

---

---

**Wheelchairs —**

**Part 14:**

Power and control systems for electric  
wheelchairs — Requirements and test  
methods

**iTeh STANDARD PREVIEW**

*Fauteuils roulants —*

*(standards.iteh.ai)*  
*Partie 14: Systèmes d'alimentation et de commande des fauteuils roulants  
électriques — Exigences et méthodes d'essai*

ISO 7176-14:1997

<https://standards.iteh.ai/catalog/standards/sist/52044f14-6fbc-425f-bb40-2ddb5aa0042/iso-7176-14-1997>



| <b>Contents</b> |   | Page |
|-----------------|---|------|
| <b>1</b>        | <b>Scope</b> .....                                    | 1    |
| <b>2</b>        | <b>Normative references</b> .....                     | 1    |
| <b>3</b>        | <b>Definitions</b> .....                              | 2    |
| <b>4</b>        | <b>Apparatus</b> .....                                | 3    |
| <b>5</b>        | <b>Preparation of test wheelchair</b> .....           | 4    |
| <b>6</b>        | <b>Electrical systems</b> .....                       | 5    |
| <b>7</b>        | <b>Non-powered mobility test</b> .....                | 21   |
| <b>8</b>        | <b>Safety guard test</b> .....                        | 23   |
| <b>9</b>        | <b>Battery chargers</b> .....                         | 23   |
| <b>10</b>       | <b>Forces needed to operate control devices</b> ..... | 26   |
| <b>11</b>       | <b>Test report</b> .....                              | 28   |
| <b>12</b>       | <b>Information to be disclosed</b> .....              | 29   |

iTech STANDARD PREVIEW  
(standards.iteh.ai)

ISO 7176-14:1997

https://standards.iteh.ai/catalog/standards/sist/52044f14-6fbc-425f-bb40-2ddbd5aa0042/iso-7176-14-1997

© ISO 1997

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Organization for Standardization  
Case postale 56 • CH-1211 Genève 20 • Switzerland  
Internet central@iso.ch  
X.400 c=ch; a=400net; p=iso; o=isocs; s=central

Printed in Switzerland

## 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.

Draft International Standards adopted by the technical committee circulated to the member bodies for approval before their acceptance as International Standards. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 7176-14 was prepared by Technical Committee ISO/TC 173, *Technical systems and aids for disabled or handicapped persons*, Subcommittee SC 1, *Wheelchairs*.

ISO 7176 consists of the following parts under the general title *Wheelchairs*:

- Part 1: *Determination of static stability*
- Part 2: *Determination of dynamic stability of electric wheelchairs*
- Part 3: *Determination of efficiency of brakes*
- Part 4: *Determination of energy consumption of electric wheelchairs*
- Part 5: *Determination of overall dimensions, mass and turning space*
- Part 6: *Determination of maximum speed, acceleration and retardation of electric wheelchairs*
- Part 7: *Method of measurement of seating and wheel dimensions*
- Part 8: *Requirements and test methods for static, impact and fatigue strengths*
- Part 9: *Climatic tests for electric wheelchairs*
- Part 10: *Determination of obstacle-climbing ability of electric wheelchairs*
- Part 11: *Test dummies*
- Part 13: *Determination of coefficient of friction of test surfaces*
- Part 14: *Power and control systems for electric wheelchairs — Requirements and test methods*
- Part 15: *Requirements for information disclosure, documentation and labelling*
- Part 16: *Requirements and test methods for resistance to ignition of upholstered parts*

The following parts are also on the programme of work

- Part 17: *Serial interface for electric wheelchair controllers*
- Part 18: *Stair traversing devices*
- Part 19: *Wheeled mobility devices for use in motor vehicles*
- Part 20: *Determination of the performance of stand-up type wheelchairs*
- Part 21: *Requirements and test methods for electromagnetic compatibility of powered wheelchairs and motorized scooters*
- Part 22: *Set up procedure*

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[ISO 7176-14:1997](https://standards.iteh.ai/catalog/standards/sist/52044f14-6fbc-425f-bb40-2ddb5aa0042/iso-7176-14-1997)

<https://standards.iteh.ai/catalog/standards/sist/52044f14-6fbc-425f-bb40-2ddb5aa0042/iso-7176-14-1997>

# Wheelchairs —

## Part 14:

### Power and control systems for electric wheelchairs — Requirements and test methods

**WARNING** — This part of ISO 7176 calls for the use of procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the manufacturer from legal obligations relating to health and safety at any stage.

