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IEC 1238-1:1993

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Australian/New Zealand Standard[®]

**Compression and mechanical
connectors for power cables with
copper or aluminium conductors**

**Part 1: Test methods and
requirements**

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RECONFIRMATION

OF

AS/NZS 4325.1:1995

**Compression and mechanical connectors for power cables with copper or
aluminium conductors**

Part 1: Test methods and requirements

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Technical Committee EL-004 has reviewed the content of this publication and in accordance with Standards Australia procedures for reconfirmation, it has been determined that the publication is still valid and does not require change.

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NOTES

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**Part 1: Test methods and
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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL/4 on Electrical Accessories, as a Joint Standard. It was prepared to align Australian and New Zealand Standards progressively with International Electrotechnical Commission (IEC) Standards for electrical accessories.

The object of the Standard is to provide test methods and requirements for two classes of connectors for power cables. Class A connectors for electricity distribution or industrial networks and Class B connectors for networks in which overloads or short circuits are restricted by protective devices.

This Standard is equivalent in technical content but not in full presentation to IEC 1238-1:1993, *Compression and mechanical connectors for power cables with copper or aluminium conductors*, Part 1: *Test methods and requirements*.

A number of variations have been made in this Standard to the requirements of IEC 1238-1:1993. These variations are necessary to take into account the national requirements for compression and mechanical connectors that apply in both Australia and New Zealand. The variations are contained in Appendix ZZ. Clauses, notes and figures subject to variation are indicated by a marginal bar.

The numbering of clauses, notes and figures closely follows those of IEC 1238-1:1993. To allow additional material to be introduced by Australia or New Zealand, the numbers 201 to 300 are used. This scheme has been introduced to reduce the likelihood of the IEC and Standards Australia or Standards New Zealand using the same numbers for different requirements.

As this Standard is reproduced from an International Standard, the following applies:

- (a) Its number does not appear on each page of text and its identity is shown only on the cover and title page.
- (b) In the source text, ‘this International Standard’ should read ‘this Australian/New Zealand Standard’.
- (c) A full point substitutes for a comma when referring to a decimal marker.

References to International Standards should be replaced by equivalent Australian or Australian/New Zealand Standards as follows:

<i>Reference to International Standard</i>		<i>Australian Standard</i>	
IEC		AS	
27	Letter symbols to be used in electrical technology	1046	Letter symbols for use in electrotechnology
27-1	Part 1: General	1046.1	Part 1: General
228	Conductors of insulated cables	1125	Conductors in insulated electric cables and flexible cords
228A	First supplement. Guide to the dimensional limits of circular conductors	—	
724	Guide to the short-circuit temperature limits of electric cables with a rated voltage not exceeding 0.6/1.0 kV	3008	Electrical installations—Selection of cables
		3008.1	Cables for alternating voltages up to and including 0.6/1 kV

The term ‘normative’ has been used in this Standard to define the application of the appendix to which it applies. A ‘normative’ appendix is an integral part of a Standard.

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INTRODUCTION

This International Standard deals with type tests for compression and mechanical connectors for use on copper and aluminium conductors of insulated cables. When a design of connector meets the requirements of this standard, then it is expected that in service:

- a) the resistance of the connection will remain stable;
- b) the temperature of the connector will be of the same order or less than that of the conductor;
- c) if the intended use demands it, application of short-circuit currents will not affect a), b) and d);
- d) the mechanical strength will be fit for the purpose.

It should be stressed that, although the electrical and mechanical tests specified in this standard are 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 highly rated plant, or where the connector is subjected to excessive mechanical vibration or shock or to corrosive conditions. In these instances, the tests in this standard may need to be supplemented by special tests agreed between supplier and purchaser.

AUSTRALIAN/NEW ZEALAND STANDARD

COMPRESSION AND MECHANICAL CONNECTORS FOR POWER CABLES WITH COPPER OR ALUMINIUM CONDUCTORS

Part 1: Test methods and requirements

1 Scope and object

This part of IEC 1238 applies to connectors for power cables, e.g. buried cables or cables in buildings.

- a) These cables conform to the requirements of IEC 228 and IEC 228A with conductor cross-sections 10 mm² and greater for copper and 16 mm² and greater for aluminium.
- b) The electrical test covers the current-carrying capacity of connectors for application at any voltage.
- c) The maximum continuous conductor temperature is less than or equal to 90 °C.

This standard is not applicable to overhead conductors, which are designed for special mechanical requirements, or to separable connectors.

Although it is not possible to define precisely the service conditions for all applications, two broad classes of connectors have been identified.

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 will be suitable for the majority of applications.

Class B

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

Depending on the application, the connectors are subjected to the following tests:

Class A The connectors are subjected to heat cycles and short-circuit tests.

Class B The connectors are subjected to heat cycles only.

The object of this standard is to define the type test methods and requirements which apply to compression and mechanical connectors for power cables with copper or aluminium conductors.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 1238. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 1238 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 27-1:1992, *Letter symbols to be used in electrical technology — Part 1: General*

IEC 228:1978, *Conductors of insulated cables*

IEC 228A:1982, *Conductors of insulated cables — First supplement: Guide to the dimensional limits of circular conductors*

IEC 724:1984, *Guide to the short-circuit temperature limits of electric cables with a rated voltage not exceeding 0,6/1,0 kV*

3 Definitions

For the purpose of this International Standard, the following definitions apply.

