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# Test Report

No.: E62099

Designation of equipment under test: electrical wheelchair Zephyr

EMC Test Laboratory  
accredited by  
DATEch e.V.  
in compliance with DIN EN ISO/IEC 17025  
under the  
Reg. No. DAT-P-105/94-32

The copying of excerpts from this report is not permitted without written the consent of the testing body. The test results indicated in this report refer exclusively to the equipment under test specified below. It is not permitted to transfer the results to other systems or configurations.

Testing body: PHOENIX TESTLAB GmbH  
Königswinkel 10  
D-32825 Blomberg  
Germany

Client: INVACARE Germany GmbH  
Kleiststraße 49  
D-32457 Porta Westfalica  
Germany

Order number: 62099

Type of test: Testing of the electromagnetic disturbances characteristics  
Testing of the electromagnetic immunity characteristics

Tested on the basis of:

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Disturbance emission: - EN 55022:1998 + A1:2000 + A2:2003 Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement (electromagnetic radio disturbances)

The limits and requirements according to  
*ISO 7176-21:2003 Requirements and test methods for electromagnetic compatibility of electrically powered wheelchairs and motorized scooters*

The requirements according to  
*EN 12184:2004 Electrically powered wheelchairs, scooters and their chargers - Requirements and test methods, ANSI/RESNA WC/Vol. 2-1998 Additional Requirements Wheelchairs (including scooters) with Electrical Systems are considered.*

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Immunity interference: - IEC 61000-4-2:1995 + AMD 1:1998 + AMD 2:2000 Electrostatic discharge immunity test  
- IEC 61000-4-3:2002 Radiated, radio-frequency, electromagnetic field immunity test

The limits and requirements according to  
*ISO 7176-21:2003 Requirements and test methods for electromagnetic compatibility of electrically powered wheelchairs and motorized scooters*

The requirements according to  
*EN 12184:2004 Electrically powered wheelchairs, scooters and their chargers - Requirements and test methods,*  
*ANSI/RESNA WC/Vol. 2-1998 Additional Requirements Wheelchairs (including scooters) with Electrical Systems*  
are considered.

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The tests were requested by the customer.

Equipment under test, EUT: electrical wheelchair

Type identification: Zephyr

Serial number: none

Manufacturer: INVACARE Germany GmbH

Date the EUT was received: 16.10.2006

Annex: Photos of the test set-ups and the test subject


Client represented during the test by the following person(s): Mr. Führung

Place of test: PHOENIX TESTLAB Blomberg

Date of test: 16.10.2006

Test result: The requirements made in the test documents were fulfilled by the equipment under test.  
The complete test results are presented in the following.

Blomberg, 17.10.2006



Test Engineer: M. Pohl



approved by authorized Engineer

<b>Contents:</b>	<b>Page</b>
1 Operational states and test set-up	6
2 List of test modules and results	7
2.1 Electromagnetic disturbance characteristics	7
2.2 EMC Immunity	7
3 Test sequence and test results electromagnetic disturbances characteristics	8
3.1 Radiated radio disturbance according to EN 55022 class B	8
4 Test sequence and test results electromagnetic immunity characteristics	16
4.1 Immunity test for high frequency electromagnetic fields according to EN 61000-4-3 and ENV 5020416	
4.2 Immunity test for discharge of static electricity according to EN 61000-4-2	19
5 Annex	21

## 1 Operational states and test set-up

The following states were defined as the operating conditions:

- for EMI-test: 50% forward driving direction.
- for EMS-Immunity-test: 50% forward driving direction and stand-by
- for ESD-test: stand-by

