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ISO/IEC TR 29125

DRAFT TECHNICAL REPORT

INFORMATION TECHNOLOGY – Telecommunications cabling requirements for remote powering of terminal equipment

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

INFORMATION TECHNOLOGY – Telecommunications cabling requirements for remote powering of terminal equipment

Foreword

1) ISO (the International Organisation for Standardisation) and IEC (the International Electrotechnical Commission) form the specialised system for worldwide standardisation. National bodies that are members of ISO or IEC participate in the development of International Standards and Technical Reports through technical committees established by these organisations to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organisations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.
2) In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards and Technical Reports adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard or Technical Report requires approval by at least 75% of the national bodies casting a vote.
3) Technical Report ISO/IEC TR 29125, Information Technology – Telecommunications cabling guidelines for remote powering of terminal equipment, was prepared by the Joint Technical Committee ISO/IEC JTC 1/SC 25, Interconnection of Information Technology Equipment.
4) This Technical Report has taken into account requirements specified in application. It refers to International Standards for components and test methods whenever an appropriate International Standard is available.
5) Attention is drawn to the possibility that some of the elements of this Technical Report may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

This document is being issued as a Technical Report Type 2 (according to 15.2.2 of the ISO/IEC JTC 1 Directives) as the subject in question is still under technical development and as a “prospective standard for provisional application” in the field of Information Technology Infrastructure because there is an urgent need for guidance on how standards in this field should be used to meet an identified need.

This document is not to be regarded as an “International Standard”. It is proposed for provisional application so that information and experience of its use in practice may be gathered. Comments on the content of this document should be sent to the IEC Central Office. A review of this Technical Report will be carried out not later than 3 years after its publication with the options of: extension for another 3 years; conversion into an International Standard; or withdrawal.

Technical report ISO/IEC TR 29125 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

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

Introduction

This document specifies the use of generic balanced cabling for customer premises, as specified in international standards ISO/IEC 11801, ISO/IEC 15018, ISO/IEC 24702 and ISO/IEC 24764, for remote powering of terminal equipment. It provides guidance on new cabling installations and renovations. The customer premises may encompass one or more buildings or may be within a building that contains more than one organisation. The cabling may be installed prior to the selection of remote powering equipment or powered terminal equipment.

International standards ISO/IEC 11801, ISO/IEC 15018, ISO/IEC 24702 and ISO/IEC 24764 specify a structure and performance requirements for cabling subsystems that support a wide range of applications. They provide appropriate equipment interfaces to the cabling infrastructure in equipment rooms, telecommunications rooms and work areas.

A growing number of organisations employ equipment at locations that require the provision of remote powering. This Technical Report was created to provide supplementary information to ISO/IEC 11801 to implement remote powering over generic balanced cabling as specified in ISO/IEC 11801, ISO/IEC 15018, ISO/IEC 24702 and ISO/IEC 24764.

This Technical Report provides additional guidance for remote powering on the use of balanced cabling systems as specified in ISO/IEC 11801, ISO/IEC 15018, ISO/IEC 24702 and ISO/IEC 24764 guidance on different installation conditions that require special considerations;

- information to bring together all the considerations about remote powering in a single document,
- guidance on mating and unmating of connectors that convey remote power.

This Technical Report does not include requirements from national or local safety standards and regulations.

The Technical Report was developed based on a number of contributions describing remote powering over telecommunications cabling under different installation conditions. Consult with the relevant safety standards and regulations, application standard, and with equipment manufacturers for guidance on factors that should be taken into account during design of the generic balanced cabling that supports the distribution of remote power.

INFORMATION TECHNOLOGY –
Telecommunications cabling requirements for remote powering of terminal equipment

1 Scope

This Technical Report:

- targets the support of applications that provide remote power over balanced cabling to terminal equipment;
- covers the transmission and electrical parameters needed to support remote power over balanced cabling;
- covers various installation scenarios and how these may impact the capability of balanced cabling to support remote powering;
- specifies design and configuration of cabling as specified in International Standards ISO/IEC 11801, ISO/IEC 15018, ISO/IEC 24702 and ISO/IEC 24764;
- provides requirements and guidelines that will enable the support of a wide variety of extra low voltage (ELV) limited power source (LPS) applications using remote power supplied over balanced cabling.

