TEST REPORT

issued by an Accredited Laboratory

SWEDAC ACKREDITERING
1688
ISO/IEC 17025

Environmental test of R4 AIS transponder

Performed for SAAB TransponderTech AB

Project no.: 237C75 / E700581

Date: 2002-12-19

DELTA Development Technology AB

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DELTA Development Technology AB is a subsidiary company to DELTA Danish Electronics, Light & Acoustics.

DELTA

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REPORT
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Title:	Environmental test of **R4 AIS transponder**
Project No:	237C75 /E700581
Issued to:	SAAB TransponderTech AB SE-581 88 Linköping Sweden
Date of issue:	2002-12-19
Test period:	2002-09-23 to 2002-12-19

Project managers:

Lars Johnsson

Niels Engel

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Ulf Bjerke

Kennet Palm

The results in this report apply only to the sample(s) tested.

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1 SCOPE

This report gives the result of an EMC (Electromagnetic Compatibility) test on R4 AIS transponder.

The abbreviation EUT mentioned in this report stands for Equipment Under Test and is thus equal to R4 transponder.

The purpose of this test was to measure the emission of RF (radio-frequency) electromagnetic fields generated by the EUT and to verify the capability of the EUT to satisfy the requirements of function under influence of electromagnetic interference all in accordance with the test procedures below

Test Procedures:

Emission according to IEC 60945:2002

•Conducted RF emission:	CISPR 16-1 *(1993)*, IEC 60945 *(2002)*
•Radiated RF emission:	CISPR 16-1 *(1993)*, IEC 60945 *(2002)*

Immunity according to IEC 60945:2002

•Dry heat	IEC 60068-2-2:1984 + Amendments
•Damp heat (steady state)	IEC 60068-2-56:1988
•Low temperature (cold)	IEC 60068-2-1:1990 + Amendments
•Vibration (resonance search)	IEC 60068-2-6:1995
•Vibration (random)	IEC 60068-2-64:1993
•Conducted RF voltage:	IEC / EN 61000-4-6 *(1996)*
•Radiated RF field:	IEC / EN 61000-4-3 *(1995)*
•Fast transient/burst:	IEC / EN 61000-4-4 *(1995)*
•Power supply variations	IEC 60945:2002
•Power supply failure	IEC 60945:2002 / IEC 61000-4-11:1994
•Reverse polarity check	IEC 60945:2002
•Electrostatic discharge (ESD):	IEC / EN 61000-4-2 *(1995/96)*

Compass safe distance according to IEC 60945:2002

•Compass safe distance	IEC 60945:2002

2 IDENTIFICATION

General description of the EUT (Equipment Under Test)	The R4 transponder is a vessel transponder for AIS (Automatic Identification System)
EUT: Model	R4 AIS transponder
EUT: Part no	152.20012.001
EUT: Serial no	001002
EUT: Power	24 VDC
EUT: Manufacturer	SAAB TransponderTech AB
Project number	237C75
Client: Code	C75
Client: Company	SAAB TransponderTech AB dept.
Client: Reference	Mikael Pettersson
Test date:	2002-09-23 to 2002-12-19
Test place:	DELTA Västerås
	DELTA Hörsholm

2.1 Modifications incorporated in EUT.

1. Two Y capacitors on the power supply module were changed from 2,2 nF to 68 nF. (AVX SV03AC683KAA)

The modification was done in order to improve the result of Conducted RF emission test.

Tests performed previous to the incorporation of the modification were not repeated. The modification was considered not to have any negative effect of the result of previously performed tests.

2.2 Test sequence for EMC tests.

•Radiated emission. 30 MHz - 1 GHz

•ESD

•Fast transient/ burst.

•Conducted immunity

•Radiated immunity

•Power supply failure/ interruption

•Radiated emission 0.15 MHz - 30 MHz, 1 gHz - 2 GHz.

•Conducted emission

3 SUMMARY OF RESULT

The result of the tests on R4 transponder can be summarized as follows:

Emission	**Port**	**Limits**	**Result [1)]**
Conducted emission	DC power port	limits of IEC 60945	**Passed[2)]**
Radiated emission	Enclosure	limits of IEC 60945	**Passed**

Immunity	**Enclosure port**	**Signal ports**	**24 VDC port**	**Earth ports**	**Result/ Criteria [1)]**
Dry heat	+55^{o} C				**Passed**
Damp heat (steady state)	40^{o} C 93% RH				**Passed**
Low temperature (cold)	-15^{o} C				**Passed**
Vibration (resonance search)	2-13 Hz: ±1.0 mm 13-100 Hz: ±0.7 g				**Passed**
Vibration (random)	2 - 100 Hz, 1G				**Passed**
Conducted RF voltage	-	10 V	10 V	10 V	**Passed /A**
Radiated RF fields	15 V/m	-	-	-	**Passed /A**
Fast transient/ burst	-	1 kV	2 kV	-	**Passed /A**
Power supply variations			+30%, -10% 15 min		**Passed /A**
Power supply failure			-100%, 5 min		**Passed**
Reverse polarity check			5 min		**Passed**
Electrostatic discharge	6 kV contact/ indirect	-	-	-	**Passed /A**

Magnetism	**Port**	**Result [1)]**
Compass safe distance	Enclosure	15 cm for 5.4°/H deviation (Horizontal Magn. Flux of 0.094 uT)
		9 cm for 18°/H deviation (Horizontal Magn. Flux of 0.313 uT)

1) Passed = Complied with the specification.
Failed = Did not comply with the specification. See relevant chapter for details.
Criteria, see chapter 4.5 Criteria for approval.

2) With the modification described in chapter 2.1 implemented.

4 GENERAL TEST SET UP

The R4 transponder (the EUT) is connected to a reference R3 transponder with a coaxial cable, so that they can receive each others VHF signals. A PC is connected to the PSP (Presentation Port) of the EUT and the Config Port of the reference transponder. The operation of the transponders is monitored on this PC with specific software. Thus, it is possible to verify that the VHF telegrams sent by the EUT are received by the reference transponder, and vice versa. Should the tests cause a software restart in the EUT, this will also be displayed on the PC.

A principal connection diagram is shown in the figure below.

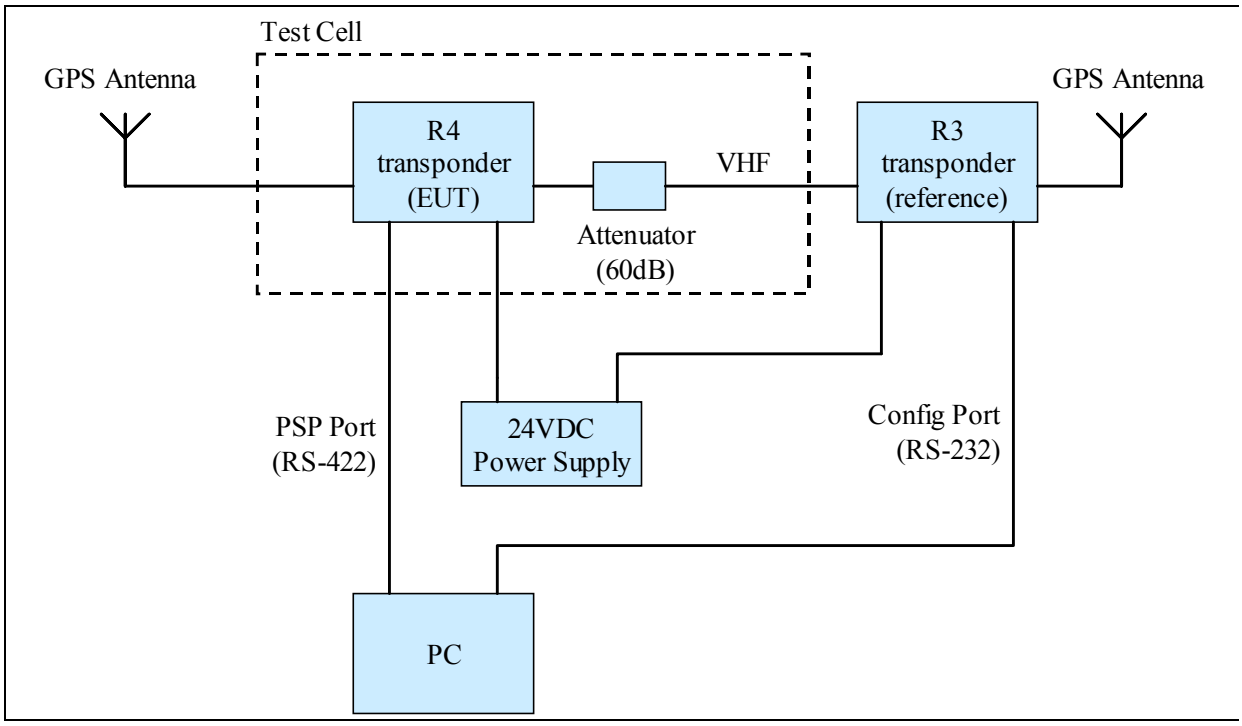


Figure 1 Principal connection diagram of test set up

Photo 1 Left; EUT. Right; Auxiliary equipment (R3 transponder & PC)

4.1 Cables

The following cables were used during the tests.

Port	Type	Data
24 VDC supply	Unscreened	8 x 0.25mm^2
RS422	Screened	
VHF	Coax	
GPS	Coax	

4.2 Peripheral equipment

The following peripheral equipment were used during the tests.

Peripheral equipment	Remarks
R3 AIS transponder	Part no: 7000 00-065 Serial no: 6022
Software AisMon	Ver. 2.0
Software WinConfig	Version 4.12-2002

4.3 EUT operation condition

The EUT was operating in its standard mode, receiving GPS signal, exchanging VHF telegrams with the reference transponder and communicating with the PC connected to the presentation port.

4.4 EUT Performance supervision

The operation of the transponders is monitored on a PC with specific software. Thus, it is possible to verify that the VHF telegrams sent by the EUT are received by the reference transponder, and vice versa. Should the tests cause a software restart in the EUT, this will also be displayed on the PC.

The AisMon software is used to verify that the EUT receives VHF telegrams from the reference transponder. This can be seen in the *User List* window of AisMon
It is also used to verify that there are no software restarts in the EUT during the tests. This can be seen in the *Restart List View* window of AisMon.

The WinConfig program is used to verify that VHF telegrams sent by the EUT are received by the reference transponder. This is achieved by using a feature called *Tx/Rx Log*.

4.5 Criteria for approval.

Performance criteria according to corresponding standard were applied during immunity tests as follows:

General:

The equipment shall not become dangerous or unsafe as a result of the application of the tests.

Performance criterion A:

– The equipment shall continue to operate as intended during the test.
– The EUT shall receive VHF telegrams from the reference transponder with a period of 10 seconds ±10% (normal operation). Occasional transmissions is allowed to fail.
– The reference transponder shall receive VHF telegrams from the EUT. The list should show receptions with a Transponder ID of 1 every 10 seconds ±10% (at least).
– The EUT shall not spontaneously restart.

Performance criterion B:

The equipment shall continue to operate as intended after the test.

– No change of operating state or stored data are allowed.

Performance criterion C:

The equipment is allowed to have temporary degradation or loss of function or performance which requires operator intervention or systems reset.

During continuous radio frequency tests the R4 transponder shall meet performance criterion A, and during transient tests at least criterion B shall be fulfilled.

5 DRY HEAT

This test was performed at DELTA Hörsholm

5.1 Severity and procedure

IEC 60068-2-2 (1974), Test Bd: Dry heat for heat-dissipating specimen with gradual change of temperature, Amendment 1 (1993), Amendment 2 (1994).

The following exposure is performed:

Temperature:	55°C
Duration:	16 hours
Humidity:	Below 50%RH

The test specimen is energized and in normal operational mode during the exposure. During the last hour of the exposure, a functional test is performed. After recovery the functional test is repeated in standard environment.

