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INTERNATIONAL STANDARD

Compression and mechanical connectors for power cables – Part 1-1: Test methods and requirements for compression and mechanical connectors for power cables for rated voltages up to 1 kV (U_m = 1,2 kV) tested on non-insulated conductors

IEC 61238-1-1:2018-05(en)

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FOREWORD

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International Standard IEC 61238-1-1 has been prepared by IEC technical committee 20: Electric cables.

This first edition, together with IEC 61238-1-2 and IEC 61238-1-3, cancels and replaces IEC 61238-1:2003.

This edition includes the following significant technical changes with respect to IEC 61238-1:2003:

a) The scope has been widened to cover connectors for copper conductors from 10 mm^2 down to 2,5 mm^2 and has been limited to 1 200 mm^2 for connectors for copper and aluminium conductors because test experience and applications are rare for conductors of larger cross-sectional areas.

b) Two new mechanical classes have been introduced to satisfy the demand for connectors subjected to no mechanical force and for connectors subjected to higher mechanical forces than those specified in Class 1 for conductors of larger cross-sectional areas.

c) For the electrical test, a maximum elevated heating current has been set in order to avoid unrealistic current densities during testing which may change properties of tested connectors.

d) For the short-circuit test, the method of calculation and requirements have been updated.

e) For the mechanical test, the methods and requirements have been updated.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
20/1788/FDIS	20/1803/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61238 series, published under the general title *Compression and mechanical connectors for power cables*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

The IEC 61238 series has been divided into the following parts:

Part 1-1: Test methods and requirements for compression and mechanical connectors for power cables for rated voltages up to 1 kV (U_m = 1,2 kV) tested on non-insulated conductors

Part 1-2: Test methods and requirements for insulation piercing connectors for power cables for rated voltages up to 1 kV (U_m = 1,2 kV) tested on insulated conductors

Part 1-3: Test methods and requirements for compression and mechanical connectors for power cables for rated voltages above 1 kV (U_m = 1,2 kV) up to 30 kV (U_m = 36 kV) tested on non-insulated conductors

This Part 1-1 of IEC 61238 deals with type tests for compression and mechanical connectors for use on copper or aluminium conductors of power cables for rated voltages up to 1 kV (U_m = 1,2 kV).

When a design of connector meets the requirements of this document, then it is expected that in service:

a) the resistance of the connection will remain stable within specified limits;

b) the temperature of the connector will be of the same order or less than that of the conductor during current heating;

c) if the intended use demands it, application of short-circuit currents will not affect a) and b);

d) independently from the electrical performance, conforming axial tensile strength will ensure an acceptable mechanical performance for the connections to the cable conductors, when applicable.

It should be stressed that, although the object of the electrical and mechanical tests specified in this document is to prove the suitability of connectors for most operating conditions, they do not necessarily apply to situations where a connector may be raised to a high temperature by virtue of connection to a highly rated plant, to corrosive conditions, or where the connector is subjected to external mechanical stresses such as excessive vibration, shock and large displacement after installation. In these instances, the tests in this document may need to be supplemented by special tests agreed between supplier and purchaser.

This document does not invalidate existing approvals of products achieved on the basis of national standards and specifications and/or the demonstration of satisfactory service performance. However, products approved according to such national standards or specifications cannot directly claim approval to this document.

Once successfully completed, these tests are not repeated unless changes are made in material, manufacturing process and design which might adversely change the connector performance characteristics.

COMPRESSION AND MECHANICAL CONNECTORS FOR POWER CABLES –

Part 1-1: Test methods and requirements for compression and mechanical connectors for power cables for rated voltages up to 1 kV (U_m = 1,2 kV) tested on non-insulated conductors

1 Scope

This part of IEC 61238 applies to compression and mechanical connectors for power cables for rated voltages up to 1 kV (U_m = 1,2 kV), for example buried cables or cables installed in buildings, having

a) conductors complying with IEC 60228 having nominal cross-sectional areas between 2,5 mm^2 and 1 200 mm^2 for copper and between 16 mm^2 and 1 200 mm^2 for aluminium;

b) a maximum continuous conductor temperature not exceeding 90 °C.

This document is not applicable to connectors for overhead line conductors nor to connectors with a sliding contact.

The object of this document is to define the type test methods and requirements which apply to compression and mechanical connectors for power cables with copper or aluminium conductors. The reference method is to perform the tests on unused conductors.

2 Normative references

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

IEC 60050-461, *International Electrotechnical Vocabulary – Part 461: Electric cables* (available at http://www.electropedia.org)

IEC 60228, *Conductors of insulated cables*

IEC 60493-1, *Guide for the statistical analysis of ageing test data – Part 1: Methods based on mean values of normally distributed test results*

IEC 60949:1988, *Calculation of thermally permissible short-circuit currents, taking into account non-adiabatic heating effects*
IEC 60949:1988/AMD1:2008

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-461 and the following apply.

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

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

3.1
connector
<of cables> device for connecting a conductor to an equipment terminal or for connecting two or more conductors to each other

[SOURCE: IEC 60050-461:2008, 461-17-03, modified – the definition has been revised.]

