भारतीय मानक
Indian Standard

IS 17017 (Part 2/Sec 1) : 2020

विद्युतीय वाहन चालकता चार्जिंग पद्धति

भाग 2 प्लग, साकेट-निकास, वाहन कनेक्टर्स, और वाहन के इनलेट्स

अनुभाग 1 सामान्य अपेक्षायें

Electric Vehicle Conductive Charging System

Part 2 Plugs, Socket-Outlets, Vehicle Connectors, and Vehicle Inlets

Section 1 General requirements

ICS 29.120.30, 43.120

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July 2020 **Price Group 14**

FOREWORD

This Indian Standard (Part 2/Sec 1) was adopted by the Bureau of Indian Standards, after the draft finalized by the Electrotechnology in Mobility Sectional Committee had been approved by the Electrotechnical Division Council

This standard (Part 2) is the series of standards which covers the mechanical, electrical and performance requirements for dedicated plugs, socket outlets, vehicle connectors and vehicle inlets for interfacing between such dedicated charging equipment and the electric vehicle. This series consists of the following sections.

Section 1 General requirements, comprising clauses of a general character.

Section 2 Dimensional compatibility and interchangeability requirements for a.c. pin and contact-tube accessories.

Section 3 Dimensional compatibility and interchangeability requirements for d.c. and a.c./d.c. pin and contact-tube vehicle couplers.

Considerable assistance has been obtained from IEC 62196-1: 2014 while preparing this standard. Most of the requirements of this standard correspond to the requirements of IEC 62196- 1:2014 (except for the exemptions described in the following paragraphs).

The regulatory bodies, had decided that an India specific charging system be defined and the development of this has been entrusted to the Department of Science and Technology. As such, some provisions for inclusion of the outcome of this scientific exercise has been left in this standard. The standard will be modified/amended once the new design is validated and found stable.

The cross references of IEC have been modified to refer Indian Standards whenever available. Where corresponding Indian Standards are not available, the IEC references have been retained. The committee has decided that these IEC standards are suitable to be used till equivalent/corresponding Indian Standards are published.

The composition of the committee responsible for formulation of this standard is given at Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding of numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

ELECTRIC VEHICLE CONDUCTIVE CHARGING SYSTEM

PART 2 PLUGS, SOCKET-OUTLETS, VEHICLE CONNECTORS AND VEHICLE INLETS

Section 1 General requirements

1 SCOPE

This standard (Part 2/Sec 1) is applicable to plugs, socket-outlets, vehicle connectors, vehicle inlets and cable assemblies for electric vehicles, herein referred to as "accessories", intended for use in conductive charging systems which incorporate control means, with a rated operating voltage not exceeding:

a) 690 V a.c. 50 Hz, at a rated current not exceeding 250 A; and

b) 1 500 V d.c. at a rated current not exceeding 200 A.

These accessories are intended to be installed by instructed persons or skilled persons only.

These accessories and cable assemblies are intended to be used for circuits specified in IS 17017 (Part 1) which operate at different voltages and frequencies and which may include extra-low voltage and communication signals.

These accessories and cable assemblies are to be used at an ambient temperature between -25°C and 55°C.

These accessories are intended to be connected only to cables with copper or copper-alloy conductors.

The accessories covered by this section of IS 17017 (Part 2) are for use in certain modes of charging electric vehicles. These modes are defined in IS 17017 (Part 1). These definitions and a description of the types of connection (Cases A, B and C), are described in **3.1.10, 3.1.11** and **3.1.12** of IS 17017 (Part 1):2018.

This standard (Part 2/Sec 1) does not apply to those standardized accessories used in charging systems where the use of such accessories constructed to the requirements of other standards is permitted (for example in mode 1 and mode 2). Such standardized accessories may be used for those situations (Mode and Case) identified in IS 17017 (Part 1).

This standard (Part 2/Sec 1) may be used as a guide for accessories with a lesser number of contacts and lower ratings for use with light duty vehicles.

2 REFERENCES

The standards listed below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below

IS No./ Other Publication	*Title*
IS 694 : 2010	Polyvinyl chloride insulated unsheathed and sheathed cables/cords with rigid and flexible conductor for rated voltages up to and including 450/750 V.
IS 1068:1993	Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium – Specification.
IS 1359 : 1992	Electroplated coatings of tin – Specification.
IS 1573 : 1986	Specification for electroplated coatings of zinc on iron and steel.
IS 2824 : 2007	Method for the determination of the proof and the comparative tracking indices of solid insulating materials.
IS 8130 : 2013	Conductors for insulated electric cables and flexible cords.
IS 9000 (Part 14/ Sec 1 to 3) : 1988	Basic Environmental Testing Procedures for Electronic and Electrical Items Part 14: Test N: Change of Temperature

IS No./ Other Publication	*Title*
IS 12032 (Part 2) : 1987	Graphical symbols for diagrams in the field of electrotechnology Part 2 symbols elements, qualifying symbols and other symbols having general application.
IS 12360 : 1988	Voltage bands for electrical installations including preferred voltages and frequency.
IS 13703 (Part 2/Sec 1) : 1993	Specification for low-voltage fuses for voltages not exceeding 1100 V a.c. or 1500 V d.c. Part 2: Fuses for use by authorized persons Sec 1: Supplementary requirements.
IS 15382 (Part 1) : 2014	Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests
IS 15382 (Part 3) : 2006	Insulation coordination for equipment within low-voltage systems – Part 3: Use of coating, potting or moulding for protection against pollution.
IS 17017 (Part 1) : 2018	Electric Vehicle Conductive Charging System Part 1: General Requirements.
IS 17120 : 2019	In-cable control and protection device for mode 2 charging of electric road vehicles(IC-CPD)
IS/IEC 60269-1 : 2014	Low-voltage Fuses : Part 1: General Requirements.
IEC 60309-4 : 2006	Plugs, socket-outlets and couplers for industrial purposes – Part 4: Switched socket-outlets and connectors with or without interlock
IS/IEC 60529 : 2001	Degrees of protection provided by enclosures (IP code)
IS/IEC 60695-2 -11 : 2014	Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products
IS/IEC 60695-10-2 : 2014	Fire hazard testing – Part 10-2: Abnormal heat – Ball pressure test
IS/IEC 60947-1 : 2007	Low-voltage switchgear and controlgear. Part 1 General rules.
IS/IEC 60947-3 : 2012	Low-voltage switchgear and controlgear: Part 3 Switches, disconnectors, switch-disconnectors and fuse-combination units.
IS/IEC 60947-5-1 : 2009	Low-voltage switchgear and controlgear: Part 5 Control circuit devices and switching elements Section 1Electromechanical control circuit devices.
IS/IEC 61058-1 : 2000	Switches for appliances Part 1 General requirements.
IEC 61851-23 : 2014	Electric vehicle conductive charging system – Part 23: d.c. electric vehicle charging station

3 TERMINOLOGY

For the purposes of this standard, the definitions given in IS 17017(Part 1):2018 shall apply, in addition to the following:

NOTES

1 Where the terms voltage and current are used, they imply r.m.s. values, unless otherwise specified.

2 The application of accessories is shown in Fig. 1.

3.1 Cable Assembly — Assembly consisting of flexible cable or cord fitted with a plug and/or a vehicle connector, that is used to establish the connection between the EV and the supply network or an EV charging station.

NOTES

1 A cable assembly can be detachable or be a part of the EV or the EV charging station.

2 A cable assembly can include one or more cables, with or without a fixed jacket, which can be in a flexible tube, conduit or wire way.

3.2 Plug and Socket-Outlet — Means of enabling the connection at will of a flexible cable to fixed wiring.

NOTE — It consists of two parts: a socket-outlet and a plug.

3.2.1 *Plug* — Accessory having pins designed to engage with the contacts of a socket-outlet, also incorporating means for the electrical connection and mechanical retention of flexible cables or cords

NOTE — May include mechanical, electrical or electronic components and circuitry, which perform control functions.

3.2.2 *Socket-Outlet* — Accessory having socket-contacts designed to engage with the pins of plug and having terminals for the connection of cables or cords.

3.3 Vehicle Coupler (Electric Vehicle Coupler) — Means of enabling the connection at will of flexible cable to an electric vehicle.

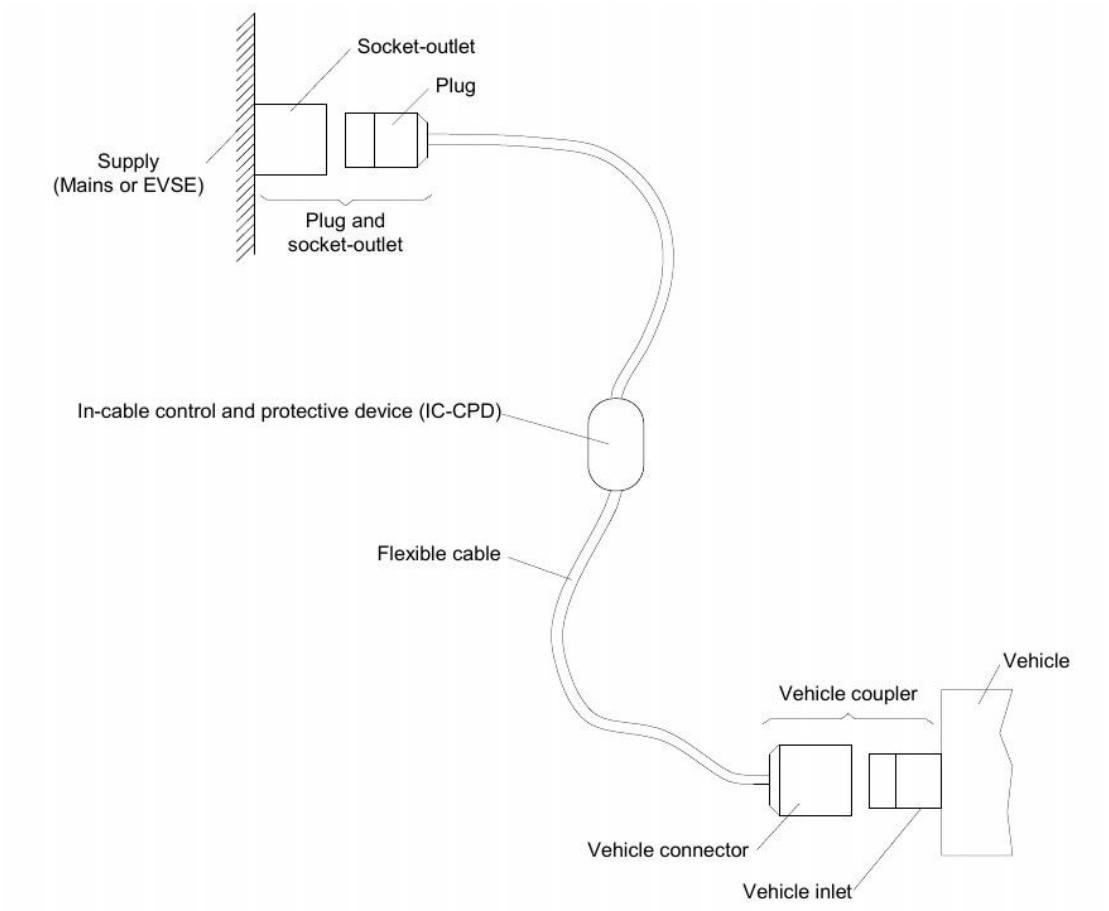


FIG. 1 APPLICATION OF ACCESSORIES

NOTE — It consists of two parts: a vehicle connector and a vehicle inlet.

3.3.1 *Vehicle Connector (Electric Vehicle Connector)* — Part of a vehicle coupler integral with, or intended to be attached to the cable assembly.

3.3.2 *Vehicle Inlet (Electric Vehicle Inlet)* — Part of a vehicle coupler incorporated in, or fixed to, the electric vehicle.

3.4 Shutter — Movable part incorporated into an accessory arranged to automatically shield at least the live contacts when the accessory is withdrawn from the complementary accessory.

3.5 Insulated End Cap — Part made of insulating material, located at the tip of a contact, ensuring a protection against access to hazardous parts with a standard test finger (IPXXB).

3.6 Pilot Contact — Auxiliary electric contact for use in a control, signaling, monitoring or interlock function.

NOTE — Pilot contact is not considered to be a pole.

3.7 Compatibility/Compatible — Ability of accessories to join together and be functional.

NOTE — Non-compatible accessories may physically join together, but not be functional.

3.8 Interchangeability/Interchangeable — Ability of an accessory to replace another, without any modification.

NOTE — Interchangeable accessories generally have similar outer dimensions, fixing centers, etc.

3.9 Retaining Means — Device (for example, mechanical or electromechanical) that holds a plug or vehicle connector in position when it is in proper engagement, and prevents its unintentional withdrawal.

Example:

See standard sheets in IS 17017 (Part 2/Sec 2) and IS 17017 (Part 2/Sec 3).

3.10 Latching Device — Part of the interlock mechanism provided to hold a plug in the socket outlet or to hold a vehicle connector in the vehicle inlet and to prevent its intentional or unintentional withdrawal.

Example:

See standard sheets 2-II in IS 17017(Part 2/Sec 2).

3.11 Locking Mechanism — Means intended to reduce the likelihood of tampering with, or an unauthorized removal, of the accessories.

3.12 Interlock — Device or combination of devices that prevents the power contacts of a socket-outlet/

vehicle connector from becoming live before it is in proper engagement with a plug/vehicle inlet, and which either prevents the plug/vehicle connector from being withdrawn while its power contacts are live or makes the power contacts dead before separation.

3.13 Wiring

3.13.1 *Rewirable Accessory* — Accessory so constructed that the cable or wiring can be replaced; it can be either a user-serviceable accessory or a field-serviceable accessory.

3.13.2 *Non-Rewirable Accessory* — Accessory so constructed that the cable or wiring cannot be separated from the accessory without making it permanently useless.

Example:

A plug which is integrally moulded to the cable is an example of non-rewirable accessory.

3.13.3 *User-Serviceable Accessory* — Accessory so constructed that it can be rewired, or parts can be replaced, using commonly available tools and without having to replace individual parts of the accessory.

Example:

An ordinary plug, which can be disassembled and wired using a common screwdriver, is an example of user-serviceable accessory.

3.13.4 *Field-Serviceable Accessory* — Accessory constructed so that it can only be rewired, repaired or replaced by manufacturer's authorized personnel or skilled person according to national regulations.

3.14 Terminal — Conductive part provided for the connection of a conductor to an accessory.

3.14.1 *Pillar Terminal* — Terminal in which the conductor is inserted into a hole or cavity, where it is clamped under the shank of the screw or screws.

NOTES

1 The clamping pressure may be applied directly by the shank of the screw or through an intermediate clamping member to which pressure is applied by the shank of the screw.

2 See Fig. 2A.

3.14.2 *Screw Terminal* — Terminal in which the conductor is clamped under the head of the screw.

NOTES

1 The clamping pressure may be applied directly by the head of the screw or through an intermediate part, such as a washer, clamping plate or anti-spread device.

2 *See* Fig. 2B.

3.14.3 *Stud Terminal* — Terminal in which the conductor is clamped under a nut.

NOTES

1 The clamping pressure may be applied directly by a suitably shaped nut or through an intermediate part, such as a washer, clamping plate or anti-spread device.

2 *See* Fig. 2C.

3.14.4 *Saddle Terminal* — Terminal in which the conductor is clamped under a saddle by means of two or more screws or nuts.

NOTE — *See* Fig. 2D.

3.14.5 *Lug Terminal* — Screw terminal or a stud terminal, designed for clamping a cable lug or bar by means of a screw or nut.

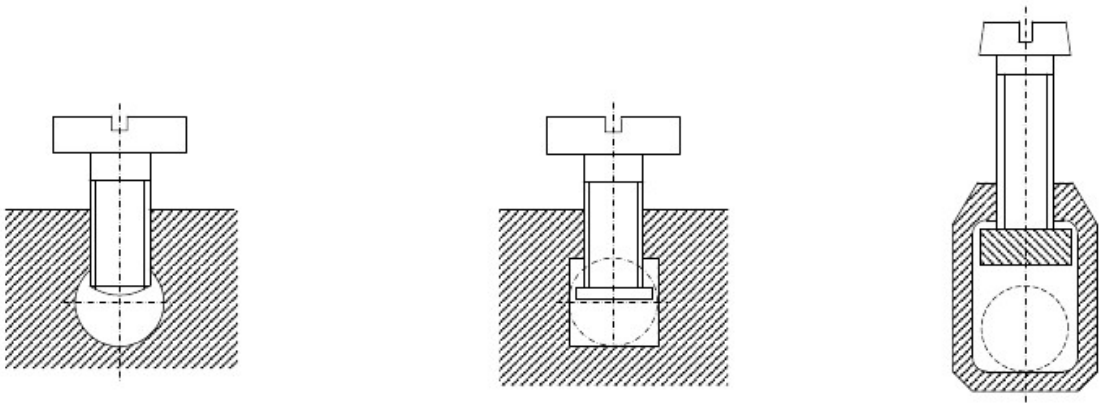
NOTE — *See* Fig. 2E.

3.14.6 *Mantle Terminal* — Terminal in which the conductor is clamped against the base of a slot in a threaded stud by means of a nut.

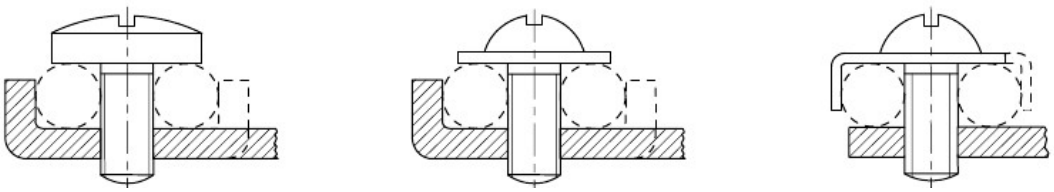
NOTES

1 The conductor is clamped against the base of the slot by a suitably shaped washer under the nut, by a central peg if the nut is a cap nut, or by equally effective means for transmitting the pressure from the nut to the conductor within the slot.

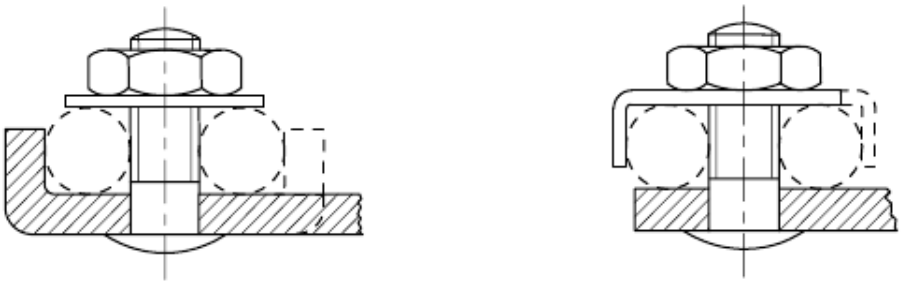
2 *See* Fig. 2F.



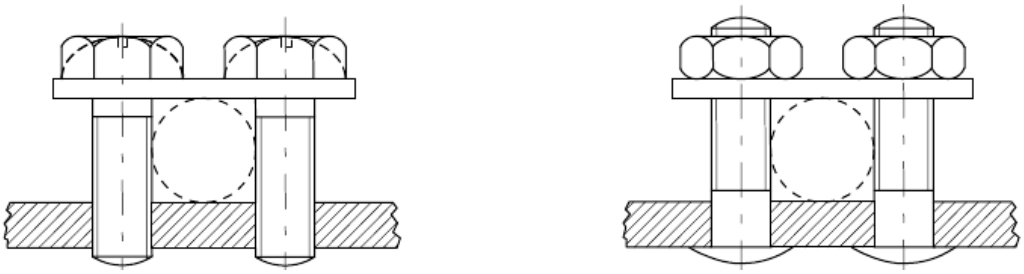
A. Pillar terminals



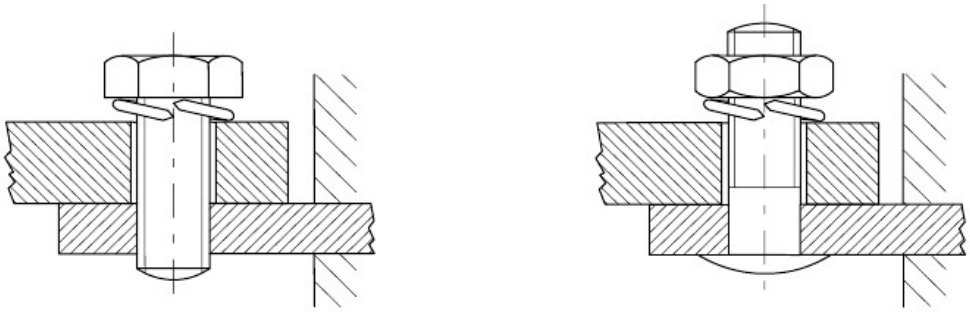
B. Screw-type terminals



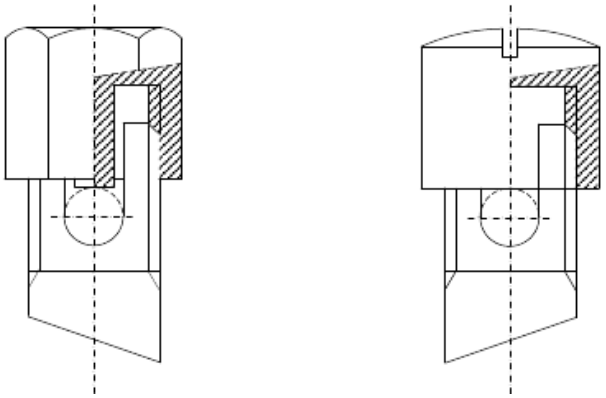
C. Stud terminals



D. Saddle terminals



E. Lug terminals



F. Mantle terminals

FIG. 2 EXAMPLES OF TERMINALS

3.15 Clamping Unit — Part of a terminal necessary for the clamping and the electrical connection of the conductor.

3.16 Cable Management System — One or more devices that is intended to protect a cable assembly from mechanical damage and/or to facilitate its handling.

