



BSI Standards Publication

Wheelchairs

Part 14: Power and control systems for electrically powered wheelchairs and scooters — Requirements and test methods

National foreword

This British Standard is the UK implementation of ISO 7176-14:2022+A1:2025. It supersedes BS ISO 7176-14:2022, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to ISO text carry the number of the ISO amendment. For example, text altered by ISO amendment 1 is indicated by A1 A1.

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A list of organizations represented on this committee can be obtained on request to its committee manager.

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Part 14:

Power and control systems for electrically powered wheelchairs and scooters — Requirements and test methods

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*Partie 14: Systèmes d'alimentation et de commande des fauteuils
roulants et des scooters électriques — Exigences et méthodes d'essai*



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 173, *Assistive products*, Subcommittee SC 1, *Wheelchairs*.

This third edition cancels and replaces the second edition (ISO 7176-14:2008), which has been technically revised.

The main changes compared to the previous edition are as follows:

- addition of provisions on the following:
 - wireless communication technology;
 - thermal drive test;
 - occupant operable battery isolation switch;
 - battery chemistries other than lead-acid.

A list of all parts in the ISO 7176 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Electronic control systems in electric powered wheelchairs and scooters are critical for the safety, functionality and reliability of the vehicle.

This document specifies some wheelchair tests that are conducted on an inclined test plane. The intention of these tests is not to evaluate the performance of a wheelchair at the maximum gradient on which it is capable of operating. Instead, the objective is to reveal any changes in the wheelchair's behaviour that might occur under fault conditions, and these changes are more readily discovered when it is operated on a slope. For convenience, the inclined test plane has a fixed gradient, representative of those on which the wheelchair might be used.

The range of ambient temperatures under which testing is carried out is limited to allow comparison between the performance of a wheelchair in normal operation and performance when faults are introduced.

With inter-module wireless communication becoming more common with the possibility that the communication may cause changes in the behaviour of other devices, a subclause has been added to assist with an associated safety assessment.

Wheelchairs —

Part 14:

Power and control systems for electrically powered wheelchairs and scooters — Requirements and test methods

1 Scope

This document specifies requirements and associated test methods for the power, and control systems of electrically powered wheelchairs and scooters. It sets safety and performance requirements that apply during normal use and some conditions of abuse and failure. It also specifies methods of measurement of the forces necessary to operate controls and sets limits on the forces needed for some operations.

This document is applicable to electrically powered wheelchairs and scooters with a maximum speed no greater than 15 km/h intended to provide indoor and/or outdoor mobility for one disabled person whose mass lies in the range specified in ISO 7176-11.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12182, *Assistive products for persons with disability — General requirements and test methods*

A1 IEC 60332-1-2:2004 **A1**, *Tests on electrical and optical fibre cables under fire conditions - Part 1-2: Test for vertical flame propagation for a single insulated wire or cable - Procedure for 1 kW pre-mixed flame*

IEC 60417, *Graphical symbols for use on equipment*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60601-1, *Medical electrical equipment — Part 1: General requirements for basic safety and essential performance*

IEC 61032, *Protection of persons and equipment by enclosures — Probes for verification*

IEC 62262, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*

IEC 62304, *Medical device software – Software life cycle processes*

ISO 10993-1, *Biological evaluation of medical devices — Part 1: Evaluation and testing within a risk management process*

ISO 7176-2, *Wheelchairs — Part 2: Determination of dynamic stability of electrically powered wheelchairs*

ISO 7176-3, *Wheelchairs — Part 3: Determination of effectiveness of brakes*

ISO 7176-4, *Wheelchairs — Part 4: Energy consumption of electric wheelchairs and scooters for determination of theoretical distance range*

ISO 7176-5, *Wheelchairs — Part 5: Determination of dimensions, mass and manoeuvring space*

ISO 7176-6, *Wheelchairs — Part 6: Determination of maximum speed of electrically powered wheelchairs*

ISO 7176-7, *Wheelchairs — Part 7: Measurement of seating and wheel dimensions*

ISO 7176-9:2009, *Wheelchairs — Part 9: Climatic tests for electric wheelchairs*

ISO 7176-10, *Wheelchairs — Part 10: Determination of obstacle-climbing ability of electrically powered wheelchairs*

