

*Compliance is checked by inspection.*

**25.13** Inlet openings for **supply cords** shall be constructed so that the sheath of the **supply cord** can be introduced without risk of damage. If it is not evident from the construction of the appliance that the **supply cord** can be introduced without risk of damage, a **non-detachable lining** or **non-detachable bushing** shall be provided that complies with 29.3 for **supplementary insulation**. If the **supply cord** is unsheathed, a similar additional bushing or lining is required, unless the appliance is a **class 0 appliance** or a **class III appliance** that does not contain **live parts**.

*Compliance is checked by inspection.*

**25.14** Appliances provided with a **supply cord** and that are moved while in operation shall be constructed so that the **supply cord** is adequately protected against excessive flexing where it enters the appliance.

This requirement does not apply to appliances with automatic cord reels that comply with the requirement and test of 22.16.

*Compliance is checked by the following test that is carried out on an apparatus having an oscillating member as shown in Figure 8.*

*The part of the appliance that includes the inlet opening is fixed to the oscillating member so that, when the **supply cord** is at the middle of its travel, the axis of the cord where it enters the cord guard or inlet is vertical and passes through the axis of oscillation. The major axis of the section of flat cords shall be parallel to the axis of oscillation.*

*The cord is loaded so that the force applied is:*

- 10 N, for cords having a nominal cross-sectional area exceeding 0,75 mm<sup>2</sup>;
- 5 N, for other cords.

*The distance X, as shown in Figure 8, between the axis of oscillation and the point where the cord or cord guard enters the appliance, is adjusted so that when the oscillating member moves over its full range, the cord and load make the minimum lateral movement.*

*The oscillating member is moved through an angle of 90° (45° on either side of the vertical), the number of flexings for **type Z attachments** being 20 000 and for other attachments 10 000. A flexing is one movement of 90°. The rate of flexing is 60 per minute.*

*The cord and its associated parts are turned through an angle of 90° after half the number of flexings, unless a flat cord is fitted.*

*During the test, the conductors are supplied at **rated voltage** and loaded with the **rated current** of the appliance. Current is not passed through the earthing conductor or functional earthing conductor.*

*The test shall not result in:*

- a short circuit between the conductors, such that the current exceeds a value equal to twice the **rated current** of the appliance;
- a breakage of more than 10 % of the strands of any conductor;
- separation of the conductor from its terminal;
- loosening of any cord guard;
- damage to the cord or cord guard which could impair compliance with this standard;
- broken strands piercing the insulation and becoming accessible.

**25.15** Appliances provided with a **supply cord**, and appliances intended to be permanently connected to fixed wiring by a flexible cord, shall have a cord anchorage. The cord anchorage shall relieve conductors from strain, including twisting, at the terminals and protect the insulation of the conductors from abrasion.

It shall not be possible to push the cord into the appliance to such an extent that the cord or internal parts of the appliance could be damaged.

*Compliance is checked by inspection, by manual test and by the following test.*

*A mark is made on the cord at a distance of approximately 20 mm from the cord anchorage or other suitable point. The mark is made while the cord is subjected to a pull force of:*

- 100 N, for **fixed appliances** regardless of the mass of the appliance;
- the value as shown in Table 12, for other appliances.

*The cord is then pulled, without jerking, for 1 s in the most unfavourable direction with the force specified. The test is carried out 25 times.*

*The cord, unless on an automatic cord reel, is then subjected to a torque that is applied as close as possible to the appliance. The torque is specified in Table 12 and is applied for 1 min.*

**Table 12 – Pull force and torque**

<i>Mass of appliance</i> kg	<i>Pull force</i> N	<i>Torque</i> Nm
$\leq 1$	30	0,10
$>1 \text{ and } \leq 4$	60	0,25
$> 4$	100	0,35

*During the tests, the cord shall not be damaged and shall show no appreciable strain at the terminals. The pull force is reapplied and the cord shall not be longitudinally displaced by more than 2 mm.*