Example:

Cable suspension device.

3.17 Cap — Part separated or attached, which may be used to provide the degree of protection of a plug or vehicle inlet, when it is not engaged with a socket-outlet or a vehicle connector.

3.18 Cover — Means providing the degree of protection of an accessory when it is not engaged with a socket-outlet or vehicle connector.

NOTES

1 It can be used as the retaining means or a part of the retaining means.

2 Caps, lids, shutters and similar devices can perform the function of a cover.

3.19 Lid — Means to ensure the degree of protection on an accessory.

NOTE — A lid is generally hinged.

3.20 Universal a.c. — Interface which provides for high power a.c. and 32 A a.c.

3.21 Universal d.c. — Interface which provides for high power d.c. and 32 A a.c.

3.22 Combined — Interface which provides for a.c. and d.c.

3.23 Rated Current — Current assigned to the accessory by the manufacturer for a specified operating condition of an accessory.

3.24 Rated Operating Voltage — Nominal voltage of the supply(ies) for which the pole of the accessory is intended to be used.

3.25 Insulation Voltage — Voltage assigned to the accessory by the manufacturer and to which dielectric tests, clearances and creepage distances are referred.

3.26 Reinforced Insulation — Improved basic insulation with such mechanical and electrical qualities that it provides the same degree of protection against electric shock as double insulation.

3.27 Double Insulation — Insulation comprising both basic insulation and supplementary insulation.

3.28 Isolation Monitor(IM) — Electrical circuit to monitor the vehicle to electric vehicle supply equipment earth isolation function.

3.29 Off-Board Isolation Function — Function of off-board charger which provides the electrical isolation for personnel protection against electric shock.

3.30 Conditional Short-Circuit Current — Prospective current that an accessory, protected by a specified short-circuit protective device, can withstand satisfactorily for the total operating time of that device under specified conditions of use and behavior.

3.31 Extra-Low Voltage(ELV) — Voltage not exceeding the relevant voltage limit of band I specified in IS 12360.

3.32 Safety Extra-Low Voltage System(SELV) — Electric system in which the voltage cannot exceed the value of extra-low voltage'

a) under normal conditions; and

b) under single fault conditions, including earth faults in other electric circuits.

3.33 Connection — Single conductive path.

3.34 Control Circuit Device — Electrical device intended for the controlling, signaling, interlocking, etc. of switchgear and controlgear (*see* **2.1.1** of IS/IEC 60947-1 : 2007)

3.35 Domestic — Intended for household and similar purposes, up to a maximum current rating of 30 A to 32 A a.c.

3.36 Electric Vehicle(EV)(Electric Road Vehicle) — Any vehicle propelled by an electric motor drawing current from an RESS, intended primarily for use on public roads.

NOTE — In this standard, these terms refer only to those vehicles that can be charged from an external electrical source

3.37 Electric Vehicle Supply Equipment(EVSE) — Equipment or a combination of equipment, providing dedicated functions to supply electric energy from a fixed electrical installation or supply network to an EV for the purpose of charging

Examples:

1) For Mode 3 case B, the EV supply equipment consists of the charging station and the cable assembly.

2) For Mode 3 case C, the EV supply equipment consists of the charging station with its cable assembly.

3.38 In-Cable Assemblies

3.38.1 *In-Cable Control Box (ICCB)* — Device incorporated in the Mode 2 cable assembly, which performs control functions and safety functions.

NOTE — The "ICCB" is called "function box" in IS 17120.

3.38.2 *In-Cable Control and Protective Device (IC-CPD)* — Mode 2 cable assembly that complies with IS 17120.

3.39 Auxiliary Power — Electrical energy provision from an external source used for purposes other than charging of the electric vehicle propulsion battery.

3.40 Thermal Cut-out — Temperature sensitive device which limits the temperature of an accessory, or of parts of it, during operation by automatically opening the circuit or by reducing the current, and which is so constructed that its settings cannot be altered by the user.

4 GENERAL

4.1 General Requirements

The accessories covered by this standard shall only be used with vehicles that comply with the requirements of **8.2.1 of** IS 17017 (Part1) : 2018.

Accessories shall be so designed and constructed that in normal use their performance is reliable and minimizes the risk of danger to the user or surroundings.

Compliance is checked by meeting all of the relevant requirements and tests specified.

Accessories shall be so designed and constructed that it is not possible to make a cord extension set [*see* IS 17017 (Part 1)]. The plug and the vehicle connector shall not be compatible.

Compliance is checked by a manual test.

4.2 General Notes on Tests

4.2.1 Tests according to this standard are type tests. If a part of an accessory has previously passed tests for a given degree of severity, the relevant type tests shall not be repeated if the severity is not greater.

4.2.2 Unless otherwise specified, the samples are tested as delivered and under normal conditions of use, at an ambient temperature of 27°C + 2K; the tests are made at rated frequency.

4.2.3 Unless otherwise specified, the tests are carried out in the order of the clauses of this standard.

4.2.4 Three samples are subjected to all the tests, except if necessary for the test of **22.3**, three new additional samples are tested. For the test of **31** one new additional sample is tested. . If, however, the tests of **22**, **23**, and **24** have to be carried out with both d.c. and a.c., the tests with a.c. in **22**, **23,** and **24**, are made on three additional samples.

4.2.5 Accessories are deemed to comply with this standard if no sample fails in the complete series of appropriate tests. If one sample fails in a test, that test and those preceding which may have influenced the test result are repeated on another set of three samples, all of which shall then pass the repeated tests.

In general, it will only be necessary to repeat the test which caused the failure, unless the sample fails in one of the tests of **23** and **24**, in which case the tests are repeated from that of **22** onwards. The applicant may submit, together with the first set of samples, an additional set which may be wanted should one sample fail. The testing station, without further request, will then test the additional samples and will only reject if a further failure occurs. If the additional set of samples is not submitted at the same time, the failure of one sample will entail a rejection.

When the tests are carried out with conductors, they shall be copper or copper alloy and comply with IS 694 and IS 8130.

5 RATINGS

5.1 Preferred Rated Operating Voltage Ranges

The preferred rated operating voltage ranges are:

a) 0 V to 30 V(signal or control purposes only),
b) 100 V a.c. to 130 V a.c.,
c) 200 V a.c. to 250 V a.c.,
d) 380 V a.c. to 480 V a.c.,
e) 600 V a.c to 690 V a.c.,
f) 480 V d.c.,
g) 600 V d.c.,
h) 750 V d.c., and
i) 1000 V d.c.

5.2 Preferred Rated Currents

5.2.1 *General*

The preferred rated currents are:

a) 13 A,
b) 16 A to 20 A,
c) 30 A to 32 A,
d) 60 A to 63 A,
e) 70 A,
f) 80 A(d.c. only),
g) 125 A, and
h) 200 A(d.c. only).

5.2.2 *Rated Current for Signal or Control Purposes*

Rated current for signal or control purposes is 2 A.

For configuration AA, control pilot contacts are rated 30 V, 10 A

For configurations AA, see IS 17017(Part 2/Sec 3) standard sheets 3-Ia to 3-If.

5.2.3 *Accessories not Suitable for Making and Breaking an Electrical Circuit Under Load*

An accessory rated 250 A a.c. shall be classified as not suitable for making and breaking an electrical circuit under load.

An accessory rated above 30 V d.c. shall be classified as not suitable for making and breaking an electrical circuit under load.

5.2.4 *Accessories Suitable for, or not Suitable for, Making and Breaking an Electrical Circuit Under Load*

An accessory, with a pilot circuit contact may be classified as suitable for, or not suitable for, making and breaking an electrical circuit under load. *See* **7.4.**

6 CONNECTION BETWEEN THE POWER SUPPLY AND THE ELECTRIC VEHICLE

6.1 General

This clause provides a description of the physical conductive electrical interface requirements between the vehicle and the power supply, which allows different types at the vehicle interface:

a) basic interface for mode 1, 2 and 3 charging only;
b) d.c. interface; and
c) combined interface.

NOTE — Refer to IS 17017 (Part 2/Sec 2) for a.c. ratings and types and to IS 17017(Part 2/Sec 3) for d.c. or a.c./d.c. ratings and types.

6.2 Types of Vehicle Inlets

There are three types of vehicle inlets:

a) basic.
b) d.c.; and
c) combined.

6.3 Types of Vehicle Connectors

There are three types of vehicle connectors as shown in Table 1:

a) basic;
b) d.c.; and
c) combined.

6.4 Universal Interface

Under Consideration

6.5 Basic Interface

The basic interface may contain up to 7 (power or signal) contacts, with physical configurations of contact positions for single-phase and for three-phase or both. The electrical ratings and their functions are described in Table 2.

The basic vehicle inlet shall be compatible with either the single-phase or the three-phase vehicle connector. It shall not be possible to connect the basic vehicle connector with a universal a.c. or d.c. vehicle inlet.

This vehicle coupler is rated 240 V, 32 A single-phase or 415 V, 32 A, three-phase. It may include additional contacts for control pilot wire and power indicator (proximity function).

6.6 d.c. Configurations

For d.c. configurations, the d.c. interface may contain up to 12 (power or signal) contacts, with only one physical configuration of contact positions.

For use with non-isolated d.c. charging equipment, the interface shall be provided with a contact for protective earthing conductors.

For use with isolated d.c. charging equipment, the interface may be provided with a contact for protective earthing conductors.

The interfaces shall be used with one of the specific electric vehicle charging systems described in one of the Annexes AA or CC in IEC 61851-23.

It shall not be possible to connect the d.c. vehicle connector with combined inlet.

The electrical ratings and their function are described in Table 3. See IS 17017 (Part 2/Sec 3) for additional details.

Table 1 Compatibility of Mating Accessories at Vehicle

(*Clause* 6.3)

		Vehicle Connector		
Vehicle inlet		**Type 2**	**Configuration AA**	**Configuration FF**
Basic configurations	**Type 2**	Yes	-	
d.c.	**Configuration AA**	-	Yes	-
Combined configurations d.c. and a.c.	**Configuration DD**			(Under Consideration)
	Configuration FF	Yes	-	Yes

NOTES

1 For Type 2, refer to the corresponding standard sheets in IS 17017 (Part 2/Sec 2)

2 For configurations AA and FF, refer to the corresponding standard sheets IS 17017 (Part 2/Sec 3).

3 This table shows the actual status of accessories but does not preclude the development of other accessories.

Table 2 Overview of The Basic Vehicle Interface

(*Clause* 6.5)

Position number [1]	a.c.		Functions
	Single phase	Three phase	
1	240 V 32 A	415 V 32 A	L1 (Mains 1)
2	—	415 V 32 A	L2 (Mains 2)
3	—	415 V 32 A	L3 (Mains 3)
4	240 V 32 A	415 V 32 A	N (Neutral)
5	Rated for fault [2]		PE (Protective Ground/Earth)
6	30 V 2 A		Control pilot
7	30 V 2 A		Proximity

[1] Position number does not refer to the location and/or identification of the contact in the accessory

[2] "Rated for fault" means "rated for the highest fault current".

Table 3 Overview of the d.c. Vehicle Interface

(*Clause* 6.6)

Position number[1]	Configuration AA		Symbol	Function
	U_{max} V	I_{max} A		
1	600	200	D.C. +	D.C.
2	600	200	D.C. –	D.C. –
3	30	10	CP	Control Pilot 1
4	30	10	CP2	Control Pilot 2
5	30	10	CP3	Control Pilot 3
6	30	2	COM1	Communication 1 ()
7	30	2	COM2	Communication 1 (-)
8	30	2	IM	Isolation Monitor
9	-	-	E	Protective earth
10	30	2	PP or CS	Proximity detection or connection switch
11	-	-	AUX1	Auxiliary Power Supply 1 ()
12	-	-	AUX2	Auxiliary Power Supply 1 (-)

[1] Position number does not refer to the location and/or identification of the contact in the access

NOTE — For d.c. vehicle interface, *see* IS 17017 (Part 2/Sec 3).

6.7 Combined interface

The combined interface extends the use of a basic interface for a.c. and d.c charging. The combined interface has two distinct contact arrangements:

a) Group 1 uses the same power contacts (under consideration) to supply either a.c. or d.c. energy to the electric vehicle, and

b) Group 2 is provided with separate a.c. and d.c. power contacts to supply either a.c. or d.c. energy to the electric vehicle.

The basic portion of the combined vehicle inlet can be used with a basic vehicle connector or a combined vehicle connector.

Combined vehicle couplers shall only be used for d.c. charging with the d.c. electric vehicle charging station of System C described in Annex CC of IEC 61851-23.

The electrical ratings and their function are described in Table 4. *See* IS 17017(Part 2/Sec 3) for additional details.

Table 4 Overview of the Combined a.c./d.c. Vehicle Interface

(*Clause* 6.7)

Position number[1)]	Configuration Group 2 FF		Symbol	Function
	U_{max} V	I_{max} A		
1	1 000	200	D.C.	d.c.
2	1 000	200	D.C. -	d.c. -
3	--	--		d.c. -
4	--[2)]	--[2)]		d.c. -
5	--[2)]	--[2)]		d.c.
6	--	--		d.c.
7	1 000[3)]	--	PE	Protective earth
8	30[3)]	2[3)]	CP	Control Pilot
9	30[3)]	2[3)]	PP or CS	Proximity detection or connection switch

[1)] Position number does not refer to the location and/or identification of the contact in the accessory.

[2)] This contact is only available in Configuration FF Inlets, may be used as portion of basic interface, see IS 17017 (Part 2/Sec 2), Standard Sheets 2-II.

[3)] May be used as basic interface, requirements for basic interface see IS 17017(Part 2/Sec 2), Standard Sheets 2-II.

NOTE — For combined a.c./d.c. vehicle interface, *see* IS 17017(Part 2/Sec 3).

6.8 Contact Sequencing

The contact sequence during the connection process shall be:

a) Protective earth contact,
b) Neutral contact N,
c) Line contact L1, (and L2 and L3, if any), and
d) Control pilot contact.

The proximity contact or the connection switch contact, if any, shall make after the protective earth contact and before or simultaneously with the control pilot contact.

During disconnection, the order shall be reversed.

The neutral contact N shall make before or simultaneously with line contacts L1, L2 and L3 and break after or simultaneously with line contacts L1, L2 and L3. *See* **10.3**.

7 CLASSIFICATION OF ACCESSORIES

7.1 According to Purpose

a) Plugs;
b) Socket-outlets;
c) Vehicle connectors;
d) Vehicle inlets; and
e) Cable assemblies.

7.2 According to the Method of Connecting the Conductors

a) Rewirable accessories, and
b) Non-rewirable accessories.

7.3 According to Serviceability

a) Field serviceable accessories, and
b) User serviceable accessories.

7.4 According to Electrical Operation

a) Accessories suitable for making and breaking an electrical circuit under load, and
b) Accessories not suitable for making and breaking an electrical circuit under load.

7.5 According to Interface

Interface specified *see* **6.**

a) Basic,
b) d.c., and
c) Combined.

7.6 According to Use with Cable Management Systems

(Under consideration)

7.7 According to the Locking and Interlock Functions

7.7.1 *According to Locking Facilities*

a) Non-lockable accessories, and

b) Lockable accessories.

7.7.2 *According to Interlock Facilities*

a) Accessories without an interlock, and

b) Accessories with an interlock

1) With latching device (mechanical interlock); and

2) Without latching device (electrical interlock).

7.8 According to the Presence of Shutter(s)

a) Accessories without shutter(s), and

b) Accessories with shutter(s).

8 MARKING

8.1 Accessories shall be marked with:

a) Rated current(s) in amperes for power,

b) Rated maximum operating voltage(s) in volts,

c) The relevant symbol for degree of protection,

d) Either the name or trade mark of the manufacturer or of the responsible vendor, and

e) Type reference, which may be a catalogue number.

Compliance is checked by inspection.

8.2 When symbols are used, they shall be as follows:

A	..... amperes	
V	.....volts	
Hz	.....hertz	
	.....protective earth.	Symbol No. 02-15-03 of IS 12032 (Part 2):1987.
	.....alternating current	Symbol No. 02-02-04 of IS 12032(Part 2):1987.
	.....direct current	Symbol No. 02-02-04 of IS 12032(Part 2):1987.

Compliance is checked by inspection.

8.3 For plugs and vehicle connectors, the marking for either the name or trade mark of the manufacturer or the responsible vendor and the type reference, catalogue number or designation shall also be on the outside of the accessory, visible to the user.

8.4 For all accessories, the marking for the maximum rated operating voltage range and rated current shall be in a place which is visible before installation of the accessory. For socket-outlets and vehicle inlets, the marking for either the name or trademark of the manufacturer or the responsible vendor and the type reference, catalogue number or designation shall be in a place which is visible before installation of the accessory. It need not be visible after installation.

Compliance is checked by inspection.

8.5 For rewirable accessories, the contacts shall be indicated by the following symbols:

a) For three-pole, the symbols L1, L2, L3 and N for neutral, if any, and the symbol symbol No. 02-15-03 of IS 12032(Part 2) for protective earth;

b) For two-pole, the symbols L1, L2 or N for neutral, if any, and the symbol symbol No. 02-15-03 of IS 12032(Part 2) for protective earth;

c) CP for control pilot;

d) PP for proximity contact;

e) CS for connection switch;

f) L1, L2, L3 (or 1, 2, 3), for high power a.c.;

g) D.C., D.C. – for d.c., if any;

h) COM1, COM2 for communication contact, if any; and

i) CDE for clean data earth, if any.

These symbols shall be placed close to the relevant terminals; they shall not be placed on screws, removable washers or other removable parts.

Compliance is checked by inspection.

8.6 For rewirable accessories, wiring instructions shall be provided.

Compliance is checked by inspection.

8.7 For non-rewirable accessories, the markings in **8.5** and **8.6** are not required.

8.8 Markings shall be indelible and easily legible.

Compliance is checked by inspection and by the following test:

After the humidity treatment of **20.3**, the marking is rubbed vigorously by hand for 15 s with a piece of cloth soaked in water and again for 15 s with a piece of cloth soaked with petroleum spirit.

It is recommended that the petroleum spirit used consist of a solvent hexane with an aromatic content of maximum 0.1 volume percentage, a kauributanol value of approximately 29, an initial boiling point of approximately 65°C, a dry point of approximately 69°C, and a density of approximately 0.68 g/cm^3.

8.9 Cable assemblies comprised of the cable and one accessory shall be provided with information to identify the wire terminations, terminals, etc., to provide wiring and installation instructions.

The unwired end of a cable assembly intended for connection to a rewirable accessory shall be marked to identify the conductors.

Compliance is checked by inspection.

9 DIMENSIONS

9.1 Accessories shall comply with the appropriate standard sheets, if any. If no standard sheet is available, the accessories shall comply with the specifications provided by the manufacturer.

9.2 Accessories shall be compatible only with other standardized accessories of the same type.

9.3 It shall not be possible to make single-pole connections between plugs and socket-outlets or vehicle connectors, and between vehicle inlets and vehicle connectors.

Compliance is checked by inspection and manual test.

9.4 It shall not be possible to engage plugs or vehicle connectors with socket-outlets or vehicle inlets having different ratings, or having different contact combinations unless safe operation is ensured or other means are provided to ensure safe operation.

In addition, improper connections between different electric vehicle accessories shall not be possible between:

a) signal and control contacts and a live (power) contact;
b) the protective earth and/or pilot plug-contact and a live socket-outlet contact, or a live plug contact and the protective earth and/or pilot socket-outlet contact;
c) the phase plug contacts and the neutral socket-outlet contact, if any;
d) a neutral plug contact and a phase socket-outlet contact.

Compliance is checked by inspection and the following manual test:

Insertion of the appropriate accessory is tested for 1 min with a force of 150 N for accessories with a rated current not exceeding 16 A, or 250 N for other accessories.

Where the use of elastomeric or thermoplastic material is likely to influence the result of the test, it is carried out at an ambient temperature of 55°C ±2K, both the accessories being conditioned at this temperature.

10 PROTECTION AGAINST ELECTRIC SHOCK

10.1 Accessories shall be so designed that live parts of socket-outlets and vehicle connectors, when they are wired as in normal use, and live parts of plugs and vehicle inlets, when they are in partial or complete engagement with the complementary accessories, are not accessible.

In addition, it shall not be possible to make contact between a live part of a plug or vehicle inlet and

A live part of a socket-outlet or vehicle connector while any live part is accessible.

NOTE — Neutral contacts of socket-outlets and vehicle connectors are deemed to be live parts. Pilot contacts, signal, data earth, protective earth contacts are not considered live parts.

This clause does not apply to contacts and conductors used for signal, data, communications and control circuits.

Compliance is checked by inspection and, if necessary, by a test on the sample wired as in normal use.

The standard test finger shown in Fig. 3 is applied in every possible position, an electrical indicator, with a voltage not less than 40 V, being used to show contact with the relevant part.

Using the pin and groove solution is only one of the possible approaches in order to limit the bending angle to 90°. For this reason dimensions and tolerances of these details are not given in the drawing. The actual design shall ensure a 90° bending angle with a 0° to 10° tolerance.

