receiver or a frequency analyser may be used, in accordance with the agreement between the manufacturer and the test house.

Table 9

2.1.7 Test Results

Configuration and mode: Test Configuration 1, Transmitting and Receiving.

Performance assessment of the EUT made during this test: Pass.

Detailed results are shown below.

Frequency Range of Test: 30 MHz to 2 GHz

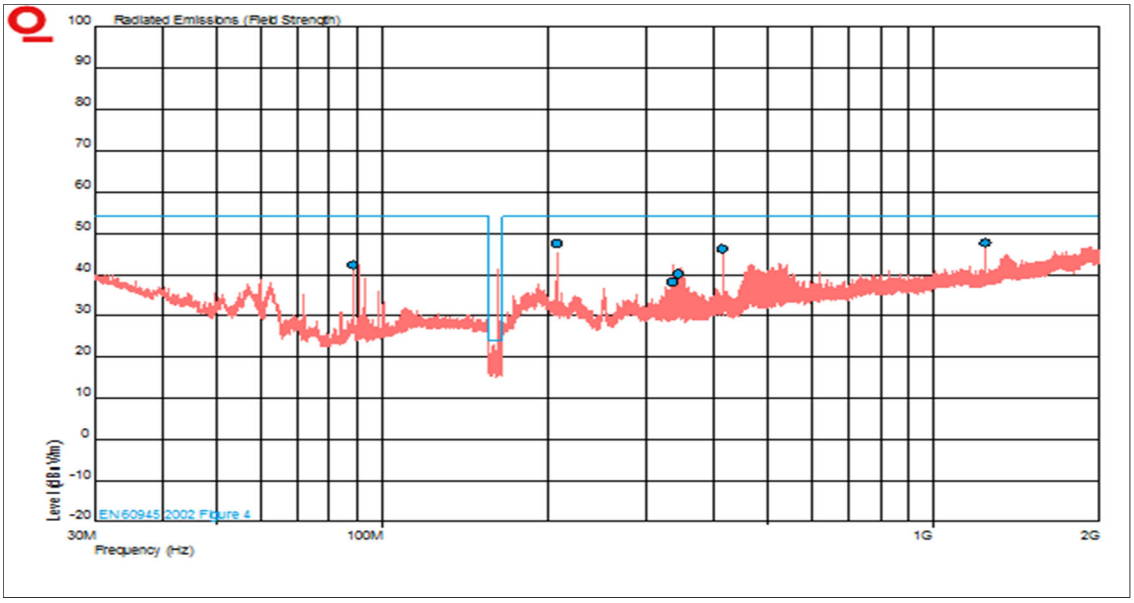

Figure 3 - Graphical Results - Horizontal and Vertical Polarity

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dBuV/m)	Angle (Deg)	Height(m)	Polarity
88.507	42.3	54.0	-11.7	309	1.00	Vertical
207.003	47.5	54.0	-6.5	133	1.29	Horizontal
336.060	38.1	54.0	-15.9	110	1.00	Horizontal
344.610	40.0	54.0	-14.0	335	1.00	Horizontal
413.983	46.2	54.0	-7.8	70	1.00	Horizontal
1241.985	47.7	54.0	-6.3	211	1.00	Horizontal

Table 10

Frequency Range of Test: 156 MHz to 165 MHz

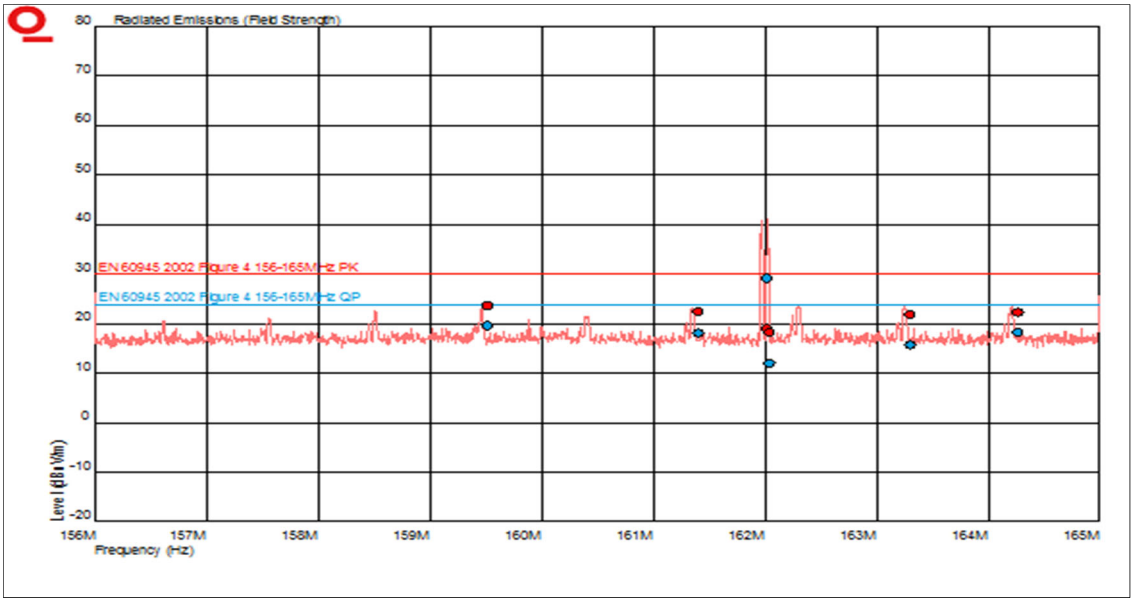

Figure 4 - Graphical Results - Horizontal and Vertical Polarity

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dBuV/m)	Peak Level (dBuV/m)	Peak Limit (dBuV/m)	Peak Margin (dBuV/m)	Angle(Deg)	Height(m)	Polarity
159.519	19.6	24	-4.4	23.6	30	-6.4	283	1.50	Vertical
161.410	18.1	24	-5.9	22.5	30	-7.5	125	1.00	Vertical
162.025	29.2	24	5.2	19	30	-11	271	1.00	Vertical
162.043	12	24	-12	18.3	30	-11.7	0	1.69	Vertical
163.306	15.8	24	-8.2	21.8	30	-8.2	124	1.26	Vertical
164.273	18.3	24	-5.7	22.3	30	-7.7	138	1.00	Vertical

Table 11

The emission seen at 162.025 MHz is the AIS Class B Transmit frequency. The AIS antenna output was connected to an AIS simulator / data logger using a coaxial cable.

