Expert contribution on

Single Pair Cable Heating (ISO/IEC TS 29125)

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Content

General

ISO/IEC TS 29125 Ed. 2.0 (Information technology – Telecommunications cabling requirements for remote powering of terminal equipment) was published in 2017.

It covers:

- **4-pair balanced cabling using currents up to 500mA per conductor**
- **1-pair balanced cabling using currents up to 1000 mA per conductor**

During the last meeting it was agreed to start the revision on ISO/IEC TS 29125 with a second amendment. This document will consist of:

- **1-pair balanced cabling using currents of 1000mA up to 2000mA per conductor**

International References to ISO/IEC TS 29125

a) ISO/IEC 11801-1
Clause 6.3.3.6 (DC loop resistance)
Clause 6.3.3.7 (DC resistance unbalance)
Clause 6.3.3.8 (DC current carrying capacity)
Annex E.1 (supported applications)

b) ISO/IEC 11801-1 AMD1
Figure 1 (Introduction)
Clause 6.6.3.5 (DC current carrying capacity)
Annex G.1.1 (Remote powering on single pair balanced cabling)

c) IEC 61156-5/-6
Clause 1 (Scope)
Clause 6.2.9 (Current carrying capacity)

International References to ISO/IEC TS 29125

d) ISO/IEC 14763-2
Clause 7.14 (Planning and assessment of cabling in support of remote powering objectives)
Table 19 (formula which is a simplified approximation to the model)

e) IEEE 802.3bt Power over Ethernet over 4 Pairs
Table 145-1 (System parameters)
Clause 145C.4 (Bundled cabling applications)

Determination of the heating of bundled SP Cables with a current load of 2A

The calculation is based on the specifications of EN TR 50174-99-1 and ISO/IEC TS 29125. The following formulas were used to determine the **approximate** temperature increase:

Where is:

$$\Delta T = C \times i_c^2 \times R$$

Delta T: Temperature increase (°C)
i_C: Current load per conductor (A)
R: DC Resistance of the conductor (Ohm/m)

$$C \approx \frac{\rho_u \times n_c \times \sqrt{N}}{(5{,}182 \times d)} + \frac{\rho_{th} \times N \times n_c}{12{,}6}$$

N: Number of loaded cables in the bundle
n_C: Number of loaded conductors
d: Cable diameter (m)

Rho_{th}: Cable factor depending on cable design:

- S/FTP: 2,75
- F/FTP: 2,9
- U/FTP, F/UTP: 3,0
- U/UTP: 5,0

Rho_u: Environmental factor as a function of the environment condition:

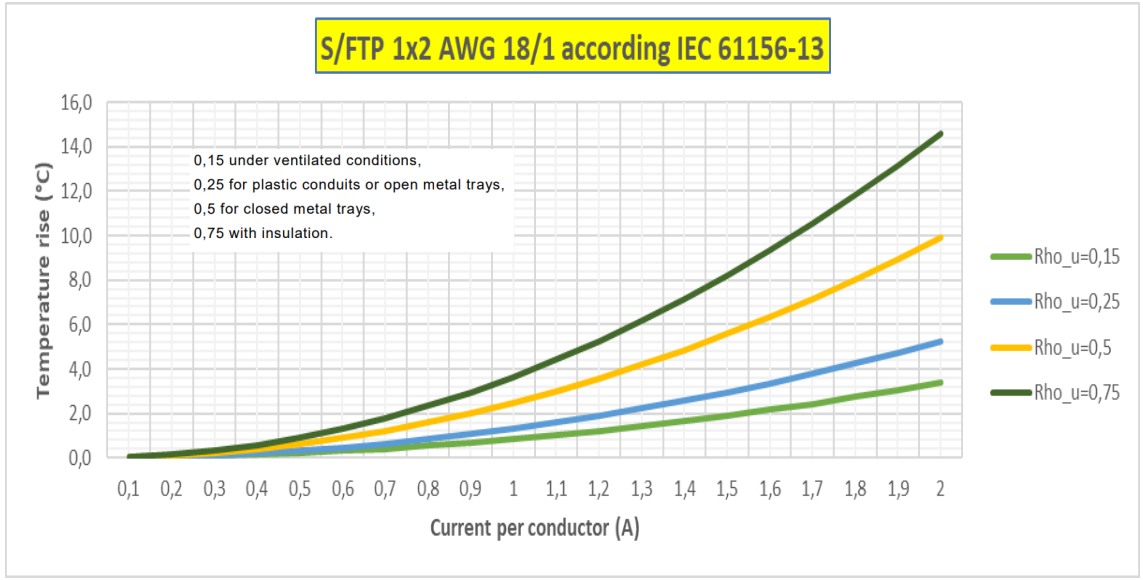
- ventilated conditions: 0,15
- open cable tray: 0,25
- closed cable tray: 0,50
- insulated environment: 0,75