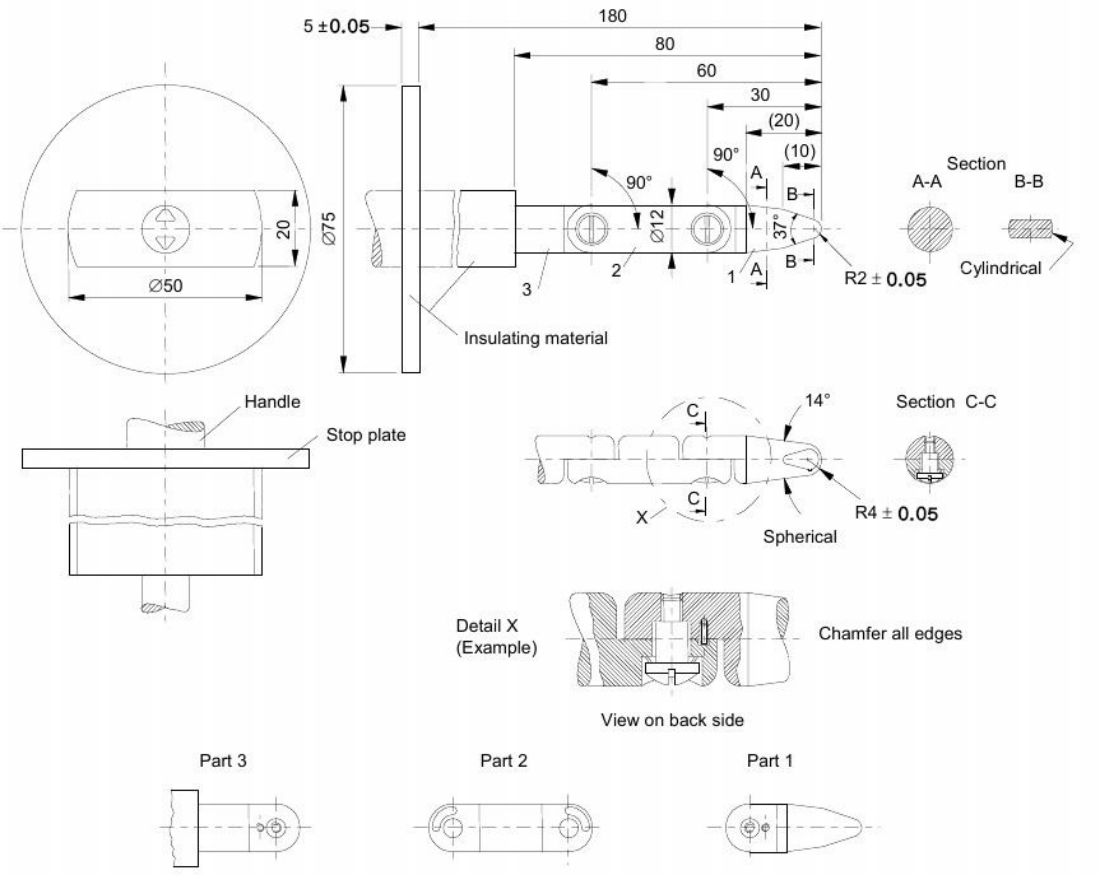
Material of finger: for example heat-treated steel.

NOTE — Both joints of this finger may be bent through an angle of $90^{+10^\circ}_{0^\circ}$ but in one and the same direction only.

10.2 For accessories provided with shutters, the shutters shall be so constructed that live parts are not accessible without a plug in engagement, with the gauges shown in Figures 4 and 5.

The gauges shall be applied to the entry holes corresponding to the live contacts and to any other opening of the engagement surface. The gauges shall not touch any live part.

NOTE — Neutral contacts of socket-outlets and vehicle connectors are deemed to be live parts. Pilot contacts, signal, data earth, protective earth contacts are not considered live parts.



Linear dimensions in millimetres

Tolerances on dimensions without specific tolerance:

a) on angles : $^{+0°}_{-10°}$

b) on linear dimensions:

1) up to $25\,^{+0}_{-0.05}$ mm

2) over 25 ± 0.2 mm

FIG. 3 STANDARD TEST FINGER

To ensure this degree of protection, accessories shall be so constructed that live contacts are automatically screened when complementary accessories are withdrawn.

The means for achieving this shall be such that they cannot easily be operated by anything other than complementary accessories and shall not depend upon parts which are liable to be lost.

An electrical indicator with a voltage between 40 V and 50 V included is used to show contact with the relevant part.

Compliance is checked by inspection and for socket-outlets with a plug completely withdrawn by applying the above gauges as follows.

The gauge according to Fig. 4 is applied to the entry holes corresponding to the live contacts and to any other opening of the engagement surface with a force of 20 N.

The gauge is applied to the shutters in the most unfavourable position, successively in three directions, to the same place for approximately 5 s in each of the three directions.

During each application the gauge shall not be rotated and it shall be applied in such a way that the 20 N force is maintained. When moving the gauge from one direction to the next, no force is applied but the gauge shall not be withdrawn.

A steel gauge, according to Fig. 5, is then applied with a force of 1 N and in three directions, for approximately 5 s in each direction, with independent movements, withdrawing the gauge after each movement.

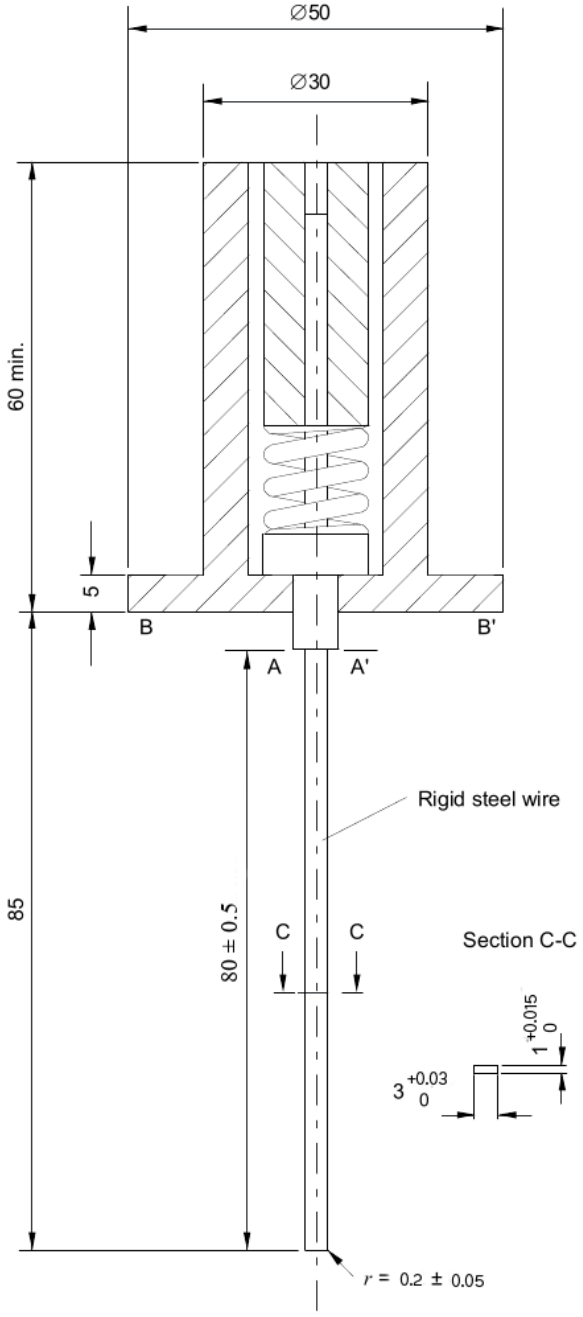
For socket-outlets and vehicle inlet with enclosures or bodies of thermoplastic material, the test is made at an ambient temperature of 35 °C ± 2K, both the socket-outlets and the gauge being at this temperature.

This test shall be repeated after the tests of **23**.

NOTES

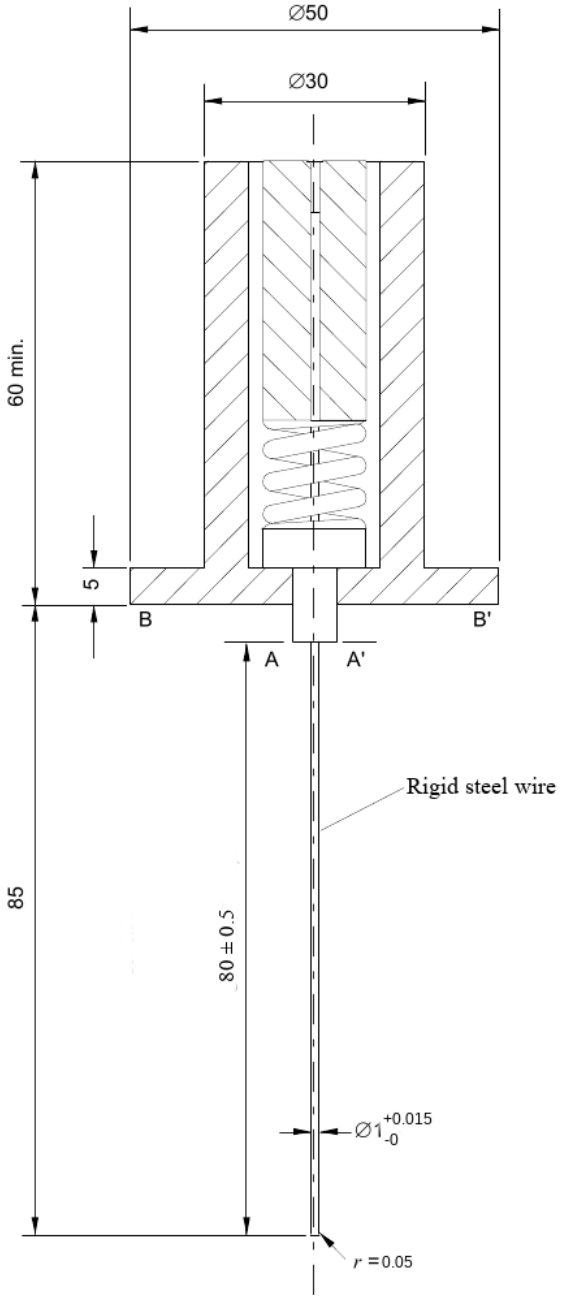
1 To calibrate the gauge "A" (Fig. 4), a push force of 20 N is applied on the steel rigid wire in the direction of its axis: the characteristics of the gauge internal spring shall be such that the surface A-A' is brought practically to the same level as the surface B-B' when this force is applied.

2 To calibrate the gauge "B" (Fig. 5), a push force of 1 N is applied on the steel rigid wire in the direction of its axis: the characteristics of the gauge internal spring shall be such that the surface A-A' is brought practically to the same level as the surface B-B' when this force is applied.



All dimensions in millimetres.

FIG. 4 GAUGE "A" FOR CHECKING SHUTTERS



All dimensions in millimetres

FIG. 5 GAUGE "B" FOR CHECKING SHUTTERS

10.3 Accessories shall be so designed that,

a) when inserting the plug or vehicle connector,
   1) the protective earth connection is made before the phase connections and neutral, if any, are made;
   2) the control pilot connection, if any, is made after the phase connections and neutral are made; and
   3) the proximity contact or connection switch contact, if any, is made after the protective earth contact and before or simultaneously the control pilot are made.

b) when withdrawing the plug or vehicle connector,
   1) the phase connections and neutral, if any, are broken before the protective earth connection is broken;

2) the control pilot connection, if any, is broken before the phase connections and neutral are broken; and
3) the proximity contact or connection switch contact, if any, is broken before the protective earth contact and after or simultaneously the control pilot are opened.

Compliance is checked by inspection and manual test, if required.

10.4 It shall not be possible to inadvertently assemble either the part carrying plug or inlet contacts into the enclosure of a socket-outlet or vehicle connector or the part carrying the socket-outlet or vehicle connector contacts into the enclosure of a plug or inlet.

Compliance is checked by inspection and manual test, if required.

11 SIZE AND COLOUR OF PROTECTIVE EARTHING CONDUCTORS

The conductor connected to the protective earthing terminal shall be identified by the colour combination green-and-yellow. The nominal cross-sectional area of the protective earthing conductor and of the neutral conductor, if any, shall be at least equal to that of the phase conductors, or as specified in Table 6.

12 PROVISIONS FOR PROTECTIVE EARTHING

12.1 Accessories shall be provided with a protective earthing contact and a protective earthing terminal.

Protective earthing contacts shall be directly and reliably connected to the protective earthing terminals.

Compliance is checked by inspection.

12.2 Accessible metal parts of accessories which may become live in the event of an insulation fault shall be reliably connected to the internal protective earthing terminal(s) by construction.

For the purpose of this requirement, screws for fixing bases, covers and the like are not deemed to be accessible parts which may become live in the event of an insulation fault.

If accessible metal parts are screened from live parts by metal parts which are connected to a protective earthing terminal or protective earthing contact, or if they are separated from live parts by double insulation or reinforced insulation, they are not, for the purpose of this requirement, regarded as likely to become live in the event of an insulation fault.

Compliance is checked by inspection and by the following test:

A current of 25 A derived from an a.c. source having a no-load voltage not exceeding 12 V is passed between the protective earthing terminal and each of the accessible metal parts in turn.

The voltage drop between the protective earthing terminal and the accessible metal part is measured, and the resistance calculated from the current and this voltage drop.

In no case shall the resistance exceed 0.05 Ω.

Care should be taken that the contact resistance between the tip of the measuring probe and the

metal part under test does not influence the test results.

12.3 Protective earthing contacts shall comply with the test requirements in either **12.3**(a) or **12.3**(b) to **12.3**(d), as specified by the manufacturer.

a) Protective earthing contacts shall be capable of carrying a current equal to that specified for the phase contacts without overheating. Compliance is checked by the test of **24**.
b) The assembly of mating accessories with protective earthing contacts shall carry the current specified in Table 5 for the time specified in that table. The current is to be based on the minimum size equipment protective earthing conductor for the ampere rating of the accessory. The components in the protective earthing path shall not crack, break, or melt.

Table 5 Short-time Test Currents

(*Clause* 12.3)

Rating of the Accessory	Minimum Size For Protective Earthing (Grounding) Copper Conductor	Time	Test Current
A	mm^2	s	A
10 to 15	2.5	4	300
16 and 20	4	4	470
21 to 60	6	4	750
61 to 70	10	4	1180
80 to 100	10	4	1180
125	16	6	1530
200	16	6	1530
250	25	6	2450
400	35	6	3100

NOTE — For accessories' ratings less than 10 A in Table 5, test current is based on the smallest size equipment protective earthing conductor permitted or can be determined by linear approximation of rated current (or 120 A/mm2), whichever is greater.

c) The mating accessories are to be mounted and assembled as intended. A protective earthing conductor of the minimum intended size, not less than 0.6 m long, is to be connected to the protective earthing terminal of each accessory, with the terminals employed to hold the conductor

tightened using a torque as specified by the manufacturer. Socket-outlets and vehicle inlets are to be wired with the minimum allowable size copper conductor. Plugs and vehicle connectors are to be wired with flexible, stranded conductors or cable sized based on the ampere rating of the accessory. The test current shall be passed through the mating accessories and protective earthing wires in series.

d) After having carried the current specified in **12.3**(b), continuity shall exist on the test assembly when measured between the protective earthing conductors. Any indicating device such as an ohmmeter, battery-and-buzzer combination, or the like, may be used to determine whether continuity exists.

Compliance is checked by inspection and test.

12.4 Protective earthing contacts shall be so shrouded or guarded that they are protected against mechanical damage.

This requirement precludes the use of side protective earthing contacts.

Compliance is checked by inspection.

Clean data (signal) earth contacts shall be capable of carrying a current of 2 A without overheating.

Compliance is checked by the test of **24**.

13 TERMINALS

13.1 Common Requirements

13.1.1 Rewirable accessories shall be provided with terminals.

Rewirable plugs and connectors shall be provided with terminals that accept flexible conductors.

13.1.2 Non-rewirable accessories shall be provided with soldered, welded, crimped or equally effective permanent connections (terminations).

Connections made by crimping a pre-soldered flexible conductor are not permitted, unless the soldered area is outside the crimping area.

Compliance is checked by inspection.

13.1.3 Terminals shall allow the conductor to be connected without special preparation.

This requirement is not applicable to lug terminals.

Compliance is checked by inspection.

NOTE - The term “special preparation” covers soldering of the wires of the conductor, use of terminal ends, etc., but not the reshaping of the conductor before introduction into the terminal or the twisting of a flexible conductor to consolidate the end.

13.1.4 Parts of terminals shall be of a metal having, under conditions occurring in the equipment, mechanical strength, electrical conductivity and resistance to corrosion adequate to intended use.

Table 6 Size for Conductors

(*Clauses* 11,13.1.9,13.2.1,13.3.2,16.10,16.13,27.1,28.1 and 31.3)

Contact Rating	**Internal Connection**			
Current	**Flexible Cables for Plugs and Vehicle Connectors Solid or Stranded Cables for Vehicle Inlets**[1)]		**Solid or Stranded Cables for Socket-outlets**[1)]	
A	mm^2	E	mm^2	E
2	0.5	--	0.5	--
10 to 13	1.0 to 1.5	2.5	1.0 to 1.5	2.5
16 and 20	1.0 to 2.5	2.5	1.5 to 4	4
30 and 32	2.5 to 6	6	2.5 to 10	10
60 to 70	6 to 16	16	6 to 25	25
80	10 to 25	25	16 to 35	25
125	25 to 70	25	35 to 95	50
200 and 250	70 to 150	25	70 to 185	95
400	240	120[2)]	300	150[2)]

[1)] Classification of conductors: according to IS 8130.

[2)] For isolated d.c. equipment – E conductor size based on a.c. mains (branch) circuit over-current protective size.

NOTE — The Table is not intended to specify the protective earthing conductor size but rather minimum/maximum range of conductor sizes for terminal tests and other tests.

Examples of suitable metals, when used within a permissible temperature range and under normal conditions of chemical pollution, are:

a) Copper;
b) An alloy containing at least 58 percent copper for parts that are worked cold or at least 50 percent copper for other parts;
c) Stainless steel containing at least 13 percent chromium and not more than 0.09 percent carbon;
d) Steel provided with an electroplated coating of zinc according to IS 1573, the coating having a thickness of at least:
   1) 8 µm for IP X4 accessories; and
   2) 12 µm for IP X5 accessories.
e) Steel provided with an electroplated coating of nickel and chromium according to IS 1068, the coating having a thickness of at least:
   1) 20 µm for IP X4 accessories; and
   2) 30 µm for IP X5 accessories.
f) Steel provided with an electroplated coating of tin according to IS 1359, the coating having a thickness equal to at least that specified for:
   1) 20 µm for IP X4 accessories; and
   2) 30 µm for IP X5 accessories.

Current-carrying parts, which may be subjected to mechanical wear, shall not be made of steel

provided with an electroplated coating of silver (Ag) or comparable material of same resistance.

Compliance is checked by inspection and by chemical analysis.

13.1.5 If the body of a protective earthing terminal is not part of the metal frame or housing of the accessory, the body shall be of material as prescribed in **13.1.4** for parts of terminals. If the body is part of the metal frame or housing, the clamping means shall be of such material.

If the body of a protective earthing terminal is part of a frame or housing made 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.

The requirement regarding the avoidance of the risk of corrosion does not preclude the use of adequately coated metal screws or nuts.

Compliance is checked by inspection and by chemical analysis.

13.1.6 Terminals shall be properly fixed to the accessory and shall not loosen when connecting and disconnecting the conductors.

Clamping means shall not serve to fix any other component.

The clamping means for the conductor may be used to stop rotation or displacement of the plug or socket contacts.

Compliance is checked by inspection and, if necessary, by test of **29.1**.

These requirements do not preclude terminals that are floating or terminals so designed that rotation or displacement of the terminal is prevented by the clamping screw or nut, provided that their movement is appropriately limited and does not impair the correct operation of the accessory.

Terminals may be prevented from working loose by fixing with two screws, by fixing with one screw in a recess such that there is no appreciable play, or by other suitable means.

Covering with sealing compound without other means of locking is not deemed to be sufficient. Self-hardening resins may, however, be used to lock terminals which are not subject to torsion in normal use.

13.1.7 Each terminal shall be located in proximity to the other terminals, as well as to the internal protective earthing terminal, if any, unless there is a sound technical reason to the contrary.

Compliance is checked by inspection.

13.1.8 Terminals shall be so located or shielded that

a) screws or other parts becoming loose from the terminals, cannot establish any electrical connection between live parts and metal parts connected to the protective earthing terminal;
b) conductors becoming detached from live terminals cannot touch metal parts connected to the protective earthing terminal; and
c) conductors becoming detached from the protective earthing terminal cannot touch live parts.

This requirement applies also to terminals for pilot conductors.

Compliance is checked by inspection and by manual test.

13.1.9 When the conductors have been correctly fitted, there shall be no risk of accidental contact between live parts of different polarity or between such parts and accessible metal parts, and, should a wire of a stranded conductor escape from a terminal, there shall be no risk that such a wire emerges from the enclosure.

The requirement with regard to the risk of accidental contact between live parts and accessible metal parts does not apply to accessories having rated voltages not exceeding 50 V.

Compliance is checked by inspection and, where the risk of accidental contact between live parts and other metal parts is concerned, by the following test:

An 8 mm length of insulation is removed from the end of a flexible conductor having a cross sectional area in the middle of the range specified in Table 6. One wire of the stranded conductor is left free and the other wires are fully inserted and clamped into the terminal. The free wire is bent back, without tearing the insulation, in every possible direction, but without making sharp bends around barriers.

The free wire of a conductor connected to a live terminal shall neither touch any metal part which is not a live part nor emerge from the enclosure. The free wire of a conductor connected to the protective earthing terminal shall not touch any live part.

If necessary, the test is repeated with the free wire in another position.

13.2 Screw Type Terminals

13.2.1 Screw type terminals shall allow the proper connection of copper or copper-alloy conductors having nominal cross-sectional areas as shown in Table 6.

For terminals other than lug terminals, compliance is checked by the following test and by tests of **13.3**.

Gauges as specified in Fig. 6, having a measuring section for testing the insertability of the maximum specified cross-sectional area of Table 6, shall be able to penetrate into the terminal aperture, down to the designated depth of the terminal, under their own weight.

Screw type terminals that cannot be checked with the gauges specified in Fig. 6 shall be tested by suitably shaped gauges, having the same cross-section as those of the appropriate gauges given in Fig. 6.