**25.16** Cord anchorages for **type X attachments** shall be constructed and located so that:

- replacement of the cord is easily possible;
- it is clear how the relief from strain and the prevention of twisting are obtained;
- they are suitable for the different types of **supply cord** that may be connected, unless the cord is specially prepared;
- the cord cannot touch the clamping screws of the cord anchorage if these screws are accessible, unless they are separated from **accessible metal parts** by **supplementary insulation**;
- the cord is not clamped by a metal screw which bears directly on the cord;
- at least one part of the cord anchorage is securely fixed to the appliance, unless it is part of a specially prepared cord. However, this does not apply if:
  - the cord anchorage comprises one or more clamping members to which pressure is applied by means of nuts engaging with studs that are securely attached to the appliance, even if the clamping member can be removed from the studs;
  - one of the clamping members is fixed to the appliance or the surface of the appliance is of insulating material and shaped so that it is obvious that this surface is one of the clamping members;

NOTE 1 If the pressure on the clamping members is applied by means of one or more screws engaging with separate nuts or with a thread in a part that is integral with the appliance, the cord anchorage is not considered to have one part securely fixed to the appliance.

- screws which have to be operated when replacing the cord do not fix any other component. However, this does not apply if:
  - after removal of the screws, or if the component is incorrectly repositioned, the appliance becomes inoperative or is obviously incomplete;
  - the parts intended to be fastened by them cannot be removed without the aid of a **tool** during the replacement of the cord;
- if labyrinths can be bypassed, the test of 25.15 is nevertheless withstood;
- for **class 0 appliances**, **class 0I appliances** and **class I appliances**, they are of insulating material or are provided with an insulating lining, unless failure of the insulation of the cord does not make **accessible metal parts** live;
- for **class II appliances**, they are of insulating material or, if of metal, they are insulated from **accessible metal parts** by **supplementary insulation**.

NOTE 2 Examples of acceptable and unacceptable constructions of cord anchorages are shown in Figure 9.

*Compliance is checked by inspection and by the test of 25.15 under the following conditions.*

*The tests are carried out with the lightest permissible type of cord of the smallest cross-sectional area specified in Table 13 and then with the next heavier type cord having the largest cross-sectional area specified. However, if the appliance is fitted with a specially prepared cord, the test is carried out with this cord.*

*The conductors are placed in the terminals and any terminal screws tightened just sufficiently to prevent the conductors from easily changing their position. The clamping screws of the cord anchorage are tightened with two-thirds of the torque specified in 28.1.*

*Screws of insulating material bearing directly on the cord are fastened with two-thirds of the torque specified in column I of Table 14, the length of the slot in the screw head being taken as the nominal diameter of the screw.*

*After the test, the conductors shall not have moved by more than 1 mm in the terminals.*

**25.17** For **type Y attachment** and **type Z attachment**, cord anchorages shall be adequate.

*Compliance is checked by the test of 25.15 with the cord supplied with the appliance.*

**25.18** Cord anchorages shall be arranged so that they are only accessible with the aid of a **tool** or shall be constructed so that the cord can only be fitted with the aid of a **tool**.

*Compliance is checked by inspection.*

**25.19** For **type X attachment**, glands shall not be used as cord anchorages in **portable appliances**. Tying the cord into a knot or tying the cord with string is not allowed.

*Compliance is checked by inspection.*

**25.20** The conductors of the **supply cord** for **type Y attachment** and **type Z attachment** shall be insulated from **accessible metal parts** by **basic insulation** for **class 0 appliances**, **class 0I appliances** and **class I appliances**, and by **supplementary insulation** for **class II appliances**. This insulation may be provided by the sheath of the **supply cord** or by other means.

*Compliance is checked by inspection and by the relevant tests.*

**25.21** The space for the connection of **supply cords** having **type X attachment**, or for the connection of fixed wiring, shall be constructed:

- so that it is possible to check that the supply conductors are correctly positioned and connected before fitting any cover;
- so that any cover can be fitted without risk of damage to the conductors or their insulation;
- for **portable appliances**, so that the uninsulated end of a conductor, should it become free from the terminal, cannot come into contact with **accessible metal parts**.

*Compliance is checked by inspection after fitting cables or flexible cords having the largest cross-sectional area specified in Table 13.*

**Portable appliances** are subjected to the following additional test unless they are provided with pillar terminals and the **supply cord** is clamped within 30 mm of them. The cord anchorage may be used to provide the clamping.