Requirements and guidelines are provided with respect to:

- cabling selection and performance (clause 5)
- installation conditions (clause 6)
- transmission requirements (clause 7)
- power delivery (clause 8)
- connecting hardware (clause 9)
- mitigation considerations (annex A).

Safety (electrical, fire, etc.) and electromagnetic compatibility (EMC) requirements are outside the scope of this Technical Report.

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.

ISO/IEC 11801, *Information Technology – Generic cabling for customer premises*

ISO/IEC 14763-2, Information technology – Implementation and operation of customer premises cabling – Part 2: Planning and installation

ISO/IEC 15018, *Information Technology – Generic cabling for homes*

ISO/IEC 18010, *Information technology – Pathways and spaces for customer premises cabling*

ISO/IEC 24702, *Information Technology – Generic cabling - Industrial premises*

ISO/IEC TR 24746, *Information technology - Generic cabling for customer premises - Mid-span DTE power insertion*

ISO/IEC 24764, *Information Technology – Generic cabling systems for data centres*

IEC 60512-99-001, *Connectors for electronic equipment: - Tests and measurements - Part 99: Test schedules: Mechanical operation, un-mating connectors under electrical load, applicable to IEC 60603-7 series connectors and IEC 61076-3-1xx connectors having the IEC 60603-7 series mating interface (under consideration)*

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 11801, ISO/IEC 18010, ISO/IEC 14763-2 (under consideration), and the following apply.

3.1.1
power source equipment
equipment that provides power

3.1.2
remote powering
supply of power to application specific equipment via balanced cabling

3.1.3
terminal equipment
equipment that provides access to an application / service

3.1.4
current carrying capacity
maximum current a cable circuit (one or several conductors) can support resulting in a specified increase of the surface temperature of the conductor beyond the ambient temperature, not exceeding the maximum allowed operating temperature of the cable (3.24 of IEC 61156-1 ed.3:2007-06)

3.1.5
temperature rise
difference in the temperature in degrees 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 Abbreviations

EMC	Electromagnetic Compatibility
FD	Floor Distributor

4 Conformance

For cabling to conform to this Technical Report the following applies:

- the design of the cabling shall conform to the relevant cabling design standard developed by ISO/IEC JTC 1/SC 25 (e.g. ISO/IEC 11801, ISO/IEC 15018, ISO/IEC 24702 and ISO/IEC 24764),
- the installation conditions meet the additional requirements of this Technical Report.

5 Cabling selection and performance

The remote powering should be implemented using 4-pair balanced cabling.

NOTE 2 pairs may be used as an alternative to 4 pairs, however this may not support some applications.

This channel will be used simultaneously to support signal transmission and remote power feeding for the terminal equipment. This Technical Report assumes the use of balanced cabling models and components specified in the reference implementation clause of the relevant design standards.

6 Installation conditions

6.1 General

Cabling may be installed in different types of pathway systems such as trays, conduit, hangers, etc., and shall be installed in accordance with ISO/IEC 14763-2. The installation conditions shall not compromise safety regulations (e.g. exceed the temperature rating of the cable) For example, assuming all 4-pairs are energized, larger cable bundles (number of cables) retain more heat than smaller cable bundles.

The cable bundle size should take account of the temperature rise and current capacity information in 6.3.

6.2 Ambient temperature

The ambient temperature at different length segments of a link or channel has an impact on the local temperature rise of the cable used for the link or channel and may limit the remote power delivery to the powered terminal equipment. The worst case installed cabling condition with respect to the maximum ambient temperature shall be used to determine the maximum operating temperature for a link or channel when under electrical load.

6.3 Temperature rise and current capacity

When remote power is applied to balanced cabling, the temperature of the cabling will rise due to resistive heat generation in the conductors. Depending on cable construction and installed cabling conditions, the heat generated will be dissipated into the surrounding environment until a steady state is reached with the temperature of the cable bundle (operating temperature) higher than the ambient temperature of the surrounding environment. The maximum temperature of any cable (at the cable conductor surface) shall not exceed the temperature rating of the cable. Generally, balanced cables used in commercial premises have a temperature rating of 60 °C.

