ISO/IEC 24764

Edition 1.1 2014-04

CONSOLIDATED VERSION

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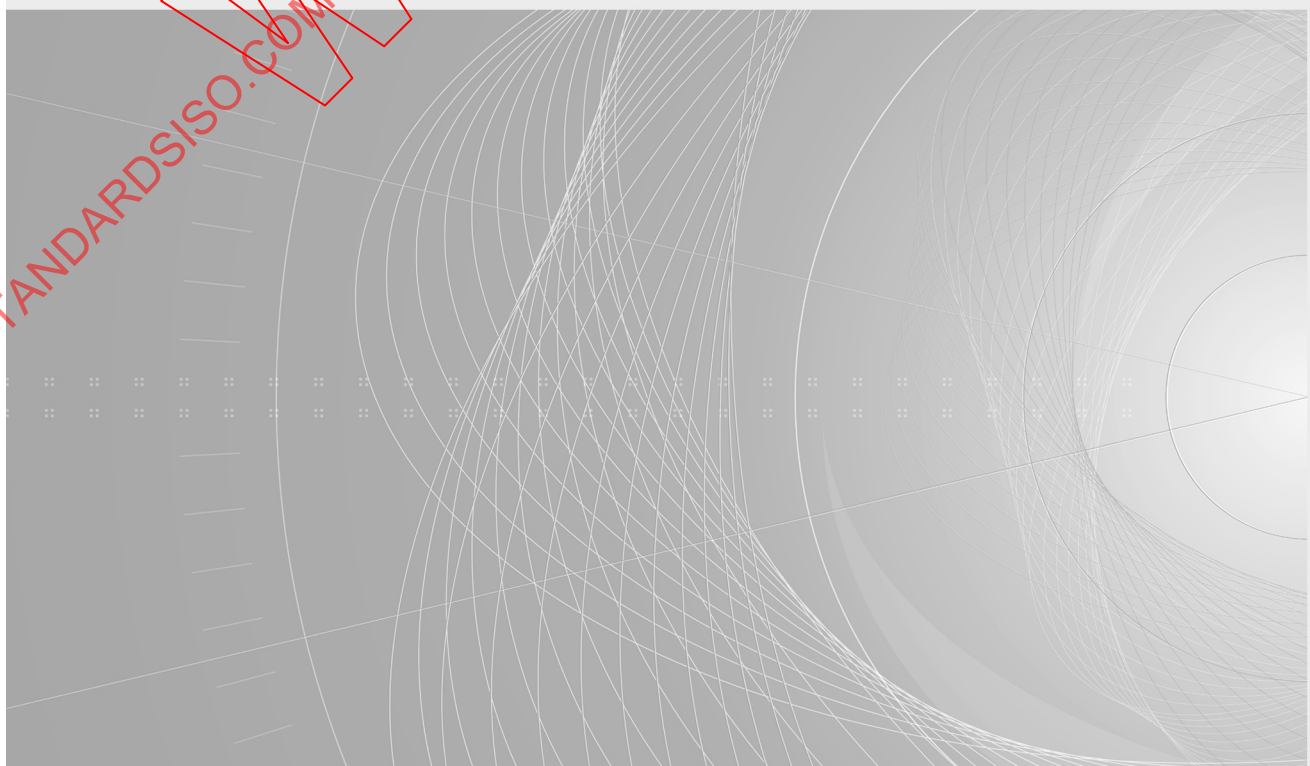
Information technology – Generic cabling systems for data centres



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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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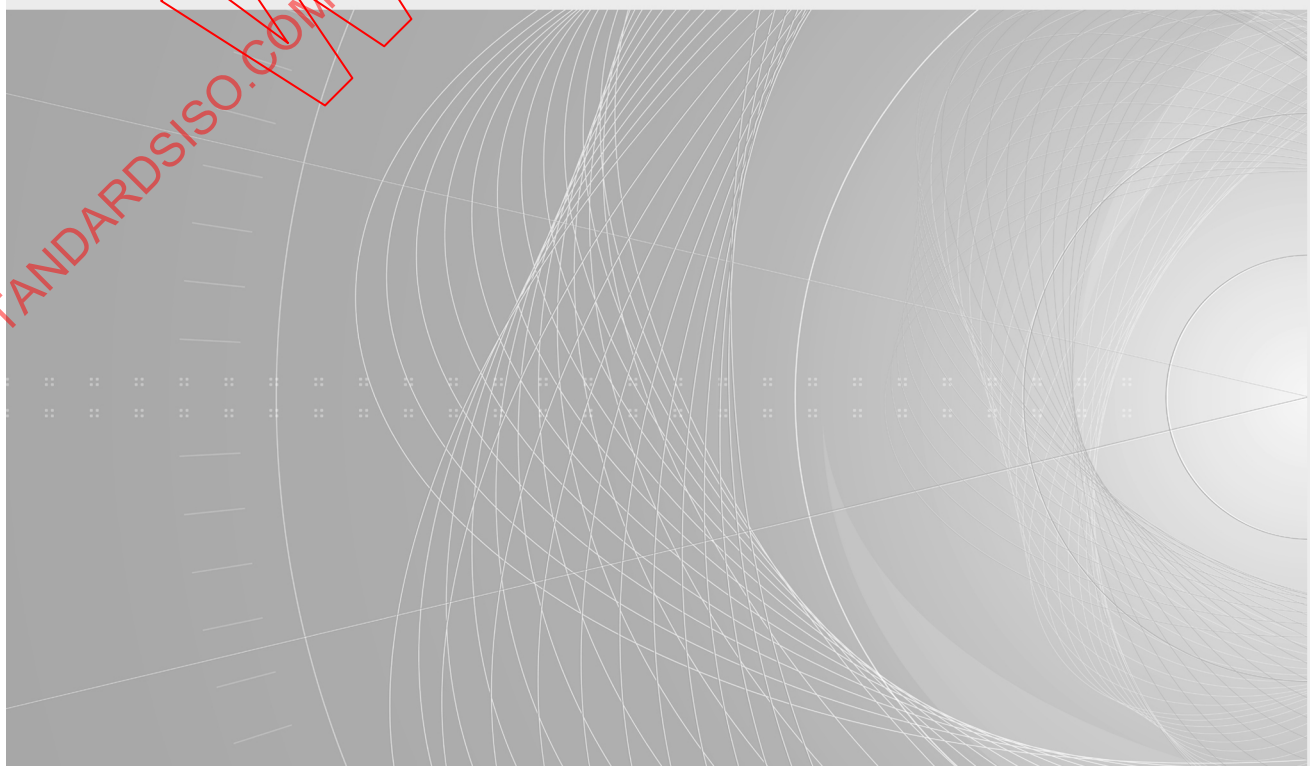

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CONTENTS

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INFORMATION TECHNOLOGY – GENERIC CABLING SYSTEMS FOR DATA CENTRES

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This Consolidated version of ISO/IEC 24764 bears the edition number 1.1. It consists of the first edition (2010-04) and its amendment 1 (2014-04). The technical content is identical to the base edition and its amendment.

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions and deletions are displayed in red, with deletions being struck through. A separate Final version with all changes accepted is available in this publication.

This publication has been prepared for user convenience.

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International Standard ISO/IEC 24764 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

ISO/IEC 24764 is to be read in conjunction with International Standard ISO/IEC 11801:2002, its Amendment 1 (2008) and Amendment 2 (2010).

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

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INTRODUCTION

Within premises, the importance of the information technology cabling infrastructure is similar to that of other fundamental building utilities such as heating, lighting and mains power. As with other utilities, interruptions to service can have serious impact. Poor quality of service due to lack of design foresight, use of inappropriate components, incorrect installation, poor administration or inadequate support can threaten an organisation's effectiveness.

Cabling within data centres comprises both application-specific and multipurpose networks that are mission-critical. Generic cabling designs in accordance with ISO/IEC 11801 have supported the development of high data rate applications based upon a defined cabling model. This International standard recognizes the benefit of generic cabling to provision multiple services and to connect large quantities of equipment within the limited space of data centre premises, and is to be used in conjunction with ISO/IEC 11801.

