Report on the EMC Testing of:

Vesper Marine Ltd
Marlin POD, Model: Cortex M1
Handset. Model: Cortex H1

In accordance with IEC 60945, ETSI EN 301 843-1 and ETSI EN 301 843-2

Prepared for: Vesper Marine Ltd
Auckland
1142
New Zealand

Add value.
Inspire trust.

COMMERCIAL-IN-CONFIDENCE

Document Number: 75943855-04 | Issue: 02

SIGNATURE			
			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Andrew Lawson	Senior Engineer	Authorised Signatory	21 April 2020

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

EXECUTIVE SUMMARY
A sample of this product was tested and found to be compliant with IEC 60945: 2002 C1:2008, ETSI EN 301 843-1 V2.2.1 (2017-11) and ETSI EN 301 843-2 V2.2.1 (2017-11)

TÜV SÜD
is a trading name of TUV SUD Ltd
Registered in Scotland at East Kilbride,
Glasgow G75 0QF, United Kingdom
Registered number: SC215164

TUV SUD Ltd is a
TÜV SÜD Group Company

Phone: +44 (0) 1489 558100
Fax: +44 (0) 1489 558101
www.tuv-sud.co.uk

TÜV SÜD
Octagon House
Concorde Way
Fareham
Hampshire PO15 5RL
United Kingdom

Contents

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 January 2020
2	Additional modes of testing added	21 April 2020

Table 1

1.2 Introduction

Applicant	Vesper Marine Ltd
Manufacturer	Vesper Marine Ltd
Model Number(s)	Cortex M1 Cortex H1
Serial Number(s)	M100000069 M100000065 H1.0000000B H1.0000000F
Hardware Version(s)	B C
Software Version(s)	0.2 0.9
Number of Samples Tested	2
Test Specification/Issue/Date	IEC 60945: 2002 C1:2008 ETSI EN 301 843-1 V2.2.1 (2017-11) ETSI EN 301 843-2 V2.2.1 (2017-11)
Test Plan/Issue/Date	Marlin Compliance Testing/EMC Test Plan v0.1/10 December 2018
Order Number Date	13976 20-September-2018
Date of Receipt of EUT	10-December-2018
Start of Test	12-December-2018
Finish of Test	25-March-2020
Name of Engineer(s)	Colin McKean and Jack Tuckwell
Related Document(s)	IEC 61000-4-2: 2008 IEC 61000-4-4: 2012 IEC 61000-4-11: 2004 IEC 61000-4-3: 2006 + A1: 2007 + A2: 2010 IEC 61000-4-6: 2013

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with IEC 60945, ETSI EN 301 843-1 and ETSI EN 301 843-2 is shown below.

Section	IEC 60945 Specification Clause	ETSI EN 301 843-1 Specification Clause	Test Description	Result	Comments/Base Standard
Configuration and Mode: POD DC Powered - AIS					
2.2	9.2	8.3	Conducted Emissions	Pass	CISPR 16-1-2
2.3	10.9	9.3	Immunity to Electrostatic Discharge	Pass	IEC 61000-4-2
2.4	10.5	9.4	Immunity to Fast Transients on AC Power, Signal and Control Lines	Pass	IEC 61000-4-4
2.5	10.8	9.6	Immunity to Power Supply Failure	Pass	IEC 61000-4-11
2.6	10.4	9.2	Immunity to Radiated Radio Frequencies	Pass	IEC 61000-4-3
2.7	10.3	9.5	Immunity to Conducted Radio Frequency Disturbance	Pass	IEC 61000-4-6
Configuration and Mode: POD DC Powered - Not Transmitting					
2.1	9.3	8.2	Radiated Emissions	Pass	CISPR 16-1-4
Configuration and Mode: POD and Handset, DC Powered - VHF TX/RX					
2.6	10.4	9.2	Immunity to Radiated Radio Frequencies	Pass	IEC 61000-4-3
2.7	10.3	9.5	Immunity to Conducted Radio Frequency Disturbance	Pass	IEC 61000-4-6
Configuration and Mode: POD and Handset, DC Powered - DSC					
2.6	10.4	9.2	Immunity to Radiated Radio Frequencies	Pass	IEC 61000-4-3
2.7	10.3	9.5	Immunity to Conducted Radio Frequency Disturbance	Pass	IEC 61000-4-6

Table 2

1.4 Declaration of Build Status

MAIN EUT			
MANUFACTURING DESCRIPTION	AIS/VHF/Monitoring Transceiver		
MANUFACTURER	Vesper Marine Ltd		
MODEL NAME/NUMBER	Cortex M1		
PART NUMBER	CM1		
SERIAL NUMBER	100		
HARDWARE VERSION	C		
SOFTWARE VERSION	0.21		
PSU VOLTAGE/FREQUENCY/CURRENT	12-24V,350mA nominal		
HIGHEST INTERNALLY GENERATED FREQUENCY	2.4GHz		
FCC ID (if applicable)	YJDVESPM1		
INDUSTRY CANADA ID (if applicable)	9118A-M1		
TECHNICAL DESCRIPTION (a brief technical description of the intended use and operation)	A VHF and Class B AIS Transponder with integrated WiFi and Cellular Connectivity.		
COUNTRY OF ORIGIN	New Zealand		
RF CHARACTERISTICS (if applicable)			
TRANSMITTER FREQUENCY OPERATING RANGE (MHz)	156.025-162.025		
RECEIVER FREQUENCY OPERATING RANGE (MHz)	156.025-162.025		
INTERMEDIATE FREQUENCIES	SDR DC		
EMISSION DESIGNATOR(S): https://fccid.io/Emissions-Designator/			
MODULATION TYPES: (i.e. GMSK, QPSK)	FM,GMSK,FSK		
OUTPUT POWER (W or dBm)	25W max, 1W min		
SEPARATE BATTERY/POWER SUPPLY (if applicable)			
MANUFACTURING DESCRIPTION			
MANUFACTURER			
TYPE			
PART NUMBER			
PSU VOLTAGE/FREQUENCY/CURRENT			
COUNTRY OF ORIGIN			
MODULES (if applicable)			
MANUFACTURING DESCRIPTION	WiFi	3G	
MANUFACTURER	TI	Sierra	
TYPE	WL18MODGB	HL8548	
POWER	17dBm	23dBm	
FCC ID	Z64-WL18SBMOD	N7NHL8548	
INDUSTRY CANADA ID	23244-WL18SBMOD	2417C-HL8548	
EMISSION DESIGNATOR	n/a	n/a	https://fccid.io/N7NHL8548
DHSS/FHSS/COMBINED OR OTHER	n/a	n/a	
COUNTRY OF ORIGIN	U.S.A	Canada	
ANCILLARIES (if applicable)			
MANUFACTURING DESCRIPTION			
MANUFACTURER			
TYPE			
PART NUMBER			
SERIAL NUMBER			
COUNTRY OF ORIGIN			

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

Name: Darcy Williams
Position held: Engineer
Date: 26-02-2020

MAIN EUT			
MANUFACTURING DESCRIPTION	Cortex H1 / H1P Handset		
MANUFACTURER	Vesper Marine Ltd		
MODEL NAME/NUMBER	Cortex H1		
PART NUMBER	CH1		
SERIAL NUMBER			
HARDWARE VERSION	C		
SOFTWARE VERSION	0.9		
PSU VOLTAGE/FREQUENCY/CURRENT	12-24V, 200mA nominal		
HIGHEST INTERNALLY GENERATED / USED FREQUENCY	2.4GHz		
FCC ID (if applicable)	YJDVESPH1		
INDUSTRY CANADA ID (if applicable)	9118A-H1		
TECHNICAL DESCRIPTION (a brief description of the intended use and operation)	Handset for the Cortex VHF system, with integrated Wi-Fi connectivity		
COUNTRY OF ORIGIN	New Zealand		
RF CHARACTERISTICS (if applicable)			
TRANSMITTER FREQUENCY OPERATING RANGE (MHz)			
RECEIVER FREQUENCY OPERATING RANGE (MHz)			
INTERMEDIATE FREQUENCIES			
EMISSION DESIGNATOR(S): (i.e. G1D, GXW)			
MODULATION TYPES: (i.e. GMSK, QPSK)			
OUTPUT POWER (W or dBm)			
SEPARATE BATTERY/POWER SUPPLY (if applicable)			
MANUFACTURING DESCRIPTION	3.7V Lithium-Ion Battery		
MANUFACTURER	General Electronics Technology Co. Ltd.		
TYPE	Polymer Lithium-Ion		
PART NUMBER	GEB 654060		
PSU VOLTAGE/FREQUENCY/CURRENT	3.7V, 2000mAh, 7.4 W		
COUNTRY OF ORIGIN	China		
MODULES (if applicable)			
MANUFACTURING DESCRIPTION	Open-Q 410 SOM		
MANUFACTURER	Intrinsyc		
TYPE	Open-Q 410 SOM		
POWER	< 20 dBm		
FCC ID	2AFDI-ITCOQ410S		
INDUSTRY CANADA ID	9049A-ITCOQ410S		
EMISSION DESIGNATOR			
DHSS/FHSS/COMBINED OR OTHER			
COUNTRY OF ORIGIN	U.S.A.		
ANCILLARIES (if applicable)			
MANUFACTURING DESCRIPTION			
MANUFACTURER			
TYPE			
PART NUMBER			
SERIAL NUMBER			
COUNTRY OF ORIGIN			

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

Name: Darcy Williams Position held: Engineer
Date: 20 January 2020

1.5 Product Information

1.5.1 Technical Description

The Equipment Under Test (EUT) was a Vesper Marine, Cortex VHF System consisting of a POD, Model: Cortex M1 and Handset Model: Cortex H1.