Temperature rise in the cable will lead to an increase in insertion loss as specified in ISO/IEC 11801 and should be taken into account when selecting cables.

The maximum current per pair for different temperature rises in a bundle of 100 cables of 4-pair category 5 cables with solid conductors with all pairs energized is shown in Table 1. For example, cable bundles up to 100 cables are expected to support remote powering with all pairs energized with up to 600 mA, if the ambient temperature along the cabling is less than 50 °C for a 60 °C rated cables.

Table 1 – Maximum current per pair versus temperature rise in a bundle of 100 4-pair Category 5 cables (all pairs energised

Temperature rise °C	**Current per pair** mA
5,0	420
7,5	520
10,0	600
12,5	670
15,0	720
NOTE These values are based on conductor temperature measurement of typical cables.	

Table 2 shows current capacity for different Categories of cable, independent of construction, for a given temperature rise. Manufacturers'/suppliers' specifications should be consulted for information relating to a specific cable.

Table 2– Current per pair versus temperature rise in a bundle of 100 4-pair cables (all pairs energized)

Temperature rise °C	**Current per pair** [a] mA				
	Category 5	**Category 6**	**Category 6_A**	**Category 7**	**Category 7_A**
2,0	268	294	316	316	330
4,0	380	416	447	447	467
6,0	465	509	547	547	572
8,0	537	588	632	632	660
10,0	600	657	706	706	738
12,0	657	720	774	774	809
14,0	710	778	836	836	873

a Calculated values for worst case.

NOTE 1 The values in this table are based on the implicit DC resistance derived from the insertion loss of the various categories of cable. Manufacturers'/suppliers' specifications should be consulted for information relating to a specific cable.

NOTE 2 The current per pair for each category is dependent on the cable construction.

6.4 Factors affecting temperature increase

6.4.1 General

The excess heat responsible for the conductor temperature rise of any power carrying cable is the difference of the resistive heat generation in the cable minus the heat dissipated into the environment, be it the open atmosphere, trays, ducts or other cables which may also be power carrying cables**.**

6.4.2 Cable count within a bundle

This Technical Report uses 100-cable bundles as the basis for developing the temperature rise and current per pair with all pairs energized. The correlation between cable bundle size and temperature rise was established from measured data. For other cases (e.g. where bundle count exceeds 100 cables), the guidelines provided in this clause can be used. Refer to Table 3 to determine the maximum temperature rise using 600 mA per pair for cable bundles of different count.

Table 3 – Temperature rise for a Category of cable versus cable bundle size (600 mA per pair)

Cable bundle size (number of cables)	Temperature rise [a] °C				
	Category 5	**Category 6**	**Category 6_A**	**Category 7**	**Category 7_A**
1	0,8	0,6	0,6	0,6	0,6
7	1,4	1,1	1,0	1,0	0,9
19	2,6	2,1	1,8	1,8	1,6
37	4,7	3,7	3,2	3,2	2,9
61	6,9	5,5	4,8	4,8	4,4
91	9,7	7,7	6,7	6,7	6,2
127	13,1	10,4	9,0	9,0	8,3
169	16,9	13,5	11,7	11,7	10,8

[a] Calculated values for worst case

NOTE 1 The temperature rise (°C) is based upon a current of 600 mA per pair, for all pairs in all cables in the bundle.

NOTE 2 The values in this table are based on the implicit DC resistance derived from the insertion loss of the various categories of cable. Manufacturers'/suppliers' specifications should be consulted for information relating to a specific cable.

NOTE 3 The current per pair for each category is dependent on the cable construction.

6.4.3 Reducing temperature increase

Minimizing the cabling temperature rise is recommended, as it:

a) reduces the impact on the transmission performance (e.g. insertion loss) of the cabling;

b) reduces the HVAC loading within the premises;

c) allows operation in higher ambient temperatures without exceeding the cable temperature rating;

d) reduces the overall cost of delivering remote power by minimizing the resistive heating loss (power dissipated in the cabling).

