

EMC Testing of the
 Uniden America Corporation.
 Marine Fixed Mount VHF with DSC,
 Model: VHF490
 In accordance with IEC 60945

Prepared for: TÜV SÜD America Inc.
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 USA



Product Service

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Date: October 2017
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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	24 October 2017

Table 1

1.2 Introduction

Applicant	TÜV SÜD America Inc.
Manufacturer	Undien America Corporation.
Model Number(s)	VHF490
Serial Number(s)	Not Serialised (75938884-TSR-0001) and UT655ZV T/A Sample No 1
Hardware Version(s)	EPP
Software Version(s)	1.00.01
Number of Samples Tested	2
Test Specification/Issue/Date	IEC 60945: 2002 C1:2008
Order Number	72127187
Date	24-April-2017
Date of Receipt of EUT	08-August-2017 and 07-September-2017
Start of Test	11-September-2017
Finish of Test	02-October-2017
Name of Engineer(s)	Colin McKean
Related Document(s)	IEC 61000-4-6: 2006 IEC 61000-4-11: 2004 IEC 61000-4-2: 2001 IEC 61000-4-3: 2006 CISPR 16-1-2: 2006 CISPR 16-1-4: 2007 ISO 694: 2000



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: 13.8V DC Powered - Transmit				
2.1	9.2	Conducted Emissions	Pass	CISPR 16-1-2:2006
2.2	10.3	Immunity to Conducted Radio Frequency Disturbance	Pass	IEC 61000-4-6: 2006
2.3	10.4	Immunity to Radiated Radiofrequencies	Pass	IEC 61000-4-3: 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
Configuration and Mode: 13.8V DC Powered - Receive				
2.1	9.2	Conducted Emissions	Pass	CISPR 16-1-2:2006
2.7	9.3	Radiated Emissions	Pass	CISPR 16-1-4:2007
2.2	10.3	Immunity to Conducted Radio Frequency Disturbance	Pass	IEC 61000-4-6: 2006
2.6	10.4	Immunity to Radiated Radiofrequencies	Pass	IEC 61000-4-3: 2006
2.3	10.8	Immunity to Power Supply Failure	Pass	IEC 61000-4-11: 2004
2.4	10.9	Immunity to Electrostatic Discharge	Pass	IEC 61000-4-2: 2001
2.5	11.2	Compass Safe Distance	Pass	ISO 694: 2000

Table 2



1.4 Declaration of Build Status

MAIN EUT	
MANUFACTURING DESCRIPTION	Marine Fixed Mount VHF with DSC
MANUFACTURER	Undien America Corporation
MODEL NAME/NUMBER	VHF490
PART NUMBER	NA
SERIAL NUMBER	NA
HARDWARE VERSION	EPP
SOFTWARE VERSION	1.00.01
TRANSMITTER FREQUENCY OPERATING RANGE (MHz)	156.050MHz to 161.600MHz
RECEIVER FREQUENCY OPERATING RANGE (MHz)	156.050MHz to 162.550MHz
COUNTRY OF ORIGIN	Vietnam
INTERMEDIATE FREQUENCIES	± 50kHz and ± 100kHz
EMISSION DESIGNATOR(S): (i.e. G1D, GXW)	G3E , G2B
MODULATION TYPES: (i.e. GMSK, QPSK)	FM , FSK
HIGHEST INTERNALLY GENERATED FREQUENCY	161.600MHz
OUTPUT POWER (W or dBm)	25W and 1W
FCC ID	AMWUT655
INDUSTRY CANADA ID	513C-UT655D
TECHNICAL DESCRIPTION (a brief description of the intended use and operation)	See Owner's Manual
BATTERY/POWER SUPPLY	
MANUFACTURING DESCRIPTION	NA
MANUFACTURER	NA
TYPE	NA
PART NUMBER	NA
VOLTAGE	NA
COUNTRY OF ORIGIN	NA
MODULES (if applicable)	
MANUFACTURING DESCRIPTION	NA
MANUFACTURER	NA
TYPE	NA
POWER	NA
FCC ID	NA
COUNTRY OF ORIGIN	NA
INDUSTRY CANADA ID	NA
EMISSION DESIGNATOR	NA
DHSS/FHSS/COMBINED OR OTHER	NA
ANCILLARIES (if applicable)	
MANUFACTURING DESCRIPTION	NA
MANUFACTURER	NA
TYPE	NA
PART NUMBER	NA
SERIAL NUMBER	NA
COUNTRY OF ORIGIN	NA

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

Name: Tetsuro Otake
 Date: 6, June 2017

Position held: Senior Engineering Director

1.5 Product Information

1.5.1 Technical Description

The Equipment Under Test (EUT) was a Uniden America Corporation, VHF 490 Fixed Mount Marine Radio.

The primary function of the EUT is to communicate over a distress channel with international calling.

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: 13.8V DC Powered - Transmit				
DC Power Cable	>1m	DC Power Supply	2 Core Cable	No
Antenna Port	>3m	Signal	Co-axial Cable	Yes
Configuration and Mode: 13.8V DC Powered - Receive				
DC Power Cable	>1m	DC Power Supply	2 Core Cable	No
Antenna Port	>3m	Signal	Co-axial Cable	Yes

Table 3

1.5.3 Test Configuration

Configuration	Description
13.8V DC powered	The EUT's power cable was connected to a 13.8V DC supply.

Table 4



1.5.4 Modes of Operation

Mode	Description
Transmit	A 1kHz tone was injected into the Fist mic of the EUT via an acoustic tube, speaker, audio amplifier and audio analyser. The antenna port of the EUT was connected to a modulation analyser measuring the EUT's transmitted signal via a 30dB attenuation. The Demodulated output of the Modulation analyser was connected to the audio analyser via a Band-Pass filter. The PTT button was de-pressed placing the EUT in Transmit mode. The EUT was transmitting at 156.85MHz on channel 17.
Receive	The speaker of the EUT was connected to an audio analyser via an acoustic tube, pre-amplifier and a Band-Pass filter. The EUT was switched on and ready to receive a signal on the EUT's antenna port. The EUT was set for channel 17.

Table 5

1.5.5 Monitoring of Performance

Mode	Description
Transmit	The SINAD level of the EUT's demodulated transmitted signal was monitored using an audio analyser from the output of a modulation analyser.
Receive	The SINAD level of the EUT fist mic was monitored using an audio analyser.

