IEC 61515

Edition 2.0 2016-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Mineral insulated metal-sheathed thermocouple cables and thermocouples

Câbles et couples thermoélectriques à isolation minérale dits "chemisés"

IEC 61515:2016-04(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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MINERAL INSULATED METAL-SHEATHED THERMOCOUPLE CABLES AND THERMOCOUPLES

FOREWORD

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International Standard IEC 61515 has been prepared by subcommittee 65B: Measurement and control devices, of IEC technical committee 65: Industrial-process measurement, control and automation.

This second edition cancels and replaces the first edition published in 1995. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) Duplex and triplex are standardized.
b) Specification of insulation resistance is revised so that the user can choose the best product to fit for the purpose.
c) "Table 2 Recommended maximum operating temperatures" in the previous version is expanded significantly including newly developed sheath material and it is moved to Annex C.
d) Test items and their methods are expanded and a guide table (Table 4) is added for userfriendliness.

The text of this standard is based on the following documents:

FDIS	Report on voting
65B/1034/FDIS	65B/1038/RVD

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

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

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

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- withdrawn,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

INTRODUCTION

This new edition of IEC 61515 reflects recent developments in production technology, sheath materials and insulation materials. It aims to be a flexible standard allowing suppliers to provide fit-for-purpose products at an acceptable cost.

It includes informative guidance to help users choose the products that meet their needs.

Annex A gives alternative adjacent conductor configurations for duplex and triplex MIMS thermocouple cables and thermocouples.

Annex B gives recommendations to suppliers with respect to insulation composition.

Annex C gives guidelines to users with regard to temperature limits of operation.

MINERAL INSULATED METAL-SHEATHED THERMOCOUPLE CABLES AND THERMOCOUPLES

1 Scope

This International Standard establishes the requirements for simplex, duplex and triplex mineral-insulated metal-sheathed thermocouple cables and thermocouples, which are intended for use in general industrial applications. The abbreviation MIMS (for "mineral-insulated metal-sheathed") will be used hereafter. It covers thermocouple cables and thermocouples with only base-metal conductors of Types T, J, E, K and N. The specifications in this standard apply to new thermocouple cables and thermocouple units as delivered to the user. They do not apply to the product after use.

External seals, terminations, connections and other accessories are not within the scope of this International Standard.

This standard does not apply to precious metal thermocouple cables and thermocouples. The special requirements for nuclear primary loop applications are dealt with in the other standards.

2 Normative references

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

IEC 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60584-1, *Thermocouples: Part 1 – EMF specifications and tolerances*

ISO 1302, *Geometrical Product Specifications (GPS) — Indication of surface texture in technical product documentation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60584-1 and the following apply.

3.1
mineral insulated metal-sheathed thermocouple cable
bendable cable consisting of one or more pairs of thermocouple conductors encapsulated in a metal protecting sheath, insulated from each other and from the sheath by a compacted mineral material

Note 1 to entry: Abbreviation MIMS for "mineral insulated metal-sheathed" is used hereafter.

3.2
MIMS thermocouple
thermocouple manufactured from mineral-insulated metal-sheathed thermocouple cable

Note 1 to entry: This note applies to the French language only.

3.3
simplex thermocouple
thermocouple unit comprising one pair of thermocouple conductors

3.4
duplex thermocouple
thermocouple unit comprising two pairs of thermocouple conductors

3.5
triplex thermocouple
thermocouple unit comprising three pairs of thermocouple conductors

3.6
measuring junction
junction of the thermocouple conductors which is subjected to the temperature to be measured

3.7
grounded junction
bonded junction
earthed junction
measuring junction electrically connected to the metal sheath

3.8
insulated junction
ungrounded junction
measuring junction electrically insulated from the metal sheath

3.9
thermal response time
time a thermocouple takes to respond at a specified percentage to a step change in temperature

Note 1 to entry: The time to register 50 % of the step change, for example, is written $\tau_{0,5}$.

Note 2 to entry: The test medium and its flow conditions shall be specified (usually flowing water or flowing air).