## 1 Scope

This part of ISO 7176 specifies the requirements for the power and control systems of electrically powered wheelchairs, including battery chargers, and associated test methods. It sets minimum requirements for the protection of the wheelchair user during normal use and some conditions of abuse and failure. It also specifies methods of measurement of the forces necessary to operate the controls and sets limits on the forces needed for some operations.

This part of ISO 7176 is applicable to electrically powered vehicles intended to provide indoor and outdoor mobility for disabled persons whose mass at speeds up to 15 km/h does not exceed 100 kg.

It is not applicable to electrically powered vehicles which incorporate devices that need to be connected to a domestic or industrial power supply greater than 100 volts (e.g. those with built-in battery chargers).

It does not include requirements on electromagnetic susceptibility or emissions.

NOTE — Further work is in progress by CEN/TC 293 on electromagnetic compatibility requirements for wheelchairs related to the Medical Device Directive, whilst work in ISO/TC 173/SC 1 will provide specific electromagnetic compatibility requirements for wheelchairs.

## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 7176. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 7176 are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 6440:1985, *Wheelchairs — Nomenclature, terms and definitions*

ISO 7176-3:1988, *Wheelchairs — Part 3: Determination of efficiency of brakes*

ISO 7176-6:1988, *Wheelchairs — Part 6: Determination of maximum speed, acceleration and retardation of electric wheelchairs*

ISO 7176-8:—<sup>1)</sup>, *Wheelchairs — Part 8: Requirements and test methods for static impact and fatigue strengths*

ISO 7176-11:1992, *Wheelchairs — Part 11: Test dummies*

ISO 7176-15:—<sup>1)</sup>, *Wheelchairs — Part 15: Requirements for information disclosure, documentation and labelling*

IEC 335-2-29:1994, *Safety of household and similar electrical appliances — Part 2: Particular requirements for battery chargers*

IEC 529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 601-1:1988, *Safety of medical electrical equipment — Part 1: General requirements*

### 3 Definitions

For the purposes of this part of ISO 7176, the definitions given in ISO 6440 together with the following apply.

**3.1 battery nominal voltage:** Voltage by which a battery is designated.

NOTE — The actual voltage may be significantly different under operating conditions.

**3.2 command signal:** Electrical signal from the device with which the user indicates the desired speed and/or direction of movement.

**3.3 controller:** All electrical devices, circuits, and the case(s) in which they are housed that are used to convert the user's indication of desired speed and/or direction of movement into the appropriate power to be supplied to the motor(s).

**3.4 pinch point:** Location at which a moving part contacts or comes in close proximity to another part such that a third part at that location would be cut or crushed.

**3.5 watchdog:** Circuit dedicated to monitoring the operation of a microprocessor.

**3.6 battery:** Set of interconnected electric cells integrated into a physical package and designated as a battery by its manufacturer.

**3.7 battery pack:** Removable enclosure which contains one or more batteries.

NOTE — If there are no such enclosures, a battery pack consists of a single battery.

**3.8 battery set:** Set of interconnected batteries used to power a wheelchair.

**3.9 battery charger:** Device that is connected to supply mains and to a battery set for the purpose of charging the batteries.

NOTE — This part of ISO 7176 does not apply to battery chargers which are an integral part of the wheelchair.

---

<sup>1)</sup> To be published.

## 4 Apparatus

**4.1 Inclined test plane**, fixed at 5° to the horizontal, of sufficient size to enable the tests described in 6.13.3, 6.15.3 and 6.17.3 to be performed, and with a surface of sufficient friction to cause minimal wheel slippage during the performance of those tests.

NOTE — The recommended minimum size is 5 m x 1,5 m.

**4.2 Horizontal test plane**, with the same high-friction surface as the inclined test plane (4.1), of sufficient size to enable the tests described in 6.11.3, 6.12.3, 6.16.3 and 7.3 to be performed.

NOTE — The recommended minimum size is 5 m x 1,5 m.

**4.3 Speedometer**, or other means of measuring the speed of a wheelchair within a range of 0 km/h to 15 km/h, to an accuracy of  $\pm 5\%$ .