- 3.1 **connector**: Device for connecting a conductor to an equipment terminal or for connecting two or more conductors to each other.
- 3.2 **through connector**: Connector for connecting two consecutive lengths of conductor.
- 3.3 **branch connector**: Connector for connecting a branch conductor to a main conductor.
- 3.4 **terminal lug**: Connector comprising a palm and a connector barrel, for connecting a conductor to an equipment terminal.
- 3.5 **palm**: Part of a terminal lug used to make the connection to equipment terminals.
- 3.6 **connector barrel**: Part of a connector, into which the conductor to be connected is introduced.
- 3.7 **joint**: Assembly comprising the connector barrel and that portion of the conductor which has been brought into intimate contact with it during the jointing process.
- 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 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.

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

4 List of principal symbols

I	is the direct measuring current flowing through a connection during resistance measurement
U	is the potential difference between measurement points when current I is flowing
I_r	is the direct measuring current flowing through the reference conductor/conductors during resistance measurement
U_r	is the potential difference between measuring points on a reference conductor when current I_r is flowing
Θ	is the temperature of a connector
$\Theta_{\max}$	is the maximum temperature recorded on a connector over the total period of test
Θ_R	is the temperature of the reference conductor determined in the first heat cycle
Θ_{ref}	is the temperature of the reference conductor at the moment of measuring $\Theta_{\max}$
I_N	is the a.c. current necessary to maintain the reference conductor at its specified temperature
t_1	is the heating time
t_2	is the time necessary for the connectors and the reference conductor to cool to a value equal to or below 35 °C
I_{rms}	is the equivalent r.m.s. short-circuit current
l_a, l_b, l_j	are the lengths of the connector assembly associated with the measurement points after jointing
l_r	is the length of the reference conductor between measurement points
A	is the nominal cross-sectional area of the conductor
α	is the temperature coefficient of resistance at 20 °C
k	is the ratio of the resistance of a connector to that of the resistance of the equivalent length of the reference conductor.

NOTE – Where possible the letter symbols used are in accordance with IEC 27-1.

5 General

5.1 Conductor

The following information shall be recorded in the test report:

- Conductor material.
- Nominal cross-sectional area, leading dimensions and shape. It is recommended that the actual conductor area should also be given.
- Type of conductor, i.e. solid or stranded; in the case of stranded conductors details of conductor constructions shall be given, e.g.:
 - compacted;
 - non-compacted;
 - flexible;
 - number of wires;
 - direction of lay;
 - plating;
 - type of impregnation, if any;
 - approximate indication of hardness, e.g. annealed, half-hard, hard;
 - type of insulation in case of insulation-piercing connectors.

5.2 Connectors and tooling

The following information shall be recorded in the test report:

- the assembly technique that is to be used;
- tooling and necessary setting;
- preparation of contact surfaces;
- type, reference number and any other identification of the connector.

5.3 Range of acceptance

In general, tests made on one type of connector/conductor combination apply to that arrangement only. However, to limit the number of tests the following is permitted:

- A connector which covers a range of cross-sections shall be accepted, if satisfactory results are obtained on the smallest and largest sections (see note below).
- A connector which can be used on round conductors or sector-shaped conductors that are to be rounded, is accepted for both types if satisfactory results are obtained on any one type of conductor.
- If a connector is a through connector for two conductors of different sectional areas, shapes, or materials, and if the technique and the connector barrels used have already been tested separately for each cross-section, no additional test is necessary. If not, then additional tests shall be made using the smaller of the two conductors for the control.

NOTE – In case of connectors of which one or both sides are designed for a range of cross-sections, and a common clamping or crimping arrangement serves for the connection of the different cross-sections, then a mechanical test on all area combinations is carried out according to clause 7.

6 Electrical tests

6.1 Installation

For each series of tests, six connectors shall be fitted in accordance with the manufacturer's instructions, on bare conductor or conductor that has had the insulation removed before assembly, to form a test loop together with the corresponding reference conductor.

For stranded conductors, potential between the strands at measuring points can cause errors in measuring electrical resistance. Welded equalizers can be used to overcome this problem and to ensure uniform current distribution in the reference conductor.

Welded equalizers is the reference method to ensure reliable measurements (annex A).

NOTE – If the connector is intended for use on a conductor of a paper-insulated cable it should be tested on a conductor from such a cable.

In the case of insulation-piercing connectors, the insulation shall be retained on the conductor under the connector, and for a distance of at least 100 mm outside the connector.

The test loop shall be installed in a location where the air is calm. The ambient temperature of the test location shall be between 15 °C and 30 °C.

To permit the short-circuit tests (class A connectors only) to be made easily, the loop can be made dismantlable. In this case, the technology of the sectioning joints shall be such that they do not influence the measurements, particularly from the point of view of temperature. Retightening of bolts or screws of the connectors under test is not permitted.

6.1.1 Through connectors and terminal lugs

The test loop is shown in figure 1, which indicates the dimensions that shall be used.

Where terminal lugs are to be tested, the palms shall be bolted to linking bars in accordance with the manufacturer's instructions. These linking bars shall, at the point of connection, be of the same dimensions and thickness as the palm, and also of the same material.

It may be necessary to adjust the section of the linking bar remote from the point of connection, to achieve the temperatures specified in 6.3. As an alternative to linking bars, test can be made on terminal lugs with palm connected direct to palm. In case of disagreement, the method with linking bars shall be used.

If however it is requested that the terminal lug test includes an evaluation of the performance of the bolted palm when connected to terminal plant, then linking bar ends shall be used of a material, size and surface coating agreed between the parties.