The primary function of the Cortex System (POD + Handset) is to provide a fully featured 25 W VHF radio with complete Class D DSC functionality and AIS Class B SOTDMA transponder functionality with integrated on-board and on-land vessel monitoring and control.

The system also features integrated 802.11 b/g/n WLAN functionality which allows configuration and control via a dedicated smartphone app or via the Cortex handset.

The EUT features integrated 802.11 b/g/n Wi-Fi functionality which allows configuration and control via a dedicated smart phone app or via the Marine Remote.

On-land vessel monitoring, and control are supported via a built-in cellular modem and a sim with global roaming capability.

The POD also features an integrated GNSS receiver (supporting GPS, GLONASS, BeiDou) fully isolated NMEA0183 / NMEA2000 ports and 2 x high-power (10W/30W) external speaker drivers.

Figure 1 – POD - General View

Figure 2 – POD - Rear View

Figure 3 – Handset – Front View

Figure 4 – Handset – Rear View

1.5.2 EUT Port/Cable Identification

Port	Max Cable Length specified	Usage	Type	Screened
Configuration and Mode: All configurations and Modes				
DC Power Port	<3 m	12 V DC	2 Core	No
VHF/AIS Antenna	>3 m	VHF & AIS TX / RX	Coaxial	Yes
External GPS	>3 m	Signal	Coaxial	Yes
NMEA2000	>3 m	Data	Multicore	Yes
GPIO, NMEA0183 & Test IO	>3 m	Data	Multicore	Yes
External Speakers	>3 m	Data	Multicore	Yes

Table 3

1.5.3 Test Configuration

Configuration	Description
POD DC Powered	The POD was powered from a 12 V DC supply. The EUT had the following connections: • An external active GPS antenna. • A VHF Co-axial cable terminated into a 50 Ohm load. • An NMEA2000 Cable terminated into a 120 Ohm load. • An unterminated GPIO Cable. • An audio Cable terminated into 2 x 10 Ohm loads.
POD and Handset DC Powered	For VHF TX/RX - The system consisted of a pod and handset for transmitting and a pod and handset for receiving. The pods and handsets were powered from a 12 V DC Power Supply. The two pods were connected directly at their VHF antenna ports via an RF cable and an antenna. A 1 kHz tone was injected into the microphone of the transmitting handset using a hose pipe attached to audio setup. Another hose pipe was attached to the receive handset connected to audio equipment measuring a SINAD level. For DSC - The system consists of a pod and handset for transmitting a DSC message and a pod and handset for receiving the DSC message. The pods and handsets were powered from a 12 V DC Power Supply. The two pods were connected directly at their VHF antenna ports via a RF cable and an antenna.

Table 4

1.5.4 Modes of Operation

Mode	Description
AIS	The EUT was powered and receiving a GPS location from a GPS simulator and a 2.4 GHz Wi-Fi signal from a router.
Not Transmitting	The EUT was powered but not transmitting.
VHF TX/RX	The EUT was place into a VHF transmitting mode via the handset controls. The PTT button was depressed sending a 1 kHz tone over a direct link to a receive pod and handset where the audio 1 kHz tone was heard from the output speaker of the receive handset.
DSC	The EUT was place into a DSC transmitting mode using the handset. The second handset displayed the received message.

Table 5

1.5.5 Monitoring of Performance

AIS
The EUT was monitored for correct performance visually by ensuring that the indication light on top of the EUT remained green indicating a GPS signal was being received and a Wi-Fi link was present.

To confirm normal operation, a supplied smart phone was used with the Cortex application installed. Normal AIS transmit and receive was confirmed correct using a test AIS transponder.

DSC
The RX Handset was monitored for a received message transmitted from the EUT every time a call was activated.

VHF TX/RX
A 1 kHz tone received at the output speaker of the Received Handset was monitored for a SINAD level of greater than 20 dB.

1.5.6 Performance Criteria

Performance Criteria A – IEC 60945

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.

Performance Criteria B – IEC 60945

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.

Performance Criteria C – IEC 60945

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

Performance criteria A for continuous phenomena applied to transmitters and receivers – ETSI EN 301 843-1

If no further details are given in the relevant part of the present document dealing with the particular type of radio equipment, the following general performance criteria A for continuous phenomena shall apply.

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

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

If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be deduced from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended.

The EUT shall be subjected to the performance check (see clause 6.4) during and after the test.

The EUT shall meet the requirements of the performance check.

Performance criteria B for transient phenomena applied to transmitters and receivers – ETSI EN 301 843-1

If no further details are given in the relevant part of the present multi-part deliverable dealing with the particular type of radio equipment, the following general performance criteria B for transient phenomena shall apply.

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

During the EMC exposure to an electromagnetic phenomenon, a degradation of performance is, however, allowed. No change of the actual mode of operation (e.g. unintended transmission) or stored data is allowed.

If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be deduced from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended.

The EUT shall be subjected to the performance check (see clause 6.4) after the test. The EUT shall meet the requirements of the performance check.

Performance criteria C applied to power supply failure – ETSI EN 301 843-1

During the test sequence the EUT shall not unintentionally transmit or change stored data. Temporary degradation or loss of function or performance is allowed during the test sequence, provided the function, as defined by the immunity performance assessment procedure and in the technical specification published by the manufacturer, is self-recoverable or can be restored after the test by operation of user controls.

The EUT shall be subjected to the performance check (see clause 6.4) after the test. The EUT shall meet the requirements of the performance check.

The manufacturers specified performance level is detailed as:

The EUT was to continue to operate as per the requirements of the manufacturer with no unexpected behaviour.

DSC - The transmit handset shall continue to transmit message data the Receive Handset with no loss of performance.

VHF TX/RX - The EUT shall continue to transmit with a SINAD level > 20 dB received speaker port of the Receive handset.

Normal AIS transmit and receive was confirmed using a test AIS transponder.

1.6 Deviations from the Standard

Section 2.1 – Radiated Emissions

In order to avoid carrying out the test twice, testing was carried out to the limits in both standards with the EUT at a height of 0.8 m from the ground plane.

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
Serial Number: M0000065			
0	As supplied by the customer	Not Applicable	Not Applicable
1	On-board PSU filtering optimised to minimise noise coupling to external connectors.	Client	17-December-2019
2	TVS protection strategy for all ports optimised to provide comprehensive protection against FTB.	Client	21-December-2019

Table 6

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Serial Number: M00000069			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 7

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Serial Number: H1.0000000B			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 8

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Serial Number: H1.0000000F			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 9

1.8 Test Location

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

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: DC Powered – AIS		
Conducted Emissions	Colin McKean	UKAS
Immunity to Electrostatic Discharge	Colin McKean	UKAS
Immunity to Power Supply Failure	Colin McKean	UKAS
Immunity to Fast Transients on AC Power, Signal and Control Lines	Colin McKean	UKAS
Immunity to Radiated Radio Frequencies	Colin McKean	UKAS
Immunity to Conducted Radio Frequency Disturbance	Colin McKean	UKAS
Configuration and Mode: DC Powered – Not Transmitting		
Radiated Emissions	Colin McKean	UKAS
Configuration and Mode: Configuration and Mode: Pod and Handset, DC Powered - VHF TX/RX		
Immunity to Radiated Radio Frequencies	Colin McKean	UKAS
Immunity to Radio Frequency, Common Mode	Colin Mckean and Jack Tuckwell	UKAS
Configuration and Mode: Pod and Handset, DC Powered - DSC		
Immunity to Radiated Radio Frequencies	Colin McKean	UKAS
Immunity to Radio Frequency, Common Mode	Colin Mckean and Jack Tuckwell	UKAS

Table 10

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
ETSI EN 301 843-1, Clause 8.2
ETSI EN 301 843-2

2.1.2 Equipment Under Test and Modification State

Cortex M1, S/N: M0000065 - Modification State 2

2.1.3 Date of Test

26-March-2019

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 antenna-to-EUT azimuth and antenna-to-EUT polarisation 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 a Quasi-Peak detector. 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	20.0 °C
Relative Humidity	45.0 %

2.1.6 Specification Limits

150 kHz to 30 MHz

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 11

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 12

2.1.7 Test Results

Results for Configuration and Mode: POD DC Powered - Not Transmitting.