ISO 7176-13, *Wheelchairs — Part 13: Determination of coefficient of friction of test surfaces*

ISO 7176-15, *Wheelchairs — Part 15: Requirements for information disclosure, documentation and labelling*

ISO 7176-21:2009, *Wheelchairs — Part 21: Requirements and test methods for electromagnetic compatibility of electrically powered wheelchairs and scooters, and battery chargers*

ISO 7176-22, *Wheelchairs — Part 22: Set-up procedures*

ISO 7176-26, *Wheelchairs — Part 26: Vocabulary*

ISO 13732-1, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 1: Hot surfaces*

ISO 14971, *Medical devices — Application of risk management to medical devices*

UL 94, *Tests for flammability of plastic materials for parts in devices and appliances*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7176-26 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

analogue signal

signal in which the characteristic quantity representing information can at any instant assume any value within a continuous interval

Note 1 to entry: An analogue signal can follow continuously the values of another physical quantity representing information.

[SOURCE: IEC 702-04-02]

3.2

battery

one or more cells that are electrically connected together and fitted with devices necessary for use

EXAMPLE Case, terminals, marking and protective devices.

[SOURCE: IEC 482-01-04, modified]

3.3

battery charger

device that is connected to supply mains and to a battery set for the purpose of charging the batteries

3.4**battery compartment**

removable or non-removable enclosure for one or more batteries

3.5**battery set**

set of interconnected batteries used to power a wheelchair

3.6**battery terminal**

terminal on a battery to which a cable or connector can be connected

3.7**capacity**

electric charge that a cell or battery can deliver under specified discharge conditions

Note 1 to entry: The SI unit for electric charge is the coulomb, C [1 C = 1 A·s (ampere-seconds)] but in practice, capacity is usually expressed in ampere-hours (A·h) or watt-hours (Wh).

[SOURCE: IEC 482-03-14, modified]

3.8**charge completion voltage**

voltage, normally specified by the battery manufacturer, to which a battery is charged in defined circumstances, required to assure that a battery can be fully charged

3.9**charge rate**

electric current at which a secondary cell or battery is charged

Note 1 to entry: The charge rate is expressed as the reference current $I_t = C_r/n$ where C_r is the rated capacity declared by the manufacturer and n is the time base in hours for which the rated capacity is declared.

[SOURCE: IEC 482-05-45]

3.10**coexistence**

ability of two or more spectrum-dependent devices or networks to operate without harmful interference.

Note 1 to entry: Spectrum dependence may include, but is not limited to radio, ultrasound and infrared.

[SOURCE: IEEE Std 1900.1:2008, B28]

3.11**command signal**

electrical signal from the control device

3.12**control device**

device with which the operator indicates the desired speed and/or direction of movement of the wheelchair and can optionally control their position within the wheelchair

Note 1 to entry: A control device can be an integral part of a controller.

3.13**controller**

electrical devices, circuits, and the case(s) in which they are housed, that are used to convert the operator's indication of desired speed and/or direction of movement into the appropriate power that is supplied to the motor(s)

3.14

cut-off voltage

voltage specified by the battery manufacturer at which the discharge of a battery is considered finished

[SOURCE: IEC 482-03-30, modified]

3.15

discharge rate

electric current at which a battery is discharged

Note 1 to entry: The discharge rate is calculated as the rated capacity divided by the corresponding discharge time, which results in an electric current.

[SOURCE: IEC 482-03-25]

3.16

draught-free environment

space in which the results of experiments are not significantly affected by the local air speed

Note 1 to entry: A qualitative example is a space in which a wax candle flame remains essentially undisturbed. Quantitative examples are small-scale fire tests in which a maximum air speed of $0,1 \text{ m}\cdot\text{s}^{-1}$ or $0,2 \text{ m}\cdot\text{s}^{-1}$ is sometimes specified.

[SOURCE: ISO 13943:2017, 3.83]

3.17

enclosure

part providing protection of equipment against certain external influences and, in any direction, protection against contact

Note 1 to entry: Enclosures provide protection of equipment against harmful effects of mechanical impacts.