*The clamping screws or nuts are loosened in turn. A force of 2 N is applied to the conductor in any direction at a position adjacent to the terminal. The uninsulated end of the conductor shall not come into contact with **accessible metal parts**.*

**25.22** Appliance inlets shall:

- be located or enclosed so that **live parts** are not accessible during insertion or removal of the connector. This requirement is not applicable to appliance inlets complying with IEC 60320-1;
- be located so that the connector can be inserted without difficulty;
- be located so that, after insertion of the connector, the appliance is not supported by the connector when it is placed in any position of normal use on a flat surface;
- not be an appliance inlet for cold conditions if the temperature rise of external metal parts of the appliance exceeds 75 K during the test of Clause 11, unless the flexible cord of the cord set is unlikely to touch such metal parts in normal use.

*Compliance is checked by inspection.*

**25.23 Interconnection cords** shall comply with the requirements for the **supply cord**, except that:

- the cross-sectional area of the conductors of the **interconnection cord** is determined on the basis of the maximum current carried by the conductor during the test of Clause 10 and not by the **rated current** of the appliance. If the measured current in the **interconnection cord** is greater than the **rated current** but does not exceed the **rated current** by more than the current deviation in Table 2, the cross-sectional area of the conductors in the **interconnection cord** do not need to be greater than the cross-sectional area of the conductors in the **supply cord**;
- the thickness of the insulation of the conductor may be reduced if the voltage of the conductor is less than the **rated voltage**;
- for **class III construction, interconnection cords** of a **class I appliance or class II appliance**, the cross-sectional areas of the conductors need not comply with 25.8 if the temperature of the cord insulation specified in Table 3 and Table 9 are not exceeded during the tests of Clause 11 and Clause 19, respectively.

*Compliance is checked by inspection, by measurement and, if necessary, by tests, such as the electric strength test of 16.3.*

**25.24 Interconnection cords** shall not be detachable without the aid of a **tool** if compliance with this standard is impaired when they are disconnected.

*Compliance is checked by inspection and if necessary by appropriate tests.*

**25.25** The dimensions of pins of appliances that are inserted into socket-outlets shall be compatible with the dimensions of the relevant socket-outlet. Dimensions of the pins and engagement face are to be in accordance with the dimensions of the relevant plug listed in IEC TR 60083.

*Compliance is checked by measurement.*

## 26 Terminals for external conductors

**26.1** Appliances shall be provided with terminals or equally effective devices, such as male tabs of flat quick-connect terminations in accordance with IEC 61210, screw type terminals in accordance with IEC 60998-2-1, screwless terminals in accordance with IEC 60998-2-2 and clamping units in accordance with IEC 60999-1:1999, for the connection of external conductors. The terminals of a component such as a switch may also be used as terminals for external conductors as long as they comply with the requirements of this clause.

The terminals, other than terminals in **class III appliances** that do not contain **live parts**, shall only be accessible after the removal of a **non-detachable cover**. However, earthing terminals and functional earthing terminals may be accessible if a **tool** is required to make the connections and means are provided to clamp the wire independently from its connection.

*Compliance is checked by inspection and by manual test.*

**26.2** Appliances having **type X attachment**, except those having a specially prepared cord, and appliances for the connection of cables of fixed wiring shall be provided with terminals in which the connections are made by means of screws, nuts or similar devices, unless the connections are soldered.

The screws and nuts shall not be used to fix any other component except that they may also clamp internal conductors if these are arranged so that they are unlikely to be displaced when fitting the supply conductors.

If soldered connections are used, the conductor shall be positioned or fixed so that reliance is not placed upon the soldering alone to maintain it in position. However, soldering alone may be used if barriers are provided so that neither **clearances** nor **creepage distances** between **live parts** and other metal parts can be reduced below the values specified for **supplementary insulation** if the conductor becomes free at the soldered joint.

*Compliance is checked by inspection and by measurement.*

**26.3** Terminals for **type X attachment** and those for the connection of cables of fixed wiring shall be constructed so that they clamp the conductor between metal surfaces with sufficient contact pressure but without causing damage to the conductor.