The temperature rise can be reduced by minimizing the heat generation and maximizing the heat dissipation. Examples of how this may be achieved include:

- using higher Category cable;
- selecting a larger conductor size which decreases per unit length dc resistance;
- improving thermal dissipation by selecting cable with:
  - improved thermal conductivity;
  - improved heat transfer coefficient between materials;
  - improved heat transfer coefficient between cable sheath and air;
  - screen or other additional metallic elements;
  - solid insulation;
  - a larger diameter.
- reducing the number of energized pairs;
- choosing pathways and spaces with good air circulation, e.g. open trays or baskets;
- reducing the number of cables per bundle and avoiding tight cable bundles;
- selection of applications and devices that use lower current.

Table 4 shows the effect of energizing the number of pairs within a 100-cable bundle for different cable Categories. For example, the temperature rise for applications delivering 600 mA on two pairs of each cable in a 100-cable bundle of Category 5 is 5 °C.

Table 4 – Temperature rise for Category of cable versus number of energised pairs in 100-cable bundle (600 mA per pair)

Number of pairs	**Temperature rise [a] °C**				
	Category 5	**Category 6**	**Category 6_A**	**Category 7**	**Category 7_A**
24	0,6	0,5	0,4	0,4	0,4
48	1,2	1,0	0,9	0,9	0,8
96	2,4	2,0	1,7	1,7	1,5
144	3,6	3,0	2,6	2,6	2,4
192	4,8	4,0	3,5	3,5	3,2
200	5,0	4,2	3,6	3,6	3,3
236	5,9	4,9	4,2	4,2	3,8
284	7,1	5,9	5,1	5,1	4,7
332	8,3	6,9	6,0	6,0	5,5
380	9,5	7,9	6,8	6,8	6,2
400	10,0	8,3	7,2	7,2	6,6

[a] Calculated values for worst case

NOTE 1 The temperature rise (°C) is based upon a current of 600 mA on each energised pair.

NOTE 2 The values in this table are based on the implicit DC resistance derived from the insertion loss of the various categories of cable. Manufacturers'/suppliers' specifications should be consulted for information relating to a specific cable.

NOTE 3 The current per pair for each category is dependent on the cable construction.

7 Transmission requirements

Figure 1**Fehler! Verweisquelle konnte nicht gefunden werden.** shows examples of specified transmission paths used in generic balanced cabling. The channel is the transmission path between equipment such as a LAN switch/hub and the terminal equipment. The channel does not include the connections at the data source equipment and the terminal equipment. The channel, the permanent link or the CP link shall meet the transmission requirements specified in the design standards.

8 Remote power delivery over balanced cabling

Remote power may be provided to terminal equipment via balanced cabling equipment interfaces. Remote power may be introduced to the balanced cabling channel at the FD using spare pairs, if available, or by remote power supplied over the phantom circuit of data pairs from the power sourcing equipment, as shown in Figure 1.