A functional check at extreme power supply condition is also performed during the last hour of the exposure.

A low temperature retest was performed at DELTA Västerås during which a “channel switching” performance test was carried out on 12,5 and 25 kHz according to IEC61993-2, section 14.7.

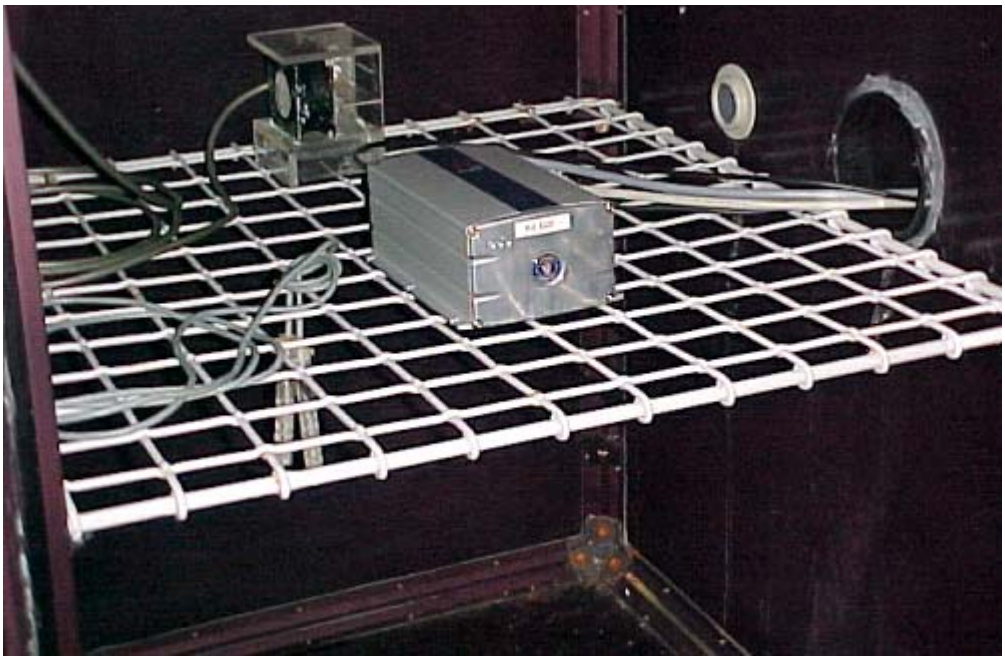


Figure 2 Climatic testing (low temperature, dry heat and damp heat)

5.2 Results

No malfunction was observed during the exposure, and the function of the test specimen was OK during the last hour of the exposure and after recovery.

6 DAMP HEAT (STEADY STATE)

This test was performed at DELTA Hörsholm

6.1 Severity and procedure

IEC 60068-2-56 (1988), Test Cb: Damp heat, steady state, primarily for equipment.

Temperature:	40°C
Humidity:	93%RH
Duration:	16 hours

The test specimen is de-energized during the exposure. However, during the last hour of the exposure the test specimens are energized and a functional test is performed at 40°C and 93%RH.

A visual inspection was performed after the exposure.

6.2 Results

No malfunction was observed during the exposure, and the function of the test specimen was OK during the exposure and after recovery.

No corrosion attack was observed after the exposure.

7 LOW TEMPERATURE (COLD)

This test was performed at DELTA Hörsholm

7.1 Severity and procedure

IEC 60068-2-1 (1990), Test Ad: Cold for heat-dissipating specimen with gradual change of temperature, Amendment 1 (1993), Amendment 2 (1994).

Temperature: -15°C
Duration: 16 hours

The test specimens are de-energized during the exposure. However, during the last hour of the exposure the test specimens are energized and a functional test is performed at -15°C. After recovery a functional test is performed in standard environment.

A functional check at extreme power supply condition is also performed during the last hour of the exposure.

A low temperature retest was performed at DELTA Västerås during which a “channel switching” performance test was carried out on 12,5 and 25 kHz according to IEC61993-2, section 14.7.

Figure 3 Test set up for “channel switching test” during climatic stress.

7.2 Results

No malfunction was observed during the exposure, and the function of the test specimen was OK during the last hour of the exposure and after recovery.

8 VIBRATION - RESONANCE SEARCH

This test was performed at DELTA Hörsholm

8.1 Severity and procedure

IEC 60068-2-6 (1995), Test Fc: Vibration (sinusoidal).

Frequency range:	2-100 Hz		
Frequency/amplitude:	2-13 Hz	:	±1.0 mm
	13-100 Hz	:	±0.7 g
Sweep rate:	Max. 0.5 octave/min.		
Number of axes:	3 mutually perpendicular		

The test specimen is de-energized during the exposure.

During the resonance search, the resonance frequencies are determined by means of stroboscopic light with slow-motion facility and accelerometer measurements of the amplification factors (Q).

Resonance frequencies with an amplification factor above 2 are recorded.

8.2 Results

No amplification factors above 2 were recorded.

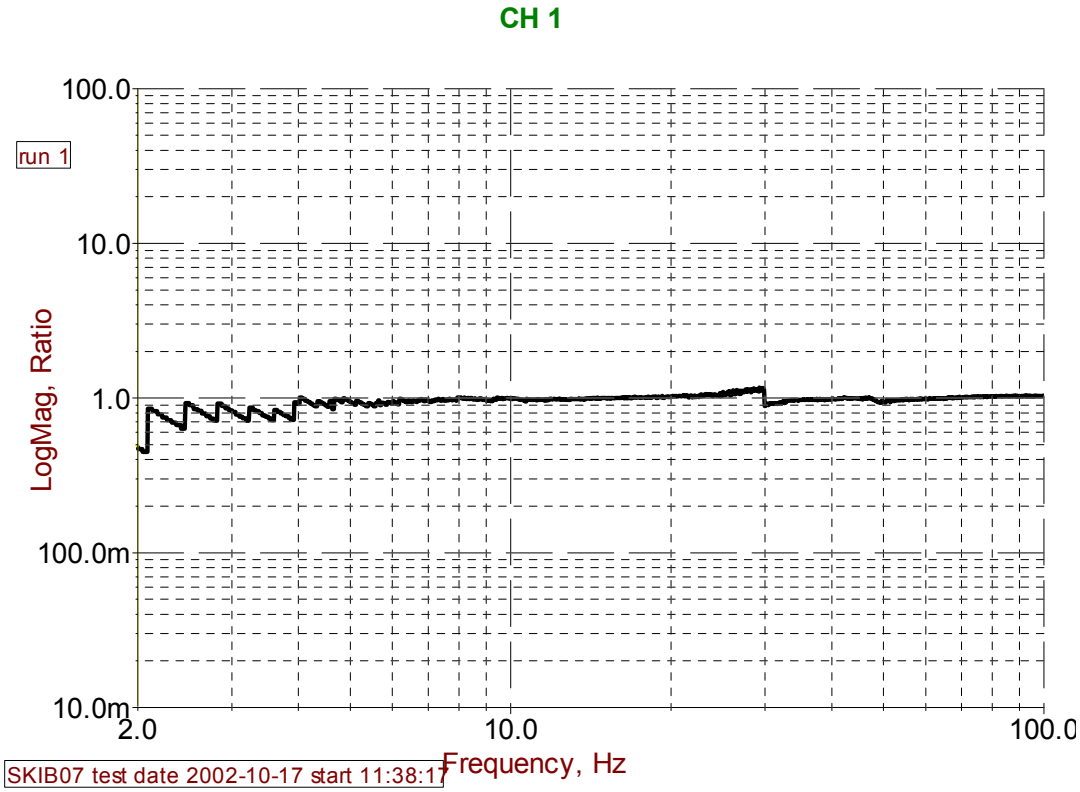


Figure 4 Details of resonance search test – X axis (max. ampl.)

9 VIBRATION – ENDURANCE

This test was performed at DELTA Hörsholm

Specification:

The sinusoidal vibration test according to IEC 60945 is replaced by random vibration test according to Standards for Certification No. 2.4, issued April 2001 by DNV.

This random vibration test will cover the requirements of the sinusoidal vibration test according to IEC 60945.

9.1 Severity and procedure

IEC 60068-2-64 (1993), Test Fh: Vibration, broadband random (digital control).

Frequency range:	2-100 Hz		
Acceleration spectral:	2-13 Hz	:	+12 dB/octave
Density:	13-100 Hz	:	0.011 g^2/Hz
Total RMS level:	1.0 g		
Duration:	150 minutes per axis		
Number of axes:	3 mutually perpendicular		

The test specimen is energized and in normal operational mode during the exposures. A functional test is performed after the exposure in each axis.

A visual inspection is performed after the exposure.

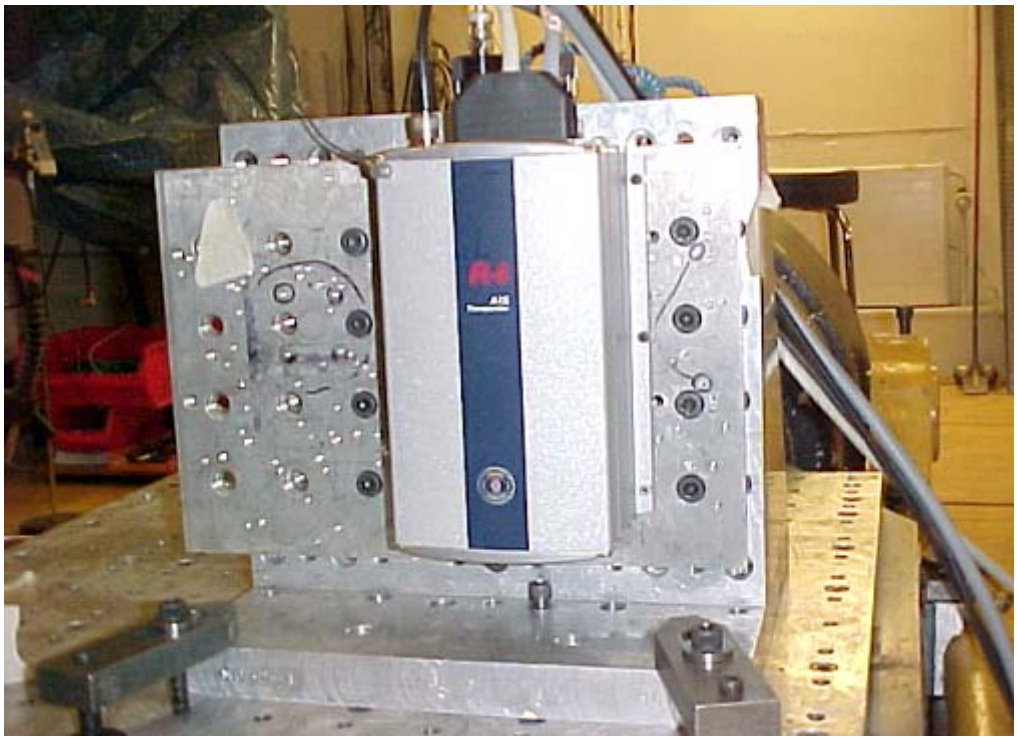


Figure 5 Vibration testing

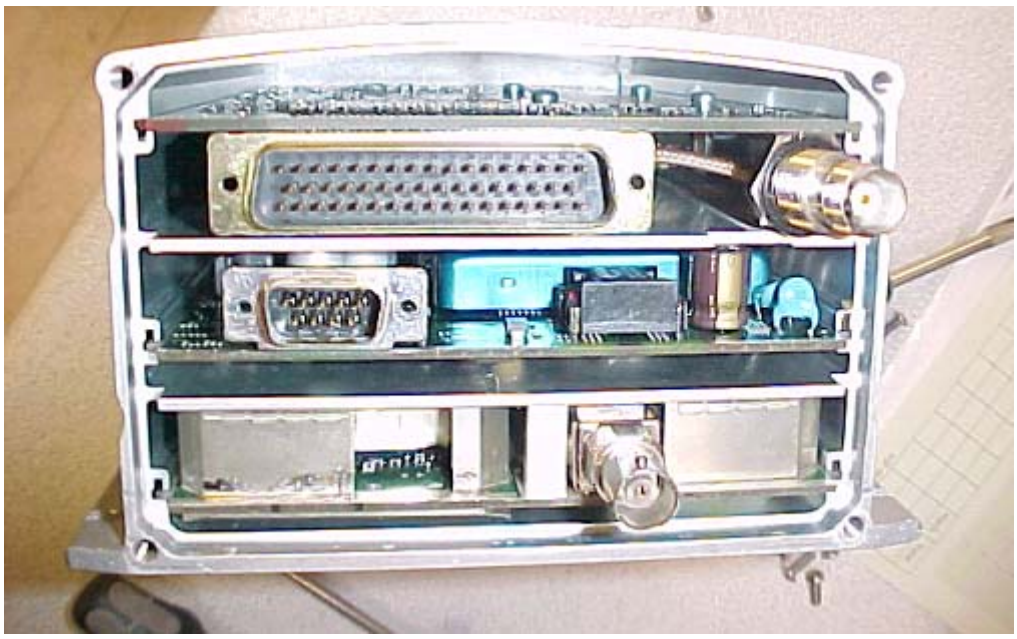


Figure 6 Vibration testing (visual inspection)

9.2 Results

No malfunction was observed during the exposure and the function of the test specimen was OK after the exposure in each axis.

