

# PUBLICLY AVAILABLE SPECIFICATION

## PRE-STANDARD

**Multicore and symmetrical pair/quad cables for digital communications –  
Part 1-4: Symmetrical pair/quad cables with transmission characteristics up to  
1 000 MHz – Conductor heating of bundled data grade cables for limited power  
transmission based on IEEE 802.3**



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MULTICORE AND SYMMETRICAL PAIR/QUAD CABLES  
FOR DIGITAL COMMUNICATIONS –**

**Part 1-4: Symmetrical pair/quad cables with transmission  
characteristics up to 1 000 MHz – Conductor heating of bundled data  
grade cables for limited power transmission based on IEEE 802.3**

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A PAS is a technical specification not fulfilling the requirements for a standard, but made available to the public.

IEC-PAS 61156-1-4 has been processed by subcommittee 46C: Wires and symmetric cables, of IEC technical committee 46: Cables, wires, waveguides, R.F. connectors, R.F. and microwave passive components and accessories.

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

This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document

Draft PAS	Report on voting
46C/912/PAS	46C/918/RVD

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This PAS shall remain valid for an initial maximum period of 3 years starting from the publication date. The validity may be extended for a single period up to a maximum of 3 years, at the end of which it shall be published as another type of normative document, or shall be withdrawn.

A list of all parts of the IEC 61156 series, under the general title: *Multicore and symmetrical pair/quad cables for digital communications*, can be found on the IEC website.

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## MULTICORE AND SYMMETRICAL PAIR/QUAD CABLES FOR DIGITAL COMMUNICATIONS –

### Part 1-4: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Conductor heating of bundled data grade cables for limited power transmission based on IEEE 802.3

#### 1 Scope

This PAS is a technical supplement to IEC 61156-1, edition 3 (2007): *Multicore and symmetrical pair/quad cables for digital communications – Part 1: Generic specification*.

This PAS, covering exclusively four-pair data grade cables, is intended to provide a test method for the determination of the maximum attained conductor temperatures which occur due to the deployment of the IEEE protocol for PoE /PoEP.

It gives as well the required background information about the thermodynamic behaviour of such bundled cables, if they are located in areas with restricted heat dissipation, a reality which occurs in every installation situation. However, only the basic principles are given, as the rigorous application and solution of these problems fall into the relevant cabling standards.

NOTE 1 The restriction to four-pair data grade cables is very important, as the heating of a multiple pair cable, especially if it has a protective screen, is much worse, since the ratio of the heat generation within the cross-section versus the overall circumferential surface to dissipate the heat is dramatically decreased, thus yielding substantially higher conductor temperatures. Additionally, the screen acts as a near perfect IR-reflector, thus increasing additionally only the excess heat within the cable.

This restriction is of importance considering the installed base, where individual four-pair cables in a loose bundle arrangement may need to replace multiple pair cables.

Hence, the main objective is

- a) the indication of a suitable measuring method to assess the heating gradient across bundled data grade cables subject to d.c. power transmission, using for the incident and return conductors the common mode circuits of either two or four pairs;
- b) to provide, toward this end, the worst case assessment of the conductor and cable heating in bundled cable configurations, where the densest hexagonal packing configuration is required. This assessment of the heating is anticipated to be carried out under the extremely lenient condition of freely suspended cable bundles in an air-conditioned environment free of any air draft, the heat dissipation thus being achieved by undisturbed convection into the surrounding environment;
- c) to provide some explanatory background information on the heat dissipation of heated conductors, insulated conductors, pair and cables, both screened or unscreened;
- d) to provide means to assess the installed base of data grade cables with a view to their compliance with the requirements of either PoE or PoEP, if required in a comparative way, but based on the resistance assessment of at least one short cable length withdrawn from the installed base by replacement;
- e) to indicate the basic physical assessment procedure, based upon the testing of a cable bundle according to item b). A comparable heating trial on the same cable bundle, but under restricted heat dissipation conditions, yields then some indication of how to assess the maximum occurring temperatures under these conditions;
- f) towards this end, the densest hexagonal packing configuration has to be simplified, using an equivalence in order to allow a consecutive evaluation of the heating under any heat dissipation restriction using a layered structure of the cables and the interstitial air spaces within the bundled structure.