The terminals shall be fixed so that when the clamping means is tightened or loosened:

- the terminal does not become loose. This does not apply if the terminals are fixed with two screws, or are fixed with one screw in a recess so that there is no appreciable movement or if they are not subject to torsion in normal use and they are locked by a self-hardening resin;
- internal wiring is not subjected to stress;
- neither **clearances** nor **creepage distances** are reduced below the values specified in Clause 29.

*Compliance is checked by inspection and by the test of Subclause 9.6 of IEC 60999-1:1999, the torque applied being equal to two-thirds of the torque specified.*

*After the test, the conductors shall show no deep or sharp indentations.*

**26.4** Terminals for **type X attachment**, except **type X attachments** having a specially prepared cord, and terminals for the connection of cables of fixed wiring, shall not require special preparation of the conductor such as by soldering of the strands of the conductor, the use of cable lugs, eyelets or similar devices. Reshaping of the conductor before its introduction into the terminal or twisting a stranded conductor to consolidate the end is not considered special preparation.

The terminals shall be constructed or placed so that the conductor cannot slip out when clamping screws or nuts are tightened.

*Compliance is checked by inspection of the terminals and conductors after the test of 26.3.*

**26.5** Terminals for **type X attachment** shall be located or shielded so that if a wire of a stranded conductor escapes when the conductors are fitted, there is no risk of accidental connection to other parts that could result in a hazard.

*Compliance is checked by inspection and by the following test.*

*A 8 mm length of insulation is removed from the end of a flexible conductor having a nominal cross-sectional area as specified in Table 11. One wire of the stranded conductor is left free and the other wires are fully inserted and clamped in the terminal. The free wire is bent, without tearing the insulation back, in every possible direction but without making sharp bends around barriers.*

*There shall be no contact between **live parts** and **accessible metal parts** and, for **class II constructions**, between **live parts** and metal parts separated from **accessible metal parts** by **supplementary insulation** only.*

**26.6** Terminals for **type X attachment** and for the connection of cables of fixed wiring shall allow the connection of conductors having the nominal cross-sectional areas shown in Table 13. However, if a specially prepared cord is used, the terminals need only be suitable for the connection of that cord.

**Table 13 – Nominal cross-sectional area of conductors**

Rated current of appliance A	Nominal cross-sectional area mm <sup>2</sup>	
	Flexible cords	Cable for fixed wiring
≤ 3	0,5 and 0,75	1 to 2,5
> 3 and ≤ 6	0,75 and 1	1 to 2,5
> 6 and ≤ 10	1 and 1,5	1 to 2,5
> 10 and ≤ 16	1,5 and 2,5	1,5 to 4
> 16 and ≤ 25	2,5 and 4	2,5 to 6
> 25 and ≤ 32	4 and 6	4 to 10
> 32 and ≤ 50	6 and 10	6 to 16
> 50 and ≤ 63	10 and 16	10 to 25

*Compliance is checked by inspection, by measurement and by fitting cables or cords of the smallest and largest cross-sectional areas specified.*

**26.7** Terminals for **type X attachment**, other than those in **class III appliances** that do not contain **live parts**, shall be accessible after removal of a cover or part of the enclosure.

*Compliance is checked by inspection.*

**26.8** Terminals for the connection of fixed wiring, including the earthing terminal, shall be located close to each other.

*Compliance is checked by inspection.*

**26.9** Terminals of the pillar type shall be constructed and located so that the end of a conductor introduced into the hole is visible, or can pass beyond the threaded hole for a distance equal to half the nominal diameter of the screw but at least 2,5 mm.

*Compliance is checked by inspection and by measurement.*

**26.10** Terminals with screw clamping and screwless terminals shall not be used for the connection of the conductors of flat twin tinsel cords unless the ends of the conductors are fitted with means suitable for use with screw terminals.

*Compliance is checked by inspection and by applying a pull of 5 N to the connection.*

*After the test, the connection shall show no damage that could impair compliance with this standard.*

**26.11** For appliances having **type Y attachment** or **type Z attachment**, soldered, welded, crimped or similar connections may be used for the connection of external conductors. For **class II appliances**, the conductor shall be positioned or fixed so that reliance is not placed upon the soldering, crimping or welding alone to maintain the conductor in position. However, these methods may be used alone if barriers are provided so that **clearances** and **creepage distances** between **live parts** and other metal parts cannot be reduced below the values specified for **supplementary insulation**, if the conductor becomes free at the soldered or welded joint or slips out of the crimped connection.