Table 6

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:

The SINAD level measured on the analyser shall not be no less than 20dB.



1.6 Deviations from the Standard

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

Refer to Annex A for Manufacturer document detailing testing of DSC mode.

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: Not Serialised (75938884-TSR-0001)			
0	As supplied by the customer	Not Applicable	Not Applicable
Serial Number: UT655ZV T/A Sample No 1 (75939274-TSR-0001)			
1	1, Added Chip Inductor to all lines of mic PCB from curl code and mic wire to PCB (Chip inductor: Sunlord, GZ1608D601TF). 2, Separated GND connection for PCB to other side. 3, Deleted Resistor: R924 10KΩ 4, Added Capacitor: 33pF Note: Document "UT655Z (VHF490) Report of counter measure for Immunity Test".	Tetsuro Otake	02-October-2017

Table 7



1.8 Test Location

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

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: 13.8V DC Powered - Transmit		
Conducted Emissions	Colin McKean	UKAS
Immunity to Conducted Radio Frequency Disturbance	Colin McKean	UKAS
Immunity to Radiated Radiofrequencies	Colin McKean	UKAS
Immunity to Power Supply Failure	Colin McKean	UKAS
Immunity to Electrostatic Discharge	Colin McKean	UKAS
Configuration and Mode: 13.8V DC Powered - Receive		
Conducted Emissions	Colin McKean	UKAS
Radiated Emissions	Colin McKean	UKAS
Immunity to Conducted Radio Frequency Disturbance	Colin McKean	UKAS
Immunity to Radiated Radiofrequencies	Colin McKean	UKAS
Immunity to Power Supply Failure	Colin McKean	UKAS
Immunity to Electrostatic Discharge	Colin McKean	UKAS
Compass Safe Distance	Colin McKean	UKAS

Table 8

Office Address:

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



2 Test Details

2.1 Conducted Emissions

2.1.1 Specification Reference

IEC 60945, Clause 9.2

2.1.2 Equipment Under Test and Modification State

VHF490, S/N: Not Serialised (75938884-TSR-0001) - Modification State 0

2.1.3 Date of Test

12-September-2017

2.1.4 Test Method

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

Where provision of an earth plane is not practicable, equivalent arrangements shall be made using the metallic frame or mass of the EUT as the earth reference.

The power input cables between the AC and the DC power ports of the EUT and the artificial mains network shall be screened and 0,8 m in length.

If the EUT consists of more than one unit with individual AC and/or AC power ports, power ports of identical nominal supply voltage may be connected in parallel to the artificial mains supply network.

2.1.5 Environmental Conditions

Ambient Temperature 18.0 - 24.0 °C
 Relative Humidity 53.0 - 56.0 %

2.1.6 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 9



2.1.7 Test Results

Results for Configuration and Mode: 13.8V DC Powered - Receive.

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

Detailed results are shown below.

Line Under Test: 13.8V DC Line

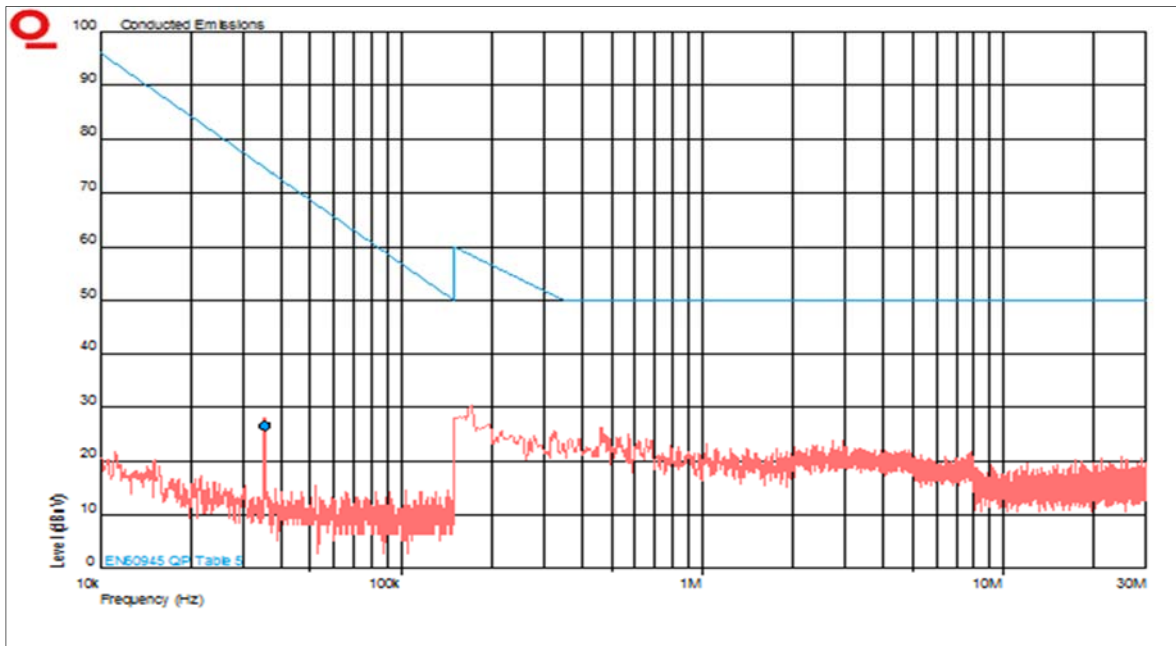


Figure 3 - Graphical Results - 13.8V DC Line

Frequency (MHz)	QP Level (dBuV)	QP Limit (dBuV)	QP Margin (dBuV)
0.035	26.4	74.6	-48.2

