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Railway applications — Rolling stock — Electrical connectors, requirements and test methods

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National foreword

This British Standard is the UK implementation of EN 50467:2011. It supersedes DD CLC/TS 50467:2008, which is withdrawn.

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Foreword

This document (EN 50467:2011) has been prepared by SC 9XB, "Electromechanical material on board rolling stock", of Technical Committee CENELEC TC 9X, "Electrical and electronic applications for railways".

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2012-10-10
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2014-10-10

This document supersedes CLC/TS 50467:2008.

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Introduction

This European Standard provides performance requirements and tests for low-voltage electrical connectors deemed to be installed on board railway rolling stock, either indoors or outdoors. Safety requirements and tests for electrical connectors are already covered in general by EN 61984:2001. The additional requirements and testing of specific characteristics demanded by rolling stock applications are set out in this European Standard. One goal of this European Standard is to avoid retesting of electrical connectors already in compliance with EN 61984:2001 for those characteristics that have been assessed suitable also for use on board rolling stock.

Among the additional requirements for use on board rolling stock, those that can be verified by documentation of tests on the raw materials are distinguished from those to be assessed by tests on the component.

Due to the wide spectrum of existing and future specific rolling stock applications of electrical connectors, this European Standard does not select any particular geometric configuration of connectors, nor establish any particular values for electrical ratings such as voltage and current, or for any other characteristic. All such details should be selected and agreed between the parties involved (e.g. manufacturer and user) depending on the electrical, mechanical and environmental conditions expected in the intended use. Annexes A and C of this European Standard provide guidance.

Upon agreement between the parties involved, this European Standard may be used in conjunction with existing connector detail specifications for interchangeability purposes.

Other standards may be developed in future under the umbrella format of this European Standard, for particular connector designs for applications on board rolling stock, to fix dimensions for interchangeability and to set the additional requirements for specific applications that, due to complexity and variety, are left here to agreement between parties involved.

This European Standard does not cover:

- *connectors with breaking capacity (CBCs)* as defined in EN 61984:2001, 3.2, because on board rolling stock connectors are not deemed to be operated (i.e. connected or disconnected) under load or when live, either by means of procedures or by the presence of interlocks, as required by EN 50153,

  NOTE For the purpose of this European Standard connectors on board rolling stock are therefore considered as being always without breaking capacity, therefore where needed for safety reasons, adequate procedures or interlocks (i.e. locking devices that cannot be opened without the aid of a special tool) shall be provided in the end application.

- *non-rewirable connectors* as defined in EN 61984:2001, 3.5,
- *automatic couplers*, due to their additional mechanical complexity and the need for more specific requirements and testing,
- *inter-vehicle jumpers*, as they are connector and cable assemblies whose characteristics depend on those of both elements. Inter-vehicle connectors within the limits set in the scope of this European Standard are therefore covered by the agreed choice of suitable mechanical and environmental characteristics as defined by Annex B, and suggested by Annex C.

1 Scope

This European Standard retains EN 61984:2001 as the minimum performance requirements for railway rolling stock electrical connectors.

It identifies additional terms, test methods and performance requirements for single-pole and multipole connectors with rated voltages up to 1 000 V, rated currents up to 125 A per contact and frequencies below 3 MHz used for indoor and outdoor applications in railway rolling stock.

This European Standard identifies the application levels for electrical connectors based on

- the severity of the service conditions in different rolling stock technologies,
- the intended use of the rolling stock,
- the location of the connector in the rolling stock system.

This European Standard is not applicable to internal connections of electronic devices such as connectors for printed boards and rack-and-panel connectors.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 50124-1:2001 + A2:2005	Railway applications - Insulation coordination - Part 1: Basic requirements - Clearances and creepage distances for all electrical and electronic equipment
EN 50153:2002	Railway applications - Rolling stock - Protective provisions relating to electrical hazards
EN 50264-1:2008	Railway rolling stock power and control cables having special fire performance - Part 1: General requirements
EN 50264-2-1	Railway applications - Railway rolling stock power and control cables having special fire performance - Part 2-1: Cables with crosslinked elastomeric insulation - Single core cables
EN 50264-2-2	Railway applications - Railway rolling stock power and control cables having special fire performance - Part 2-2: Cables with crosslinked elastomeric insulation - Multicore cables
EN 50264-3-1	Railway applications - Railway rolling stock power and control cables having special fire performance - Part 3-1: Cables with crosslinked elastomeric insulation with reduced dimensions - Single core cables
EN 50264-3-2	Railway applications - Railway rolling stock power and control cables having special fire performance - Part 3-2: Cables with crosslinked elastomeric insulation with reduced dimensions - Multicore cables
EN 50306-1:2002	Railway applications - Railway rolling stock cables having special fire performance - Thin wall - Part 1: General requirements
EN 50306-2:2002	Railway applications - Railway rolling stock cables having special fire performance - Thin wall - Part 2: Single core cables
EN 50306-3:2002	Railway applications - Railway rolling stock cables having special fire performance - Thin wall - Part 3: Single core and multicore cables (pairs, triples and quads) screened and thin wall sheathed
EN 50306-4:2002	Railway applications - Railway rolling stock cables having special fire performance - Thin wall - Part 4: Multicore and multipair cables standard wall sheathed

EN 50382-1:2008	Railway applications - Railway rolling stock high temperature power cables having special fire performance - Part 1: General requirements
EN 50382-2:2008	Railway applications - Railway rolling stock high temperature power cables having special fire performance - Part 2: Single core silicone rubber insulated cables for 120 °C or 150 °C
EN 60068-1	Environmental testing - Part 1: General and guidance (IEC 60068-1:1988 + corrigendum Oct. 1988 + A1:1992)
EN 60068-2-70:1996	Environmental testing - Part 2: Tests - Test Xb: Abrasion of markings and letterings caused by rubbing of fingers and hands (IEC 60068-2-70:1995)
EN 60309-1:1999	Plugs, socket-outlets and couplers for industrial purposes - Part 1: General requirements (IEC 60309-1:1999)
EN 60352-2:2006	Solderless connections - Part 2: Crimped connections - General requirements, test methods and practical guidance (IEC 60352-2:2006)
EN 60352-3	Solderless connections - Part 3: Solderless accessible insulation displacement connections - General requirements, test methods and practical guidance (IEC 60352-3:1993)
EN 60352-4:1994 + A1:2000	Solderless connections - Part 4: Solderless non-accessible insulation displacement connections - General requirements, test methods and practical guidance (IEC 60352-4:1994 + A1:2000)
EN 60352-5:2008	Solderless connections - Part 5: Press-in connections - General requirements, test methods and practical guidance (IEC 60352-5:2008)
EN 60352-6	Solderless connections - Part 6: Insulation piercing connections - General requirements, test methods and practical guidance (IEC 60352-6:1997)
EN 60352-7	Solderless connections - Part 7: Spring clamp connections - General requirements, test methods and practical guidance (IEC 60352-7:2002)
EN 60512-1	Connectors for electronic equipment - Tests and measurements - Part 1: General (IEC 60512-1:2001)
EN 60512-1-1:2002	Connectors for electronic equipment - Tests and measurements - Part 1-1: General examination - Test 1a: Visual examination (IEC 60512-1-1:2002)
EN 60512-4-1:2003	Connectors for electronic equipment - Tests and measurements - Part 4-1: Voltage stress tests - Test 4a: Voltage proof (IEC 60512-4-1:2003)
EN 60512-5-1:2002	Connectors for electronic equipment - Tests and measurements - Part 5-1: Current-carrying capacity tests - Test 5a: Temperature rise (IEC 60512-5-1:2002)
EN 60512-11-6:2002	Connectors for electronic equipment - Tests and measurements - Part 11-6: Climatic tests - Test 11f: Corrosion, salt mist (IEC 60512-11-6:2002)
EN 60512-11-7:2003	Connectors for electronic equipment - Tests and measurements - Part 11- 7: Climatic tests - Test 11g: Flowing mixed gas corrosion test (IEC 60512-11-7:2003)
EN 60512-19-3:1997	Electromechanical components for electronic equipment - Basic testing procedures and measuring methods - Part 19: Chemical resistance tests - Section 3: Test 19c - Fluid resistance (IEC 60512-19-3:1997)
EN 60512-23-3:2001	Electromechanical components for electronic equipment - Basic testing procedures and measuring methods - Part 23-3: Test 23c: Shielding effectiveness of connectors and accessories (IEC 60512-23-3:2000)
EN 60512-23-4:2001	Connectors for electronic equipment - Tests and measurements - Part 23-4: Screening and filtering tests - Test 23d: Transmission line reflections in the time domain (IEC 60512-23-4:2001)
EN 60529:1991 + A1:2000	Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989 + A1:1999)