For pillar terminals in which the end of a conductor is not visible, the hole to accommodate the conductor shall have a depth such that the distance between the bottom of the hole and the last screw will be equal to at least half the diameter of the screw, and in any case not less than 1.5 mm.

Compliance is checked by inspection.

For terminals complying with Fig. 2E, the lug shall accept conductors having nominal cross- sectional areas within the appropriate range specified in Table 6.

Compliance is checked by inspection.

13.2.2 Screw type terminals shall have appropriate mechanical strength.

Screws and nuts for clamping shall have an ISO thread or a thread comparable in pitch and mechanical strength.

Compliance is checked by inspection, measurement and the test of **29.1**. In addition to the requirements of **29.1**, the terminals shall not have undergone changes after the test that would adversely affect their future use.

13.2.3 Screw-type terminals shall be so designed that they clamp the conductor between metal surfaces with sufficient contact pressure and without damaging the conductor.

Compliance is checked by inspection and by the type tests of **13.3**.

13.2.4 Lug terminals shall be used only for accessories having a rated current of at least 60 A. If such terminals are provided, they shall be fitted with spring washers or equally effective locking means.

Compliance is checked by inspection.

13.2.5 Clamping screws or nuts of protective earthing terminals shall be adequately locked against accidental loosening, and it shall not be possible to loosen them without the aid of a tool.

Compliance is checked by inspection, by manual test and by the relevant test of **13**.

13.3 Mechanical Tests on Terminals

13.3.1 New terminals are fitted with new conductors and of the minimum and the maximum cross- sectional areas and are tested with the apparatus shown in Fig. 7.

The test shall be carried out on six samples: three with the smallest conductor cross- sectional area and three with the largest conductor cross-sectional area.

The length of the test conductor shall be 75 mm longer than the height H specified in Table 7.

Clamping screws, if any, are tightened with the torque according to Table 23. Otherwise the terminals are connected according to the manufacturer's instructions.

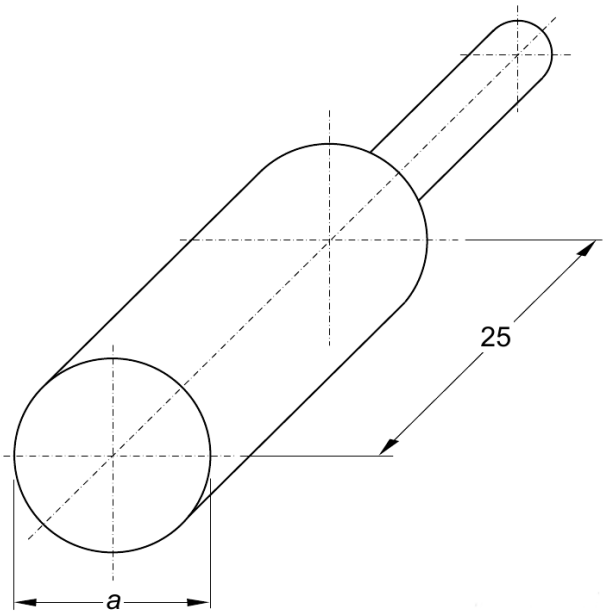
Each conductor is subjected to the following test.

The end of the conductor is passed through an appropriate-sized bushing in a platen, positioned at a height H below the accessory, as given in Table 7. The bushing is positioned in a horizontal plane, such that its centre line describes a circle of 75 mm diameter, concentric with the centre of the clamping unit in the horizontal plane. The platen is then rotated at a rate of 10 ± 2 rev/min.

The distance between the mouth of the clamping unit and the upper surface of the bushing shall be within 15 mm of the height in Table 7. The bushing may be lubricated to prevent binding, twisting or rotation of the insulated conductor. A mass, as specified in Table 7, is suspended from the end of the conductor. The duration of the test is 15 min.

During the test, the conductor shall neither slip out of the clamping unit nor break near the clamping unit.

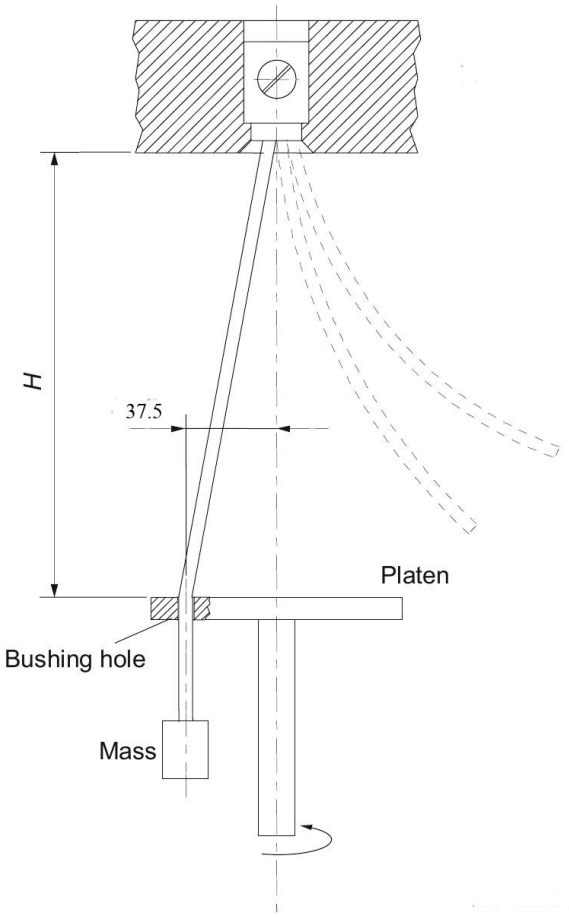
Terminals shall not, during this test, damage the conductor in such a way as to render it unfit for further use.



All dimensions in millimetres.

Conductor cross-sectional area		Gauge	
Flexible	**Rigid (solid or stranded)**	**Diameter *a***	**Tolerances for *a***
mm2	mm2	mm	mm
1.5	1.5	2.4	+0 -0.05
2.5	4	2.8	+0 -0.05
4	6	3.6	+0 -0.06
6	10	4.3	+0 -0.06
10	–	5.3	+0 -0.06
16	25	6.9	+0 -0.07
50	70	12.0	+0 -0.08
70	–	14.0	+0 -0.08
–	150	18.0	+0 -0.08
150	185	20.0	+0 -0.08
185	240	25	+0 -0.08
240	300	28	+0 -0.08
Maximum cross-section of conductors and corresponding gauges. Material: steel			

FIG. 6 GAUGES FOR TESTING INSERTABILITY OF ROUND UNPREPARED CONDUCTORS HAVING THE MAXIMUM SPECIFIED CROSS-SECTION



All dimensions in millimetres.

FIG. 7 EQUIPMENT TEST ARRANGEMENT

Table 7 Values for Flexing under Mechanical Load Test

(*Clause* 13.3.1)

Nominal Cross-Sectional area	Diameter of Bushing	Height [1)]	Mass
mm^2	mm	mm	kg
1.0	6.5	260	0.4
1.5	6.5	260	0.4
2.5	9.5	280	0.7
4.0	9.5	280	0.9
6.0	9.5	280	1.4
10.0	9.5	280	2.0
16.0	13.0	300	2.9
25.0	13.0	300	4.5
35.0	14.5	300	6.8
50.0	15.9	343	9.5
70.0	19.1	368	10.4
95.0	19.1	368	14.0
120.0	22.2	406	14.0
150.0	22.2	406	15.0
185.0	25.4	432	16.8
240.0	28.6	464	20.0
300.0	28.6	464	22.7

[1)] Tolerance for height *H:* ±15 mm.

NOTE — If a bushing with the given hole diameter is not adequate to accommodate the conductor without binding, a bushing having the next largest hole may be used.

13.3.2 Verification is carried out successively with conductors of the largest and smallest cross- sectional areas specified in Table 6, using Class 1 or Class 2 conductors for terminals of socket- outlets or appliance inlets, and Class 5 conductors for terminals of plugs or connectors.

The conductors shall be connected to the clamping unit, and the clamping screws or nuts tightened to two-thirds of the torque indicated in Table 23, unless the torque is specified by the manufacturer on the product or in an instruction sheet.

Each conductor is subjected to a pull according to the value in Table 8, exerted in the opposite direction to that in which the conductor was inserted. The pull is applied without jerks for 1 min. The maximum length of the test conductor shall be 1 m.

During the test, the conductor shall not slip out of the terminal nor shall it break at, or in, the clamping unit.

Table 8 Value for Terminal Pull Test

(*Clause* 13.3.2)

Nominal Cross- Sectional Area	Pulling Force
mm^2	N
1	35
1.5	40
2.5	50
4	60
6	80
10	90
16	100
25	135
35	190
50	236
70	285
95	351
120	427
150	427
185	503
240	578
300	578

14 INTERLOCKS

14.1 Accessories with Interlock

14.1.1 Accessories classified in accordance with **7.4** "not suitable for making and breaking an electrical circuit under load" shall be provided with an interlock.

NOTE — Switching, related interlocks and control systems, other than the control pilot contact, are part of the electric vehicle supply equipment or part of the Electric Vehicle.

14.1.2 Plugs and socket-outlets with interlocks shall be so constructed that a plug cannot be completely withdrawn from the socket-outlet while the contacts of that socket-outlet are live, and the contacts of the socket-outlet cannot be made live until a plug is in proper engagement.

Vehicle couplers with interlocks shall be so constructed that a vehicle connector cannot be completely withdrawn from the vehicle inlet while the contacts of that vehicle connector are live, and the contacts of the vehicle connector cannot be made live until the vehicle connector is in proper engagement.

The power contacts shall not make or break under load.

Accessories shall be so designed that, after engagement with a complementary accessory, the interlock operates correctly.

The operation of an interlock shall not be impaired by normal wear of the portion of the accessory used for interlocking.

Compliance is checked by carrying out the tests of **14.1.5** or **14.1.6** as applicable after the test of **23**.

14.1.3 Accessories with interlock but without latching function (electrical interlock) shall be so constructed that

a) the time interval between the opening of the contacts of the control switching device and the opening of the line contacts and neutral contact, if any, of the accessory shall be sufficient to ensure that the mechanical switching device interrupts the current before the contacts of the plug are disconnected from the contacts of the socket-outlet; and

b) during the closing operation, the contacts of the control switching device shall close after or simultaneously with the contacts of the main poles.

Compliance is checked by the following test:

For products provided with an actuator, an attempt shall be made, without the plug inserted, to close the switching device by applying a force according to **24.101** of IEC 60309-4:2006. The switching device contacts shall not close.

This is checked by a continuity test made between the supply terminals and the contact assembly of the socket-outlet.

The time interval is checked by measuring the time interval between the instant of opening of the contacts of the control switching device and the instant of opening of the contact of the mechanical switching device, under no-load conditions.

Where the control switching device depends on pilot contacts, the time interval shall not be greater than 35 ms.

The time interval of 35 ms is the ratio between the distances given in the standard sheets, in the worst condition, and the separation speed given in **22.2**.

Switched socket-outlets with interlock and latching device holding the plug into the socket- outlet (mechanical interlock) shall be so constructed that the interlock is linked with the operation of a switch so that the plug can neither be inserted nor withdrawn from the socket-outlet while the contacts of the socket-outlet are live, and the contacts of the socket-outlet cannot be made live until a plug is almost completely in engagement.

Switched vehicle connectors with interlock and latching device holding the vehicle connector onto the vehicle inlet (mechanical interlock) shall be so constructed that the interlock is linked with the operation of a switch so that the vehicle connector can neither be inserted nor withdrawn from the vehicle inlet while the contacts of the vehicle connector are live and the contacts of the vehicle connector cannot be made live until it is almost completely in engagement with a vehicle inlet.

Compliance is checked by inspection, by a manual test and by the following test:

Without the plug inserted an attempt shall be made to close the switching device by applying a force according to **24.101** of IEC 60309-4:2006. The switching device contacts shall not close.

This is checked by a continuity test made between the supply terminals and the contact assembly of the socket-outlet.

Accessories with interlock and latching device which hold the plug into the socket-outlet or connector are subjected to the test of **14.1.5** and **14.1.6**.

The switched socket-outlet or connector with interlock is fixed to the support of an apparatus as shown in Fig. 8 so that the axis of separation is vertical and the movement of the plug is downwards. With the latching devices holding the plug into the socket-outlet or connector in the engaged position, an axial pull is applied to an appropriate plug inserted in the switched socket- outlet or connector with interlock. The test plug, according to the relevant standard sheets, shall have finely ground contacts of hardened steel, having a surface roughness not exceeding 0.8 mm over their active length and spaced at the nominal distances, with a tolerance of ±0.05 mm.

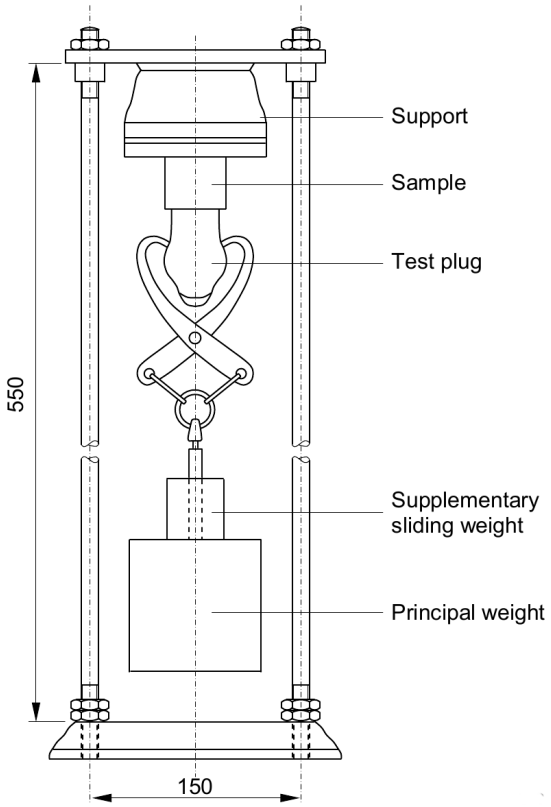
The dimension of the plug contacts or the distance between contact surfaces for other types of plug contacts shall be in accordance with the minimum dimension(s) given in the relevant standard sheets, with a tolerance of $^{+0.01}_{-0}$

The plug contacts are wiped free from grease before test.

The test plug is inserted into and withdrawn from the socket-outlet or connector ten times. It is then again inserted, a mass being attached to it by means of a suitable clamp. The total mass of the plug, the clamp, the carrier, the principal and the supplementary weight shall exert a pull force according to Table 9. The supplementary weight shall be such that it exerts a force equal to one-tenth of the withdrawal force. The retaining means, if any, shall be opened.

The principal weight is hung without jolting on the test plug, and the supplementary weight is allowed to fall from a height of 5 cm onto the principal weight.

After this test, the total weight shall be maintained for 60 s.



All dimensions in millimetres

FIG. 8 APPARATUS FOR CHECKING THE WITHDRAWAL FORCE

14.1.6 The switched socket-outlet or connector with interlock is fixed to the support of an apparatus as shown in Fig.9A so that the axis of separation is horizontal. With the latching devices holding the plug into the socket-outlet or connector in the engaged position, an axial pull is applied to the cable attached at an appropriate plug inserted in the switched socket-outlet or connector with interlock. The test plug, according to the relevant standard sheets, shall have finely ground contacts of hardened steel, having a surface roughness not exceeding 0.8 µm over their active length and spaced at the nominal distances, with a tolerance of ±0.05 mm.

The dimension of the plug contacts or the distance between contact surfaces for other types of plug contacts shall be in accordance with the minimum dimension(s) given in the relevant standard sheets, with a tolerance of $^{+0.01}_{-0}$ mm.

The plug contacts are wiped free from grease before test.

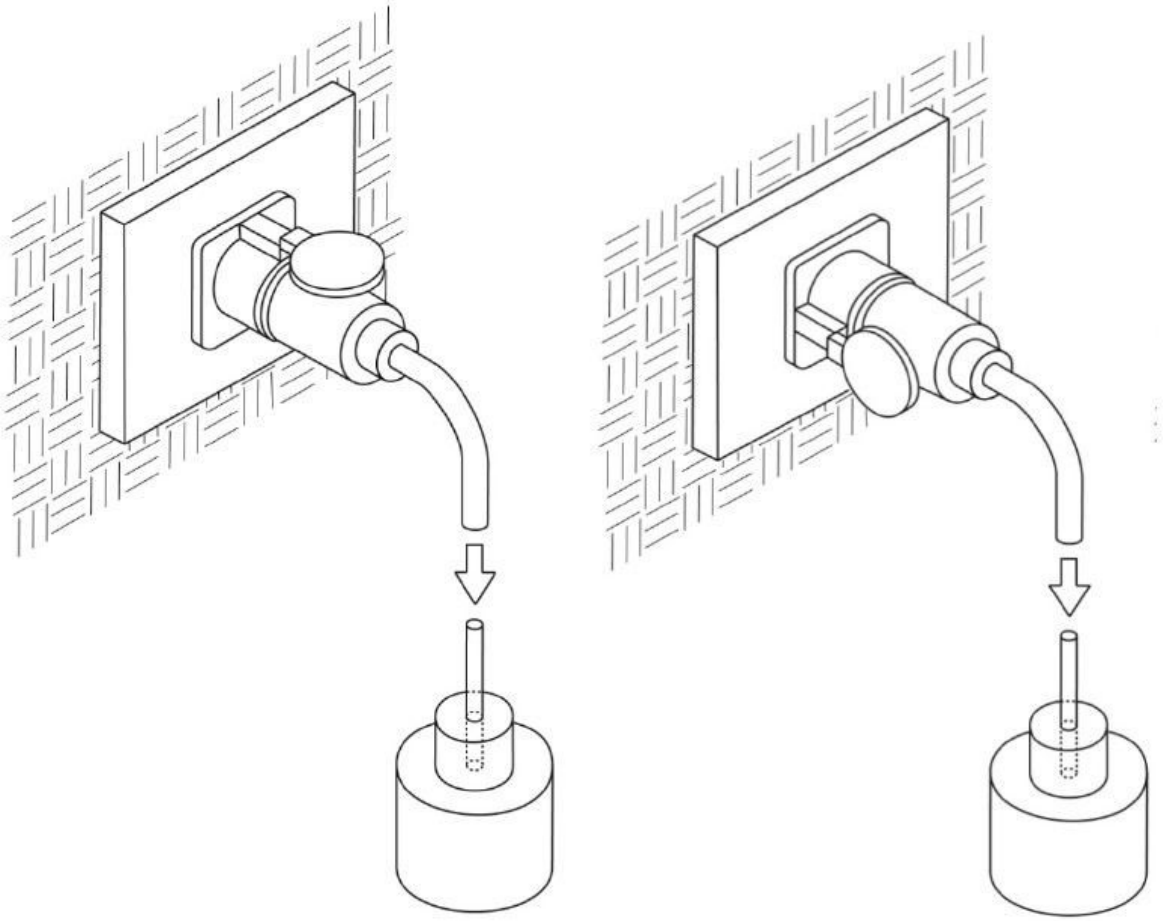
The test plug is inserted into and withdrawn from the socket-outlet or connector ten times. It is then again inserted, a mass being attached to it by means of a suitable clamp. The total mass of the plug, the clamp, the carrier, the principal and the supplementary

weight shall exert a pull force according to Table 9. The supplementary weight shall be such that it exerts a force equal to one-tenth of the withdrawal force. The retaining means, if any, shall be opened.

The principal weight is hung without jolting on the test plug, and the supplementary weight is allowed to fall from a height of 5 cm onto the principal weight.

After this test, the total weight shall be maintained for 60 s.

The test of **14.1.6** is repeated three times, rotating the socket-outlet of 90° on the vertical plane each time (*see* Fig. 9B)



A. First Test **B. Second Test at 90°**

FIG. 9 VERIFICATION OF THE LATCHING DEVICE

Table 9 Withdrawal Force with Respect to Ratings

(*Clauses* 14.1.5 and 14.1.6)

a.c. Rated Current	Withdrawal Force
A	N
From 6 up to and including 40	165
From 41 up to and including 80	300
From 81 up to and including 150	440
From 151 up to and including 250	660
d.c. Rated Current	750
Any	

During the tests of **14.1.5** and **14.1.6**, the plug shall not come out of the socket-outlet or vehicle connector and the latching devices holding the plug in the socket-outlet or vehicle connector shall remain in locked position.

During the test the electrical continuity shall be maintained.

After the test, the switched socket-outlet or vehicle connector with interlock shall show no damage or deformation which may impair the function of the product.

Compliance is checked by inspection and test.

14.2 Accessories with Integral Switching Device

Integral switching devices shall comply with IS/IEC 60947-3 as far as it is applicable and,

a) for a.c. application, shall have a rated current, at a utilization category of at least AC-22A, not less that the rated current of the associated socket-outlet or vehicle connector; and

b) for d.c. application, shall have a rated current, at a utilization category of at least DC-21A, not less than the rated current of the associated socket-outlet or vehicle connector.

14.3 Control Circuit Devices and Switching Elements

Control circuit devices and switching elements, if any, used in the control circuit of an electrically interlocked socket-outlet or connector shall comply with IS/IEC 60947-5-1 or IS/IEC 61058-1 and they shall have ratings suitable for the load to be controlled.

Control switching devices according to IS/IEC 61058-1 shall be classified with at least 10 000 cycles.

Compliance is checked by inspection, by measurement and by tests.

14.4 Pilot Contacts and Auxiliary Circuits

Pilot contacts and auxiliary circuits used for interlocks shall make after the neutral and phase(s) are made.

Pilot contacts and auxiliary circuits used for interlocks shall break before the phase(s) and neutral are broken.

Compliance is checked by inspection and by the test of **14.1.5**.