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

Detailed results are shown below.

Frequency Range of Test: 150 kHz to 30 MHz

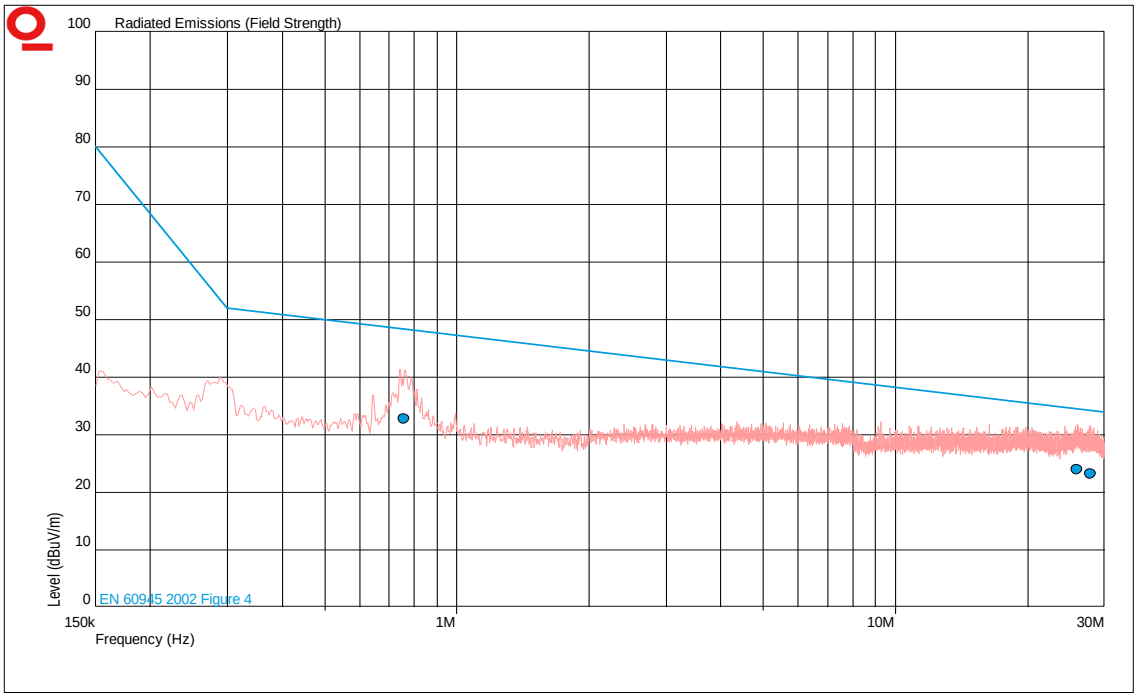

Figure 5 - Graphical Results - Horizontal and Vertical Polarity

Frequency (MHz)	QP Level (dBµV/m)	QP Limit (dBµV/m)	QP Margin (dB)	Angle (Deg)	Height(m)	Polarity
0.759	32.7	48.4	15.7	129	1.50	Edge On
25.929	23.9	34.6	10.7	360	1.50	Face On
27.815	23.2	34.3	11.1	54	1.50	Edge On

Table 13

Frequency Range of Test: 30 MHz to 2 GHz

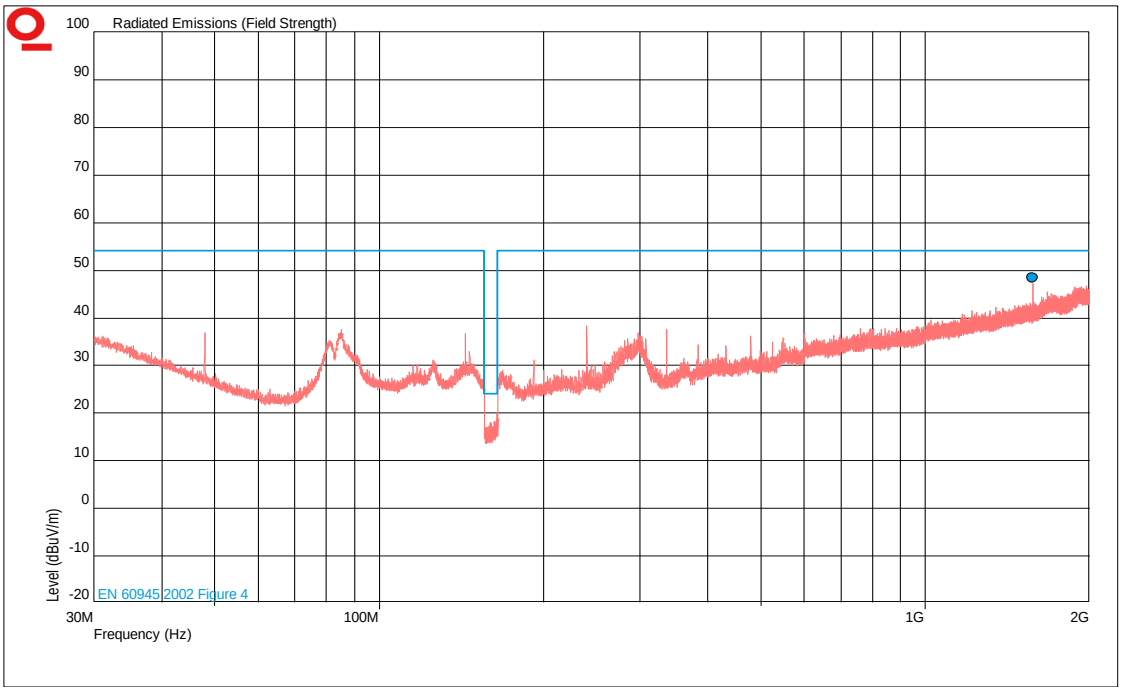

Figure 6 - Graphical Results - Horizontal and Vertical Polarity

Frequency (MHz)	QP Level (dBµV/m)	QP Limit (dBµV/m)	QP Margin (dB)	Angle (Deg)	Height(m)	Polarity
1572.480	48.4	54.0	5.6	253	1.37	Vertical

Table 14

No other measurements were made as all peak emissions seen in the pre-scan were greater than 10 dB below the Quasi-Peak test limit.