Table 10

Line Under Test: 0V Return Line

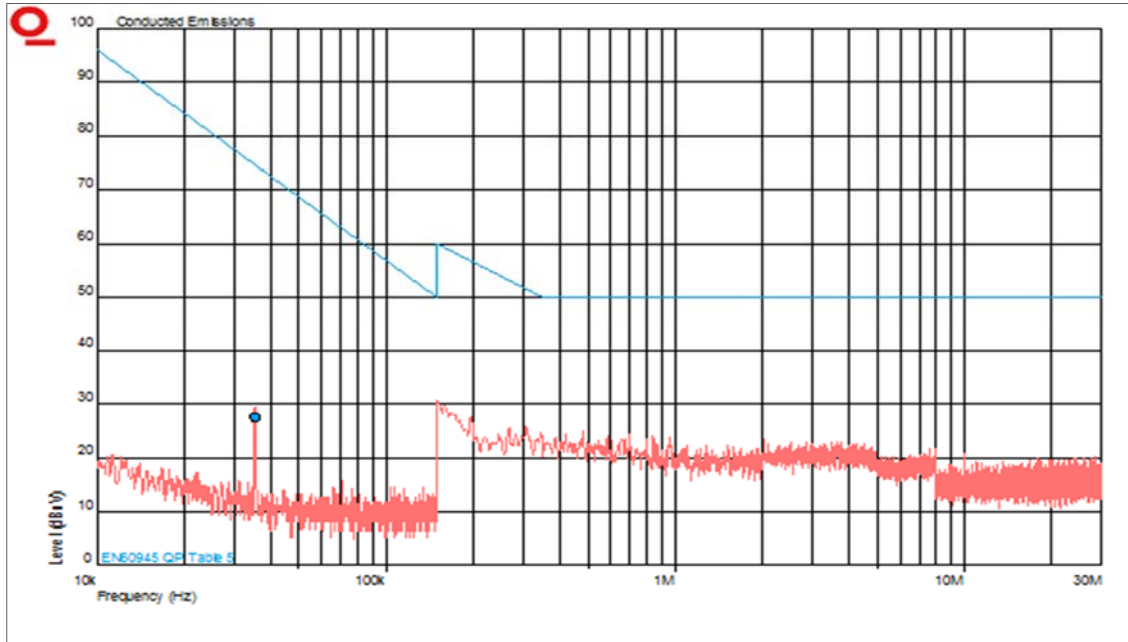


Figure 4 - Graphical Results - 0V Return Line

Frequency (MHz)	QP Level (dBuV)	QP Limit (dBuV)	QP Margin (dBuV)
0.035	27.5	74.6	-47.1

Table 11

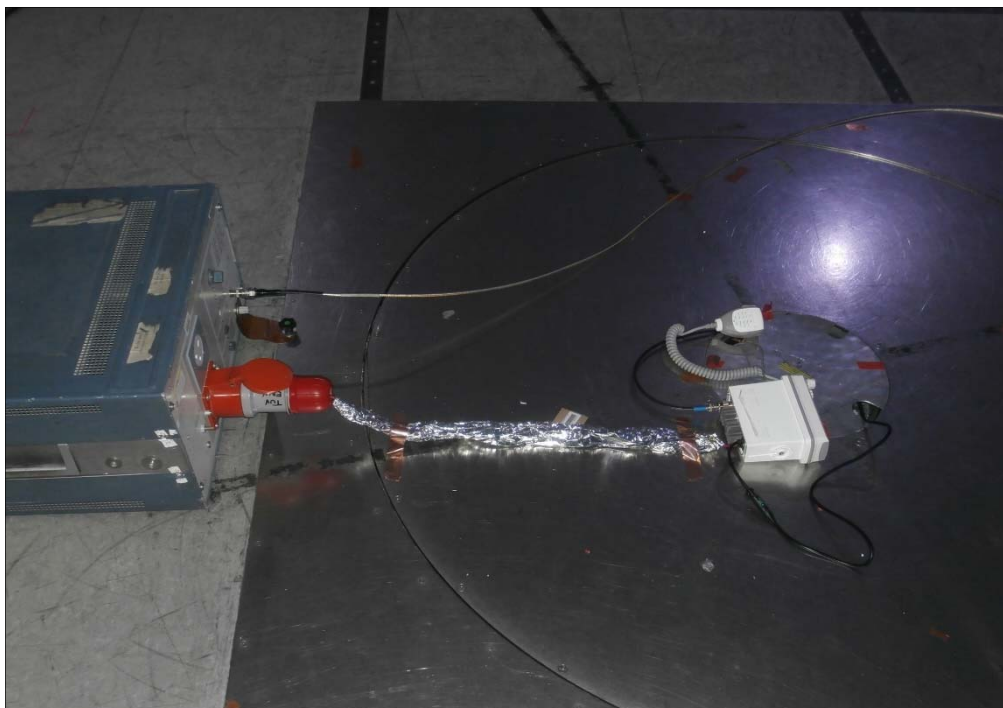


Figure 5 - Test Setup



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
Transient Limiter	Hewlett Packard	11947A	15	12	30-May-2018
3 Phase Artificial Mains Network (LISN)	Rohde & Schwarz	ESH2-Z5	16	12	13-Feb-2018
Compliance 5 Emissions	Schaffner	C5e Software	3275		Software
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	12-Nov-2017

Table 12



2.2 Radiated Emissions

2.2.1 Specification Reference

IEC 60945, Clause 9.3

2.2.2 Equipment Under Test and Modification State

VHF490, S/N: Not Serialised (75938884-TSR-0001) - Modification State 0

2.2.3 Date of Test

11-September-2017

2.2.4 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.

2.2.5 Environmental Conditions

Ambient Temperature 19.6 °C
 Relative Humidity 45.0 %

2.2.6 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 13



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 to 165 MHz, a peak receiver or a frequency analyser may be used, in accordance with the agreement between the manufacturer and the test house.

Table 14

2.2.7 Test Results

Results for Configuration and Mode: 13.8V DC Powered - Receive.

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

Detailed results are shown below.

Highest frequency generated or used within the EUT: 156.8489MHz
 Which necessitates an upper frequency test limit of: 2 GHz