Temperature Rise of S/FTP Cable 1x2xAWG 18/1 according IEC 61156-13

„Closed conduit“

Number of cables in a bundle carrying power: N	14
Number of conductors carrying power: n_c	2
DC resistance of conductor (Ohm/m): R	0,023
Cable diameter (m): d	0,0071

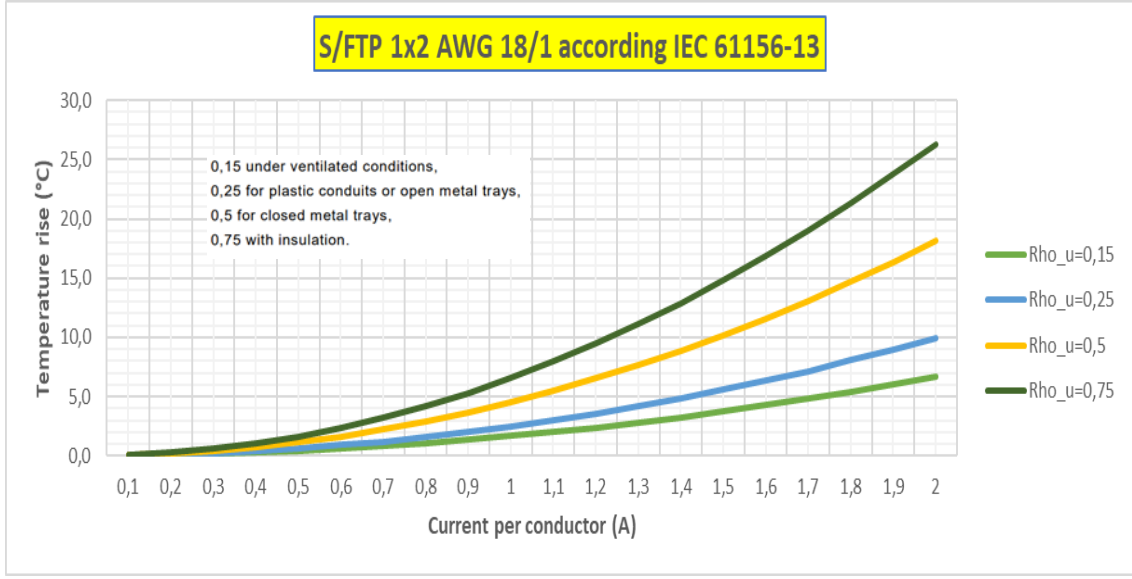
Cable factor: Rho_{th}	2,75



„Open conduit“

Number of cables in a bundle carrying power: N	43
Number of conductors carrying power: n_c	2
DC resistance of conductor (Ohm/m): R	0,023
Cable diameter (m): d	0,0071

Cable factor: Rho_{th}	2,75



Result:

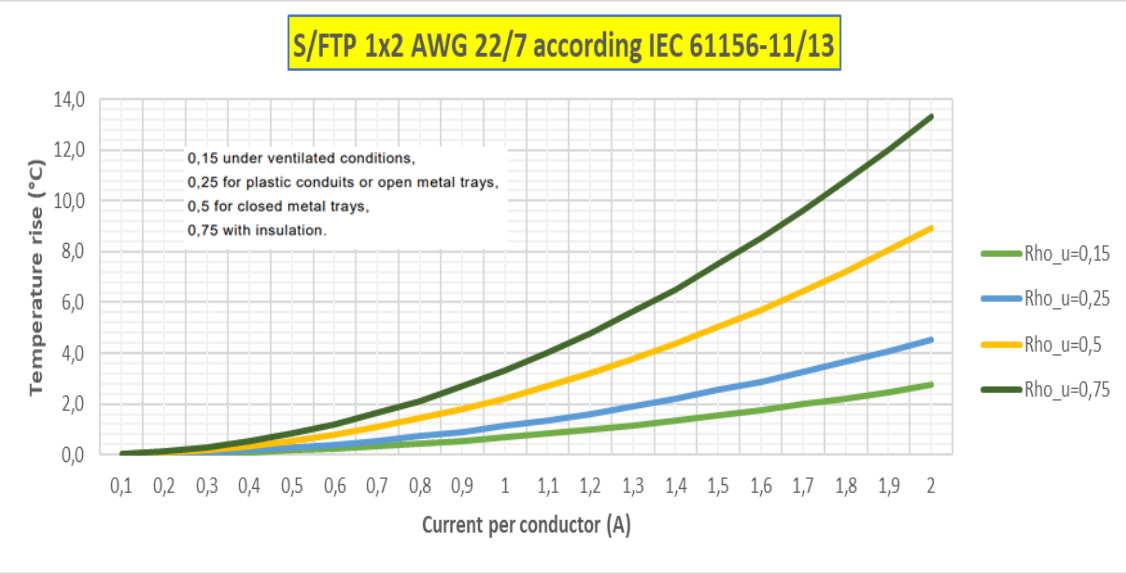
- **max. number of cables bundled in a closed conduit with 2A per conductor = 14**
- **max. number of cables bundled in a open conduit with 2A per conductor = 43**