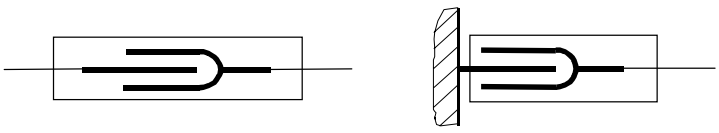
EN 60664-1:2007	Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests (IEC 60664-1:2007)
EN 60999-1:2000	Connecting devices - Electrical copper conductors - Safety requirements for screw-type and screwless-type clamping units - Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm² up to 35 mm² (included) (IEC 60999-1:1999)
EN 60999-2:2003	Connecting devices - Electrical copper conductors - Safety requirements for screw-type and screwless-type clamping units - Part 2: Particular requirements for clamping units for conductors above 35 mm² up to 300 mm² (included) (IEC 60999-2:2003)
EN 61210	Connecting devices - Flat quick-connect terminations for electrical copper conductors - Safety requirements (IEC 61210:1993, mod.)
EN 61373:1999	Railway applications - Rolling stock equipment - Shock and vibration tests (IEC 61373:1999)
EN 61984:2001[1])	Connectors - Safety requirements and tests (IEC 61984:2001)
EN ISO 4892-2:2006	Plastics - Methods of exposure to laboratory light sources - Part 2: Xenon-arc lamps (ISO 4892-2:2006)
HD 588.1 S1:1991	High-voltage test techniques - Part 1: General definitions and test requirements (IEC 60060-1:1989 + corrigendum Mar. 1990 + corrigendum Mar. 1992)
IEC 60050-581:2008	International Electrotechnical Vocabulary - Part 581: Electromechanical components for electronic equipment
IEC 60417-DB	Graphical symbols for use on equipment
IEC 60760	Flat, quick-connect terminations
ISO 1431-1:2004	Rubber, vulcanized or thermoplastic – Resistance to ozone cracking – Part 1: Static and dynamic strain testing

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-581:2008 and the following apply.

3.1
connection
two mated connectors or contacts

EXAMPLES See Figure 1.



a) Cable-to-cable connection b) Connection to apparatus

Figure 1 — Typical examples of connections

[1]) Will be superseded by EN 61984:2009, *Connectors - Safety requirements and tests* (IEC 61984:2008) at the dow of the latter, i.e. 2012-06-01.

3.2
connector
component which terminates conductors for the purpose of providing connection to and disconnection from a suitable mating component

[IEV 581-26-01]

NOTE Connectors covered by this standard are not intended to be connected and disconnected under electrical load]

3.3
free connector
connector for attachment to the free end of a wire or cable

[IEV 581-26-10]

3.4
fixed connector
connector for attachment to a rigid surface

[IEV 581-06-10]

3.5
enclosed connector
connector where protection against electric shock is provided by its enclosures

3.6
unenclosed connector
connector where protection against electric shock is provided by the enclosure of the equipment, in which the connector is mounted.

NOTE The protection against electrical shock is provided by e.g the enclosure of the equipment in which the unenclosed connector is mounted. In accordance with the applicable product standard.

3.7
inter-vehicle connector
connector deemed to be assembled with proper cable to form a cable assembly for inter-vehicle electrical connection

3.8
contact
conductive element in a connector (including means for cable termination) that mates with a corresponding element to provide an electrical path

3.9
male contact
contact (including means for cable termination) designed for electrical engagement on its outer surface and to enter a female contact, thus forming an electrical connection

EXAMPLES Tab, pin, blade.

3.10
female contact
contact (including means for cable termination) designed for electrical engagement on its inner surface, and to accept entry of a male contact, thus forming an electrical connection

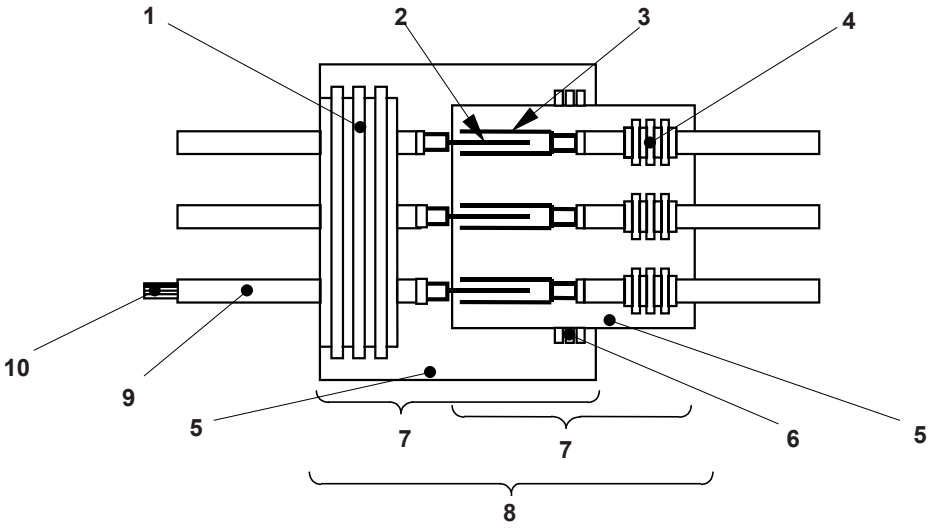
EXAMPLES Receptacle, sleeve.

3.11
cable termination
any joining of cable to contact

EXAMPLES Crimp, insulation displacement, screwing, spring clamp.

3.12
multipole connector
connector with more than one contact

EXAMPLE See Figure 2.



Key

1	Multiple cable seal	6	Housing seal
2	Male contact	7	Multipole connector
3	Female contact	8	Multipole connection
4	Single cable seal	9	Cable
5	Housing	10	Conductor

Figure 2 — Multipole connectors

3.13
connector coding
device, either visual, or mechanical or sensitive, or a combinations of these, preventing connection of connectors from the same family and having the same number of contacts but with different coding

3.14
intended use
application conditions of connectors which are included within the permissible rated values and environmental conditions and characteristic assigned by the manufacturer's specification

3.15
interlock
device, either electrical or mechanical, which prevents the contacts of a connector from becoming live before it is in proper engagement with its counterpart, and which either prevents the connector from being withdrawn while its contacts are live or makes the contacts dead before separation

[EN 60309-1:1999, 2.9, mod.]

3.16
cycle of mechanical operation (mating cycles)
one insertion and one withdrawal of the connector halves

[EN 61984:2001, 3.9]

3.17
clamping unit
part(s) of the terminal necessary for the mechanical clamping and the electrical connection of the conductor(s), including the parts which are necessary to ensure the correct contact pressure

[EN 60999-1:2000, 2.1]

3.18
upper limiting temperature
maximum permissible temperature of a connector assigned by the manufacturer at which the connector may still operate. It takes into consideration the temperature rise due to heating of the contacts by current flow plus the ambient temperature

3.19
lower limiting temperature
minimum permissible temperature of a connector assigned by the manufacturer at which the connector may still operate

3.20
clearance
shortest distance in air between two conductive parts

[EN 60664-1:2007, 1.3.2]

3.21
creepage distance
shortest distance along the surface of the insulating material between two conductive parts

[EN 60664-1:2007, 1.3.3]

3.22
over voltage category
numeral defining a transient over voltage condition

[EN 60664-1:2007, 1.3.10]

3.23
pollution
any addition of foreign matter, solid, liquid, or gaseous (ionised gases), that can result in a reduction of electrical strength or specific surface resistivity of the insulation

[EN 60664-1:2007, 1.3.11]

3.24
pollution degree
numeral characterising the expected pollution of the micro-environment

[EN 60664-1:2007, 1.3.13]

3.25
rated voltage
value of voltage assigned by the manufacturer to the connector and to which operation and performance characteristics are referred

NOTE A connector may have more than one rated voltage value.

[EN 60664-1:2007, 1.3.9, mod.]

3.26
rated insulation voltage
r.m.s. withstand voltage value assigned by the manufacturer to the connector, characterising the specified (long term) withstand capability of its insulation

NOTE The rated insulation voltage is not necessarily equal to the rated voltage which is primarily related to functional performance.

[EN 60664-1:2007, 1.3.9.1]

3.27
rated impulse voltage
impulse withstand voltage value assigned by the manufacturer to the connector, characterising the specified withstand capability of its insulation against transient over voltages

[EN 60664-1:2007, 1.3.9.2, mod.]

3.28
impulse withstand voltage
highest peak value of impulse voltage, of prescribed form and polarity, which does not cause breakdown of the insulation under specified conditions

NOTE The impulse withstand voltage is equal to or higher than the rated impulse voltage.