15 RESISTANCE TO AGEING OF RUBBER AND THERMOPLASTIC MATERIAL

Accessories with enclosures of rubber or thermoplastic material, and parts of elastomeric such as sealing rings and gaskets, shall be sufficiently resistant to ageing.

Compliance is checked by an accelerated ageing test made in an atmosphere having the composition and pressure of the ambient air.

The samples are suspended freely in a heating cabinet, ventilated by natural circulation.

The temperature in the cabinet and the duration of the ageing test are

a) 70°C ± 2 K and 10 days (240 h), for rubber; and

b) 80°C ± 2 K and 7 days (168 h), for thermoplastic material.

NOTE — The ageing temperatures for materials used at higher ambient temperatures are under consideration.

After the samples have been allowed to attain approximately room temperature, they shall be examined and show no crack visible to the naked eye, nor shall the material have become sticky or greasy.

After the test, the samples shall show no damage which would lead to non-compliance with this standard. If there is a doubt as to whether the material has become sticky, the sample is placed on one of the pans of a balance and the other pan is loaded with a mass equal to the mass of the sample plus 500 g. Equilibrium is then restored by pressing the sample with the

forefinger, wrapped in a dry piece of coarse woven cloth.

No trace of the cloth shall remain on the sample and the material of the sample shall not stick to the cloth.

The use of an electrically heated cabinet is recommended. Natural circulation may be provided by holes in the walls of the cabinet.

16 GENERAL CONSTRUCTION

16.1 Accessible surfaces of accessories shall be free from burrs, flashes and similar sharp edges.

Compliance is checked by inspection.

16.2 Screws or other means for fixing the part carrying the socket-outlet contacts or the part carrying the plug contacts to its mounting surface, in a box or in an enclosure, shall be easily accessible.

These fixings and those which fix the enclosure shall not serve any other purpose except in the case whereby an internal protective earthing connection is established automatically and in a reliable way by such a fixing.

Compliance is checked by inspection.

16.3 It shall not be possible for the user to alter the position of the protective earthing contact, or of the neutral contact, if any, in relation to the means of non-interchangeability of the socket-outlet or vehicle connector, or in relation to the means of non-interchangeability of the plug or vehicle inlet.

Compliance is checked by manual test to ensure that only one mounting position is possible.

16.4 Socket-outlets and vehicle connectors when mounted as in normal use and without a plug and vehicle inlet respectively in position shall ensure the degree of protection specified on its marking.

In addition, when a plug or vehicle inlet is fully engaged with the socket-outlet or vehicle connector, the lower degree of protection of the two accessories shall be ensured.

Compliance is checked by inspection and by the tests of **20** and **21**.

16.5 The maximum permissible temperature of those parts of the plug and the vehicle connector that can be grasped during normal operation, when tested with the accessory carrying the maximum rated current, shall not exceed

a) 50°C for metal parts, and

b) 60°C for non-metal parts.

For parts which may be touched but not grasped the permissible temperature are

c) 60°C for metal parts, and

d) 85°C for non-metal parts.

Compliance is checked by the test of **24.2** performed at an ambient temperature of 25°C ± 5 K and the results obtained corrected to an ambient of 40°C.

16.6 Contacts shall be so designed as to ensure adequate contact pressure when completely engaged with the corresponding accessory.

Compliance is checked by inspection and the temperature-rise test of Clause **24**.

16.7 A retaining means shall be provided.

A mechanical interlock may provide the function of the retaining means.

Compliance is checked by inspection and test of **16.8**.

16.8 With the retaining means in place, the mating accessory shall be pulled with a force equal to the weight of the accessory and a length of the maximum size cable or cable assembly used with the accessory, as specified in Table 10. The retaining means shall not release.

Table 10 Cable Length Used to Determine Pull Force on Retaining Means

(*Clause* 16.8)

Accessory	Cable Length m
Universal a.c.	1.5
Universal d.c.	1.5
Basic	4
D.C.	1.5
Combined	1.5

Compliance is checked by inspection and test.

16.9 The vehicle coupler and/or the plug may include a means to allow engagement of an optional locking mechanism to reduce the likelihood of tampering or unauthorised removal or connection.

Compliance is checked by inspection.

16.10 Rewirable accessories shall be so constructed as to allow

a) the conductors to be easily introduced into the terminals and secured therein;

b) the correct positioning of the conductors, without their insulation coming into contact with live parts of a polarity different from that of the conductor; or without reducing the creepage distances and clearances below the values in **28.1**; and

c) the covers or enclosures to be easily removable for inspection and easily fixed after connection of the conductors.

Compliance is checked by inspection and by an installation test with conductors of the largest cross-sectional area specified in Table 6.

16.11 Field serviceable accessories shall be so designed and constructed to discourage user servicing, rewiring or accessing live parts by non-qualified personnel. This can be accomplished through one or more of the following means:

a) necessity of the use of special tools (that is crimping tool, soldering equipment),

b) necessity of replacing individual parts of the accessory (that is replacement of terminals, contacts), and/or

c) necessity to break seals to disassemble the accessory.

Compliance is checked by inspection.

16.12 Enclosures and parts of accessories providing protection against electric shock shall have adequate

mechanical strength; they shall be securely fixed in such a way that they will not work loose in normal use. It shall not be possible to remove these parts without the aid of a tool.

Compliance is checked by inspection and test.

16.13 Cable entries shall allow the introduction of the conduit or the protective covering of the cable to afford complete mechanical protection.

Compliance is checked by inspection and by an installation test with conductors of the largest cross-sectional area specified in Table 6.

16.14 Insulating linings, barriers and the like shall have adequate mechanical strength. They shall be secured to the enclosure or body in such a way that they cannot be removed without being seriously damaged, or be so designed that they cannot be replaced in an incorrect position.

The use of adhesives is allowed for fixing insulating linings.

Compliance is checked by inspection and by the tests of **20.2** and **26.3**.

16.5 The force to insert and withdraw a plug or a vehicle connector shall be less than 100 N. This can be achieved with the help of a means to facilitate the insertion and withdrawal of the plug from

the socket-outlet or the connector from the vehicle inlet.

The movement of either of these accessories need not necessarily be a single linear movement. The insertion and withdrawal force shall be applied as required by each stage of the insertion and withdrawal movement. The manufacturer shall state the position and direction at which this force(s) shall be applied.

Compliance may be checked by a spring scale or the following test:

The fixed accessory (the socket-outlet or vehicle inlet) is mounted such that the mating accessory moves vertically downward into it during the first stage of insertion. A principal weight of 9.2 kg is suitably suspended from the matching accessory. A supplementary weight of 0.8 kg is allowed to fall from a height of 5 cm onto the principal weight. The moving accessory shall enter the fixed accessory to the position required to engage the contacts properly.

The operation is then repeated for any subsequent movements.

The test is repeated using a fixed weight of 2.0 kg and no supplementary weight. The moving accessory shall not become inserted in the fixed accessory to the extent specified by the manufacturer. These tests are carried out in reverse also to check the withdrawal force to determine that the contacts disengage properly.

16.16 A gripping surface shall be provided and so designed that the accessory can be withdrawn without having to pull the flexible cable.

Compliance is checked by inspection.

17 CONSTRUCTION OF SOCKET-OUTLETS

17.1 General

When a plug is not engaged, socket-outlets shall be totally enclosed when fitted with screwed conduits, or sheathed cables. Polyvinyl chloride sheathed cables are not excluded. The means for achieving total enclosure and that for ensuring the marked degree of protection, if any, shall be securely fixed to the socket-outlet. In addition, when a plug is completely engaged, the socket-outlet shall incorporate means for ensuring the marked degree of protection.

Lid springs, if any, shall be of corrosion-resistant material, such as bronze, stainless steel, or other suitable material adequately protected against corrosion.

IP44 socket-outlets, designed for only one mounting position, may have provision for opening a drain-hole at least 5 mm in diameter or 20 mm2 in area with a width of at least 3 mm which is effective when the socket-outlet is in the mounting position.

The total enclosure and the marked degree of protection may be achieved by means of a lid.

Compliance is checked by inspection, by measurement and by the tests of **20**, **21** and **23**.

NOTE — A drain-hole in the back of the enclosure of a socket-outlet, up to IP44 intended to be mounted on a vertical wall, is deemed to be effective only if the design of the enclosure ensures a clearance of at least 5 mm from the wall, or provides a drainage channel of at least the size specified.

17.2 Contact Tubes

17.2.1 For accessories using pins and contact tubes, contact tubes, shall be self-adjusting and so designed as to ensure adequate contact continuity before and after a number of operations corresponding to their operational life.

Contact tubes other than the protective earth contact shall be floating.

Protective earth contact tubes need not be floating, provided that they have the necessary resilience in all directions.

Compliance is checked by inspection and by the following test:

The sample is mounted so that the axes of the contact tubes are vertical with the contact openings downwards.

A gauge of hardened steel, with a finish of 0.002 mm and free from grease, having the dimensions shown in Table 11, is inserted into each contact tube, also free from grease, and the force necessary to withdraw the gauge is measured.

The sum of the force and the weight of the gauge shall exceed the minimum total force shown in Table 11.

Table 11 Gauges to Measure Withdrawal Force

(*Clause* 17.2.1)

Nominal Pin Diameter	Gauge	
	Diameter of Gauge	Minimum Total Force
	mm $^{+0}_{0.01}$	N
5	4.80	2.5
6	5.80	5
7	6.80	5
8	7.80	10
10	9.80	15
12	11.80	20

This test shall be made after that of **17.2.2**.

17.2.2 The pressure exerted by the contact tubes on the pins of a plug shall not be so great as to prevent easy insertion and withdrawal of the plug.

Compliance is checked by determining the force necessary to withdraw the test plug from the sample, this being mounted so that the axes of the contact tubes are vertical with the contact opening downwards, as shown in Fig. 8.

A test plug provided with pins having the dimensions shown in Table 12 is inserted into the sample.

Table 12 Diameter of Pins of the Test Plug

(*Clause* 17.2.2)

Nominal Pin Diameter	Diameter of Pins of the Test Plug
mm	mm $^{+0.01}_{-0}$
5	5.00
6	6.00
7	7.00
8	8.00
10	10.00
12	12.00

The principal weight, together with the supplementary weight (the latter being such that it exerts a force equal to one-tenth of the force exerted by the principal weight) and the test plug exert a force equal to the maximum withdrawal force shown in Table 13.

The principal weight is hung without jolting on the test plug, and the supplementary weight is allowed to fall from a height of 5 cm onto the principal weight.

The plug shall not remain in the sample.

Table 13 Maximum Withdrawal Force

(*Clause* 17.2.2)

Rated Current	Maximum Withdrawal Force
A	N
up to and including 59	150
from 60 up to and including 99	275
from 100 up to and including 125	400

NOTE — These forces do not take into account any means to facilitate insertion and withdrawal of the accessory.

18 CONSTRUCTION OF PLUGS AND VEHICLE CONNECTORS

18.1 The enclosure of plugs and vehicle connectors shall completely enclose the terminals and the ends of the flexible cable.

The construction of rewirable plugs and vehicle connectors shall be such that the conductors can be properly connected and the cores kept in place so that there is no risk of contact between them from the point of separation of the cores to the terminals.

Accessories shall be so designed that they can only be reassembled so as to ensure the correct relationship between the components as originally assembled.

Compliance is checked by inspection and, if necessary, by manual test.

18.2 The various parts of a plug or vehicle connector shall be reliably fixed to one another in such a way that they will not work loose in normal use. It shall not be possible to dismantle plugs or vehicle connectors without the aid of a tool.

Compliance is checked by manual test and by the test of **25.3**.

18.3 Plugs shall incorporate means for ensuring the marked degree of protection when in complete engagement with the complementary accessory.

Where there is an attached cap, which cannot be removed without the aid of a tool, then the plug shall also meet this requirement when that cap is correctly fitted.

It shall not be possible to dismantle these means without the aid of a tool.

Compliance is checked by inspection and by the tests of **20** and **21**.

18.4 Vehicle connectors shall be totally enclosed when fitted with a flexible cable as in normal use and when

not in engagement with the vehicle inlet. In addition, they shall incorporate means for ensuring the marked degree of protection when in complete engagement with the vehicle inlet.

The marked degree of protection when not in engagement with the vehicle inlet may be achieved by means of a cap, lid or cover.

The means for ensuring the marked degree of protection shall be securely fixed to the vehicle connector.

Lid springs shall be of corrosion-resistant material, such as bronze, stainless steel or other suitable materials adequately protected against corrosion.

Compliance is checked by inspection and by the tests of **20**, **21** and **23**.

19 CONSTRUCTION OF VEHICLE INLETS

19.1 Vehicle inlets shall incorporate means for ensuring the marked degree of protection when an appropriate vehicle connector is completely engaged.

The IP degree of protection of the vehicle inlet must be considered, assuming that any accessible parts that may be live when a vehicle connector is connected are not live when the vehicle connector is removed and may be touched by the test finger.

Where there is an attached cap, which cannot be removed without the aid of a tool, then the vehicle inlets shall also meet this requirement when that cap is correctly fitted.

It shall not be possible to dismantle these means without the aid of a tool.

When a connector is not mated, the IP degree shall be achieved by the vehicle inlet or by a combination of the vehicle and the vehicle inlet.

Compliance is checked by inspection and by the tests of **19** and **20**.

19.2 Vehicle inlets having rated operating voltage exceeding 50 V shall be provided with protective earthing contacts.

Compliance is checked by inspection.

19.3 Vehicle inlets may have provision for a suitably located drain-hole of at least 5 mm in diameter or 20 mm2 in area with a width of at least 3 mm, which is effective when the vehicle inlet is in the mounting position.

Compliance is checked by inspection and measurement.

20 DEGREES OF PROTECTION

20.1 Accessories shall have the minimum degrees of protection as required in IEC 61851-1.

Compliance is checked by the appropriate tests mentioned in **20.2** and **20.3**.

The tests are made on accessories fitted with the cables or conduits for which they are designed, screwed glands and fixing screws of enclosures and covers being tightened with a torque equal to two-thirds of that applied in the tests of **26.5** or **27.1**, as appropriate.

Screwed caps or lids, if any, are tightened as in normal use.

Socket-outlets are mounted on a vertical surface so that the open drain-hole, if any, is in the lowest position and remains open.

Vehicle inlets are mounted in position as intended in the vehicle. Tests shall be conducted with any doors, access panels, covers, etc., provided by the vehicle both in the unmated, open, and closed (in the road position) positions. Vehicle connectors are placed in the most unfavourable position and the drain-hole, if any, remains open.

Socket-outlets and vehicle connectors are tested with and without the complementary accessory in engagement, the means for ensuring the required degree of protection against moisture being positioned as in normal use.

Plugs and vehicle inlets are tested as described in **18.3** or **19.1**.

20.2 Accessories shall be tested in accordance with **20.1** and IS/IEC 60529. When the first characteristic numeral is 5, category 2 shall apply.

For IPX4, the oscillating tube according to **14.2.4** (a) of IS/IEC 60529:2001 shall be used.

Immediately after the tests, the samples while still mounted in the test position, shall withstand the dielectric strength test specified in **21.3**, and inspection shall show that water has not entered the samples to any appreciable extent and has not reached live parts.

20.3 All accessories shall be proof against humid conditions which may occur in normal use.

Compliance is checked by the humidity treatment described in **20.3** (this clause), followed immediately by the measurement of the insulation resistance and by the dielectric strength test, specified in **21**. Cable entries, if any, are left open; if knockouts are provided, one of them is opened.

Covers, which can be removed without the aid of a tool, are removed and subjected to the humidity treatment with the main part; spring lids are open during this treatment.

The humidity treatment is carried out in a humidity cabinet containing air with a relative humidity maintained between 91 percent and 95 percent. The temperature of the air, at all places where samples can be located, is maintained within 1°C of any convenient value T between 20°C and 30°C.

Before being placed in the humidity cabinet, the samples are brought to a temperature

between T and T + 4 K.

The samples are kept in the cabinet for 7 days (168 h).

In most cases, the samples may be brought to the temperature specified by keeping them at this temperature for at least 4 h before the humidity treatment.

A relative humidity between 91 percent and 95 percent can be obtained by placing in the humidity cabinet a saturated solution of sodium sulphate (Na2SO4) or potassium nitrate (KNO3) in water, having a sufficiently large contact surface with the air.

In order to achieve the specified conditions within the cabinet, it is necessary to ensure constant circulation of the air within it and, in general, to use a cabinet that is thermally insulated.

After this treatment, the samples shall show no damage within the meaning of this standard.

21 INSULATION RESISTANCE AND DIELECTRIC STRENGTH

21.1 The insulation resistance and the dielectric strength of accessories shall be adequate.

Compliance is checked by the tests of **21.2** and **21.3**, which are made immediately after the test of **20.3** in the humidity cabinet or in the room in which the samples were brought to the prescribed temperature, after reassembly of covers that may have been removed.

Accessories with enclosures of thermoplastic material are subjected to the additional test of **21.4**.

NOTE — For the purpose of these tests, the neutral contact, the pilot contact, the communications contacts, and any other contacts for signal or control purposes (positions 9 to 14 for "universal" accessories, positions 9 to 12 for "basic" accessories) if any, are each considered as a pole.

21.2 The insulation resistance is measured with a d.c. voltage of approximately 500 V applied, the measurement being made 1 min after application of the voltage. Where the rated voltage is greater than 500 V, the test voltage shall be approximately 1 000 V.

The insulation resistance shall be not less than 5 MΩ.

a) For socket-outlets and vehicle connectors, the insulation resistance is measured consecutively'
   1) between all poles connected together and the body, the measurement being made with and also without a plug or vehicle inlet engaged;
   2) between each pole in turn and all others, these being connected to the body, with a plug or vehicle inlet engaged; and
   3) between any metal enclosure and metal foil in contact with the inner surface of its insulating lining, if any, a gap of approximately 4 mm being left between the metal foil and the edge of the lining.

   NOTE — The term "body" includes all accessible metal parts, metal foil in contact with the outer surface of external parts of insulating material, other than the engagement face of vehicle connectors and plugs, fixing screws of bases, enclosures and covers, external assembly screws and protective earthing terminals, if any.

b) For plugs and vehicle inlets, the insulation resistance is measured consecutively
   1) between all poles connected together and the body;
   2) between each pole in turn and all others, these being connected to the body; and
   3) between any metal enclosure and metal foil in contact with the inner surface of its insulating lining, if any, a gap of approximately 4 mm being left between the metal foil and the edge of the lining.

21.3 A test voltage of substantially sine-wave form, having a frequency of 50 Hz and the value

shown in Table 14 is applied for 1 min between the parts indicated in **21.2**(a) and **21.2**(b).

For the parts indicated in **21.2**(a)(1) and **21.2**(b)(1), which are used in non-power circuits (control pilot circuit, communications circuits, including clean data earth, or other signal or control circuits (positions 6-7 for "basic" accessories), each circuit may be tested separately, using a test voltage based on the highest voltage in the circuit.

For the parts indicated in **21.2**(a)(2) and **21.2**(b)(2), which are used in non-power circuits [control pilot circuit, communications circuits, including clean data earth, or other signal or control circuits (positions 6 to 7 for "basic" accessories)], the test voltage between these circuits and the power circuits shall be based on the voltage of the power circuit.

Table 14 Test Voltage for Dielectric Strength Test

(Clause 21.3 *)*

Insulation Voltage (*U*) of the Accessory[1)] V	**Test Voltage** V
Up to and including 50	500
Over 50 up to and including 500	2 000[2)]
Over 500	$2 \cdot U + 1\,000$

[1)] The insulation voltage is at least equal to the highest rated operating voltage.

[2)] This value is increased by 500 V for metal enclosures lined with insulating material.

Initially, no more than half the prescribed voltage is applied, and then it is raised rapidly to the full value.

No flashover or breakdown shall occur during the test.

NOTE — Glow discharges without drop in voltage are neglected.

21.4 Immediately after the test of **21.3**, it shall be verified that for accessories with enclosures of thermoplastic material, the means of providing non-interchangeability have not been impaired.

Compliance is checked by inspection and by manual test.

22 BREAKING CAPACITY

22.1 Accessories intended for current interruption (making and breaking under load) shall have adequate breaking capacity.

Compliance is checked by testing mating complementary accessories in accordance with **22.2**.

The test position shall be horizontal or, if not possible, as in normal use.

The plug or vehicle connector is inserted into and withdrawn from the socket-outlet or vehicle inlet at a rate of 7.5 strokes per minute, or at the rate recommended by the manufacturer, whichever is less. The speed of insertion and separation of the plug or vehicle connector shall be 0.8 ± 0.1 m/s.

The speed of insertion may differ according to manufacturer's recommendation.

The measurement of speed is made by recording the interval of time between insertion or separation of the main contacts and the insertion or separation of the protective earthing contact, relative to the distance.

Electrical contacts shall be maintained for no more than 4 s and no less than 2 s.

The movement(s) of a plug or vehicle connector during insertion into the mating accessory may be more complex than a single linear movement. At the manufacturer's option, the test may be made with the insertion and withdrawal made manually or by machine. The movement may be limited to provide adequate separation of the mating contacts.

The number of cycles is specified in Table 15. A stroke is an insertion or a withdrawal of a plug or vehicle connector with its mating accessory. A cycle is composed of two strokes, one for insertion and one for withdrawal.

Accessories are tested as defined in Table 15.

For accessories rated for a.c. and d.c. operation, a new set of accessories shall be tested on each circuit.

The test is made using the connections shown in Fig. 10. For two-pole accessories the selector switch C, connecting the metal support and the accessible metal parts to one of the poles of the supply, is operated after half the number of strokes; for three-pole and three-pole plus neutral accessories, the selector switch C is operated after one-third of the number of strokes and again after two-thirds of the number of strokes, so as to connect each pole in turn.

Resistors and inductors are not connected in parallel, except that, if an air-core inductor is used, a resistor taking approximately 1 percent of the current through the inductor is connected in parallel with it. Iron-core inductors may be used, provided the current has substantially sine-wave form. For the tests on three-pole accessories, three-core inductors are used.

