TECHNICAL REPORT

KONGSBERG SEATEX AS

TYPE TESTING OF SEATEX AIS 100 TRANSPONDER

REPORT NO. 2002-3207

REVISION NO. 03

DET NORSKE VERITAS

TECHNICAL REPORT

Date of first issue: 2002-05-21	Project No.: 420 10366
Approved by: Per Ove Øyberg, Head of Section	Organisational unit: Testing, Product & Pers. Certification
Client: Kongsberg Seatex AS	Client ref.: Sigfred Avdal

DET NORSKE VERITAS CERTIFICATION AS

Testing, Product & Pers. Certification

Veritasveien 1
N-1322 HØVIK Norway
Tel: +47 67 57 99 00
Fax: +47 67 57 89 60
http://www.dnv.com
Org. No: NO 959 627 606 MVA

Summary:

An Universal Automatic Identification System, Type Seatex AIS 100 manufactured by Kongsberg Seatex AS, has been EMC and environmentally tested in accordance with relevant parts of the following standard:

EN 60945 (Jan. 1997): Maritime navigation and radio communication equipment and systems - General requirements - Methods of testing and required test results (IEC 60945: 1996)

The purpose of the testing was to verify compliance with requirements stated in the EU "Council Directive 96/98/EC on Marine Equipment".

Test results:

The Universal Automatic Identification System, Type Seatex AIS 100 passed all the tests.

Rev 3:

Correction of the text in chapters 7.1.2 and 7.1.3.

Report No.: **2002-3207**	Subject Group: R1
Report title: Type testing of Seatex AIS 100 Transponder	
Work carried out by: Steinar Andersen	
Work verified by: Per Gulbrandsen	
Date of this revision: 2003-02-04	Rev. No.: 03 / Number of pages: 22

Indexing terms

Navigational aids
Type testing
Electromagnetic compatibility
Environmental testing

☒ No distribution without permission from the client or responsible organisational unit, i.e. free distribution within DNV after 3 years

☐ Strictly confidential

☐ Unrestricted distribution

Table of Content *Page*

1 SCOPE OF WORK

An Universal Automatic Identification System, Type Seatex AIS 100 manufactured by Kongsberg Seatex AS, has been EMC and environmentally tested The in accordance with relevant parts of the following standard:

EN 60945 (Jan. 1997): Maritime navigation and radio communication equipment and systems - General requirements - Methods of testing and required test results (IEC 60945: 1996)

The purpose of the testing was to verify compliance with requirements stated in the EU "Council Directive 96/98/EC on Marine Equipment".

For each test, reference is made to the relevant section or paragraph in the specifications.

2 TEST LABORATORY

The tests were carried out in the Environmental Test Laboratory at Det Norske Veritas, Høvik, Norway.

Laboratory accreditation:

NORSK AKKREDITERING, No. TEST 034
P6 – Electromagnetic Compatibility
P17 – Environmental Testing
According to NS-EN ISO/IEC 17025. Valid through 25.04.2003.

Ambient conditions in the laboratory:

Parameter	**Required (IEC 60068-1)**	**Actual**
Temperature	15 – 35 °C	19.6 - 24.6
Humidity	25 – 75 % RH (30-60 for ESD)	25 - 51
Barometric pressure	860 – 1060 mbar	994 - 1034

For details about the test facilities and instruments used, see Chapter 9.

3 TEST PERIOD

The tests were carried out during the time period 8 March to 21 June 2002.

4 ATTENDING REPRESENTATIVES

The following client representatives were partly present during the testing and took part in the performance testing:

- Sigfred Avdal
- Martin Stensby

5 EQUIPMENT UNDER TEST

5.1 General description

The main function of the Seatex AIS 100 Transponder is to communicate vessel position, speed and course over ground and ship related data in broadcast mode to other vessels equipped with AIS transponders. The position is derived from the GPS receiver of the vessel and is transmitted by the transponders integral VHF transmitter.

5.2 Equipment submitted for tests

A test system assembly comprising of the following units was submitted for test.

Unit No.	Description	Type	Part no.	Category
1	AIS main unit	AIS 100	A100-20	Protected
2 (See note below)	Display unit	AIS-MKD	A100-21 (20212676)	Exposed
3	Connection box	AIS-COB	A130-19	Portable

The above will from now on be referred to as **EUT** (**E**quipment **U**nder **T**est).

Note:

The display unit used in the AIS 100 system is a SIMRAD EGERSUND AS, Automatic Identification Display Unit, Type AIS MIN DISPLAY/KBD, Part no. 20212676. The display unit is fitted with software for the AIS 100 application. Otherwise, the display is mechanically and electrically identical to the unit tested in accordance with EN 60945: 1996-11, third edition with reference to Det Norske Veritas test report No. 2002-3131 and The EC Declaration of Conformity issued by Simrad Egersund AS.