[EN 60664-1:2007, 1.3.8.1]

3.29
r.m.s. withstand voltage (power-frequency withstand voltage)
highest r.m.s. value of a voltage which does not cause breakdown of the insulation under specified conditions

[EN 60664-1:2007, 1.3.8.2]

3.30
rated current
current value assigned by the manufacturer, which the connector can carry continuously (without interruption) and simultaneously through all its contacts wired with the largest specified conductor, preferably at an ambient temperature of 40 °C, without the upper limiting temperature being exceeded

NOTE If other ambient temperature values are used for the definition of the rated current, reference shall be made by the manufacturer in the technical documentation to the derating curve as defined by EN 60512-5-2:2002, test 5b.

3.31
functional insulation
insulation between conductive parts which is necessary only for the proper functioning of the equipment

[EN 60664-1:2007, 1.3.17.1]

3.32
basic insulation
insulation applied to live parts to provide basic protection against electric shock

NOTE Basic insulation does not necessarily include insulation used exclusively for functional purposes (see EN 61140:2002, 3.10.1).

[EN 60664-1:2007, 1.3.17.2]

3.33
supplementary insulation
independent insulation applied in addition to basic insulation, in order to provide protection against electric shock in the event of a failure of basic insulation

NOTE See EN 61140:2002, 3.10.2.

[EN 60664-1:2007, 1.3.17.3]

3.34
double insulation
insulation comprising both basic insulation and supplementary insulation

NOTE See EN 61140:2002, 3.10.3.

[EN 60664-1:2007, 1.3.17.4]

3.35
reinforced insulation
single insulation system applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation under the conditions specified in the relevant standard (see EN 61140:2002, 3.10.4)

NOTE A single insulation system does not imply that the insulation must be a homogeneous piece. It may comprise several layers which cannot be tested separately as basic or supplementary insulation.

[EN 60664-1:2007, 1.3.17.5]

3.36
internal insulation
part of basic insulation providing the required clearance and creepage distances inside a conducting housing or enclosure

3.37
protective conductor (symbol PE)
conductor provided for purposes of safety, for example protection against electric shock. Applicable for electrically connecting any of the following parts:

- exposed conductive parts,
- extraneous conductive parts,
- main earthing terminal,
- earthed point of the source or artificial neutral

[IEV 826-13-22, mod.]

3.38
rolling stock
general term covering all vehicles with or without motors

[IEV 811-02-01]

3.39
vehicle
general term denoting any single item of rolling stock, e.g. a locomotive, a coach or a wagon

[IEV 811-02-02]

3.40
vehicle compartment
compartment of vehicles in which people may enter during normal operation

[EN 50125-1:1999, 3.2]

3.41
vehicle cubicle
enclosure for housing of mechanical, electrical and/or electronic equipment

[EN 50125-1:1999, 3.3]

3.42
electrical operating area
room or location which serves primarily for the operation of electrical equipment and is normally entered only by *skilled persons* or *instructed persons*

NOTE Generally speaking an electrical operating area is any location (mainly inside the car body) where electrical equipment operate. The above is the main function of this area but not the only one. In fact normally the area is not kept secured and the protection against direct contact is achieved by other means (e.g. obstacles).

[EN 50153:2002, 3.2.6]

3.43
closed electrical operating area
room or location which serve exclusively for the operation of electrical equipment and is kept secure by a means appropriate to the voltage and location

NOTE 1 Access to such areas is permitted only to *skilled persons* and *instructed persons*.

NOTE 2 The definition of *closed electrical operating area* can be suitable for under floor or upper roof cabinets. Generally speaking it is any location (inside or outside the car body) which is kept secured because of the voltage that can assume the equipment inside it. Access to such areas is not allowed to *ordinary persons*.

[EN 50153:2002, 3.2.1]

4 Technical information (electrical ratings)

For connectors that comply with this European Standard, no particular values have been specified for electrical ratings such as voltage and current. Values shall be specified in compliance with mechanical and environmental conditions given in the manufacturer's specification depending from the intended use.

NOTE For voltage ratings in electrical circuits and components for rolling stock, information may be found in EN 50153:2002, Table 1, EN 50163, and EN 60077-1.

5 Classification

5.1 General

For the purpose of this European Standard, in order to apply the relevant test requirements, connectors shall be classified by the manufacturer’s specification according to their intended use and characteristics, as set out below.

5.2 Severity of service conditions in different rolling stock technologies

Different rolling stock technologies are e.g. mass transit underground, mass transit and high speed for passenger trains, or freight trains for non passenger trains. They need specific service conditions as those listed in Annex B (normative) and Annex C (informative).

5.3 Intended use of rolling stock

The intended use of rolling stock is affected by the geographical destination and whether it is used underground or above ground. The specific conditions for connectors may differ depending on such intended use (e.g. underground requirements for fire protection and for resistance to UV are different than for above ground). The relevant requirements have to be agreed by manufacturer and user.