Note 2 to entry: Barriers, shapes of openings or any other means – whether attached to the enclosure or formed by the enclosed equipment – suitable to prevent or limit the penetration of the specified test probes, are considered as a part of the enclosure, except when they can be removed without the use of a key or tool.

3.18

entry point

output terminals of the battery charger for on-board, off-board and carry-on chargers

3.19

harm

physical injury or damage to the health of people or animals, or damage to property or the environment

[SOURCE: IEC 60601-1:2005+AMD1:2012, 3.38]

3.20

hazard

potential source of harm

[SOURCE: IEC 60601-1:2005+AMD1:2012, 3.39]

3.21

hazardous situation

circumstance in which people, property or the environment are exposed to one or more hazard(s)

[SOURCE: IEC 60601-1:2005+AMD1:2012, 3.40]

3.22

latched control

function that remains active without continuous input from the operator

3.23**leakage current**

electric current in an unwanted conductive path other than a short circuit

[SOURCE: IEC 151-15-49]

3.24**pinch point**

location at which a moving part comes into contact with or close proximity to another part such that another object at that location would be cut or crushed

3.25**single fault condition**

condition in which a single means for reducing a risk is defective or a single abnormal condition is present

[SOURCE: IEC 60601-1:2005+AMD1:2012, 3.115, modified]

3.26**switch**

mechanical switching device capable of making, carrying and breaking currents under normal operating conditions which might include specified operating conditions, overload conditions and also carrying for a specified time currents under specified abnormal circuit conditions such as those of short circuit

Note 1 to entry: A switch may be capable of making but not breaking short circuit currents.

[SOURCE: IEC 441-14-10]

3.27**terminal**

conductive part of a device, electric circuit or electric network, provided for connecting that device, electric circuit or electric network to one or more external conductors

Note 1 to entry: Removable bolts, screws and fasteners are not considered part of a terminal.

[SOURCE: IEC 151-12-12]

3.28**theoretical state of charge**

electric charge added to a fully discharged battery by charging at a known charge rate for a known time, or estimated to remain in a battery that has been fully charged and then discharged at a known discharge rate for a known time, and expressed as a percentage of the rated capacity

4 Apparatus

4.1 Inclined test plane, with a surface of sufficient friction as specified in ISO 7176-13 to cause minimal wheel slippage, of sufficient size to enable the applicable tests specified in this document to be performed and with a marker from which wheelchair stopping distance can be measured.

The inclined test plane shall be able to be fixed at 3°, 6° or 10° to the horizontal. The 6° gradient shall be used unless the loaded wheelchair (see 5.2) is unable to climb at a speed greater than 0,5 km/h or where its primary purpose specified by the manufacturer is for indoor use in which case the gradient shall be set at 3°.

NOTE A ramp approximately 10 m × 3 m is normally of sufficient area, but the testing of larger and/or faster wheelchairs might need a larger ramp.

4.2 Horizontal test plane, with the same high-friction surface as the inclined test plane (4.1), and of sufficient size to enable the applicable tests specified in this document to be performed.

NOTE An area of approximately 10 m × 3 m is normally of sufficient size but the testing of larger and/or faster wheelchairs might need a larger test plane.

4.3 Acoustic test area, marked on a horizontal plane in a room with an ambient noise level not exceeding 55 dB(A-weighted) and of sufficient length for the wheelchair to attain its maximum speed before reaching the test area specified in [10.6](#) and to stop safely beyond the test area.

The room shall also have a mean reverberation time (R_T) less than 0,5 s for frequencies from 125 Hz to 4 kHz at the position where sound pressure levels are measured. See [Annex B](#) for guidance on estimation of reverberation time.

The test floor shall be uncoated concrete in the area where the chair is driven.

4.4 Means for measuring and recording speed up to 5 m/s, with an accuracy of $\pm 0,1$ m/s and a sample rate of at least 60 Hz. for digital measuring devices.

4.5 Means of measuring stopping distance of a wheelchair, to an accuracy of ± 100 mm.

NOTE It is important that the means for measuring the speed ([4.4](#)) and stopping distance give the required accuracy. Suitable methods include, but are not limited to:

- a) a photocell-operated interrupting switch capable of detecting reflective tape or a light source on the test plane;
- b) a “fifth wheel” capable of recording the distance travelled where the recording device can be started by the interrupting switch.