After the test, the samples shall show no damage impairing their further use and no part shall become detached.

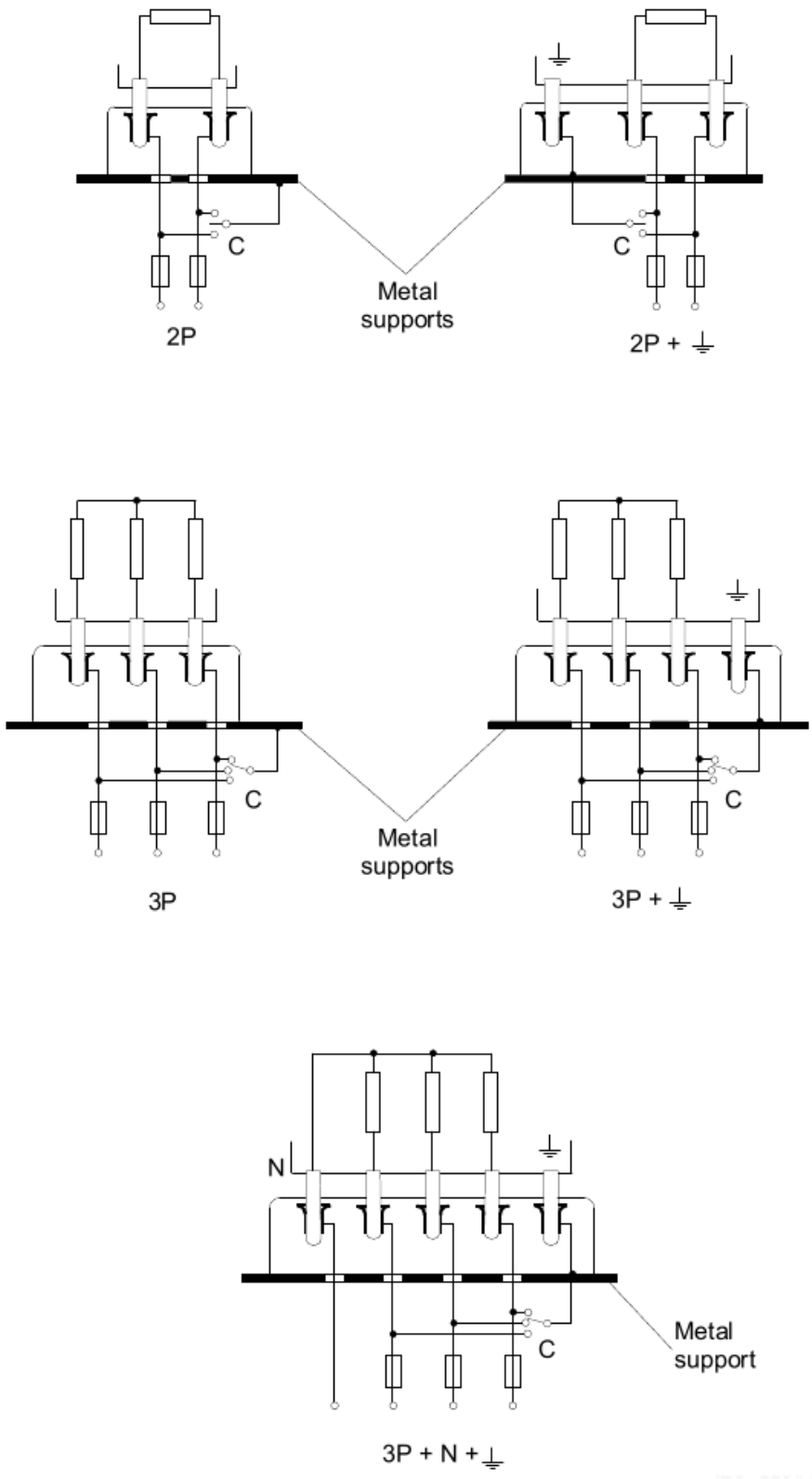


FIG. 10 CIRCUIT DIAGRAMS FOR BREAKING CAPACITY AND NORMAL OPERATION TESTS

Table 15 Breaking Capacity

(Clause 22.2 *)*

Rated Current A	Test Current A	Test Voltage	cos ø ±0.05	Number of Cycles on Load
13	17	1.1 × maximum rated	0.8	50
16 and 20	20	1.1 × maximum rated	0.8	50
30 and 32	40	1.1 × maximum rated	0.8	50
60 to 70	70	1.1 × maximum rated	0.8	20
125	125	1.1 × maximum rated	0.8	20
250	250	× maximum rated	0.8	–[1)]
80 (d.c.)	–[1)]	–[1)]	–	–[1)]
125 (d.c.)	–[1)]	–[1)]	–	–[1)]
200 (d.c.)	–[1)]	–[1)]	–	–[1)]
400 (d.c.)	–[1)]	–[1)]	–	–[1)]

[1)] Under consideration.

22.3 An accessory classified "Not suitable for making and breaking an electrical circuit under load" shall have sufficient breaking capacity to interrupt the circuit in case of a fault, without any indication of a fire or shock hazard. The accessory need not remain functional after the completion of the test. It shall not be used for any further tests.

Compliance is checked by testing the mating accessories in accordance with **22.2** for up to three making and breaking operations, if the accessory permits, under the indicated load.

Following the test, the accessories shall comply with a dielectric test in accordance to **21.3** with voltage applied between the parts as indicated in **21.2(a)** or **21.2(b)**, as applicable.

23 NORMAL OPERATION

23.1 Accessories shall withstand, without excessive wear or other harmful effect, the mechanical, electrical and thermal stresses occurring in normal use.

Compliance is checked by testing any accessory with a new complementary accessory.

This test is carried out by the same means as in **22** used in the manner indicated and in the test position as specified in **22**.

The test is made using the connections indicated in **22**, the selector switch C being operated as prescribed in that clause.

The samples are tested at maximum rated operating voltage and rated current.

Accessories are tested for the number of cycles of operation specified and as defined in Table 16, where a cycle is composed of two strokes, one for insertion and one for withdrawal.

Accessories are tested with a.c. in a circuit with cos ϕ as specified in Table 16.

23.2 For accessories rated for a.c. and d.c. operation, a separate set of accessories shall be tested on each circuit.

23.3 During the test, no sustained arcing shall occur. After the test, the samples shall show,

a) jno wear impairing the further use of the accessory or of its interlock, if any;
b) no detached part;
c) no deterioration of enclosures or barriers;
d) no damage to the entry holes for the plug contacts that might impair proper working;
e) no loosening of electrical or mechanical connections; no seepage of sealing compound; and
f) that the continuity between mating signal and pilot contacts are maintained.

The samples shall then withstand a dielectric strength test made in accordance with **21.3**, the test voltage, however, being decreased by 500 V.

NOTE — The humidity treatment is not repeated before the dielectric strength test of **23.3**.

23.4 Lid springs or other devices which are not automatically operated during the normal operation test, if any, are tested separately by completely opening and closing the part, the number of times the part is opened being the same as the maximum number of insertions of the plug specified in Table 16.

NOTE — The rate of operation can be increased according to the manufacturer's recommendation.

Table 16 Normal Operation

(Clause 23.1, 23.4 *)*

Rated current	cos φ	Cycles of operation	
A	±0.05[2)]	Load	No-load
2	0.8	6 000	4 000
13, 16 and 20	0.6	5 000[1)]	5 000
30 and 32	0.6	5 000[1)]	5 000
60 to 70	0.6	5 000[1)]	5 000
125	0.6	5 000[1)]	5 000
250	–	–[1)]	10 000
80 (d.c.)	–	–	10 000
125 (d.c.)	–	–	10 000
200 (d.c.)	–	–	10 000
400 (d.c.)	–	–	10 000

[1)] For an accessory provided with an interlock (for example, pilot circuit) or classified "Not suitable for making and breaking an electrical circuit under load", the number of cycles of operation under load is 50 and no-load is 10 000.

[2)] cos φ denotes lagging power factor.

24 TEMPERATURE RISE

24.1 Accessories shall be so constructed that the temperature rise in normal use is not excessive. Compliance is checked by testing any accessory with a new complementary accessory. Accessories are to be mounted as intended in normal use.

The test current is an alternating current of the value shown in Table 17.

Unless a dedicated cable is provided as specified by the manufacturer, rewirable accessories are fitted with conductors of a cross-sectional area as specified in Table 17, the terminal screws or nuts being tightened with a torque specified on the product or in the instruction sheets by the manufacturer or equal to two-thirds of that specified in Table 23..

For the purpose of this test, a length of at least 2 m of the cable shall be connected to the terminals.

Non-rewirable accessories are tested as delivered.

For accessories having three or more poles per circuit, for multiphase circuits, the test current during the test shall be passed through the phase contacts. If there is a neutral contact, a separate test shall be carried out passing the test current through the neutral contact and the nearest phase contact.

A current of 2 A shall be passed through the pilot contact and clean data (signal) earth, if any, at the same time as any of these tests.

Table 17 Test Current and Nominal Cross-Sectional Areas of Copper Conductors for Temperature Rise Test

(Clause 24.1 *)*

Rated Current	Test Current	Cross-sectional Area(s) of the Conductors	
		Plugs, Vehicle Inlets, Vehicle Connectors	Socket-outlets
A	A	mm²	mm²
2	2	0.5	0.5
13	17	1.5	2.5
16 and 20	22	2.5	4
30 and 32	42	6	10
60 to 70	Rated current	16	25
80	Rated current[1)]	25	35
125	Rated current	50	70
200	Rated current[1)]	150	150
250	Rated current[1)]	150	185
400	Rated current[1)]	240	300

[1)] A duty cycle is under consideration.

The test shall be continued until thermal stabilization is reached.

NOTE — Thermal stabilization is considered to have occurred when three successive readings, taken at intervals of not less than 10 min, indicate no increase greater than 2 K.

The temperature is determined by means such as melting particles, colour-changing indicators, or thermocouples, which are so chosen and positioned that they have negligible effect on the temperature being determined.

The temperature rise of terminals shall not exceed 50 K.

Accessories shall be so constructed that the surface temperatures in normal use are not excessive, as indicated in **16.5.**

Compliance is checked by repeating the test in **24.1**, except for the test on the neutral contact. The accessory is tested at rated current.

At the discretion of the manufacturer, surface temperature measurements may be made during the temperature rise tests in **24.1**.

25 FLEXIBLE CABLES AND THEIR CONNECTION

25.1 Strain Relief

Plugs and vehicle connectors shall be so designed that the conductors are relieved from strain, including twisting, where they are connected to the terminals or terminations, and that their covering is protected from abrasion.

The construction shall ensure that the cable cannot touch accessible metal parts or internal metal parts, for example cable anchorage screws, if these are electrically connected to accessible metal parts, unless the accessible metal parts are connected to the internal protective earth terminal.

Compliance is checked by inspection and by the following tests in **25**.

25.2 Requirements for plugs and vehicle connectors

25.2.1 *Non-rewirable plugs and vehicle connectors*

Non-rewirable plugs and vehicle connectors shall be provided with a suitable flexible cable appropriate for the rating of the plug and vehicle connector and as specified by the manufacturer.

Non-rewirable plugs and vehicle connectors shall be tested as a cable assembly.

Compliance is checked by inspection and by the test of **25.3**.

25.2.2 *Rewirable plugs and vehicle connectors*

Rewirable accessories shall be provided with a strain relief means designed to prevent the twisting of the cable that may occur. If any one of the components is not in position in the accessory as provided, an instruction sheet shall be provided to identify the necessary parts, the method of assembly and the maximum and minimum size cable for which it is suitable.

The design of the cable anchorage shall be such that the anchorage or components are properly positioned relative to the accessory when assembled.

Cable anchorages shall present no sharp edges to the cable and shall be so designed that the anchorages or their components are not likely to be lost when the enclosure of the accessory and not the cable anchorage is being opened.

Makeshift methods, such as tying the cable into a knot or tying the ends with string, shall not be used.

Cable anchorages and cable inlets shall be suitable for the different types of flexible cable that may be connected.

If a cable entrance is provided with a sleeve to prevent damage to the cable, this sleeve shall be of insulating material and shall be smooth and free from burrs.

If a bell-mouthed opening is provided, the diameter at the end shall be at least 1.5 times the diameter of the cable with the largest cross-sectional area to be connected.

Helical metal springs, whether bare or covered with insulating material, are not allowed as cable sleeves.

Compliance is checked by inspection and by the test of **25.3**.

25.3 Plugs and Vehicle Connectors Provided with a Flexible Cable

Plugs and vehicle connectors provided with a flexible cable are subjected to a pull test in apparatus similar to that shown in Fig. 11, followed by a torque test.

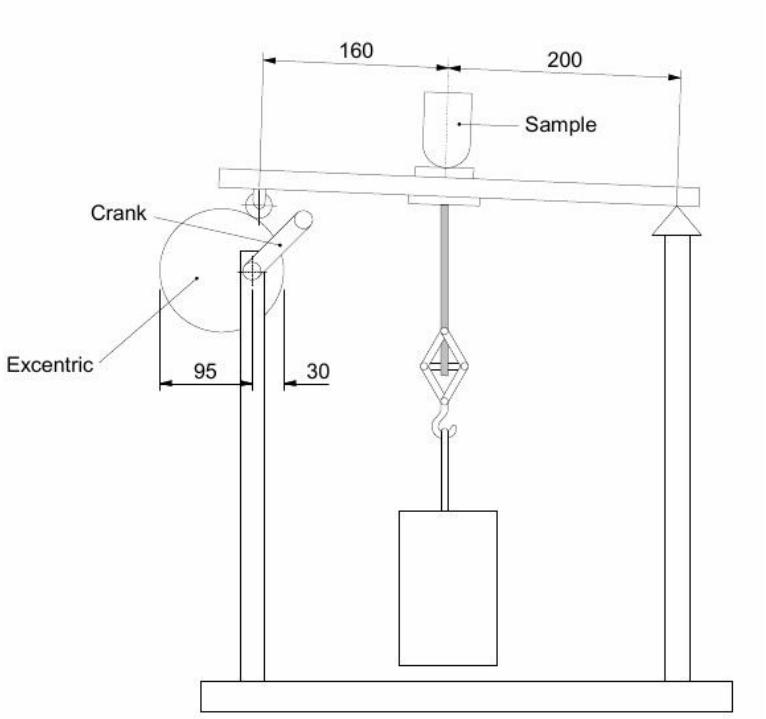
Non-rewirable accessories are tested as delivered.

Rewirable accessories are tested with the maximum and minimum size cables recommended by the manufacturer.

Conductors of the cable of rewirable accessories are introduced into the terminals, the terminal screws being tightened just sufficiently to prevent the conductors from easily changing their position.

The cable anchorage is used in the normal way, clamping screws being tightened with a torque equal to two-thirds of that specified in **27.1**. After reassembly of the sample, with cable glands, if any, in position, the component parts shall fit snugly and it shall not be possible to push the cable into the sample to any appreciable extent.

The sample is fixed in the test apparatus so that the axis of the cable is vertical where it enters the sample.



All dimensions in millimeters.

FIG. 11 APPARATUS FOR TESTING THE CABLE ANCHORAGE

The cable is then subjected 100 times to a pull of the value shown in Table 18. Each pull is applied without jerks and has a duration of 1s.

Immediately afterwards, the cable is subjected to a torque, of the value specified in Table 18,

for 1 min.

Table 18 Pull Force and Torque Test Values for Cable Anchorage

(Clause 25.3 *)*

Rated current	Pulling Force	Torque	Maximum Displacement
A	N	N·m	mm
13 to 20	160	0.6	2
30 to 32	200	0.7	2
60 to 70	240	1.2	2
125	240	1.5	2
200	250	2.3	2
250	500	11.0	5
400	500	11.0	5

During the tests, the cable shall not be damaged.

After the tests, the cable shall not have been displaced by more than the values indicated in Table 18. For rewirable accessories, the ends of the conductors shall not have moved noticeably in the terminals; for non-rewirable accessories, there shall be no break in the electrical connections.

For the measurement of the longitudinal displacement, a mark is made on the cable at a distance of approximately 2 cm from the end of the sample or the cable anchorage before starting the tests. If, for non-rewirable accessories, there is no definite end to the sample, an additional mark is made on the body of the sample.

After the tests, the displacement of the mark on the cable in relation to the sample or the cable anchorage is measured.

26 MECHANICAL STRENGTH

26.1 General

Accessories shall have adequate mechanical strength so as to withstand the stresses imposed during installation and use.

Compliance is checked by the appropriate tests of **26.2** to **26.9** as follows:

a) For socket-outlets and vehicle inlets, **26**;

b) For rewirable plugs and vehicle connectors, **26.3**;

c) For non-rewirable plugs and vehicle connectors, **26.3** and **26.4;**

d) For rewirable cable assemblies intended to be used with cable management systems, **26.2**;

e) For non-rewirable assemblies, **26.2** and **26.4**;

f) For non-rewirable cable assemblies intended to be used with cable for accessories with a degree of protection IP44 or higher, **26.5**;

g) For socket-outlets and vehicle connectors, **26.6**; and

h) For plugs, vehicle inlets or vehicle connectors with insulating end caps on the contacts, **26.7**.

Before starting the test of **26.2** or **26.3**, accessories with enclosures of resilient or thermoplastic material are placed, with their bases or flexible cables, in a chamber at a temperature of 30°C ± 2 K for at least 16 h; they are then removed from the chamber and immediately subjected to the test of **26.2** or **26.3**, as appropriate.

26.2 Degree of Protection

Accessories shall have adequate strength to maintain the integrity of the marked degree of protection after being subjected to impact blows occurring in normal use.

Blows are applied to the samples by swinging or dropping a 50.8 mm diameter steel sphere, weighing 0.535 kg, from a height (H), which will produce an impact as indicated in Table 19. The sample being tested shall be rigidly supported and the impact made normal to sample by means of the ball impact test apparatus. The ball impact test apparatus is shown in Fig. 12.

It is intended that blows applied to samples in these tests will not strike mounting flanges or male contacts of vehicle inlets. The ball impact test apparatus is adjusted to apply blows as they might occur in actual use and according to **26.2** (b).

Five blows are applied to each test sample by means of ball impact test apparatus.

The first four blows are applied when the accessory is mounted as in normal use on a vertical board. The ball pendulum shall be mounted so that it swings parallel to that board. The impact face of the ball pendulum shall be arranged such that when the ball pendulum hangs freely, the impact face just touches the side of the accessory. The point of contact shall be substantially at the geometric centre of the side face of the accessory, or the appropriate projections of that face. The ball pendulum is then raised, released and the blow applied. The accessory is then revolved 90° about an axis perpendicular to the mounting face and its relationship to the impact face corrected, if necessary. A second blow is then applied.

The same procedure is repeated for two successive rotations of 90°, with a total of 4 blows being applied.

The fifth blow is applied with the plane of the ball pendulum perpendicular to the plane of the mounting board such that the ball pendulum strikes the sample at its furthermost projection from the mounting board.

Each blow shall provide an impact energy according to Table 19.

Table 19 Impact Energy for Ball Impact Test

(Clause 26.2 *)*

Rating	Energy	
A	J	
	Vehicle Inlets	**Socket-outlets**
Up to and including 32	1	1
Above 32 and up to and including 100	2	2
Above 100 and up to and including 150	3	3
Above 150 and up to and including 400	4	4

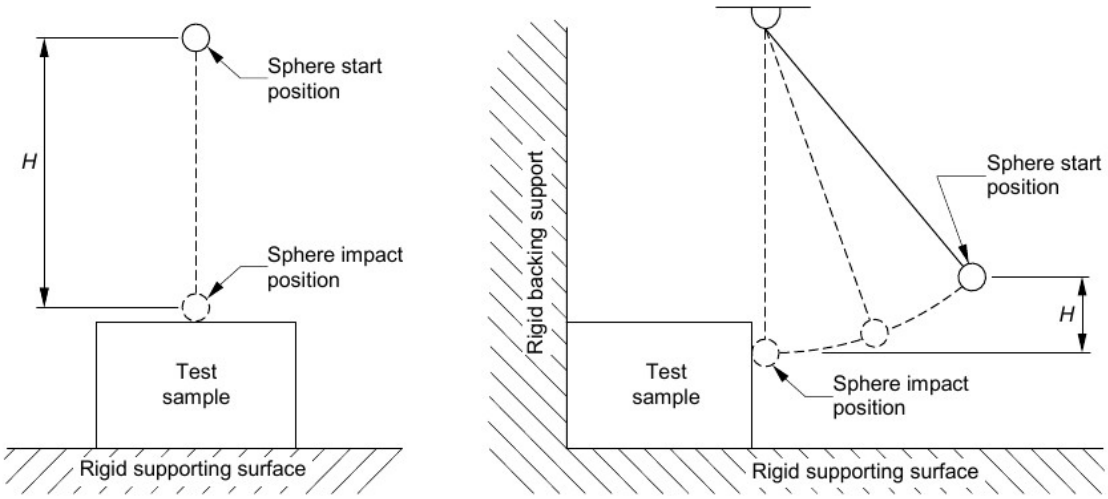


FIG. 12 BALL IMPACT TEST

Socket-outlet and vehicle inlet samples shall each be fixed to a rigid mounting board as in normal use, cable entries are left open and fixing screws of covers and enclosures are tightened with a torque equal to two-thirds of that specified in Table 23. Lids on socket-outlets are left normally closed. Caps supplied with vehicle inlets will be installed.

After the test, the samples shall show that'

a) no part has become detached; and

b) no part has moved, loosened or deformed to the extent that the part no longer functions or operates as intended.

The samples shall show no damage that'

c) makes uninsulated live parts accessible to contact, by the probe illustrated in Fig. 3;

d) defeats the integrity of the enclosure so that acceptable mechanical protection is not afforded to the internal parts of the accessory;

e) causes a condition that results in the accessory not complying with the strain relief requirements, if applicable;

f) results in a reduction of creepage and clearance between uninsulated live parts of opposite polarity, uninsulated live parts and accessible dead or grounded metal below the minimum acceptable values; and

g) results in any other evidence of damage that could increase the risk of fire or electric shock.