Frequency Range of Test: 156 MHz to 165 MHz

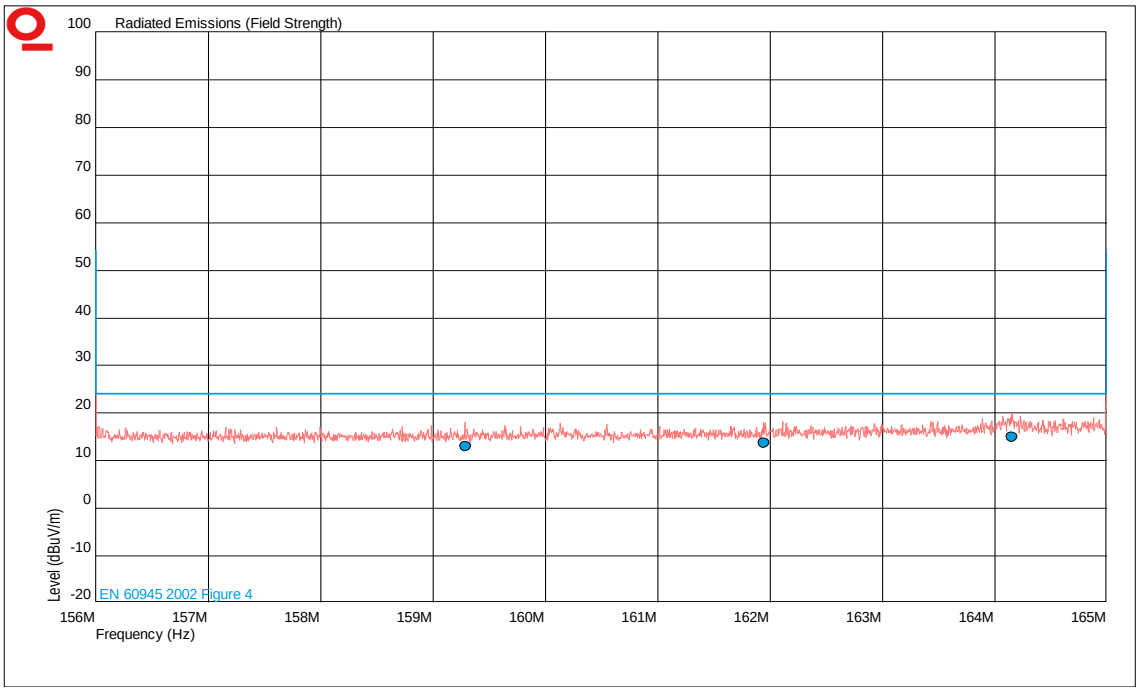

Figure 7 - Graphical Results - Horizontal and Vertical Polarity

Frequency (MHz)	QP Level (dBµV/m)	QP Limit (dBµV/m)	QP Margin (dB)	Angle (Deg)	Height(m)	Polarity
159.293	12.8	24.0	11.2	359	1.00	Vertical
161.949	13.6	24.0	10.4	0	1.00	Horizontal
164.158	14.9	24.0	9.1	359	2.49	Horizontal

Table 15

Figure 8 - Test Setup – 150 kHz to 30 MHz

Figure 9 - Test Setup – 30 MHz to 2 GHz

2.1.8 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Screened Room (5)	Rainford	Rainford	1545	36	23-Jan-2021
Compliance 5 Emissions	Teseq	V5.26.51	3275	-	Software
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	17-Dec-2019
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	3916	-	TU
Mast Controller	Maturo Gmbh	NCD	4810	-	TU
Antenna (Active Loop, 9kHz-30MHz)	Rohde & Schwarz	HFH2-Z2	333	24	11-Jan-2021
Antenna with permanent attenuator (Bilog)	Chase	CBL6143	2904	24	08-Aug-2019

Table 16

TU - Traceability Unscheduled

2.2 Conducted Emissions

2.2.1 Specification Reference

IEC 60945, Clause 9.2
ETSI EN 301 843-1, Clause 8.3
ETSI EN 301 843-2

2.2.2 Equipment Under Test and Modification State

Cortex M1, S/N: M0000065 - Modification State 2

2.2.3 Date of Test

07-March-2019

2.2.4 Test Method

The EUT was powered from an artificial Mains Network.

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

The power input cables between the AC and 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	22.0 °C
Relative Humidity	45.0 %

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 AC and the DC 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 AC and/or DC 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 17

2.2.7 Test Results

Results for Configuration and Mode: DC Powered - AIS.

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

Detailed results are shown below.

Line Under Test: +12 V DC Line

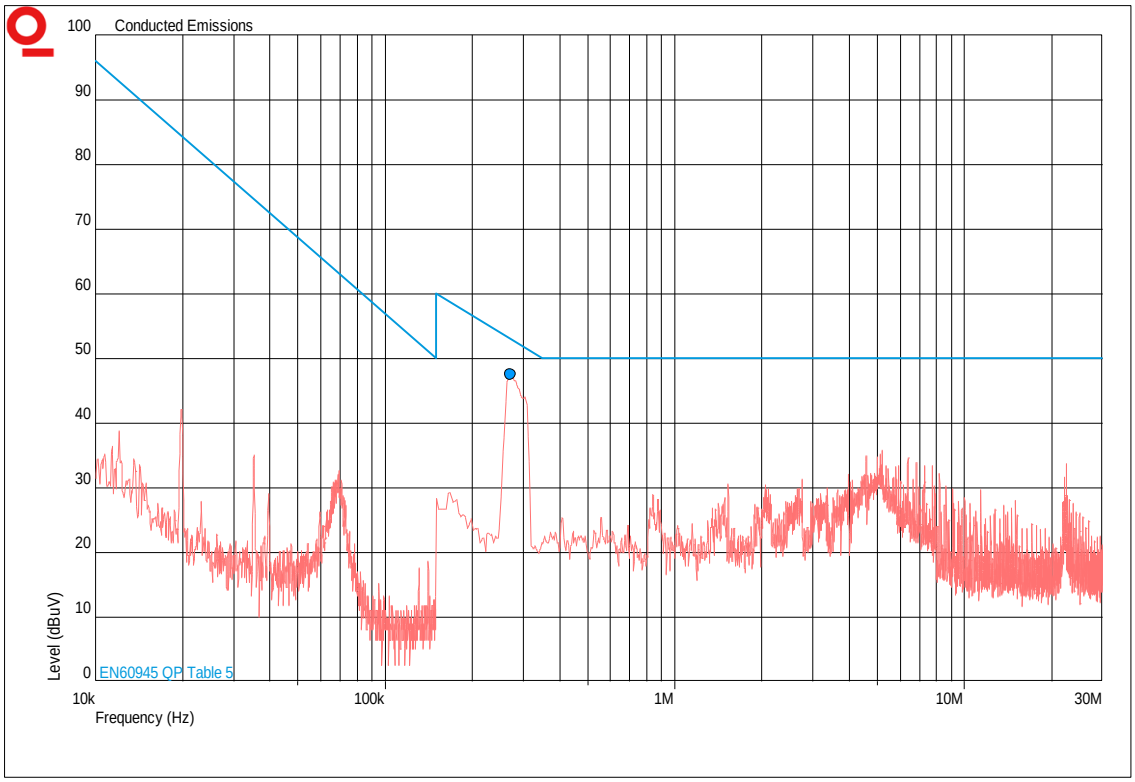

Figure 10 - Graphical Results - +12 V DC Line

Frequency (MHz)	QP Level (dBµV)	QP Limit (dBµV)	QP Margin (dB)
0.271	47.5	53.0	5.5

Table 18

No other measurements were made as all peak emissions seen in the pre-scan were greater than 10 dB below the Quasi-Peak test limit.

Line Under Test: DC Return Line

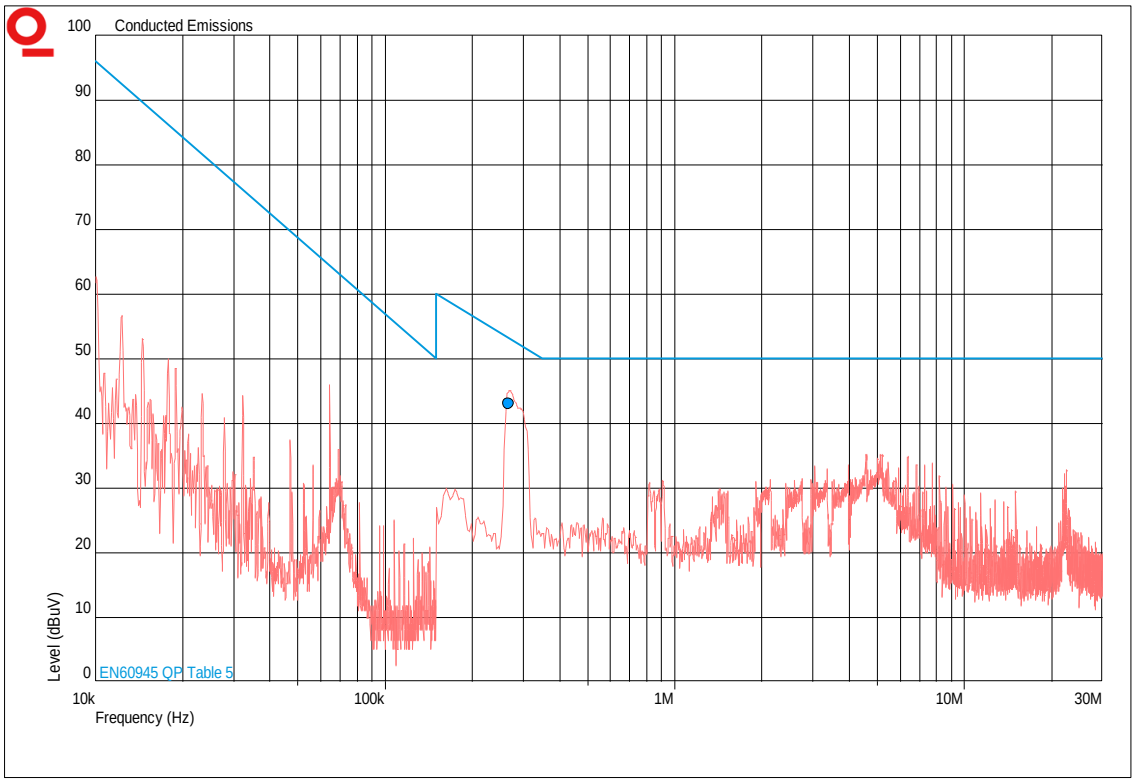

Figure 11 - Graphical Results – DC Return Line

Frequency (MHz)	QP Level (dBµV)	QP Limit (dBµV)	QP Margin (dB)
0.268	43.0	53.1	10.1

Table 19

No other measurements were made as all peak emissions seen in the pre-scan were greater than 10 dB below the Quasi-Peak test limit.