3.10
type test
test conducted on one or more samples of the production to verify that the product is compliant with the requirements of IEC 61515 following the introduction or change of material specification, design or manufacturing process

3.11
routine test
test to which each individual product is subjected during or after manufacture to ascertain whether it complies with the requirements of IEC 61515

3.12
optional test
test that is performed upon agreement between a supplier and a user to ensure compliance with the user's specific application

4 General principles

4.1 A MIMS thermocouple

A MIMS thermocouple specified in this standard shall be made of a MIMS thermocouple cable that complies with this standard.

4.2 Electromotive force

The electromotive force (abbreviated EMF hereafter) versus temperature relationship shall comply with IEC 60584-1. The EMF tolerance, as specified in IEC 60584-1, should be agreed between the supplier and the user.

4.3 Materials and their properties

4.3.1 Sheath

The sheath material shall be of qualified stainless steel or high nickel alloy or other metals selected by agreement between users and suppliers. It shall be chosen to suit user's application in order to protect the thermocouple during use. The general surface finish of the sheath upon delivery shall be equal to, or better than, roughness grade ISO 1302 scale 8 (3,2 μm Ra).

4.3.2 Conductors

Conductors shall be those forming thermocouple types T, J, E, K or N as specified in IEC 60584-1.This standard applies to thermocouple cables and thermocouples that have 1, 2 and 3 pairs of thermocouple conductors.

For duplex and triplex, cables basic adjacent conductor configurations are specified. Alternative configurations are acceptable by the agreement between supplier and user provided that all the other requirements of this standard are met.

Some examples of alternative adjacent conductor configurations are given in Annex A.

4.3.3 Insulation materials

The mineral insulation shall consist of compacted ceramic powder.

The purity of insulating material should be at least 96 % and informative compositions are shown in Annex B.

Specific requirements, concerning the purity of the insulation material, can be customized by agreement between the user and the supplier.

4.4 Maximum operating temperature

Definitive maximum operating temperatures cannot be specified because of the number of influencing factors. Instead Annex C gives indicative temperature limits which are the recommended maximum operating temperatures for the standardized thermocouples and some commonly used sheath materials and diameters. They are to be considered only as guidance for users.

4.5 Dimensions

4.5.1 Transverse section of MIMS thermocouple cables and thermocouples

The outside diameter, conductor diameter and sheath wall thickness shall be as specified in the following 4.5.2 to 4.5.4. Throughout this standard the following symbols are used.

- outside diameter D;
- conductor diameter C;
- sheath wall thickness S;
- insulation thickness I.

The insulation thickness I is not quantified in this standard. It shall be such that the specified requirements for dielectric strength (specified in 5.2.2.3 and 5.3.2.3) and insulation resistance

(specified in 5.2.2.5 and 5.3.2.4) shall be met. (The maximum value of the insulation thickness can be deduced from the specified value of D, S and C). Conductors shall be approximately evenly spaced unless specified otherwise. The following Figures 1, 2 and 3, as well as Figures A.1, A.2, A.3 and A.4 clarify which part the specifications of D, C and S are applied to. Insulation thickness is always given in brackets in those figures because it is not numerically specified.