Frequency Range of Test: 30 MHz to 2 GHz

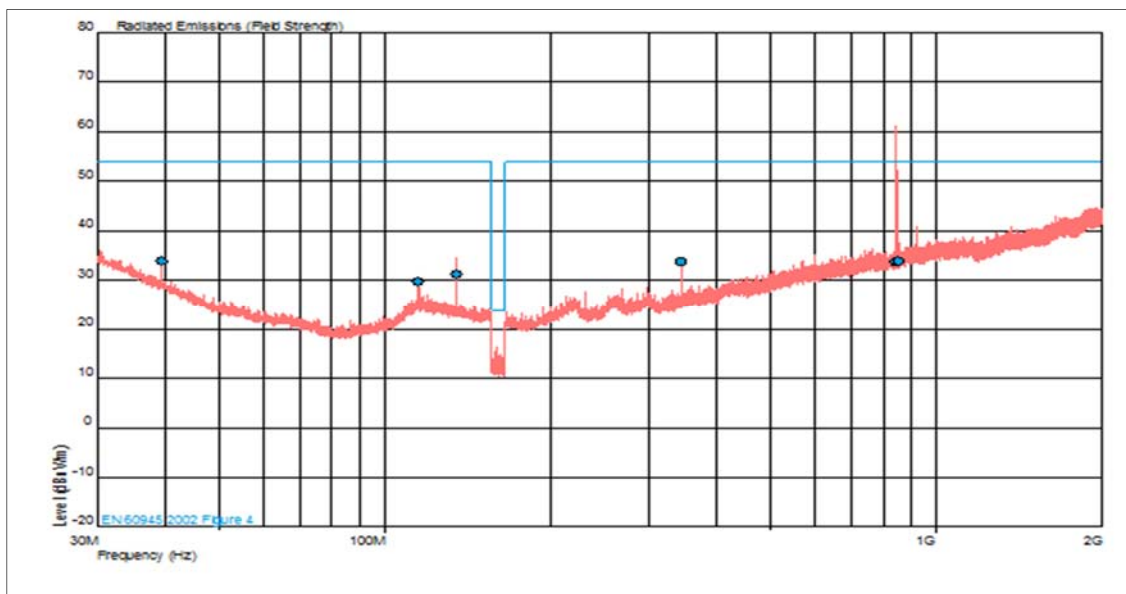


Figure 6 - Graphical Results - Horizontal and Vertical Polarity



Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dBuV/m)	Angle(Deg)	Height(m)	Polarity
39.334	34.0	54.0	-20.0	251	1.00	Vertical
114.904	29.8	54.0	-24.2	0	2.75	Horizontal
134.831	31.3	54.0	-22.7	356	1.00	Horizontal
344.750	33.8	54.0	-20.2	107	1.00	Horizontal
842.741	33.9	54.0	-20.1	360	1.00	Horizontal
853.546	34.0	54.0	-20.0	209	1.37	Horizontal

Table 15

Frequency Range of Test: 9 kHz to 30MHz

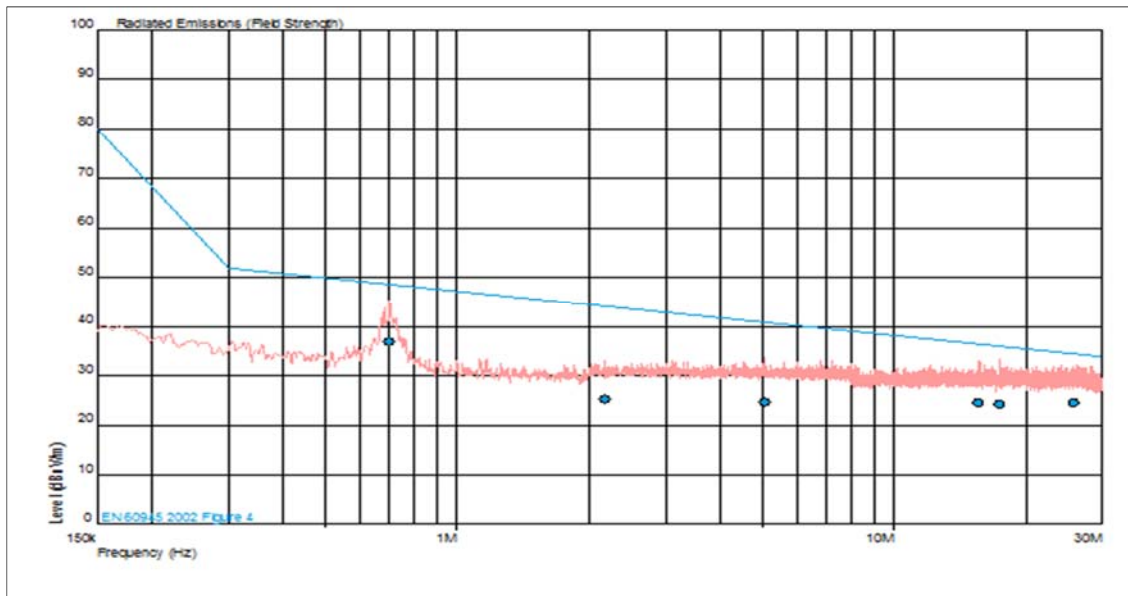


Figure 7 - Graphical Results - Horizontal and Vertical Polarity

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dBuV/m)	Angle(Deg)	Height(m)	Polarity
0.701	37.0	48.7	-11.7	240	1.50	Edge On
2.180	25.2	44.2	-19.0	190	1.50	Edge On
5.056	24.7	41.0	-16.2	253	1.50	Edge On
15.637	24.6	36.5	-12.0	156	1.50	Edge On
17.440	24.3	36.1	-11.8	355	1.50	Edge On
25.823	24.5	34.6	-10.1	28	1.50	Edge On