*Compliance is checked by inspection and by measurement.*

## **27 Provision for earthing**

**27.1 Accessible metal parts**, including metal parts behind a decorative cover that does not withstand the test of 21.1, of **class 0I appliances** and **class I appliances** that may become live in the event of a failure of **basic insulation**, shall be permanently and reliably connected to an earthing terminal within the appliance or to the earthing contact of the appliance inlet.

Earthing terminals and earthing contacts shall not be connected to the neutral terminal.

**Class 0 appliances**, **class II appliances** and **class III appliances** shall have no provision for protective earthing.

**Safety extra-low voltage** circuits shall not be earthed unless they are **protective extra-low voltage circuits**.

*Compliance is checked by inspection.*

**27.2** The clamping means of earthing terminals shall be adequately secured against accidental loosening.

Terminals for the connection of external equipotential bonding conductors shall allow the connection of conductors having nominal cross-sectional areas of 2,5 mm<sup>2</sup> to 6 mm<sup>2</sup> and shall not be used to provide earthing continuity between different parts of the appliance. It shall not be possible to loosen the conductors without the aid of a **tool**.

NOTE The terminal for the earthing conductor in a **supply cord** is not a terminal for external equipotential bonding conductors.

*Compliance is checked by inspection and by manual test.*

**27.3** If a **detachable part** having an earth connection is plugged into another part of the appliance, the earth connection shall be made before the current-carrying connections are established. The current-carrying connections shall be separated before the earth connection when removing the part.

For appliances with **supply cords**, the arrangement of the terminals, or the length of the conductors between the cord anchorage and the terminals, shall be such that the current-carrying conductors become taut before the earthing conductor if the cord slips out of the cord anchorage.

*Compliance is checked by inspection and by manual test.*

**27.4** All parts of the earthing terminal intended for the connection of external conductors shall be such that there is no risk of corrosion resulting from contact between these parts and the copper of the earthing conductor or any other metal in contact with these parts.

Parts providing earthing continuity, other than parts of a metal frame or enclosure, shall be of metal having adequate resistance to corrosion, unless they are parts of copper or copper alloys containing at least 58 % copper for parts that are processed by cold forming, and at least 50 % copper for other parts, or unless they are parts of stainless steel containing at least 13 % chrome. If these parts are of steel, they shall be provided with an electroplated coating having a thickness of at least 5 µm at essential areas such as those liable to transmit a fault current.

Parts of coated or uncoated steel that are only intended to provide or to transmit contact pressure shall be adequately protected against rusting.

NOTE 1 Examples of parts providing earthing continuity and parts that are only intended to provide or to transmit contact pressure are shown in Figure 10.

NOTE 2 Parts subjected to a treatment such as chromate conversion coating are in general not considered to be adequately protected against corrosion, but they can be used to provide or to transmit contact pressure.

If the body of the earthing terminal is a part of a frame or enclosure of aluminium or aluminium alloy, precautions shall be taken to avoid the risk of corrosion resulting from contact between copper and aluminium or its alloys.

*Compliance is checked by inspection and by measurement.*

*In case of doubt, the thickness of the coating is measured as described in ISO 2178 or in ISO 1463.*

**27.5** The connection between the earthing terminal or earthing contact and earthed metal parts shall have low resistance.

If the **clearances** of **basic insulation** in a **protective extra-low voltage circuit** are based on the **rated voltage** of the appliance, this requirement does not apply to connections providing earthing continuity in the **protective extra-low voltage circuit**.