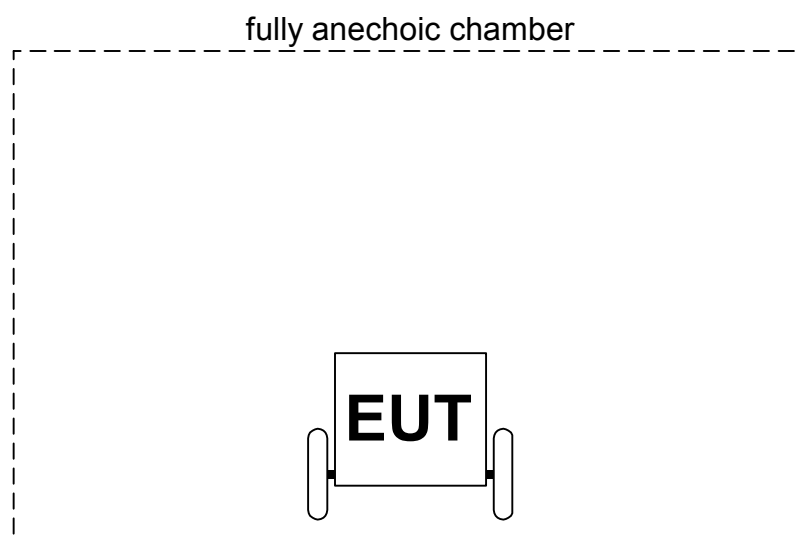
Definition of the functions to be monitored and corresponding tolerance limits:

- According to the standard, for the radiated immunity test the average wheel speed change shall not exceed  $\pm 20\%$ , the differential wheel speed change shall not exceed  $\pm 25\%$  and electrically powered devices which are not used for driving shall not move.
- According to the standard, for all other immunity tests except the radiated immunity test the driven wheels shall not move, the automatic brakes shall not release and electrically powered devices which are not used for driving shall not move.

Special EMC measures:

- all measurements are done without attended control

The system was set up as follows:



## 2 List of test modules and results

### 2.1 Electromagnetic disturbance characteristics

Electromagnetic radiation disturbances characteristics – enclosure port				
Frequency range	Limits	Basic standard	Remark	Status
30 to 230 MHz 230 to 1000 MHz	30 dB( $\mu$ V/m) at 10 m 37 dB( $\mu$ V/m) at 10 m	EN 55022 Class B	see note 1	fulfilled
note 1: Only applies to operating media that contain microelectronics, e.g. microprocessors, with a working frequency above 9 kHz. The statistical assessment in compliance with the standard must be used.				

### 2.2 EMC Immunity

Definition of evaluation criterion:

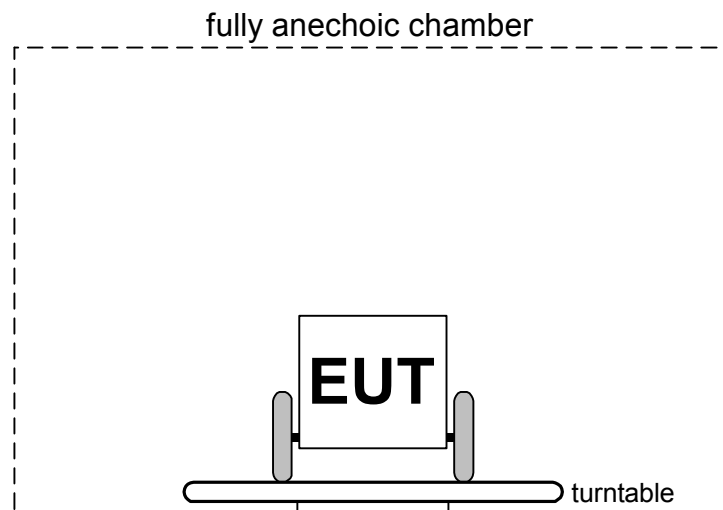
- A: The average wheel speed change shall not exceed  $\pm 20\%$ , the differential wheel speed change shall not exceed  $\pm 25\%$  and electrically powered devices which are not used for driving shall not move.
- B: The driven wheels shall not move, the automatic brakes shall not release and electrically powered devices which are not used for driving shall not move.

Immunity - Enclosure Port				
Environmental phenomena	Test specification and units	Basic standards	Performance criterion	Status
Radio-frequency electromagnetic field	26 - 1000 MHz; 1710 - 1785 MHz; 1850 - 1910 MHz; 2000 - 2160 MHz 20 V/m, 80% AM (1 kHz)	IEC 61000-4-3	A	fulfilled
Electrostatic discharge (ESD)	up to $\pm 8$ kV charge voltage (contact discharge)	IEC 61000-4-2	B	fulfilled
	up to $\pm 8$ kV charge voltage (air discharge)		B	fulfilled

### 3 Test sequence and test results electromagnetic disturbances characteristics

#### 3.1 Radiated radio disturbance according to EN 55022 class B

- Test set-up:
- Stand set-up
  - Photos of the test set-up can be referred to in the annex.
  - The drawing below schematically shows the test set-up.