Table 16



Frequency Range of Test: 156 MHz to 165 MHz

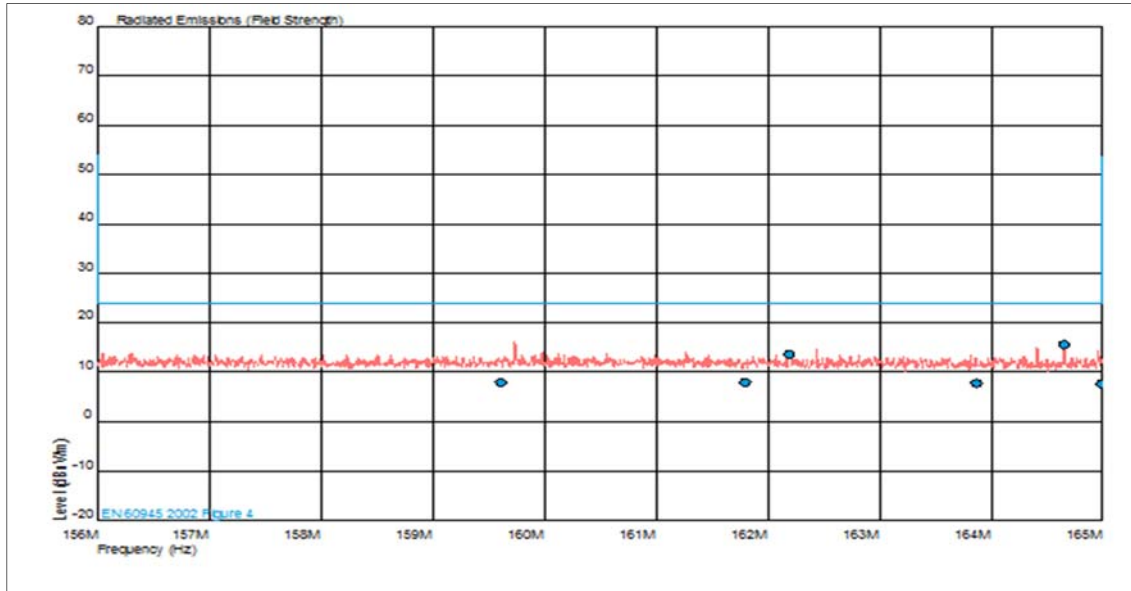


Figure 8 - Graphical Results - Horizontal and Vertical Polarity

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dBuV/m)	Angle(Deg)	Height(m)	Polarity
159.616	7.8	24.0	-16.2	212	1.16	Horizontal
161.804	7.8	24.0	-16.2	313	1.00	Horizontal
162.200	13.5	24.0	-10.5	148	2.01	Horizontal
163.874	7.7	24.0	-16.3	360	1.00	Horizontal
164.660	15.4	24.0	-8.6	154	1.89	Horizontal
164.992	7.5	24.0	-16.5	160	1.47	Horizontal

Table 17



Figure 9 - Test Setup - 9kHz to 30MHz

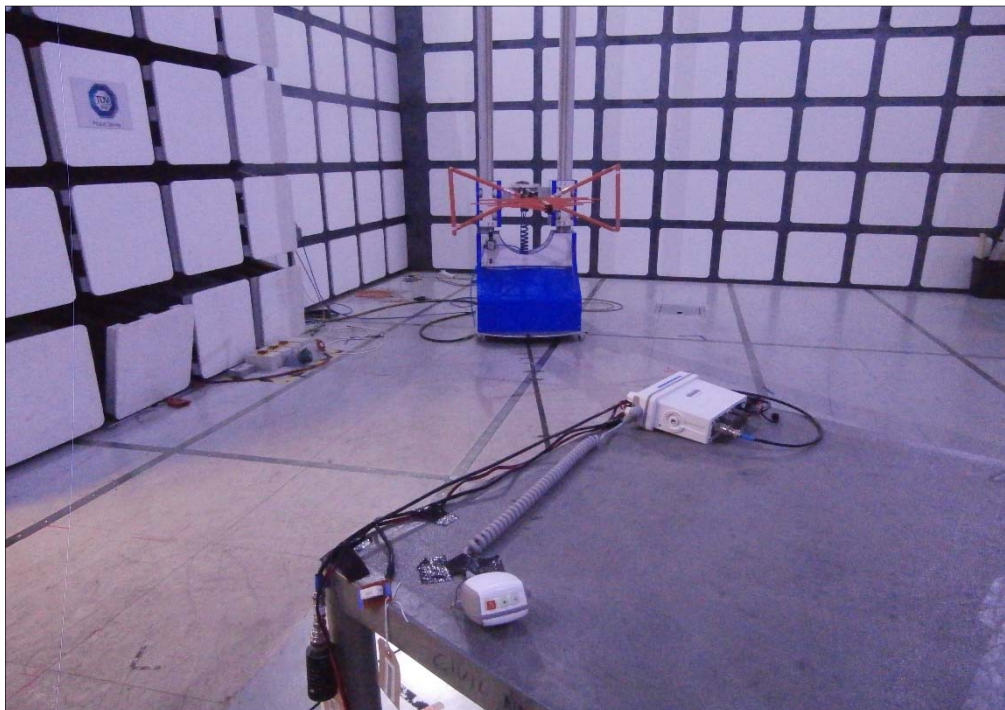


Figure 10 - Test Setup - 30MHz to 2GHz



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
Dual Power Supply Unit	Thurlby	PL320	288	-	TU
Antenna (Active Loop, 9kHz-30MHz)	Rohde & Schwarz	HFH2-Z2	333	24	09-Dec-2018
Screened Room (5)	Rainford	Rainford	1545	36	20-Dec-2017
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Compliance 5 Emissions	Schaffner	C5e Software	3275	-	Software
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	12-Nov-2017
Tilt Antenna Mast	maturo GmbH	TAM 4.0-P	3916	-	TU
Mast Controller	maturo GmbH	NCD	3917	-	TU

Table 18

TU - Traceability Unscheduled



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

VHF490, S/N: Not Serialised (75938884-TSR-0001) - Modification State 0

2.3.3 Date of Test

19-September-2017 to 20-September-2017

2.3.4 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 testing any anomalies in the equipment under tests performance was recorded.

2.3.5 Environmental Conditions

Ambient Temperature 22.0 °C
 Relative Humidity 52.0 %

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 19



2.3.7 Test Results

Results for Configuration and Mode: 13.8V DC Powered - Transmit.

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
13.8V DC Line	150kHz to 80MHz	3 V	M2 CDN	M3 CDN	Pass PC A
Antenna Port	150kHz to 80MHz	3 V	EM Clamp	M3 CDN	Pass PC A

Table 20

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
13.8V DC Line	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	M2 CDN	M3 CDN	Pass PC A
Antenna Port	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM CLAMP	M3 CDN	Pass PC A

Table 21

Results for Configuration and Mode: 13.8V DC Powered - Receive.

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
13.8V DC Line	150kHz to 80MHz	3 V	M2 CDN	M3 CDN	Pass PC A
Antenna Port	150kHz to 80MHz	3 V	EM Clamp	M3 CDN	Pass PC A

Table 22

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
13.8V DC Line	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	M3 CDN	M3 CDN	Fail
Antenna Port	2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz	10 V	EM CLAMP	M3 CDN	Fail

Table 23



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	M2-801-CDN (150kHz to 80MHz)	204	12	18-Oct-2017
Termination	MEB Messelektronik	TRA150	209	-	TU
CDN Jig	MEB Messelektronik	M2-801	213	12	21-Nov-2013
RF Generator + Attenuator	Schaffner	NSG2070-400	222	12	23-Jan-2018
Load (50ohm, 30W)	JFW	50T-054	351	12	20-Jun-2018
Attenuator 6dB	Advance	10023-6/MF	1539	12	16-Dec-2017
EM Clamp	Teseq	KEMZ 801S	3373	-	TU

Table 24

TU - Traceability Unscheduled



2.4 Immunity to Radiated Radiofrequencies

2.4.1 Specification Reference

IEC 60945, Clause 10.4

2.4.2 Equipment Under Test and Modification State

VHF490, S/N: Not Serialised (75938884-TSR-0001) - Modification State 0
 VHF490, S/N: UT655ZV T/A Sample No 1 - Modification State 1

2.4.3 Date of Test

14-September-2017 to 02-October-2017

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; 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 testing any anomalies in the equipment under tests performance was recorded.