4.6 Voltage source, with a voltage adjustable in the range $0,25 U_B$ to $1,5 U_B$, where U_B is the nominal voltage of the battery set, expressed in volts.

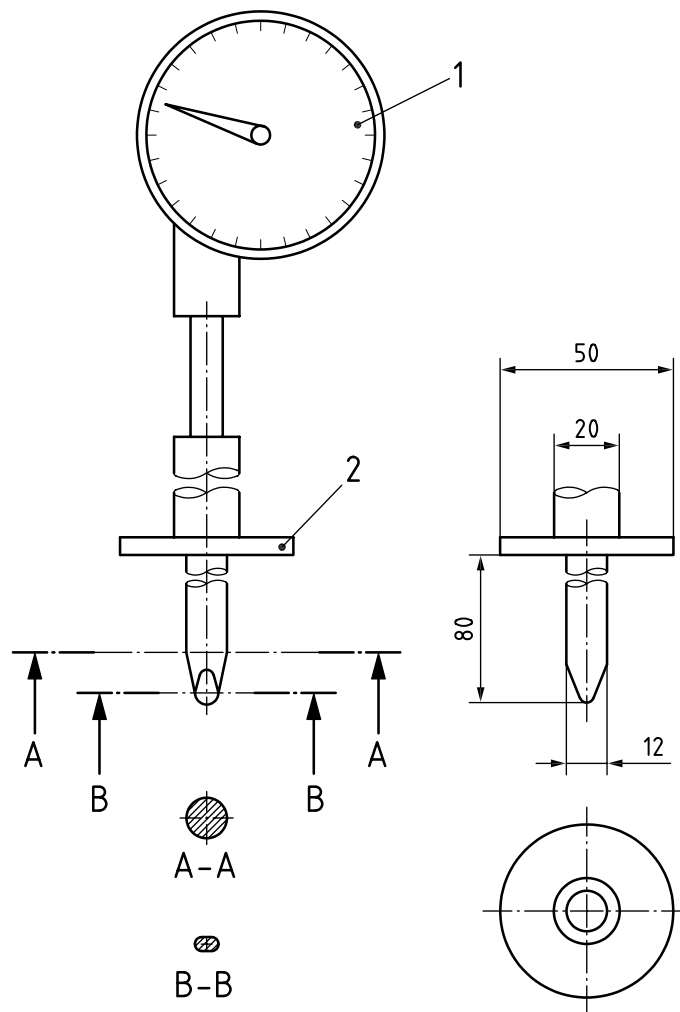
The voltage source shall be capable of supplying the peak current drawn from the battery set during wheelchair operation and shall be capable of sinking the peak current returned to the battery during wheelchair operation. Any change in the voltage shall be no greater than 5 % of U_B while the current is within this range.

4.7 Test probe B, as specified in IEC 61032.

4.8 Test probe 18, as specified in IEC 61032.

4.9 Test probe 11, as specified in IEC 61032, capable of attachment to a force measuring instrument ([4.11](#)). See [Figure 1](#).

Dimensions in millimetres

**Key**

- 1 force measuring instrument
- 2 stop plate

Figure 1 — Test probe 11

4.10 Small unjointed test probe, constructed as specified for test probe 18 (4.8), but without joints, and capable of attachment to a force measuring instrument (4.11) both with and without the handle extension.

4.11 Force measuring instrument, capable of measuring forces in the range of 0 N to 150 N in increments of 1 N with an accuracy of ± 1 N.

4.12 Force measuring instrument for control devices, capable of measuring forces in a range of 0 N to 10 N in 0,1 N increments with an accuracy of $\pm 0,1$ N, and that can be fitted with a rigid spherical tip of radius $5,0 \text{ mm} \pm 0,2 \text{ mm}$.

4.13 Positive differential air pressure measuring device, capable of measuring positive differential air pressure, relative to local atmospheric pressure, in a range of 0 kPa to 20 kPa in 200 Pa increments with an accuracy of ± 200 Pa.

4.14 Negative differential air pressure measuring device, capable of measuring negative differential air pressure, relative to local atmospheric pressure, in a range of 0 kPa to -20 kPa in 200 Pa increments with an accuracy of ± 200 Pa.