- Test:
- The interfering field strength is measured in two stages. In the first non-standard stage, preliminary measurements are made in a fully anechoic chamber. Here the equipment under test is measured from various sides in normal fitted position. This procedure makes it possible to ascertain without the effect of external interference sources and without adjusting the antenna in height whether the test object is emitting interference at certain frequencies. In the second stage, the frequencies determined in the preliminary measurements are measured in compliance with the standard on a standard open area test site with a quasi-peak detector.



measuring devices used for preliminary measurement:  
fully anechoic chamber M8 (PM-No. 480190)  
antenna mast (PM-No. 480455)  
turntable (PM-No. 480186)  
controller HD100 (PM-No. 480181)  
EMI-software package ES-K1 (PM-No. 480111)  
measuring receiver ESIB 7 (PM-No. 480479)  
bi.-log. antenna CBL6112C (PM-No. 480327)

measuring devices used for final measurement:  
open area test site M6 (PM-No. 480085)  
antenna mast  
turntable (PM-No. 480087)  
controller HD 100 (PM-No. 480139)  
relay interface RSU (PM-No. 480077)  
EMI-software package ES-K1 (PM-No. 480111)  
measuring receiver ESCS30 (PM-No. 480270)  
bi.-log. antenna CBL6111A (PM-No. 480147)

Measuring records:      The measuring records are presented on the following pages.

Test result:              The requirements of the test documents were fulfilled.

Title: Preliminary measurement on a 3m distance  
 ESIB7 receiver by Rohde & Schwarz  
 EUT: electrical wheelchair "Zephyr"  
 Manufacturer: INVACARE  
 Operating Condition: 50% forward run  
 Test site: PHOENIX TESTLAB Blomberg; fully anechoic chamber M8  
 Operator: L. Witte / M. Pohl  
 Test Specification: stand set-up  
 Comment:

**Scantable for the preliminary measurement: E-Field M8**

Unit: dB $\mu$ V/m                      Curve 1                      Curve 2  
 Detector / Mode                      MaxPeak / ClearWrite                      Average / ClearWrite

Subrange	1	2	3	4	5
Start frequency	30.0 MHz	250.0 MHz			
Stop frequency	250.0 MHz	1.0 GHz			
Increment	80.0 kHz	80.0 kHz			
IF-bandwidth	120 kHz	120 kHz			
Measurement time	20.0 ms	20.0 ms			
Demodulation	AM	AM			
Autorange	On	On			
Preamplifier	20 dB	20 dB			
RF-attenuation	0 dB	0 dB			
min. RF-attenuation	0 dB	0 dB			
IF-attenuation					
Ref.-Level	-40.0 dBm	-40.0 dBm			
Receiver	ESIX	ESIX			
Signal path	ANT_RFIN2	ANT_RFIN2			
Scan-mode	Lin	Lin			
Input	2DC	2DC			
Tracking-gen.					
Probe transducer	_CBL 6112	_CBL 6112			
System transducer	ANT 1GHz M8	ANT 1GHz M8			
add. transducer 1	None	None			
add. transducer 2	None	None			
add. transducer 3	None	None			

**Scantable for the subsequent measurement: E-Field M8\_fin**

Unit: dB $\mu$ V/m

Curve 1

Curve 2

Detector / Mode

MaxPeak / ClearWrite

Average / ClearWrite

Subrange	1	2	3	4	5
Start frequency	30.0 MHz				
Stop frequency	1.0 GHz				
Increment	12.0 kHz				
IF-bandwidth	120 kHz				
Measurement time	100.0 ms				
Demodulation	AM				
Autorange	On				
Preamplifier	20 dB				
RF-attenuation	0 dB				
min. RF-attenuation	0 dB				
IF-attenuation					
Ref.-Level	-70.0 dBm				
Receiver	ESIX				
Signal path	ANT_RF2				
Scan-mode	Lin				
Input	2DC				
Tracking-gen.					
Probe transducer	_CBL 6112				
System transducer	ANT 1GHz M8				
add. transducer 1	None				
add. transducer 2	None				
add. transducer 3	None				