2.4.5 Environmental Conditions

Ambient Temperature 19.0 - 21.0 °C
 Relative Humidity 44.0 - 56.0 %

2.4.6 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 25



2.4.7 Test Results

Results for Configuration and Mode: 13.8V DC Powered - Transmit.

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 MHz to 2 GHz	Front, Right, Left and Rear	Horizontal and Vertical	2.6 V/m (10 + MU)	Pass PC A

Table 26

Results for Configuration and Mode: 13.8V DC Powered - Receive.

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 MHz to 2 GHz	Front, Right, Left and Rear	Horizontal and Vertical	12.6 V/m (10 + MU)	Pass

Table 27

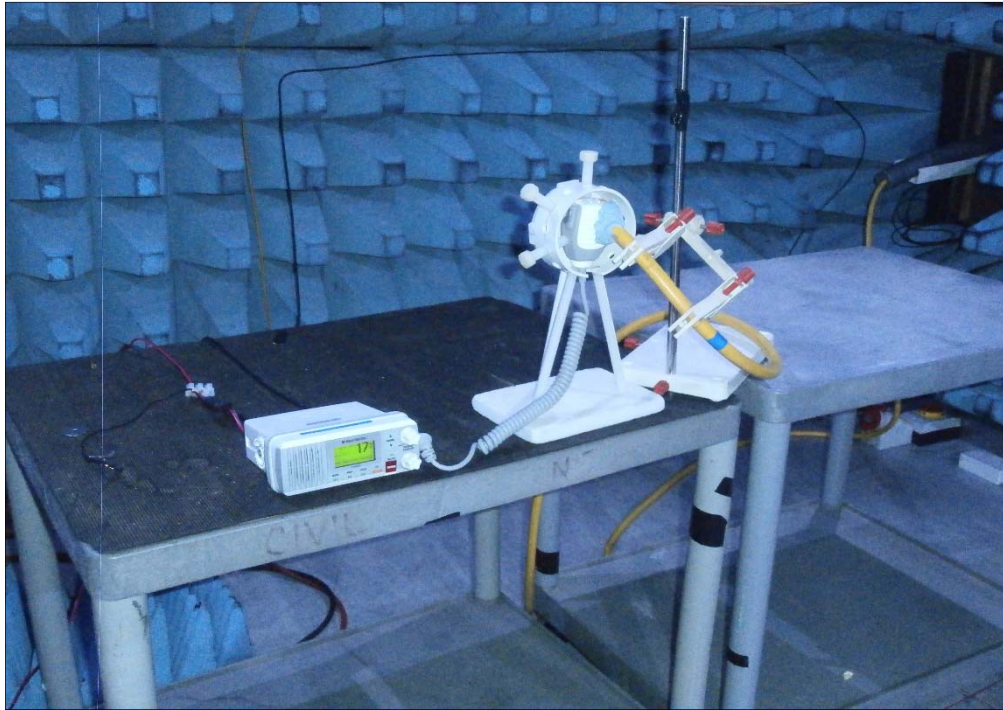


Figure 12 - Test Setup

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
Antenna (Double Ridge Guide, 1GHz-18GHz)	EMCO	3115	234	-	TU
Directional Coupler	Amp Research	DC6180	283	-	TU
Antenna	Schaffner	CBL6143	322	-	TU
Termination (50ohm)	Meca	405-1	370	12	13-Oct-2017
Power Meter	Rohde & Schwarz	NRVD	748	-	TU
Screened Room (2)	Rainford	Rainford	1542	-	TU
CW TWT (1-2.5GHz)	Thorn	PTC6341	2069	-	TU
Amplifier (250W, 80MHz - 1GHz)	Amp Research	250W1000A	3029	-	TU
Signal Generator, 9kHz to 6GHz	Rohde & Schwarz	SMB 100A	3500	12	09-Jun-2018
Power Sensor; 100kHz - 6GHz/500pW - 20mW	Rohde & Schwarz	NRV-Z4	3815	-	TU

Table 28

TU - Traceability Unscheduled



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

VHF490, S/N: Not Serialised (75938884-TSR-0001) - Modification State 0

2.5.3 Date of Test

18-September-2017

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 testing any anomalies in the equipment under tests performance was recorded.

2.5.5 Environmental Conditions

Ambient Temperature 20.0 - 21.0 °C
 Relative Humidity 56.0 %

2.5.6 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 29

2.5.7 Test Results

Results for Configuration and Mode: 13.8V DC Powered - Transmit.

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 Cable	0	13.8	0	60	Pass PC C

Table 30

Results for Configuration and Mode: 13.8V DC Powered - Receive.

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
13.8V DC Line	0	13.8	0	60	Pass PC C
DC Power Cable	0	13.8	0	60	Pass PC C