It was not possible to put the EUT into a non-transmitting state as per the requirements of EN 60945 as stated below:

> "For radiated emission tests, equipment including a radio transmitter operating within the measurement bands shall be in the operational state but not the transmitting state."

To this end, the emission seen at 162.025 MHz is not subject to the EN 60945 limit and can be disregarded.

Whilst emissions were measured with both a Quasi-Peak and Peak detector, the Peak detector emissions met the requirements of the standard in accordance with EN 60945, Section 9.3.2 and Section 9.3.3, Clause C which states the following:

> “Alternatively, for the frequency band 156 MHz to165 MHz, a peak receiver or a frequency analyser may be used, in accordance with the agreement between the manufacturer and the test house.”
>
> “Alternatively, the radiation limit at a distance of 3 m from the enclosure port over the frequency 156 MHz to 165 MHz shall be 30 dBµV/m.”

The EUT failed to meet the requirement of the Quasi-Peak limit at 159.519 MHz however the EUT met the requirements of the Peak limit for all frequencies measured and therefore passed the test.

Frequency Range of Test: 150 kHz to 30 MHz

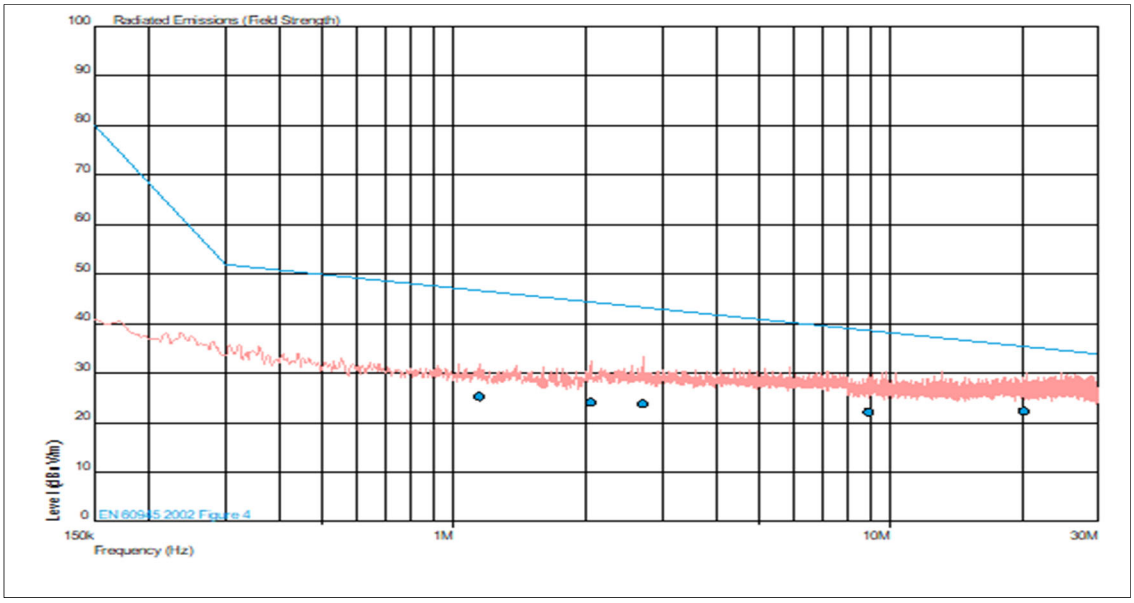

Figure 5 - Graphical Results – Face On and Edge On Polarity

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dBuV/m)	Angle(Deg)	Height(m)	Polarity
1.147	25.2	46.8	-21.5	95	1.50	Face On
2.060	24.2	44.5	-20.3	92	1.50	Face On
2.709	23.8	43.4	-19.6	297	1.50	Face On
8.952	22.2	38.7	-16.5	78	1.50	Face On
20.213	22.3	35.5	-13.2	5	1.50	Face On