No damage was observed after the exposures.

10 CONDUCTED RADIO FREQUENCY EMISSION TEST

10.1 Test set-up. Conducted RF emission.

The test was carried out in the semi-anechoic chamber with the R4 AIS transponder placed on and bounded to the horizontal ground reference plane.

The R4 transponder was supplied from an artificial mains network (LISN), where also the emission was measured.

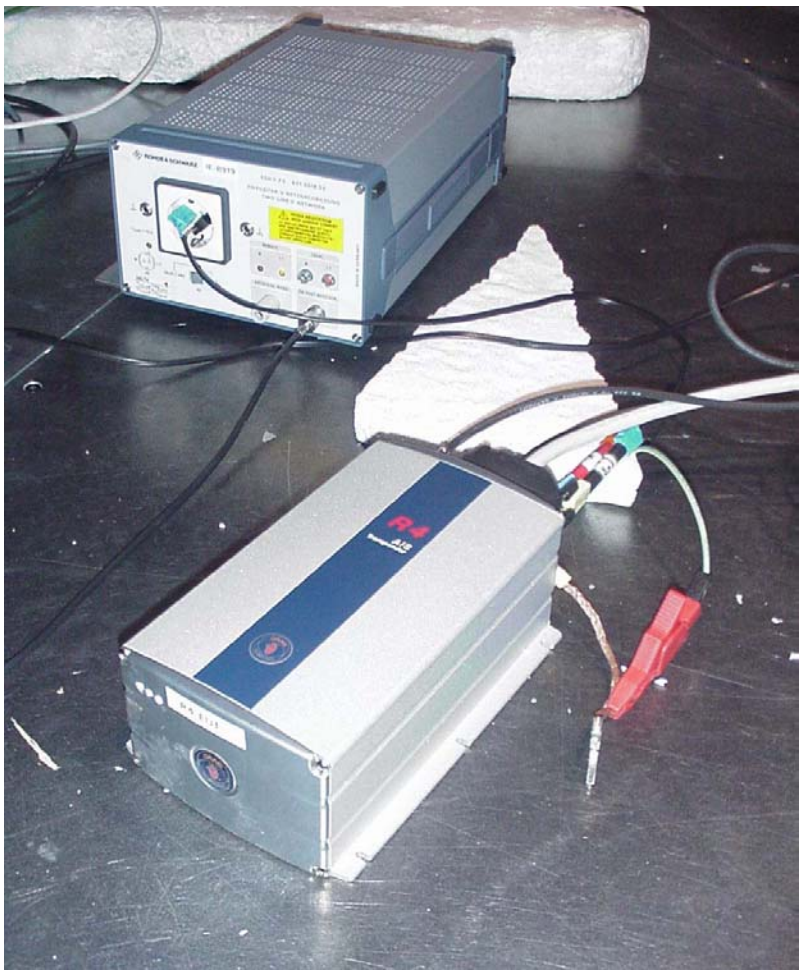


Photo 2 Test set up for conducted RF emission test

10.2 Test result. Conducted RF emission (DC mains)

The test was performed in accordance with:

Standard	IEC 60945
Frequency range:	10 kHz - 30 MHz
Bandwidth:	200 Hz in the frequency range 10 kHz to150 kHz 10 kHz in the frequency range 150 kHz to 30 MHz
Measure time:	5.0 s at quasi-peak measurement else 0.02 s

Limits.

Frequency	**Limit Quasi-peak**
10 kHz – 150 kHz	63 mV – 0,3 mV (96 dBµV – 50 dBµV)
150 kHz – 350 kHz	1 mV – 0,3 mV (60 dBµV – 50 dBµV)
350 kHz – 30 MHz	0,3 mV (50 dBµV)

Table 1 Limits IEC 60945

Climatic conditions during the test:

Temperature	21 ± 3 °C
Relative humidity	43 ± 5%

RESULT: Conducted RF emission:

The plotted result (see figure 7) demonstrates that with the modification described in Chapter 2.1 on page 5, the conducted RF emission from the R4 AIS transponder complies with the limit line for EN 55011 class A equipment.

The measured Quasi-peak values are listed below.

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Line	PE
0.528000	45.80	0.10	50.00	4.20	L1	GND
8.646000	47.10	0.70	50.00	2.90	L1	GND

The measurement uncertainty (with a 95% confidence level) for this test has been calculated to 3.3 dB.

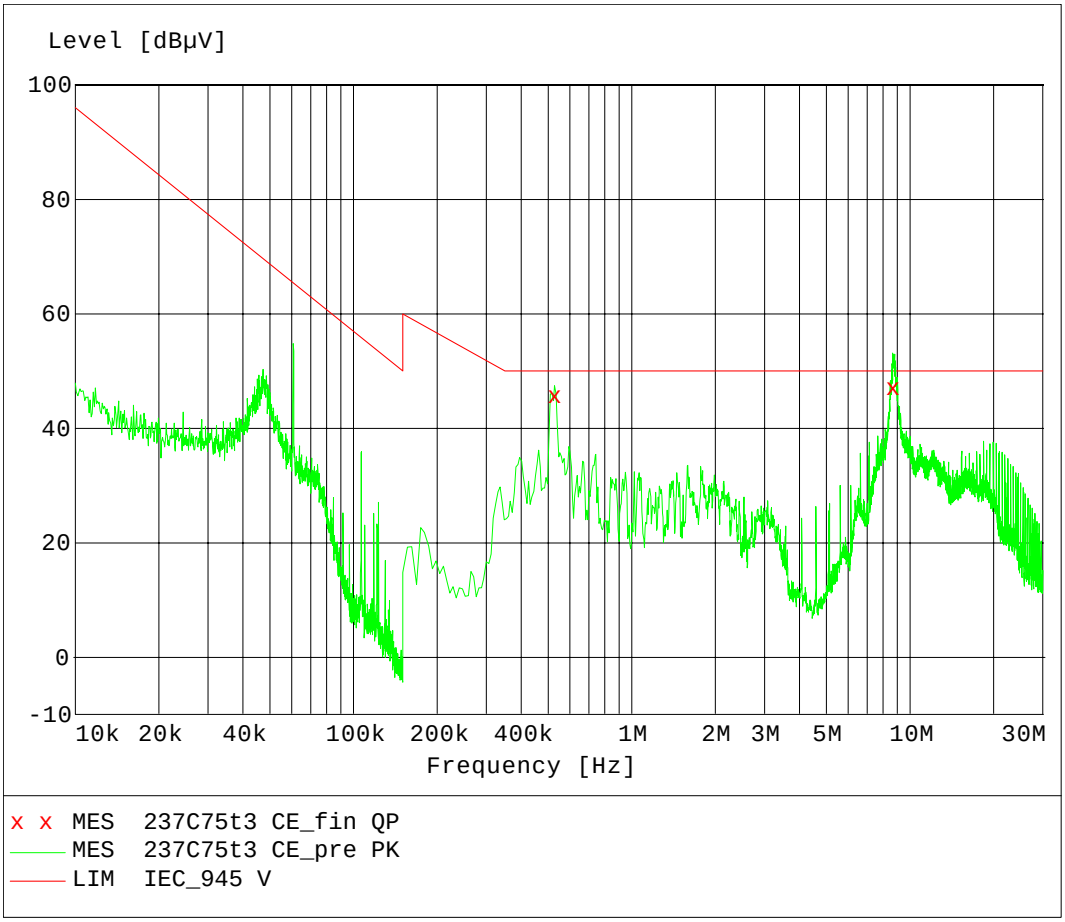


Figure 7 Conducted emission plot.

11 RADIATED RADIO FREQUENCY EMISSION TEST

11.1 Test set-up. Radiated emission.

The test was carried out in a semi-anechoic chamber with the R4 AIS transponder placed on a wooden table 0.8 m above the ground reference plane. It was grounded via a ~1.2 m long cable to the reference groundplane.

The tests in the frequency ranges 0.15 MHz - 30 MHz and 1 GHz - 2 GHz were performed at DELTA Hörsholm.