Table 31

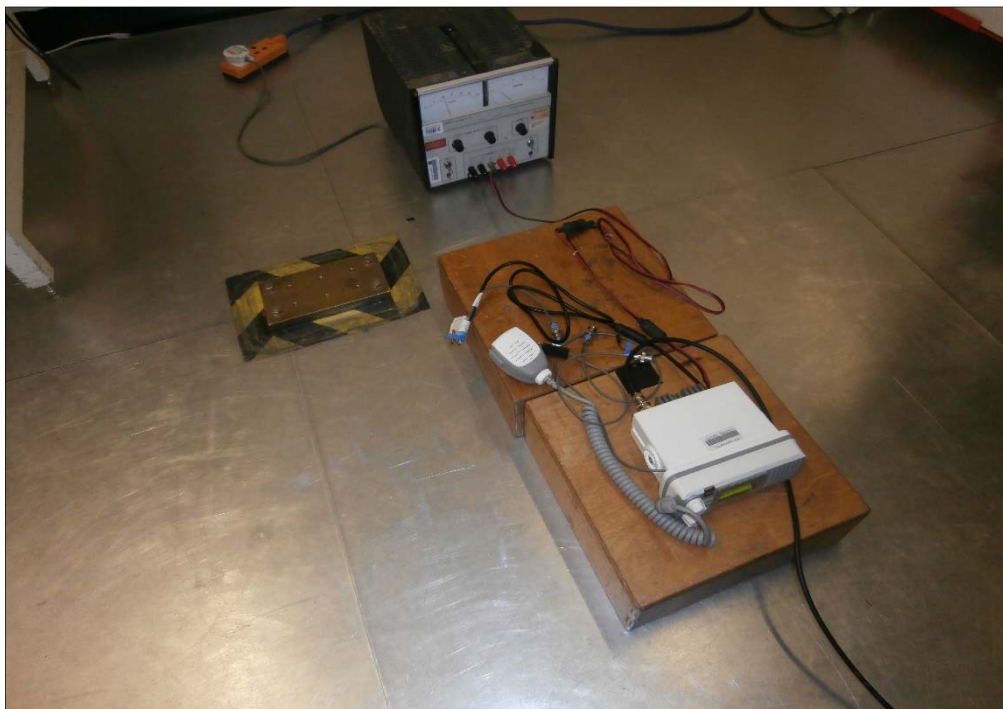


Figure 13 - Test Setup



2.5.8 Test Location and Test Equipment Used

This test was carried out in EMC Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
30V/5A Power Supply	Farnell	L30-5	191	-	O/P Mon
Handheld Digital Multimeter	Agilent Technologies	U1241A	3625	12	30-Sep-2017

Table 32

O/P Mon – Output Monitored using calibrated equipment



2.6 Immunity to Electrostatic Discharge

2.6.1 Specification Reference

IEC 60945, Clause 10.9

2.6.2 Equipment Under Test and Modification State

VHF490, S/N: Not Serialised (75938884-TSR-0001) - Modification State 0

2.6.3 Date of Test

20-September-2017

2.6.4 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 repartition rate.

During testing any anomalies in the equipment under tests performance was recorded.

2.6.5 Environmental Conditions

Ambient Temperature 19.0 °C
 Relative Humidity 54.0 %

2.6.6 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 33



2.6.7 Test Results

Results for Configuration and Mode: 13.8V DC Powered - Transmit.

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
Vertical Coupling Plane	Contact	✓	✓	✓	✓	✓	✓	N/A	N/A	N/A	N/A
Contact Discharge Points	Contact	✓	✓	✓	✓	✓	✓	N/A	N/A	N/A	N/A
Air Discharge Points	Air	✓*	✓*	✓*	✓*	N/A	N/A	✓*	✓*	N/A	N/A

Table 34

Results for Configuration and Mode: 13.8V DC Powered - Receive.

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
Vertical Coupling Plane	Contact	✓	✓	✓	✓	✓	✓	N/A	N/A	N/A	N/A
Contact Discharge Points	Contact	✓	✓	✓	✓	✓	✓	N/A	N/A	N/A	N/A
Air Discharge Points	Air	✓*	✓*	✓*	✓*	N/A	N/A	✓*	✓*	N/A	N/A

Table 35

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 36



Figure 14 - Test Positions

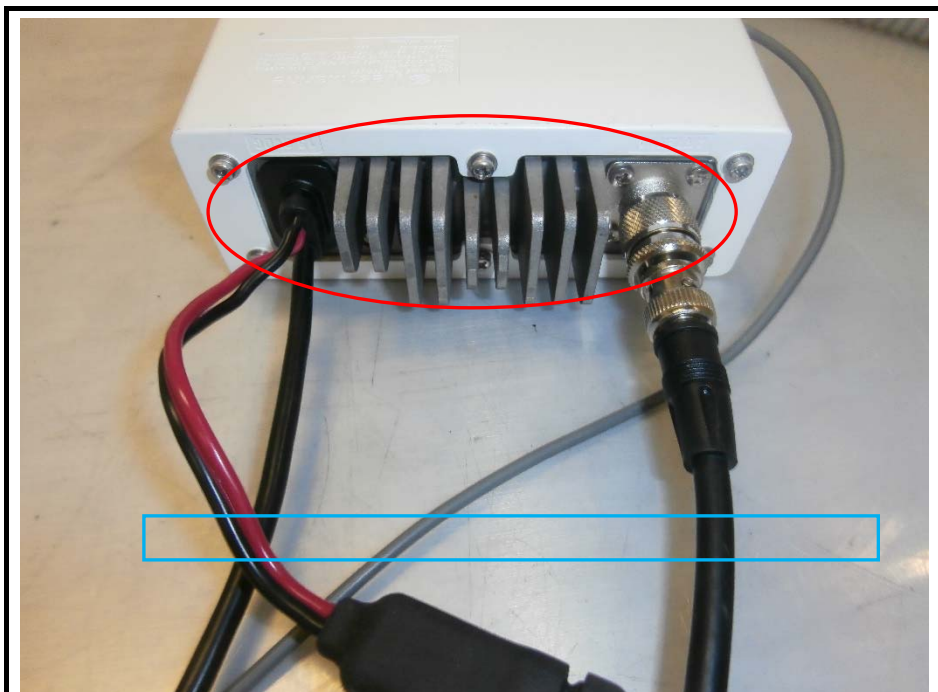


Figure 15 - Test Positions



Figure 16 - Test Positions



Figure 17 - Test Positions



Product Service

2.6.8 Test Location and Test Equipment Used

This test was carried out in EMC Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
ESD Generator	Schloder	SESD 30000	4724	12	28-Apr-2018

Table 37



2.7 Compass Safe Distance

2.7.1 Specification Reference

IEC 60945, Clause 11.2

2.7.2 Equipment Under Test and Modification State

VHF490, S/N: Not Serialised (75938884-TSR-0001) - Modification State 0

2.7.3 Date of Test

18-September-2017

2.7.4 Test Method

The test was applied in accordance with the test method requirements of IEC 60945.

2.7.5 Environmental Conditions

Ambient Temperature 22.0 °C

Relative Humidity 58.0 %

2.7.6 Test Results

Results for Configuration and Mode: 13.8V DC Powered - Powered.