Table 12

Figure 6 - Test Setup - Radiated Emissions 30 MHz to 1 GHz

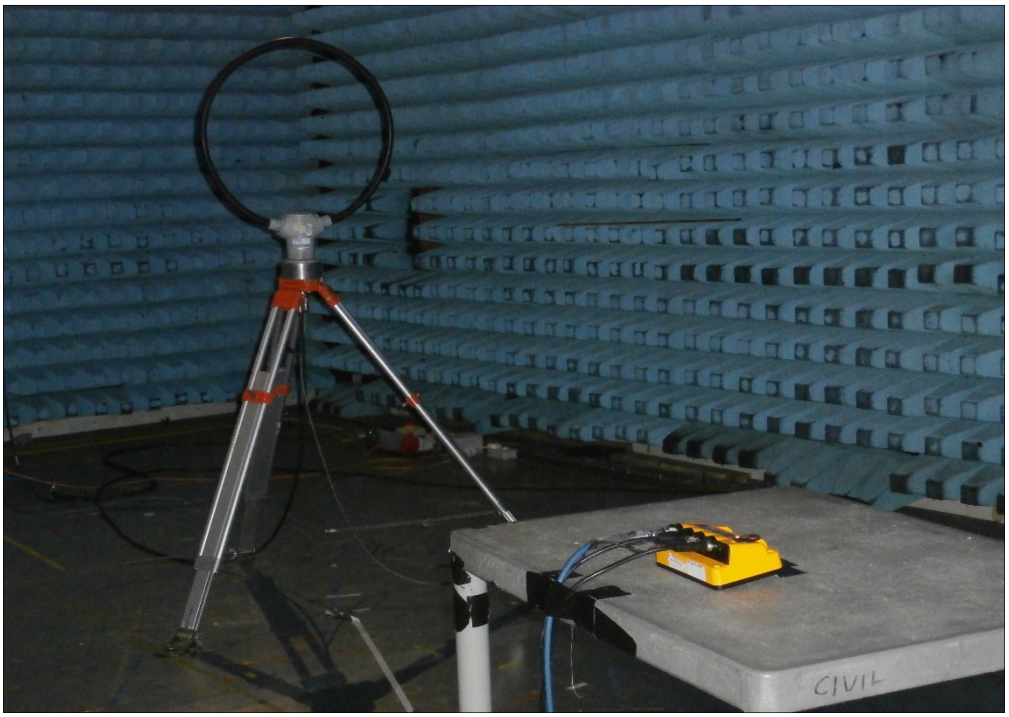

Figure 7 - Test Setup - Radiated Emissions 150 kHz to 30 MHz

2.1.8 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5 and EMC Chamber 7.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Turntable Controller	Heinrich Diesel	HD 050	280	-	TU
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Comb Generator	Schaffner	RSG1000	3034	-	TU
Mast Controller	Maturo Gmbh	NCD	4810	-	TU
Mast Controller	Maturo Gmbh	NCD	3917	-	TU
Screened Room 5	Rainford	SM	1545	36	23-Jan-2021
Screened Room 7	Siemens	SM	1547	36	21-Jan-2021
Antenna (Active Loop, 9kHz-30MHz)	Rohde & Schwarz	HFH2-Z2	333	24	09-Dec-2018
Antenna (Bilog)	Chase	CBL6143	2904	24	08-Aug-2019
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	22-Nov-2018
Multi-GNSS Simulator (GPS)	Spirent	GSS6700	4596	12	16-Aug-2019

Table 13

TU - Traceability Unscheduled

2.2 Conducted Emissions

2.2.1 Specification Reference

IEC 60945, Clause 9.2

2.2.2 Equipment Under Test and Modification State

ATB1, S/N: TA 003 - Modification State 2

2.2.3 Date of Test

09-August-2018 to 15-August-2018

2.2.4 Test Method

Measurements were made with all measuring equipment and the EUT mounted on and bonded to an earth plane.

The power input cables between the DC power ports of the EUT and the artificial mains network were screened and 0.8 m in length.

2.2.5 Environmental Conditions

Ambient Temperature	23.0 °C
Relative Humidity	42.0 %

2.2.6 Specification Limits

Required Specification Limits		
Line Under Test	Frequency Range (MHz)	Quasi-peak (dBµV)
Power Input	0.01 to 0.15	96 to 50*
	0.15 to 0.35	60 to 50*
	0.35 to 30	50*

Supplementary information:
Note 1: The emission shall be measured by means of the quasi-peak measuring receiver only.

The power input cables between the a.c. and the d.c. power ports of the EUT and the artificial mains network shall be screened and not exceed 0,8 m in length. If the EUT consists of more than one unit with individual a.c. and/or d.c. power ports, power ports of identical nominal supply voltage may be connected in parallel to the artificial mains supply network.

*As detailed in specification clause 5.3 Test results, the EUT shall pass the test only if the measured performance margin is favourable and greater than the test measurement uncertainty.

Table 14

2.2.7 Test Results

Configuration and mode: Test Configuration 2, Transmitting and Receiving.

Performance assessment of the EUT made during this test: *Pass*.

Detailed results are shown below.