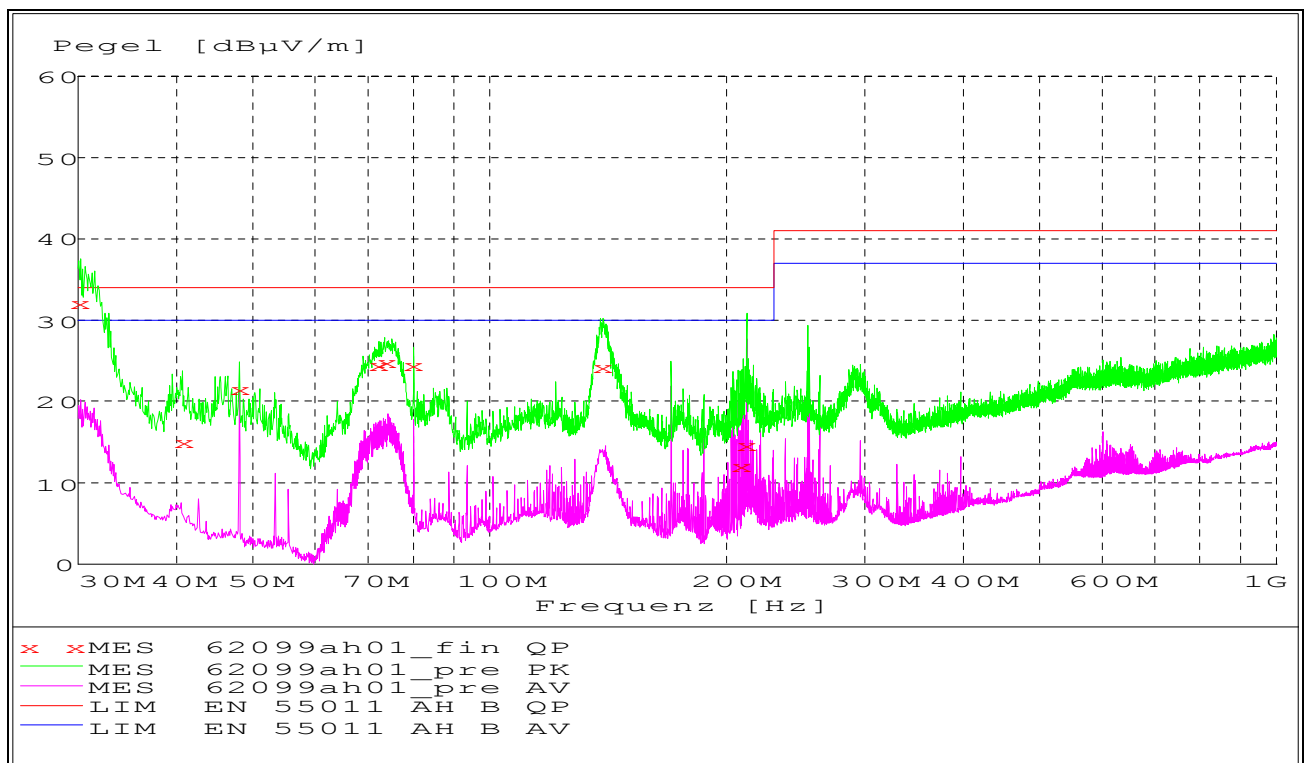
The measurement time with the quasi-peak measuring detector is 1 second.

The limit line and measurement curve shown in the diagram below refer to the preliminary measurements. Here, it must be noted that because of the reduced measuring distance and because of the floor absorbers, the measured values do not comply with the values of the above mentioned standard; they only serve as orientation in determining which frequencies must be measured on the open area test site.

The limit line is achieved with the applied standard by converting to a 3m measurement distance (+10 dB) and the correction for the free space in which in the "worst case" the reflected floor wave is missing entirely (-6dB). Therefore 4dB is added to the limit line of the standard concerned.