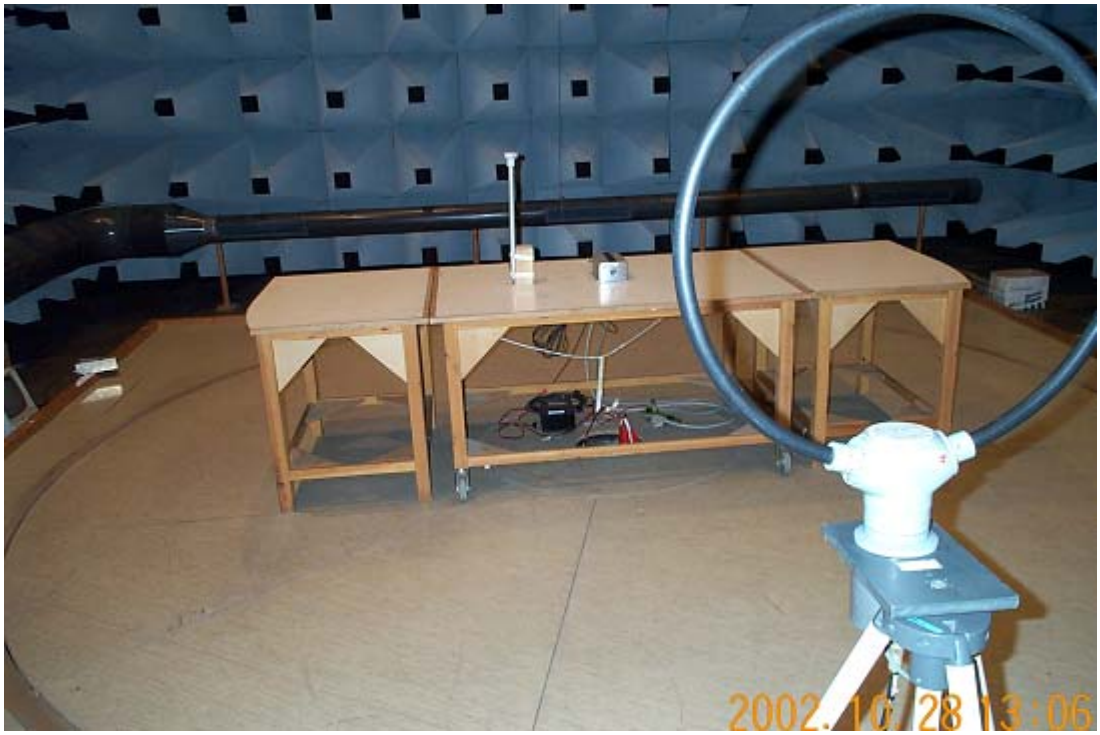


Photo 3 Test set up for radiated RF emission test. 0.15 MHz - 30 MHz

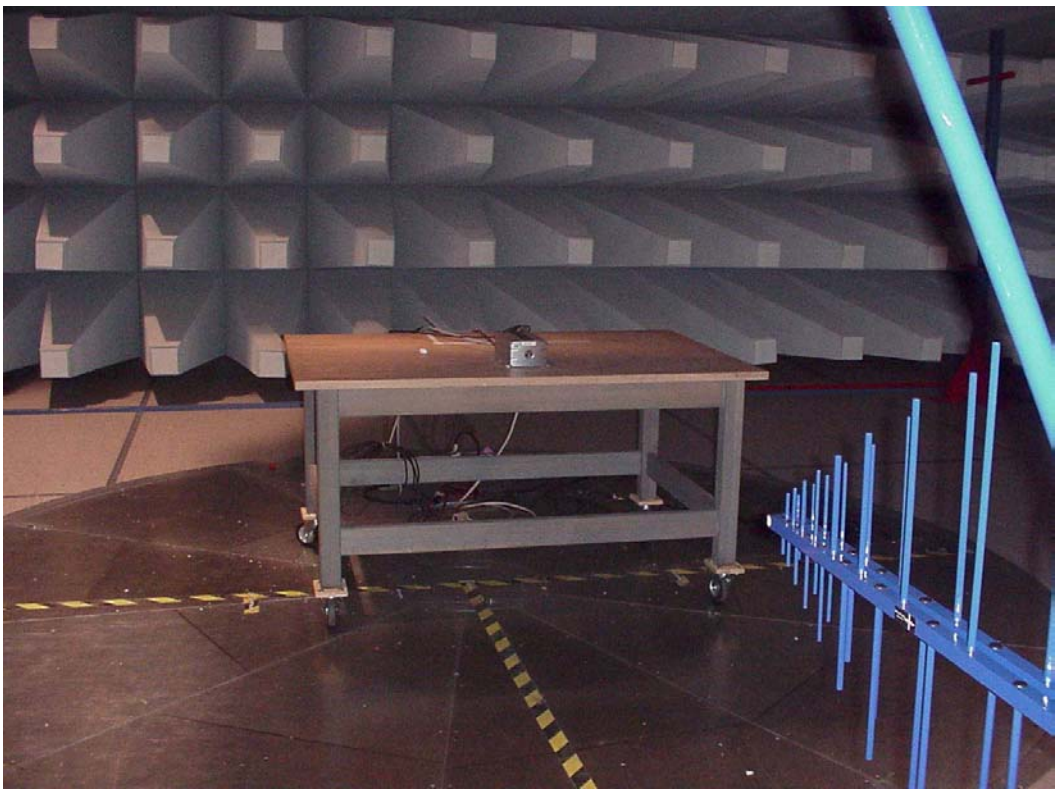


Photo 4 Test set up for radiated RF emission test. 30 - 1000 MHz

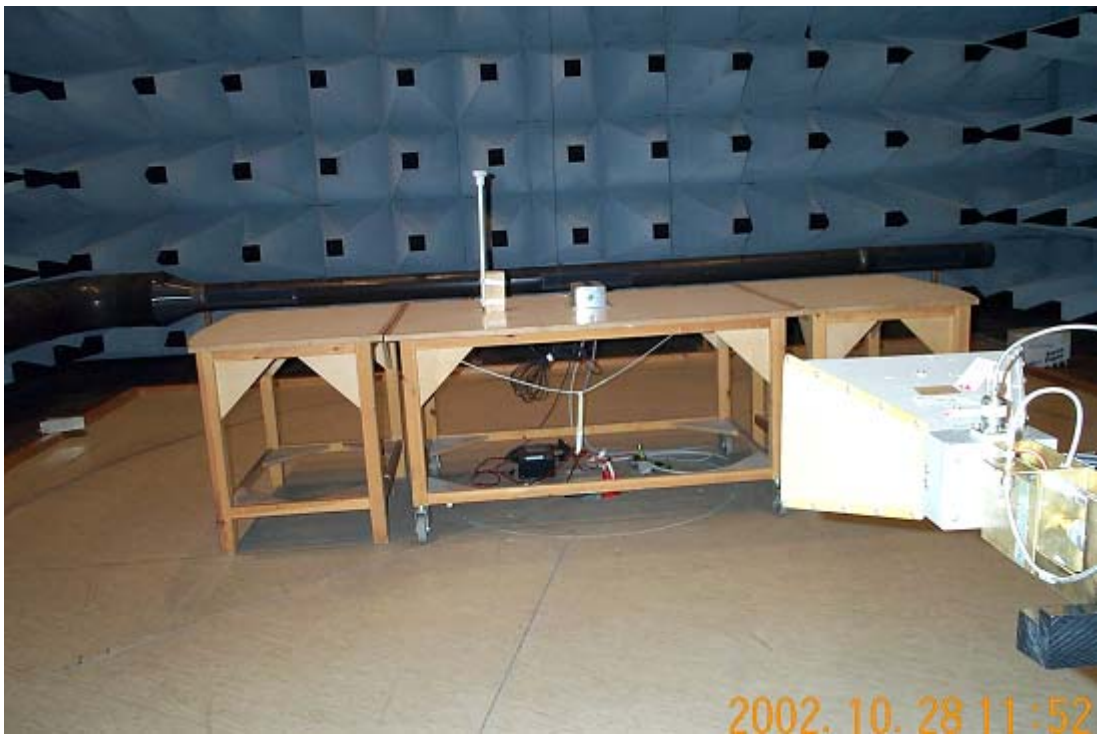


Photo 5 Test set up for radiated RF emission test. 1000 MHz - 2000 MHz.

11.2 Test result. Radiated emission (Enclosure)

The test was performed in accordance with:

Standard	CISPR 16-1, IEC 60945
Frequency range:	0.15 MHz - 2000 MHz
Measure time:	5.0 s during quasi-peak measurement else 0.01 s

Limits:

Frequency	**Limit Quasi-peak IEC 60945**
150 kHz – 300 kHz	10 mV/m – 316 µV/m (80 dBµV/m – 52 dBµV/m)
300 kHz – 30 MHz	316 µV/m – 50µV/m (52 dBµV/m – 34 dBµV/m)
30 MHz – 2 GHz	500 µV/m (54 dBµV/m) except for
156 MHz – 165 MHz	16 µV/m (24 dBµV/m) quasi-peak or 32 µV/m (30 dBµV/m) peak

Table 2 Limits IEC 60945

Climatic conditions during the test:

Temperature	21 ± 3 °C
Relative humidity	43 ± 5%

RESULT: Radiated emission:

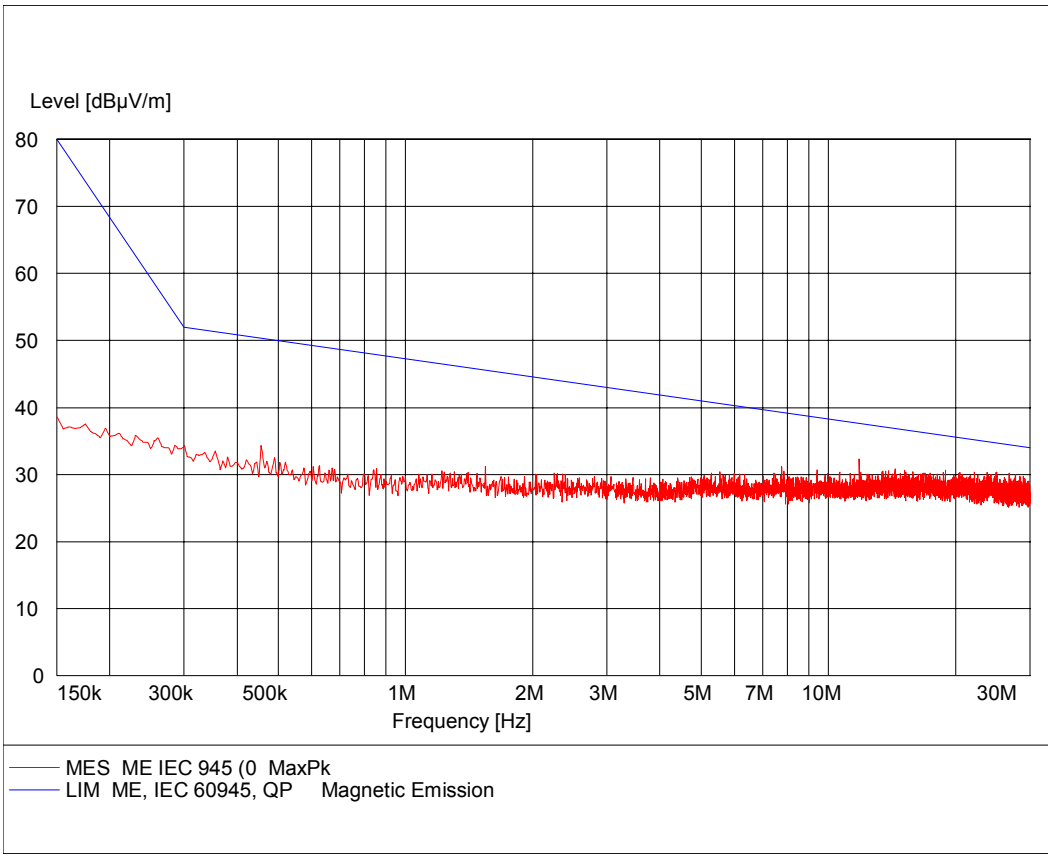
The plotted results demonstrates that the radiated emission from the R4 AIS transponder complies with the limit of IEC 60945

The measurement uncertainty (with a 95% confidence level) for this test has been calculated to 4.5 dB.