This International Standard provides:

a) data centre users with an application independent generic cabling system capable of supporting a wide range of applications;

b) data centre users with a flexible cabling scheme such that modifications are both easy and economical;

c) data centre professionals (for example, data centre architects) with guidance allowing the accommodation of cabling before specific requirements are known; that is, in the initial planning either for construction or refurbishment;

d) industry and applications standardization bodies with a cabling system which supports current products and provides a basis for future product development.

This International Standard specifies multi-vendor cabling, and is related to:

- the associated standard covering general requirements for generic cabling within premises (ISO/IEC 11801);
- standards for cabling components developed by technical committees of the IEC;
- standards for the quality assurance, installation and administration of information technology cabling (ISO/IEC 14763-2[1]) and testing of installed cabling (IEC 61935-1 and ISO/IEC 14763-3);
- applications developed by the technical committees of IEC, subcommittees of ISO/IEC JTC 1 and study groups of ITU-T[2].

It is anticipated that the generic cabling system meeting the requirements of this International Standard will have a life expectancy of up to ten years.

This International Standard has taken into account requirements specified in application standards listed in Annex F of ISO/IEC 11801:2002 and Amendment 2 (2010). It refers to International Standards for components and test methods whenever appropriate International Standards are available.

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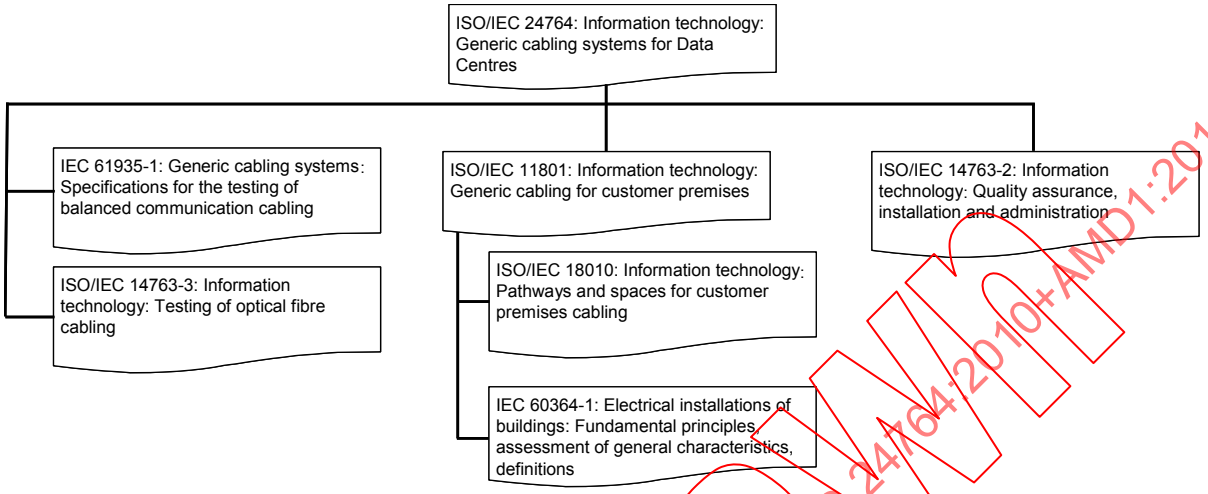
1 Until ISO/IEC 14763-2 is published, relevant information may be found in ISO/IEC 18010.

2 International Telecommunication Union – Telecommunications Standardization Sector.

Figure 1 shows the schematic and contextual relationships between the standards produced by ISO/IEC JTC 1/SC 25 for information technology cabling, namely this and other generic cabling design standards (ISO/IEC 11801), cabling installation standards (ISO/IEC 14763-2[3]), testing of installed cabling (IEC 61935-1 and ISO/IEC 14763-3).



Scheme of the relationship between cabling standards such as ISO/IEC 11801 and other standards relevant for information technology cabling systems.

Figure 1 – Relationship between generic cabling standards

INTRODUCTION to Amendment 1

Amendment 1 of ISO/IEC 24764:2010 provides an introduction to the intermediate cabling subsystem and an explanatory annex for the combination of several permanent links to form a single transmission channel.

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3 Until ISO/IEC 14763-2 is published, relevant information may be found in ISO/IEC 18010.

INFORMATION TECHNOLOGY – GENERIC CABLING SYSTEMS FOR DATA CENTRES

1 Scope

This International Standard specifies generic cabling that supports a wide range of communications services for use within a data centre. It covers balanced cabling and optical fibre cabling.

This International Standard is based upon and references the requirements of ISO/IEC 11801.

This International Standard contains additional requirements that are appropriate to data centres in which the maximum distance over which communications services have to be distributed is 2 000 m. The principles of this International Standard may also be applied to data centre installations that do not fall within this range.

In addition to the requirements of ISO/IEC 11801, this International Standard specifies:

a) a modified structure and configuration for generic cabling within data centres used to support existing and emerging applications;

b) a reference implementation specific to data centre infrastructures.

Data centres have specific pathway and space requirements that are specified in ISO/IEC 14763-2. Until ISO/IEC 14763-2 is published, relevant information may be found in ISO/IEC 18010 (see Bibliography).

Safety (electrical safety and protection, fire, optical power etc.) and electromagnetic compatibility (EMC) requirements are outside the scope of this International Standard and are covered by other standards and regulations. However, information given in this International Standard and those identified in Figure 1 can be of assistance in meeting these other standards and regulations.

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 2002, Information technology – Generic cabling for customer premises
Amendment 1(2008)
Amendment 2(2010)

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

ISO/IEC 14763-3, *Information technology – Implementation and operation of customer premises cabling – Part 3: Testing of optical fibre cabling*

IEC 60603-7 (all parts), *Connectors for electronic equipment – Part 7: Detail specification for 8-way, unshielded, free and fixed connectors*

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IEC 60603-7-2:, *Connectors for electronic equipment – Part 7-2: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 100 MHz*[4]

IEC 60603-7-3:, *Connectors for electronic equipment – Part 7-3: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 100 MHz*[5]

IEC 60603-7-4:, *Connectors for electronic equipment – Part 7-4: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 250 MHz*[6]

IEC 60603-7-5:, *Connectors for electronic equipment – Part 7-5: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 250 MHz*[7]

IEC 60603-7-7:, *Connectors for electronic equipment – Part 7-7: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 600 MHz*[8]

IEC 60603-7-41:, *Connectors for electronic equipment – Part 7-41: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 500 MHz*[9]

IEC 60603-7-51:, *Connectors for electronic equipment – Part 7-51: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 500 MHz*[10]

IEC 60603-7-71:, *Connectors for electronic equipment – Part 7-71: Detail specification for 8-way, shielded, free and fixed connectors, for data transmission with frequencies up to 1 000 MHz*[11]

IEC 60794-2-11, *Optical fibre cables – Part 2-11: Indoor cables – Detailed specification for simplex and duplex cables for use in premises cabling*

IEC 60874-19-1, *Fibre optic interconnecting devices and passive components Connectors for optical fibres and cables – Part 19-1: Fibre optic patch cord connector type SC-PC (floating duplex) standard terminated on multimode fibre type A1a, A1b – Detail specification*

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*

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4 Second edition in preparation.

5 Second edition in preparation.

6 Second edition in preparation.

7 Second edition in preparation.

8 Third edition in preparation.

9 In preparation.

10 In preparation.

11 In preparation.

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 61754-7, *Fibre optic interconnecting devices and passive components – Fibre optic connector interfaces – Part 7: Type MPO connector family*

IEC 61754-20, *Fibre optic connector interfaces – Part 20: Type LC connector family*

IEC 61755-3-2, *Fibre optic connector optical interfaces – Part 3-2: Optical interface, 2,5 mm and 1,25 mm diameter cylindrical full zirconia ferrules for 8 degrees angled-PC single mode fibres*

IEC 61935-1, *Specification for the testing of balanced and coaxial information technology cabling – Part 1: Installed balanced cabling as specified in ISO/IEC 11801 and related standards*

3 Terms and definitions and abbreviations

3.1 Terms and definitions

For the purposes of this International Standard the following terms and definitions apply in addition to those of ISO/IEC 11801.

3.1.1
cabled optical fibre Category
system of defining requirements for the cabled optical fibre performance within optical fibre channels and links.

3.1.2
equipment outlet
fixed connecting device for terminating the zone distribution cabling and providing the interface to the equipment cabling

3.1.3
fixed zone distribution cable
cable connecting the zone distributor to either the equipment outlet or, if present, the local distribution point

3.1.4
local distribution point
connection point in the zone distribution cabling subsystem between a zone distributor and an equipment outlet

3.1.5
local distribution point cable
cable connecting a local distribution point to an equipment outlet

3.1.6
local distribution point link
transmission path between a local distribution point and the interface at the other end of the fixed zone distribution cable including the connecting hardware at each end

3.1.7
main distribution cable
cable connecting the main distributor to the zone distributor

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3.1.8
main distributor
distributor used to make connections between the main distribution cabling subsystem, network access cabling subsystem and cabling subsystems as specified in ISO/IEC 11801 and active equipment

3.1.9
network access cable
cable connecting the external network interface to the main distributor or zone distributor

3.1.10
transition assembly
assembly of cabled optical fibres and connectors, with an array connector on one end and simplex or duplex connectors on the other end

3.1.11
zone distribution cable
cable connecting the zone distributor to the equipment outlet(s) or local distribution point(s)

3.1.12
zone distributor
distributor used to make connections between the main distribution cabling subsystem, zone distribution cabling subsystem, network access cabling subsystem and cabling subsystems specified in ISO/IEC 11801 and active equipment

3.1.13
equipment cord
cord connecting equipment to the equipment interfaces of generic cabling

3.1.14
equipment outlet
fixed connecting device for terminating the zone distribution cabling and providing the interface to the equipment cord

3.1.15
intermediate distribution cable
cable connecting the intermediate distributor to the zone distributor

3.1.16
intermediate distributor
distributor used to make connections between the main distribution cabling subsystem, intermediate distribution cabling subsystem, network access cabling subsystem and cabling subsystems specified in ISO/IEC 11801 and active equipment

3.2 Abbreviations

For the purposes of this International Standard the following abbreviations apply in addition to those of ISO/IEC 11801.

BEF	Building Entrance Facility
ENI	External Network Interface
EO	Equipment Outlet
ID	Intermediate Distributor
ILD	Insertion Loss Deviation
LDP	Local Distribution Point
MD	Main Distributor
OE EQP	Opto-Electronic EQuiPment
ZD	Zone Distributor

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4 Conformance

For a cabling system to conform to this International Standard the following applies.

a) The configuration and structure shall conform to the requirements of Clause 5.

b) The performance of balanced channels shall conform to the transmission performance and environmental requirements of Clause 6. This shall be achieved by one of the following:

   1) a channel design and implementation ensuring that the prescribed channel performance is met;

   2) attachment of appropriate components to a link design meeting the prescribed performance class of Clause 6 and Annex A. Channel performance shall be ensured where a channel is created by adding more than one cord to either end of a link meeting the requirements of Clause 6 and Annex A;

   3) using the reference implementations of Clause 7 and compatible cabling components conforming to the requirements of Clauses 8, 9 and 10, based upon a statistical approach of performance modelling.

c) The implementation and performance of optical fibre cabling channels shall meet the requirements specified in Clause 6.

d) The interfaces to the cabling shall conform to the requirements of Clause 9 with respect to mating interfaces and performance.

e) If present, screens shall be handled as specified in Clause 11 of ISO/IEC 11801.

f) Regulations on safety and EMC applicable at the location of the installation shall be met.

Test methods to assess conformance with the channel and link requirements of Clause 6 and Annex A respectively are specified in IEC 61935-1 for balanced cabling and ISO/IEC 14763-3 for optical fibre cabling. The treatment of measured results that fail to meet the requirements of this clause, or lie within the relevant measurement accuracy, shall be clearly documented within a quality plan as described in ISO/IEC 14763-2[12].

Installation and administration of cabling in accordance with this standard shall be undertaken in accordance with ISO/IEC 14763-2[13].

This International Standard does not specify which tests and sampling levels should be adopted. The test parameters to be measured and the sampling levels to be applied for a particular installation shall be defined in the installation specification and quality plans for that installation prepared in accordance with ISO/IEC 14763-2[14].

In the absence of the channel, the conformance of the link shall be used to verify conformance with this International Standard.

5 Structure of the generic cabling system

5.1 General

This clause identifies the functional elements of generic cabling for data centres, describes how they are connected together to form subsystems and identifies the interfaces at which application-specific components are connected to the generic cabling.

Applications listed in Annex F of ISO/IEC 11801are supported by connecting active equipment at the external network interfaces, equipment outlets and the distributors.

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12 Until ISO/IEC 14763-2 is published, relevant information may be found in ISO/IEC 18010.

13 Until ISO/IEC 14763-2 is published, relevant information may be found in ISO/IEC 18010.

14 Until ISO/IEC 14763-2 is published, relevant information may be found in ISO/IEC 18010.

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The structured cabling system specified by this standard is intended to restrict the use of cords for point-to-point cabling within data centres, which can be detrimental to the administration and operation of the data centre. Exceptions are permitted between equipment located in close proximity or between equipment that cannot communicate over the generic cabling system.

5.2 Functional elements

In addition to the distributors specified in ISO/IEC 11801, this standard specifies the following functional elements and interfaces of generic cabling:

a) external network interface (ENI);
b) network access cable;
c) main distributor (MD);
d) main distribution cable;
e) zone distributor (ZD);
f) zone distribution cable;
g) local distribution point (LDP);
h) local distribution point cable (LDP cable);
i) equipment outlet (EO).

NOTE This standard includes additional functional elements, the intermediate distributor and the intermediate distribution cable. The requirements for these functional elements are defined in Annex C.

Groups of these functional elements are connected together to form cabling subsystems.

5.3 General structure and hierarchy

Generic cabling systems in data centres contain up to three cabling subsystems: network access cabling, main distribution cabling and zone distribution cabling. Where present within the premises, a distributor in accordance with ISO/IEC 11801 is connected to the generic cabling within the data centre using the network access cabling.

The cabling subsystems are connected together to create a generic cabling system with a structure as shown in Figure 2. The composition of the cabling subsystems is described in 5.4.2, 5.4.3 and 5.4.4. The functional elements of the cabling subsystems are interconnected to form a basic hierarchical topology as shown in Figure 3.

~~Where the functions of distributors are combined (see 5.7.1) the intermediate cabling subsystem(s) are not required.~~ The functions of multiple distributors may be combined, see 5.7.1.

NOTE This standard includes an additional cabling subsystem: the intermediate cabling subsystem. The requirements for this additional cabling subsystem and the modifications to the cabling subsystems of this clause are defined in Annex C.

Connections between cabling subsystems are either active, requiring application-specific equipment, or passive. Connection to application-specific equipment at an MD or a ZD adopts either an interconnect or a cross-connect approach (see ISO/IEC 11801). Connection to application-specific equipment at an ENI and EO adopts an interconnect approach (see ISO/IEC 11801). Passive connections between cabling subsystems adopt either a cross-connect approach, by way of either patch cords or jumpers, or an interconnect approach.

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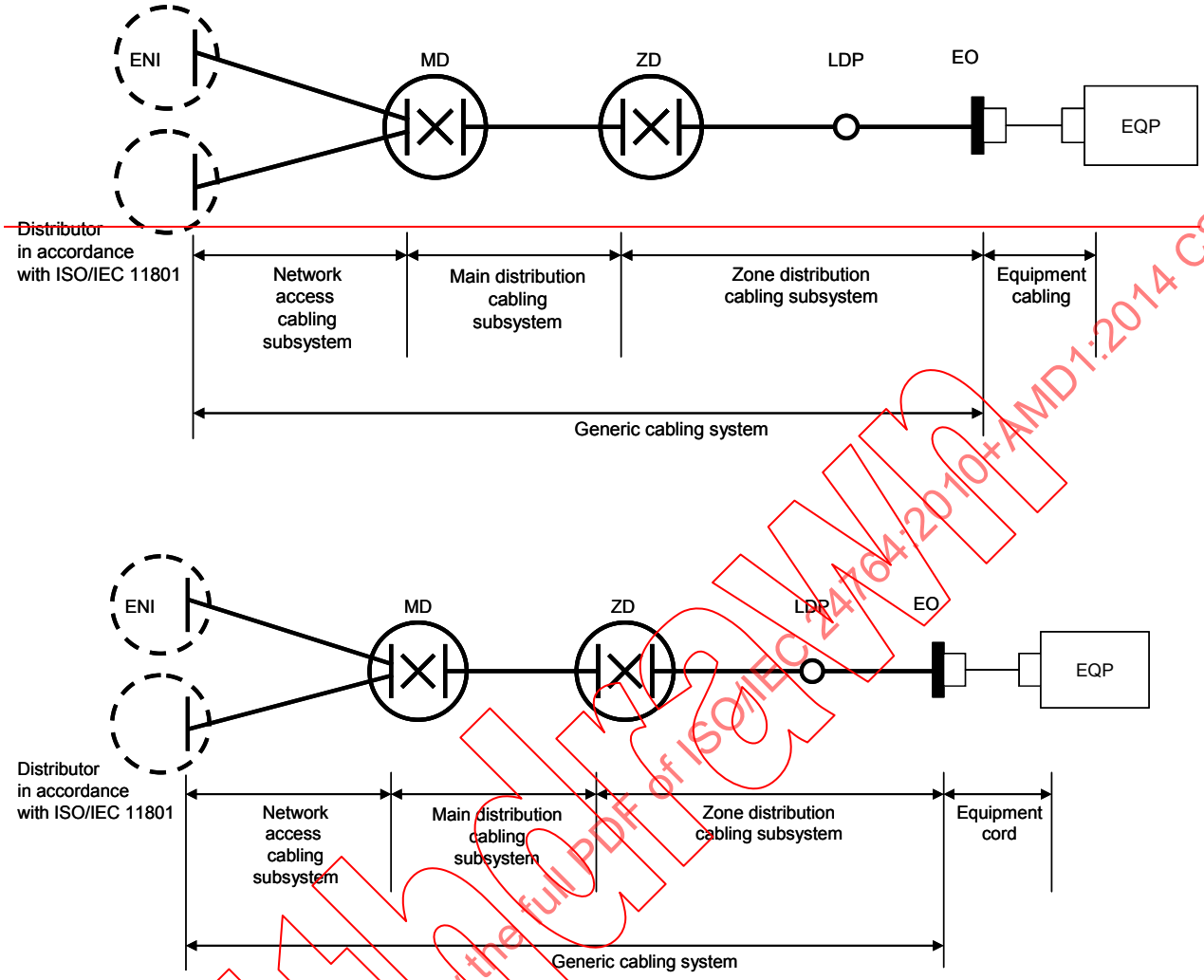

Figure 2 – Structure of generic cabling within a data centre

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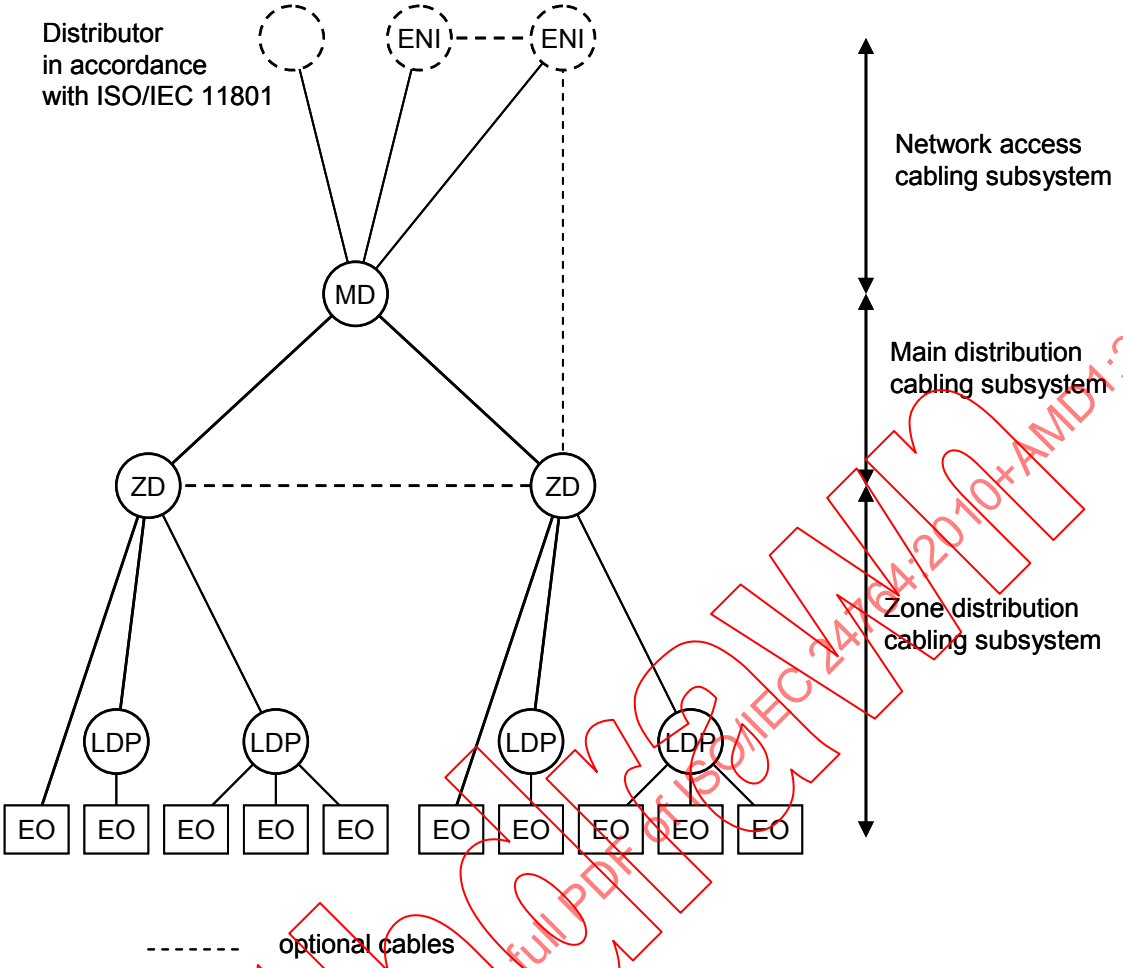

NOTE Network access cabling is also used to connect ENI to ZD.

Figure 3 – Hierarchical structure of generic cabling within a data centre

5.4 Cabling subsystems

5.4.1 General

Although equipment cords are used to connect the equipment to a cabling subsystem, they are not considered part of the cabling subsystem.

5.4.2 Network access cabling subsystem

The network access cabling subsystem extends from an MD (or ZD) to the ENIs and/or other distributors (in accordance with ISO/IEC 11801) connected to it.

The subsystem includes:

a) the network access cables;

b) the mechanical termination of the network access cables at the ENI(s);

c) the mechanical termination of the network access cables at the MD, ZD(s) or other distributors in accordance with ISO/IEC 11801.

5.4.3 Main distribution cabling subsystem

The main distribution cabling subsystem extends from an MD to the ZD(s) connected to it. The subsystem includes:

a) the main distribution cables;

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b) the mechanical termination of the main distribution cables at the MD together with associated patch cords and/or jumpers at the MD;

c) the mechanical termination of the main distribution cables at the ZD(s).

5.4.4 Zone distribution cabling subsystem

The zone distribution cabling subsystem extends from a ZD to the EO(s) connected to it. The subsystem includes:

a) the zone distribution cables;

b) the mechanical termination of the zone distribution cables at the EO(s) and the ZD together with associated patch cords and/or jumpers at the ZD;

c) LDP(s) (optional);

d) LDP cable(s) (optional)

e) the EO(s).

Zone distribution cables shall be continuous from the ZD to the EO(s) unless (an) LDP(s) is (are) installed (see 5.7.8).

5.4.5 Design objectives

In order to provide the longest operational life while minimising the disruption and cost associated with re-cabling, the fixed installed cabling should be designed to:

- support the broadest set of existing and emerging applications;
- accommodate the anticipated growth in volume of supported applications throughout the predicted lifetime of the installation.

In addition the provision of redundancy within a cabling design should be considered (see also 5.7.1).

5.5 Accommodation of functional elements

Figure 4 shows an example of how the functional elements are accommodated in a building (only a single floor of the building is shown for simplicity).

The MD, ZD and LDP shall be housed in permanent and accessible locations within the data centre.

The ENI shall be housed in permanent and accessible location either internal or external to the data centre.

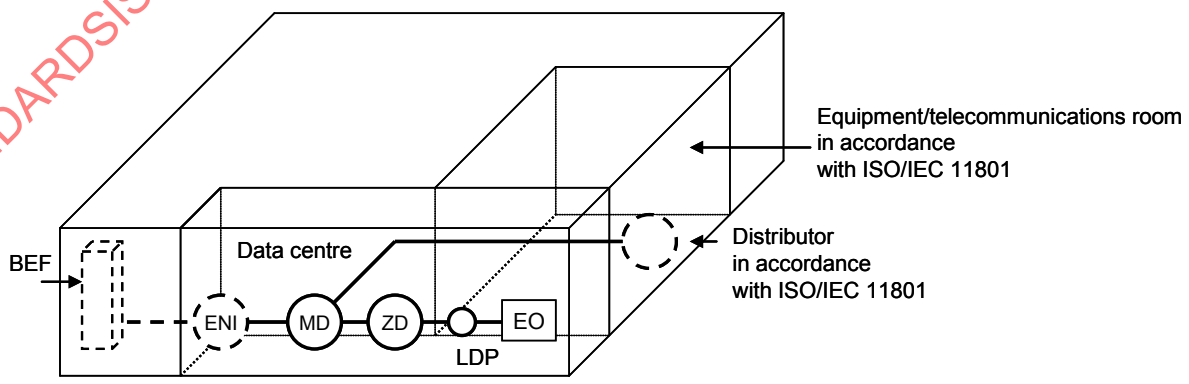

Figure 4 – Example of accommodation of functional elements

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5.6 Interfaces

5.6.1 Equipment interfaces and test interfaces

Potential equipment interfaces for data centres are located at the ends of the cabling subsystems (as shown in Figure 5). An LDP does not provide an equipment interface to the generic cabling system.

Potential test interfaces for data centres are located at the ends of the cabling subsystems and at the LDP, if present (as shown in Figure 5).

5.6.2 Channels and links

The transmission performance of generic cabling is detailed in Clause 6 for channels and Annex A for links.

The channel is the transmission path between data centre equipment such as a switches and servers (EQP in Figure 5). A typical channel in a data centre would consist of the zone distribution cabling subsystem together with an equipment cord at each end. For longer reach services, the channel would be formed by the connection of two or more subsystems (including patch cords and equipment cords), see Annex D. The performance of the channel excludes the connections at the application-specific equipment.

The permanent link is the transmission path of ~~an installed~~ the fixed cabling subsystem, including the connecting hardware at the ends of the installed cable. In a data centre zone distribution cabling subsystem, the permanent link consists of the EO, an optional LDP cable, an optional LDP, the zone distribution cable and the termination of the zone distribution cable at the zone distributor. The permanent link includes the connections at the ends of the installed cabling.

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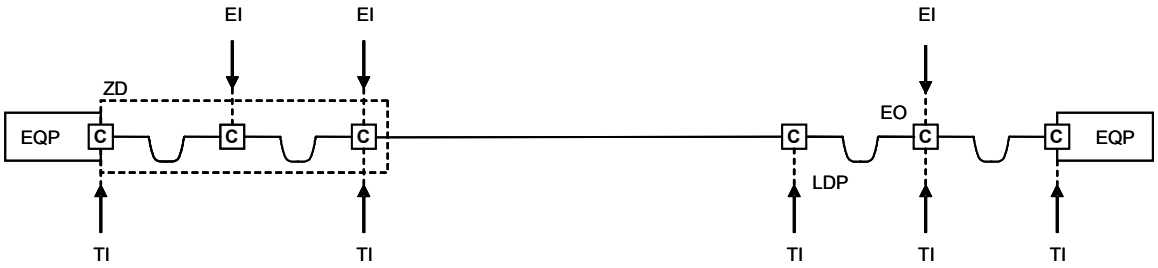

Figure 5a – Zone distribution cabling

Figure 5b – Main distribution cabling

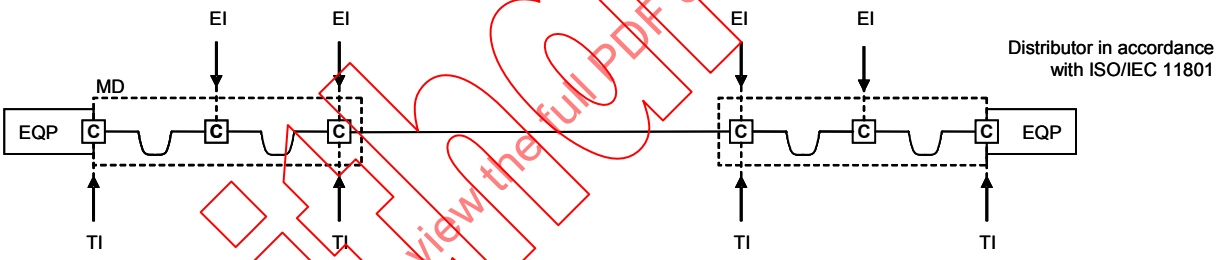

Figure 5c – Network access cabling from MD to distributor in accordance with ISO/IEC 11801

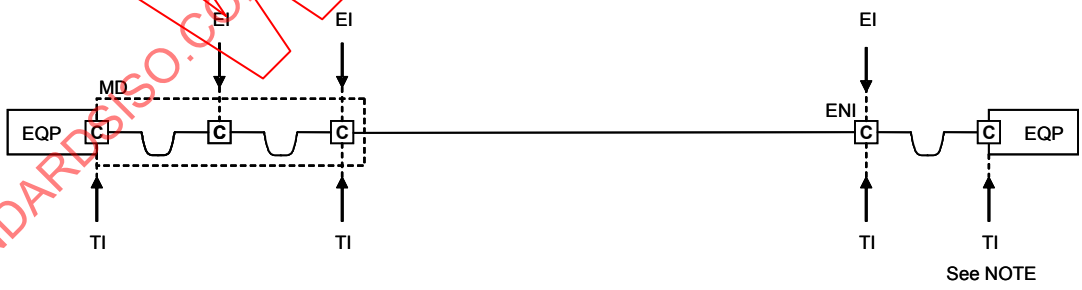

Figure 5d – Network access cabling from MD to ENI

NOTE Where the EQP connected to the ENI lies outside the premises containing the data centres, the interconnecting cord will typically comprise a combination of fixed cabling and cords that are outside the scope of this standard. In such cases the connection to the EQP may not provide a TI.

Figure 5 – Test and equipment interfaces

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5.7 Dimensioning and configuring

5.7.1 Distributors

The number and type of subsystems that are included in a generic cabling implementation depends upon the layout and size of the data centre and upon the strategy of the user.

The design of distributors shall ensure that the length of patch cords, jumpers and equipment cords are minimized, and administration should ensure that the design lengths are maintained during operation. Administration should ensure that the requirements of ISO/IEC 11801 are observed regarding the mixing of optical fibre types at the distributors. Distributors should be located in such a way that the resulting cable lengths are consistent with the channel performance requirements of Clause 6.

Where the components of Clauses 8, 9 and 10 are used, the distributors shall be located in accordance with the reference implementations of Clause 7. Where other components are used, the distributors shall be located so that the desired performance Class of Clause 6 is delivered.

The functions of multiple distributors may be combined into a single distributor. For example, an MD may serve the function of a ZD. However, every data centre must have at least one MD.

5.7.2 Redundancy

Consideration should be given to the resilience of the data centre with respect to the cabling infrastructure. This may be enhanced by the provision of redundant distributors, cabling, and pathways.

In certain circumstances, for example for security or reliability reasons, redundancy may be built into a cabling design. Figure 6 shows one of many possible examples of the connection of functional elements within the structured framework to provide such protection against failure in one or more parts of the cabling infrastructure. This might form the basis for the design of generic cabling for a data centre providing some protection against such hazards as fire damage or the failure of an external network.

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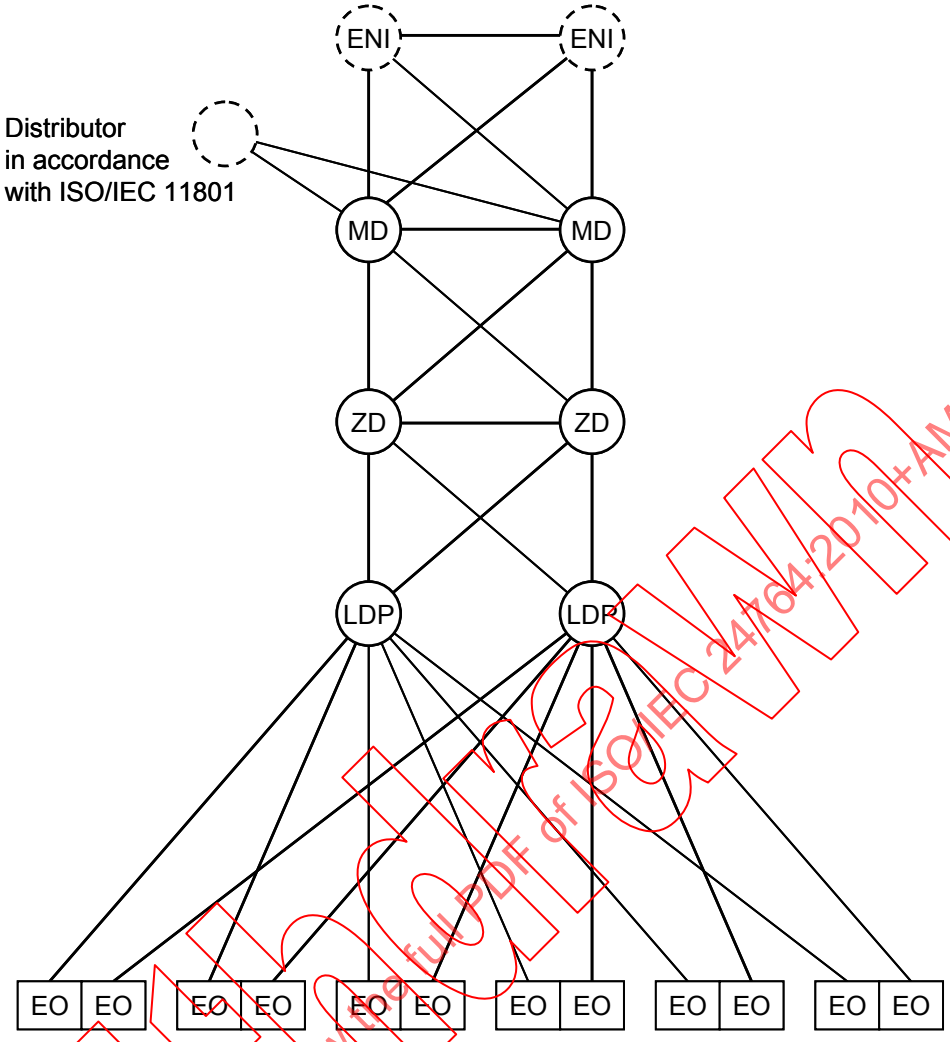

Figure 6 – Connection of functional elements providing redundancy

Additionally, redundancy may be provided by utilizing multiple cables between distributors, with cables following different routes.

NOTE Connections between ZD and ZD are in addition to the connection between MD and ZD and not a replacement for the MD to ZD connection.

5.7.3 External network interface

The ENI provides a termination of the network access cabling that allows connection of external services to the network access cabling as shown in Figure 7.

NOTE The multiple service providers should have diverse routes to each of the multiple ENIs.

The ENI shall be in accordance with Clause 9.

Where the components of Clauses 8, 9 and 10 are used, the ENIs shall be located in accordance with the reference implementations of Clause 7.

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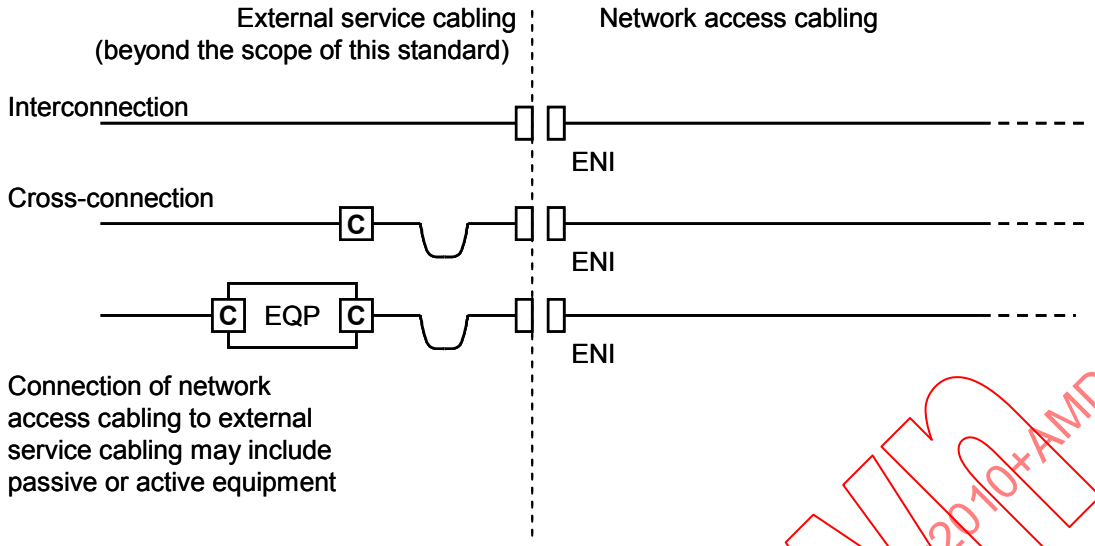

Figure 7 – Examples of external service cabling connections to the ENI

5.7.4 Cables

Cable types used in the reference implementations of Clause 7 are specified in Clause 8.

5.7.5 Equipment cords

Equipment cords are non-permanent and can be application-specific.

5.7.6 Patch cords and jumpers

Patch cords and jumpers are used within cross-connect implementations at distributors. The performance contribution of these cords shall be taken into account in the design of the channel. Clause 7 provides guidance on cord/jumper lengths for reference implementations of generic cabling.

5.7.7 Equipment outlets

The design of generic cabling should provide for EOs to be installed with a high density and located in close proximity to the application-specific equipment to which they are to be connected. The number of cable elements presented at the EO is not restricted by this standard.

A group of EOs can be served directly by multiple ZDs, or by multiple ZDs via multiple LDPs.

The EO interface presented shall be in accordance with Clause 9.

5.7.8 LDP

The installation of an LDP in the zone distribution cabling between the ZD and the EO may be useful where frequent additions or movements of equipment are required. One LDP is permitted between a ZD and any EO. The LDP shall be an interconnect, not a cross-connect, because the LDP adds one connection per channel or link. There shall be no active equipment in the LDP area with the exception of DC powering equipment.

Where an LDP is used, it shall have sufficient capacity to support the area of the data centre which it is designed to serve during its intended operational life. The area served may be defined in terms of number of frames/cabinets/closures to be supported and should include allowance for growth.

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Provided that the requirements of 5.5 are met, LDP(s) may be located in ceiling voids or under floors.

For balanced cabling, the effect of multiple connections in close proximity on transmission performance should be taken into consideration when planning the cable lengths between the ZD and the LDP.

5.7.9 Building entrance facilities

See 5.7.8 of ISO/IEC 11801:2002 and Amendment 1 (2008).

5.8 Earthing and equipotential bonding

See ISO/IEC 14763-2[15].

6 Channel performance

6.1 General

This clause specifies the minimum channel performance of balanced and optical fibre cabling in terms of the Classes as specified in 6.2. The transmission performance of channels is specified at and between the connections to active equipment as shown in Figure 8. The channel comprises only passive sections of cable, connections, equipment cords, patch cords and jumpers.

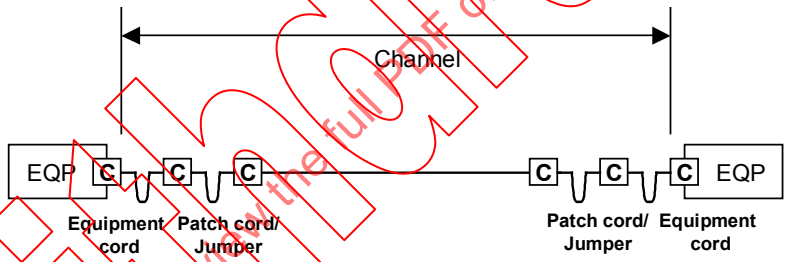

Figure 8 – Example of a channel with 4 connections

Application support depends on channel performance only, which in turn depends on cable length, number of connections, connector termination practices and workmanship.

Channels are implemented using either:

- network access cabling only;
- main distribution cabling only;
- zone distribution cabling only;
- a combination of the above, see Annex D.

Figure 9 shows an example of equipment at the MD connected to equipment at the EO using two channels, an optical fibre cabling channel and a balanced cabling channel. The optical fibre and balanced cabling channels are connected together using an optical fibre to balanced cable converter. There are four channel interfaces; one at each end of the balanced cabling channel, and one at each end of the optical fibre cabling channel.

15 Until ISO/IEC 14763-2 is published, relevant information may be found in ISO/IEC 18010.

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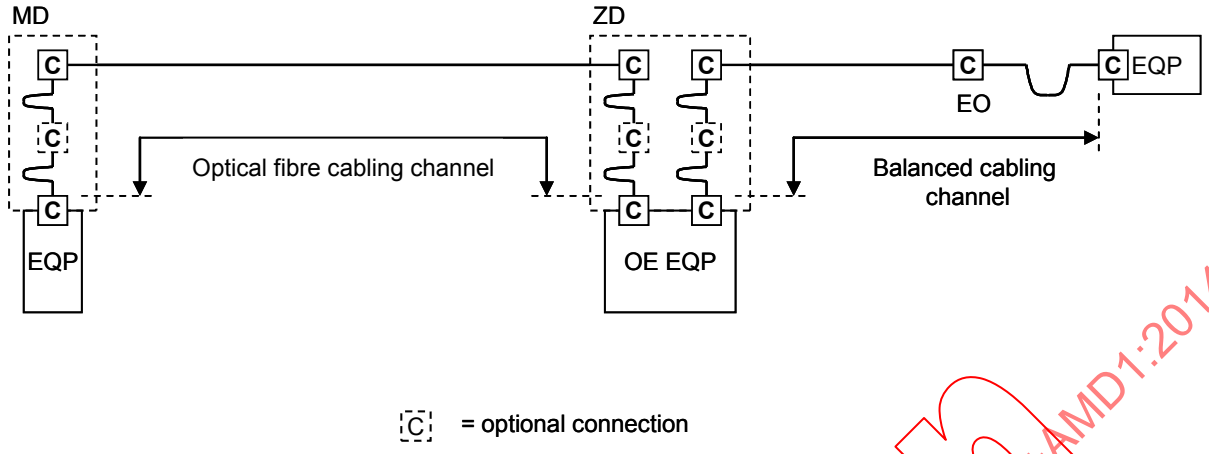

Figure 9 – Example of a system showing the location of cabling interfaces

6.2 Transmission performance

6.2.1 General

The channel transmission performance specifications are separated into Classes that allow for the transmission of the applications in Annex F of ISO/IEC 11801:2002.

The channel performance requirements described in this clause shall be used for the design and may be used for verification of any implementation of this International Standard, using the test methods defined, or referred to, in this clause. In addition, these requirements can be used for application development and trouble shooting.

The channel specifications in this clause allow for the transmission of defined Classes of applications over distances other than those of Clause 7, and/or using media and components with different transmission performance than those of Clauses 8, 9 and 10.

Consideration should be given to measuring performance at worst case temperatures, or calculating worst case performance based on measurements made at other temperatures.

Link performance requirements are specified in Annex A.

6.2.2 Balanced cabling

The main distribution and zone distribution cabling shall be designed to provide a minimum of Class E_A channel performance as specified in ISO/IEC 11801.

6.2.3 Optical fibre cabling

Optical fibre cabling shall be designed using the optical fibre cables specified in Clause 8. Where multimode optical fibre is used, the main distribution and zone distribution cabling shall provide channel performance as specified in ISO/IEC 11801 using a minimum of Category OM3 cabled optical fibre and optical connecting hardware as specified in 9.3.

7 Reference implementations

7.1 General

This clause describes implementations of generic cabling that utilise components referenced in Clauses 8, 9 and 10. These reference implementations meet the requirements of Clause 5

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and, when installed in accordance with ISO/IEC 14763-2[16], comply with the channel performance requirements of Clause 6.

7.2 Balanced cabling

7.2.1 Assumptions

Balanced cabling components referenced in Clauses 8, 9 and 10 are defined in terms of Category. In the reference implementations of this clause, the components used in each cabling channel shall have the same nominal characteristic impedance in accordance with 7.2 of ISO/IEC 11801:2002 and Amendment 2 (2010).

Cables and connections of different Categories should not be mixed within a channel. If different Categories are mixed, the resultant cabling performance will be determined by the Category of the lowest performing component.

The implementations are based on component performance at 20 °C. The effect of temperature on the performance of cables shall be taken into account as shown in Table 2, Table 4 and Table 5.

7.2.2 Zone distribution cabling

7.2.2.1 Component choice

The selection of balanced cabling components will be determined by the Class of applications to be supported by the cabling. Refer to Annex F of ISO/IEC 11801for guidance.

Using the models of 7.2.2.2:

- Category 6_A components provide Class E_A balanced cabling performance;
- Category 7 components provide Class F balanced cabling performance;
- Category 7_A components provide Class F_A balanced cabling performance.

7.2.2.2 Dimensions

Figure 10 shows the models used to correlate zone distribution cabling dimensions specified in this clause with the channel specifications in Clause 6.

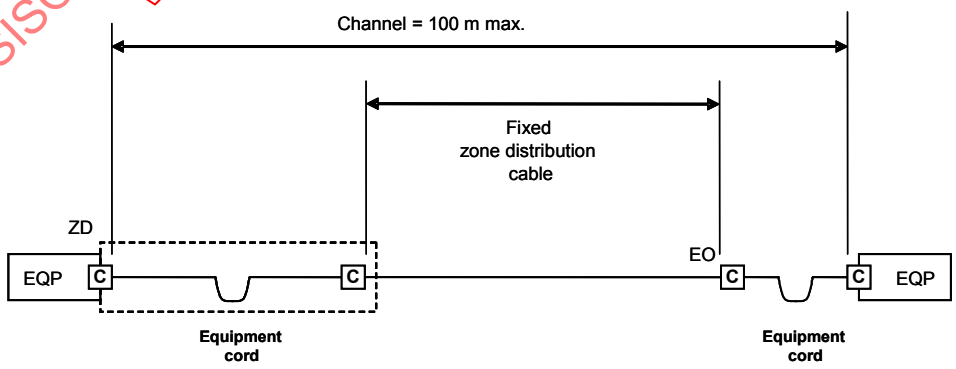

Figure 10a – Interconnect – EO model

[16] Until ISO/IEC 14763-2 is published, relevant information may be found in ISO/IEC 18010.