4.15 Test circuit, that can be arranged as shown in [Figure 2](#) and [Figure 3](#), comprising the following:

- a) direct current ammeter, capable of measuring current in the range 0 mA to 10 mA in 1 mA increments with an accuracy of ± 1 mA, and capable of withstanding a current of 100 mA;
- b) a resistor of resistance $R \pm 5\%$, where R (in ohms) is calculated from:

$$R = \frac{U_B}{0,1}$$

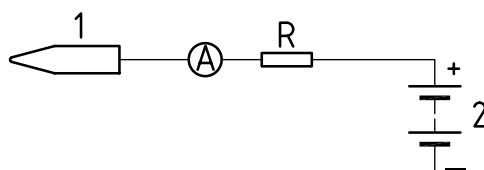
where U_B is the nominal voltage of the battery set.

EXAMPLE At 12 V, R is 120 Ω ; at 24 V, R is 240 Ω .

The minimum power rating P (in watts) of the resistor is calculated from:

$$P = 0,1 \times U_B$$

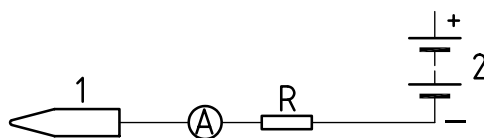
- c) test probe 11 ([4.9](#)).



Key

- 1 test probe
- 2 wheelchair battery set

Figure 2 — Test circuit in positive configuration



Key

- 1 test probe
- 2 wheelchair battery set

Figure 3 — Test circuit in negative configuration

4.16 Circuit breaker, manually operated, capable of interrupting the maximum possible current obtainable from the battery set or batteries, such that the voltage drop across the circuit breaker and its associated wiring at that current does not exceed 10 % of the nominal voltage of the battery set.

NOTE Typical wheelchair batteries have maximum short-circuit currents of several hundred amperes.

4.17 Means for supporting the wheelchair, such that it is upright and secure, with all wheels lifted off the ground and free to revolve.

4.18 Means for measuring sound pressure level, to an accuracy of ± 3 dB (A-weighted).

4.19 Fine wire thermocouples, with suitable means for indicating temperature to an accuracy of ± 2 °C.

4.20 Means for measuring motor current, to an accuracy of ± 5 % of the maximum stall current of the wheelchair motors, e.g. a clamp-on ammeter.

4.21 Test track, as specified in ISO 7176-4.

4.22 Voltmeter, capable of measuring the voltage of the battery set to an accuracy of ± 1 %.

4.23 Variable resistance, capable of being set within the range 20 k Ω to 1 M Ω .

4.24 Adjustable resistive load or constant current load selected so that it can be adjusted for the required current and rated to carry the current capacity of the protection device in the circuit under test.

5 Preparation of test wheelchair

5.1 Wheelchair set-up

Set up the wheelchair in accordance with ISO 7176-22.

NOTE The battery set-up is changed for some tests.

5.2 Loading the wheelchair

If required for a particular test, load the wheelchair using one of the following:

- a) a dummy as specified in ISO 7176-22, selected and fitted as specified in this document;
- b) a human test occupant that conforms with the Human Test Occupant requirements of ISO 7176-22.

Where a dummy is fitted to a wheelchair that has an anterior pelvic support, the support should be used to restrain the dummy. Upper thoracic restraints shall be used to limit forward rotation of the dummy trunk to between 20° and 25°.

Where a human test occupant is used, it is essential that appropriate precautions be taken to ensure the person's safety.

NOTE Use of anterior pelvic support by a human test occupant might be hazardous, for example in the event that the test occupant needs to get out of the chair quickly.

5.3 Wheelchair attributes

Measure and record the maximum speed, v , of the wheelchair on a horizontal surface by the method specified in ISO 7176-6.

NOTE The wheelchair set-up might not be changed or modified for these tests.

Measure and record the stopping distance, L_1 , at speed $(0,5 \pm 0,05) \times v$, of the wheelchair moving down the inclined test plane (4.1) by the method specified in ISO 7176-3 for normal operation.

5.4 Wheelchair documentation

Obtain applicable circuit diagrams for the wheelchair from the wheelchair manufacturer.