(0.15-30 MHz)

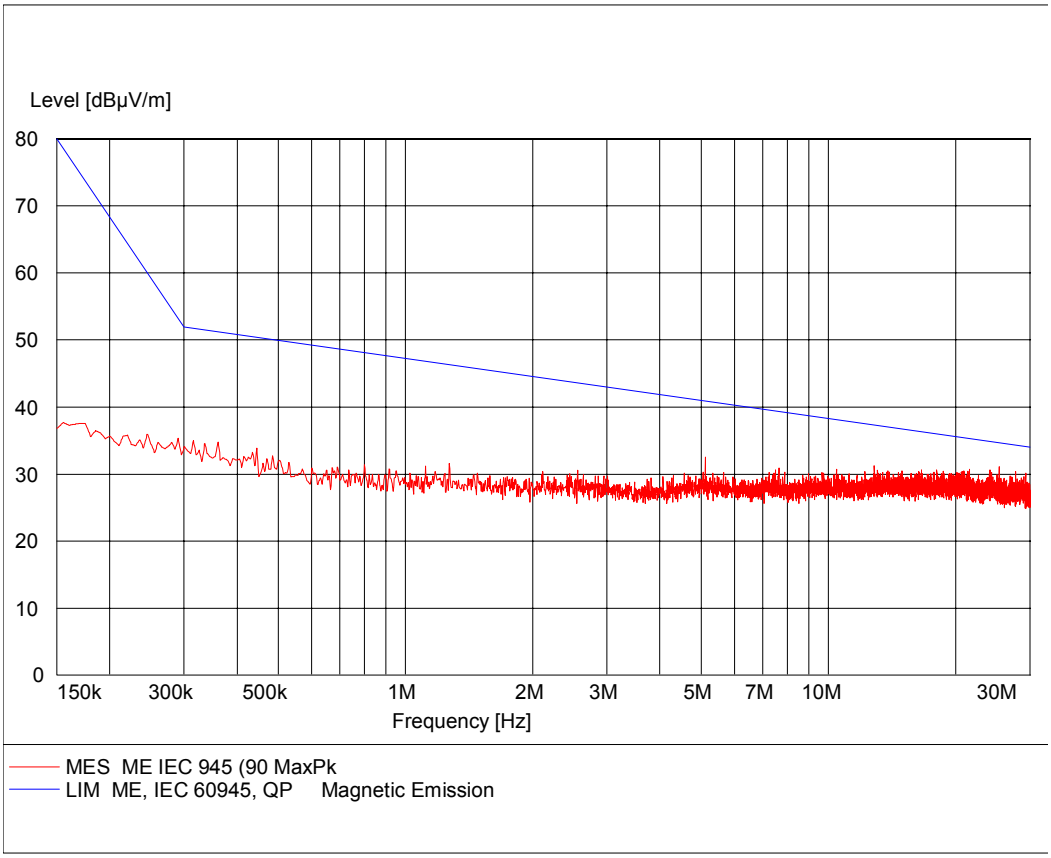
DELTA Electronics Testing. EMC section

EUT: R4-AIS Transponder
Manufacturer: Saab TransponderTech AB
Operating Condition: Ant 0 deg. 24 VDC
Test Site: EMC-5
Operator: HEN - E500581
Test Specification: IEC 60945
Comment: Sheet 3



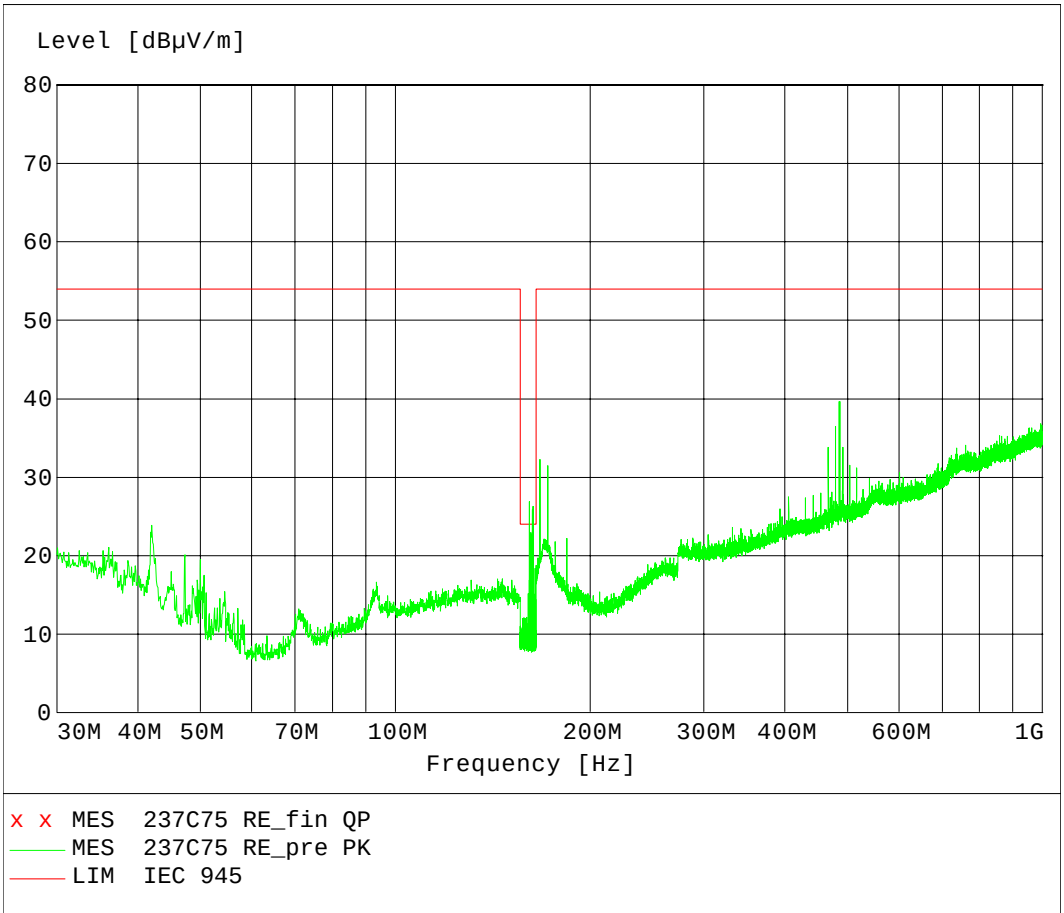
DELTA Electronics Testing. EMC section

EUT: R4-AIS Transponder
Manufacturer: Saab TransponderTech AB
Operating Condition: Ant 90 deg. 24 VDC
Test Site: EMC-5
Operator: HEN - E500581
Test Specification: IEC 60945
Comment: Sheet 4



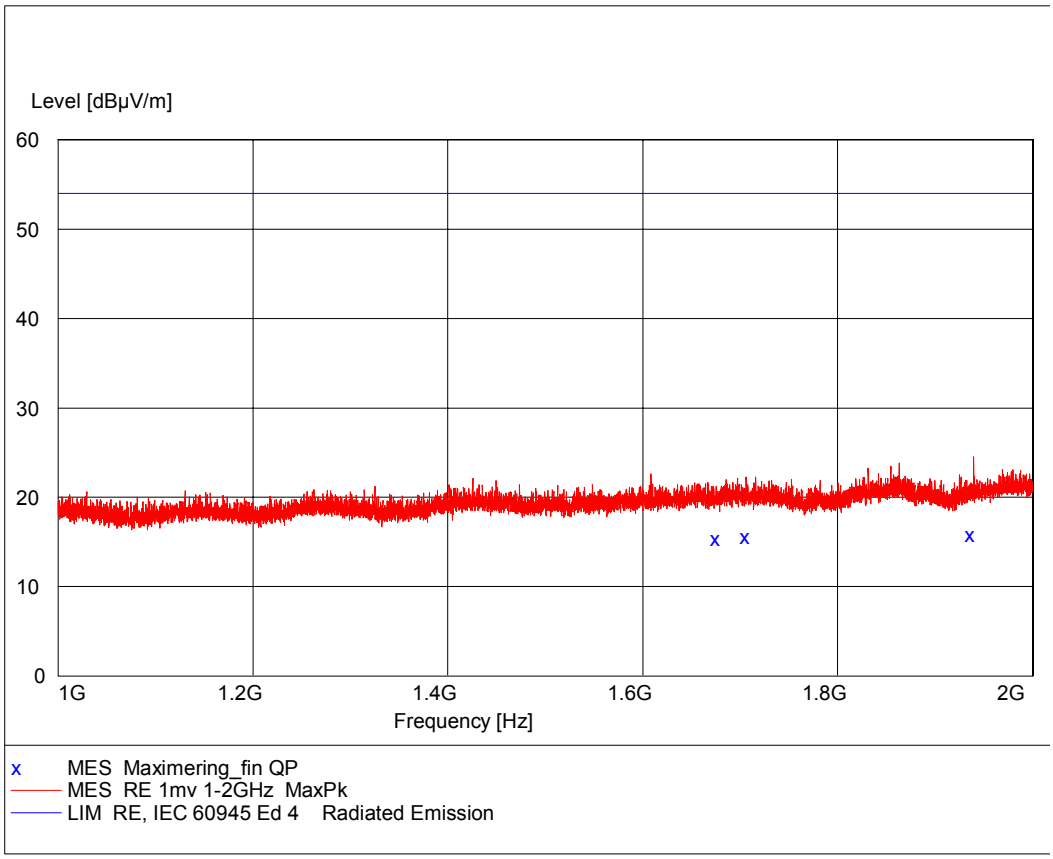
Radiated emission 2002-09-23 proj no: 237C75
Complete measurement 30-1000 MHz

EUT: R4 AIS Transponder
Manufacturer: SAAB TransponderTech AB
Operating Condition: 24 VDC
Test Site: DELTA Development Technology AB
Operator: Lars J
Test Specification: IEC 60945 Ed 4
Comment:
Start of Test: 2002-09-23 / 15:27:06



(1-2 GHz)
DELTA Electronics Testing. EMC section

EUT: R4-AIS Transponder
Manufacturer: Saab TransponderTech AB
Operating Condition: Ant 1 m vertical. 24 VDC
Test Site: EMC-5
Operator: HEN - E500581
Test Specification: IEC 60945
Comment: Sheet 1



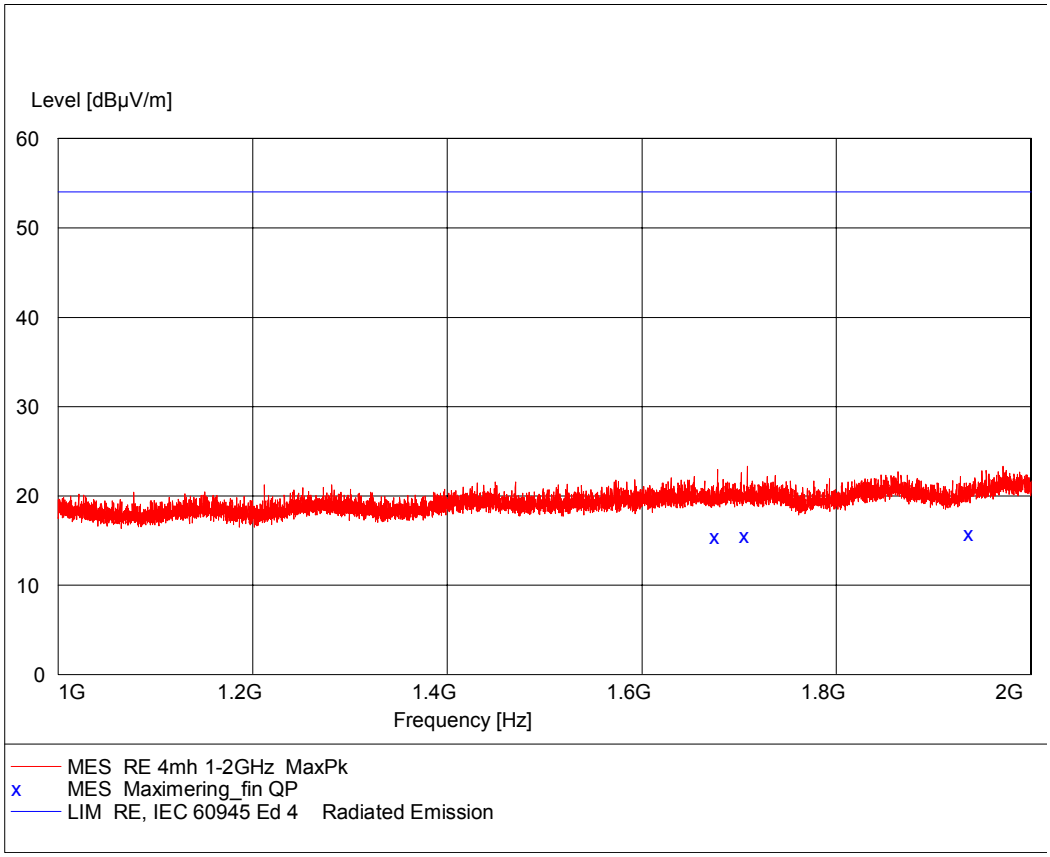
MEASUREMENT RESULT: "Maximering_fin QP"

10/28/2002 10:05AM

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Height cm	Azimuth deg	Polarization
1677.700000	15.40	-13.8	54.0	38.6	300.0	322.00	VERTICAL
1708.600000	15.60	-13.6	54.0	38.4	101.0	287.00	VERTICAL
1939.600000	15.80	-12.5	54.0	38.2	101.0	180.00	VERTICAL

DELTA Electronics Testing. EMC section

EUT: R4-AIS Transponder
Manufacturer: Saab TransponderTech AB
Operating Condition: Ant 2 m horizontal. 24 VDC
Test Site: EMC-5
Operator: HEN - E500581
Test Specification: IEC 60945
Comment: Sheet 2



12 CONDUCTED RADIO FREQUENCY IMMUNITY TEST

12.1 Test set-up. Conducted immunity.

The test was carried out on the metallic turntable (Φ 4 m) in the semi-anechoic chamber.