5.4 Location of connector on board rolling stock

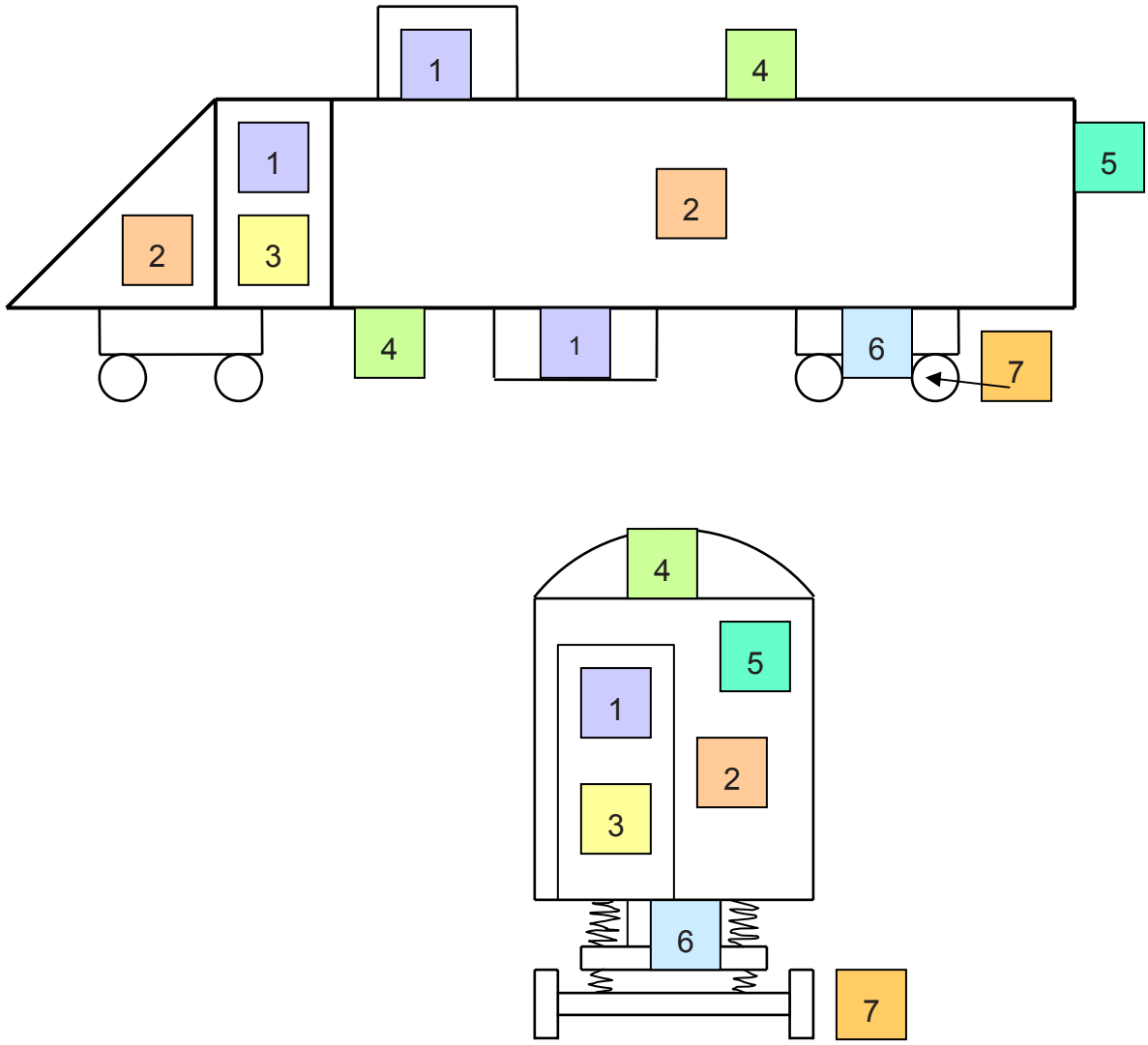


Figure 3 — Typical connector locations on board rolling stock

Table 1 — Example of typical connector locations on board rolling stock

Location according to Figure 3	Definition	Examples	Examples of consequences on requirements
1	closed electrical operating area	indoor vehicle cubicle (weather-protected) outdoor vehicle cubicle (weather-protected) either under-frame or upper-roof	different vibration and shock levels depending on the installation on bogie or car body resistance to ozone for exposed elastomer is required for areas with power switching
2	cabin and interiors	passenger vehicle compartment and driver cabin	low IP degree required (air with low dust and chemical contamination)
3	closed electrical operating area; forced filtered ventilation with outside air	machinery compartment	higher temperature resistance if diesel engine, then resistance to fuels and fluids
4	outdoor static applications	under car body, roof (non weather-protected locations)	non weather-protected location higher IP degree resistance to light (UV) resistance to ozone for rubber and plastic parts
5	outdoor dynamic applications	inter-vehicle	non weather-protected location higher IP degree resistance to light (UV) resistance to ozone for rubber and plastic parts higher mechanical resistance
6	outdoor highly dynamic applications	bogie	non weather-protected location higher IP degree resistance to light (UV) resistance to ozone for rubber and plastic parts higher mechanical resistance High vibration and shock constraints Resistance to fuel and fluids
7	outdoor highly dynamic applications	axles	non weather-protected location higher IP degree resistance to light (UV) resistance to ozone for rubber and plastic parts higher mechanical resistance very high vibration and shock constraints resistance to fuels and fluids

6 Requirements

6.1 General

Connectors shall be so designed and dimensioned that they can withstand the electrical, mechanical, thermal and corrosive stresses to which they are exposed during their intended use and present no danger to the user or the environment.

The manufacturer and the user shall select the appropriate characteristics related to the application of the connector; specific attention should be given to Annex B (normative) and Annex C (informative).

In addition, characteristics which are not covered by the constructional and performance requirements specified in this European Standard but are necessary for the intended use of the connector, shall be given in the manufacturer's specification. These can be additional geometrical, mechanical, electrical and/or environmental characteristics. Details shall be agreed between manufacturer and user.

Examples for additional characteristics can be found in Annex A.

The manufacturer and user shall select the appropriate characteristics related to the location in the rolling stock system: specific attention should be given to Annex B.

6.2 Marking and identification

6.2.1 Identification

Connectors shall be identified and characterised by the following:

a) manufacturer's name, trademark or mark of origin;
b) type identification;
c) rated current in A;
d) rated voltages or rated insulation voltages between line to earth and line to line in V;
e) rated impulse voltage in kV, if specified;
f) pollution degree;
g) degree of protection by enclosure according to EN 60529:1991, if applicable;
h) range of temperature;
i) type of terminals;
j) connectable conductors;
k) reference to this European Standard;
l) traceability.

6.2.2 Marking

The marking shall be indelible and easily legible.

The minimum marking on the connector shall be a) of 6.2.1. Additional information may be agreed between manufacturer and user.

Markings a) and b) of 6.2.1 shall be found on the smallest unit of packaging.

Traceability shall be agreed between manufacturer and user.

All other markings of 6.2.1 shall be given in the technical documentation or catalogue of the manufacturer.

The positions for the contacts and protective earthing contacts shall be clearly indicated. Marking of the first contact and first row by a letter, number or another clear symbol is sufficient. This requirement does not apply to a connector in which contact identification is ensured in the end-use product. Relevant information shall be given in the technical documentation of the manufacturer.

Marking of protective earthing contacts shall apply the symbol  or PE.

Marking shall not be applied to screws or other removable parts.

Symbols are given in IEC 60417-DB.

6.3 Provision against incorrect mating (non-intermateable)

A multipole connector shall be so designed that contact between protective earthing contacts and live contacts and the contact between live contacts of different polarity is not possible by engagement.

Compliance is checked by using a polarisation test.

6.4 Protection against electric shock

Subclauses 6.4.1 and 6.4.2 of EN 61984:2001 and the relevant requirements of EN 50153 shall apply.

6.5 Provisions for earthing

Accessible metal parts of a connector with an earthing contact (which may become live in the event of an insulation fault) shall be reliably connected to the earthing contact.

In no case shall the resistance of this connection exceed 0,1 Ω.

NOTE If accessible metal parts are screened from live parts by metal parts which are connected to an earthing terminal or earthing contact, or if they are separated from live parts by double 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 the test of 7.13.

6.6 Terminations and connection methods

Terminations shall be suitable for the type and range of conductor cross-sectional areas according to the manufacturer's specification. See Annex A.

The following terminations and connection methods meet the requirements of this European Standard:

a) crimped connections according to EN 60352-2 [2)];

b) accessible insulation displacement connections according to EN 60352-3;

c) non-accessible insulation displacement connections according to EN 60352-4;

d) press-in connections according to EN 60352-5;

e) spring-clamp connections according to EN 60352-7;

f) insulation piercing connection according to EN 60352-6;

g) screwless-type clamping units according to EN 60999-1 or EN 60999-2;

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2) Crimped connections with wire size greater than 10 mm² are not covered by EN 60352-2:2006. Requirements for cross-sectional areas greater than 10 mm² to be agreed between manufacturer and user.

h) screw-type clamping units according to EN 60999-1 or EN 60999-2;

i) flat, quick-connect terminations according to IEC 60760 and EN 61210.

Where connections do not fully comply to any of the standards cited above, the following minimum tests shall be carried out.

a) For crimped connections,

visual and dimensional tests on the crimp barrel and tensile strength test of the crimp connection as specified in EN 60352-2:2006.

b)
and
c) For insulation displacement connections,

visual examination of the insulation displacement terminal as specified in EN 60352-3 or EN 60352-4.

d) For press-in connections,

visual and dimensional tests on the press-in post and test of the retention force as specified by EN 60352-5.

e) For spring clamp connections,

visual and dimensional tests on the spring clamp connection and test of the pull-out force as specified by EN 60352-7.

f) For insulation piercing connections,

mechanical tests on the conductor as specified in EN 60352-6,

g) For the screwless-type clamping unit,

mechanical tests on the conductor connection as specified in EN 60999-1 or EN 60999-2.

h) For the screw-type clamping unit,

mechanical tests on the conductor connection as specified in En 60999-1 or EN 60999-2.

NOTE For prepared conductors the specific standard for the preparation applies.

i) For flat, quick-connect terminations,

dimensional tests and safety tests as specified in EN 61210 as far as applicable.

Electrical and thermal tests on terminations shall be carried out in conjunction with the test on the connector.

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 not less suitable, unless there is sufficient resiliency in the metallic parts to compensate for any shrinkage or yielding of the insulating material (see EN 60309-1:1999, 25.3, or EN 60999-1:2000 or EN 60999-2:2003, Clause 7).

6.7 Resistance to ageing

Parts which, due to ageing, might impair safety shall be so resistant that the specified characteristics such as dielectric strength, contact resistance or degree of protection are maintained.

6.8 General design

Multipole connectors shall be so polarised that improper connection of mating parts is prevented. This requirement does not apply to connectors where mismating is prevented by mounting provisions in the end-use or additional accessories, if necessary and available.

Fixing means, actuated in the mounting and in the connection of conductors, shall not be used to fix live parts, where as a result of their change of position their efficiency might be impaired and creepage distances and clearances be reduced.

Connectors shall be so designed that connection of conductors of the type and cross-sectional areas as specified by the manufacturer shall be possible. Outside of the termination of the conductor care shall be taken that no damage of the insulation is possible to occur, e.g. by avoiding of sharp edges.

6.9 Design of a free connector

In a free connector the wires shall be protected against shear and tensile stress at the termination and be secured to prevent twisting.

This requirement does not apply to:

a) free connectors for termination to cables in fixed mountings (plug connection in the sense of a detachable connection),

b) free connectors in which the termination is protected against pull and twisting by mounting provisions in the end-use product.

6.10 Interlock

Connectors with interlock shall comply with EN 61984:2001, 6.7.

6.11 Degree of protection IP

A connector shall have a degree of protection according to EN 60529:1991, as specified by the manufacturer.

NOTE Depending on the location on board rolling stock, different minimum IP degrees of protection are specified in Annex B. (normative).

6.12 Dielectric strength

A connector shall withstand the specified test voltage, preferably the impulse withstand voltage (1,2/50 µs) or the r.m.s. withstand voltage (50/60 Hz) alternatively. The connector shall withstand the test voltage specified in Table 14, in accordance with 7.12.

6.13 Mechanical and electrical durability

A connector shall meet the mechanical operations without load as specified by the manufacturer.