Line Under Test: +12 V DC Line

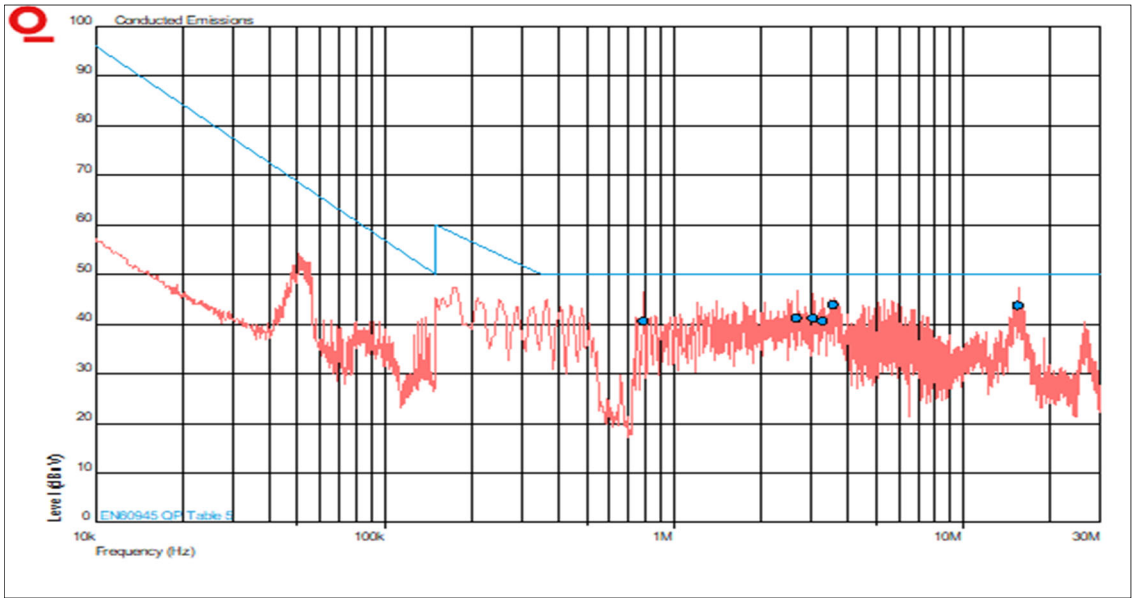

Figure 8 - Graphical Results - +12 V DC Line

Frequency (MHz)	QP Level (dBuV)	QP Limit (dBuV)	QP Margin (dBuV)
0.789	40.6	50.0	-9.4
2.669	41.3	50.0	-8.7
3.052	41.2	50.0	-8.8
3.277	40.6	50.0	-9.4
3.569	44.0	50.0	-6.0
15.554	43.8	50.0	-6.2

Table 15

Line Under Test: 0V DC Line

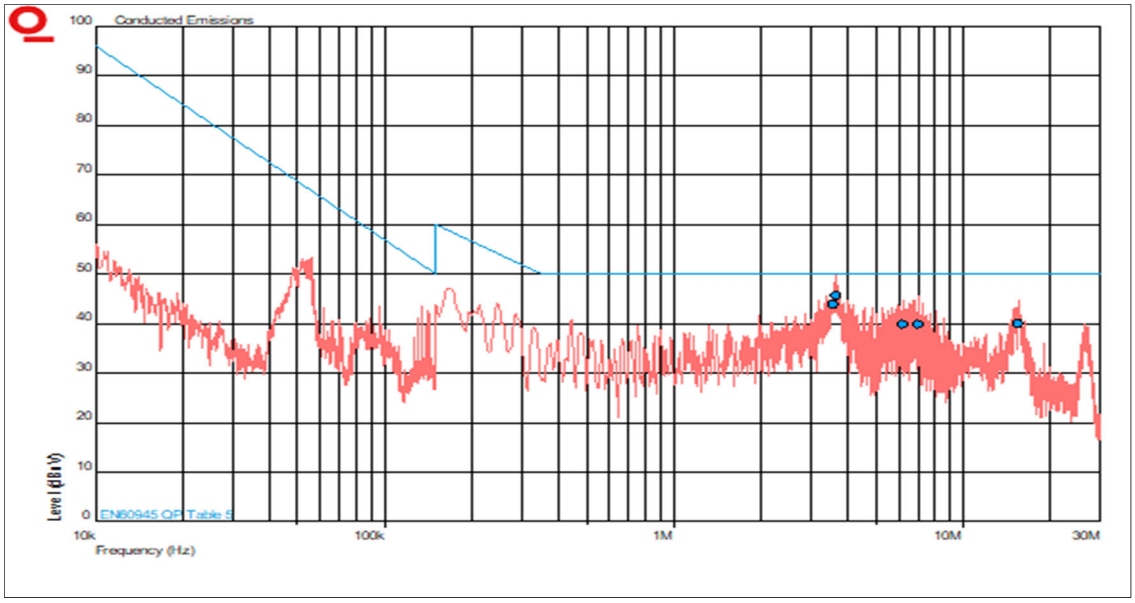

Figure 9 - Graphical Results – 0 V DC Line

Frequency (MHz)	QP Level (dBuV)	QP Limit (dBuV)	QP Margin (dBuV)
3.583	43.9	50.0	-6.1
3.664	45.8	50.0	-4.2
6.199	39.9	50.0	-10.1
7.006	39.9	50.0	-10.1
15.527	40.1	50.0	-9.9