In order to obtain a common mode impedance of 150 Ω to ground for the whole set up the R4 transponder, auxiliary equipment and cables were placed on insulating supports above the ground reference plane, 10 cm for the EUT and 3 cm for the cables. The EUT and auxiliary equipment were also provided with decoupling networks and ferrites in accordance with the figure below.

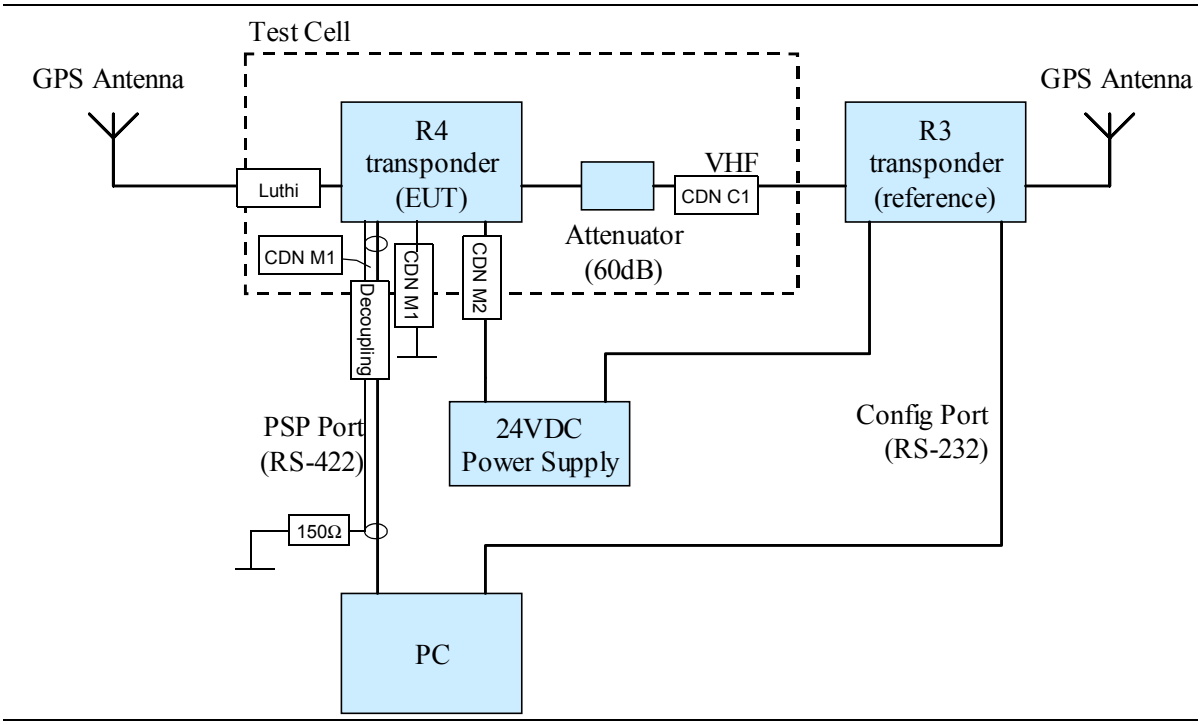


Figure 8 Test set-up for conducted RF immunity test

RF-voltage was injected via coupling decoupling networks (CDN) into the following cables:

Cable:	**CDN:**	**Identification no:**
• Protective earth	M1_3	E-I889
• 24 VDC supply cable	M2_1	IE-D011
• VHF channel	C1	IE-B902
• GPS channel	EM-clamp.	IE-B897 (LÜTHI).
• RS422	M1_1	IE-B929

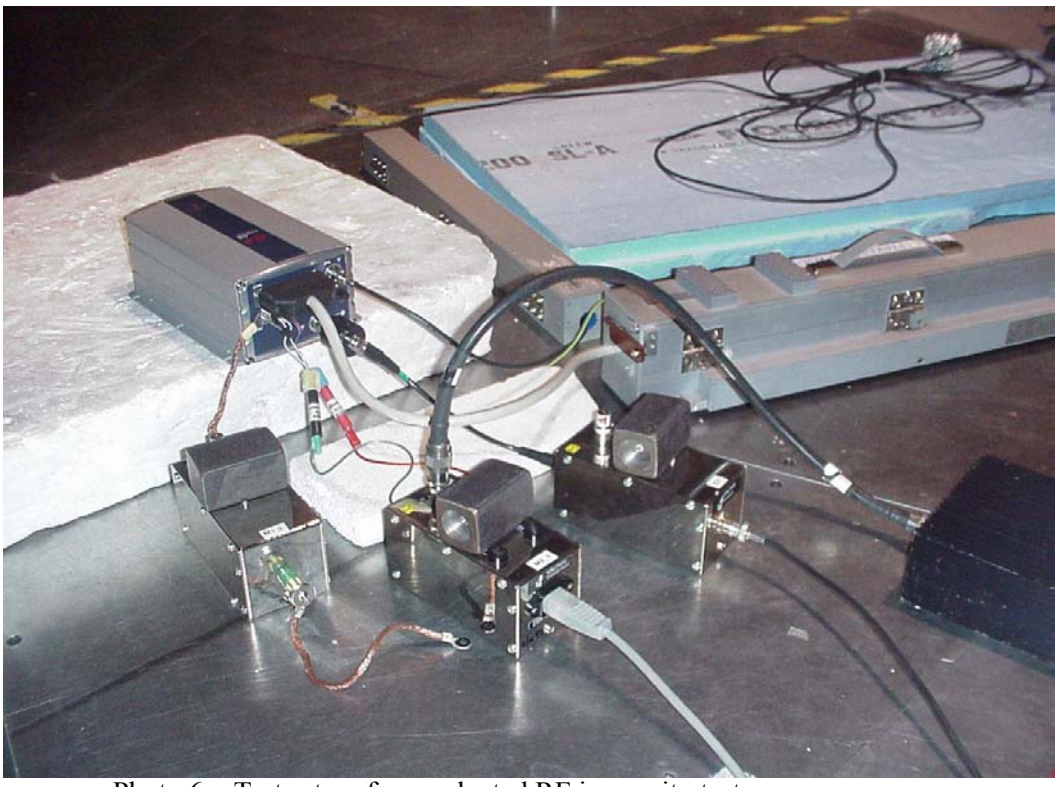


Photo 6 Test set up for conducted RF immunity test

12.2 Test result. Conducted immunity (Cables)

The test was performed in accordance with:

Standard:	IEC / EN 61000-4-6
Test level:	10 V
Frequency:	0.15 MHz - 80 MHz
Modulation:	80% AM sine at 400 Hz
Step size:	0.01 x f_p
Dwell time:	3 s

Climatic conditions during the test:

Temperature	21 ± 3 °C
Relative humidity	43 ± 5%

RESULT: Conducted immunity:

No error in the function of R4 AIS transponder was observed during the test. RF-voltage up to 10 V was injected to 24 VDC power supply, earth port, GPS channel, VHF channel and RS422 port.

The VHF telegrams was received with an interval of 20 s instead of 10s during test at 4 MHz and 8.2 MHz on earth port.

Test level uncertainty (with a 95% confidence level) has been calculated to 0.7 dB.

13 RADIATED RADIO FREQUENCY IMMUNITY TEST

13.1 Test set-up. Radiated immunity.

This test was carried out in the modified semi-anechoic chamber with the R4 transponder placed on a wooden table 0.8 m above the ground reference plane.

More than 1 meter of the interconnecting cables to the R4 transponder was exposed to the field, the rest of the cable was placed on the ground plane.
It was grounded via a ~1.2 m long cable to the reference groundplane.

The PC with supervision software was placed in the control room and communicating with the R4 transponder via twisted pair cables and with the auxiliary equipment (R3) through optical fibres.

The test facility is calibrated and complies with the requirements of field uniformity over 16 calibration points in the frequency range of 26 MHz - 1000 MHz.

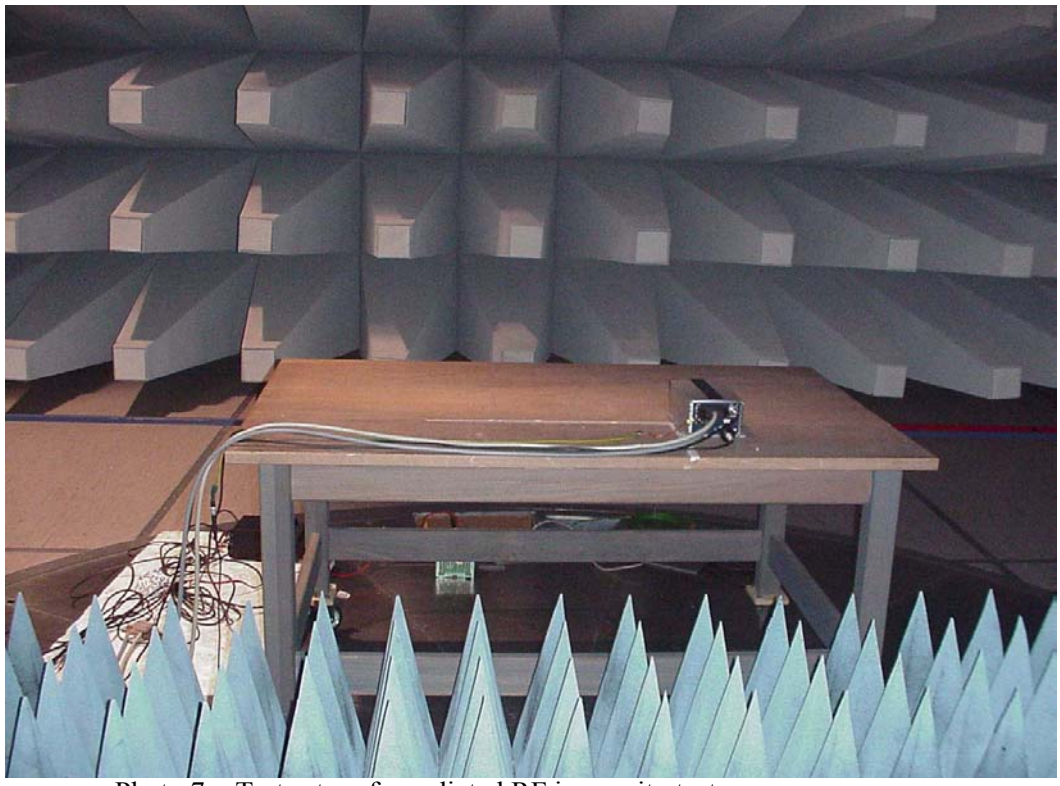


Photo 7 Test set up for radiated RF immunity test

13.2 Test result. Radiated immunity (Enclosure)

The test was performed in accordance with:

Standard:	IEC / EN 61000-4-3
Test level:	15 V/m (*)
Frequency:	80 MHz - 2000 MHz
Test distance:	3 m
Modulation:	80% AM at 400 Hz
Step size:	0.01 x f_p
Dwell time:	3 s

(*): IEC 60945 specifies a field level of 10 V/m.

Climatic conditions during the test:

Temperature	21 ± 3 °C
Relative humidity	43 ± 5%

RESULT: Radiated immunity:

Test with a field strength of 15 V/m did not influence the function of the R4 AIS transponder.

The test was done with the back side of the R4 transponder facing the transmitting antenna and with both horizontal and vertical polarization of the field.