Temperature Rise of S/FTP Cable 1x2xAWG 22/7 according IEC 61156-11/13

„Closed conduit“

Number of cables in a bundle carrying power: N	1
Number of conductors carrying power: n_c	2
DC resistance of conductor (Ohm/m): R	0,065
Cable diameter (m): d	0,0057

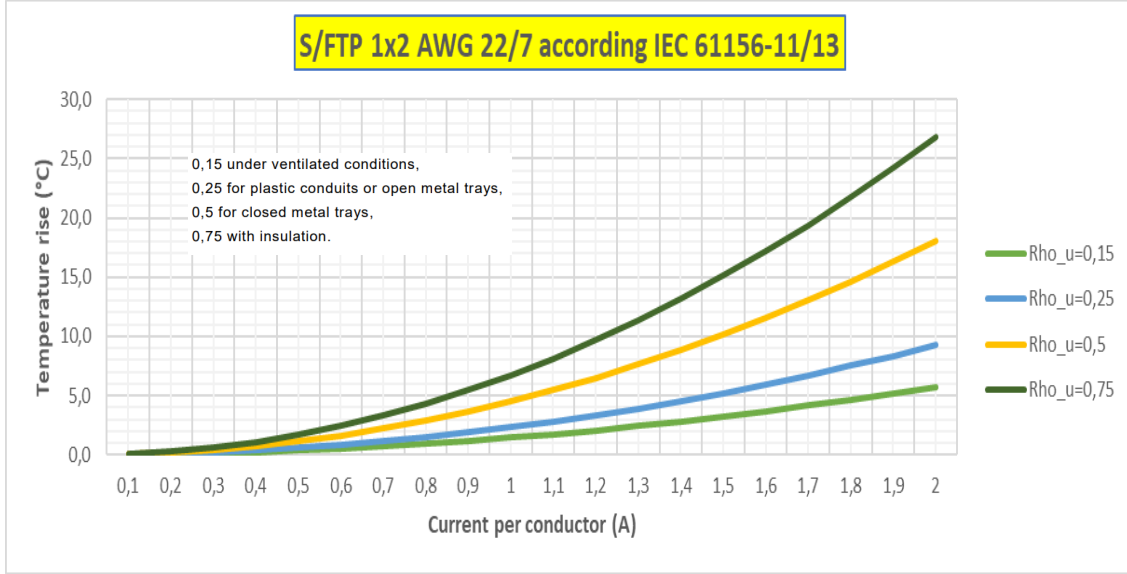
Cable factor: Rho_{th}	2,75



„Open conduit“

Number of cables in a bundle carrying power: N	4
Number of conductors carrying power: n_c	2
DC resistance of conductor (Ohm/m): R	0,065
Cable diameter (m): d	0,0057

Cable factor: Rho_{th}	2,75



Result:

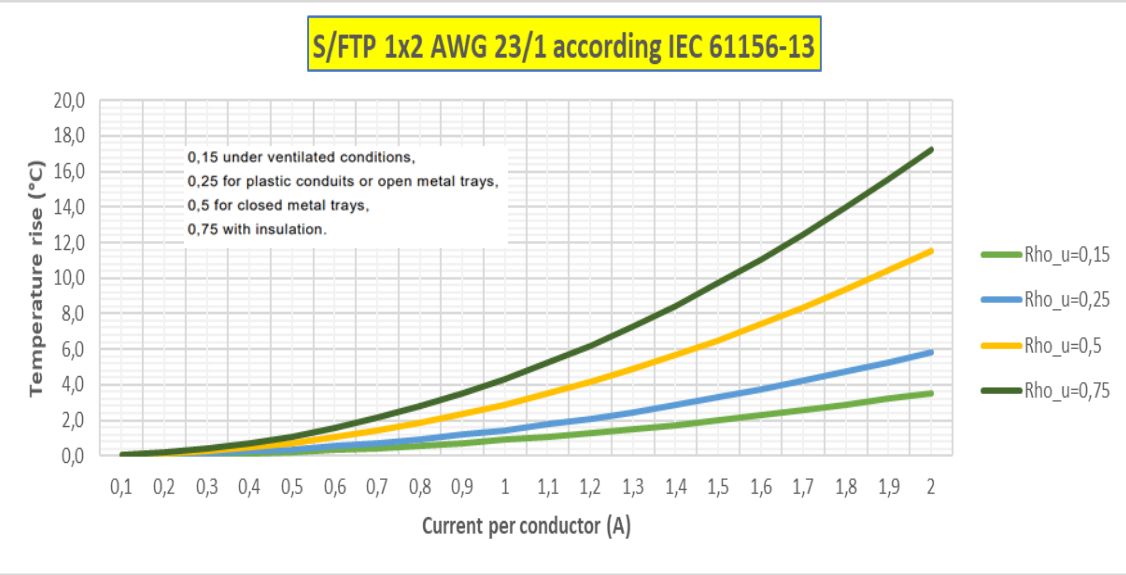
- **max. number of cables bundled in a closed conduit with 2A per conductor = 1**
- **max. number of cables bundled in a open conduit with 2A per conductor = 4**