Table 16

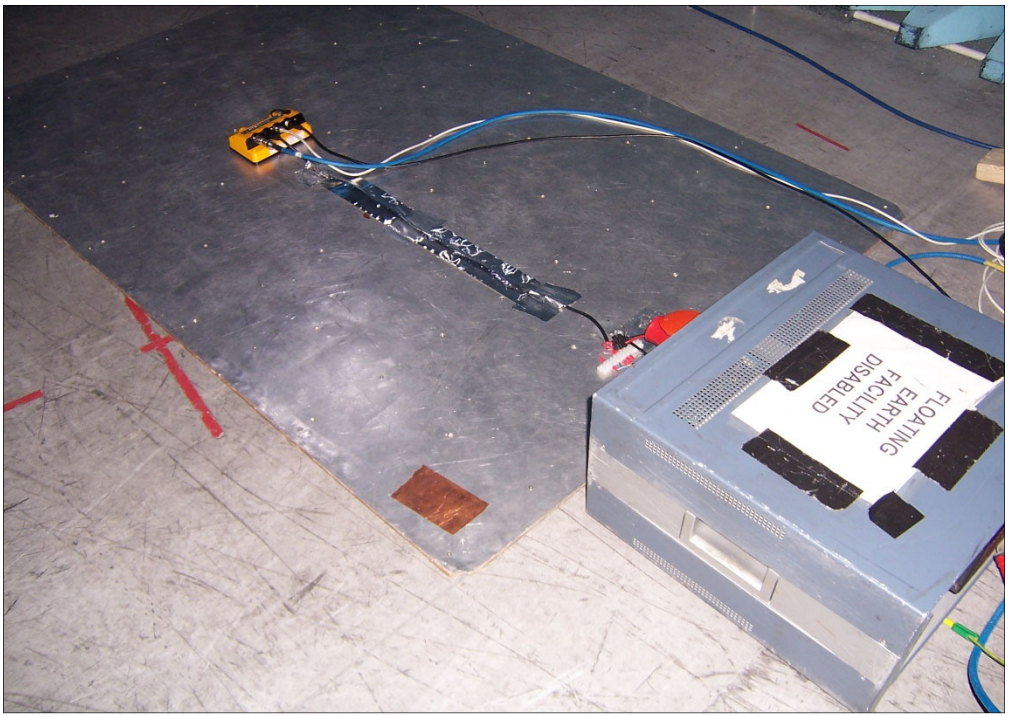

Figure 10 - Test Setup

2.2.8 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 1 and EMC Chamber 3.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
3 phase LISN	Rohde & Schwarz	ESH2-Z5	323	12	09-Apr-2019
Transient Limiter	Hewlett Packard	11947A	2377	12	23-Feb-2019
Compliance 5 Emissions	Teseq	V5.26.51	3275	-	Software
EMI Receiver	Keysight Technologies	N9038A MXE	4628	12	04-Jul-2019

Table 17

2.3 Immunity to Conducted Radio Frequency Disturbance

2.3.1 Specification Reference

IEC 60945, Clause 10.3

2.3.2 Equipment Under Test and Modification State

ATB1, S/N: TA 003 - Modification State 2

2.3.3 Date of Test

04-July-2018 to 20-July-2018

2.3.4 Test Method

The equipment under test was configured, on but insulted from, using a 0.1 m isolator, a ground reference plane within a test laboratory.

All associated cabling was configured on, but insulted from, using a 50 mm isolator, the same horizontal coupling plane as the equipment under test.

Using CDNs, EM Clamps or current clamps as appropriate, the power ports and applicable signal and control ports were subjected to the required, pre-calibrated RF injected signal strength, modulated as described, swept over the frequency range of test.

During this test, any anomalies in the equipment under tests performance were recorded.

2.3.5 Environmental Conditions

Ambient Temperature	22.0 - 23.0 °C
Relative Humidity	44.0 - 45.0 %

2.3.6 Specification Limits

Required Test Levels						Performance Criteria
Line Under Test	Frequency Range (MHz)	Level (V/m)	Modulation	Step Size (%)	Dwell (s)	
Power Port Signal / Control Port	0.15 to 80	3	AM (80 %,400 Hz, sine wave)	1	1	A
	Spot Frequencies	10	AM (80 %,400 Hz, sine wave)	-	1	A
Supplementary information: Note 1. EUT powered at one of the Nominal input voltages and frequencies. Spot Frequencies: 2 MHz, 3 MHz, 4 MHz, 6,2 MHz, 8,2 MHz, 12,6 MHz, 16,5 MHz, 18,8 MHz, 22 MHz and 25 MHz.						

Table 18

2.3.7 Test Results

Configuration and mode: Test Configuration 1, Transmitting and Receiving.

Performance assessment of the EUT made during this test: Pass.

Detailed results are shown below.

Tabulated Results for Conducted Radio Frequency Interference					
Modulation = 80 % AM (400 Hz)		Step Size = 1 %		Dwell = 3 s	
Line Under Test	Frequency Range	Test Level	Coupling Method	Interference Return Path	Result
Antenna	150kHz to 80MHz	3 V	EM Clamp	M3 CDN	Pass
Power / Data	150kHz to 80MHz	3 V	EM Clamp	M3 CDN	Pass
GPS	150kHz to 80MHz	3 V	EM Clamp	M3 CDN	Pass
NMEA	150kHz to 80MHz	3 V	EM Clamp	M3 CDN	Pass

Table 19

Tabulated Results for Conducted Radio Frequency Interference (Spot Frequencies)					
Modulation = 80 % AM (400 Hz)			Dwell = 3 s		
Line Under Test	Spot Frequencies	Test Level	Coupling Method	Interference Return Path	Result
Antenna	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M3 CDN	Pass
Power / Data	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M3 CDN	Pass
GPS	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M3 CDN	Pass
NMEA	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M3 CDN	Pass