Accessories with a degree of protection IP44 and higher shall withstand the relevant test specified in **20**.

Accessories with enclosures of thermoplastic material shall withstand the test of **21.4**.

NOTE — Small chips, cracks and dents, which do not adversely affect the protection against electrical shock or moisture, are neglected. In case of doubts, appropriate tests of **19** and **20** are carried out.

26.3 Rewirable Plugs and Vehicle Connectors

Rewirable plugs and vehicle connectors are fitted with a small section (approximately 200 mm) of the lightest type of flexible cable of the smallest cross-sectional area recommended by the manufacturer.

Non-rewirable plugs and vehicle connectors are tested with a small section (approximately 200 mm) of the flexible cable as delivered.

Cable assemblies specified to be used with cable management systems are to be tested per **26.2**.

The free end of the cable and an additional rope or other flexible means, etc., attached to the flexible cable, both having a total length of 2.25 m, is fixed to a wall at a height of 1 m above the floor, as shown in Fig. 13.

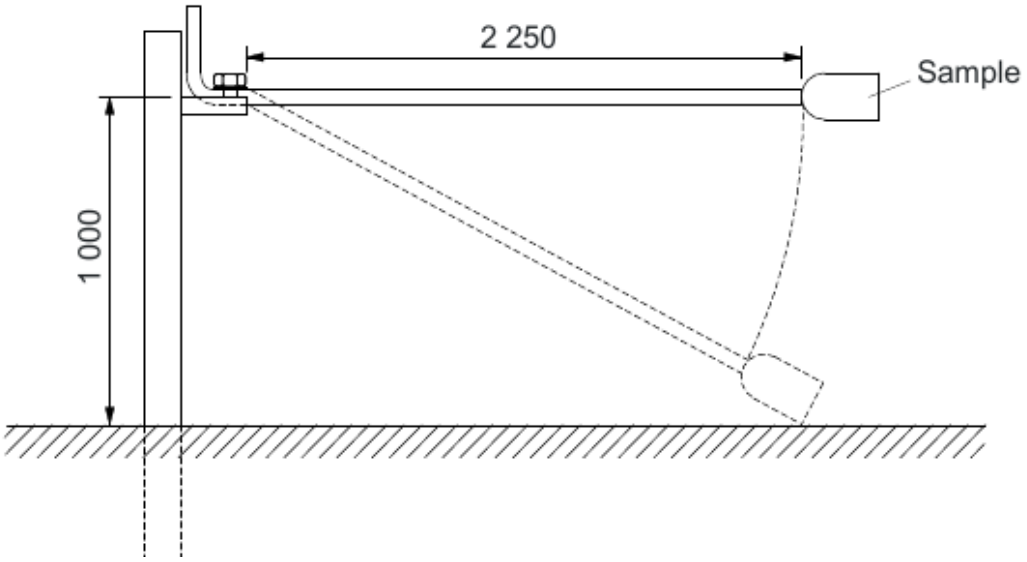
The sample is held so that the cable is horizontal and then it is allowed to fall on to a concrete floor. This is done eight times, the cable being rotated through 45 ° at its fixing each time.

After the test, the samples shall show no damage within the meaning of this standard; in particular, no part shall have become detached or loosened. The samples shall not expose parts likely to become live. The samples shall maintain their IP rating.

Accessories with a degree of protection IP44 and higher shall withstand the relevant test specified in **20**.

Accessories with enclosures of thermoplastic material shall withstand the test of **21.4**.

NOTE — Small chips and dents, which do not adversely affect the protection against electric shock or moisture, are neglected.



All dimensions in millimetres.

FIG. 13 ARRANGEMENT FOR MECHANICAL STRENGTH TEST FOR PLUGS AND VEHICLE CONNECTORS

26.4 Non-Rewirable Accessories

Non-rewirable accessories are subjected to a flexing test in an apparatus similar to that shown in Fig. 14.

The sample is fixed to the oscillating member of the apparatus so that, when this is at the middle of its travel, the axis of the flexible cable, where it enters the sample, is vertical and passes through the axis of oscillation.

The oscillating member is so positioned that the flexible cable makes the minimum lateral movement when the oscillating member of the test apparatus is moved over its full travel.

The cable is loaded with a weight such that the force applied is as shown in Table 20.

Table 20 Mechanical Load Flexing Test

(Clause 26.4 *)*

Rated Current	Force
A	N
Up to and including 20	20
from 21 up to and including 32	25
from 33 up to and including 70	50
from 71 up to and including 250	75
from 251 up to and including 400	100

A current equal to the rated current of the accessory is passed through the conductors, the voltage between them being the rated voltage.

The oscillating member is moved backwards and forwards through an angle of 90° (45° on either side of the vertical), the number of flexing being 20 000 and the rate of flexing 60 per minute.

After the test, the samples shall show no damage within the meaning of this standard.

NOTE — A flexing is one movement, either backwards or forwards.

26.5 Cable Glands

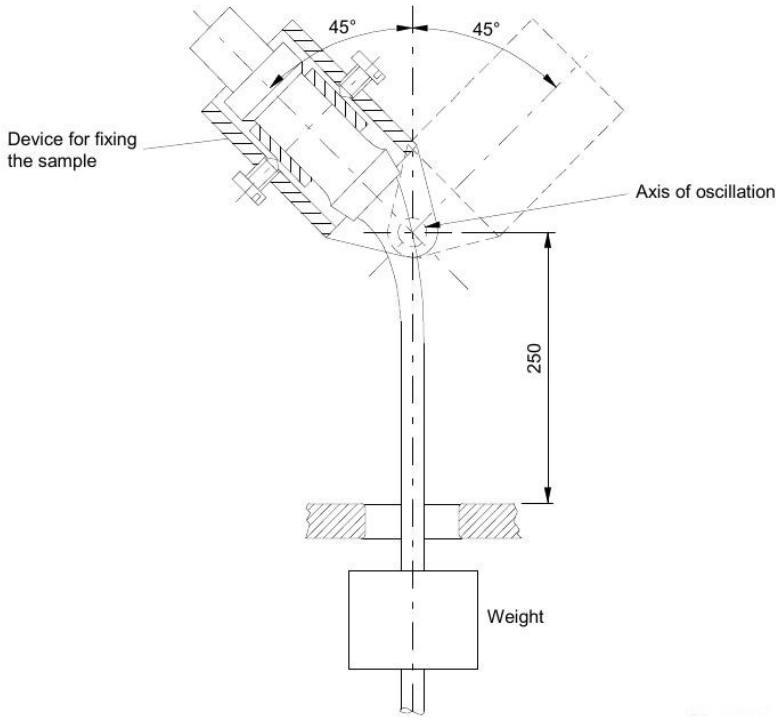
Screwed glands are fitted with a cylindrical metal rod having a diameter, in millimetres, equal to the nearest whole number below the internal diameter of the packing, in millimetres. The glands are then tightened by means of a suitable spanner, the force shown in Table 21 being applied to the spanner for 1 min, at a point 25 cm from the axis of the gland.

Table 21 Torque Test Values for Glands

(Clause 26.5 *)*

Diameter of Test Rod	Force	
mm	N	
	Metal Glands	Glands of Moulded Material
Up to and including 20	30	20
Over 20 up to and including 30	40	30
Over 30	50	40

After the test, the glands and the enclosures of the samples shall show no damage within the meaning of this standard.



Linear dimension in millimetres.

FIG. 14 APPARATUS FOR FLEXING TEST

26.6 Shutters

Shutters shall be so designed that they withstand the mechanical force which may be expected in normal use, for example when a plug contact is inadvertently forced against the shutter of a socket-outlet entry hole.

Compliance is checked by the following test, which is carried out on specimens which have been submitted to the test according to **23**.

One plug contact of the same system is applied for 1 min with a force of 75 N against the shutter of an entry hole in a direction perpendicular to the front surface of the socket-outlet.

The plug contact shall not come in contact with live parts.

An electrical indicator with a voltage not less than 40 V and not more than 50 V is used to show contact with the relevant part.

After the test, the specimens shall show no damage within the meaning of this standard.

NOTE — Small dents on the surface which do not adversely affect further use of the socket-outlet are ignored.

26.7 Insulated End Caps

Insulated end caps, if any, shall be fixed sufficiently to the contact pins so that they withstand the mechanical force and abuse to which the accessories may be exposed in normal use.

They shall be subjected to the tests of **26.8** and **26.9**.

After each of the following tests, the samples shall show no damage as follows:

a) No part shall become detached;
b) No part shall have moved, loosened or deformed to the extent that the samples no longer function or operate as intended;
c) No uninsulated live part shall become accessible with the probe illustrated in, Fig. 3;
d) No reduction shall occur of creepage and clearance between uninsulated live parts of opposite polarity, uninsulated live parts and accessible dead or grounded metal parts, below the minimum acceptable values; and
e) No other evidence of damage shall result, that could increase the risk of fire or electric shock.

26.8 Change of Temperature Test

Accessories with insulated end cap on the contacts shall not be adversely affected by the temperature stress conditions which may occur in normal use.

Compliance is checked by conditioning the accessories, while mated with their complementary accessory, as specified in **26.8**. The specimens are mated with their complimentary accessory and subjected to the change of temperature test of IS 9000 (Part 14/Sec 2) with following parameters:

a) Test procedure: Nb;
b) Lower temperature ($T_{A)}$: -30°C;
c) Higher temperature ($T_{B)}$: 100°C;
d) Slew rate: 3 K/min;
e) Exposure time (t_1): 1 h; and
f) Number of cycles: 5.

26.9 Pull test

A set of six contact assemblies with insulated end caps shall be subjected to a pull test. A force defined in Table 22 is applied for 1 min and it shall be applied in a direction opposite from the contact, along the contact axis. The pulling force shall be applied in a way where it causes no effect on the fixing area of the part.

NOTE — The force can be applied by a drilling in the insulated end cap, rectangular to the contact axis, close to the end.

Table 22 Pulling Force on Insulated End Caps

(Clause 26.9 *)*

Contact Diameter	Pulling Force
mm	N
Up to 3	20
Above 3	40

27 SCREWS, CURRENT-CARRYING PARTS AND CONNECTIONS

27.1 Connections, electrical or otherwise, shall withstand the mechanical stresses occurring in normal use.

Screws transmitting contact pressure and screws, which are operated when connecting the accessory, and have a nominal diameter less than 3.5 mm shall screw into a metal nut or metal insert.

Compliance is checked by inspection and by the following test for screws and nuts which transmit contact pressure or which are operated when connecting the accessory.

The screws or nuts are tightened and loosened,

a) ten times for screws in engagement with a thread of insulating material; and
b) five times for nuts and other screws.

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

This removal and insertion of the screws or nuts shall be carried out at such a rate that the thread in the insulating material suffers no appreciable temperature rise owing to friction.

When testing terminal screws and nuts, a copper conductor having the largest cross- sectional area in Table 6, rigid (solid or stranded) for socket-outlets and vehicle inlets and flexible for plugs and vehicle connectors, is placed in the terminal.

The test is made by means of a suitable screwdriver or spanner. The maximum torque applied when tightening is equal to that shown in Table 23 except that the torque is increased by 20 percent for screws in engagement with a thread in a hole which is obtained by plunging, if the length of the extrusion exceeds 80 percent of the original thickness of the metal.

When the manufacturer specifies, for terminal screws, a torque greater than values given in Table 23, this specified torque shall be applied for the test.

Table 23 Tightening Torque for Verification of Mechanical Strength of Screw-Type Terminals

(Clauses 13.3.1,13.3.2,24.1,26.2 and 27.1 *)*

Metric standard values	Nominal diameter of thread	Torque		
	mm	Nm		
		I[1]	II[2]	III[3]
2.5	≤ 2.8	0.2	0.4	0.4
3.0	> 2.8 ≤ 3.0	0.25	0.5	0.5
–	> 3.0 ≤ 3.2	0.3	0.6	0.6
3.5	> 3.2 ≤ 3.6	0.4	0.8	0.8
4.0	> 3.6 ≤ 4.1	0.7	1.2	1.2
4.5	> 4.1 ≤ 4.7	0.8	1.8	1.8
5.0	> 4.7 ≤ 5.3	0.8	2.0	2.0
6.0	> 5.3 ≤ 6.0	1.2	2.5	3.0
8.0	> 6.0 ≤ 8.0	2.5	3.5	6.0
10.0	> 8.0 ≤ 10.0		4.0	10.0
12.0	> 10.0 ≤ 12.0			14.0
14.0	> 12.0 ≤ 15.0			19.0
16.0	> 15.0 ≤ 20.0			25.0
20.0	> 20.0 ≤ 24.0			36.0
24.0	> 24.0			50.0

[1] Applies to screws without heads which when tightened do not protrude from the hole, and to screws which cannot be tightened by means of a screwdriver having a blade wider than the diameter of the screw.

[2] Applies to other screws and nuts which are tightened by means of a screwdriver.

[3] Applies to screws and nuts which can be tightened by means other than a screwdriver.

Each time the clamping screw(s) or nut(s) is (are) loosened, a new conductor shall be used for a further connection.

When a screw has a hexagonal head with means for tightening with a screwdriver and the values in columns II and III are different, the test is made twice, first applying the torque specified in column III to the hexagonal head and then, on another set of samples, applying the torque specified in column II by means of a screwdriver. If the values in columns II and III are the same, only the test with the screwdriver is made.

After the test for clamping screws or nuts, the clamping unit shall not have undergone changes that adversely affect its further use.

NOTES

1 For mantle terminals, the specified nominal diameter is that of the slotted stud.

2 For mantle terminals in which the nut is tightened by means other than a screwdriver and for which the nominal screw diameter is over 10 mm, the value of the torque is under consideration.

3 Screws or nuts which are operated when connecting up the accessory include terminal screws or nuts, assembly screws, screws for fixing covers, etc., but not connections for screwed conduits and screws for fixing socket-outlets or vehicle inlets to the mounting surface.

The shape of the blade of the test screwdriver shall suit the head of the screw to be tested. The screws and nuts shall not be tightened in jerks.

NOTE — Damage to covers is neglected. Connections made by screws will have been partially checked by the test of **23** and **26**.

27.2 Screws in engagement with a thread of insulating material and which are operated when connecting up the accessory shall have a length of engagement of at least 3 mm plus one-third of the nominal screw diameter, or 8 mm, whichever is shorter.

Correct introduction of the screw into the threaded hole shall be ensured.

Compliance is checked by inspection, by measurement and by manual test.

The requirement with regard to correct introduction is met if introduction of the screw in a slanting manner is prevented, for example by guiding the screw by the pan to be fixed, by a recess in the threaded hole or by the use of a screw with the leading thread removed.

27.3 Electrical connections shall be so designed that the contact pressure is not transmitted through insulating material other than ceramic, pure mica or other material with characteristics no less suitable, unless there is sufficient resiliency in the metallic parts to compensate for any shrinkage or yielding of the insulating material.

Compliance is checked by inspection.

NOTE — The suitability of the material is considered with respect to its dimensional stability.

27.4 Screws and rivets, which serve as electrical as well as mechanical connections, shall be locked against loosening.

Compliance is checked by inspection and by manual test.

Spring washers may provide satisfactory locking.

For rivets, a non-circular shank or an appropriate notch may be sufficient.

Sealing compound, which softens on heating, provides satisfactory locking only for screw connections not subject to torsion in normal use.

27.5 Current-carrying parts, other than terminals, shall be either of,

a) copper;
b) an alloy containing at least 50 percent copper; and
c) or other metal no less resistant to corrosion than copper and having mechanical properties no less suitable.

Compliance is checked by inspection and, if necessary, by chemical analysis.

The requirements for terminals are included in **13**.

27.6 Contacts, which are subjected to a sliding action in normal use, shall be of a metal resistant to corrosion. Springs ensuring the resiliency of contact tubes shall be of metal resistant to corrosion or be adequately protected against corrosion.

Compliance is checked by inspection and, if necessary, by chemical analysis.

NOTE — A test for determining the resistance to corrosion or the adequacy to the protection against corrosion is under consideration.

28 CREEPAGE DISTANCES, CLEARANCES AND DISTANCES

28.1 Creepage distances, clearances and distances through sealing compound:

a) between live parts of different polarity;
b) between live parts and:
   1) accessible metal parts;
   2) protective earthing contacts, fixing screws and similar devices;
   3) external assembly screws, other than screws which are on the engagement face of plugs and are isolated from the protective earthing contacts;
   4) metal enclosures, if not lined with insulating material, including fittings for conduit or armoured cable;
   5) the surface on which the base of a socket-outlet is mounted; and
   6) the bottom of any conductor recess in the base of a socket-outlet.
c) through sealing compound (as solid insulation):
   1) between live parts covered with at least 2.5 mm of sealing compound and the surface on which the base of a socket-outlet is mounted; and
   2) between live parts covered with at least 2 mm of sealing compound and the bottom of any conductor recess in the base of a socket-outlet.

shall be evaluated in accordance with IS 15382 (Part 1) and IS 15382 (Part 3), according to **28.1**. The control pilot and signal circuits shall be treated as "accessible metal parts" for the purpose of **28.1**.

For rewirable accessories, compliance is checked using samples fitted with conductors of the largest cross-sectional area specified in Table 6, and also without conductors. For non- rewirable accessories, compliance is checked using samples as delivered.

Socket-outlets and vehicle connectors are checked when in engagement with a plug and also without a plug.

NOTE — Any air gap less than 1 mm wide is ignored in computing the total clearance. The surface on which the base of a socket-outlet is mounted includes any surface with which the base is in contact when the socket-outlet is installed. If the base is provided with a metal plate at the back, this plate is not regarded as the mounting surface.

28.2 Sealing compound shall not protrude above the edge of the cavity in which it is contained.

Compliance is checked by inspection.

28.3 Accessories shall be designed for pollution degree 3 according to IS 15382 (Part 1).

28.4 For the interior of the accessory a lower pollution degree can be considered, if protection is afforded by a suitable enclosure. If other pollution degrees are needed, creepage and clearance distances have to be in accordance with IS 15382 (Part 1). The comparative tracking index (CTI) value shall be evaluated in accordance with IS 2824.

28.5 In conducting evaluations in accordance with IS 15382 (Part 1) and IS 15382 (Part 3), the following guidelines shall be used:

a) All accessories shall be considered overvoltage Category II.
b) Pollution degree 2 may be considered to exist on a printed wiring board between adjacent conductive material which is covered by any coating, which provides an uninterrupted covering over at least one side, and the complete distance up to the other side of conductive material.
c) Pollution degree 1 may be achieved at a specific printed wiring board location by application of at least 0.8 mm thick layer of suitable silicone rubber or for a group of printed wiring boards through potting, without air bubbles, in epoxy or a suitable potting material.
d) Evaluation of clearances, only, may be conducted in accordance with **6** of IS 15382 (Part 1).
e) Evaluation of clearances and creepage distances shall be conducted in accordance with **5**, **5.1**, and **5.2** of IS 15382 (Part 1).

f) Evaluation of permanent protective coatings applied to rigid printed board assemblies used to improve the insulation properties shall be conducted in accordance with IS 15382 (Part 3).

g) The phase-to-ground rated system voltage used in the determination of clearances shall be the equipment rated supply voltage rounded to the next higher value (in the table for determining clearances for equipment) for all points on the supply side of an isolating transformer or the entire product if no isolating transformer is provided. The system voltage used in the evaluation of secondary circuitry may be interpolated with the interpolation continued across the table for rated impulse withstand voltage peak and clearance.

h) Determination of the dimensions of clearance and creepage distances shall be conducted in accordance with **6.2** (Measurement of Creepage Distances and Clearances) of IS 15382 (Part 1).

29 RESISTANCE TO HEAT, TO FIRE AND TO TRACKING

29.1 Accessories shall be sufficiently resistant to heat.

Compliance is checked by the tests of **29.2** and **29.3**.

29.2 The samples are kept for 1 h in a heating cabinet at a temperature of 110°C ± 5 K.

They shall not undergo any change impairing their further use, and sealing compound shall not flow to such an extent that live parts are exposed.

Marking shall still be easily legible.

NOTE — A slight displacement of the sealing compound is neglected.

29.3 Parts of insulating material are subjected to a ball-pressure test according to IS/IEC 60695-10-2. The test is made in a heating cabinet at a temperature of:

a) 125°C ± 5 K for parts supporting live parts of rewirable accessories; and

b) 80°C ± 3 K for other parts.

For materials which show deformation, this diameter shall not exceed 2 m

The test is not made on parts of ceramic material.

NOTE — For elastomeric materials a test is under consideration.

29.4 External parts of insulating material and insulating parts supporting live parts of accessories shall be resistant to abnormal heat and to fire.

29.5 External conductors cannot be considered as retaining the current-carrying parts.

In case of doubt, to determine whether an insulating material is necessary to retain current-carrying parts and parts of the protective earthing circuit in position, the accessory is examined without conductors while held in positions with the insulating material in question removed.

Compliance is checked by the glow-wire test given in IS/IEC 60695-2-11 with the following specifications.

The temperature of the tip of the glow-wire is:

a) 650°C ± 10 K for parts of insulating material not necessary to retain current-carrying parts and parts of the protective earthing circuits in position, even though they are in contact with them; and

NOTE — Tests are not made on glands and sealing compounds.

b) 850°C ± 15 K for parts of insulating material necessary to retain current-carrying parts and parts of the protective earthing circuits in position.

The tip of the glow-wire is applied to the following places:

1) in the middle of one external part for each material, with the exception of glands and sealing compounds; and

2) in the middle of an insulating contact-carrying part for each material.

The tip is applied to flat surfaces and not to grooves, knock-outs, narrow recesses or sharp edges and if possible not less than 9 mm from the edges of the accessories.