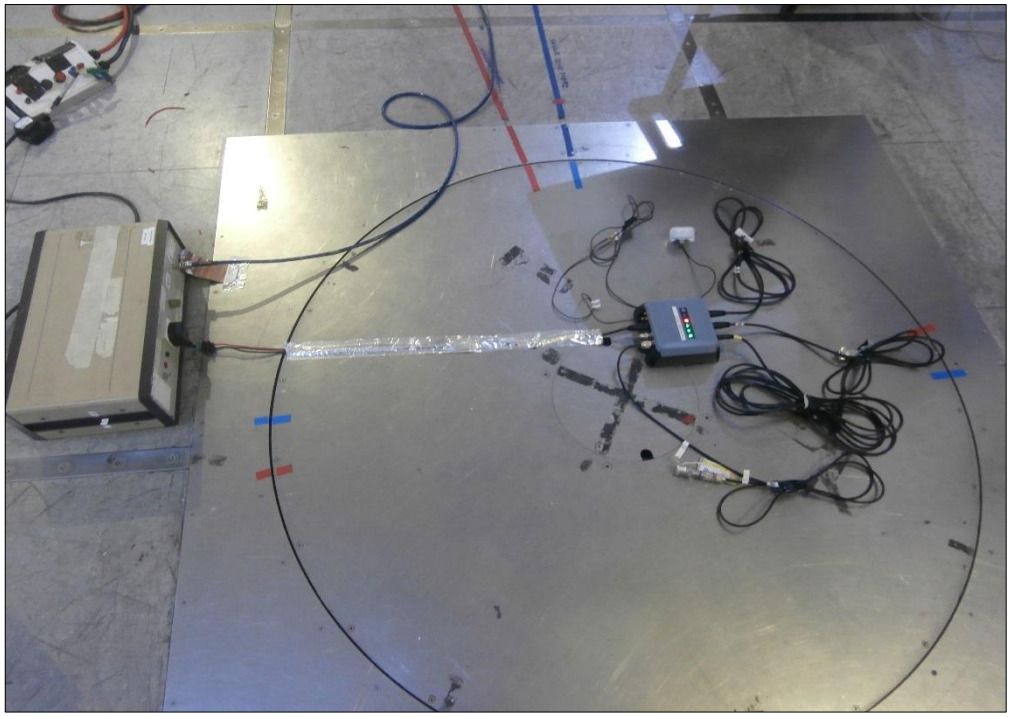

Figure 12 – Test Setup

2.2.8 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Screened Room (5)	Rainford	Rainford	1545	36	23-Jan-2021
Compliance 5 Emissions	Teseq	V5.26.51	3275	-	Software
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	17-Dec-2019
LISN (1 Phase)	Chase	MN 2050	336	12	10-Apr-2019
Transient Limiter	Hewlett Packard	11947A	15	12	26-Jul-2019
Cable (Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4526	6	26-Apr-2019
8 Meter Cable	Teledyne	PR90-088-8MTR	5212	6	28-Jul-2019

Table 20

2.3 Immunity to Electrostatic Discharge

2.3.1 Specification Reference

IEC 60945, Clause 10.9
ETSI EN 301 843-1, Clause 9.3
ETSI EN 301 843-2

2.3.2 Equipment Under Test and Modification State

Cortex M1, S/N: M0000065 - Modification State 2

2.3.3 Date of Test

02-January-2019

2.3.4 Test Method

The equipment under test including associated cabling was configured on but insulated from, using a 0.5mm isolator, a horizontal coupling plane fitted to the top of a 0.8m non-conductive table for table-top equipment; and on a 0.1m insulated support for floor standing equipment; above a ground reference plane all 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 repetition rate.

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

2.3.5 Environmental Conditions

Ambient Temperature	22.0 °C
Relative Humidity	40.0 %

2.3.6 Specification Limits

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

Table 21

2.3.7 Test Results

Results for Configuration and Mode: DC Powered - AIS.

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

Detailed results are shown below.