Table 20

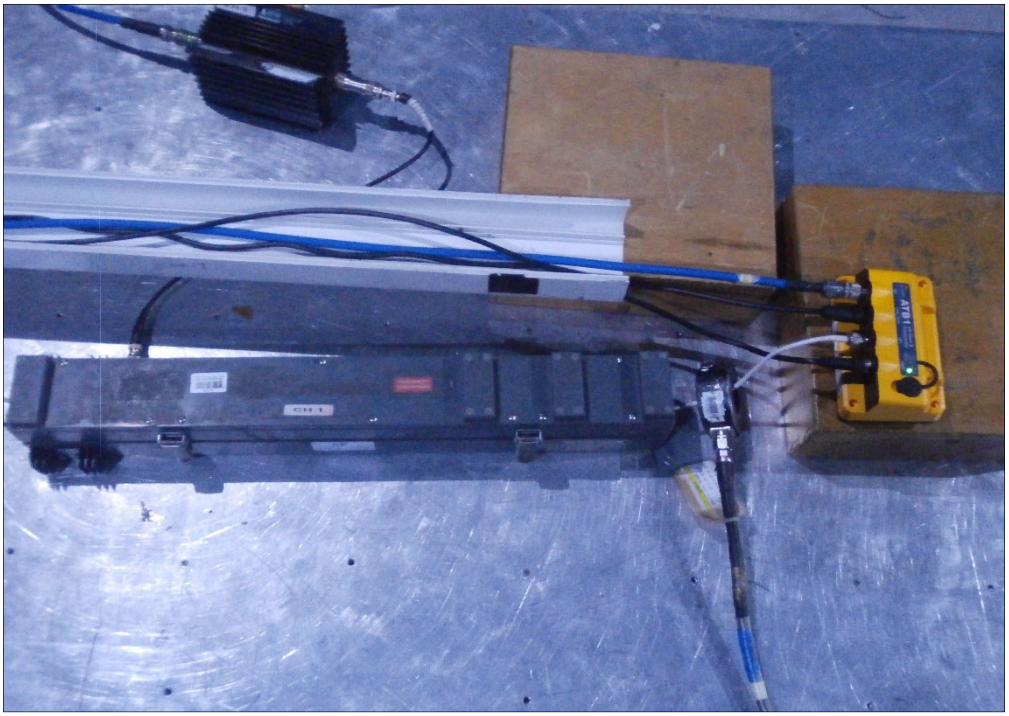

Figure 11 - Test Setup

2.3.8 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Coupling Network	MEB Messelektronik	M3	201	12	19-Oct-2018
Coupling Network	MEB Messelektronik	M2-801-CDN (150kHz to 80MHz)	204	12	19-Oct-2018
RF Generator + Attenuator	Schaffner	NSG2070-400	222	12	22-Jan-2019
Coupling Clamp	MEB Messelektronik	KEMZ-801	228	-	TU
Calibration Fixture (x2)	MEB Messelektronik	KEMZ-801	229	-	TU
Load (50ohm, 30W)	JFW	50T-054	284	12	09-May-2019
Termination (50ohm)	JFW	50T-054	348	12	30-Jan-2019
Current Probe	Ailtech	91550-1	520	12	22-Jun-2019
Attenuator 6dB	Advance	10023-6/MF	1539	12	19-Dec-2018
Current Probe	Tegam	91550-1	2135	12	19-Jun-2019
Termination	Tyco Electronics	1329823-1	3249	12	16-Aug-2018
EM Clamp	Teseq	KEMZ 801S	3373	-	TU
Cable (2m, N type)	Teledyne	239-0195-2000	3541	12	18-Dec-2018
Coupling Decoupling Network	Teseq	CDN M116	3978	12	28-Sep-2018
Attenuator (10dB, 250W)	Weinschel	45-10-43	4864	12	02-May-2019
UL94 Wire screen	E.D & D	WS-04	4889	-	TU

Table 21

TU - Traceability Unscheduled

2.4 Immunity to Power Supply Failure

2.4.1 Specification Reference

IEC 60945, Clause 10.8

2.4.2 Equipment Under Test and Modification State

ATB1, S/N: TA 003 - Modification State 2

2.4.3 Date of Test

20-July-2018

2.4.4 Test Method

The equipment under test including associated cabling was configured, on a 0.8 m non-conductive table for table-top equipment and on a 0.1 m insulated support for floor standing equipment above a ground reference plane all within a test laboratory.

Using a programmable power supply the equipment under test was subjected to the detailed supply voltage interruptions. The required supply phase synchronisation and test repetition rate, detailed, was controlled by the programmable power supply.

During this test, any anomalies in the equipment under tests performance were recorded.

2.4.5 Environmental Conditions

Ambient Temperature	23.0 °C
Relative Humidity	45.0 %

2.4.6 Specification Limits

Required Test Levels			Performance Criteria
Test	Test Level % of nominal Voltage	Duration (s)	
Short Interruption	0	60 repeated 3 times	C
Supplementary information: Note 1. EUT powered at one of the Nominal input voltages and frequencies			

Table 22

2.4.7 Test Results

Configuration and mode: Test Configuration 1, Transmitting and Receiving.

Performance assessment of the EUT made during this test: Pass.

Detailed results are shown below.

Tabulated Results for Power Supply Failure					
Line under test	Operating Frequency	Nominal Voltage (V)	Test Level Voltage (V)	Duration (s)	Result
DC Power	N/A - DC	24 V DC	0	60	Pass

Table 23

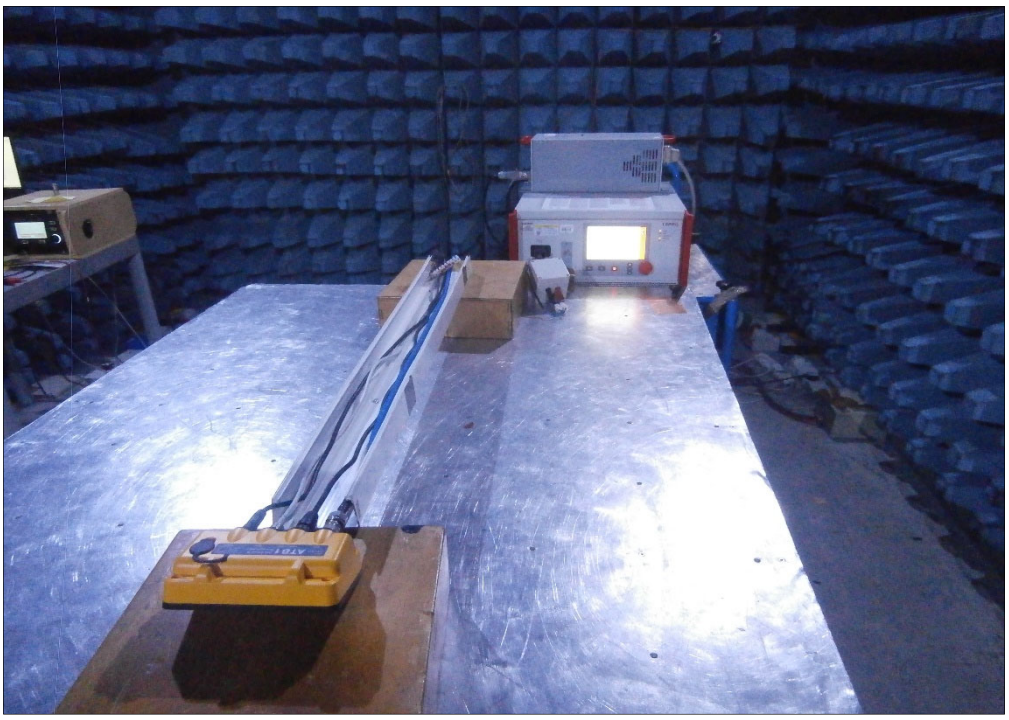

Figure 12 – Test Setup

2.4.8 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Handheld Digital Multimeter	Agilent Technologies	U1241A	3625	12	02-Oct-2018
EMI Generator	Teseq	NSG 3040-05	4861	12	8-May-2019
Stepped Transformer	Teseq	INA 6502-05	4862	12	8-May-2019

Table 24

2.5 Immunity to Electrostatic Discharge

2.5.1 Specification Reference

IEC 60945, Clause 10.9

2.5.2 Equipment Under Test and Modification State

ATB1, S/N: TA 003 - Modification State 2

2.5.3 Date of Test

11-July-2018

2.5.4 Test Method

The equipment under test, including associated cabling was configured on a horizontal coupling plane which was fitted to the top of a 0.8m non-conductive table (for table-top equipment) the EUT was insulated from the horizontal coupling plane using a 0.5mm isolator. For floor standing equipment the EUT shall be on a 0.1m insulated support above a ground reference plane within a test laboratory.

Using the air discharge method for non-metallic parts, contact discharge method for metallic parts with both vertical and horizontal couple plane discharge methods for the sides of the equipment under test, the required electrostatic discharge voltage levels in both voltage polarities were applied at the detailed pulse repartition rate.

During this test, any anomalies in the equipment under tests performance were recorded.

2.5.5 Environmental Conditions

Ambient Temperature	24.0 °C
Relative Humidity	48.0 %

2.5.6 Specification Limits

Required Test Levels				Performance Criteria
Discharge type	Discharge Level (kV)		Number of discharges per location (each polarity)	
	Positive	Negative		
Air – Direct	2, 4 and 8	2, 4 and 8	10	B
Contact – Direct	2, 4 and 6	2, 4 and 6	10	B
Contact – Indirect	2, 4 and 6	2, 4 and 6	10	B
Supplementary information: None				

Table 25

2.5.7 Test Results

Configuration and mode: Test Configuration 1, Transmitting and Receiving.

Performance assessment of the EUT made during this test: Pass.

Detailed results are shown below.

○ Contact □ Air

ID	Test Point	Discharge	Results									
			2kV		4kV		6kV		8kV		15kV	
			+	-	+	-	+	-	+	-	+	-
	Horizontal Coupling Plane	Contact	N/A	N/A	✓	✓	N/A	N/A	N/A	N/A	N/A	N/A
	Vertical Coupling Plane	Contact	N/A	N/A	✓	✓	N/A	N/A	N/A	N/A	N/A	N/A
	Contact Discharge Points	Contact	N/A	N/A	✓	✓	N/A	N/A	N/A	N/A	N/A	N/A
	Air Discharge Points	Air	✓*	✓*	✓*	✓*	N/A	N/A	✓*	✓*	N/A	N/A

Table 26

Key to Results	
✓	The EUT's performance was not impaired at this test point when the ESD pulse was applied.
✓*	No discharge occurred at this point when the ESD pulse was applied.
N/A	Not Applicable.

Table 27

Figure 13 - ESD Test Positions

Figure 14 – ESD Test Positions

2.5.8 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Handheld Digital Multimeter	Agilent Technologies	U1241A	3625	12	02-Oct-2018
ESD Generator	Schloder	SESD 30000	4724	12	14-May-2019

Table 28

2.6 Compass Safe Distance

2.6.1 Specification Reference

IEC 60945, Clause 11.2

2.6.2 Equipment Under Test and Modification State

ATB1, S/N: 003 - Modification State 2

2.6.3 Date of Test

20-July-2018 to 31-July-2018

2.6.4 Test Method

The EUT was setup in the outside test area on a wooden bench. The compass was zeroed and the EUT was gradually moved into the compass to achieve desired deflection. Exercise completed in off, normalized and powered states.

2.6.5 Environmental Conditions

Ambient Temperature	24.0 °C
Relative Humidity	45.0 %

2.6.6 Specification Limits

For the steering compass, the standby steering compass and the emergency compass, the permitted deviation is 18°/H, H being defined as the horizontal component of the magnetic flux density in uT (microtesla) at the place of testing.

2.6.7 Test Results

Standard Compass safe distance (mm)	550
Emergency Compass safe distance (mm)	300

Table 29

Horizontal maximum flux density, Magnetic North (H)	H	19.72
Standard compass deviation limit (degrees)	5.4/H = A	A = 0.3
Emergency compass deviation limit (degrees)	18/H = B	B = 0.9

Table 30

Orientation of the EUT	Un-powered State		Normalised		Powered Up	
	Distance From Compass Centre (mm) at A° deflection	Distance From Compass Centre (mm) at B° deflection	Distance From Compass Centre (mm) at A° deflection	Distance From Compass Centre (mm) at B° deflection	Distance From Compass Centre (mm) at A° deflection	Distance From Compass Centre (mm) at B° deflection
Front	210	190	290	220	340	170 0.6°deflection
Top	180	170 0.4°deflection	200	170 0.6°deflection	280	170 0.4°deflection
Left Hand Side	280	170	300	170	400	200
Right Hand Side	300	170	260	170 0.5°deflection	450	180
Underside	400	170	280	170 0.7°deflection	500	220
Rear	260	170	300	170	360	260