4.5.2 Transverse section of simplex cable and thermocouple

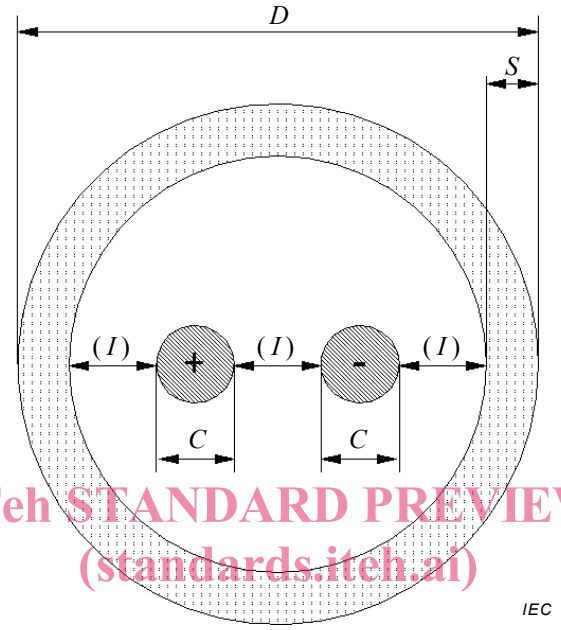

Figure 1 – Transverse section of simplex

Table 1 – Dimensional specifications of simplex

Outside diameter D and its tolerance mm	Minimum sheath wall thickness S mm	Minimum diameter of conductor C mm
0,5 ± 0,025	0,05	0,08
1,0 ± 0,025	0,10	0,15
1,5 ± 0,025	0,15	0,23
2,0 ± 0,025	0,20	0,30
3,0 ± 0,030	0,30	0,45
3,2 ± 0,032	0,32	0,48
4,0 ± 0,040	0,40	0,60
4,5 ± 0,045	0,45	0,68
4,8 ± 0,048	0,48	0,72
6,0 ± 0,060	0,60	0,90
6,4 ± 0,064	0,64	0,96
8,0 ± 0,080	0,80	1,20
9,5 ± 0,095	0,95	1,43
10,8 ± 0,108	1,08	1,62

Sizes not included in Table 1 are acceptable provided that the sheath wall thickness is not less than 10 % of the thermocouple cable diameter (D) and the conductor diameter (C) is not less than 15 % of D. The tolerance on D shall be the greater of 0,025 mm or 0,01·D.

4.5.3 Transverse section of duplex cable and thermocouple

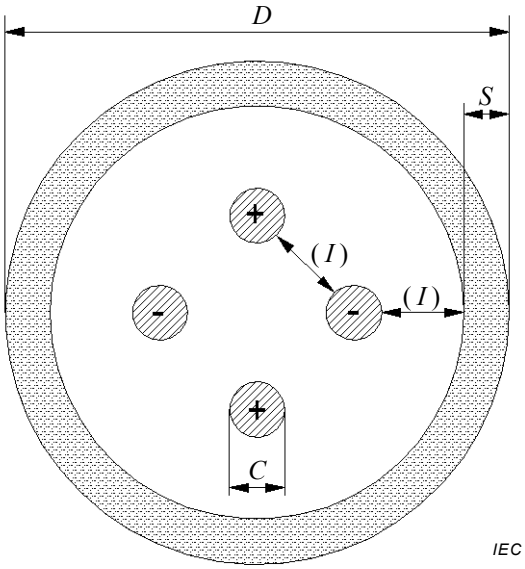

Figure 2 – Transverse section of duplex

Table 2 – Dimensional specifications of duplex

Outside diameter *D* and its tolerance mm	Minimum sheath wall thickness *S* mm	Minimum diameter of conductor *C* mm
1,5 ± 0,025	0,14	0,17
2,0 ± 0,025	0,18	0,22
3,0 ± 0,030	0,27	0,33
3,2 ± 0,032	0,29	0,35
4,0 ± 0,040	0,36	0,44
4,5 ± 0,045	0,41	0,50
4,8 ± 0,048	0,43	0,53
6,0 ± 0,060	0,54	0,66
6,4 ± 0,064	0,58	0,70
8,0 ± 0,080	0,72	0,88
9,5 ± 0,095	0,86	1,05
10,8 ± 0,108	0,97	1,19

Sizes not included in Table 2 are acceptable provided that sheath wall thickness is not less than 9 % of the thermocouple cable diameter (D) and conductor diameter (C) is not less than 11 % of D. The tolerance on D, shall be the greater of 0,025 mm or 0,01·D.