**4.4 Means of measuring braking distance** of a wheelchair, to an accuracy of  $\pm 100$  mm.

**4.5 Direct current source**, comprising a battery set, which has a voltage 1,25 times the nominal voltage of the battery set of the wheelchair to be tested  $^{+2}_0$  V, and which has a capacity not less than that of the battery set of the wheelchair.

NOTE — Other direct current power supplies are not suitable because the wheelchair can return energy during braking.

**4.6 Standard jointed test finger**, as specified in figure 7 of IEC 601-1:1988 (see also figure 1 of this part of ISO 7176).

**4.7 Standard unjointed test finger**, of the dimensions specified in figure 7 of IEC 601-1:1988, but without joints (see also figure 2 of this part of ISO 7176), capable of attachment to a force measuring instrument (4.8).

**4.8 Force measuring instrument**, capable of measuring forces in the range of 0 N to 100 N in increments of 1 N with an accuracy of  $\pm 1\%$  of the rated capacity.

**4.9 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  $\pm 1\%$  of the rated capacity.

**4.10 Positive air pressure measuring device**, capable of measuring positive air pressure, relative to local atmospheric pressure, in a range of 0 kPa to 20 kPa in 200 Pa increments with an accuracy of  $\pm 1\%$  of the rated capacity.

**4.11 Reduced air pressure measuring device**, capable of measuring reduced air pressure, relative to local atmospheric pressure, in a range of 0 kPa to -20 kPa in 200 Pa increments with an accuracy of  $\pm 1\%$  of the rated capacity.

**4.12 Test circuit**, arranged as shown in figures 3a) and 3b) and 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 not less than  $\pm 1$  mA, and capable of withstanding a current of 100 mA;

b) resistor of resistance  $R$  (in ohms), calculated from the following expression:

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

where  $U$  is the nominal voltage of the wheelchair's battery set (in volts).

#### EXAMPLE

At 12 V,  $R$  is 120  $\Omega$ ; at 24 V,  $R$  is 240  $\Omega$ .

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

$$P = 0,1 U$$

where  $U$  is the nominal voltage of the wheelchair's battery set (in volts).

c) standard unjointed test finger (see 4.7).

**4.13 Circuit breaker**, manually operated, capable of interrupting the maximum possible current obtainable from the battery set or batteries.

NOTE — Testing personnel may add wiring to connect to the circuit breaker. It is important that any such additional wiring does not limit the current.

**4.14 Means of supporting the wheelchair**, such that it is secure, with all wheels lifted off the ground and free to revolve.

**4.15 Means of detecting current flow with a timing function**, capable of measuring the time for which current flows to an accuracy of  $\pm 100$  ms, and the time between the occurrence of an external event and the flow of current, described in 9.3.2, to an accuracy of  $\pm 100$  ms.

NOTE — This is used to detect currents up to the maximum current delivered by the battery set under fault conditions.

## 5 Preparation of test wheelchair

NOTE — A more precisely defined set-up procedure for the reference configuration of adjustable wheelchairs is under development in part 22 of ISO 7176. This work may influence the reference configuration.

### 5.1 Wheelchair set-up

Set up the wheelchair for normal use as specified by the manufacturer.

### 5.2 Inflation of pneumatic tyres

If the wheelchair has pneumatic tyres, inflate them to the pressure recommended by the manufacturer. If a pressure range is recommended, inflate the tyres to the highest pressure in that range.

### 5.3 Adjustments

Adjust the wheelchair in accordance with the methods specified for adjustment in ISO 7176-8.

Set any controls, except those that determine the speed and/or direction of movement of the wheelchair, to the manufacturer's recommended position for driving. If there is no recommended position for any such controls, set them to the mid-position.



## 5.4 Batteries

Fit batteries of the size and type recommended by the wheelchair manufacturer. Charge the batteries to not less than 75 % of their rated capacity.

## 5.5 Loading the wheelchair

Load the wheelchair using one of the following:

- a) one of the dummies specified in ISO 7176-11 of mass equal to, or the next size greater than, the maximum mass of occupant recommended by the manufacturer; or
- b) a human test occupant, combined with a mass evenly distributed over the seat of the wheelchair such that the total is within  $+2_0$  kg of the mass of the appropriate dummy specified in item a).

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

## 5.6 Records

For each test record the following information:

- a) the wheelchair equipment specified for the test;
- b) the position of any adjustable parts of a body support system;
- c) the battery manufacturer and battery type reference; and
- d) the mass and configuration of the dummy or human load.