3.2
through connector
device for connecting two consecutive lengths of conductor together

[SOURCE: IEC 60050-461:2008, 461-17-04, modified – the term "joint ferrule" has been deleted and the definition revised.]

3.3
branch connector
device for connecting a branch conductor to a main conductor at an intermediate point on the latter

[SOURCE: IEC 60050-461:2008, 461-17-05, modified – the term "branch ferrule" has been deleted and in the definition "metallic" has been deleted.]

3.4
termination
device fitted to the end of a cable conductor to ensure electrical connection with other parts of the system

[SOURCE: IEC 60050-461:2008, 461-10-01, modified – "conductor" has been added and "and to maintain the insulation up to the point of connection" has been deleted.]

3.5
terminal lug
device to connect a cable conductor to other electrical equipment

[SOURCE: IEC 60050-461:2008, 461-17-01, modified – "metallic" has been deleted.]

3.6
palm
<of terminal lug> part of a terminal lug used to make the connection to electrical equipment

[SOURCE: IEC 60050-461:2008, 461-17-07]

3.7
barrel
<of terminal lug, of connector, etc.> part of a device into which the conductor to be connected is introduced

[SOURCE: IEC 60050-461:2008, 461-17-06]

3.8
reference conductor
length of unjointed bare conductor or conductor with the insulation removed, which is included in the test loop and which enables the reference temperature and reference resistance to be determined

3.9
equalizer
arrangement used in the test loop to ensure a point of equipotential and uniform current distribution in a stranded conductor

3.10
compression jointing
method of securing a connector to a conductor by using a special tool to produce permanent deformation of the connector and the conductor

3.11
mechanical jointing
method of securing a connector to a conductor, for example by means of a bolt or screw acting on the latter or by alternative methods

3.12
median connector
connector which during the first heat cycle records the third highest temperature of the six connectors in the test loop

3.13
conductor
<of a cable> part of a cable which has the specific function of carrying current

[SOURCE: IEC 60050-461:2008, 461-01-01]

3.14
family of connectors
group of connectors of a manufacturer to be considered of the same design criteria, the same material characteristic and the same installation procedure

4 Symbols

A	nominal cross-sectional area of the conductor
D	change in the resistance factor of the connector
I	direct current flowing through a connection during resistance measurement
I_{RMS}	equivalent RMS short-circuit current
I_N	alternating current necessary to maintain the reference conductor at its equilibrium temperature
I_r	direct current flowing through the reference conductor/conductors during resistance measurement
k	connector resistance factor: ratio of the resistance of a connector to that of the resistance of the equivalent length of the reference conductor
k_0	initial connector resistance factor: ratio of the resistance of a connector to that of the resistance of the equivalent length of the reference conductor at cycle no. 0
l_a, l_b, l_j	lengths of each connector assembly associated with the measurement positions in the test setup after installation
l_r	length of the reference conductor between measurement positions
R	measured resistance value of connector/conductor installation under an electrical test corrected to 20 °C
R_r	measured resistance value of the reference conductor corrected to 20 °C
R_j	length related calculated resistance value of a connector under an electrical test corrected to 20 °C

t_1 heating time

t_2 time necessary for the connectors and the reference conductor to cool to a value equal to or less than 35 °C

U potential difference between measurement positions while current I is applied

U_r potential difference between measurement positions on a reference conductor while current I_r is applied

α temperature coefficient of resistance at 20 °C

β mean scatter of the connector resistance factors

δ initial scatter of the connector resistance factors

λ resistance factor ratio: the actual resistance factor of the connector at each measurement stage divided by its initial resistance factor

θ temperature of a connector

θ_{max} maximum temperature recorded on a connector over the total period of test during heat cycling

θ_R temperature of the reference conductor determined in the first heat cycle

θ_{ref} temperature of the related reference conductor at the moment of measuring θ_{max}

5 General

5.1 Definition of classes

Although it is not possible to define precisely the service conditions for all applications, the following requirements have been identified.

a) Electrical requirements:

Class A

These are connectors intended for electricity distribution or industrial networks in which they can be subjected to short-circuits of relatively high intensity and duration. As a consequence, Class A connectors are suitable for the majority of applications.

Class B

These are connectors for networks in which overloads or short-circuits are rapidly cleared by the installed protective devices, for example fast-acting fuses.

b) Mechanical requirements:

Class 0

Connectors subjected to practically no mechanical pull-out force. These are for example, connectors inside switchgear where the cable or conductors are secured or anchored.

Class 1

Connectors subjected to a mechanical pull-out force related to the conductor nominal cross-sectional area and material (according to Table 4) but limited to a 20 kN pull-out force. These are for example connectors for underground cable joints.

Class 2

Connectors subjected to a mechanical pull-out force above 20 kN and related to the conductor nominal cross-sectional area and material (according to Table 4). This Class 2 is only applicable to conductor nominal cross-sectional areas ≥ 400 mm^2 for copper and ≥ 630 mm^2 for aluminium. These are for example connectors in cable installations where thermomechanical forces are estimated to exceed 20 kN.

Hence, the five classes correspond to the following tests: