Product Service

TEST REPORT

PPP 31025A:2011 Rev. 2

TUV SUD Test Report for power and control systems for electrically powered wheelchairs and scooters

Report No.: Date of issue: Project handler:	713186854-2 2021-04-27 Matthias Müller
Testing laboratory: Address: Testing location:	TÜV SÜD Product Service GmbH Masurenweg 1-3, 30163 Hanover, Germany as above
Client: Client number: Address: Contact person:	SANO Transportgeraete GmbH 5010787488 Am Holzpoldlgut 22, 4040 Linz/Lichtenberg, Austria Stefan Schaubmair
Standard:	ISO 7176-14:2008
TRF number and revision*:*	PPP_31025A:2011, Rev. 2 of 2018-10
TRF originated by:	TUV SUD Product Service, Mr. Michael Steinmann *(product specialist)*
Copyright blank test report:	This test report is based on the content of the standard (see above). The test report considered selected clauses of the a.m. standard(s) and experience gained with product testing. It was prepared by TUV SUD Product Service. TUV SUD Group takes no responsibility for and will not assume liability for damages resulting from the reader's interpretation of the reproduced material due to its placement and context.
General disclaimer:	This test report may only be quoted in full. Any use for advertising purposes must be granted in writing. This report is the result of a single examination of the object in question and is not generally applicable evaluation of the quality of other products in regular production.
Scheme: Non-standard test method: National deviations:	☐ TUV Mark ☒ without certification ☐ EU-Directive ☒ No ☐ Yes, see details under Summary of testing N/A
Number of pages *(Report)*: Number of pages *(Attachments)*:	16 N/A
Compiled by: Andrei Ninu/ Matthias Müller	*SIGN-ID 498994* 27.04.2021
Approved by: Matthias Müller/ Andrei Ninu	*SIGN-ID 499437* 2021-04-28

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Test sample: Type of test object: Trademark: Model and/or type reference:	StoriX ID: HAN-540768-1 Stair climbing device  PTR
Rating(s):	See copy of marking plate
Manufacturer: Manufacturer number: Address:	SANO Transportgeraete GmbH 5010787488 Am Holzpoldlgut 22, 4040 Linz/Lichtenberg, Austria
Sub-contractors/ tests (clause): Name:	N/A N/A
Order description:	☐ Complete test according to TRF
	☒ Partial test according to manufacturer's specifications
	☐ Preliminary test
	☐ Spot check
	☐ Others:
Date of order: Date of receipt of test item: Date(s) of performance of test:	2020-03-03 2020-12-21 2020-12-21 to 2021-04-27

Test item particulars:

Electrically powered stair climbing device, type PTR

Purpose of the product (Description of intended use):

The PTR is a mobile stair climbing device with which wheelchairs and the wheelchair user sitting in them can navigate all types of stairs. It fits most commercially available wheelchair models It enables persons with walking disability to navigate over steps by an authorized assistant.

Characteristic data *(not shown on the marking plate)*:

N/A

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Attachments:

Attachment	Description	Pages
Kept in file	EMC Test Report (stair climbing device) EMV Consulting Test Report No. EMVC 2020-07-13-Rev_1, 2021-02-05	69
Kept in file	EMC Test Report (external power supply) EMV Consulting Test Report No. EMVC 2020-11-08, 2020-01-05	44
Kept in file	IEC 60335-2-29 Test Report Hongcai Testing Test Report No. HCT16HR-1116S, 2016-08-25	114
Kept in file	IP21 Test Report (external power supply) Waltek Testing Group Test Report No.WTH21F03018385S, 2021-03-25	8
Kept in file	User manual Liftkar PTR (LIFTKAR PTR 2020-10, REV 01)	39

General remarks:

"(see remark #)" refers to a remark appended to the report.
"(see appended table)" refers to a table appended to the report.
*Throughout this report **a comma** is used as the decimal separator.*
The test results presented in this report relate only to the object tested.

Summary of testing:

This report is the result of a partial test according to manufacturer's specifications.
In case of a full testing non-compliances can be located.

☐ deviation(s) found
☒ no deviations found

Additional information on Non-standard test method(s)

Sub clause: --

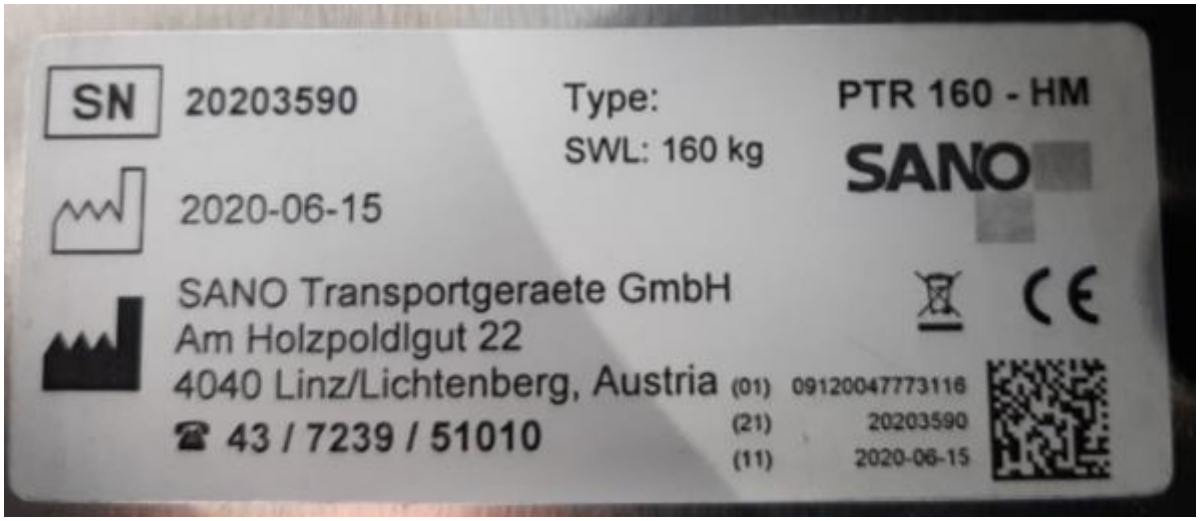
Page: --

Rational: --

If additional information is necessary, please provide

Following clauses were not part of clients order and not evaluated:
- 13.1 Protection against ingress of liquids min. IPX4 (according to ISO 7176-9)

Copy of marking plate:



Battery connection diagram: N/A

(bolted housing, access only for authorised personnel)

Picture of the product:




Name and address of factory (ies) *(only if certification is provided)*:
N/A

Possible test case verdicts:

test case does not apply to the test object:	N/A (not applicable / not included in the order)
test object does meet the requirement:	P (Pass)
test object does not meet the requirement:	F (Fail)

Possible suffixes to the verdicts:

suffix for detailed information for the client:	C (Comment)
suffix for important information for factory inspection:	M (Manufacturing)

Clause	Requirement + Test	Result – Remark	Verdict
5	**Preparation of test wheelchair**		---
5.1	Wheelchair/scooter set-up in accordance with ISO 7176-22.	Stair climbing device	N/A
5.2	Mass and configuration of test load		---
	a) Dummy acc. ISO 7176-22		N/A
	b) Human combinied with weights	82 kg combinied with 80 kg	P
5.3	Wheelchair/scooter attributes		---
	Maximum speed V_{MAX} on a horizontal surface (according to ISO 7176-6)	V_{MAX} = 0.5 km/h not designed for long runs over horizontal surfaces.	P
	Maximum stopping distance Li on inclined test plane (according to ISO 7176-3)	Li = 0.05 m (3° slope)	P
5.4	Obtain circuit diagrams for the wheelchair from the the wheelchair manufacturer.		P
5.5	Preparation records		---
5.5.a)	Equipment specified for test		P
5.5.b)	Position of adjustable parts (body support)	No such	N/A
5.5.c)	Battery type and manufacturer	See appended table 9.7	P
5.5.d)	Safe working load (SWL):	160 kg (user + manual wheelchair)	P

6	**Guidance for tests**		---
6.2	Batteries		---
	Nominal voltage of the battery set	V_{NOM} = 24 V_{DC}	P
	Cut-off voltage of the battery set	$V_{cut-off}$ = 10 V_{DC}	P
6.3	Test conditions		---
	Ambient temperature (20 °C ± 5 °C)	T = 21.0 °C - 22.4 °C	P

7	**Single fault safety**		---
7.1	Software testing addressed separately	Software developed and maintained in accordance with EN 62304 (see appended table 7.1)	P
	Means by which the wheelchair is made safe against single fault conditions	(see appended table 7.1)	P
7.2	Controller **command signal processing** failures		---

Clause	Requirement + Test	Result – Remark	Verdict
7.2.3.2	Open-circuit test at 0.5v_I		---
	Open switch	Li = 0.04 m (3° slope)	P
	Open switch (control device in stop position)	Li = 0.04 m (3° slope)	P
7.2.3.3	Short-circuit test at 0.5v_I		---
	Open switch	Li = 0.04 m (3° slope)	P
	Open switch (control device in stop position)	Li = 0.05m (3° slope)	P
7.2.3.4	Leakage current test	(see appended table 7.2.3.4)	P
7.3	Controller **output device** failure		---
7.3.3.2	Open-circuit test at 0.5v_I		---
	Open switch	Li = 0.05 m (3° slope)	P
	Open switch (control device in stop position)	--	N/A
7.3.3.3	Short-circuit test at 0.5v_I		---
	Open switch	Li = 0.04 m (3° slope)	P
	Open switch (control device in stop position)	--	N/A
7.4	Ability to stop when power is removed		---
7.4.3.d	Stopping distance (control device in FWD direction)		N/A
7.4.3.e	Steering response		N/A
7.4.3.f	Stopping distance		N/A
7.4.3.i	Arithmetic mean stopping distance (d, e, f)		N/A
7.4.3.k	Stopping distance (control device in stop position)		N/A
7.4.3.m	Arithmetic mean stopping distance (k)		N/A

8	**Design**		---
8.1	There shall be available at least one means to switch on/off the wheelchair.	On/Off switch on hand control	P
	On/Off switch marking		P
	Switching off does not cause drive wheels to revolve		P
8.2	Current consumption while switched off	$I_{2900} = C_{20} / 2900 = 4.14$ mA $I_{measured} = 0.2$ mA	P
8.3	Control signal at switch on		---

Clause	Requirement + Test	Result – Remark	Verdict
	No moving if any control device is not in neutral position if the wheelchair is switched on.		P
8.4	Safe operation as the battery set becomes depleted		---
8.4.1	No hazardous situation when the battery set nears depletion.	Visual and acoustic signal	P
8.4.3.2	Upslope test		N/A
8.4.3.3	Downslope test		N/A
8.5	Over-discharge protection		---
8.5.2.2	Battery set test method (discharge)	See 8.5.2.3	P
8.5.2.3	Voltage source test (discharge simulation)	U_{min} = 20.2 V_{DC}	P
8.6	Controller over-voltage protection	U_{max} = 39.0 V_{DC}	P
8.7	Switch-off while driving		---
8.7.c	Switch-off at max. forward speed shall not create a hazardous situation	System STOP, no hazard	P
8.7.e	Switch-off at max. reverse speed shall not create a hazardous situation	System STOP, no hazard	P
8.8	Measuring devices		---
8.8.2.3	Indication that battery set is nearing depletion		P
8.8.2.4	Indication of remaining distance range (informative)		N/A
8.9	Drive inhibit during charging		P
8.10	Charging connection voltage drop		---
8.10.2	Voltage difference dU does not exceed 3.5 % of the nominal voltage of thre battery set	Battery charger supplied with the device	N/A
	Charging current		---
	Entry point voltage		---
	Terminal voltages of batteries		---
	Total battery voltage		---
	Voltage drop		---
8.11	Non-powered mobility		---
	The force to disengage the braking system shall not exceed		---
	– 60 N for combined hand and arm operation;		N/A
	– 13,5 N for operation by one hand;		N/A
	– 5 N for operation by one finger;		N/A