Table 31

Figure 15 - Compass Safe Distance

2.6.8 Test Location and Test Equipment Used

This test was carried out in the outside test area.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Magnetometer	Bartington	MAG01	671	36	05-Jun-2021
Marine Binnacle Compass with Repeater Display	Cassens & Plath	Compass: Type 11	3834	-	TU

Table 32

TU - Traceability Unscheduled

2.7 Immunity to Radiated Radio Frequencies

2.7.1 Specification Reference

IEC 60945, Clause 10.4

2.7.2 Equipment Under Test and Modification State

ATB1, S/N: TA 003 - Modification State 2

2.7.3 Date of Test

29-June-2018 to 04-July-2018

2.7.4 Test Method

The equipment under test, including associated cabling was configured on a 0.8 m non-conductive table for table-top equipment and on a 0.1 m insulated support for floor standing equipment; with a pre-calibrated semi anechoic chamber.

All four sides of the equipment under test were subjected to the required RF field strength, modulated as described, swept over the frequency range of test with the antenna positioned in both horizontal and vertical polarizations.

During this test, any anomalies in the equipment under tests performance were recorded.

2.7.5 Environmental Conditions

Ambient Temperature	22.8 - 24.0 °C
Relative Humidity	45.0 - 58.0 %

2.7.6 Specification Limits

Required Test Levels					Performance Criteria
Frequency Range (MHz)	Level (V/m)	Modulation	Step Size (%)	Dwell (s)	
80 to 1000	10*	AM (80 %,400 Hz, sine wave)	1	3[1]	A
1000 to 2000	10*	AM (80 %,400 Hz, sine wave)	1	9[1]	A

Supplementary information:

Note 1. dwell times <1GHz can be reduced to 2 s and >1GHz to 6 s for samples with fast cycle times.

Note 2. EUT powered at one of the Nominal input voltages and frequencies

*As detailed in specification clause 5.3 Test results, the EUT shall pass the test only if the measured performance margin is favourable and greater than the test measurement uncertainty.

Table 33

2.7.7 Test Results

Configuration and mode: Test Configuration 1, Transmitting and Receiving.

Performance assessment of the EUT made during this test: Pass.

Detailed results are shown below.

Tabulated Results for RF Electromagnetic Field				
Step Size	1%			
Dwell Time < 1GHz	3 s			
Dwell Time > 1GHz	5 s			
Modulation	400Hz Sine 80% AM			
Frequency Range (MHz)	Test Face	Antenna Polarisation	Test Level (V/m)	Result
80 to 2000	Left	Horizontal and Vertical	12.6 (10 + MU)	Pass
80 to 2000	Right	Horizontal and Vertical	12.6 (10 + MU)	Pass
80 to 2000	Base	Horizontal and Vertical	12.6 (10 + MU)	Pass
80 to 2000	Front	Horizontal and Vertical	12.6 (10 + MU)	Pass
80 to 2000	Top	Horizontal and Vertical	12.6 (10 + MU)	Pass
80 to 2000	Rear	Horizontal and Vertical	12.6 (10 + MU)	Pass

Table 34

Figure 16 - Immunity to Radiated Radio Frequencies

2.7.8 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Signal Generator, 9kHz to 6GHz	Rohde & Schwarz	SMB 100A	3499	12	7-Jun-2019
Amplifier (250W, 80MHz - 1GHz)	Amp Research	250W1000A	3029	-	TU
Directional Coupler	Amp Research	DC618-	283	-	TU
50ohm Load (50W)	Weinschel	M1426	361	12	13-Sep-2018
Power Meter	Rohde & Schwarz	NRVD	747	-	TU
Power Sensor: 100kHz - 6GHz/100pW - 20mW	Rohde & Schwarz	NRV-Z4	3816	-	TU
Antenna	Schaffner	CBL6143	322	-	TU
CW TWT (1-2.5GHz)	Thorn	PTC6341	2069	-	TU
Antenna (Double Ridge Guide, 1GHz-18GHz)	EMCO	3115	234	-	TU

Table 35

TU - Traceability Unscheduled

3 Incident Reports

The following Incident Reports were issued during testing covered by this test report.

Report Serial No	75936859 IR 01 Issue 1
Date of issue	10 August 2018
Applicable test	Conducted Emissions

4 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

Test Name	Measurement Uncertainty
Radiated Emissions	30 MHz to 1 GHz, Bilog Antenna, ±5.2 dB 1 GHz to 40 GHz, Horn Antenna, ±6.3 dB
Conducted Emissions	150 kHz to 30 MHz, LISN, ±3.7 dB
Immunity to Conducted Radio Frequency Disturbance	50 kHz to 1000 MHz EM Clamp Method of Test, Amplitude ±3.1 dB CDN Method of Test, Amplitude ±1.2 dB BCI Clamp Method of Test, Amplitude ±1.1 dB Direct Injection Method of Test, Amplitude ±1.2 dB
Immunity to Power Supply Failure	The test was applied using proprietary equipment that meets the requirements of EN 61000-4-11
Immunity to Electrostatic Discharge	The test was applied using proprietary equipment that meets the requirements of EN 61000-4-2
Compass Safe Distance	±0.1°
Immunity to Radiated Radio Frequencies	10 MHz to 6 GHz Test Amplitude ±2.0 dB

Table 36

Worst case error for both Time and Frequency measurement 12 parts in 106.

*In accordance with CISPR 16-4
†In accordance with UKAS Lab 34