The test is made on one specimen. In case of doubt regarding the results of the test, the test is repeated with two further specimens.

The accessories are considered to have withstood the glow-wire test if:

(i) there is no visible flame and no sustained glowing; or

(ii) flame or glowing of the specimen or of the surroundings extinguish within 30 s after the removal of the glow-wire, and the surrounding parts have not burned away completely. There shall be no permanent ignition of the tissue paper.

29.6 Insulating parts supporting live parts shall be of material resistant to tracking.

For materials other than ceramic, compliance is checked by the test according to IS 2824 with the following parameters:

a) PTI test;

b) solution A; and

c) applied voltage 175 V.

No flashover or breakdown between electrodes shall occur before a total of 50 drops has fallen.

30 CORROSION AND RESISTANCE TO RUSTING

Ferrous parts, including enclosures, shall be adequately protected against rusting.

Where corrosion can be a problem on electrical parts, IP67 accessories are recommended.

For specific conditions and the provisions for these conditions, special consideration should be given to the product by the manufacturer with regard to resistance to corrosion.

Compliance is checked by the following test.

All grease is removed from the parts to be tested, by immersion in ethyl acetone, acetone, methylethyl ketone or an equivalent degreasing agent for 10 min. The parts are then immersed for 10 min in a 10 percent solution of ammonium chloride in water at a temperature of 20°C ± 5 K.

Without drying, but after shaking off any drops, the parts are placed for 10 min in a box containing air saturated with moisture at a temperature of 20°C ± 5 K.

After the parts have been dried for 10 min in a heating cabinet at a temperature of 100°C ± 5 K, their surfaces shall show no signs of rust.

Traces of rust on sharp edges and any yellowish film removable by rubbing are ignored.

For small helical springs and the like, and for inaccessible parts exposed to abrasion, a layer of grease may provide sufficient protection against rusting. Such parts are subjected to the test only if there is doubt about the effectiveness of the grease film and the test is then made without previous removal of the grease.

31 CONDITIONAL SHORT-CIRCUIT CURRENT WITHSTAND TEST

31.1 General

Socket-outlets and mating plugs shall be submitted to the tests listed below.

31.2 Ratings and Test Conditions

The test is applied to a new socket-outlet and mating plug mounted as in normal use and connected according to the indications of **31.3**.

Different numbers of poles for the same rated current and the same construction are considered as representative of the type. Compliance is checked by testing each socket- outlet and mating plug with a new complementary socket-outlet and mating plug complying with this standard.

The short-circuit protective device shall be a "gG" type fuse for general application complying with the requirements of IS 13703 (Part 1) and IS 13703 (Part 2/Sec 1) and having rating identical to those of the socket-outlets and mating plugs.

In the case a fuse with a rated current equal to that of the socket-outlets and mating plugs being tested does not exist, a fuse having the next higher rated value shall be used.

Fuse technical data as well as its cut-off value shall be stated in the test report.

The fuse (F1) shall be installed between the supply source and the socket-outlets and mating plugs being tested.

The minimum prospective short-circuit current withstand of 10 kA or of a higher value specified by the manufacturer shall be applied to a socket-outlet and mating plug and a complementary accessory in the connected position.

NOTE — Higher short-circuit test currents are under consideration for accessories rated 250 A or higher.

The test voltage shall be identical to the rated operating voltage of the socket-outlets and mating plugs tested.

No power-factor value or time constant is specified for this test. The following tolerances shall be applied during the test:

a) current: from 90 percent to 110 percent;
b) voltage: from 100 percent to 105 percent; and
c) frequency: from 95 percent to 105 percent.

31.3 Test Circuit

The test circuits and test conditions are as follows:

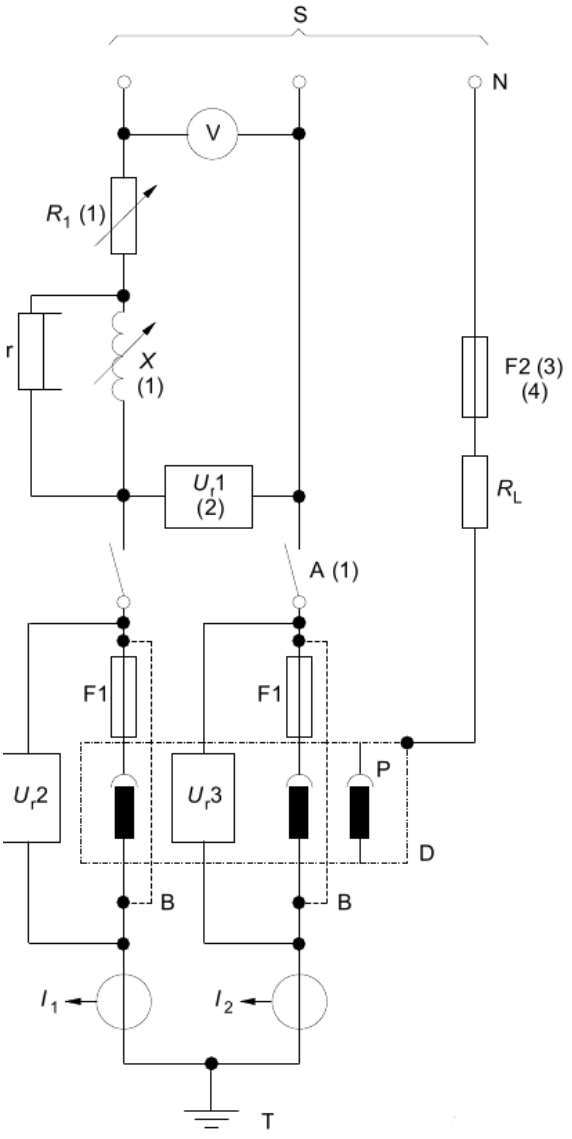
a) Figures 15, 16 and 17 give the diagrams of the circuit to be used for the test:
   1) two-pole accessories on single-phase a.c. or d.c. (Fig. 15);
   2) three-pole accessories on three-phase a.c. (Fig. 16); and
   3) four-pole accessories on three-phase four-wire a.c. (Fig. 17).
b) The supply S feeds a circuit including resistors R 1, reactors X and the accessories D under test;
c) In all cases, the supply shall have sufficient power to permit the verification of the characteristics given by the manufacturer;
d) In each test circuit (Figures 15, 16 and 17), the resistors and reactors are inserted between the supply source S and the equipment D under test. The position of the closing device A and the current sensing devices (I1, I2, I3) may be different;
e) There shall be one and only one point of the test circuit which is earthed; this may be the short-circuit link of the test circuit of the neutral point of the supply or any other convenient point;
f) All parts of the accessories normally earthed in service, including the protective earth contact and pilot contact, the enclosure or the screens, shall be insulated from earth and connected to a point as indicated in Figures 15, 16 and 17;
g) This connection shall comprise a fuse element F2 consisting of a copper wire 0.8 mm in diameter and at least 50 mm long, or of a fuse element of 30/35 A for the detection of the fault current; and;f

h) connection of the accessories under test shall be made with copper wires having cross- sectional areas as indicated in Table 6, and lengths as short as possible, not exceeding 1 m on either side.

NOTES

1 In figures 15, 16, and 17, adjustable loads *X* and *R*1 may be located either on the high-voltage side or on the low-voltage side of the supply circuit, the closing device A being located on the low-voltage side.

2 In figures 15, 16, and 17, *U*r1, *U*r2 and *U*r3 may, alternatively, be connected between phase and neutral.



S	supply
*U*r1, *U*r2, *U*r3	voltage sensors
V	voltage measuring device
A	closing device
*R*1	adjustable resistor
N	neutral of supply (or artificial neutral)
F2	fusible element
X	adjustable reactor
*R*L	fault current limiting resistor
D	accessory under test (including connecting cables)
F1	fuses
B	temporary connections for calibration
*I*1, *I*2	current sensors
T	earth - one earthing point only (load side or supply side)
r	shunt resistor
P	pilot contact

FIG. 15 DIAGRAM OF THE TEST CIRCUIT FOR THE VERIFICATION OF SHORT-CIRCUIT CURRENT WITHSTAND OF A TWO POLE EQUIPMENT ON D.C. OR SINGLE PHASE A.C.

S	supply
*U*r1, *U*r2, *U*r3, *U*r4, *U*r5, *U*r6	voltage sensors
V	voltage measuring device
A	closing device
*R*1	adjustable resistor
N	neutral of supply (or artificial neutral)
F2	fusible element
X	adjustable reactors
*R*L	fault current limiting resistor
D	accessory under test (including connecting cables)
F1	fuses
B	temporary connections for calibration
*I*1, *I*2, *I*3	current sensors
T	earth - one earthing point only (load side or supply side)
r	shunt resistor
P	pilot contact

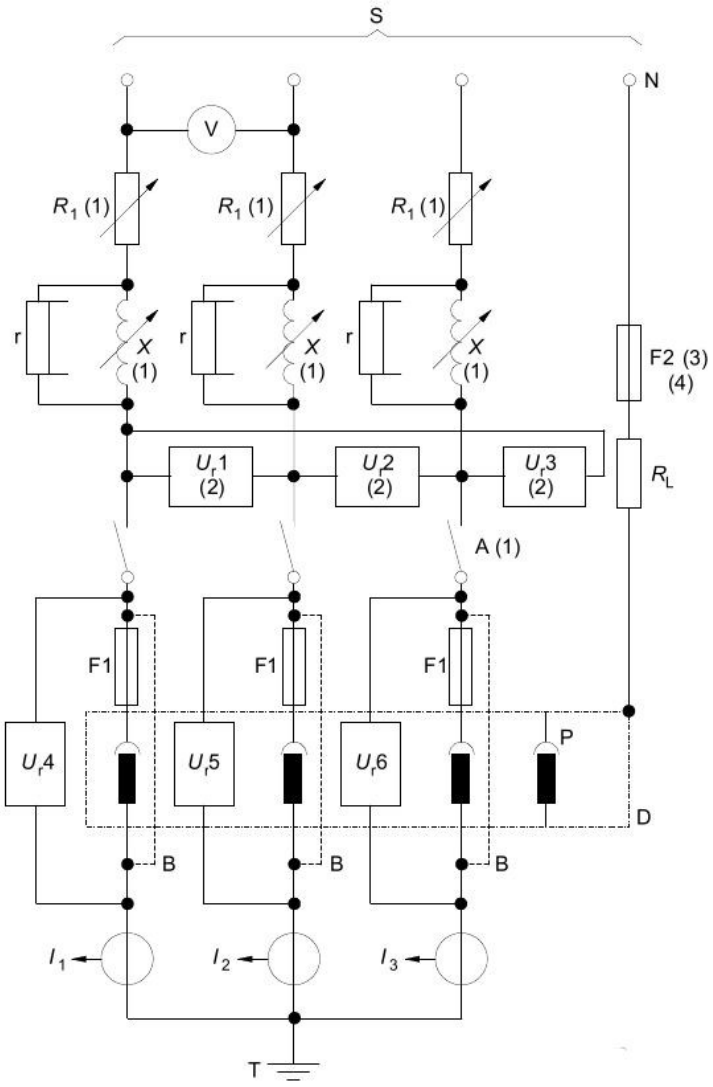


FIG. 16 DIAGRAM OF THE TEST CIRCUIT FOR THE VERIFICATION OF SHORT-CIRCUIT CURRENT WITHSTAND OF A THREE-POLE EQUIPMENT

S	supply
U_r1, U_r2, U_r3 U_r4, U_r5, U_r6	voltage sensors
V	voltage measuring device
R_1	adjustable resistor
N	neutral or supply for artificial neutral
F2	fusible element
X	adjustable reactors
R_L	fault current limiting resistor
D	accessory under test (including connecting cables)
F1	fuses
B	temporary connections for calibration
I_1, I_2, I_3	current sensors
T	earth – one earthing point only (load side or power side)
r	shunt resistor
P	pilot contact

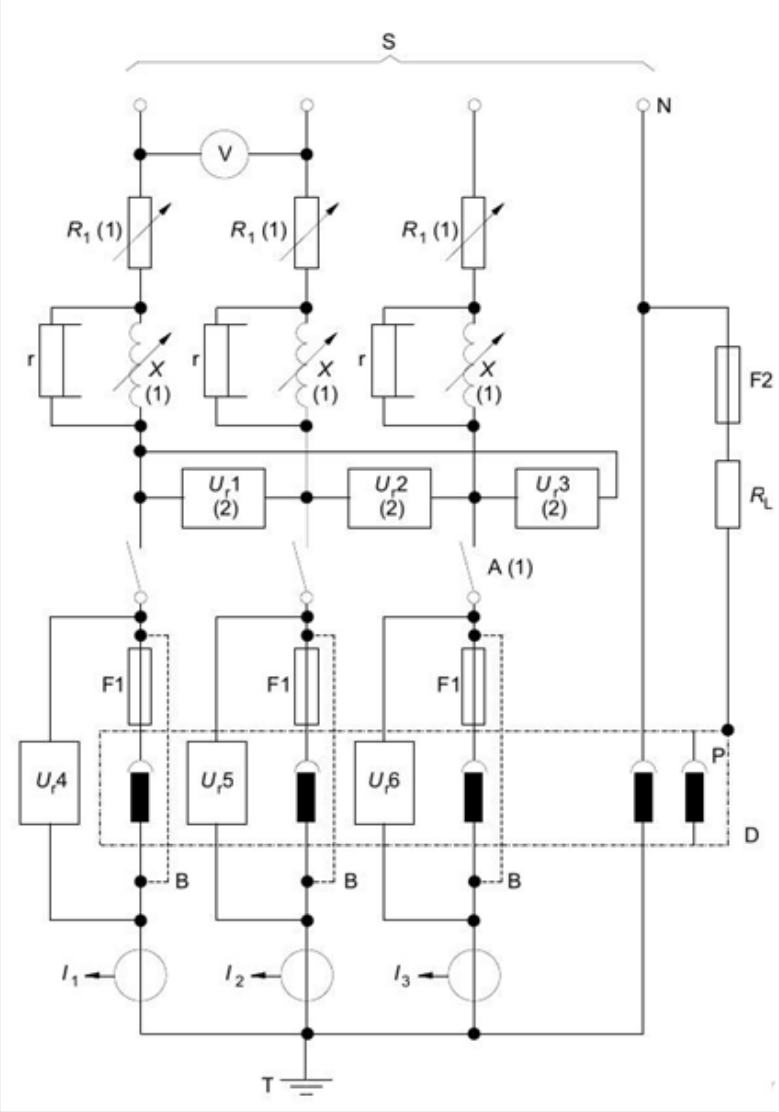


FIG. 17 DIAGRAM OF THE TEST CIRCUIT FOR THE VERIFICATION OF SHORT-CIRCUIT CURRENT WITHSTAND OF A FOUR-POLE EQUIPMENT

31.4 Calibration

The calibration of the test circuit is carried out by placing temporary connections B of negligible impedance as close as reasonably possible to the terminals provided for connecting the accessories under test.

31.5 Test Procedure

Temporary connections B are replaced by the accessories under test. The circuit is closed on a value of the prospective current at least equal to the conditional short-circuit withstand current of the accessories under test.

31.6 Behaviour of the Equipment Under Test

During the test, the accessories shall not endanger the operator nor damage the adjacent equipment. There shall be neither arcing nor flashover between poles, and no melting of the fault detection circuit fuse of the exposed conductive parts (F2).

31.7 Acceptance Conditions

Acceptance conditions are as follows:

a) The accessories shall remain mechanically operable.

b) Contact welding, such as to prevent an opening operation using normal operating means, is not permitted.

c) Immediately after the test, the accessories shall comply with a dielectric test in accordance with **21.3** with voltage applied between the parts as indicated in **21.2**(a) or **21.2**(b), as applicable.

32 ELECTROMAGNETIC COMPATIBILITY

32.1 Immunity

The operation of accessories within the scope of this standard in normal use is not affected by electromagnetic disturbances.

32.2 Emission

Accessories within the scope of this standard are intended for continuous use. In normal use, they do not generate electromagnetic disturbances.

33 VEHICLE DRIVEOVER

33.1 A plug or vehicle connector shall have adequate resistance to damage from being driven over by a vehicle, unless it is provided with a cable management system which prevents the accessory from being left on the ground.

Compliance is checked by the test mentioned in **33.2** and **33.3**.

33.2 Accessories wired with the minimum size cable of a type recommended by the manufacturer shall be placed on a concrete floor in any normal position of rest, with the means for ensuring the required degree of protection against moisture, if any, being positioned as in normal use. A crushing force shall be applied with a wheel load of 5 000 ± 250 N by a conventional automotive tyre, P225/75R15 or an equivalent tyre suitable for the load, mounted on a steel rim and inflated to a pressure of 2.2 ± 0.1 bar(1 bar = 105Pa). The wheel is to be rolled over the vehicle connector or plug at a speed of 8 ± 2 km/h. The accessory is to be oriented in a natural resting position before applying the force in a different direction for each sample. The accessory under test shall be held or blocked in a fixed position so that it does not move substantially during the application of the applied force. In no case is the force to be applied to the projecting pins.

There shall be no severe cracking, breakage, or deformation to the extent that'

a) live parts, other than exposed wiring terminals, or internal wiring are made accessible to contact by the standard test finger shown in Fig. 3. *See* **10.1**;
b) the integrity of the enclosure is defeated so that acceptable mechanical or environmental (degrees of) protection is not afforded to the internal parts of the accessory, or polarization of the accessory is defeated;
c) there is interference with the operation, function or installation of the accessory;
d) the accessory does not provide adequate strain relief for the flexible cable;
e) the creepage distances and clearances between live parts of opposite polarity, live parts and accessible dead or earthed metal are reduced below the values in **28.1**;
f) other evidence of damage that could increase the risk of fire or electric shock occurs; and
g) the accessory does not comply with a repeated dielectric test in accordance with **21.3**.

33.3 The procedure described in **33.2** is to be repeated on additional samples, with an applied crushing force of 11 000 ± 550 N using a conventional automotive tyre suitable for the load, and inflated to its rated pressure.

33.4 As a result of the test in **33.3**, the accessories shall either comply with **33.1** or be damaged or broken to the extent that the accessory is rendered unusable and will have to be removed from service.

ANNEXA

(Foreword)

COMMITTEE COMPOSITION

Electrotechnology in Mobility Sectional Committee, ETD-51

Organization	*Representative(s)*
Department of Science And Technology, New Delhi, Delhi	Dr Sajid Mubashir (***Chairman***)
ABB India Limited, Faridabad, Haryana	Shri Divya Kumar
Amara Raja Batteries Limited, Tirupati, Andhra Pradesh	Shri Niranjan C Shri Jasmeet Singh (*Alternate*)
Ashok Leyland Limited, Chennai, Tamil Nadu	Shri Arun Kumar Gelli Shri Huzefa A. C. (*Alternate* I) Ms Suchismita Chatterjee (*Alternate* II)
Ather Energy Private Limited, Bengaluru, Karnataka	Shri Swapnil Jain Shri Nishant D. K. (*Alternate* I) Shri Chennasetty Prashanth Manikumar (*Alternate* II)
Automotive Component Manufactures Association of India (ACMA), New Delhi, Delhi	Ms Pooja Sharma Shri Uday Harite (*Alternate*)
Bangalore Electricity Supply Company Limited, Bangalore, Karnataka	Shri Anil Kumar Dsouza
Bharat Heavy Electricals Limited, Lodhi Road, New Delhi	Shri Imran Mansury Shri Pushkar Khakha (*Alternate*)
Bajaj Auto Limited, Pune, Maharashtra	Dr Philip Jose Shri Arvind Kumbhar (*Alternate*)
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Castus Energy Solutions Private Limited, Chennai, Tamilnadu	Shri Sivam Sabesan
Center For Study of Science, Technology, and Policy, Noida, Uttar Pradesh	Dr Mridula Dixit Bharadwaj Shri Aumkar Borgaonkar (*Alternate* I) Shri Arunesh Karkun (*Alternate* II)
Central Electricity Authority, R K Puram, New Delhi	Shrimati Vandana Singhal Ms Seema Saxena (*Alternate*)
Central Electricity Regulatory Commission, New Delhi, Delhi	Shri M. M. Chaudhari
Central Power Research Institute (CPRI), Bangalore, Karnataka	Dr Kuldeep Singh Rana
CG Power and Industrial Solutions Limited, Ahmednagar, Gujarat	Shri A. Sudhakaran Shri Sandeep R. Bachkar (*Alternate*)
Council of Scientific and Industrial Research, New Delhi, Delhi	Dr R. P. Aloysius Ms Priyanka Jain (*Alternate* I) Shri Atul Suresh Somkuwar (*Alternate* II)
Delta Power Solutions (India) Private Limited, Gurgaon, Haryana	Shri Akshaye Barbuddhe Shri R. Om Prakash (*Alternate*)
D E N S O International India Private Limited, Gurgaon, Haryana	Shri Noel Alexander Peters Shri Alok Kumar (*Alternate* I) Ms Alka Sharma (*Alternate* II)

Organization	*Representative(s)*
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Exicom Tele-Systems Private Limited, Gurgaon, Haryana	Shri Akshay Ahuja Shri P. M. Singh (*Alternate*)
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Honda Cars R and D India, Gautam Budh Nagar District, Uttar Pradesh	Shri Koji Tamenori Shri Adish Aggarwal (*Alternate* I) Shri S. Muthu Kumar (*Alternate* II)
Honda Motorcycle and Scooter India Private Limited, Gurugram, Haryana	Shri Suraj Agarwal Shri Sandeep Miskeen (*Alternate* I) Shri Vipin Sharma (*Alternate* II)
India Smart Grid Forum, Chanakyapuri, New Delhi	Shri Reji Kumar Pillai Shri Shuvam Sarkar Roy (*Alternate*)
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This Indian Standard has been developed from Doc No.: ETD 51 (15093).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Published by BIS, New Delhi