The following tests of the Display Unit are considered covered by the testing carried out with reference to the above documentation and thus not performed during the testing covered by this report:

- Vibration
- Corrosion (salt mist)
- Conducted radio-frequency interferences
- Fast transients (bursts)
- Electrostatic discharge
- Compass safe distance

5.3 Test configuration

The following Auxiliary equipment (AE) was used in order to operate and function test the system:

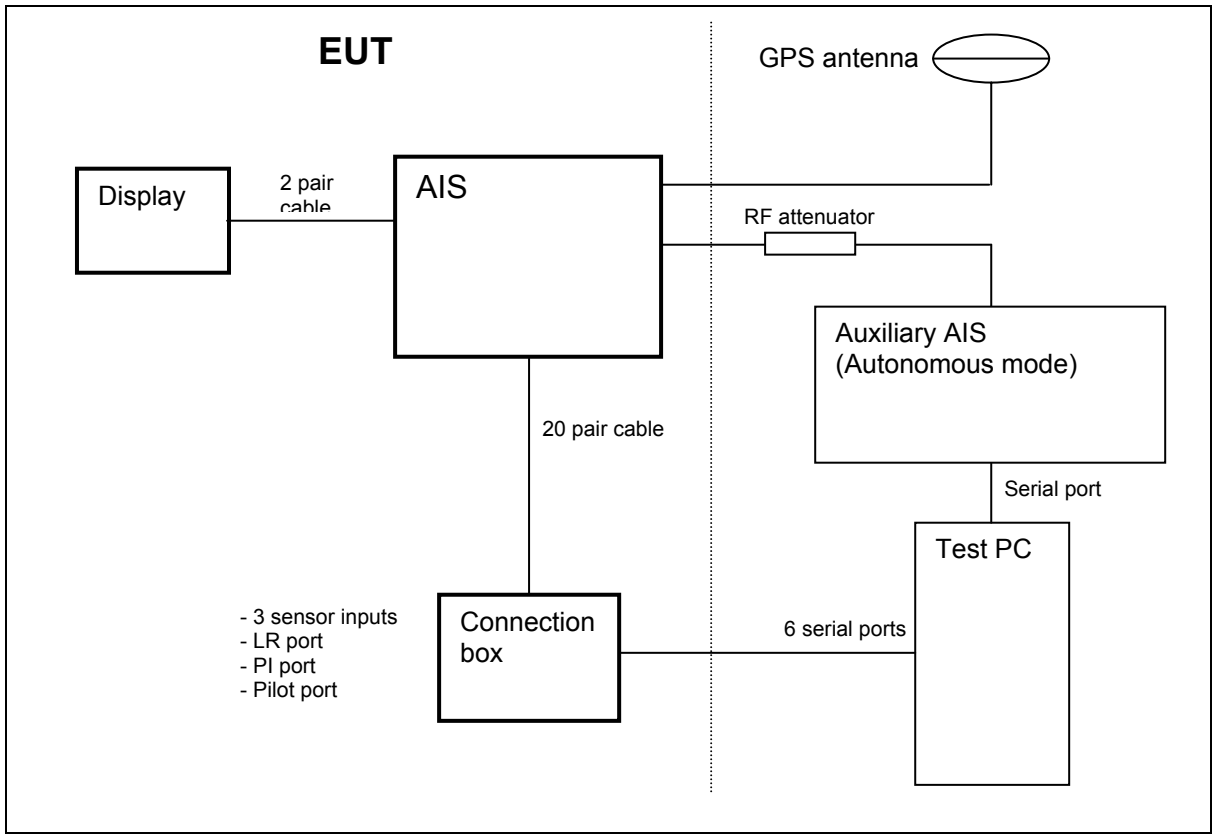
AE No.	Description
1	Auxiliary AIS (Autonomous mode)
2	RF attenuator
3	Test PC
4	GPS antenna

The following input/output power and signal ports were identified as relevant for EMC testing:

Port No.	Unit No.	Description	Cable/Termination
1	1	Output to display unit	2 pair shielded / D-sub conn.
2	1	VHF transmitter output	Coaxial / TNC connector
3	1	Multipair cable input	20 pair / Plug
4	1	GPS antenna input	Coaxial / N connector

All items of the test system were interconnected by screened cable corresponding to the manufacturer specification for a normal installation.

Test set-up:



Test set-up for operation and monitoring of the EUT. Coupling networks and cabling modifications were applied as required to perform the tests according to the relevant standards.

5.4 Modes of operation

The testing was carried out with the EUT powered by 24 VDC.

Test mode:
The system is configured with reference to IEC 61993-2, Ed1 : Chapter 10.3, Standard test environment, and Chapter 13, EMC tests.

The auxiliary AIS unit simulates 5 targets. For the test purpose the radio signals are transmitted from EUT to auxiliary unit through a coaxial cable with an attenuator inserted.
A specific test program running on the test PC monitors and logs the data on the serial ports (IEC 61162-2 compliant), and this program also monitors and logs data sent on the radio channels.

5.5 Modifications during testing

In order to pass the various tests, the EUT was modified as follows:

Unit	Test	Modifications
1 AIS 100	Vibration	• A 3 mm support bar installed between upper and lower PCB rail plates • All PCB rails glued to the base plates
2 Connection box AIS-COB	Conducted emission	• Capacitors 2x 0,47µF added from power leads (+24V, and GND) to chassis in connection box.