## 6 Electrical systems

NOTE — The tests used to verify the requirements given in this clause can be performed in any order unless otherwise stated in the test procedures. Any modifications made to the wheelchair while a test is being conducted should be reversed before beginning the next test. Any parts of the wheelchair damaged while a test is being conducted should be repaired or replaced before beginning the next test.

### 6.1 Battery connection and circuit protection diagram

A diagram shall be clearly visible when the batteries are uncovered. It shall be permanently attached to a surface as close as possible to the batteries.

NOTE — The diagram should be protected from deterioration from battery gases and acid.

The diagram shall show the following:

- a) connections to the batteries with the identification of the wires and terminals;
- b) the location and pictorial instructions for use of all circuit breakers and fuses intended to be serviced by the user or an attendant; and
- c) the current rating and type of any fuses.

## 6.2 Colour and marking of wires connected to the batteries

All wires connected to the positive terminal of the most positive battery pack shall be red and permanently marked with a '+' symbol.

All wires connected to the negative terminal of the most negative battery pack shall not be red and be permanently marked with a '-' symbol.

Other wires connected to batteries shall not be red.

## 6.3 Electrical isolation of wheelchair

### 6.3.1 General

The chassis of an electric wheelchair should not be connected to the battery set or any other part of the electrical system of the wheelchair except by high d.c. impedance circuits. This will reduce the risk of fire that could be caused by a short circuit between parts in the electrical system and the chassis but will allow the use of the chassis for circuits which are intended to provide electromagnetic interference protection or electrostatic discharge protection.

### 6.3.2 Requirements

The wheelchair frames, motor cases, gearbox cases, battery cases and the controller cases shall not be connected to the battery set or any other part of the electrical system except by a circuit with a d.c. impedance of not less than 10 k $\Omega$ .

When tested in accordance with 6.3.3 the ammeter in the test circuit shall not indicate a current of more than 5 mA.

NOTE — This current limit indicates a d.c. impedance within the specified value.

### 6.3.3 Test procedure

#### 6.3.3.1 General

Using the necessary means (see 4.14), support the wheelchair so that it is secure, with the drive wheels lifted off the ground and free to revolve.

#### 6.3.3.2 Positive connection test

Identify all the electrically conducting parts of the chassis that can be touched by the test finger of the circuit described in 4.12 and shown in figure 3a).

Remove paint or other protective coating from part of the wheelchair frame and electrically connect the test finger of the circuit described in 4.12 as shown in figure 3a).

Operate control devices to drive each motor on the wheelchair, one at a time, at maximum speed, in each direction.

Apply the test finger in turn to all the electrically conductive parts of the chassis that it can touch and check that the ammeter in the test circuit does not indicate a current of more than 5 mA  $\pm$  1 mA.

### 6.3.3.3 Negative connection test

Repeat the test described in 6.3.3.2 except connect the test circuit described in 4.12 as shown in figure 3b).

## 6.4 Fuses

When changing fuses that do not need a tool for access, it shall not be possible to touch electrically live leads or terminals exposed during this procedure to any other part of any electrical circuit.

## 6.5 Interchangeability of connectors

Connectors provided for use by the wheelchair occupant or attendant shall be impossible to connect in a manner that will cause operation different from that specified by the manufacturer.

NOTE — Suitable methods include:

- plug and socket shapes that only permit correct assembly;
- length of wire to plugs and sockets that only permits correct assembly.

Connectors shall not simply be colour coded to identify correct assembly.

It shall not be possible to connect any connector intended for operation at or below the battery set nominal voltage to any socket intended for domestic or industrial electrical power distribution.

## 6.6 Attachment and positioning of wiring

### 6.6.1 General

<https://standards.iteh.ai/catalog/standards/sist/52044f14-6fbc-425f-bb40-2ddb5aa0042/iso-7176-14-1997>

Protruding wires from the wheelchair can be damaged by moving parts or snag objects that the wheelchair passes. This could cause malfunction of the wheelchair or damage the objects.

### 6.6.2 Requirements

All wires shall be routed and secured in such a manner that they cannot be snagged on furniture or any other protrusion or be damaged by, or interfere with, any moving part of the wheelchair.

When examined and tested in accordance with 6.6.3 it shall be demonstrable that no wires could

- a) be snagged on furniture or any other protrusion;
- b) be damaged by parts that move; or
- c) be trapped in any pinch points.