The preferred numbers of operating cycles is given in Table 2.

Table 2 – Preferred number of operating cycles

Preferred number
50
100
200
500
1 000
2 000
5 000

NOTE 1 Values other than those in Table 2 are allowed, upon agreement between manufacturer and user.

NOTE 2 The durability adequate to the application in terms of number of operating cycles is related to the expected service conditions of the connector, i.e. the number of expected operating cycles in its design lifetime and the expected environmental parameters which may shorten the lifetime of materials. In this regard, upon agreement between manufacturer and user, connectors deemed to be operated very seldom may be specified (and designed) for a limited number of operations, while connectors deemed to be operated very frequently may require special maintenance procedures and even scheduled replacement.

6.14 Cable strain relief

Strain relief, where applicable, shall be suitable for the cable to be connected. The range of acceptable cable diameters shall be specified by the manufacturer. Tensile and torsion requirements shall be agreed between manufacturer and user.

Compliance is checked by the tests of test phases A7.1 and A7.2 of Table 5.

Loose parts inserted to obtain clamping of the cable are permissible, if they are fixed in the connector in the assembled state. The cable clamp can be made of insulating material or metal. In that case, the requirements of EN 61984:2001, 6.17 shall apply.

6.15 Mechanical strength

A connector shall show no damage likely to impair safety after exposure to mechanical stress according to the test programme.

In a connector assembled for final use the contacts shall be securely retained in the contact insert.

After exposure to the stresses according to the test schedule the internal insulation shall show no damage which could impair normal use.

Test shall be performed according to 7.2, Table 5.

6.16 Vibration and shock

Connectors shall be capable of withstanding the environmental vibration conditions normally expected for railway vehicles as specified in EN 61373:1999. For the classification of connectors based upon the location on board see Annex B (normative).

Test shall be performed according to 7.2, Table 10.

During and after simulated long life testing and random vibration tests and after the shock test the operation of connectors, either mechanical or electrical, shall be maintained.

6.17 Insulation coordination

For insulation coordination the requirements shall be specified according to EN 60664-1:2007 or EN 50124-1:2001 (Table A.4, PD1 to PD4), unless otherwise agreed between manufacturer and user. In case of conflict, EN 50124-1 shall prevail.

Applicable rated impulse voltage, over voltage category and pollution degree shall be agreed between manufacturer and user according to the intended use of the connector.

NOTE Additional information may be found in EN 60664-1 or in EN 50124-1.

6.18 Temperature classes

A connector shall comply with the upper and lower values of the range of temperature as specified by the manufacturer. Preferred values for lower and upper temperature are given in Table 3.

Table 3 – Preferred test temperatures

Table 3a – Lower limiting temperature (LLT) – Preferred values

Lower limiting temperature (LLT) Preferred values °C
-10
-25
-40
-55

Table 3b – Uper limiting temperature (ULT) – Preferred values

Upper limiting temperature (ULT) Preferred values °C
70
85
100
125

NOTE Any temperature class other than those in Table 3 is allowed upon agreement between manufacturer and user.

6.19 Temperature rise

The sum of the ambient temperature and the temperature rise of a connector shall not exceed the upper limiting temperature.

Compliance shall be checked by the test of 7.8.

6.20 Protection against corrosion

Metal parts shall be so designed that corrosion shall not impair functionality with regard to electrical and mechanical characteristics.

Compliance shall be checked by the test of 7.14.

NOTE In order to keep corrosion resistance, care should be taken by the user to avoid misuses and malpractice during operation of connectors, such as improper handling causing mechanical wear and damage to the protective coatings of the housings or to the contact plating, wrong or incomplete installation of cable harnesses, use of improper tools, omitted use of caps or dummy connectors that reset the specified IP degree when counterpart is missing. All these misuses would imply consistent reduction of corrosion resistance and anticipated failure of electrical connectors that are impossible to prevent by design.

6.21 Electromagnetic compatibility (EMC) requirements

Depending on the location and the function of the connector, shielding effectiveness of connector housings shall be required upon agreement between manufacturer and user, if applicable. Shielding effectiveness shall be tested according to EN 60512-23-3:2001 or EN 60512-23-4:2001 as appropriate.

NOTE Connectors are passive components that are themselves intrinsically immune from EMC disturbances, either radiated or conducted. It is the circuit in which they are integrated that may be source of disturbances either radiated or conducted or be affected by disturbances coming from the surrounding electromagnetic environment. Connectors are part of a system or sub-system. EMC requirements for railway rolling stock described in EN 50121 series can be verified only for complete systems. Under several circumstances the most concerning issue in a wiring installation is the cable shielding characteristic, not the connector shielding characteristic.

6.22 Fire behaviour of materials and components

Requirements shall be agreed between manufacturer and user.

NOTE 1 See also Annex A , A.1.4.

NOTE 2 This is due to different legislation, requirements for fire prevention concerning relevant characteristics of the combustible materials and the mass of such materials employed in electrical connectors, e.g. self-extinguishing characteristics (glow-wire index, flammability ratings), toxicity of effluents, smoke density and opacity.

6.23 Resistance to chemically active substances and to contaminating fluids

Depending on the connector location (see Annex C, informative) requirements for resistance to chemically active substances and to contaminating fluids shall be agreed by manufacturer and user.

Test shall be performed according to 7.2, Table 11, and 7.17.

NOTE This is due to the largely different policies regarding chemically active substances used, e.g. during car washing, by railway operators in different countries, as well as due to different chemical composition of fuels in different countries due to unequal restrictions in force in the various countries, and due to different exposure to contaminants depending on the protective means and the location on board as well as to the type of train and the intended service.

6.24 Resistance to ozone

Depending on the connector location (see Annex B, normative) requirements for rubber parts of connectors shall be agreed by manufacturer and user. If applicable, documentation of performance to ISO 1431-1 test on the raw material rubber used shall be required.

Test shall be performed according to 7.3, Table 13, and 7.15.

6.25 Resistance to UV

Depending on the connector location (see Annex C, informative) requirements for non metallic parts exposed to sun light shall be agreed by manufacturer and user. If applicable, documentation of performance to EN ISO 4892-2 test on the raw material used for shall be required.

Test shall be performed according to 7.3, Table 13, and 7.16.

7 Tests

7.1 Introduction

7.1.1 General

Tests in this European Standard are type tests.

Requirements of Clause 6 shall be generally verified by testing the appropriate number of specimens with the test sequences indicated below, except for some characteristics of the connectors that shall be deemed to be tested by submission of documentation of performance to the relevant standard required under Clause 6 for the raw material. Table 13 of 7.3 lists such tests and the relevant requirements that are generally to be agreed between manufacturer and user depending on the end use application of connectors.

7.1.2 Preconditioning and preparation

All test samples shall be preconditioned at (23 ± 5) °C and 45 % to 75 % relative humidity for 24 h before the start of any test sequence in accordance with EN 60512-1.

Screw-type clamping units shall be tightened with the value of the torque stipulated according to EN 60999-1 and EN 60999-2, unless otherwise specified by the manufacturer.

Unless otherwise specified in the test schedule all tests shall be made on the specimen completely assembled according to the manufacturer's instructions.

7.1.3 Test conditions

The tests shall be made under the standard atmospheric conditions of EN 60068-1, unless otherwise specified in the test schedule.

The tests shall be carried out in the sequence specified for each test group using the number of specimens as given in Table 4. For each test group a separate set of new specimens shall be used.

Table 4 — Plan of specimens required for tests

Test group	Number of specimens
Group A: mechanical	1
Group B: service life	3
Group C: thermal	1
Group D: climatic	1
Group E: degree of protection	2
Group F: vibration and shock	1
Group G: resistance to fluids	[a]
Group H: shielding effectiveness	1
NOTE For a connector family of the same design and comparable size, tests may be made only on that member of the family, which represents the worst case for that test.	
[a] Type and number of fluids upon agreement between manufacturer and user, 1 specimen per fluid.	

A specimen is defined as a pair of connectors or free contacts. Unless otherwise specified the condition used in the test schedule is unmated.

If the testing has to be made on free contacts (e.g. crimp contacts) a minimum of 3 specimens shall be used.

Contacts with a locking device shall be tested with adequate counterparts to permit locking.

The tests on the terminations shall be made on three terminations per specimen, if available.

Cables used for testing shall be in conformance with the relevant cable specification, for which the contact is intended to be used (i.e. EN 50264 series, EN 50306 series, EN 50382 series), and the cable or cables used shall be noted in the test report.

Cable termination shall be performed in accordance with the contact manufacturer's recommendations.

Care shall be taken so that test samples do not influence each other (e.g. in a heat chamber).