6 EVALUATION OF PERFORMANCE DURING THE TESTS

In order to verify correct function of the EUT a test program that was logging and calculating the statistical rate of missing data was run and recorded on the test PC. The following operational parameters were monitored:

- VDL RX (RF)
- VDL TX (RF)
- SENSOR 1 PORT (RS422)
- SENSOR 2 PORT (RS422)
- SENSOR 3 PORT (RS422)
- PILOT PORT (RS422)
- PI PORT (RS422)
- LR PORT (RS422)

6.1 Function testing

For the tests specifying non-operative condition of the EUT, verification of the function was carried out after each test by running the test program for about 15 minutes.

6.2 Performance monitoring

For the tests specifying operative condition of the EUT, verification of the performance was carried out by running the test program continuously during the test period.

6.3 Criteria of acceptance

In order to pass each test, the EUT shall meet the following criteria:

- Perform in compliance with the performance criteria stated in the EN 60945 standard
- Conform with the following manufacturer requirements for maximum allowable missing data transmissions/recordings:

VDL RX:	PER* < 20 %
VDL TX:	PER < 20 %
EUT SENSOR 1 PORT:	BER† $<10^{-5}$
EUT SENSOR 2 PORT:	BER $<10^{-5}$
EUT SENSOR 3 PORT:	BER $<10^{-5}$
EUT PILOT PORT:	BER $<10^{-5}$
EUT PI PORT:	BER $<10^{-5}$
EUT LR PORT:	BER $<10^{-5}$

- Not show signs of other malfunctions

For tests having additional criteria of acceptance, this is described in the relevant Chapters.

* PER: Packet error rate (number derived from IEC 61993-2, Ed1)
† BER: Bite error rate

7 TESTS

7.1 Durability and resistance to environmental conditions

7.1.1 Dry heat

Test specification: IEC 60945, test 8.2.2

Referenced standards:

- IEC 68-2-2, Fourth edition, 1974 + A1, 1993 and A2,1994: Basic environmental testing procedures, Part 2: Tests - Test B: Dry heat.
- IEC 68-2-48, First edition, 1982: Tests – Guidance on the application of the tests of IEC publication 68 to simulate the effects of storage

Test particulars, (protected and exposed, functional):

Parameters	**Severity levels**
Temperature	+55 °C
Duration	16 hours

The EUT was placed in the test chamber at room temperature in operative condition and kept switched on during the entire test period. A performance test was carried out at the end of the test temperature period.

Result: The EUT passed the test

7.1.2 Damp heat

Test specification: IEC 60945, test 8.3

Referenced standard: IEC 68-2-30, Second edition, 1980 + A1, 1985: Basic environmental testing procedures, Part 2: Tests - Test Db and guidance: Damp heat, cyclic (12+12-hour cycle)

Test particulars, (protected and exposed, functional):

Parameters	**Severity levels**		
Temperature	Room temp. - +40 ºC	+40 ºC	+40 ºC - room
Duration	3 hours	16 hours	1 hour
Humidity	93 %		

The EUT was placed in the test chamber at room temperature in non-operative condition. Then the temperature and humidity was raised. The EUT was switched on 30 min. after completion of the 16 hour period and kept operating for 2 hours while the temperature and humidity conditions

of the chamber was maintained as specified. A performance test was carried out during this period.

Result: The EUT passed the test

7.1.3 Low temperature

Test specification: IEC 60945, test 8.4.2

Referenced standards:

- IEC 68-2-48, First edition, 1982: Tests – Guidance on the application of the tests of IEC publication 68 to simulate the effects of storage
- IEC 68-2-1, Fifth edition, 1990-04: Environmental testing, Part 2: Tests – Test A: Cold

Test particulars, (protected, functional):

Parameters	**Severity levels**	
Temperature	Functional (protected equip.)	-15 °C
Duration	16 hours	

The EUT was placed in the test chamber at room temperature in non-operative condition. Then the temperature was reduced. The EUT was switched on 30 min. after completion of the 16 hour period and kept operating for 2 hours while the temperature conditions was maintained as specified. A performance test was carried out during this period.

Result: The EUT passed the test

The total uncertainty for this test is as follows:

- Uncertainty of the temperature: $< \pm 1.9$ °C

The uncertainty is calculated in accordance with NAMAS document NIS 80, and is given as 2 standard deviations.