### 6.6.3 Test procedure

Examine all wires to see if they can be damaged by, or interfere with, any moving parts of the wheelchair.

Pull all wires towards parts that move and any pinch points with a force of  $10\text{ N} \pm 1\text{ N}$ .

If the wheelchair is of variable configuration (e.g. adjustable back rest), repeat the procedure for all possible configurations.

## 6.7 Protection from non-insulated electrical parts

### 6.7.1 General

A wheelchair occupant or attendant shall not be burned or given an electrical shock, or the wheelchair caused to malfunction by contacting non-insulated electrical parts.

Battery terminals should be insulated when connected.

### 6.7.2 Requirement

When tested in accordance with 6.7.3, it shall not be possible for a test finger to touch non-insulated electrical parts except those protected by a circuit with a d.c. impedance of not less than 10 k $\Omega$  (see 6.3.2).

### 6.7.3 Test procedure

Apply the standard unjointed test finger (4.7) to all openings from every possible position with a force of 30 N  $\pm$  1 N.

If the finger enters any opening, use the standard jointed test finger (4.6) in every possible position, with all joints bent and then with all joints straight to determine if any non-insulated electrical part can be touched.

ITEH STANDARD PREVIEW  
(standards.iteh.ai)

## 6.8 Short-circuit protection

### 6.8.1 General

<https://standards.iteh.ai/catalog/standards/sist/52044f14-6fbc-425f-bb40-2ddb5aa0042/iso-7176-14-1997>  
ISO 7176-14:1997

Wheelchair batteries contain a large amount of energy which can cause fires if they are short circuited. Protection shall be provided as close as possible to the batteries to protect the wheelchair occupant.

### 6.8.2 Requirements

Short-circuit protection shall be provided as close as possible to each battery pack. When tested in accordance with 6.8.3, a circuit protection device shall disconnect all wheelchair circuits from each battery pack under short circuit conditions.

Circuit protection devices shall not be of the automatic resetting type.

### 6.8.3 Test procedure

**WARNING: This test can be hazardous. It is essential that appropriate safety precautions be taken to protect test personnel.**

Check that the circuit protection devices are of the type that need to be reset or replaced manually.

Disconnect the controller and any other electrical device(s) from each battery pack but leave the main leads from the battery packs in place.

Repeat the following test procedure for each battery pack on the wheelchair, one at a time.

a) Determine the point closest to the battery pack where the positive and negative wires from the battery pack, or their insulation, can be pulled into contact with a force less than  $10\text{ N} \pm 1\text{ N}$ . At this point connect the positive and negative wires to the circuit breaker (4.13) so that the wires will be connected together when the circuit breaker is closed. Ensure that the circuit breaker is positioned so that the tester can operate it without personal hazard.

**WARNING: It is essential that the tester be prepared to open the circuit breaker quickly if circuit protection devices do not operate.**

b) Close the contacts of the circuit breaker.

c) Observe and record if the circuit protection device fails to operate.

d) Open the contacts of the circuit breaker.

e) Observe and record if the circuit protection device resets automatically.

## 6.9 Safety when charging batteries

### 6.9.1 General

Battery chargers are connected to supply mains and explosive gas can be generated when charging the battery set. Electrical fires from short circuits, explosions caused by sparks igniting the gas, and mechanical damage or injury might occur if the wheelchair moves while the battery charger is connected to the battery set.

### 6.9.2 Requirement

When tested in accordance with 6.9.3, it shall not be possible to drive the wheelchair.

### 6.9.3 Test procedure

Connect the battery charger to the battery set and supply mains in accordance with the manufacturer's instructions and switch it on.

Switch on the wheelchair controller and attempt to drive the wheelchair. Record any movement of the wheelchair.

Repeat the procedure with the battery charger disconnected from supply mains.

## 6.10 Reversed polarity at the battery

### 6.10.1 General

During maintenance and new battery installation there is a possibility of connecting batteries with reversed polarity. This could cause damage to the wheelchair controller and possibly cause a fire.

### 6.10.2 Requirements

When tested in accordance with 6.10.3:

a) with the battery set connections reversed, there shall be no damage to the controller or any part of the drive system other than blown fuses and if the wheelchair operates, it shall be in accordance with the manufacturer's specification with no uncontrolled or unwanted movements;