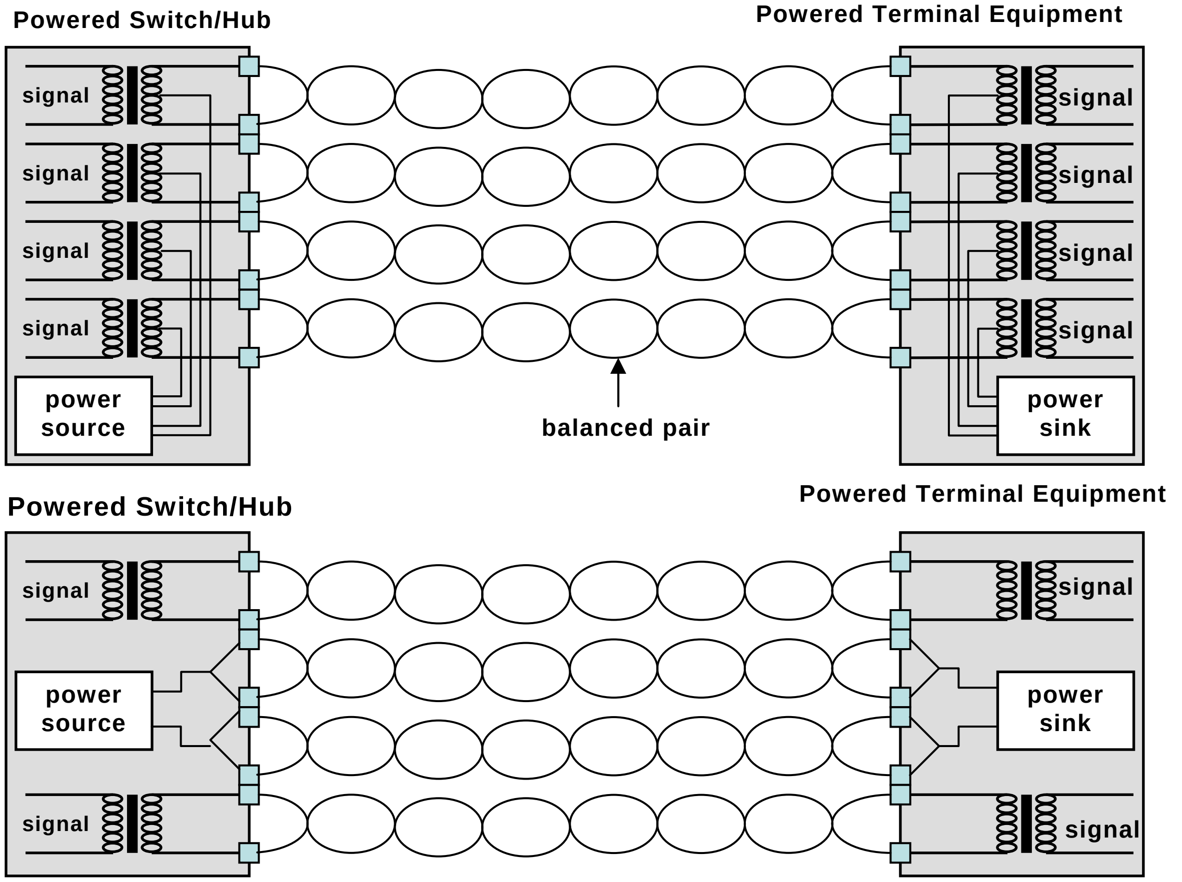

Figure 1 - Examples of end point powering systems using signal pairs (top) and spare pairs (bottom)

Alternatively, remote power may be supplied by mid-span power source equipment that inserts remote power independent of the data source equipment, as shown in Figure 2.