◯ Contact ☐ Air

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 22

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 23

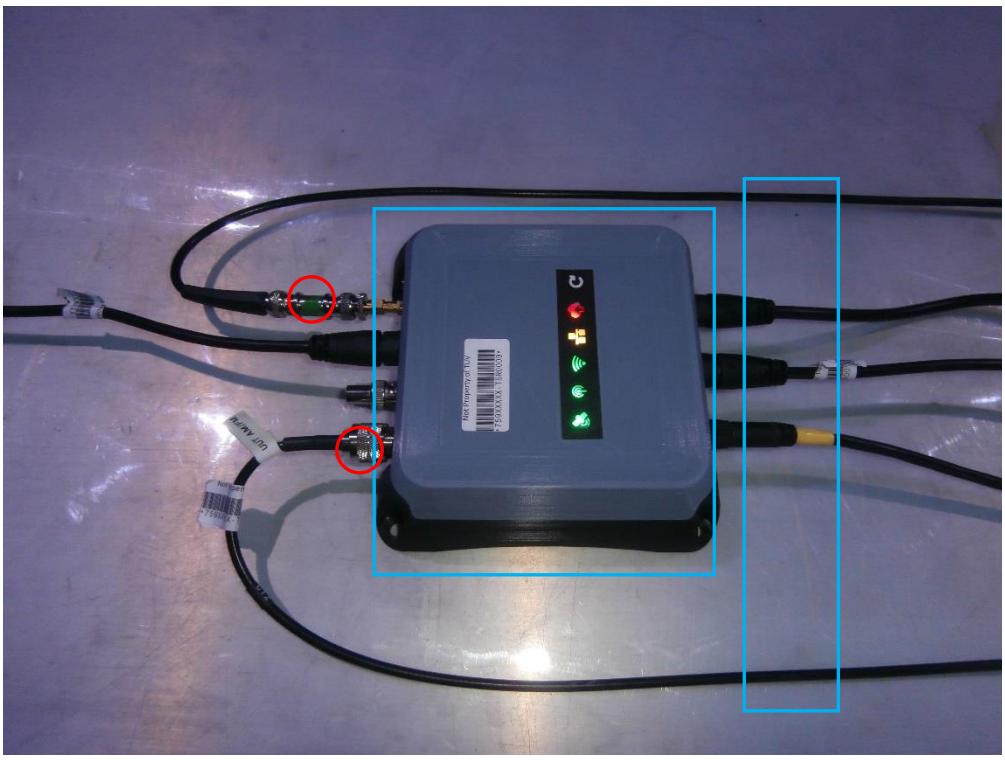

Figure 13 - Test Positions

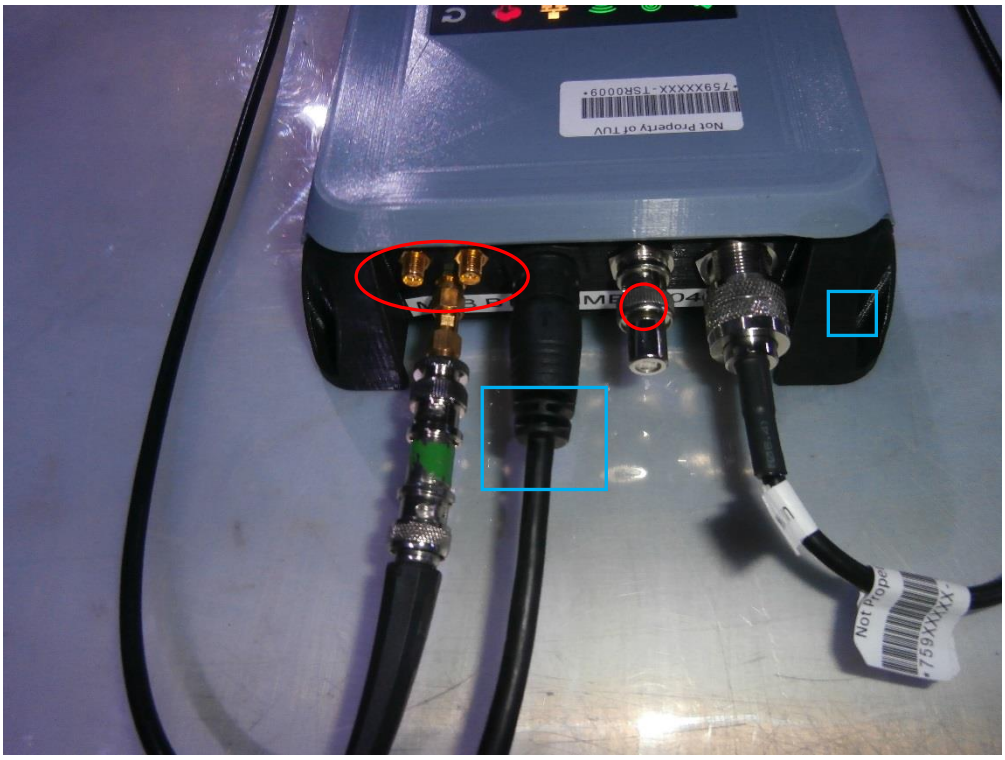

Figure 14 - Test Positions

2.3.8 Test Location and Test Equipment Used

This test was carried out in EMC Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
ESD Generator	Schloder	SESD 30000	4724	12	14-May-2019

Table 24

2.4 Immunity to Fast Transients on AC Power, Signal and Control Lines

2.4.1 Specification Reference

IEC 60945, Clause 10.5
ETSI EN 301 843-1, Clause 9.4
ETSI EN 301 843-2

2.4.2 Equipment Under Test and Modification State

Cortex M1, S/N: M0000065 - Modification State 2

2.4.3 Date of Test

21-December-2018 to 08-March-2019

2.4.4 Test Method

The equipment under test including associated cabling was configured on but insulated from, using a 0.1 m isolator, a horizontal coupling plane fitted to the top of 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 CDN for power ports, capacitive coupling clamp for signal and control ports and a 33nF coupling capacitor for earth ports, the required fast transient burst voltage levels in both voltage polarities were applied at the detailed pulse repetition rate and duration of test.

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

2.4.5 Environmental Conditions

Ambient Temperature	20.0 - 23.0 °C
Relative Humidity	44.0 - 51.0 %

2.4.6 Specification Limits

Required Test Levels					Performance Criteria
Line Under Test	Level (±kV)	Repetition Rate (kHz)	Test Duration	Coupling Method	
Signal / Control Port (1)	1.0	5	3 min per polarity	Capacitive Clamp	B
Supplementary information: None					

Table 25

2.4.7 Test Results

Results for Configuration and Mode: DC Powered - AIS.

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

Detailed results are shown below.

Tabulated Results for Fast Transient Burst Immunity					
Line under test	Test Level (±kV)	Repetition Rate (kHz)	Test Duration (min)	Coupling Method	Result
VHF/AIS Antenna	1.0	5	5	Capacitive Clamp	Pass
External GPS	1.0	5	5	Capacitive Clamp	Pass
NMEA2000	1.0	5	5	Capacitive Clamp	Pass
External Speakers	1.0	5	5	Capacitive Clamp	Pass
GPIO, NMEA0183 & Test IO	1.0	5	5	Capacitive Clamp	Pass

Table 26

Figure 15 - Immunity to Fast Transients on AC Power, Signal and Control Lines

2.4.8 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Capacitive Coupling Clamp	Omiran	EFTC 105	298	12	03-Jul-2019
Coupling / Decoupling Network	Teseq	CDN3061	4555	12	03-Jul-2019
Immunity Test Set	Teseq	NSG3060	4556	12	03-Jul-2019

Table 27

2.5 Immunity to Power Supply Failure

2.5.1 Specification Reference

IEC 60945, Clause 10.8

2.5.2 Equipment Under Test and Modification State

Cortex M1, S/N: M0000065 - Modification State 2

2.5.3 Date of Test

21-December-2018 to 08-March-2019

2.5.4 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.

2.5.5 Environmental Conditions

Ambient Temperature	20.0 °C
Relative Humidity	51.0 %

2.5.6 Specification Limits

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

Table 28

2.5.7 Test Results

Results for Configuration and Mode: DC Powered - AIS.

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 Port	N/A	12	0	60	Pass

Table 29

Figure 16 – Test Setup

2.5.8 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Multi-function Generator	Teseq	NSG 3060 FTM 3425	4556	12	03-July-2019
Single Phase CDN	Teseq	NSG 3061	4555	12	03-July-2019
Variable Supply	Teseq	VAR3005	4557	12	03-July-2019

Table 30

2.6 Immunity to Radiated Radio Frequencies

2.6.1 Specification Reference

IEC 60945, Clause 10.4
ETSI EN 301 843-1, Clause 9.2
ETSI EN 301 843-2

2.6.2 Equipment Under Test and Modification State

Cortex M1, S/N: M0000065 - Modification State 0
Cortex M1, S/N: M0000069 - Modification State 0
Cortex Handset; Model: H1, S/N: H1.0000000F – Modification State 0
Cortex Handset; Model: H1, S/N: H1.0000000B – Modification State 0

2.6.3 Date of Test

12-December-2018 to 06-March-2020

2.6.4 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 polarisations.

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

2.6.5 Environmental Conditions

Ambient Temperature	22.0 - 23.0 °C
Relative Humidity	40.0 - 46.0 %

2.6.6 Specification Limits

Required Test Levels					Performance Criteria
Frequency Range (MHz)	Level (V/m)	Modulation	Step Size (%)	Dwell (s)	
80 to 1000[2]	10[3]	AM (80 %,400 Hz, sine wave)	1	3[1]	A
1000 to 2700[2]	10[3]	AM (80 %,400 Hz, sine wave)	1	9[1]	A
Supplementary information: Note 1. Dwell times <1 GHz can be reduced to 2 s and >1 GHz to 5 s for samples with fast cycle times. Note 2. EUT powered at one of the nominal input voltages and frequencies Note 3. 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 31

2.6.7 Test Results

Results for Configuration and Mode: POD DC Powered - AIS.

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	400 Hz Sine 80 % AM			
Frequency Range (MHz)	Test Face	Antenna Polarisation	Test Level (V/m)	Result
80 to 2700	Front, Right, Left and Rear	Horizontal and Vertical	12.6 (10 + MU)	Pass

Table 32

Results for Configuration and Mode: POD and Handset DC Powered - VHF TX/RX.

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	3 s			
Modulation	400 Hz Sine 80 % AM			
Frequency Range (MHz)	Test Face	Antenna Polarisation	Test Level (V/m)	Result
80 to 2700	Front, Right, Left and Rear	Horizontal and Vertical	12.6 (10 + MU)	Pass

Table 33

Results for Configuration and Mode: POD and Handset DC Powered - DSC.

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	3 s			
Modulation	400 Hz Sine 80 % AM			
Frequency Range (MHz)	Test Face	Antenna Polarisation	Test Level (V/m)	Result
80 to 2700	Front, Right, Left and Rear	Horizontal and Vertical	12.6 (10 + MU)	Pass