The curves in the diagram only represent the maximum measured value for each frequency point of all preliminary measurements, which were carried out with the EUT in various positions.

The top measured curve represents the peak measurement. The measured points marked with x are frequency points for which later measurements with a quasi-peak detector were carried out. These values are indicated in the following table. The bottom measured curve represents average values, which are only required for control purposes.



Data record name: 62099ah01

of 16.10.06

**Result measured with the quasipeak detector:**

(These values are marked in the above diagram by x)

Frequency MHz	Level dB $\mu$ V/m	Transducer dB	Limit dB $\mu$ V/m	Margin dB	Height cm	Azimuth deg	Polarisation
30.156000	32.40	20.0	34.0	1.6	150.0	74.00	VERTICAL
40.836000	15.30	13.5	34.0	18.7	150.0	110.00	VERTICAL
47.988000	21.70	10.4	34.0	12.3	150.0	189.00	VERTICAL
72.204000	24.60	7.8	34.0	9.4	150.0	296.00	VERTICAL
73.524000	25.10	7.9	34.0	8.9	150.0	294.00	VERTICAL
80.004000	24.80	8.9	34.0	9.2	150.0	353.00	VERTICAL
139.284000	24.30	12.9	34.0	9.7	150.0	88.00	HORIZONTAL
209.028000	12.10	10.6	34.0	21.9	150.0	226.00	VERTICAL
212.220000	15.00	10.5	34.0	19.0	150.0	109.00	HORIZONTAL

Data record name: 62099ah01\_fin QP

of 16.10.06

In this case it was necessary to carry out subsequent measurements because at some frequency points a value was above the Qualify limit curve during the preliminary measurements. The results from the standard subsequent measurements on the open area test site are presented in the following.

Title: Subsequent measurement on 10m open area test site  
 Test-Receiver ESCS30 from Rohde & Schwarz  
 EUT: electrical wheelchair "Zephyr"  
 Manufacturer: Invacare Deutschland GmbH  
 Operating Condition: 50% forward run  
 Test site: PHOENIX TESTLAB Blomberg; open area test site M6  
 Operator: M. Pohl  
 Test Specification: stand set-up  
 Comment:

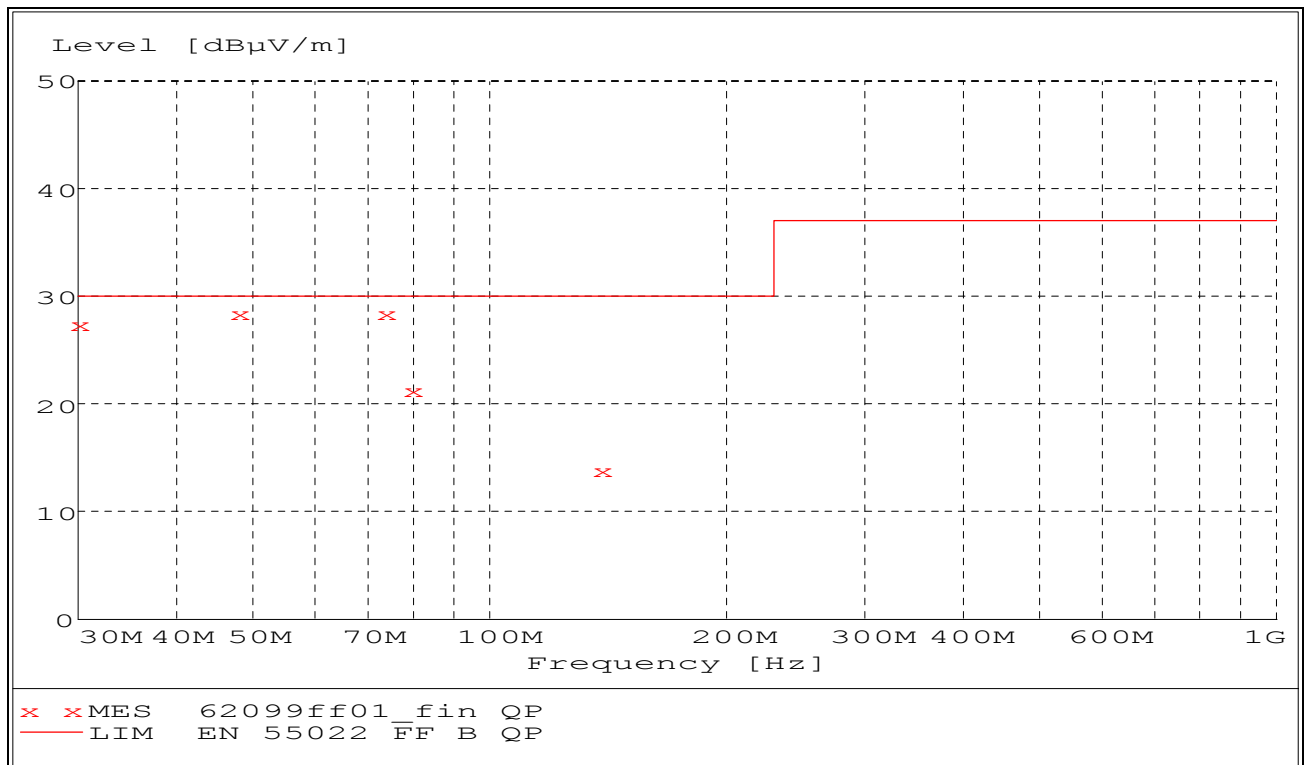
**Scantable for the subsequent measurement: E-Field M6\_fin**