7.1.4 Vibration

Test specification: IEC 60945, test 8.7

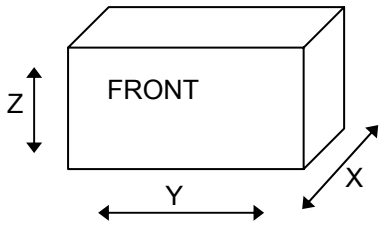
Referenced standard: IEC 68-2-6, Sixth edition, 1995-03: Environmental testing, Part 2: Tests - Tests Fc: Vibration (sinusoidal)

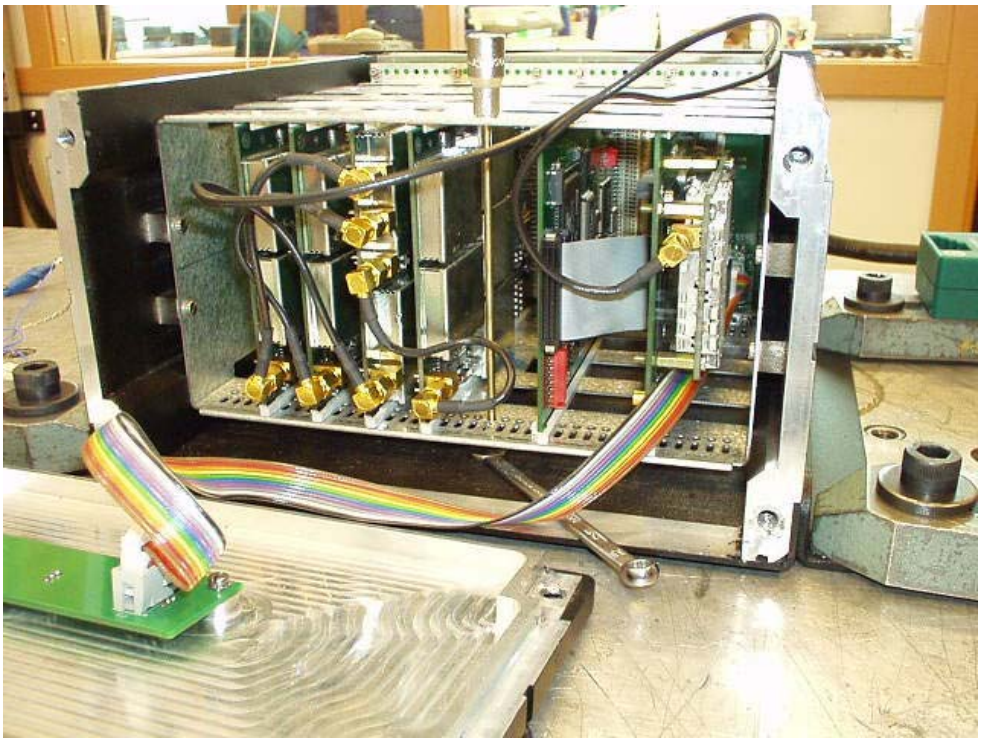
Test particulars, resonance search:

Parameters	**Severity levels**
Frequency range	3-13.2 Hz / 13.2-100 Hz
Displacement/acceleration	±1 mm / 7 m/s^2
Sweep rate	1 oct. per minute

Mounting of EUT items for vibration testing in Z-direction

Vibration direction convention:





AIS main unit during resonance search test

A single sweep resonance search was run along each of the three perpendicular axes.

Based on the resonance search tests, a 2-hour endurance test was carried out at the frequencies and directions where amplification factors above 5 or the highest one were found.

For units or directions where no amplification factor above 5 was found, the endurance test was carried out for 2 hours at 30 Hz.

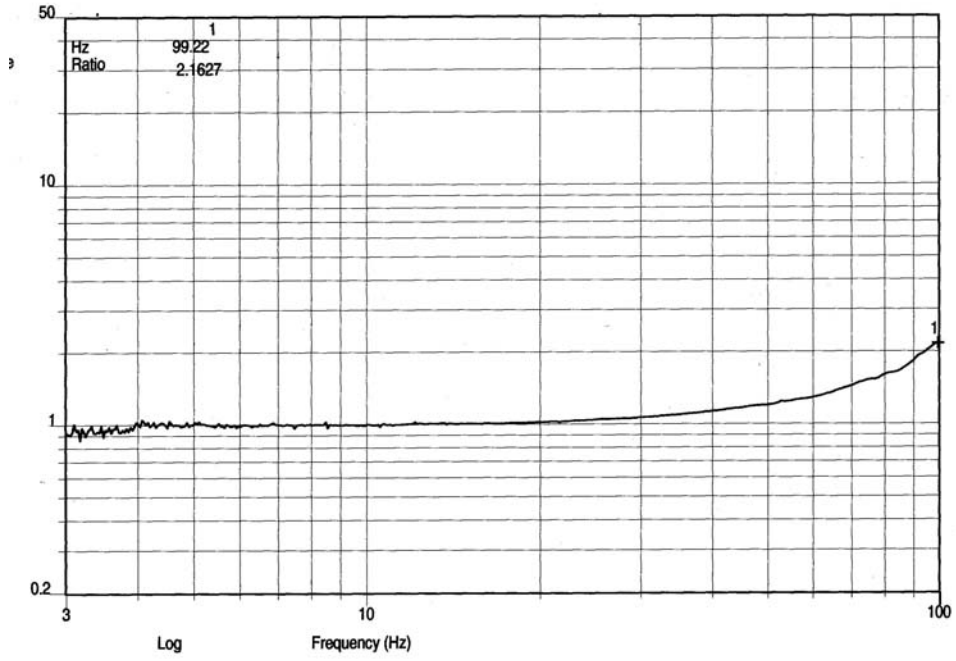
Resonance search test:

Unit	Axes	Measuring Point	Resonance frequency (Hz)	Amp. Factor
1 AIS 100	X	PCB with diodes	100	1.01
		Connector board	100	1.08
		Back-plane	100	1.03
		Conn. between PCBs	99.22	1.08
	Y	GPS- (DSP)	99.22	1.7
		Transmitter PCB, box for splitter/filter	99.22	1.7
		Processor	98.45	2.0
		Receiver PCB #3	98.45	1.4
		Receiver PCB #2	99.22	2.1
		Receiver PCB #1	100	1.4
	Z	Transmitter PCB	99.22	1.98
		Choke on connector board	99.22	0.01

Note:

The EUT unit No. 3, Connection box, does contain standard screw terminals only and was thus considered not relevant for resonance search testing. However, the unit was mounted on the vibration machine together with the AIS 100 main unit and subjected to the same endurance test.

Typical resonance search results:



Response measured on Processor, Y direction

Endurance tests were performed at the following levels:

Axes	Frequency	Level
X	30	0.7 g
Y	100	0.7 g
Z	100	0.7 g

Result: The EUT passed the test

The total uncertainty for this test is as follows:
- Uncertainty in the vibration amplitude < 5 %

The uncertainty is calculated in accordance with NAMAS document NIS 80, and is given as 2 standard deviations.

7.1.5 Corrosion (salt mist)

Test specification: EN 60945, test 8.12

Referenced standard: IEC 68-2-52

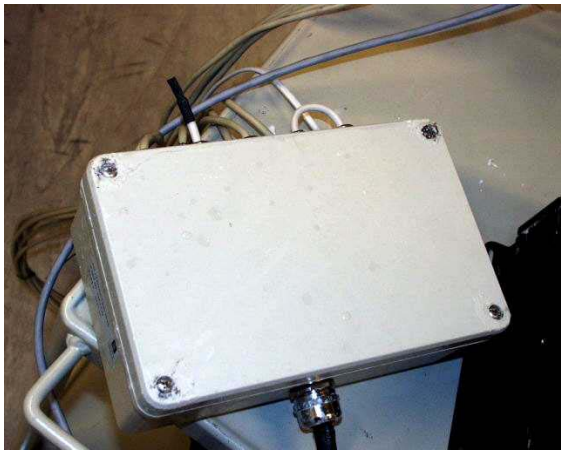
Test characteristics:

The EUT was subjected to a test comprising four spraying periods, each of duration 2 hours, with a storage period of seven days after each.

- Salt solution: 5 ± 1 part NaCl / 95 parts destilled water (by weight)
- Humid storing conditions: 7 days at 40 °C / 90 - 95 % RH

Result: Some corrosion attack and painting peeled off had occurred on vulnerable spots on the enclosure surfaces. The corrosion was assessed to have no impact on the functionality of the EUT.

A full performance test was carried out after completion of the corrosion test. The EUT performed correctly without any sign of malfunction.



Corrosion attack on Connection box

Corrosion attack on AIS main unit

As the equipment is intended for installation and operation in protected environments only, the EUT is deemed to have passed the test.

7.2 Unwanted electromagnetic emission

7.2.1 Conducted emissions

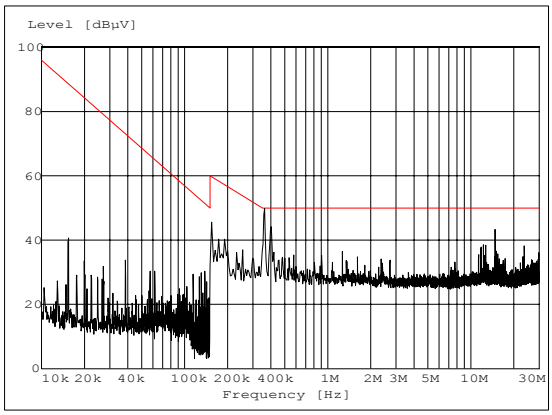
Test specification: EN 60945, test 9.2

Referenced standard: CISPR 16-1, 16-2

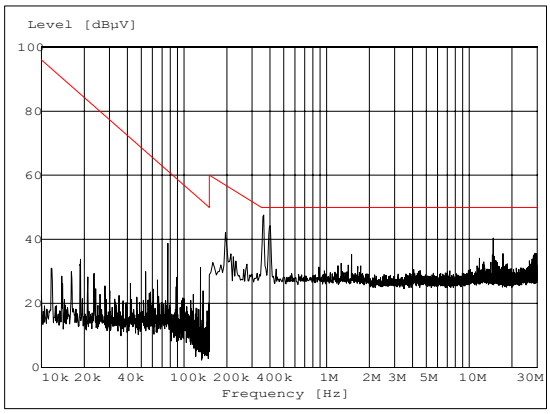
Acceptance criteria:

Frequency range	Limits, quasi-peak
10 - 150 kHz	96 – 50 dBµV
0.15 – 0.35 MHz	60 dBµV – 50 dBµV
0.35 - 30 MHz	50 dBµV

Result: The conducted emission levels are shown below.