Clause	Requirement + Test	Result – Remark	Verdict
	– 100 N for operation by pushing with a foot;		N/A
	– 60 N for operation by pulling with a foot.		N/A
	Max. pushing force to start the wheelchair loaded with SWL [$F_{push} \leq 65 + (0.6 * SWL)$]		N/A
8.12	Brakes		---
8.12.3.c	Fault of brake system with the wheelchair/scooter facing up the slope		N/A
	Fault of brake system with the wheelchair/scooter facing down the slope		N/A
8.13	Battery enclosures		---
	Adequately ventilated ($A = 0.005 * n * C_5$)	Several holes, more than 0.09 cm^2	P
	Leakage at 20° tilt (must be tested for non-spillable batteries)		N/A
8.14	Symbols		---
	Used symbols in accordance with IEC 60601-1		P
8.15	Safety of moving parts		---
	Electrically powered moving parts do not present a hazard		P
8.16	Use in combination with other devices		---
	If the wheelchair is intended by the manufacturer for use in combination with other devices that would be electrically connected to the battery set shall conform to ISO 7176-14		N/A

9	**Protection against shock, burns, fire and explosion**		---
9.1	Electrical isolation		---
9.1.3.2	Positive connection test	$I_{pos} \leq 0.1$ mA *(enclosure parts)*	P
9.1.3.3	Negative connection test	$I_{neg} \leq 0.1$ mA *(enclosure parts)*	P
9.2	Protection from non-insulated electrical parts		---
9.2.2	Battery terminals insulated	Closed battery cover, only for authorized personnel	N/A
9.2.3	Non-insulated electrical parts not touchable or no direct current above 5mA flows		N/A
9.3	Circuit protection		---

Clause	Requirement + Test	Result – Remark	Verdict
	Wiring and connection protected against excessive current flow		P
	No self-reset circuit protection device used		P
	No hazardous parts touchable when changing fuses (without using a tool)		N/A
9.3.3.2	Short circuit test for battery power wiring		---
9.3.3.2.a	Circuit protection device within circuit loop	20A car fuse (yellow)	P
9.3.3.2.d	Observed results after closing circuit breaker	Fuse blowed immediately	P
9.3.3.3	Short circuit test for other than traction current wiring		---
9.3.3.3.a	Circuit breaker on test points B	Insulated contacts	P
9.3.3.3.b	Circuit breaker on test points C	Insulated contacts	P
9.3.3.3.c	Circuit breaker on test points D	Insulated contacts	P
9.3.3.4	Load current test for wiring that carries battery charging current		---
	Capacity of the circuit protection device (must be installed) that carries battery charging current	(see appended table 7.1)	P
	Observed results after closing circuit breaker	(see appended table 7.1)	P
9.4	Stalled condition protection		---
9.4.3.1	Initial stall test for 3 minutes (up to a maximum of five test cycles if circuit protection devices is triggered)	System stops immediately, visual and acustic warning. No hot surfaces or damages, function as usual after switching ON/OFF.	P
9.4.3.2	Extended stall test for 30 minutes	System stops immediately, visual and acustic warning. No hot surfaces or damages, function as usual after switching ON/OFF.	P
9.5	Surface temperatures		---
	Max. surface temp. within occupant reach space	No surfaces with changing temperatures within occupant reach space	P
9.6	Disconnection of battery system		---
9.6.2	Means for disconnecting battery set provided (without using a tool)		P
9.7	Resistance to ignition		---
9.7.2	Material classification		P

Clause	Requirement + Test	Result – Remark	Verdict
10	**Ergonomics**		---
10.1	User interface		---
	Correct marking (IEC 60601-1 / ISO 3287)		P
	Visual indicators with the colour red only used for warning		P
	All symbols, visual indicators and sounds described in the user manual		P
	Size and style appropriate for viewing distance		P
10.2	Operating forces		---
10.2.3.1	Lever to control speed and/or direction	F_{speed} = 2 - 3 N (switch)	P
10.2.3.2	Push button, rocker and keypad switches	F_{button} = 3 - 5 N	P
10.2.3.3	Toggle switches	F_{switch} =	N/A
10.2.3.4	Pneumatic switches (sip and puff)	F_{pneu_switch} =	N/A
10.3	Display position		---
	Devices that present visual information positioned so that they are clearly visible by the occupant.		P
10.4	On/off indicator provided		P
10.5	Connectors		---
	Connectors can be connected and disconnected without the use of tools		P
10.6	Audible noise		---
10.6.3	Max. driving noise level	L_{drive} = 64.6 dB (A)	P
10.6.4	Max. electrically adjustable body support components noise level		N/A
10.7	Acoustic warning device		---
10.7.3	Max. sound level [db(A)] and frequency [Hz]		N/A