The specimen is deemed not to comply with this European Standard if the specimen fails in more than one of the tests of any test group. If the specimen fails in one of the tests, this test and the preceding tests which have affected its result shall be repeated on a new specimen, which shall then pass the repeated tests.

During the entire test sequence, lubrication or other means of attaining better test results shall not be added to the test surface. However, production-related remains of lubricants on the contacts are permitted.

7.2 Test schedule (EN 60512-1-100 – General – Applicable publications)

Table 5 — Mechanical test group A

1	2	3	4	5	6	7	8
Test phase	**Designation or title**	**EN 60512 test no.**	**Test according to**	**Severity or conditions**	**Measurements to be performed**		**Requirements**
					Designation or title	**EN 60512 test no.**	
A1				Any existing cover shall be removed, if required.	Visual and dimensional examination	1a, 1b	6.2; 6.8. 6.9; 6.15 Dimensions shall comply with manufacturer's specification.
A2	Durability of marking		7.5	With the naked eye.	Visual examination	1a	Markings according to 6.2.2
A3	Polarisation	13e		Test force: 20 N or 1,5 times the insertion force, whichever is higher.			6.3; 6.8
					Visual examination	1a	No damage likely to impair function.
A4	Interlock		7.6				6.10
A5	Terminations						6.6
A6	Contact retention in insert	15a		Test load shall be three times the specified insertion force (mating) of one contact or the specified insertion force of one contact plus 50 N, whichever is less. The minimum test load shall not be less than 20 N.			6.15
					Visual examination	1a	No axial displacement likely to impair normal operation.
A7.1	Cable strain relief resistance to cable pull	17c		With cables having the largest and smallest diameter suitable for clamping specified by the manufacturer. Any existing covers associated with the cable anchorage shall be mounted as specified.	Visual examination	1a	6.14,
A7.2	Cable strain relief resistance to cable torsion	17d			Visual examination	1a	6.14,
A8	Mechanical strength impact	7b		Only free connectors. Dropping height: - 750 mm for specimens of mass ≤ 250 g, - 500 mm for specimens of mass > 250 g. Dropping cycles: 8 Positions in 45° steps, one cycle per position.			6.15
					Visual examination	1a	Parts used for protection against electric shock shall not be damaged. A reduction of clearances and creepage distances is not allowed.

Table 6 — Service life test group B

1	2	3	4	5	6	7	8
Test phase	**Designation or title**	**EN 60512 test no.**	**Test according to**	**Severity or conditions**	**Measurements to be performed**		**Requirements**
					Designation or title	**EN 60512 test no.**	
B1	Initial measurement			Test current: 1 A or the rated current. Measuring points: at the end of the termination. Maximum three contacts per specimen plus protective earthing contact, if any.	Contact resistance	2a or 2b	Reference value for subsequent measurement.
B2	Mechanical operation	9a	7.9	Number of operating cycles according to manufacturer's specification.			6.13
					Visual examination	1a	No damage shall occur which could impair normal use.
B3	Final measurement			Same conditions as for test phase B1.	Contact resistance	2a or 2b	For initial contact resistance up to 10 mΩ the maximum rise permitted shall be 50 %. For initial contact resistance above 10 mΩ the maximum rise permitted is 5 mΩ. The higher value is permissible.
			7.12 a) or b)	Same conditions as for test phase D6.	a) Impulse withstand voltage	EN 50124-1:2001, 5.3	6.12 There shall be no breakdown or flashover.
					b) Voltage proof	4a	

Table 7 — Thermal test group C

1	2	3	4	5	6	7	8
Test phase	**Designation or title**	**EN 60512 test no.**	**Test according to**	**Severity or conditions**	**Measurements to be performed**		**Requirements**
					Designation or title	**EN 60512 test no.**	
C1	Temperature rise	5a	7.8	Mated specimen.			6.18 // 6.19 The upper limiting temperature specified shall not be exceeded.

Table 8 — Climatic test group D

1	2	3	4	5	6	7	8
Test phase	**Designation or title**	**EN 60512 test no.**	**Test according to**	**Severity or conditions**	**Measurements to be performed**		**Requirements**
					Designation or title	**EN 60512 test no.**	
D1	Initial measurement			Mated specimen. Test current: 1 A or the rated current. Measuring points [a] at the end of the termination. Maximum three contacts per specimen plus protective earth contact, if any.	Contact resistance	2a or 2b	Reference value for subsequent measurement.
D2	Cold	11j	6.18	Mated specimen. Test temperature: lower limiting temperature specified for the specimen Test duration: 2 h.			6.7
					Visual examination	1a	No damage shall occur which could impair normal use.
D3	Dry heat	11i	6.18	Mated specimen. Test temperature: upper limiting temperature specified for the specimen Test duration: 7 days.			6.7
					Visual examination	1a	No damage shall occur which could impair normal use.
D4	Flowing mixed gas corrosion	11g	7.14	Test 1 – Specimen mated			6.20
	Alternative: salt mist test	11f	7.14	Test 2 – Specimen mated	Visual examination	1a	No damage shall occur which could impair normal use.
D5	Final measurement			The same conditions as for test phase D1.	Contact resistance	2a or 2b	For initial contact resistance up to 10 mΩ the maximum rise permitted shall be 50 %. For initial contact resistance above 10 mΩ the maximum rise permitted is 5 mΩ. The higher value is permissible.
D6	Dielectric strength		7.12 a) or b)	Mated specimen. Measuring points [a] contact/contact contact/earth [b]	a) Impulse withstand voltage	EN 50124-1:2001, 5.3	6.12 There shall be no breakdown or flashover.
				Test voltage (impulse withstand voltage or the r.m.s. withstand voltage) according to Table 14 shall be applied.	b) Voltage proof	4a	

[a] Measuring points: at the conductors as close as possible to the termination. If this is not possible, the conductor resistance shall be recalculated.

[b] Earth in the sense of non-live metal parts (e.g. fixing devices/housings/accessible surfaces).

Table 9 — Degree of protection, test group E

1	2	3	4	5	6	7	8
Test phase	**Designation or title**	**EN 60512 test no.**	**Test according to**	**Severity or conditions**	**Measurements to be performed**		**Requirements**
					Designation or title	**EN 60512 test no.**	
E1	Protection against electric shock		7.7	Unenclosed connectors. Mated specimen. Test finger or 50 mm Ø sphere pressed with 20 N against the surfaces as specified by the manufacturer.			6.4 No live part shall be accessible.
			7.7	Enclosed connectors. Mated and unmated specimen. Test finger pressed with 20 N against the surfaces except the mating face of the male part of the connector.			6.4 Required clearances and creepage distances shall be ensured between all live parts and the test finger.
E2	Provision for earthing		7.13	Resistance between accessible metal parts and the earthing contact.			6.5
E3	Degree of protection IP code		7.7	IP code as specified by the manufacturer.			6.11
E4	Dielectric strength		7.12 a) or b)	Enclosed connectors only. Test voltage applied between all live parts connected together and the accessible surface.	a) Impulse withstand voltage	EN 50124-1:2001, 5.3	6.12 There shall be no breakdown or flashover.
					b) Voltage proof	4a	

Table 10 — Vibration and shock test group F

1	2	3	4	5	6	7	8
Test phase	**Designation or title**	**EN 60512 test no.**	**Test according to**	**Severity or conditions**	**Measurements to be performed**		**Requirements**
					Designation or title	**EN 60512 test no.**	
F1	Simulated long life random vibration at increased levels		EN 61373: 1999, Clause 9	Connectors mated, all contacts wired in series and monitored for micro interruption. According to classification of intended mounting location (see Annex B): – category 1 (body mounted) – class A – category 1 (body mounted) – class B – category 2 (bogie mounted)			6.16
					Contact disturbance	2e	Micro interruption ≤ 1 µs
					Visual examination	1a	No damage likely to impair function.
F2	Shock		EN 61373: 1999, Clause 10	Connectors mated. According to classification of intended mounting location (see Annex B): – category 1 (body mounted) – class A – category 1 (body mounted) – class B – category 2 (bogie mounted)			6.16
					Visual examination	1a	No damage likely to impair function.
F3	Random vibration test		EN 61373: 1999, Clause 8	Connectors mated, all contacts wired in series and monitored for micro interruption. According to classification of intended mounting location (see Annex B): – category 1 (body mounted) – class A – category 1 (body mounted) – class B – category 2 (bogie mounted)			6.16
					Contact disturbance	2e	Micro interruption ≤ 1 µs
					Visual examination	1a	No damage likely to impair function.
F4	Dielectric strength		7.12 a) or b)	Mated specimen. Measuring points [a]: contact/contact contact/earth [b]	a) Impulse withstand voltage	EN 50124-1:2001, 5.3	6.12 There shall be no breakdown or flashover.
				Test voltage (impulse withstand voltage or the r.m.s. withstand voltage) according to Table 14 shall be applied.	b) Voltage proof	4a	

[a] Measuring points: at the conductors as close as possible to the termination. If this is not possible, the conductor resistance shall be recalculated.