+24 VDC power line, peak detection



-24 VDC power line, peak detection

The EUT passed the test

The total uncertainty for this test is as follows:
- Uncertainty in measured values : ±2.3 dB

The uncertainty is calculated in accordance with NAMAS document NIS 81, and is given as 2 standard deviations.

7.2.2 Radiated emissions

Test specification: EN 60945, 9.3

Referenced standard: CISPR 16-1, 16-2

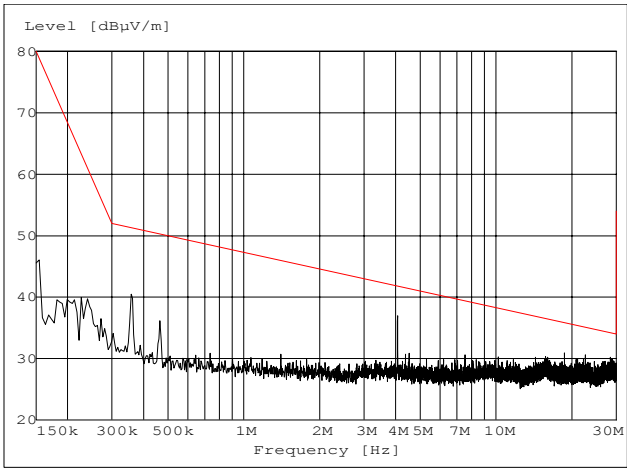
Acceptance criteria:

Frequency range	Limits, quasi-peak at 3 m
150 kHz – 300 kHz	80 – 52 dBµV/m
300 kHz – 30 MHz	52 – 34 dBµV/m
30 – 156 MHz	54 dBµV/m
156 –165 MHz	24 dBµV/m
165 – 1000 MHz	54 dBµV/m

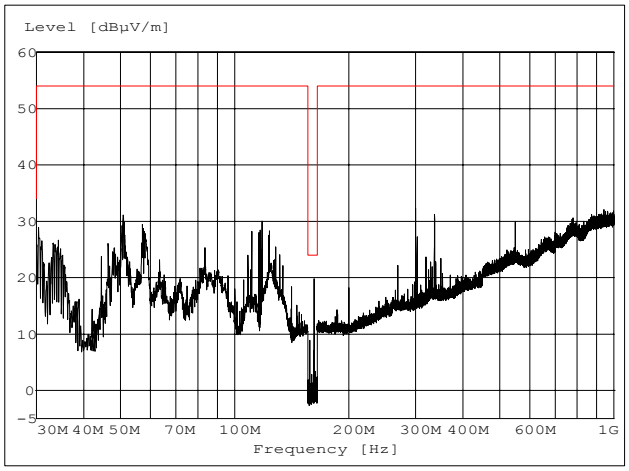
In order to detect the highest emission levels, the tests were carried out with the EUT in varying orientations relative to the antenna and with antenna elevation adjusted between 1 and 4 m. The position of cables was varied to find the condition for maximum emission.

The measurements were performed at all worst case combinations of EUT azimuth orientations, antenna elevation and polarization

Radiated emission from the test assembly:



Maximum radiated emission
150 kHz - 30 MHz, max-peak detection



Maximum radiated emission
30MHz - 1GHz, max-peak detection

Result: The EUT passed the test

The total uncertainty for this test is as follows:

- Uncertainty in measured values (30-600MHz, vertical polarization): ±5.5 dB
- Uncertainty in measured values (30-200MHz, horizontal polarization): ±3.5 dB

The uncertainty is calculated in accordance with NAMAS document NIS 81, and is given as 2 standard deviations.
Reference: DNV Test laboratory, Procedure for Equipment and Services, No 16.3.6, date 01.07.31

7.3 Immunity to electromagnetic environment

7.3.1 Conducted low frequency interference

Test specification: EN 60945, test 10.2

Test characteristics for 24 VDC supply lines:

Parameters	**Severity levels**
Frequency	50 Hz - 10 kHz
Amplitude	3 Vrms, max 2 W
Sweep rate	$\leq 1.5 \times 10^{-3}$ dec/s