Test level uncertainty (with a 95% confidence level) has been calculated to 2.6 dB.

14 ELECTRICAL FAST TRANSIENT/ BURST IMMUNITY TEST

14.1 Test set-up. EFT /Burst.

This test was carried out in the transient laboratory which is equipped with a ~40 m^2 ground reference plane (GRP) connected to protective earth in one point.

All cables connected to the tested equipment was placed on an insulating support 0.1m above the ground reference plane. The EFT/burst was coupled to the EUT via a coupling network or a capacitive clamp (according to table 3 on page 35). The cable length between the EUT and the coupling device was less than 1m.

The R4 transponder was grounded via a ~1.2 m long cable to the reference groundplane.

The figure below shows how the EUT was set-up and attached to the GRP.

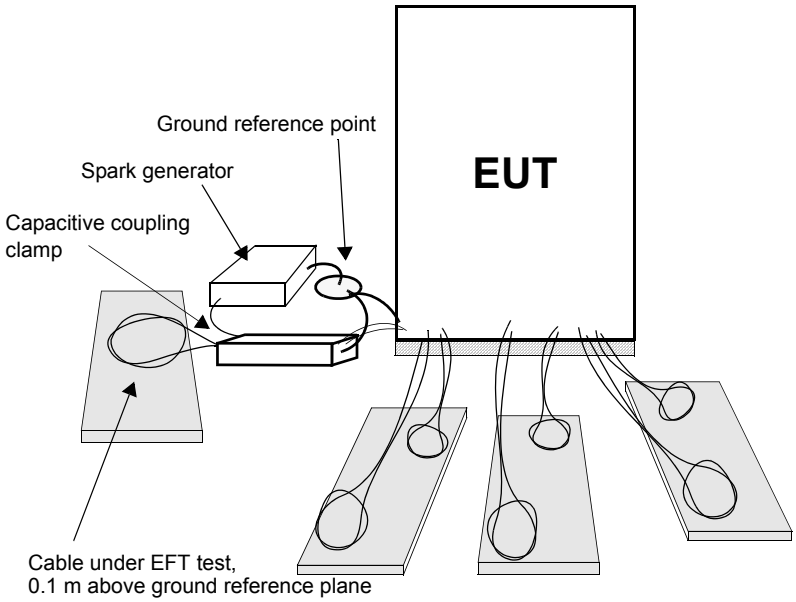


Figure 9 Principal test set up for EFT/Burst test.

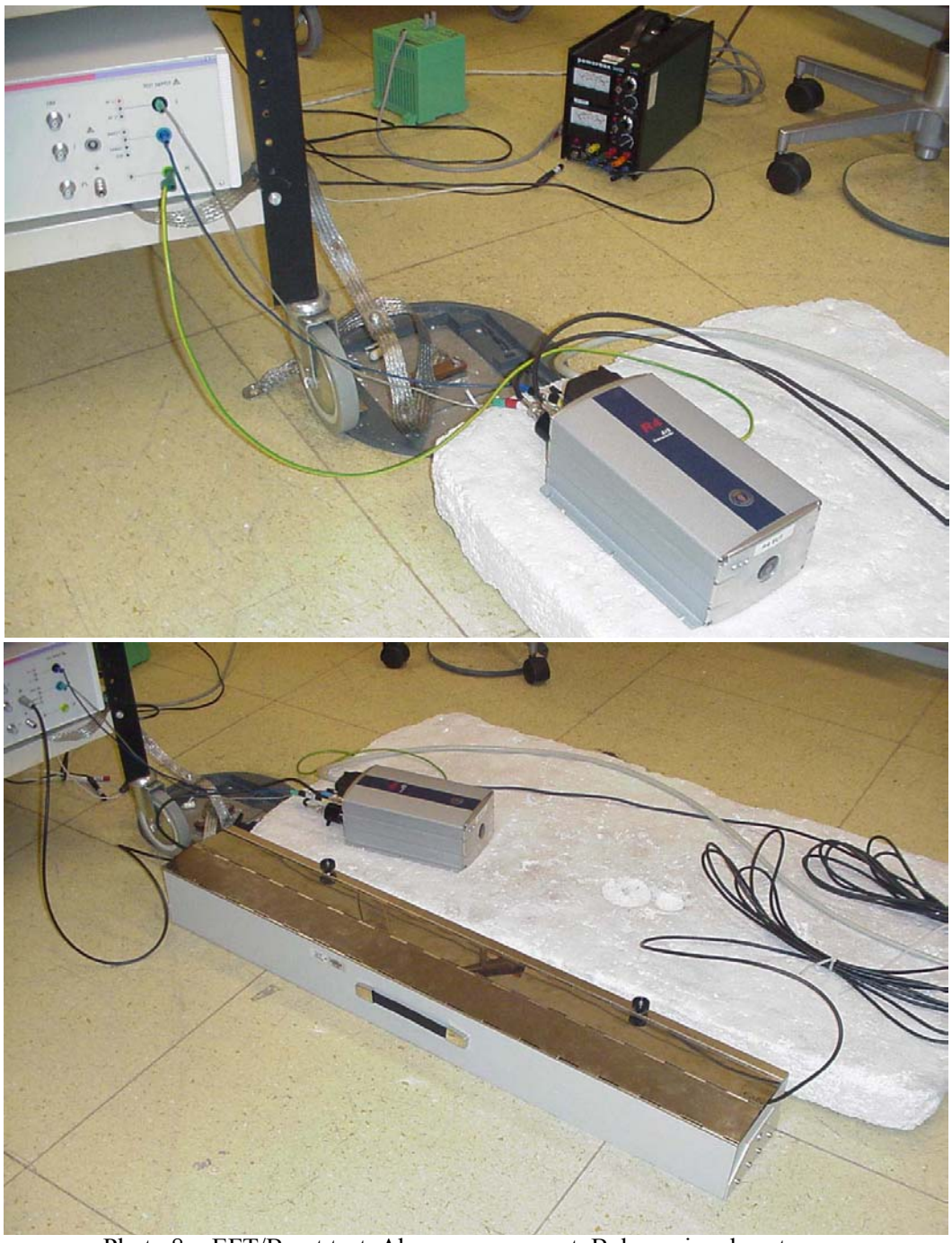


Photo 8 EFT/Burst test. Above; power port. Below; signal port.

Table 3 shows which ports were tested and which levels and coupling method that was applied.

On every cable tested the level was increased in steps up to the selected level stated in the table below.
Duration of the test on the selected level was 3 min per polarity.

Cable/ port	Coupling method	Test level (kV)
DC Mains port Common mode	Coupling decoupling network	± 2
DC Mains port +24 V to ground reference	Coupling decoupling network	± 2
DC Mains port 0 V to ground reference	Coupling decoupling network	± 2
AC Mains port chassis to ground reference	Coupling decoupling network	± 2
GPS channel	Capacitive clamp	± 1
VHF channel	Capacitive clamp	± 1
RS 422 port	Capacitive clamp	± 1

Table 3 Test levels for EFT/Burst test.

14.2 Test result. EFT/ Burst.

The test was performed in accordance with:

Standard: IEC / EN 61000-4-4
Duration of test: 3 min/ polarity
Burst duration: 15 ms

Repetition rate: 5 kHz at test levels up to 1 kV
2.5 kHz at test level 2 kV

Climatic conditions during the test:

Temperature 20 ± 3 °C
Relative humidity 50 ± 5%

RESULT: EFT/ Burst immunity:

No influence on the function of R4 AIS transponder was observed during the test. Open-circuit test voltages of up to 2 kV was applied to 24 VDC mains supply cable and 1 kV to GPS, VHF and RS422 port.

15 POWER SUPPLY VARIATIONS

This test was performed at DELTA Hörsholm

Client	Saab TransponderTech AB	**Sheet**	F - 1-1
Item	R4-AIS Transponder	**Project no.**	E500709 - 1
Manufacturer	Saab TransponderTech AB	**Date**	2002-10-22
Type	R4-AIS	**Sign.**	BLa
Serial no.	001002	**Test site**	Room 4
Test method(s)	IEC 60945:2002, clause 5.2.2		
Temperature	23°C	**Humidity**	31% RH

Cable designation	Nominal voltage [Vrms]	Changed voltage [Vrms]	Voltage change [%]	Duration [sec. or msec.]	Changed frequency [Hz]	Remarks (Description of reaction)
Extreme power supply variations at DC Power.	24 VDC	31.2 VDC	+30	15 min.	-	Ok.
	24 VDC	21.6 VDC	-10	15 min.	-	Ok.

Compliant	Yes	**Additional performance criteria (if any)**	
Comment(s)	The extreme power supply variations test was also carried out as part of the performance check during the Dry heat and Low temperature test profiles with same results as above mentioned.		

Uncertainty on test level	-
Criteria for compliance	See *section 3.2*
Results	No malfunction was detected

16 POWER SUPPLY FAILURE

This test was performed at DELTA Hörsholm

Client	Saab TransponderTech AB	**Sheet**	V - 1-1
Item	R4-AIS Transponder	**Project no.**	E500709 - 1
Manufacturer	Saab TransponderTech AB	**Date**	2002-10-22
Type	R4-AIS	**Sign.**	BLa
Serial no.	001002	**Test site**	Room 4
Test method(s)	EN 61000-4-11:1994		
Temperature	23°C	**Humidity**	31% RH

Cable designation	Nominal voltage [Vrms]	Changed voltage [Vrms]	Voltage change [%]	Duration [sec. or msec.]	Changed frequency [Hz]	Remarks (Description of reaction)
DC Power	24 VDC	0 VDC	-100	60 sec.	-	3 times within 5 min. Ok after each reboot of the EUT.

Compliant	Yes	**Additional performance criteria (if any)**	
Comment(s)			

Uncertainty on test level	-
Criteria for compliance	See *section 3.2*
Results	No malfunction was detected

17 REVERSE POLARITY CHECK

17.1 Test procedure

The polarity of the 24 VDC power supply to R4 AIS transponder was reversed for a period of 5 minutes. After completion of the test the power was connected normally and a performance check was carried out.

17.2 Test result

RESULT: Reverse polarity check:

After completion of the test the R4 AIS transponder was functioning normally.

18 ELECTROSTATIC DISCHARGE IMMUNITY TEST

18.1 Test set-up. ESD.

This test was carried out in the transient laboratory on a table equipped with a horizontal coupling plane (HCP).
All cables and the EUT itself was placed on an insulating support 0.5 mm above the HCP.

The figure below shows how the EUT was set-up. The R4 transponder was grounded via a ~1.2 m long cable to the reference groundplane.

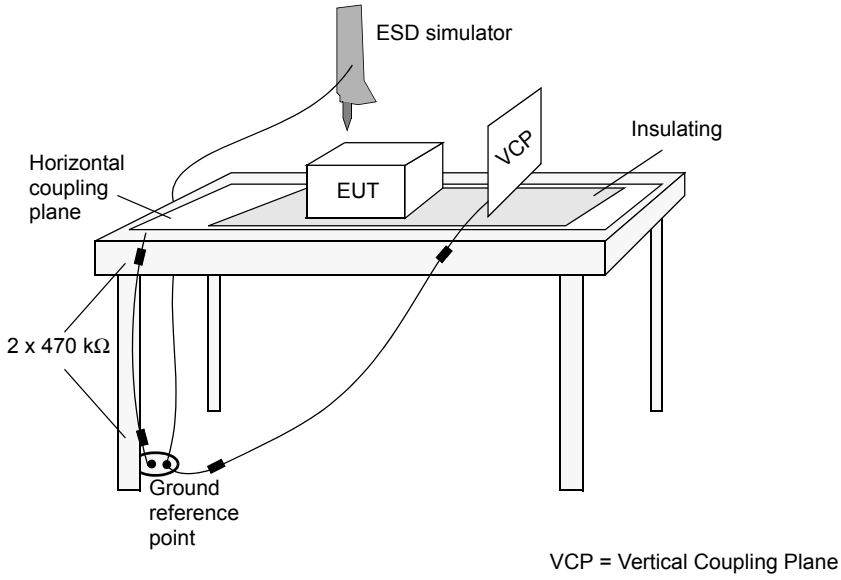


Figure 10 Principal test set-up during ESD test.

