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Foreword

This document (CLC/TR 50174-99-1:2015) has been prepared by CLC/TC 215 "Electrotechnical aspects of telecommunication equipment".

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Introduction

EN 50174 series specify the specification, planning and practices applicable to installation of telecommunications cabling.

Balanced cabling in accordance with EN 50173-1 is increasingly used to provide power as well as telecommunication services to a wide range of terminal equipment. This Technical Report examines the effects of remote powering (i.e. thermal heating) on installed cabling.

The components considered are of those specified in EN 50173-1. The components of Category 5 as defined in EN 50173:1995 were not specified in terms of current carrying capacity etc.; they are not supported by this Technical Report.

This Technical Report supports recognized application standards for power feeding produced by IEEE (IEEE 802.3at) but is not restricted to the current feeding specification of that standard.

The delivery of POTS, ISDN, PoE and PoEplus using fully energized bundles of up to 100 cables in accordance with EN 50288-X-1 in ventilated pathways is not considered to represent a problem and is not considered in this Technical Report. In addition, there is no reported evidence of such installations of those remote powering applications producing problems in unventilated conditions. As a result, this Technical Report will only consider such situations if the modelling and subsequent testing of cabling implementations indicates any cause for concern.

1 Scope

This Technical Report defines requirements and recommendations concerning limits for the application and operation of remote powering using cabling comprising balanced cabling components of Category 5 and above as defined in EN 50173-1.

This Technical Report also describes:

- a set of specific implementations which are the basis of a mathematical model for the temperature increases in bundles of cables under remote powering conditions;
- a matching testing protocol used to provide data for the mathematical model;

NOTE The testing protocol was established in order to enable comparison of data from different sources in order to support the development of the mathematical model and to develop appropriate planning and installation rules as suggested by different installation conditions. It is not the role of CLC/TC 215 to develop test methods for balanced, or other, cables and the protocol defined in Annex B is not as such a test method.

- the mathematical model that is employed as the basis for the resulting requirements and recommendations.

Safety (electrical safety and protection, optical power, fire, etc.) and electromagnetic compatibility (EMC) requirements are outside the scope of this Technical Report and are covered by standards and regulations. However, information given in this Technical Report may be of assistance in meeting these standards and regulations.

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.

EN 50173 series, *Information technology – Generic cabling systems*

EN 50173-1:2011, *Information technology – Generic cabling systems – Part 1: General requirements*

EN 50174 series, *Information technology – Cabling installation*

EN 50174-2:2009 + A1:2011 + A2:2014, *Information technology – Cabling installation – Part 2: Installation planning and practices inside buildings*

3 Terms, definitions, abbreviations and symbology

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 50173 series and in EN 50174 series and the following apply.

3.1.1
requirement met by design
requirement that does not require testing and where conformance may be achieved either by selection of appropriate components and their installation techniques or by conformance of a related parameter

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

3.2 Abbreviations

For the purposes of this document, the abbreviations given in EN 50173 series and the following apply.

d.c., DC	direct current
U/UTP	unscreened cable with unscreened balanced cable elements
F/UTP	foil screened cable with unscreened balanced cable elements
S/FTP	screened cable with foil screened balanced cable elements

3.3 Symbology

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

ΔT	total temperature rise between the ambient temperature (or that of the unpowered bundle) and the centre of the bundle
ΔT_{th}	temperature rise between the outer surface and the centre of the bundle
ΔT_u	temperature rise between the ambient temperature (or that of the unpowered bundle) and the outer surface of the bundle
i_c	the current per conductor (A)
n_c	number of conductors per cable carrying remote powering current (i_c)
N	number of cables carrying remote powering current
R	average d.c. resistance per unit length (Ω/m) of conductors carrying remote powering current
ρ_{th}	constant relating to cable construction
ρ_u	constant relating to installation environment

4 Overview

4.1 General

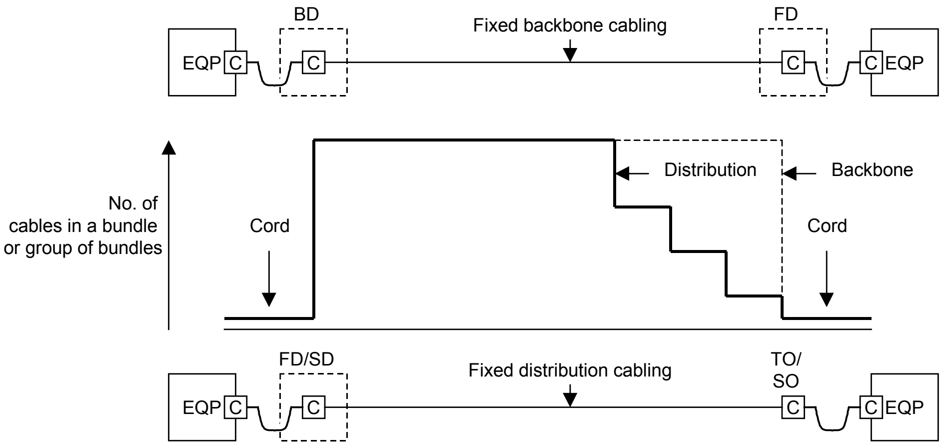
The principal concerns associated with the delivery of power are:

a) increases in the operating temperature of the cables (exceeding their specified operating temperature);

b) damage to connecting hardware contacts where mating and de-mating occurs while the power supply current is flowing;

c) the associated increase of channel attenuation/insertion loss, due to the increased temperature of installed cables, which unless balanced by reduced installed lengths will have a negative effect on channel ACR/PSACR (and may be associated with increased system bit error rates).

This Technical Report demonstrates that the thermal impact of remote powering is proportional to the number of cables in a bundle (and/or the number of bundles installed in a close proximity to others) and the length over which that installation condition is maintained. Figure 1 is a schematic of the distribution cabling subsystems defined by EN 50173-2 and EN 50173-6 (together with the supporting backbone cabling common to both standards).



Key

BD	building distributor of EN 50173-X
C	connection positions
EQP	equipment
FD	floor distributor of EN 50173-2
SD	service distributor of EN 50173-6
SO	service outlet of EN 50173-6
TO	telecommunications outlet of EN 50173-2

Figure 1 — Schematic of cabling in accordance with EN 50173 series standards showing cable bundle trends

The fixed cabling in both the backbone and distribution cabling typically contains multiple bundles of cables as they leave the distributors. In the distribution cabling, the number of bundles in a group and then the number of cables in a bundle reduces towards the outlets whereas the backbone bundles tend to be consistent along their length. Connections to equipment at either end is made via cords which tend to be installed as single components or in small groups - and even where larger bundles are created they are accessible and are able to be re-dressed to reduce any identified thermal impact.

As a result, the focus of this Technical Report in relation to thermal impact is on the fixed cabling.

4.2 Published standards

4.2.1 ISO/IEC TR 29125:2010

ISO/IEC TR 29125:2010 contains information on temperature rises found at the centre of cable bundles for cables of Category 5 and above and for currents of up to 360 mA per conductor. This information was used during the development of IEEE 802.3at to define the limits of power delivered.

ISO/IEC TR 29125:2010 suggests that cables of a higher category produce lower temperature increases for a given current and bundle size. However, all categories of cable currently have the same maximum d.c. resistance specification. This specification is based on the minimum conductor diameter to meet the transmission performances taking into account all the possible designs. Thus, the actual conductor diameter and the d.c. resistance per unit length of the conductor may have more influence than the cable category.

ISO/IEC TR 29125:2010 suggests that the temperature rise increases as both the current per pair increases and as the bundle size increases. Based on these assumptions ISO/IEC TR 29125:2010 gives figures for increases of temperature according to the current and the bundle size. However, external surfaces of the bundles were in open air, allowing

cooling by radiation and convection. This is not representative of the full range of pathway systems, and when bundles are installed in unventilated cable management systems or in insulating materials, the temperature rise will be higher.

4.2.2 EN 50173-1:2011

EN 50173-1:2011 specifies the d.c. loop resistance requirements of generic cabling channel and links.

EN 50173-1:2011 specifies the current carrying capacity requirements of generic cabling channels which are linked to the 10 °C temperature rise suggested in ISO/IEC TR 29125:2010 at the centre of a bundle of 100 cables for a current of 300 mA per conductor (all conductors powered). Additionally it is stated that:

a) relevant application standards and manufacturers‘ instructions shall be consulted with reference to safety aspects of power feeding;

b) care shall be taken when using multi-unit or bundled cables due to the possible rise of temperature within the cabling components that may degrade channel performance.

4.3 Recent developments

4.3.1 EN 50173-6

EN 50173-6 specifies generic cabling for distributed building services which is expected to be exploited by a wide range of remote powering solutions including those of IEEE 802.3 and other proprietary products.

4.3.2 IEEE 802.3

IEEE 802.3 is considering the delivery of higher powers than those specified in IEEE 802.3at. A revision of ISO/IEC TR 29125:2010 is in development at this time.

4.3.3 Other remote powering solutions

Installed cabling may be subjected to currents and voltages other than those defined for IEEE 802.3 (both now and in the future).

There are many building services such as access control, environmental monitoring and lighting that are designed to operate over the cabling within the scope of this Technical Report. It is common for these services to be the responsibility of different groups within an organization. Management of the power applied is important to control rises in cable temperature within bundles of cables that may carry multiple services, each of which may have different temperature dependencies in relation to the transmission of data traffic.

However, it is assumed that the equipment incorporates safe signal circuitry complying with the SELV circuit and the TNV requirements as defined in the EN 60950 series.

4.3.4 EN 50173-1

A revision of EN 50173-1:2011 is expected to modify the requirements for both d.c. loop resistance and current carrying capacity in order to better control the application and outcomes of remote powering over generic cabling.

The modifications to the d.c. loop resistance requirements are intended to prevent the installation of fixed cables that have d.c. loop resistance higher than those of Category 5 and are expected to include the following:

a) the existing channel requirements will be augmented by a “met by design” requirement for the d.c. loop resistance per unit length;

b) the link requirements, which are already length dependent, will be modified as per any changes to the channel limits mentioned above to define requirements at 20 °C (to which measured values are required to be corrected).

The existing current carrying capacity requirements are expected to be deleted and to be replaced with:

1) a restriction of current carrying capacity to 0,75 A per conductor under continuous operation (as specified in EN 50173-1:2011, Annex D);
2) a warning that this is:
   - not the current carrying capacity if mating or de-mating under load;
   - not a guide for application support;
3) a requirement that any equipment connected to the channels or applications operating over them shall be fitted with over-current protection not exceeding 0,75 A per conductor.

Additionally, reference is likely to be made to this Technical Report and any resulting requirements or recommendations that may be introduced to EN 50174 series standards.

4.4 Basic principles of remote powering

Annex A contains details of the basic principles of remote powering used within this Technical Report.

4.5 Testing protocols and mathematical modelling

Annex B contains details of a test protocol that allows test data obtained from a variety of independent test facilities to be directly compared.

That data has been used to develop and confirm the basic mathematical model of Annex C.

The testing protocol and mathematical model address the following installation conditions:

a) varying cable constructions and diameters;
b) bundles with differing quantities of cable of a given construction and diameter;
c) a variety of installation methods (several tight bundles, air between bundles);
d) installation environment: free ventilation, closed compartment, insulated;
e) pathway systems: cable ladder/wire basket, cable tray, duct.

5 Application of remote powering

5.1 Channel length

5.1.1 Installed cabling performance

The channel requirements of EN 50173-1 are temperature independent i.e. they are required to be met at the operating temperature of the channel. However, any temperature rise due to power feeding in combination with the ambient temperature produces an increase in attenuation/insertion loss of the installed cabling.

For cables specified in the reference implementations of the EN 50173 series standards, the attenuation increase is assumed be, for operating temperatures above 20 °C, 0,2 % per °C for screened cables and 0,4 % per °C (20 °C to 40 °C) and 0,6 % per °C (> 40 °C to 60 °C) for unscreened cables. In order for the cabling performance to meet a given class, either the length of the channel has to be reduced accordingly or the conductor diameter has to be enlarged.