[b] Earth in the sense of non-live metal parts (e.g. fixing devices/housings/accessible surfaces).

Table 11 — Resistance to fluids test group G

1	2	3	4	5	6	7	8
Test phase	**Designation or title**	**EN 60512 test no.**	**Test according to**	**Severity or conditions**	**Measurements to be performed**		**Requirements**
					Designation or title	**EN 60512 test no.**	
G1	Fluid resistance	19c		Connectors mated and or unmated – For connectors tested unmated agreement should be made between manufacturer and user.			6.23
G2					Engaging and separating forces.	13a	No damage likely to impair function.
G3					Contact resistance – millivolt level method or specified test current method.	2a or 2b	For initial contact resistance up to 10 mΩ the maximum rise permitted shall be 50 %. For initial contact resistance above 10 mΩ the maximum rise permitted is 5 mΩ. The higher value is permissible.
G4					Insulation resistance.	3a	
G5	Dielectric strength			Mated specimen. Measuring points [a]: contact/contact contact/earth [b]	a) Impulse withstand voltage	EN 50124-1:2001, 5.3	6.12 There shall be no breakdown or flashover.
				Test voltage (impulse withstand voltage or the r.m.s. withstand voltage) according to Table 14 shall be applied.	b) Voltage proof	4a	
G6				Unmated specimen.	Contact retention in insert.	15a	
G7				Unmated specimen.	Insert retention in housing (axial).	15b	
G8				Mated and unmated.	Visual examination.	1a	No damage likely to impair function. The marking shall be indelible and easily legible.

[a] Measuring points: at the conductors as close as possible to the termination. If this is not possible, the conductor resistance shall be recalculated.

[b] Earth in the sense of non-live metal parts (e.g. fixing devices/housings/accessible surfaces).

Table 12 — Shielding effectiveness test group H

1	2	3	4	5	6	7	8
Test phase	**Designation or title**	**EN 60512 test no.**	**Test according to**	**Severity or conditions**	**Measurements to be performed**		**Requirements**
					Designation or title	**EN 60512 test no.**	
H1	Shielding effectiveness or	23c		Connectors mated. According to classification of intended mounting location (see Annex B).			6.21
	Effective transfer impedance	23g					

7.3 Tests on raw materials

Table 13 — Tests on raw materials

Designation	Clause	Applicable standard	Conditions of test	Requirements
Fire behaviour of materials and components	6.22	To be agreed between manufacturer and user.	To be agreed between manufacturer and user.	To be agreed between manufacturer and user.
Resistance to ozone	6.24	ISO 1431-1	ISO 1431-1:2004, method B – Test duration: 24h, 500 ppb, temperature: 40 °C, elongation: 20 %.	Visual examination. No cracks shall appear.
Resistance to UV	6.25	EN ISO 4892-2	EN ISO 4892-2:2006, method A – Cycle n°1.	To be agreed between manufacturer and user.

7.4 Visual examination

The test shall be done according to EN 60512-1-1:2002 (test 1a).

The visual examination of all connectors and contacts shall be carried out with the naked eye, (at normal strength of vision and colour perception, at the most favourable viewing distance, and with suitable illumination).

Visual examination shall allow identification, appearance, workmanship and finish of each item to be checked against the relevant specification.

For crimped cable terminations, both insulation and the conductor shall be visible between the conductor crimp and the insulation support on the male and female contacts as specified in EN 60352-2. Conductors shall protrude from the conductor crimp but shall not interfere with the mating part. All strands shall be enclosed by the conductor crimp. There shall be no damaged wire strands.

For other types of cable terminations, no visible damage is allowed.

During visual examination of the connectors, for all test sample groups, special care shall be taken to ensure, as a minimum requirement, that no cracking, discoloration, deformation or – where applicable – ingress of water is in evidence.

7.5 Durability of marking

The test of the durability of marking shall be done as a wet test according to test Xb (abrasion of marking) of EN 60068-2-70:1996. For the test piston, size 1 shall be used and the test liquid shall be water. A force of 5 N shall be applied for duration of 10 cycles.

After the test, the marking shall still be readable.

7.6 Interlock

Connectors with interlock shall be tested according to EN 61984:2001, 7.3.4.

7.7 Protection against electric shock

For unenclosed connectors, with the exception of classification IP00, protection against electric shock shall be tested with the relevant test probe as claimed by the manufacturer, but without taking into consideration clearances and creepage distances.

Enclosed connectors shall be tested with the IEC test finger taking into consideration clearances and creepage distances between live parts and the test finger.

This does not apply to the contact openings (lead-in) in the mating face, where clearance and creepage distances through the openings are disregarded.

If the manufacturer claims an IP code higher than IP20, the relevant tests shall be carried out according to EN 60529:1991.

7.8 Temperature rise

The test shall be done as specified in EN 60512-5-1:2002, test 5a, under the following test conditions.

The test shall be carried out using cable-to-cable mated connectors and connectors on apparatus using simulated or actual part(s), with the maximum cable cross-sectional area allowed by the contact system.

The test samples shall be attached to cables of (250 ± 25) mm length for cable cross-sectional area ≤ 10 mm² and of (500 ± 50) mm length for cables with cross-sectional area > 10 mm².

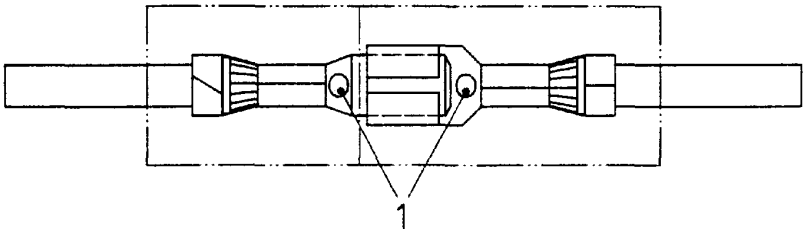
NOTE The length of each piece of wire connecting two contacts shall be therefore twice the length indicated above, i.e. (500 ± 50) mm for wire size ≤ 10 mm² and $(1\,000 \pm 100)$ mm for wire size > 10 mm².

Care shall be taken to protect the test samples from draughts and artificial cooling (e.g. caused by a thermocouple).

The contact(s) to be measured shall be those that reach the highest stabilised temperature. Figure 4 shows the typical area of measurements for crimped connections.

The test shall be carried out with a current selected from the current-carrying capacity curve depending on the test temperature.

The temperature of the contacts and the ambient temperature shall be measured and recorded after thermal equilibrium has been established.



Key

1 Typical area of measurements

Figure 4 — Test sample for temperature rise test

NOTE The temperature rise should not be used as a guide to assess the capability of the connector to operate at elevated ambient temperatures.

7.9 Mechanical operation

The object of this test is to assess the mechanical operational endurance of a connector in the normal operational mode without electrical load. The test shall be carried out according to test 9a of IEC 60512-5:1992, under the following conditions, unless otherwise specified.

Test conditions:

The specimens shall be engaged and disengaged by means of a device simulating normal operating conditions. The preparation and mounting of the specimen shall be as in normal use.

The type and cross-sectional area of the cable/wire bundle to be used shall be specified by the manufacturer.

The number of operating cycles shall be specified by the manufacturer. Preferred values are indicated in Table 2.

The speed of insertion and withdrawal shall be approximately 0,01 m/s with a rest in the unmated position of approximately 30 s.

7.10 Vibration and shock

Vibration and shock tests shall be carried out according to the relevant method of EN 61373:1999.

According to EN 61373:1999, Clause 5, a possible order of testing may be

- vertical, transverse and longitudinal simulated long life tests by increased random vibration,
- vertical, transverse and longitudinal shock tests,
- vertical transverse and longitudinal functional random tests.

The test sequence may be altered to minimise re-jigging. Performance tests shall be undertaken before and after simulated long life testing, while they shall be done during functional random tests.

Performance tests for connectors may be:

- micro-interruption of contact ≤ 1 µs (during functional test),
- dielectric withstand test (after functional test),
- visual examination (after functional test).

7.11 Measurement of clearances and creepage distances

Clearances and creepage distances shall be measured according to EN 50124-1:2001 with the following additional requirements.

Clearances and creepage distances to the accessible surface shall be measured only in the mated position.

The surface of an unenclosed connector to be incorporated into an equipment or a device shall not be regarded as accessible, unless otherwise claimed by the manufacturer.