5.5 Preparation records

Record the following information for each test:

- a) the wheelchair equipment specified for the test;
- b) the position of any adjustable parts of a body support system. The justification for the configuration shall be noted in the test report;
- c) the battery manufacturer and battery type reference and any certifications that the battery might carry;
- d) the mass and configuration of the dummy or human load if used and shall conform with the human test occupant requirements of ISO 7176-22.

6 Guidance for tests

WARNING — The use of this document can involve hazardous materials, operations and equipment. It does not purport to address all of the safety or environmental problems associated with its use. It is the responsibility of users of this document to take appropriate measures to ensure the safety and health of personnel and the environment prior to application of the standard and fulfil statutory and regulatory requirements for this purpose.

6.1 Test order

The tests used to verify the requirements given in [Clauses 7](#) to [14](#) may be performed in any order, unless otherwise stated in the test methods. Reverse any modifications made to the wheelchair for a test before beginning another test. Repair or replace any parts of the wheelchair damaged during testing before beginning another test. Record the nature of any such repairs in the test report. Repeat the applicable procedures specified in [Clause 5](#) after any such repairs.

6.2 Batteries

The manufacturer shall declare the nominal voltage and cut-off voltage of the battery set.

6.3 Test conditions

Carry out the tests in a draught-free environment with an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$.

7 Single fault safety

7.1 Single fault conditions

7.1.1 General

The manufacturer shall adopt appropriate means to eliminate or reduce as low as reasonably possible the probability of a hazardous situation developing in the event of a single fault condition. The method for the risk assessment process used is described in ISO 14971.

7.1.2 Requirements

The manufacturer shall declare to test personnel the means by which the wheelchair is made safe under the conditions and for the purposes of intended wheelchair use against single fault conditions.

The manufacturer shall employ ISO 14971 to manage risk.

The manufacturer shall consider the following in the risk management process for a single fault condition:

- fire and/or explosion;
- software;
- electric shock;
- technical knowledge, experience, education or training of intended operator;

NOTE Single fault conditions that have been observed in wheelchairs include:

- short and open circuits of conductors and wiring;
- exposure of electronic components to humidity and liquids, such as rainwater and urine;
- component failure, such as leakage, internal short circuit, latched logic state.
- drive-train failures.

7.2 Controller command signal processing failure

7.2.1 General

It is important that a single command signal error due to an open-circuit, short-circuit or leakage current does not result in a hazardous situation.

7.2.2 Requirements

Provision shall be made to ensure that an open-circuit or short-circuit command signal failure

- a) does not result in loss of control of the wheelchair other than to stop,
- b) does not prevent the wheelchair from stopping when the control device is put in its stop position,
- c) does not result in a hazardous situation.

When the wheelchair is tested in accordance with [7.2.3.2](#) and [7.2.3.3](#), it shall stop without tipping over within a distance not exceeding $2,0 \times L_1$. L_1 is defined in [5.3](#).

7.2.2.1 Testing the wheelchair in accordance with [7.2.3.4](#) shall not

- a) result in any drive wheel turning with a circumferential speed that is greater than 0,1 m/s,
- b) result in movement greater than 10 mm of any part of the wheelchair that usually comes into contact with the occupant,
- c) result in a hazardous situation (e.g. fire).

7.2.3 Test method

WARNING — This test can be hazardous. It is essential that appropriate safety precautions be taken to protect test personnel. A wide test area is needed since the wheelchair may start moving at maximum speed in an uncontrolled way.

7.2.3.1 Preparation

7.2.3.1.1 Examine the wheelchair and its circuit diagram to locate

- control device conductors that carry signals involved in the speed and/or direction control of the wheelchair,
- conductors that supply power and/or reference signals to the control device,
- conductors that carry signals involved in controlling the motion of parts of the wheelchair that usually come into contact with the occupant,

and that are suitable for introducing disturbances into those signals that could affect the control of the wheelchair.

NOTE Suitable conductors can include discrete wires, component leads, connector terminals and printed circuit tracks.

7.2.3.1.2 Identify one point on each of the conductors identified in [7.2.3.1.1](#) that may be used for introducing open circuits in them.

7.2.3.1.3 For each of the conductors identified in [7.2.3.1.1](#), identify all other conductors where it is reasonably foreseeable that a short circuit could occur between them.

