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INTERNATIONAL STANDARD

colour inside

Multicore and symmetrical pair/quad cables for digital communications – Part 1-4: Assessment of conductor heating in bundled cables due to the deployment of remote powering

IEC 61156-1-4:2018-10(en)

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MULTICORE AND SYMMETRICAL PAIR/QUAD CABLES FOR DIGITAL COMMUNICATIONS –

Part 1-4: Assessment of conductor heating in bundled cables due to the deployment of remote powering

FOREWORD

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International Standard IEC 61156-1-4 has been prepared by subcommittee 46C: Wires and symmetric cables, of IEC technical committee 46: Cables, wires, waveguides, RF connectors, RF and microwave passive components and accessories.

This first edition cancels and replaces IEC PAS 61156-1-4, published in 2010. This edition constitutes a technical revision.

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

a) Several test arrangements are considered;
b) The mathematical approach was revised

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

CDV	Report on voting
46C/1089/CDV	46C/1098A/RVC

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 61156 series, published under the general title: *Multicore and symmetrical pair/quad cables for digital communications*, 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- withdrawn,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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

The use of remote powering causes a temperature rise in cables installed in bundles.

This document specifies a method to assess the temperature increase in cable bundles by measuring the temperature change using thermocouples placed on the sheath of the cable at the centre of the bundle.

Several test arrangements are considered as well as current values.

MULTICORE AND SYMMETRICAL PAIR/QUAD CABLES FOR DIGITAL COMMUNICATIONS –

Part 1-4: Assessment of conductor heating in bundled cables due to the deployment of remote powering

1 Scope

This document specifies a method to assess the thermal behaviour of cables arranged in bundles, for digital communications. A method is described to determine the temperature increase in cable bundles for certain remote powering currents as a basis to analyse the expected performance under several test arrangements described in standards dealing with the installation of cabling systems (e.g. [1][1], [2]).

It is only intended to provide guidance to assess the thermal behaviour of cables for digital communications in reference environmental conditions and arrangements. It is therefore not intended to become a type of test method.

The following test arrangements are considered:

c) free air;

d) cable tray;

e) conduits;

f) conduit with sealed ends.

Even though this document covers four-pair data grade cables, the same principles can be applied to other cable types.

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 61156-1, *Multicore and symmetrical pair/quad cables for digital communications – Part 1: Generic specification*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61156-1 and the following apply.

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

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1 Numbers in square brackets refer to the Bibliography.

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

3.1.1
current carrying capacity
ampacity
maximum amount of current that a conductor can carry while remaining within the maximum allowable temperature for the cable insulation

3.1.2
PoE
power over Ethernet
technology describing a system to pass electrical power safely, along with data, on Ethernet cabling

3.1.3
PoEP
power over Ethernet Plus
evolution of PoE to allow higher power

3.1.4
remote powering
supply of power to application-specific equipment via balanced cabling

3.1.5
temperature rise
difference in temperature (°C) between the initial temperature of the conductor surface without power and the final temperature at the surface of the powered conductor at steady state

3.2 Symbols

For the purposes of this document, the following symbols are used.

d cable diameter (m)

i_c current per conductor (A)

M number of layers surrounding the centre cable

N number of cables carrying remote powering current

n_c number of conductors per cable carrying remote powering current i_c

R_{amb} average DC resistance per unit length (Ω/m) of conductors carrying remote powering current at ambient temperature

$R(T)$ average DC resistance per unit length (Ω/m) of conductors carrying remote powering current at temperature T

T_{amb} ambient temperature (°C)

T_c temperature at the centre of the bundle (°C)

T_s temperature of the outer surface of the bundle (°C)

ΔT total temperature rise in reference to the ambient temperature

α temperature coefficient of resistance

ρ_{th} specific constant relating to cable construction

ρ_u specific constant relating to environmental conditions

k_{th} global constant relating to cable construction

k_u global constant relating to environmental conditions

4 Testing procedure

4.1 General

In this document the current carrying capacity of conductors refers to the conductor surface temperature.

This temperature is of upmost importance in terms of the suitability of the insulation material at the interface with the conductor in order to avoid overheating and consecutive degradation of the insulation and transmission characteristics. In addition, health and safety issues may arise, such as a melt down and the potential danger of self-ignition.

The test protocol provides test configurations, methods and data submission formats that are necessary to produce effective comparative data.

4.2 Bundling of cables

To determine the maximum permissible heating of the data grade cables, consideration of the worst-case conditions prevailing is required. These conditions occur in tightly bundled cables.

Only cables with the densest hexagonal packing structure (see Figure 1) have a repetitive heat dissipation performance in a well-defined environment.

The densest hexagonal packing structure is characterized by the following number of cables in a bundle:

$$N = \left(1 + \sum_{i=1}^{M} 6 \times i\right) = 3 \times M^2 + 3 \times M + 1 \quad (1)$$

where

N is the total number of cables in the densest hexagonal packing structure $N = 1, 7, 19, 37, 61, 91.....$;

M is the number of layers surrounding the centre cable.