7.12 Dielectric strength

If the manufacturer specifies a value for the rated impulse voltage, test a) shall be used, otherwise test b) shall be used.

a) Impulse withstand test

The impulse withstand test shall be carried out with a voltage having a 1,2/50 µs waveform according to HD 588.1 S1:1991 with three impulses of each polarity and an interval of at least 1 s between pulses. The output impedance of the impulse generator should not be higher than 500 Ω. The test voltage shall be taken from Table 14.

b) Voltage proof (EN 60512-4-1:2003, test 4a)

The voltage proof test shall be performed by applying a r.m.s. withstand voltage with value as specified in Table 14 according to EN 60512-4-1:2003, test 4a. The test duration shall be 1 min.

Table 14 — Test voltages

Rated impulse voltage	Test voltages		
	Impulse withstand voltage [a]		r.m.s. withstand voltage
	At 2 000 m	At sea level	
kV	kV (1,2/50 µs)	kV (1,2/50 µs)	kV (50/60 Hz)
0,5	0,5	0,55	0,37
0,8	0,8	0,91	0,50
1,5	1,5	1,75	0,84
2,5	2,5	2,95	1,39
4	4	4,8	2,21
6	6	7,3	3,31
8	8	9,8	4,26
12	12	14,8	6,6

[a] See EN 50124-1:2001, Table A.1 for information. If the test laboratory is located between sea level and an altitude of 2 000 m above sea level, interpolation of the impulse withstand voltage is allowed.

7.13 Resistance between accessible metal parts and the protective earthing contact

For connectors with protective earthing contact, EN 61984:2001, 7.3.12 shall apply.

7.14 Corrosion test

For testing the protection of contacts against the influence of a corrosive atmosphere, one of the two alternative tests shall be selected. In all cases the specimens shall be mated.

Test 1: Flowing mixed gas corrosion according to EN 60512-11-7:2003, test 11g, with a choice of method 1 or method 4 (see EN 60512-11-7:2003, Table 1).

Test duration shall be in accordance with Table B.1.

Test 2: Salt mist test, with continuous spraying, according to EN 60512-11-6:2002, test 11f.

Test duration shall be in accordance with Table B.1.

Tests shall be selected upon agreement between manufacturer and user.

For connectors for outdoor non weather-protected applications the test duration shall be in accordance with Table B.1.

7.15 Ozone resistance (ISO 1431-1)

Compliance shall be checked according to 7.3, Table 13.

7.16 Resistance to UV (EN ISO 4892-2:2006)

Compliance shall be checked according to 7.3, Table 13.

7.17 Resistance to fluids (EN 60512-19-3:1997)

Compliance shall be checked according to 7.2, Table 11 (EN 60512-19-3:1997, test 19c).

Annex A
(informative)

Additional characteristics to be agreed by the manufacturer and the user

A.1 Additional information to be provided upon request of the user

A.1.1 General

The manufacturer and the user shall select the appropriate characteristics related to the application of the connector: specific attention should be given to the following.

A.1.2 Geometrical characteristics

Overall dimensions

Contact layout

Range of conductors that can be terminated

Maximum outer diameter of the cable core

Mounting information (panel cut-outs, access area)

Accessories cable range

Type of contact

A.1.3 Electrical characteristics

Rated current of the connector

Rated current of each type of contacts

Derating curves according to EN 60512-5-2

Rated voltage

Creepage distances

Clearance (in mated conditions)

Rated impulse voltage

Dielectric withstand voltage

Insulation resistance

Contact resistance

Screening effectiveness according to EN 60512-23-3:2001

Effective transfer impedance according to EN 60512-23-7

A.1.4 Environmental characteristics

Climatic category

IP degree of protection according to EN 60529:1991 (if applicable)

Fire behaviour classification according to CLC/TS 45545 series

Resistance to corrosion (salt mist) according to EN 60512-11-6:2002

Resistance to chemically active substances and to contaminating fluids according to EN 60512-19-3:1997

Resistance to ozone according to ISO 1431-1

Resistance to UV according to EN ISO 4892-2:2006

A.1.5 Mechanical characteristics

Severity of vibrations to be withstood according to EN 61373:1999

Severity of shocks according to EN 61373:1999

Engaging and separating forces according to EN 60512-13-1

Contact retention in insert according to IEC 60512-8:1993, test 15a (when applicable)

Insert retention in housing according to IEC 60512-8:1993, test 15b (axial) and 15c (torsional) (when applicable)

Coding and keying

Number of mating cycles

Scoop proof according to EN 60512-1-4 (if applicable)

Termination and connection methods

A.2 Information for testing additional to that mentioned above

Insulating material group (CTI value)

Nature of supply voltage a.c. or d.c.

Relevant detail specification, if available

Annex B
(normative)

Severity of the service conditions in different rolling stock locations

Table B.1 — Minimum severity of service conditions in different rolling stock locations

		Location of the connector on board rolling stock [a]						
Definition	**Standard**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Over voltage category	EN 50124-1:2001	OV2	OV2	OV2	OV2	OV2	OV2	OV2
Pollution degree	EN 50124-1:2001	PD2	PD2	PD3	PD3	PD3	PD3	PD3
IP degree of protection	EN 60529:1991	[b]	IP2X [b]	IP65	IP65	IP66	IP66	IP66
Vibration and shock	EN 61373:1999	Category 1B	Category 1B	Category 1B	Category 1B	Category 1B	Category 2	Category 3
Corrosion – mixed gas [c]	EN 60512-11-7:2003	Method 1 or 4 – 4 days	Method 1 or 4 – 4 days	Method 1 or 4 – 4 days	Method 1 or 4 – 4 days	Method 1 or 4 – 4 days	Method 1 or 4 – 4 days	Method 1 or 4 – 4 days
or Corrosion – salt mist [c]	EN 60512-11-6:2002	96 h	96 h	96 h	240 h	240 h	240 h	240 h
Ozone resistance [d]	ISO 1431-1:2004	NO [f]	NO	YES [d]	YES [d]	YES [d]	YES [d]	YES [d]
Fire, smoke and toxicity compliance		YES [e]	YES [e]	YES [e]	YES [e]	YES [e]	YES [e]	YES [e]

[a] Typical connector location on board rolling stock according to Figure 3.

[b] The relevant requirements of EN 50153 apply.

[c] See 7.14 for the choice of the test.

[d] Only for exposed rubber and plastic parts sealing, housing boots used outside.

[e] National standards shall apply until a European Standard is in place.

[f] Yes in case of power switching (see Table 1).

Annex C
(informative)

Severity of the service conditions in different rolling stock locations

NOTE Table C.1 describes the macro environmental conditions of rolling stock and not necessarily the connector requirements.

Table C.1 – Minimum severity of service conditions in different rolling stock locations

		Location of the connector on board rolling stock [a]						
Definition	**Standard**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
UV resistance	EN ISO 4892-2:2006	NO	NO	NO	YES [b]	YES [b]	YES [b]	YES [b]
Fluid resistance	EN 60512-19-3:1997	NO	NO	YES [c]	YES [c]	YES [c]	YES [c]	YES [c]

[a] Typical connector location on board rolling stock according to Figure 3.

[b] Only for exposed rubber and plastic parts.

[c] Fluids to be used could be those listed in EN 50306 series (IRM 902 Oil, Oxalic acid, Sodium hydroxide). Requirements to be agreed between manufacturer and user due to different environmental conditions and chemically active substances (e.g. detergents) or contaminating fluids (e.g. sulphur content of diesel fuel) used by the various railway operators in different countries.

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EN 50121 (series)	Railway applications - Electromagnetic compatibility
EN 50125-1:1999	Railway applications - Environmental conditions for equipment - Part 1: Equipment on board rolling stock
EN 50155:2007	Railway applications - Electronic equipment used on rolling stock
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EN 50343:2003	Railway applications - Rolling stock - Rules for installation of cabling
IEC 60050-811	International Electrotechnical Vocabulary (IEV) – Chapter 811: Electric traction
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EN 60068-2-78:2001	Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state (IEC 60068-2-78:2001)
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EN 60512-11-3:2002	Connectors for electronic equipment - Tests and measurements - Part 11-3: Climatic tests - Test 11c: Damp heat, steady state (IEC 60512-11-3:2002)
EN 60512-11-4:2002	Connectors for electronic equipment - Tests and measurements - Part 11-4: Climatic tests - Test 11d: Rapid change of temperature (IEC 60512-11-4:2002)
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EN 60512-11-10:2002	Connectors for electronic equipment - Tests and measurements - Part 11-10: Climatic tests - Test 11j: Cold (IEC 60512-11-10:2002)
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IEC 60512-9:1992	Electromechanical components for electronic equipment; basic testing procedures and measuring methods – Part 9: Miscellaneous tests

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