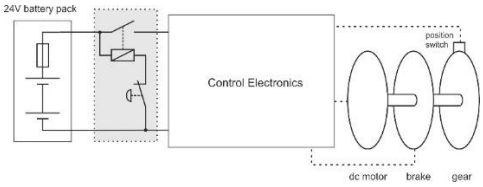
11	**Durability**		---
11.1	Control devices		---
11.1.2.2.b	Control device operates adequately		P
11.1.2.2.c	Operating force	See 10.2.3.2	P
11.1.2.2.d	Operating distance	D = 3 mm	P
	1.5 million operating cycles test		N/A
11.2	Switches		---

Clause	Requirement + Test	Result – Remark	Verdict
11.2.2	100,000 operating cycles test		P
11.3	Connectors		---
11.3.2	Connectors intended for daily use have adequately robustness (rated 4,000 cycles)	Charging connector	P
12	**Electrical connections**		---
12.1	Interchangeability of connectors		P
12.2	Wire routing secure		P
12.3	Wire colors		---
	All wires connected to the positive terminal of the battery set shall be red and permanently marked with a “+” symbol	Closed battery cover, only for authorized personnel	N/A
	All wires connected to the negative terminal of the battery set shall not be red and shall be permanently marked with a “-“ symbol	Closed battery cover, only for authorized personnel	N/A
12.4	Intermediate battery connection power drains		---
	No power drawn from the battery set other than via the positive and negative terminals		N/A
13	**Environmental**		---
13.1	Protection against ingress of liquids min. IPX4 (according to ISO 7176-9)		N/A C
13.2	Protection against leakage of substances		N/A
13.3	Electromagnetic compatibility (according to ISO 7176-21)	See summary of contents	P
14	**Misuse and abuse**		---
14.1	Reversed polarity at the battery set	Closed battery cover, only for authorized personnel	P
14.2	Integrity of enclosures (IK10 impact test)	5 kg impact hammer applied	P

Clause	Requirement + Test	Result – Remark	Verdict
15	**Information provided with the wheelchair related to control systems**		---
15.1	Accompanying documents		P
15.2	Battery connection and circuit protection diagram		P
15.3	User manual provided with the flowing information:		---
15.3.a	Safety information provided as specified in 15.4		P
15.3.b	Statement that only specified products are to be used with the wheelchair		P
15.3.c	Safety performance of set up procedures		P
15.3.d	Information of properly set up		P
15.3.e	Correct use of brakes		N/A
15.4	Safety information with the following information provided to operators:		---
15.4.a	Consult accompanying documents		P
15.4.b	Warning for switch off before entering or exiting		P
15.4.c	Warning for possible sudden stop		P
15.4.d	Warning not to operate when behaving abnormally		P
15.4.e	Special environment storage condition		P
15.4.f	Interpretation of battery gauge		P
15.4.g	Warning not to operate with depleted batteries		P
15.4.h	Instructions for service (including intervals)		P
15.4.i	Safety warnings related to pinch points		P
15.4.j	Electromagnetic interference and possible effects		P
15.5	Correct fitting of removable parts		P
15.6	Information regarding residual risks		P
	All symbols, visual indicators and sounds described in the user manual (clause 10.1)		P

17	**Disclosure**		---
	The following information shall be disclosed as specified in ISO 7176-15:		---
17.a	product meets all requirements of ISO 7176-14		P
17.b	forces necessary to operate the control devices		N/A
17.c	pressures necessary to operate pneumatic switches (sip and puff operation)		N/A