The quantities listed above are used in order to produce cable bundles with complete layers surrounding a centre cable as shown in Figure 1.

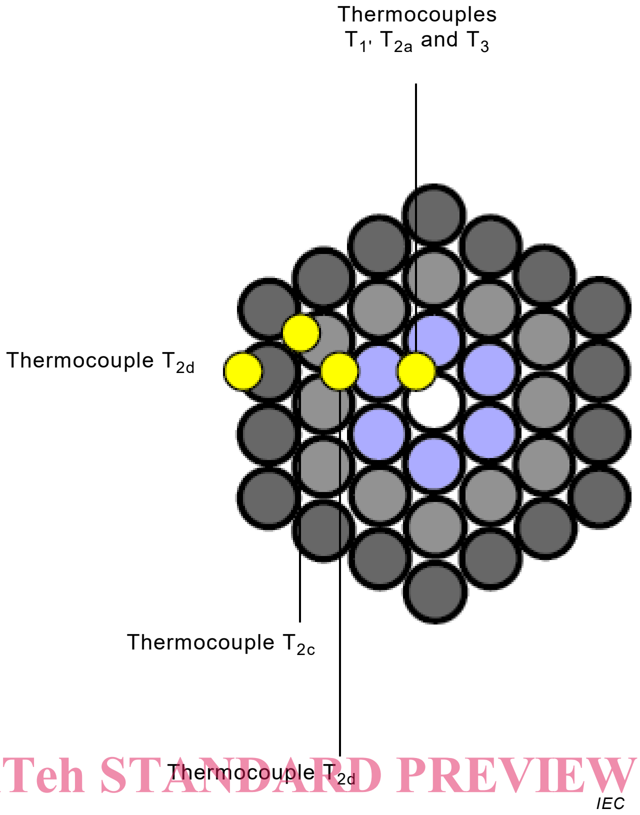

Figure 1 – Bundle of cables under test

NOTE Bundles can be constructed with lower numbers of cables (e.g. 7 or 19) where smaller containment systems are under investigation – but these are considered inappropriate for the needs of this document.

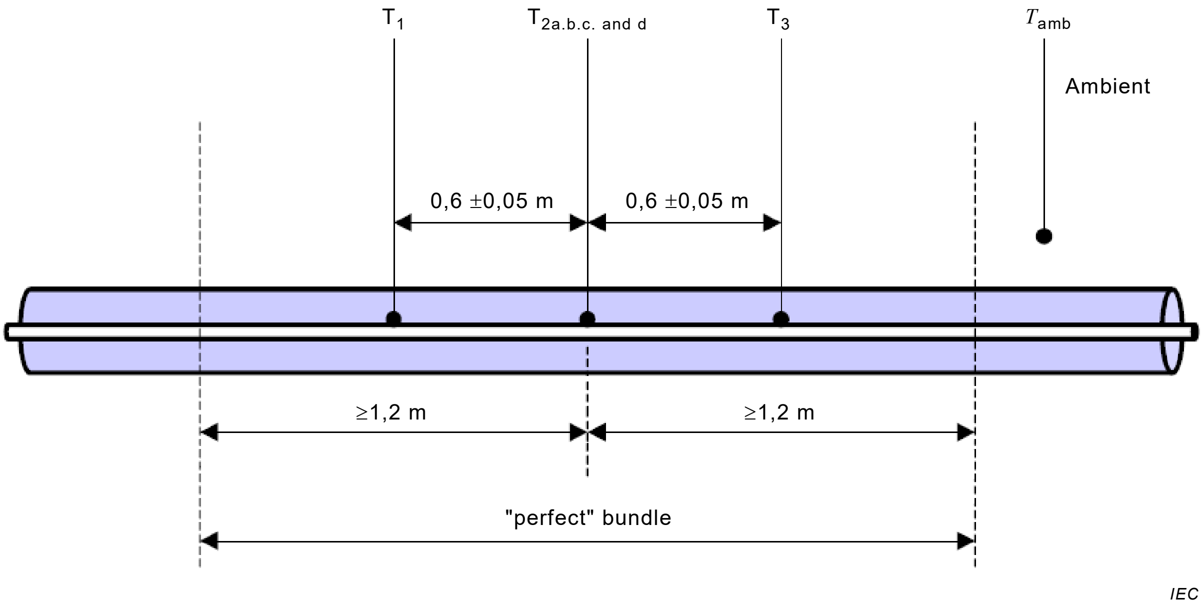

Figure 2 – Thermocouple placement

The bundle length should be about 4 m. To reduce end effects, the length of the centre cable shall be less than 80 % but more than 70 % of the length of the surrounding cable layers.