Unit: dB $\mu$ V/m                      Curve 1                      Curve 2  
 Detector / Mode                      Average / ClearWrite                      None / ClearWrite

Subrange	1	2	3	4	5
Start frequency	30.0 MHz				
Stop frequency	1.0 GHz				
Increment	80.0 kHz				
IF-bandwidth	120 kHz				
Measurement time	100.0 ms				
Demodulation	A3				
Autorange	On				
Preamplifier	10 dB				
RF-attenuation	0 dB				
min. RF-attenuation	0 dB				
IF-attenuation	LowNoise				
Ref.-Level					
Receiver	ESCS				
Signal path	ANT_FF ESVS				
Scan-mode	Lin				
Input					
Tracking-gen.	Off				
Probe transducer	_CBL 6111A				
System transducer	Transducer FF				
add. transducer 1	None				
add. transducer 2	None				
add. transducer 3	None				

The measurement time with the quasi-peak measuring detector is 1 second.

The measured points and the limit line in the following diagram refer to the standard measurement of the emitted interference in compliance with the above mentioned standard. The measured points marked with x are the measured results of the standard subsequent measurement on the open area test site.



Data record name: 62099ff01

of 16.10.06

The results of the standard subsequent measurement on the open area test site are indicated in the table below. The limits as well as the measured results (levels) refer to the above mentioned standard while taking account of the specified requirements for a 10 m measuring distance.

### Result measured with the quasipeak detector:

(These values are marked in the above diagram by x)

Frequency MHz	Level dBµV/m	Transducer dB	Limit dBµV/m	Margin dB	Height cm	Azimuth deg	Polarisation
30.156000	27.50	18.5	30.0	2.5	154.0	316.00	VERTICAL
47.988000	28.60	9.8	30.0	1.4	100.0	75.00	VERTICAL
73.524000	28.50	7.8	30.0	1.5	147.0	167.00	VERTICAL
80.004000	21.20	8.5	30.0	8.8	150.0	7.00	VERTICAL
139.284000	14.00	12.9	30.0	16.0	100.0	271.00	VERTICAL