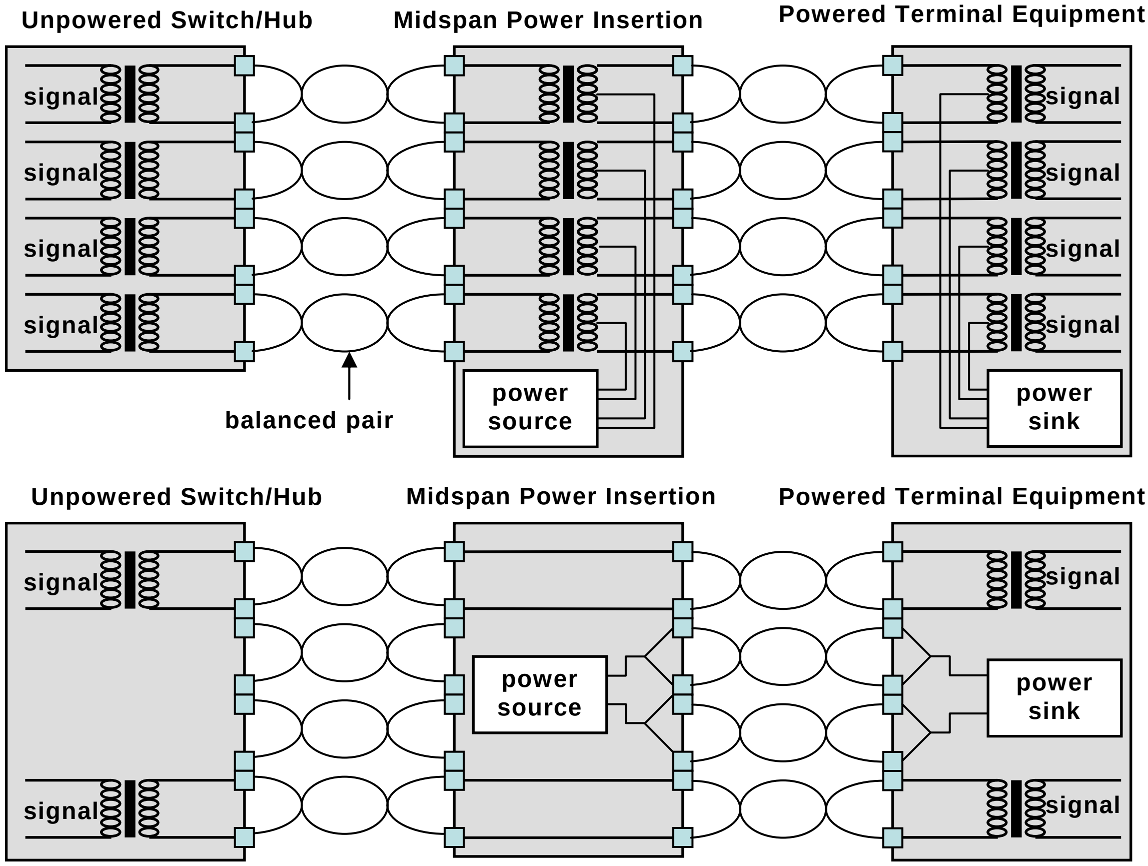

Figure 2 - Examples of midspan powering systems using signal pairs (top) and spare pairs (bottom)

When mid-span power source equipment replaces a generic balanced cabling component or components, the data pairs shall meet the performance requirements of the component or components it replaces (e.g., patch cord, patch panel or combination thereof), regardless of the equipment interfaces used for input and output connections. Placement of mid-span power insertion equipment shall be external to the permanent link, see ISO/IEC TR 24746.

Figure 3 shows an example of endpoint powering with two power sources and two power sinks. As illustrated in figures 1, 2, 3, power may be provided to terminal equipment via the common mode circuit of balanced cabling.

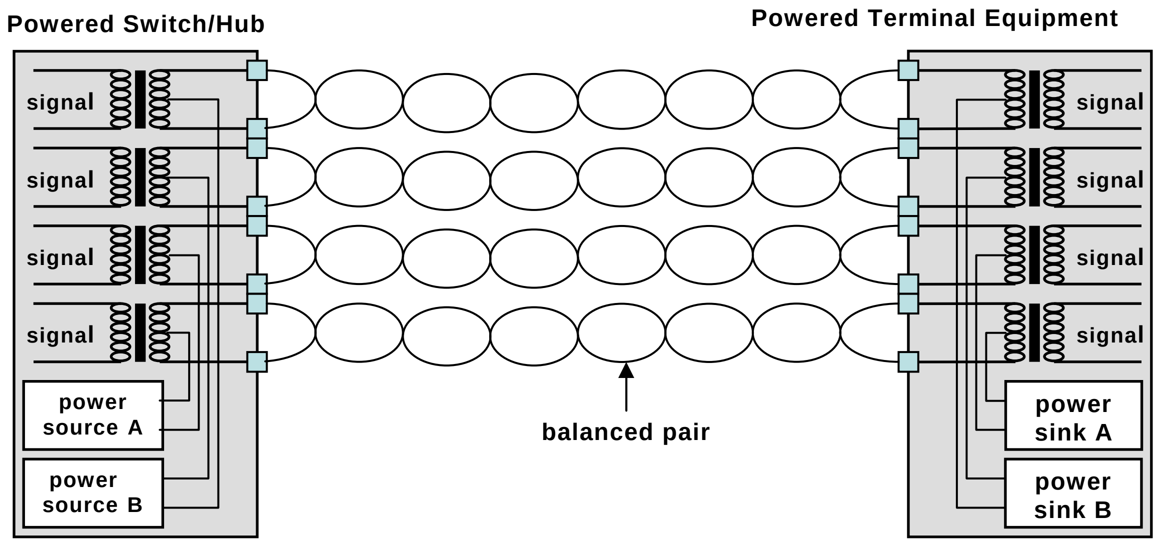

Figure 3 - Examples of endpoint powering systems with two power sources and sinks

9 Connecting hardware

Connecting hardware in channels used to support remote power applications shall have an appropriate current rating when mated. Connecting hardware contacts may deteriorate as a result of mating or unmating under electrical stress, leading to possible degradation of transmission characteristics. Manufacturers should be consulted regarding the number of mating and unmating cycles supported by connecting hardware while conveying the intended levels of electrical power.