*Compliance is checked by the following test.*

*A current derived from a source having a no-load voltage not exceeding 12 V (AC or DC) and equal to 1,5 times **rated current** of the appliance or 25 A, whichever is higher, is passed between the earthing terminal or earthing contact and each of the **accessible metal parts** in turn. The test is carried out until steady conditions have been established.*

*The voltage drop between the earthing terminal of the appliance or the earthing contact of the appliance inlet and the **accessible metal part** is measured. The resistance calculated from the current and this voltage drop shall not exceed 0,1  $\Omega$ . The resistance of the **supply cord** is not included in the resistance calculation.*

**27.6** The printed conductors of printed circuit boards shall not be used to provide earthing continuity in **hand-held appliances**. They may be used to provide earthing continuity in other appliances if at least two tracks are used with independent soldering points and the appliance complies with 27.5 for each circuit.

*Compliance is checked by inspection and by the relevant tests.*

## **28 Screws and connections**

**28.1** Fixings, the failure of which may impair compliance with this standard, electrical connections and connections providing earthing continuity shall withstand the mechanical stresses occurring in normal use.

Screws used for these purposes shall not be of metal that is soft or liable to creep, such as zinc or aluminium. If they are of insulating material, they shall have a nominal diameter of at least 3 mm and they shall not be used for any electrical connections or connections providing earthing continuity.

Screws used for electrical connections or for connections providing earthing continuity shall screw into metal.

Screws shall not be of insulating material if their replacement by a metal screw could impair **supplementary insulation** or **reinforced insulation**. Screws that may be removed when replacing a **supply cord** having a **type X attachment** or when undertaking **user maintenance** shall not be of insulating material if their replacement by a metal screw could impair **basic insulation**.

*Compliance is checked by inspection and by the following test.*

*Screws and nuts are tested if they are:*

- *used for electrical connections;*
- *used for connections providing earthing continuity, unless at least two screws or nuts are used;*
- *likely to be tightened:*
  - *during **user maintenance**;*
  - *when replacing a **supply cord** having a **type X attachment**;*
  - *during installation.*

*The screws or nuts are tightened and loosened without jerking:*

- *10 times for screws in engagement with a thread of insulating material;*
- *5 times for nuts and other screws.*

*Screws in engagement with a thread of insulating material are completely removed and reinserted each time.*

*When testing terminal screws and nuts, a cable or flexible cord of the largest cross-sectional area specified in Table 13 is placed in the terminal. It is repositioned before each tightening.*

*The test is carried out by means of a suitable screwdriver, spanner or key and by applying a torque as shown in Table 14.*

*Column I is applicable for metal screws without heads if the screw does not protrude from the hole when tightened.*

*Column II is applicable for:*

- *other metal screws and for nuts;*
- *screws of insulating material:*
  - *having a hexagonal head with the dimension across flats exceeding the overall thread diameter;*
  - *with a cylindrical head and a socket for a key, the socket having a cross-corner dimension exceeding the overall thread diameter;*
  - *with a head having a slot or cross-slots, the length of which exceeds 1,5 times the overall thread diameter.*

*Column III is applicable for other screws of insulating material.*

**Table 14 – Torque for testing screws and nuts**

Nominal diameter of screw (outer thread diameter) mm	Torque		
	Nm		
	I	II	III
≤ 2,8	0,2	0,4	0,4
> 2,8 and ≤ 3,0	0,25	0,5	0,5
> 3,0 and ≤ 3,2	0,3	0,6	0,5
> 3,2 and ≤ 3,6	0,4	0,8	0,6
> 3,6 and ≤ 4,1	0,7	1,2	0,6
> 4,1 and ≤ 4,7	0,8	1,8	0,9
> 4,7 and ≤ 5,3	0,8	2,0	1,0
> 5,3	–	2,5	1,25

*No damage impairing the further use of the fixings or connections shall occur.*

**28.2** Electrical connections and connections providing earthing continuity shall be constructed so that contact pressure is not transmitted through non-ceramic insulating material that is liable to shrink or to distort unless there is sufficient resiliency in the metallic parts to compensate for any possible shrinkage or distortion of the insulating material.

This requirement does not apply to electrical connections in circuits of appliances for which:

- 30.2.2 is applicable and that carry a current not exceeding 0,5 A;
- 30.2.3 is applicable and that carry a current not exceeding 0,2 A.

*Compliance is checked by inspection.*

**28.3** Space-threaded (sheet metal) screws shall only be used for electrical connections if they clamp the parts together.