Data record name: 62099ff01\_fin QP

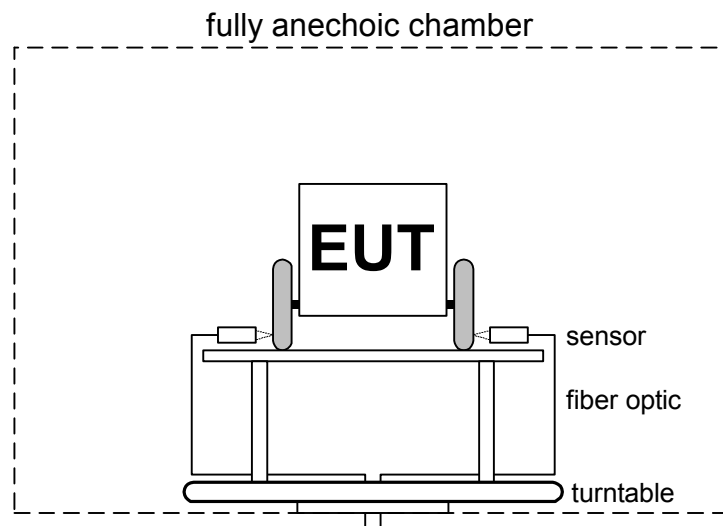
of 16.10.06

## 4 Test sequence and test results electromagnetic immunity characteristics

### 4.1 Immunity test for high frequency electromagnetic fields according to EN 61000-4-3

Test set-up:

- Table set-up
- The transmitting antenna is set at 1.5m above the floor.
- Photos of the test set-up can be referred to in the annex.
- The drawing below schematically shows the test set-up.



Monitoring of EUT:

visually:

With the camera system of the anechoic chamber

electrically:

The output signals were checked by the monitoring system outside the anechoic chamber.



Measuring devices: fully anechoic chamber M8 (PM-No. 480190)  
 antenna mast (PM-No. 480455)  
 turntable (PM-No. 480186)  
 controller HD100 (PM-No. 480181)  
 power amplifier AR1000LM20 (PM-No. 480198)  
 power amplifier AR1000W1000CM1 (PM-No. 480420)  
 signal generator SME06 (PM-No. 480174)  
 powermeter NRVD (PM-No. 480176)  
 insertion unit URV5-Z2 (PM-No. 480191, 480192)  
 terminating impedance RNB (PM-No. 410062, 410063)  
 amplifier interface SCIU (PM-No. 480178)  
 control unit Radisense (PM-No. 480430)  
 field sensor Radisense (PM-No. 480431)  
 power amplifier AR200T1G2 (PM-No. 480200)  
 waveguide coupler DC7144M1 (PM-No. 480390)  
 power amplifier AR200T2G4 (PM-No. 480201)  
 waveguide coupler DC7144M1 (PM-No. 480389)  
 signal generator SME03 (PM-No. 480245)  
 powermeter NRVD (PM-No. 480373)  
 power probe NRV-Z2 (PM-No. 480377, 480378)  
 relay interface KRE 2000-2-S-E (PM-No. 480374)  
 EMS-software package EMS-K1 (PM-No. 480112)  
 biconical antenna VHBC 9133 (PM-No. 480163)  
 log.-per. antenna AT1080 (PM-No. 480189) mounted on antenna support (PM-No. 480187)  
 horn antenna Schwarzbeck BBHA 9120 E (PM-No. 480335)  
 oscilloscope HP 54540A (PM-No. 480001)

Measuring records: The tests in the table below were carried out.

Date of test:	16.10.2006		
Ambient conditions:	42% F <sub>rel</sub> , 21°C; Air pressure conforms to the requirements of the standard		
Test level:	26 - 80 MHz; 20 V/m, 80% AM (1 kHz)		
Increment:	log 1%		
Dwell time:	2 s		
Distance antenna - test object:	2 m		
Polarisation	Radiation direction	EUT reaction	Result
vertical	0°	none detected	A
	90°	none detected	A
	180°	none detected	A
	270°	not tested	
horizontal	0°	none detected	A
	90°	none detected	A
	180°	none detected	A
	270°	not tested	

Date of test:		16.10.2006	
Ambient conditions:		42% F <sub>rel</sub> , 21°C; Air pressure conforms to the requirements of the standard	
Test level:		80 - 1000 MHz; 20 V/m, 80% AM (1 kHz)	
Increment:		log 1%	
Dwell time:		2 s	
Distance antenna - test object:		3 m	
Polarisation	Radiation direction	EUT reaction	Result
vertical	0°	none detected	A
	90°	none detected	A
	180°	none detected	A
	270°	not tested	
horizontal	0°	none detected	A
	90°	none detected	A
	180°	none detected	A
	270°	not tested	