For this purpose a test method is provided:

- to allow the evaluation of the heating of the conductors of cable bundles where all (or a certain percentage of the cables) are exposed to powering. Additionally is considered the case that either two of four pairs in a cable are used for d.c. power transmission;
- to measure the temperature of  $\left(1 + \sum_{n=1}^N 6 \cdot n\right)$  cables in hexagonal densest packing structure, in order to allow the assessment of the temperature gradient and the heat insulating properties of the cables. The densest packing of cables represents the worst case situation <sup>1</sup>;
- to provide a means to assess the performance potential of an installed base of data grade cables for power transmission. Evidently such a process has to take into account the specified d.c. resistance for categorized cables. If an experimental assessment of the installed cables is not feasible, then a normalizing procedure to IACS could be envisioned, though the specified cable d.c. resistances are substantially below 100 % IACS;
- to allow the assessment of the d.c. current transmission performance potential of the newly developed cables (these cables may be made based on the most recent design principles);
- to indicate a comparative test for a cable under 2- or 4-pair heating conditions and under free and restricted heat dissipation conditions, as encountered for instance with frame-wall, insulating material ducts etc.,
- to give the mathematical approach for this procedure;
- to allow also the extension of the results of two heating trials to any cable bundle size, i.e. also to higher bundle sizes, provided the heat insulation conditions to which the cable bundle is exposed to are known.

NOTE 2 The scope of this PAS exclusively covers the cable performances. The variable heat insulating properties of the cables resulting out of the installation practices for channels (for instance feeding bundled cables through insulating materials) is outside the scope of this PAS. This has to be initiated and be taken care of in ISO/IEC JTC1/SC25 WG3 in a suitable technical report or installation guide. This is the reason that here only general guidelines are given.

The test method described lends itself also to cable testing if higher currents than those resulting out of the basic specified d.c. resistances and the specified currents for the IEEE 802.3 PoE / PoEP protocol are required. This would eventually allow the transmission of higher powers at the same maximum ambient temperature of 60 °C, without exceeding the maximum permissible conductor temperatures in the cable. This may be applicable to higher performing cable categories in cases where the user really needs the transmission of higher power levels than anticipated in the IEEE 802.3 PoE / PoEP protocol.

In these cases, a verification of their conductor heating properties has to be assessed, and the cable performance has to be guaranteed by the manufacturer.

The PAS is written in a general way, thus covering not only horizontal cables. Stranded cord cables will have to be evaluated as well, and this very carefully, as they are so far installed in the equipment rooms in higher cable count bundles as well. This PAS establishes some basic guidelines to deal with these problems.

The heating in this PAS is the result of the resistance which is specified in IEC 61156-5 and IEC 61156-6 as 19 [ohm / 100 m] and 29 [ohm / 100 m].

<sup>1</sup> Later in this document, a method is given to determine the equivalent diameters for bundles of densest packing, having approximately the same dissipation properties with respect to convection and radiation. This may be interesting for modelling purposes, in case a statistical current loading situation may have to be evaluated, especially in cases where the convection is severely restrained due to surrounding insulation material or any other means to prevent the targeted heat dissipation by radiation and convection.

## 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.

IEC 61156-1:2007, *Multicore and symmetrical pair/quad cables for digital communications – Part 1: Generic specification*

IEC 61156-5:2009, *Multicore and symmetrical pair/quad cables for digital communications – Part 5: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Horizontal floor wiring – Sectional specification*

IEC 61156-6:2010, *Multicore and symmetrical pair/quad cables for digital communications – Part 6: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Work area wiring – Sectional specification*

IEEE 802.3af-2003, *IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications – Amendment: Data Terminal Equipment (DTE) Power via Media Dependent Interface (MDI)*

IEEE 802.3at-2009 Part 3: *Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications – Amendment 3: Data Terminal Equipment (DTE) Power via the Media Dependent Interface (MDI) Enhancements*

## 3 Terms, definitions, symbols, units and abbreviated terms

### 3.1 Terms and definitions

- Open thermodynamic systems - In this PAS, thermodynamic open systems are considered. Such systems differ from the usually considered systems in the classic thermodynamics, which have generally a constant mass flow going in and out over the system borders. In the present case, the systems have a constant mass flow equal to zero and an energy transfer over the system borders, i.e. an energy influx and/or outflux. This energy influx/outflux may be based on electrical energy going into the system and being transformed therein into heat or on any other kind of heat transfer, be it by radiation, conduction or convection, or any combination thereof.
- Two-dimensional systems - In this PAS, a two-dimensional thermodynamic system is understood as a cable or cable bundle which is homogeneous in longitudinal direction, heated by an electric energy influx, dissipating and/or absorbing energy over the system borders in radial direction. The dissipated and/or absorbed energy may be transferred by radiation, conduction and convection or any combination of the latter.

Hence the cross-sectional system borders of a two-dimensional system are subject to a radial energy flow, which is only in case of a thermal equilibrium constant and equal to the sum of the internally produced heat and energy influx minus the energy outflux by radiation, conduction and convection.