Result: The EUT passed the test

7.3.2 Conducted radio frequency interferences

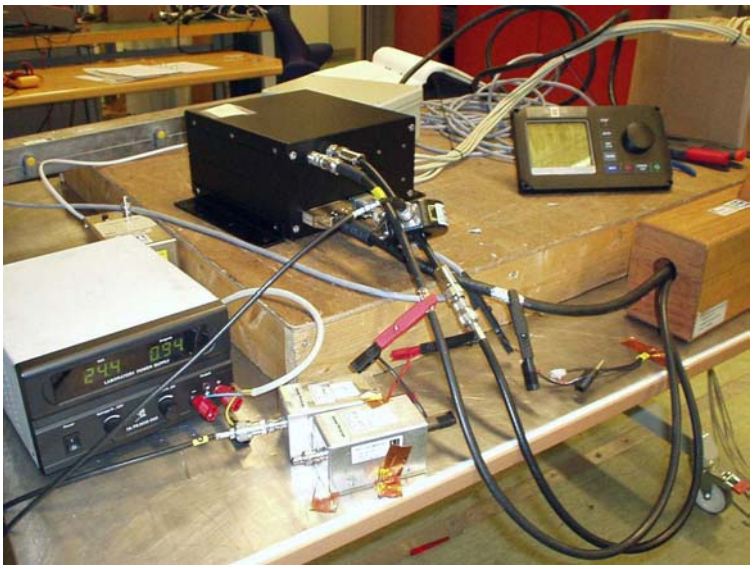
Test specification: EN 60945, test 10.3

Referenced standard: IEC 1000-4-6

Test characteristics:

Parameters	**Severity levels**
Frequency	0.01-80 MHz
Amplitude	3 Vrms
Modulation	80% AM, 0.4 kHz
Sweep rate	$\leq 1.5 \times 10^{-3}$ dec./s
No. of sweeps	1

As the equipment may be installed on bridge or open deck area, the EUT was tested at the following spot frequencies at 10 Vrms, 80 % AM / 400 Hz: 2 – 3 – 4 – 6.2 – 8.2 – 12.6 – 16.5 – 18.8 – 22 and 25 MHz.



Set-up for conducted RF immunity testing

Result: The EUT passed the test

The total uncertainty for this test is as follows:

- Uncertainty in applied voltage: ±2.55 dB

The uncertainty is calculated in accordance with NAMAS document NIS 81, and is given as 2 standard deviations.

7.3.3 Radiated interferences

Test specification: EN 60945, test 10.4

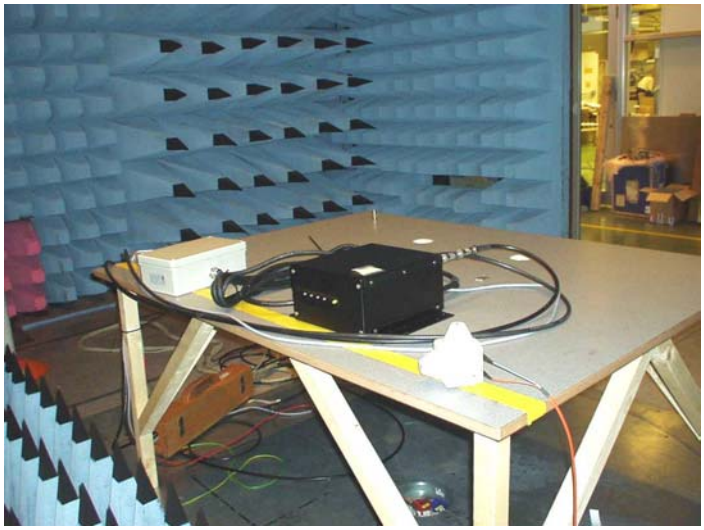
Referenced standard: IEC 1000-4-3

Test characteristics:

Parameters	**Severity levels**
Frequency	80-1000 MHz
Field strength	10 V/m
Modulation	80% AM, 0.4 kHz
Sweep rate	$1.5x10^{-3}$ decade/s
Number of sweeps	1

The distance between the antenna and the calibrated field area was 3 m for the 80 – 1000 MHz frequency range.

EUT during radiated electromagnetic field immunity testing:



EUT set-up for radiated interference testing

Result: The EUT passed the test

The total uncertainty for this test is as follows:
- Uncertainty in applied field strength (1m antenna distance): -2.2/+2.9 dB
- Uncertainty in applied field strength (3m antenna distance): -2.0/+2.7 dB

The uncertainty is calculated in accordance with NAMAS document NIS 81, and is given as 2 standard deviations.

7.3.4 Fast transients (bursts)

Test specification: EN 60945, test 10.5

Referenced standard: IEC 1000-4-4

Test characteristics for 24 VDC supply terminals:

Parameters	**Severity levels**
Amplitude	± 2 kV
Repetition frequency	5 kHz
Duration	> 5 min per polarity

Test characteristics for signal terminals:

Parameters	**Severity levels**
Amplitude	± 1 kV
Repetition frequency	5 kHz
Duration	> 5 min per polarity

The EUT unit J50 was connected to the ground plane via a separate earth cable.

Result: The EUT passed the test

The total uncertainty for this test is as follows:
- Uncertainty in risetime (10%/90%) in of the pulse: < ± 30%
- Uncertainty in halfwidth (50%/50%) in of the pulse: < ± 30%
- Uncertainty in pulse repetition: < ± 20%
- Uncertainty in the amplitude of the pulse: < ± 10.8%

The uncertainty is calculated in accordance with NAMAS document NIS 81, and is given as 2 standard deviations.