Table 34

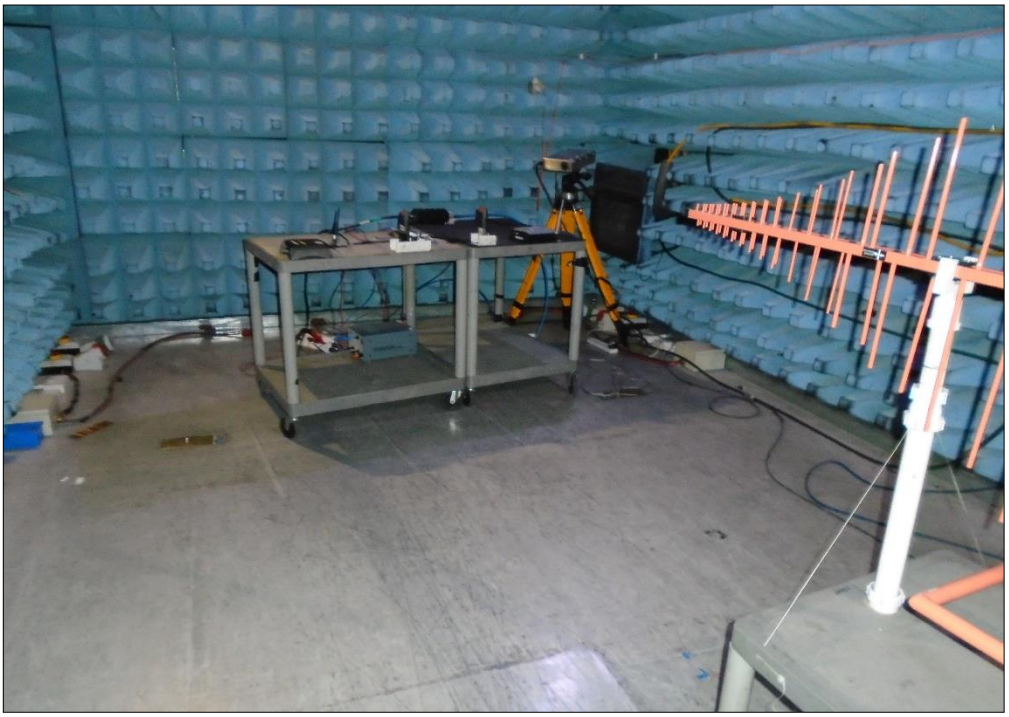

Figure 17 - Test Setup - Below 1 GHz

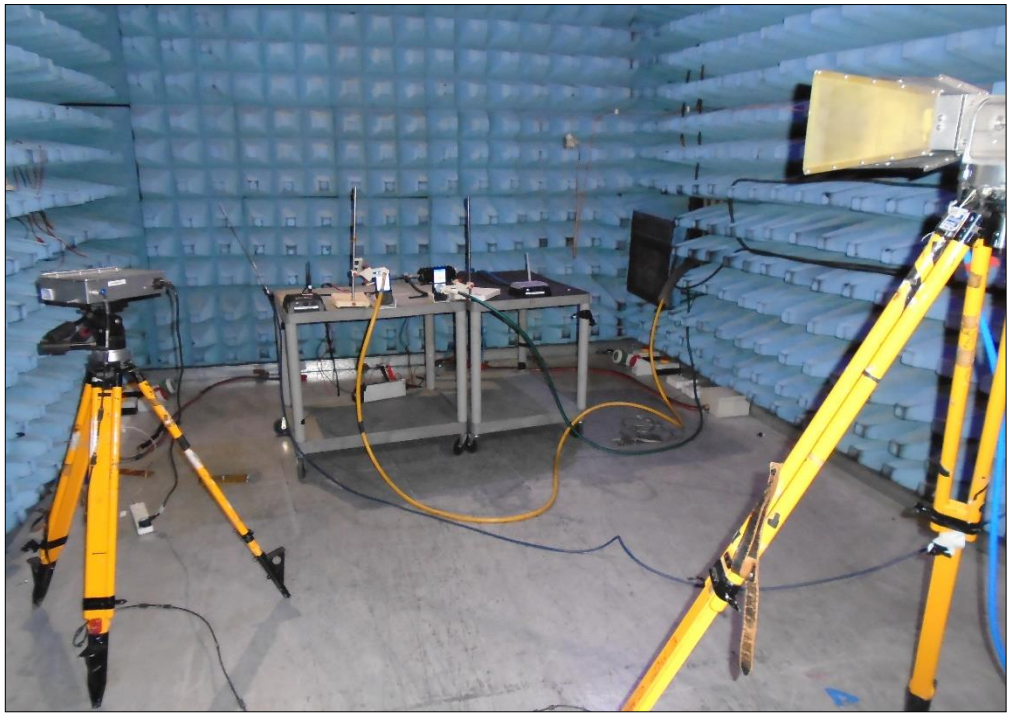

Figure 18 - Test Setup - Above 1 GHz

2.6.8 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
EmX Test Software	TUV SUD	V1.5.5	5125	-	Software
Signal Generator, 9kHz to 6GHz	Rohde & Schwarz	SMB 100A	3500	12	15-Apr-2020
Amplifier (250W, 80MHz - 1GHz)	Amp Research	250W1000A	3029	-	TU
CW TWT (1 to 2.5 GHz)	Thorn	CW TWT (1-2.5GHz)	2069	-	TU
CW TWT (2.5 to 8 GHz)	Thorn	PTC6343	2068	-	TU
Directional Coupler	Amp Research	DC6180	283	-	TU
Directional Coupler	Amp Research	DC6180	2763	-	TU
Termination (50ohm)	Diamond Antenna	DL-30N	219	12	20-Feb-2021
Termination (50ohm)	Diamond Antenna	DL-30N	341	12	05-June-2020
Power Meter	Rohde & Schwarz	NRVD	1391	-	TU
Power Meter	Rohde & Schwarz	NRVD	747	-	TU
Power Meter	Rohde & Schwarz	NRVD	748		TU
Antenna	Schaffner	CBL6143	322	-	TU
Antenna (Double Ridge Guide, 1GHz-18GHz)	EMCO	3115	234	-	TU

Table 35

TU - Traceability Unscheduled

2.7 Immunity to Conducted Radio Frequency Disturbance

2.7.1 Specification Reference

IEC 60945, Clause 10.3
ETSI EN 301 843-1, Clause 9.5
ETSI EN 301 843-2

2.7.2 Equipment Under Test and Modification State

Cortex M1, S/N: M0000065 - Modification State 1
Cortex M1, S/N: M0000069 - Modification State 0
Cortex Handset; Model: H1, S/N: H1.0000000F – Modification State 0
Cortex Handset; Model: H1, S/N: H1.0000000B – Modification State 0

2.7.3 Date of Test

18-December-2018 to 25-March-2020

2.7.4 Test Method

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

All associated cabling was configured, on but insulated 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.

2.7.5 Environmental Conditions

Ambient Temperature	20.0 - 22.0 °C
Relative Humidity	38.0 - 40.0 %

2.7.6 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(1)	0.15 to 80	3	AM (80 %,400 Hz, sine wave)	1	3	A
	Spot Frequencies(2)	10	AM (80 %,400 Hz, sine wave)	-	3	A
Supplementary information: Note 1. EUT powered at one of the nominal input voltages and frequencies. Note 2. 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 36

2.7.7 Test Results

Results for Configuration and Mode: DC Powered - AIS.

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
VHF/AIS Antenna	150kHz to 80MHz	10 V	EM Clamp	M2 CDN	Pass
External GPS	150kHz to 80MHz	10 V	EM Clamp	M2 CDN	Pass
NMEA2000	150kHz to 80MHz	10 V	EM Clamp	M2 CDN	Pass
GPIO, NMEA0183 & Test IO	150kHz to 80MHz	10 V	EM Clamp	M2 CDN	Pass
External Speakers	150kHz to 80MHz	10 V	EM Clamp	M2 CDN	Pass

Table 37

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
VHF/AIS Antenna	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
External GPS	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
NMEA2000	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
GPIO, NMEA0183 & Test IO	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
External Speakers	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass

Table 38

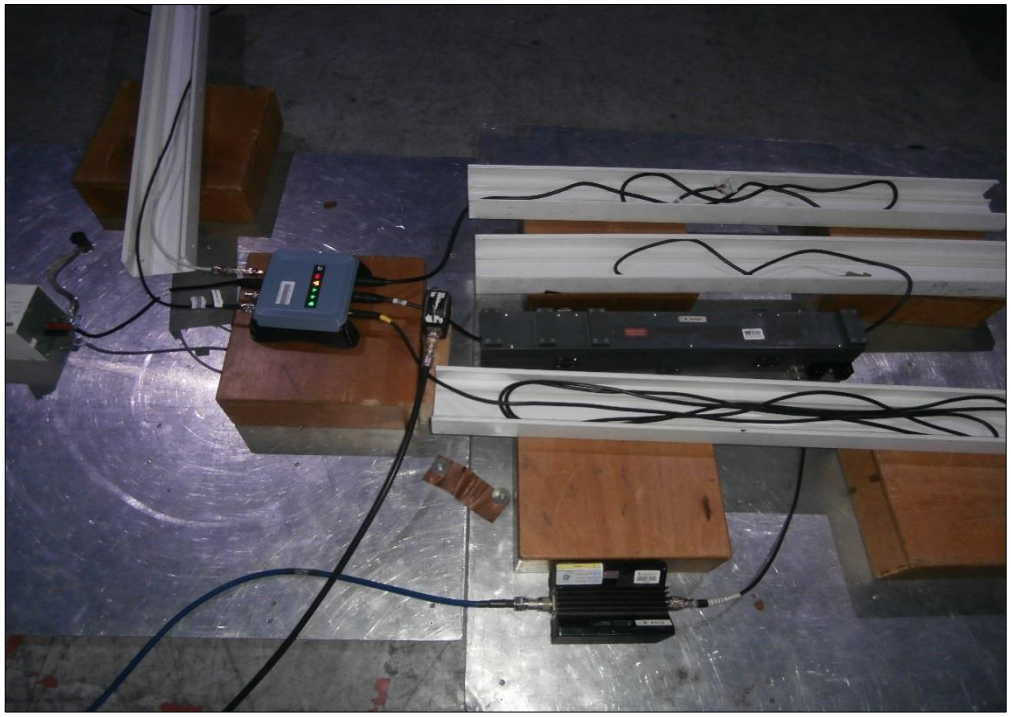

Figure 19 - Test Setup - Signal and Control Port

Results for Configuration and Mode: POD and Handset DC Powered - VHF TX/RX.