▲ =Test point, contact discharge
X =Test point, air discharge

=Position of vertical coupling plane VCP

Photo 9 Test points for ESD test.

On conductive surfaces on the EUT at least 10 single contact discharges per polarity and test-point were applied.
No non conductive surfaces exists on the EUT and therefore no air discharge was applied.

Contact discharge was applied to a vertical coupling plane situated 0.1m from the EUT (indirect discharge). The vertical coupling plane was positioned in front of, behind, above and at both sides of the EUT.
Contact discharge was also applied to the horizontal coupling plane situated under the EUT.

On every test-point the level was increased in steps up to the selected level.

18.2 Test result. ESD.

The test was performed in accordance with:

Standard:	IEC / EN 61000-4-2
Test voltages:	
-contact discharge:	± 6 kV
-indirect discharge:	± 6 kV
Repetition rate:	1/s
Number of tests:	>10 pulses per polarity and test point.

Climatic conditions during the test:

Temperature	20 ± 3 °C
Relative humidity	50 ± 5%

RESULT: Electrostatic discharge immunity:

No influence on the function of R4 AIS transponder was observed during the test. ESD-voltage up to 6 kV was injected to conductive surfaces on the EUT.

6 kV was applied to a vertical coupling plane 0.1m from the EUT and to a horizontal coupling plane under the EUT. The test points are shown in photo 9.

19 COMPASS SAFE DISTANCE

This test was performed at DELTA Hörsholm

19.1 Severity and procedure

IEC 60945:2002, fourth edition, clause 11.2, Compass safe distance.

The compass safe distance is defined as the distance between the nearest point of the test specimen and the magnetometer when the measured horizontal magnetic flux is less than or equal to 0.094 μT, corresponding to a compass deviation of 5.4° at a horizontal flux of 1μT. For the steering compass, the standby compass and the emergency compass, the permitted deviation is 18°/H. The corresponding magnetic flux is less than 0.313 μT.

The compass safe distance of the test specimens was measured:

a) In the magnetic condition in which it was received.

b) After magnetization in a DC field of 80 A/m, with a superimposed stabilizing AC field of 1.43 kA/m and 50 Hz.

c) In energized condition and normal operational mode.

In each of the above conditions, the test specimen(s) was rotated to determine the worst case direction.

Figure 11 Compass safe distance

19.2 Results

Test object condition	**Compass safe distance [cm] (5.4°/H deviation or a Horizontal Magn. Flux of 0.094 uT)**	**Compass safe distance [cm] (18°/H deviation or a Horizontal Magn. Flux of 0.313 uT)**
Not energized, as received	15	9
After Magnetization	15	9
Energized	15	9
Minimum Compass Safe Distances	**15 cm**	**9 cm**

20 TEST EQUIPMENT

INSTRUMENT EMS SYSTEM	MANUFACTURER	TYPE	IDENT NO.	USED
Software	Rohde & Schwarz	EMS-K1	ver. 1.04	✓
Signal generator 0.1-1000 MHz	Rohde & Schwarz	SMG, (+B2)	IE-B883	✓
Field measuring system. 2 probes PO-4421 10k-1000 MHz	Amplifier Research (Holaday)	AR-FM2000	IE-B884 IE-B885 IE-B886	✓
RF Voltmeter 9k-2 GHz + 10V ins. unit	Rohde & Schwarz	URV5 URV5-Z2 URV5-Z2	IE-B887 IE-B888 IE-B889	✓
Directional Coupler 0.01-220 MHz (Cond.)	Amplifier Research	DC2000	IE-B890	✓
Directional Coupler 0.01-220 MHz (Radiat.)	Amplifier Research	DC2000	IE-B891	✓
Directional Coupler 80-1000 MHz 500W	Amplifier Research	DC6180	IE-B892	✓
Directional Coupler 0.8-2.2 GHz	Milmega	AS0822-200	E-I841	
Amplifier 0.01-220 MHz 1000W	Amplifier Research	1000LM21	IE-B893	✓
Amplifier 80-1000 MHz 100W	Amplifier Research	100W1000M1	IE-B894	✓
Amplifier 0.8-2.2 GHz 8W	Milmega	AS0822-8B	E-I838	
Antenna Biconical 20-300 MHz	EMCO	EO-3109	IE-B895	✓
Antenna Log.periodic 0.2-1 GHz	EMCO	EO-3146	IE-B896	✓
Antenna Horn 1-18 GHz	ARA	DRG-118/A	E-I839	
Current injection (EM-) clamp	LÜTHI	EM101	IE-B897	✓
Decoupling clamp	LÜTHI	FTC 101	E-L344	
RF attenuator 6 dB 1.5 GHz	BNOS	AT50-6-250	IE-B926	✓
Coupling Decoupling Networks	EF	FI-CDN	See chapter 12.1	✓
Software	DELTA	CS-test		
Signal generator 10kHz - 2.4GHz	Marconi	2024	E-H908	
Digital Multimeter	Hewlett-Packard	34401A	E-H906	
Digital Multimeter	Hewlett-Packard	34401A	E-H907	
Detector Negative	Hewlett-Packard	8471D	E-I019	
Detector Negative	Hewlett-Packard	8471D	E-I021	
Amplifier 0.01-250 MHz 75W	Amplifier Research	75A250	E-H909	
Attenuator 10 dB	Radiall	R41441000	E-I023	
-40 dBc Voltage Sampler	DELTA-Denmark		E-I026	
RF attenuator 6 dB	Weinschel Corp		E-I022	

INSTRUMENT EMI SYSTEM	MANUFACTURER	TYPE	IDENT NO.	USED
Software	Rohde & Schwarz	ES-K1	ver. 1.5	✓
EMI Test receiver 9k-30 MHz	Rohde & Schwarz	ESHS10	IE-B914	✓
EMI Test receiver 20-1000 MHz	Rohde & Schwarz	ESVS10	IE-B915	✓
Antenna Biconical 20-300 MHz	Rohde & Schwarz	HK116	IE-B916	
Antenna Log.periodic 200-1300 MHz	Rohde & Schwarz	HL223	IE-B917	
Antenna Bilog 30-1000MHz	Chase	CBL6111A	IE-B928	✓
LISN 4 x 100A 800V	Schwarzbeck	NNLK8129	IE-B918	
LISN 2 x 10A 9k-30MHz	Rohde & Schwarz	ESH3-Z5	IE-B919	✓
Decoupling clamp	LÜTHI	FTC 40X15 E	E-L345	
Voltage probe	Jyske EMC	HFV 501	E-I149	

INSTRUMENT CONDUCTED TRANSIENTS	MANUFACTURER	TYPE	IDENT NO.	USED
Combination Wave generator	Haefely	PC6-288	IE-B285	✓
Coupling /Decoupling filter	Haefely	FP20/3-3	IE-B284	✓
Coupling module universal	EMC-Partner	CN-U	E-K534	✓
Decoupling module HF	EMC-Partner	DN-HF	E-K535	
Decoupling module LF	EMC-Partner	DN-LF1	E-K536	✓
Decoupling module LF	EMC-Partner	DN-LF2	E-K537	✓
Coupling capacitors 10nF	ANDI	Type 3	IE-B095	
Burst interference simulator	EM TEST	UCS 500 M4	E-L444	✓
Capacitive coupling clamp	EM TEST	HFK	E-L443	✓
Burst interference simulator	Schaffner	NSG 225	IE-D257	
Burst tester	Haefely	PB4	IE-A574	
Coupling filter	Haefely	FP16	IE-A576	
Capacitive coupling clamp	Seaward	CC Clamp	E-I840	
ESD simulator	KeyTek	MiniZap MZ-15	IE-B349	✓
Oscillatory wave generator	Haefely	P3	IE-B507	
Coupling /Decoupling filter Osc. wave	Haefely	F10/3-2	IE-B508	
Impulse generator	Haefely	P6R	IE-C359	
Line voltage variation simulator	Schaffner	NSG 203A	IE-B225	
Spark generator	ASEA	-	IE-B005	
Coupling capacitors 500nF	ANDI	Type 4	IE-B096	✓

INSTRUMENT	MANUFACTURER	TYPE	IDENT NO.	USED
Other instruments used				
Temperature- and hygrometer	Vaisala	HMI31	IM-A308	✓
Electrical safety tester	Sefelec	SMG 500	IE-D302	

INSTRUMENT	MANUFACTURER	TYPE	IDENT NO.	USED
Shunt resistor	Thermovolt	100A100MV	IE-B679	
Digital multimeter	Fluke	87	IE-B353	
Digital multimeter	Metrawatt	Metrahit 18S	IE-C966	
Digital multimeter	Data Precision	2480 R	IE-C079	
Digital multimeter	Data Precision	2480 R	IE-C082	
Data acquisition/ switch unit	Agilent	34970A	E-L346	

20.1 Instruments used at DELTA Hörsholm.

NO.	DESCRIPTION	MANUFACTURER	TYPE NO.
22608	VIBRATION CONTROLLER	DATA PHYSICS	DP550W
Acc. 93	ACCELEROMETER	BRUEL & KJÆR	4371
Acc. 94	ACCELEROMETER	BRUEL & KJÆR	4371
Acc. 75	ACCELEROMETER	BRUEL & KJÆR	4393
Acc. 76	ACCELEROMETER	BRUEL & KJÆR	4393
22613	ACCELEROMETER PREAMPLIFIER	BRUEL & KJÆR Nexus	2692
22574	ACCELEROMETER PREAMPLIFIER	BRUEL & KJÆR	2626
22600	ELECTRONIC VOLTMETER	HEWLETT-PACKARD	34401A
23796	OSCILLOSCOPE	FLUKE	SCOPMETER 123
Y221	ELECTRODYNAMIC SHAKER	MB	MB EL250
U2501	SWITCHING POWER AMPLIFIER	LING DYNAMIC SYS.	DPA 16
EFGT-23	CLIMATIC TEST CHAMBER	EC/DELTA	VKF 875-2
29223	CURRENT PROBE	SINGER	91550-4
29342	REFLECTOMETER COUPLER, 600-4200 MHz	ROHDE & SCHWARZ	ZPD
29347	RF GENERATOR , 10 kHz-1 GHz	MARCONI	2022
29461	ARTIFICIAL MAINS NETWORK	ROHDE & SCHWARZ	ESH2/Z5
29680	IMPULSE VOLTAGE LIMITER	ROHDE & SCHWARZ	ESH3/Z2
29876	1-18 GHz. HORN ANTENNA.	EMCO	3115
29861	EMI-SOFTWARE Ver. 1.60	ROHDE & SCHWARZ	ES-K1, PART: 1026.6790.02
49037	uW-PREAMPLIFIER, 1-12.8 GHz.	MITEQ	AMF-5D-001128-35-11P
29916	AUTOMATIC TEST RECEIVER, 9 kHz-2.75 GHz	ROHDE & SCHWARZ	ESCS 30 1102.4500.30
29797	BILOG ANTENNA, 30-1000 MHz	CHASE	CBL 6111A

29332	ACTIVE LOOP ANTENNA	ROHDE & SCHWARZ	HFH-Z2
29197	DC MAGNETOMETER	R.J.	GM 10
29972	HELMHOLZ COILS, 1.9 M. DIAMETER W. CONTROL BOX	TRILLINGERNE	VBN

21 REVISION

Rev. Ind.	Page (P) Chapt (C)	Description	Date/ Init
-		New document	2002-12-19/ LAJ