Standard Compass safe distance (mm)	550
Emergency Compass safe distance (mm)	400

Table 38

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	520	340	460	350	440	360
Top	290	160	240	230	290	220
Left Hand Side	340	200	210	160	200	160
Right Hand Side	280	160	220	160	250	160
Underside	160	160	160	160	220	190
Rear	420	270	360	200	340	180

Table 39



Figure 18

2.7.7 Test Location and Test Equipment Used

This test was carried out in EMC Open Area Test Site.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
30V/5A Power Supply	Farnell	L30-5	191	-	O/P Mon
DC Power Supply	Hewlett Packard	6269B	326	-	TU
Sussex Helmholtz Coil	Various	88771	327	-	TU
Magnetometer	Bartington	MAG01	671	36	24-Feb-2018
Handheld Digital Multimeter	Agilent Technologies	U1241A	3625	12	30-Sep-2017
Marine Binacle Compass with Repeater Display	Cassens & Plath	Compass: Type 11	3834	-	TU

Table 40

TU - Traceability Unscheduled

O/P Mon – Output Monitored using calibrated equipment



3 Test Equipment Information

3.1 General Test Equipment Used

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Audio Analyser	Hewlett Packard	8903B	44	12	23-May-2018
Signal Generator	Marconi	2031	53	12	28-Nov-2017
Digital Time Analyser	Marconi	2850-BS	80	-	TU
30V/5A Power Supply	Farnell	L30-5	191	-	O/P Mon
Amplifier (Acoustic Power)	Bruel & Kjaer	2706	249	-	TU
Attenuator (10dB)	Weinschel	45-10-43	509	12	21-Oct-2017
Modulation Analyser	Hewlett Packard	8901B	557	12	13-Dec-2017
2 Channel Variable Audio Filter	Kemo	Benchmark VBF813	1662	12	1-Aug-2018
20dB Attenuator	Weinschel	45-20-43	4321	12	28-Jun-2018

Table 41

TU – Traceability Unscheduled

O/P Mon – Output Monitored using calibrated equipment



4 Incident Reports

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

Report Serial No	IR05 Serial No 75938884 IR05 issue 1
Date of issue	20 September 2017
Applicable test	Immunity to Radiated Frequencies (Enclosure Port).
Report Serial No	IR06 Serial No 75938884 IR05 issue 1
Date of issue	20 September 2017
Applicable test	Immunity to Conducted Radio Frequency Disturbance (Power Port, Signal and Control Ports)



5 Measurement Uncertainty

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

Test Name	Measurement Uncertainty
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	Not Known
Immunity to radiated radiofrequencies	10 MHz to 6 GHz Test Amplitude ±2.0 dB
Radiated emissions	30 MHz to 1 GHz, Bilog Antenna, ±5.2 dB 1 GHz to 40 GHz, Horn Antenna, ±6.3 dB

Table 42

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



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ANNEX A

MANUFACTURERS DECLARED INFORMATION



REFERENCE INFORMATION FOR THE EXHIBIT

IEC 62238:2003-03 “11.1.3 Immunity to electromagnetic environment” states: “Tests for immunity to electromagnetic environment (conducted, radiated or transient) as applicable shall be performed as specified in IEC 60945.” IEC 60945:200208 “10 Immunity to electromagnetic environment – Methods of testing and required test results” contains the applicable tests. “10.4 Immunity to radiated radiofrequencies (all equipment categories except portable)” contains the applicable radiated immunity tests. “10.4.3 Required result” states: “The requirements of the EMC performance check shall be met during and after the test in accordance with the performance criterion A, as described in 10.1.” Clause “10 Immunity to electromagnetic environment – Methods of testing and required test results” contains subclause “10.1 General” which includes the following statement:

“For these tests the EUT shall conform to its normal operational configuration, mounting and earthing arrangements, unless otherwise stated, and shall operate under normal test conditions.

Particular interfaces of the EUT with the external electromagnetic environment are referred to as ports. The physical boundary of the EUT through which electromagnetic fields may radiate or impinge is the enclosure port (figure 1).”

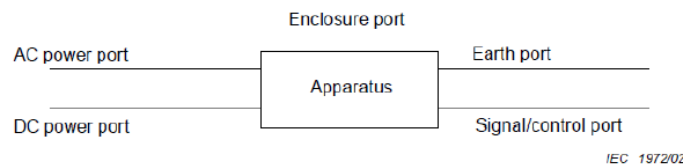


Figure 1 – Examples of ports referred to in electromagnetic emission and immunity tests

Furthermore, subclause 10.1 also states: “Conditions and tests are summarized in table 6 below...”and Table 6 in the row for “Radiated disturbance (10.4)” specifies the “Enclosure port”.

Table 6 – Electromagnetic immunity

	Portable	Protected	Exposed	Submerged
Conducted radio frequency disturbance (10.3)	*	3 V r.m.s. e.m.f. 150 kHz – 80 MHz, 10 V r.m.s. e.m.f. at specified spot frequencies. a.c. and d.c. power ports, signal and control ports, common mode. Performance criterion A.		
Radiated disturbance (10.4)		10 V/m 80 MHz – 2 GHz Enclosure port Performance criterion A		*
Fast transients (bursts) (10.5)	*	2 kV differential on a.c. power ports 1 kV common mode on signal and control ports Performance criterion B		
Slow transients (surges)(10.6)	*	1 kV line/earth, 0.5 kV line/line AC power ports Performance criterion B		
Power supply short term variation (10.7)	*	± 20 % voltage for 1.5 s, ± 10 % frequency for 5 s AC power ports Performance criterion B		
Power supply failure (10.8)	*	60 s interruption a.c. and d.c. power ports Performance criterion C		
Electrostatic discharge (10.9)		6 kV contact 8 kV air Performance criterion B		*
* Not applicable				



Product Service

EXHIBIT STATEMENTS

1. The VHF490 was tested in its normal operational configuration for receive radiated immunity in voice mode and was found to be compliant.
2. The VHF490 was also tested with a special test port added for receive radiated immunity in DSC mode and was declared to be noncompliant.
3. The DSC mode testing was not valid for two reasons:
 - 1) the added test port itself acted as an additional location for the electromagnetic fields to impinge
 - 2) adding the test port resulted in the EUT no longer conforming to its normal operational configuration as required by the standard
4. In receive mode, the VHF490 uses the same circuit for both voice and DSC. Therefore, the voice mode test in the normal operational configuration is adequate proof that the VHF490 is compliant with the receive radiated immunity requirements.