7.2.3.1.4 Among the conductors identified in [7.2.3.1.1](#), identify each conductor that is used to carry an analogue signal.

7.2.3.1.5 For each of the conductors identified in [7.2.3.1.4](#), identify all other conductors where it is reasonably foreseeable that a current leakage path due to contamination from liquids could occur between them.

NOTE 1 Examples include: conductors in a cable connecting the control device enclosure to another component or enclosure; adjacent connector terminals in exposed connectors on the control device enclosure; adjacent conductors inside the control device enclosure that could get wet if the enclosure were damaged and liquid were to leak into it.

NOTE 2 Examples of conductors not included: conductors in an encapsulated subassembly within the control device enclosure.

Conformal coating cannot be relied upon to protect tracks or components on printed circuit boards from moisture induced leakage currents. Coatings for printed circuits in accordance with IEC 60335-1:2020, Annex J can only ensure protection against pollution degree 2 or better. Therefore, it is necessary to ensure enclosures limit pollution to degree 2. If such tracks are not protected by enclosures that offer pollution degree 2 or better protection, they shall be tested as per [7.2.3.3](#) and [7.2.3.4](#).

Enclosures that do not allow ingress of water when subjected to the test specified in [13.1](#) after being subjected to the impact test specified in [14.2](#) may be considered unlikely to allow contamination by liquids, except where such enclosures have fragile flexible components as part of their environmental protection, such as typical joystick gaiters.

7.2.3.2 Open-circuit test

Make provision for the wheelchair to be driven on the inclined test plane ([4.1](#)).

Switch off the controller and disconnect it from the battery set. For one of the points identified in [7.2.3.1.2](#), disconnect the conductor to be tested and connect it via a switch back to its original connection. Close the switch and reconnect the battery set.

Switch on the controller. Note the position of the marker on the test plane and drive the wheelchair forwards in a straight line down the inclined test plane towards it until a speed of $(0,5 \pm 0,05) \times v$ is achieved. When the marker is reached, open the switch.

Measure along the centreline of the track of the driving wheels the distance taken to stop to an accuracy of ± 100 mm.

Switch off the controller and close the switch.

Reset and/or replace any circuit protection devices.

Switch on the controller. Note the position of the marker on the test plane and drive the wheelchair forwards in a straight line down the inclined test plane towards it until a speed of $0,5(\pm 0,05) \times v$ is achieved. When the marker is reached, open the switch and put the control device to its stop position.

Measure along the centre line of the track of the driving wheels the distance taken to stop to an accuracy of ± 100 mm.

Reset and/or replace any circuit protection devices.

Repeat the test for each of the conductors identified in [7.2.3.1.2](#).

7.2.3.3 Short-circuit test

Make provision for the wheelchair to be driven on the inclined test plane ([4.1](#)).

Switch off the controller and disconnect the battery set.

From those conductor pairs identified in [7.2.3.1.3](#), make provision for connecting the two conductors via a switch without changing the original connections (to simulate a short circuit).

Open the switch and reconnect the battery set.

Switch on the controller. Note the position of the marker on the test plane and drive the wheelchair forwards in a straight line down the inclined test plane towards it until a speed of $(0,5 \pm 0,05) \times v$ is achieved. When the marker is reached, close the switch.

Measure along the centreline of the track of the driving wheels the distance taken to stop to an accuracy of ± 100 mm.

Switch off the controller and open the switch.

Reset and/or replace any circuit protection devices.

Switch on the controller. Note the position of the marker on the test plane and drive the wheelchair forwards in a straight line down the inclined test plane towards it until a speed of $(0,5 \pm 0,05) \times v$ is achieved. When the marker is reached, close the switch and put the control device to its stop position.

Measure along the centreline of the track of the driving wheels the distance taken to stop to an accuracy of ± 100 mm.

Reset and/or replace any circuit protection devices.

Repeat the test for every combination of two conductors from those identified in [7.2.3.1.3](#).

7.2.3.4 Leakage current test

Support the wheelchair by suitable means ([4.17](#)) so that it is secure with the drive wheels lifted off the ground and free to revolve.

Switch off the controller and disconnect the battery set.