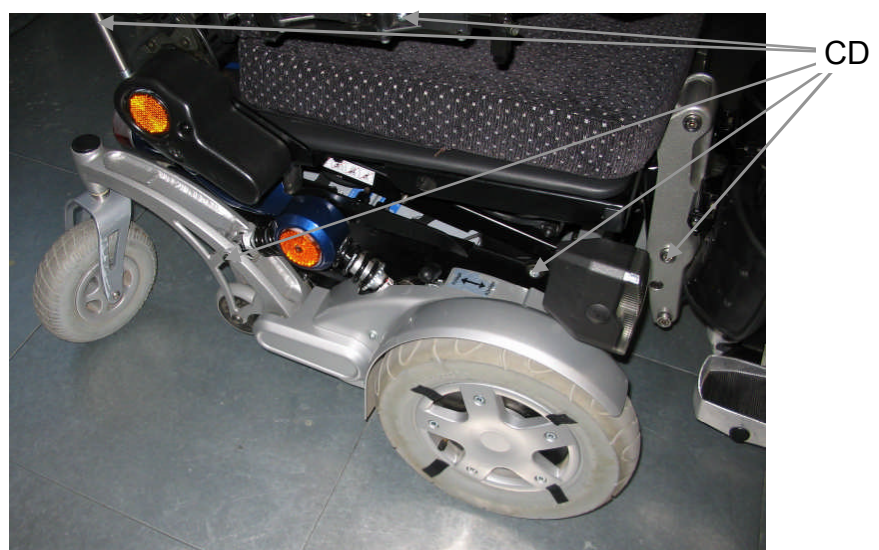
Date of test:		16.10.2006	
Ambient conditions:		42% F <sub>rel</sub> , 21°C; Air pressure conforms to the requirements of the standard	
Test level:		1710 - 1785; 1850 - 1910; 2000 - 2160 MHz, 20 V/m, 80% AM (1 kHz)	
Increment:		lin 10MHz	
Dwell time:		2 s	
Distance antenna - test object:		3 m	
Polarisation	Radiation direction	EUT reaction	Result
vertical	0°	none detected	A
	90°	none detected	A
	180°	none detected	A
	270°	not tested	
horizontal	0°	none detected	A
	90°	none detected	A
	180°	none detected	A
	270°	not tested	

Test results:                      The requirements of the test documents were fulfilled.

## 4.2 Immunity test for discharge of static electricity according to EN 61000-4-2

Test set-up:                   - Stand set-up  
                                       - Photos of the test set-up can be referred to in the annex.

Test plan:                     - The equipment under test is triggered with 10 positive and negative impulses each per discharge location and test voltage.  
                                       - Contact discharge (CD) is carried out on the conductive parts of the equipment under test and on the coupling plates for the indirect discharge.  
                                       - Air discharge (AD) is carried out on isolating parts of the equipment under test.  
                                       - The discharge locations can be seen on the following figure(s).



Measuring devices: Schaffner ESD simulator NSG 435 (PM-No. 480027)

Measuring records:

The tests in the table below were carried out.

Date of test:		16.10.2006	
Ambient conditions:		42% F <sub>rel</sub> , 21°C; Air pressure conforms to the requirements of the standard	
Number of impulses:		10 per polarity, test voltage and discharge location	
Method of discharge	Discharge location	EUT reaction	Result
contact discharge ± 2 kV	CD	none detected	A
contact discharge ± 4 kV	CD	none detected	A
contact discharge ± 6 kV	CD	none detected	A
contact discharge ± 8 kV	charge frame	none detected	A
air discharge ± 2 kV	AD	none detected	A
air discharge ± 4 kV	AD	none detected	A
air discharge ± 8 kV	AD	none detected	A

Test results: The requirements of the test documents were fulfilled.

## 5 Annex

The annex consists of 4 pages and contains pictures of the EUT and test set-ups:

Pictures of the test set-up for  
electromagnetic radiation disturbances:

62099m6a

Pictures of the test set-up for  
immunity to radio-frequency electromagnetic field:

62099m8f

Pictures of the test set-up for ESD:

62099m1e1  
62099m1e2  
62099m1e3