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 and 5 s	
Line Under Test	Frequency Range	Test Level	Coupling Method	Interference Return Path	Result
12 V DC Power Port Handset and Pod TX Unit	150 kHz to 80 MHz	10 V	M2 CDN	None	Pass
VHF/AIS Antenna - TX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass
External GPS - TX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass
NMEA2000 - TX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass
GPIO, NMEA0183 & Test IO - TX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass
External Speakers - TX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass
12 V DC Power Port Handset and Pod RX Unit	150 kHz to 80 MHz	10 V	M2 CDN	None	Pass
VHF/AIS Antenna - RX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass
External GPS - RX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass
NMEA2000 - RX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass
GPIO, NMEA0183 & Test IO - RX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass
External Speakers - RX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass

Table 39

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
12 V DC Power Port Handset and Pod TX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	M2 CDN	None	Pass
VHF/AIS Antenna - TX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
External GPS - TX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
NMEA2000 - TX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
GPIO, NMEA0183 & Test IO - TX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
External Speakers - TX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
12 V DC Power Port Handset and Pod RX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	M2 CDN	None	Pass
VHF/AIS Antenna - RX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
External GPS - RX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
NMEA2000 - RX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
GPIO, NMEA0183 & Test IO - RX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
External Speakers - RX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass

Table 40

Results for Configuration and Mode: POD and Handset DC Powered - DSC.

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 and 5 s	
Line Under Test	Frequency Range	Test Level	Coupling Method	Interference Return Path	Result
12 V DC Power Port Handset and Pod TX Unit	150 kHz to 80 MHz	10 V	M2 CDN	None	Pass
VHF/AIS Antenna - TX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass
External GPS - TX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass
NMEA2000 - TX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass
GPIO, NMEA0183 & Test IO - TX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass
External Speakers - TX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass
12 V DC Power Port Handset and Pod RX Unit	150 kHz to 80 MHz	10 V	M2 CDN	None	Pass
VHF/AIS Antenna - RX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass
External GPS - RX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass
NMEA2000 - RX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass
GPIO, NMEA0183 & Test IO - RX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass
External Speakers - RX Unit	150 kHz to 80 MHz	10 V	EM Clamp	M2 CDN	Pass

Table 41

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
12 V DC Power Port Handset and Pod TX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	M2 CDN	None	Pass
VHF/AIS Antenna - TX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
External GPS - TX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
NMEA2000 - TX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
GPIO, NMEA0183 & Test IO - TX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
External Speakers - TX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
12 V DC Power Port Handset and Pod RX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	M2 CDN	None	Pass
VHF/AIS Antenna - RX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
External GPS - RX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
NMEA2000 - RX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
GPIO, NMEA0183 & Test IO - RX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass
External Speakers - RX Unit	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM Clamp	M2 CDN	Pass

Table 42

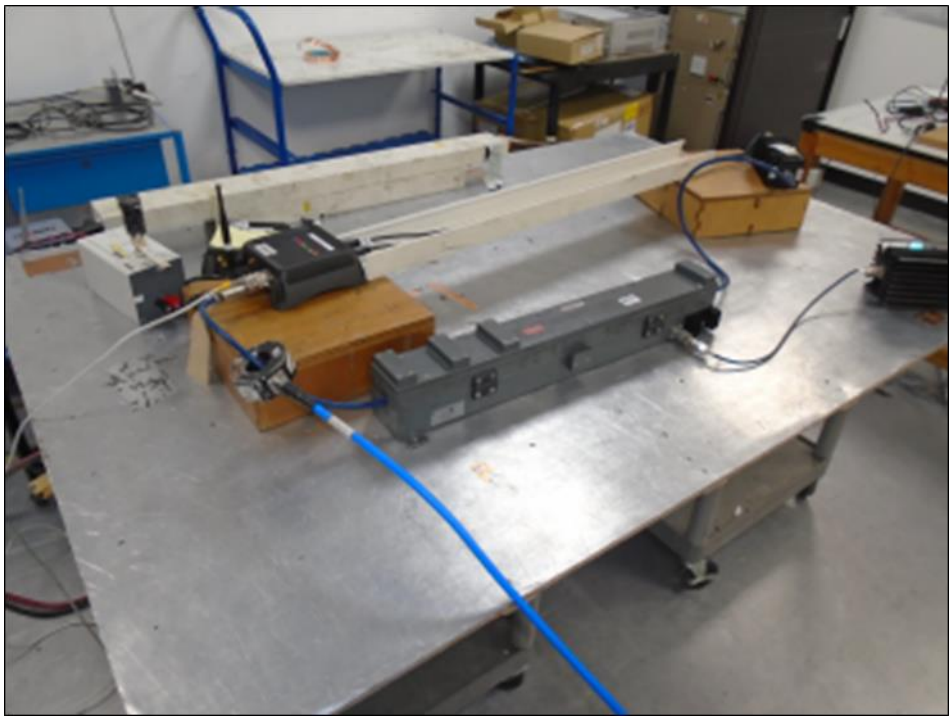

Figure 20 – Signal Cable Test Setup

2.7.8 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Conducted Immunity Test Software	Schaffner	WIN2070	5251	-	Software
RF Generator + Attenuator	Schaffner	NSG2070-400	222	12	24-Jan-2021
Termination	MEB Messelektronik	TRA150	209	-	TU
Termination	MEB Messelektronik	TRA150	210	-	TU
Load (50ohm, 30W)	JFW	50T-054	284	12	05-Jun-2020
Attenuator 6dB	Advance	10023-6/MF	1539	12	31-Jan-2021
Attenuator (30dB, 250W)	Weinschel	45-30-43	3071	12	03-May-2020
CDN Jig	MEB Messelektronik	M2-801	213	-	TU
Coupling and Decoupling Network	Schaffner	M216	224	12	11-Oct-2020
CDN, 16A, switchable M2 or M3	Teseq	CDN M016	3666	12	11-Oct-2020
Coupling Clamp	MEB Messelektronik	KEMZ-801	228	-	TU
Calibration Fixture (x2)	MEB Messelektronik	KEMZ-801	229	-	TU
Current Probe	Ailtech	91550-1	520	12	27-Jun-2020

Table 43

TU - Traceability Unscheduled

3 Test Equipment Information

3.1 General Test Equipment Used

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
GPS Simulator	Spirent	GSS7000	4978	12	29-Nov-2019

Table 44

4 Incident Reports

The following Incident Report was issued during testing covered by this test report.

Report Serial No	IR Serial No 75943855 IR01 Issue 1
Date of issue	17 December 2018
Applicable test	Conducted Emissions

Report Serial No	IR Serial No 75943855 IR02 Issue 1
Date of issue	21 December 2018
Applicable test	Immunity to Fast Transients on AC Power, Signal and Control Lines

5 Measurement Uncertainty

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

Test Name	Measurement Uncertainty
Radiated Emissions	9 kHz to 30 MHz, Active Loop Antenna, ±3.4 dB 30 MHz to 2 GHz, Bilog Antenna, ±5.2 dB
Conducted Emissions	10 kHz to 30 MHz, LISN, ±3.7 dB
Immunity to Electrostatic Discharge	The test was applied using proprietary equipment that meets the requirements of EN 61000-4-2
Immunity to Fast Transients on AC Power, Signal and Control Lines	The test was applied using proprietary equipment that meets the requirements of EN 61000-4-4
Immunity to Power Supply Failure	The test was applied using proprietary equipment that meets the requirements of EN 61000-4-11
Immunity to Radiated Radio Frequencies	80 MHz to 2 GHz Test Amplitude ±2.0 dB
Immunity to Conducted Radio Frequency Disturbance	150 kHz to 80 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

Table 45

Worst case error for both Time and Frequency measurement 12 parts in 10^6.
All measurement uncertainties have been calculated in accordance with CISPR guidelines.

Measurement Uncertainty Decision Rule

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115: 2007, clause 4.4.3 and 4.5.1.