Temperature Rise of S/FTP Cable 1x2xAWG 23/1 according IEC 61156-13

„Closed conduit“

Number of cables in a bundle carrying power: N	1
Number of conductors carrying power: n_c	2
DC resistance of conductor (Ohm/m): R	0,0725
Cable diameter (m): d	0,0049

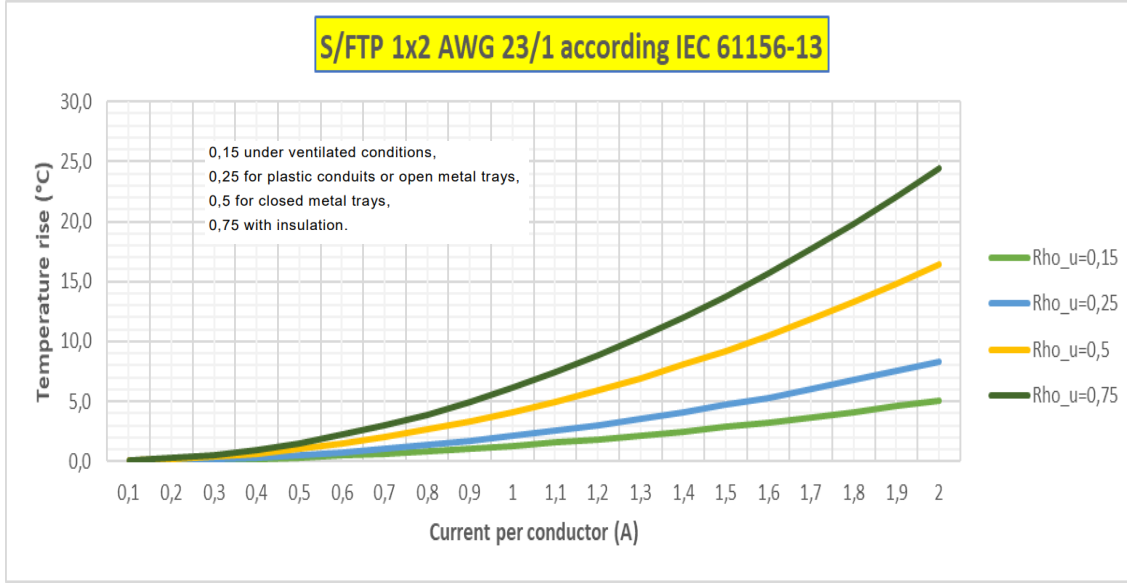
Cable factor: Rho_{th}	2,75



„Open conduit“

Number of cables in a bundle carrying power: N	2
Number of conductors carrying power: n_c	2
DC resistance of conductor (Ohm/m): R	0,0725
Cable diameter (m): d	0,0049

Cable factor: Rho_{th}	2,75



Result:

- **max. number of cables bundled in a closed conduit with 2A per conductor = 0**
- **max. number of cables bundled in a open conduit with 2A per conductor = 2**

Summary

- **The DC current capacity of 2A for each conductor within a single pair cabling channel has major consequences on the design and implementation of cabling systems.**

- **The heating effect leads to significant reduction respectively limitation regarding the max. number of loaded cables bundled in a conduit or tray** (results see slides 7, 8 and 9 , if needed: considering the introduction of a correction factor due to results < 7 and noncircular arrangements)**.**

- **This important facts must be considered by the following:**

  - ISO/IEC 11801-1 AMD1: consider the effect of heating and the limitation of the number of bundled loaded cables
  - ISO/IEC TS 29125 AMD2: create an amendment for currents of 1000 mA up to 2000 mA per conductor
  - ISO/IEC 14763-2: create an amendment currents of 1000 mA up to 2000 mA per conductor related to installation of single pair cabling
  - IEEE 802.3: revisit IEEE 802.3bu and IEEE 802.3dd Power over Data Lines of Single Pair Ethernet with respect to the effect of heating and limitation of the number of bundled cables (similar to text in IEEE 802.3 bt)