7.3.5 Power supply failure

Test specification: EN 60945, test 10.8

Referenced standard: IEC 1000-4-11

Test characteristics:

Parameters	**Severity levels**
Duration of interruptions	60 s
Number of interruptions	3
Interval between interruptions	1 min

Result: The EUT passed the test

7.3.6 Electrostatic discharge

Test specification: EN 60945, test 10.9

Referenced standard: IEC 1000-4-2

Test characteristics:

Parameters	**Severity levels**
Amplitude	Contact: ±6 kV Air: ±8 kV
Number of discharges	10 per point/polarity
Repetition rate	1 per s

The enclosure of the EUT unit 1 was all metallic and was thus subject to contact discharge only. Additionally, the unit was exposed to the impact of contact discharge against a vertical coupling plane positioned 10 cm from the EUT.

The EUT unit 3, connection box does not containing electronic circuits and was considered not relevant for ESD testing.

Result: The EUT passed the test

The total uncertainty for this test is as follows:

- Uncertainty in risetime (10%/90%) in first peak of the discharge pulse: < ± 17%
- Uncertainty in first peak value of the discharge pulse: < ± 8%
- Uncertainty in the discharge pulse value at 30ns: < ± 30%
- Uncertainty in the discharge pulse value at 60ns: < ± 30%

The uncertainty is calculated in accordance with NAMAS document NIS 81, and is given as 2 standard deviations.

7.4 Special purpose tests

7.4.1 Compass safe distance

Test specification: EN 60945, 11.2

The distance above which the EUT will not cause an unacceptable deviation of a ship's standard and emergency steering compasses was determined. This is defined, corresponding to the following levels of magnetic field:

- Standard steering compass: 0.094 μT
- Emergency compass: 0.314 μT

The EUT units were tested with and without 24 VDC power connected, but no difference was observed.

The EUT was rotated to determine the direction in which it produces the maximum deviation.

The greatest distance obtained under all these conditions is the safe distance. Distances are rounded up to the nearest 5 cm.

Result:

Unit No.	**Description**	**Safe Distance**	
		Standard Compass	**Emergency Compass**
1	AIS main unit	140 cm	90 cm
3	Connection box	50 cm	40 cm

8 SUMMARY OF TEST RESULTS

The EUT passed all the tests after implementation of modifications described in Chapter 5.5.

9 TEST FACILITIES AND INSTRUMENTS

Instrument Description	Make	Model	Serial number
Power Amplifier	AR	100A250	20028
Power Amplifier	AR	200W1000M7	12949
Log-periodic antenna	AR	AT1080	17257
Remote control for 200W1000M7	AR	CP3000	18621
Dual Directional Coupler	AR	DC6280M1	14768
Field Monitor	AR	FM2000	12784
Field Strength Probe	AR	FP2000	19064
Bi-log Antenna	Chase	CBL6121A	1019
Active Loop Antenna	Rohde & Schwarz	HFH2-Z2	100024
Personal Computer	Compaq	Prolinea 5150	None
SW for Large EMC room	DNV	EMC_ROOM	NA
SW for radiated immunity testing	DNV	EMC_RUN	NA
SW for conducted RF susceptibilty	DNV	SiGen	NA
Turntable	H. Deisel	DS 420	-
Controller	H. Deisel	HD 100	100/371 Bj:95
Antenna Mast	H. Deisel	MA 240	240/354 Bj:95
ESD Simulator	Compliance Instruments	ESDC 30/ESDP33	7610128/7620128
Coupling/Decoupling Network	Lüthi	CDN801-M2/M3	9450196
Coupling/Decoupling Network	Lüthi	CDN801-S8	9450209
Decoupling Clamp	Fischer Custom Communications, Inc.	FCC-2031-DCN	113
Signal Generator	Marconi	2030	119486-091
Personal Computer	AST	Bravo LC 4/66d	TWC9003762
Artificial Mains Network	EMCO	3825/2	1656
SW for emission testing	Rohde & Schwarz	ES-K1	1026.6790.02
EMI Test Receiver	Rohde & Schwarz	ESAI	825316/009
Signal Generator	Rohde & Schwarz	SMT 03	839441/006
Main Frame (Interference simulator system)	Schaffner	NSG600	211
Fast Transients/Burst Generator	Schaffner	NSG625	207
SW for NSG 600	Schaffner	WIN600	IN5094-068
Surge Voltage Generator	Schaffner	NSG504	341
SW for Surge Voltage Generator, Ver. 1.23	Schaffner	WIN5000	IN2191-008
Personal Computer	Thoshiba	430CDS/1.3	03716614
Semi-anechoic Chamber	Siemens Matsushita Components	NA	NA
Climatic Chamber (1)	Heraeus Vötsch	VUK 06/1000	28310
Salt Mist Chamber	ASCOTT	CC 1000	192
Vibrator	LDS	V 964	SP5555
Vibration control system	Spectral Dynamics	JAGUAR	FW 93530592
Test fixture	LDS	V 964	66 22 1/1
Accelerometer (reference)	KISTLER	8704B100	C 133396
Accelerometer	KISTLER	8732A500	C 137200
Accelerometer	B & K	4507	2195626
Accelerometer	B & K	4507	2195644

- o0o -