7.1	**TABLE: Single fault conditions** [1]		P
	Test type and condition	Remarks and observed results	---
	Motor		--
	One DC Motor Fault Injection: Short-circuit of the Power Stage => motor rotates continuously	Protection means: Short circuit detection (implemented in the motor driver) The power stage of the control electronics has a short circuit protection realised in hardware by the gate driver. Additionally, there is an emergency button for allowing the supervising person/user to timely stop the movement when a hazardous situation is identified. The emergency button is directly interrupting the connection to the battery, setting the safe state of the stair climber.	P
	Power Supply		--
	Battery – Lead From the 24V – the following voltages are derived: a 3,3V voltage supply for the microcontroller, 5V for drivers, 7V & 12V Fault Injection: under-voltage 3.3V.	The brown-out circuit will cut-off the voltage when below 2V (still within specs). In case of a voltage regulator failure and therefore possible microcontroller malfunction the measures according to subclass “User Interface” may be carried out PTR: Push emergency button) Over-undervoltage for all other voltages in the system, 5V, 7V, 12V are detected by the microcontroller which is able to timely trigger the safe-state.	P

	User Interface		--
	A switch is integrated in the Control panel for changing the direction – forwards/backwards Fault Injection: Cable issue results in an unexpected movement/direction.	Details are provided – in the Risk Assessment – "20210130 Elektonik FMEA_PT_PTR" RISK ID 1.13.5 The motor changes the direction unintentionally. Prevention of unintentional changes of direction: PTR: The single signal for the change between "up" and "down" is low active. A change of the direction during operation is not possible. If the "up/down" button is pressed for a short time during operation the direction is not changed, only the green LED indicates that the preselected direction has changed. After a stop the stairclimber will move in the direction indicated by the green LED when operation is started again. If the "up/down" button is pressed permanently (e.g. due to a cabling issue) the operation is stopped and the stairclimber is switched off. Unintentional change of direction during operation is inhibited **1 Measurements see document "Measurements 2021-01-04 SFC- Treppensteiger #2" chapter 3 "Measurements to subject 'User Interface'"** Additionally, there is an emergency button for allowing the supervising person/user to timely stop the movement when a hazardous situation is identified. The emergency button is directly interrupting the connection to the battery setting the safe state of the stair climber. Details are provided – in the Risk Assessment – "BA_de_PTR Bedienungsanleitung 10_2020 - SANO Deutschland" page 12 Functional chain of the emergency button:  Alternatively, the user/supervising person may lay down the stair-climber on the stairs. The motor will continuously move, but it will have, no consequences to the patient's safety. Details are provided – in the Risk Assessment – "BA_de_PT_Bedienungsanleitung 10_2020 - SANO Deutschland" page 46	P
[1] *Individually set by test engineer depending on safety philosophy / safety requirements, existing component certificates and result of documentation assessment*.			
Supplementary information: N/A			

7.2.3.4	**TABLE: leakage current tests**	P
Test point	Resistance value	Remark
Connecting points	20 kΩ - 1 MΩ	No moving
Supplementary information: N/A		

9.7	**TABLE: lists of critical component parts** [1]				P
Object/part No	Manufacturer/ trademark	Type/model	Technical data	Standard	Mark(s) of conformity[2])
Battery charger	Soneil International Limited	2403SRL	IN: 100-240 V_{AC}, 50/60 Hz, 1.5 A OUT: 24 V_{DC}, 2 A	EN 60335-2- 29	--
Battery	Cell Power	CP 12-12	2 x 12 V_{DC}, 12 Ah (C_{20})	--	--
Drive motor	AMT	SLB	24 V_{DC}, 12 A, 2500 RPM	--	--
Fuse	Littelfuse	ATOF® BLADE	20 A, 32 V	--	--

[1] *Safety relevant components can be programmable electronic controllers, fuses, fuseholders, plugs, sockets, motors, wiring, switches, temperature regulators and -switches, relays, battery chargers, component materials, enclosures etc.*

[2] *an asterisk indicates a mark which assures the agreed level of surveillance*

Supplementary information: N/A