The temporary removal of remote power should be considered before mating or unmating connecting hardware in a remotely powered channel. Consideration should also be given to any operational impact that loss of remote power may have, especially when a remote power source is shared by multiple end stations.

It is preferable that remote powering is not present during mating or unmating of connecting hardware.

Intelligent powering systems such as IEEE 802.3 Power over Ethernet and Power over Ethernet-*plus* (IEEE 802.3at) automatically recognise compliant loads before applying the required level of remote power, thus eliminating electrical stress during connector mating.

IEEE 802.3 Power over Ethernet also defines optional features to remotely manage the provision of electrical power to each port via port power management which may be used to remove remote power from a particular channel prior to unmating connectors.

Port power management is therefore the preferred approach to reconfiguration of remotely powered cabling channels.

Where it is not practicable to switch off the remote power before mating or unmating (e.g. for power sources that do not have power management), connecting hardware having the required performance for mating and unmating under the relevant levels of electrical power and load should be chosen. These requirements are not within the scope of the balanced connecting hardware standards (e.g. IEC 60603-7, IEC 61076-3-104 and IEC 61076-3-110) referenced from ISO/IEC 11801 and equivalent standards but may be assessed using additional test schedules described in IEC 60512-99-001.

Annex A
(informative)

Mitigation considerations for installed cabling

A.1 General

Installed cabling is not easy to change to support new applications with additional requirements. This annex offers some considerations that may be useful to provide remote power over existing installations of Class D or better balanced cabling. Consideration should be given to local heat dissipation conditions, for instance going through framed wall construction, through insulating material etc.

A.2 Minimum cabling class

Class D or better balanced cabling is recommended for remote powering.

A.3 Bundle size and location

Cables with improved thermal characteristics may be configured into larger bundles. The location of a cable bundle is also an important consideration. Conduits sealed at both ends typically retain more heat than open conduits leading to a higher temperature rise in the sealed conduit. If cables are installed in open tray, the temperature rise will be lower than the temperature rise in conduits (sealed or unsealed) for the same bundle size

A.4 Mitigation options

If an existing installation does not meet the current capacity in this Technical Report for a particular bundle size, the following mitigation options may be considered:

- Use only half the cables in a bundle for remote powering with the other half used for applications that do not need remote power.
- If ambient temperatures are high, consider adding air-conditioning or air-circulation over cabling segments that are exposed to high temperature.
- If possible, separate larger bundles into smaller bundles

If it is not possible to implement any of the mitigation options listed above, and the number of data terminals requiring remote powering is significant, upgrade the installation using cables with improved thermal characteristics.

Additionally, when the number of data terminals requiring remote powering is significant, upgrade the installation using the appropriate installation procedures to keep the bundle size reasonably low (e.g. 24 cable count) to allow proper heat dissipation all along the channel, permanent link or CP link

Bibliography

IEC 60603-7 series, *Connectors for electronic equipment - Part 7: Detail specification for 8-way, unshielded, free and fixed connectors*

IEC 60950-1, Information technology equipment - Safety - Part 1: General requirements

IEC 60950-21 Part 21: Information technology equipment - Safety - Part 21: Remote power feeding

IEC 61076-3-104, *Connectors for electronic equipment - Product requirements – Part 3-104: Detail specification for 8-way, shielded free and fixed connectors for data transmissions with frequencies up to 1 000 MHz*

IEC 61076-3-110, *Connectors for electronic equipment - Product requirements – Part 3-110: Rectangular connectors - Detail specification for shielded, free and fixed connectors for data transmission with frequencies up to 1 000 MHz*

IEEE Std 802.3at-2009, *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)*

NOTE 802.3at incorporates the requirements of IEEE Std 802.3af-2003.