4.5.4 Transverse section of triplex cable and thermocouple

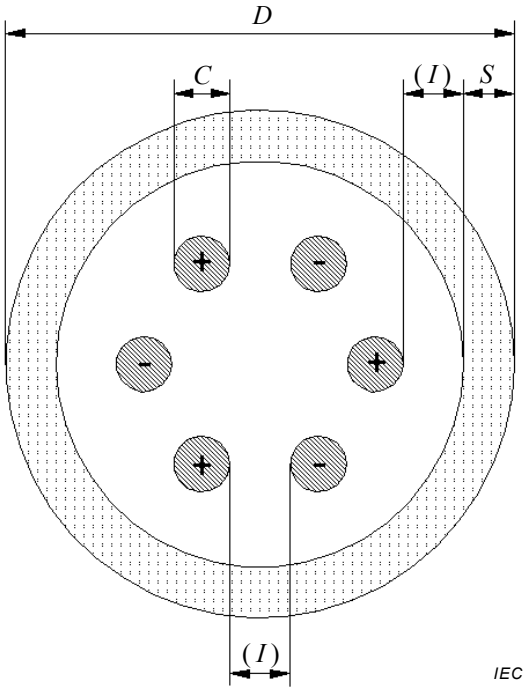

Figure 3 – Transverse section of triplex

Table 3 – Dimensional specifications of triplex

Outside diameter *D* and its tolerance mm	Minimum sheath wall thickness *S* mm	Minimum diameter of conductor *C* mm
3,0 ± 0,030	0,24	0,27
3,2 ± 0,032	0,26	0,29
4,0 ±0,040	0,32	0,36
4,5 ± 0,045	0,36	0,41
4,8 ± 0,048	0,38	0,43
6,0 ± 0,060	0,48	0,54
6,4± 0,064	0,51	0,58
8,0 ± 0,080	0,64	0,72
9,5 ± 0,095	0,76	0,86
10,8 ± 0,108	0,86	0,97

Sizes not included in the Table 3 are acceptable provided that sheath wall thickness is not less than 8 % of the thermocouple cable diameter (D) and conductor diameter (C) is not less than 9 % of D. The tolerance on D shall be $0{,}01 \cdot D$.

5 Requirements and verification tests

5.1 General

Tests are divided into three categories, type tests, routine tests and optional tests. The type tests and the routine tests are mandatory. Therefore suppliers shall keep the record of the test result which shall be provided to users upon request. Optional tests are not required unless they

are requested. Details of the optional tests shall be determined by agreement between the supplier and the user.

Some routine tests can be replaced by sampling tests provided technically established control procedures are in place to demonstrate that the statistical sample testing is sufficient. In this case the supplier shall make documentation of the statistical process available to the user upon request.

Table 4 – Tests for MIMS thermocouple cables and thermocouples

Test item	MIMS cable			MIMS thermocouple		
	Type test	Routine test	Optional test	Type test	Routine test	Optional test
Dimensions	5.2.1.1					
Outside diameter	5.2.1.2	5.2.1.2				
Surface finish	5.2.1.3	5.2.1.3				5.3.1.3
Verification of sheath integrity	5.2.1.4	5.2.1.4				
Sheath ductility	5.2.1.5					
Conductor ductility	5.2.1.6					
Sheath material identification			5.2.1.7			
Electrical continuity	5.2.2.1	5.2.2.1		5.3.2.1	5.3.2.1	
Electrical resistance of conductor	5.2.2.2	5.2.2.2				5.3.2.6
Dielectric strength	5.2.2.3	5.2.2.3		5.3.2.3		
Verification of EMF-temperature relationship	5.2.2.4	5.2.2.4				5.3.2.7
Insulation resistance at ambient temperatures	5.2.2.5	5.2.2.5		5.3.2.4	5.3.2.4	
Insulation resistance at elevated temperatures			5.2.2.6			5.3.2.5
Outside diameter of a thermocouple at the measuring junction				5.3.1.1	5.3.1.1	
Dimensions of longitudinal section of measuring junction of a thermocouple				5.3.1.2		
Weld closure integrity				5.3.1.4		5.3.1.4
Cold seal immersion test (Insulated thermocouples only)				5.3.1.5		
Radiographic inspection						5.3.1.6
Vibration test						5.3.1.7
Drop test						5.3.1.8
Polarity				5.3.2.2	5.3.2.2	
Thermal response time						5.3.2.8

5.2 MIMS thermocouple cables: requirements and verification tests

5.2.1 Structure and mechanical properties

5.2.1.1 Dimensions of transverse section

The outside diameter, sheath thickness, conductor diameter and insulation thickness shall be optically measured at necessary magnification. Dimensions specified in 4.5 shall be met.