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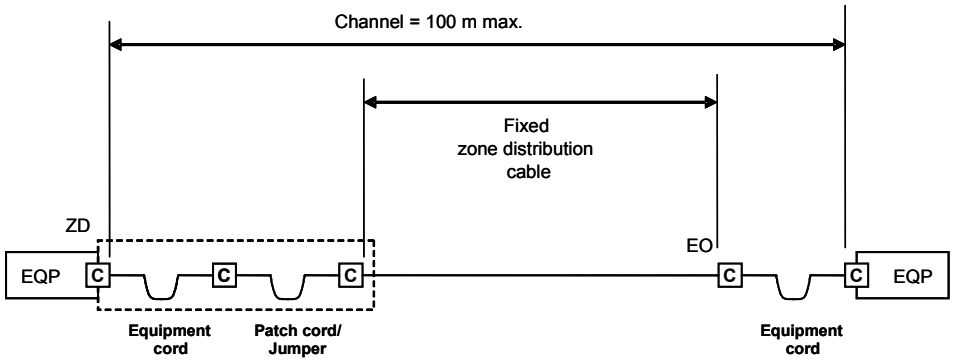

Figure 10b – Cross-connect – EO model

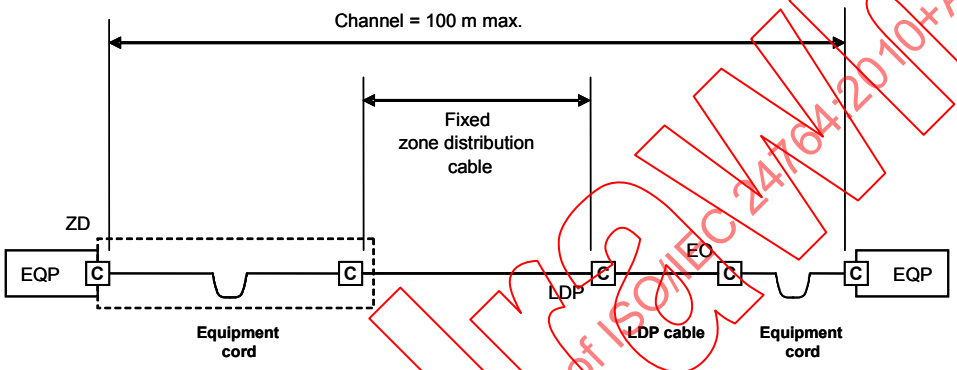

Figure 10c – Interconnect – LDP – EO model

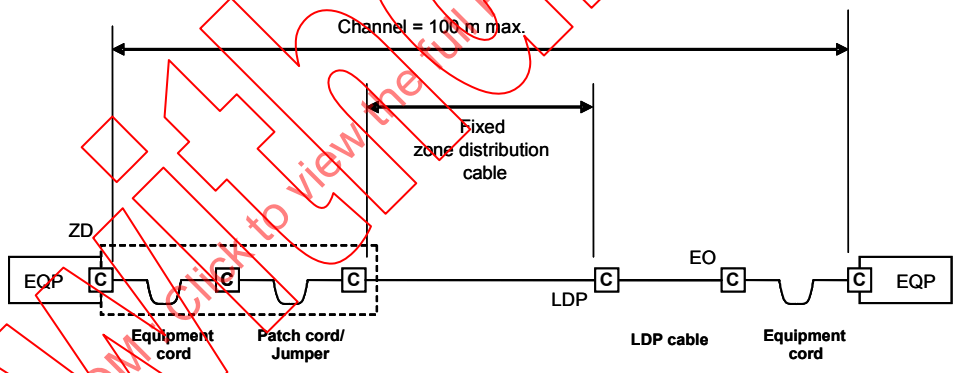

Figure 10d – Cross-connect– LDP – EO model

Figure 10 – Zone distribution cabling models

Figure 10a shows a channel containing only an interconnect and an EO. Figure 10b contains an additional connection as a cross-connect. In both cases the fixed horizontal cable connects the ZD to the EO. The channel includes patch cords and equipment cords. For the purposes of this subclause, jumpers used in place of patch cords are treated as cords.

Figure 10c shows a channel containing an interconnect, an LDP and an EO. Figure 10d contains an additional connection as a cross-connect. In both cases the fixed zone distribution cable connects the ZD to the LDP. The channel includes patch cords and equipment cords. For the purposes of this subclause, jumpers used in place of patch cords are treated as cords.

In addition to the cords, the channels shown in Figure 10c and Figure 10d contain an LDP cable. The insertion loss specification for the LDP cable may differ from that of both the fixed

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zone distribution cable and the flexible cables. The channel of Figure 10d is recognized as the maximum implementation used to define the channel performance limits of Clause 6.

In order to accommodate cables used for LDP cables, patch cords, jumpers and equipment cords with different insertion loss specifications, the maximum cable length used within a channel shall be determined by the equations shown in Table 2.

In Table 2 it is assumed that

a) the flexible cable within these cords has a higher insertion loss specification than that used in the fixed zone distribution cable (see Clause 10),

b) the cables within these cords in the channel have a common insertion loss specification.

The following general restrictions apply:

a) the physical length of the channel shall not exceed 100 m;

b) the physical length of the fixed zone distribution cable shall not exceed 90 m and may be less depending on the length of LDP cables and cords used and the number of connections.

Table 1 contains the length assumptions of the mathematical model used to validate channel performance using components specified in Clauses 8, 9 and 10. They do not represent absolute restrictions on the implementation of channels and permanent links, but may be used for guidance in reference implementations. Table 1 gives the length assumptions used in the mathematical modelling of balanced zone distribution cabling.

Table 1 – Zone distribution cabling – length assumptions for balanced cabling

Segment	Minimum m	Maximum m
ZD-LDP	15	85
LDP-EO	5	–
ZD-EO (no LDP)	15	90
Equipment cord at the EO	2[a]	5
Patch cord	2	–
Equipment cord at the ZD	2[b]	5
All cords	–	10

[a] If there is no LDP, the minimum length of the equipment cord is 1 m.

[b] If there is no cross-connect, the minimum length of the equipment cord is 1 m.

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Table 2 – Zone distribution channel length equations

Model	Figure	Implementation equations	
		Class E_A	Class F and Class F_A
Interconnect-EO	10a	$Z = 104^a - F \times X$	$Z = 105^a - F \times X$
Cross-connect-EO	10b	$Z = 103^a - F \times X$	$Z = 103^a - F \times X$
Interconnect-LDP-EO	10c	$Z = 103^a - F \times X - L \times Y$	$Z = 103^a - F \times X - L \times Y$
Cross-connect-LDP-EO	10d	$Z = 102^a - F \times X - L \times Y$	$Z = 102^a - F \times X - L \times Y$
For operating temperatures above 20 °C, Z should be reduced by 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.			
Key			
Z maximum length of the fixed zone distribution cable (m)			
F combined length of patch cords, jumpers and equipment cords (m)			
L length of the LDP cable (m)			
X ratio of flexible cable insertion loss (dB/m) to fixed zone distribution cable insertion loss (dB/m)			
Y ratio of LDP cable insertion loss (dB/m) to fixed zone distribution cable insertion loss (dB/m) - see			
[a] This includes a length reduction allocation to accommodate ILD.			

7.2.3 Main distribution cabling

7.2.3.1 Component choice

The selection of balanced cabling components will be determined by the Class of applications to be supported by the cabling. Refer to Annex F of ISO/IEC 11801for guidance.

Using the models of 7.2.3.2:

- Category 6_A components provide Class E_A balanced cabling performance;
- Category 7 components provide Class F balanced cabling performance;
- Category 7_A components provide Class F_A balanced cabling performance.

7.2.3.2 Dimensions

The connection of application-specific equipment to the main distribution cabling at the MD and ZDs adopts either an interconnect or cross-connect approach (see ISO/IEC 11801). The channel includes patch cords and equipment cords. For the purposes of this sub clause, jumpers used in place of patch cords are treated as cords.

Figure 11 shows the model used to correlate main distribution cabling dimensions specified in this clause with the channel specifications in Clause 5. This figure represents the full configuration for the main distribution channel.

Table 3 contains the length assumptions of the mathematical model used to validate Channel performance using components specified in Clauses 8, 9 and 10. They do not represent absolute restrictions on the implementation of channels and permanent links, but may be used for guidance in reference implementations. Table 3 gives the length assumptions used in the mathematical modelling of balanced main distribution cabling.

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Table 3 – Main distribution cabling – Length assumptions for balanced cabling

Segment	Minimum m	Maximum m
MD-ZD	15	90
Equipment cord at the MD	2[a]	5
Equipment cord at the ZD	2[b]	5
Patch cord	2	–
All cords	–	10

[a] If there is no cross-connect at the MD, the minimum length of the equipment cord at the MD is 1 m.

[b] If there is no cross-connect at the ZD, the minimum length of the equipment cord at the ZD is 1 m.

The maximum length of the fixed main distribution cable will depend on the total length of cords to be supported within a channel.

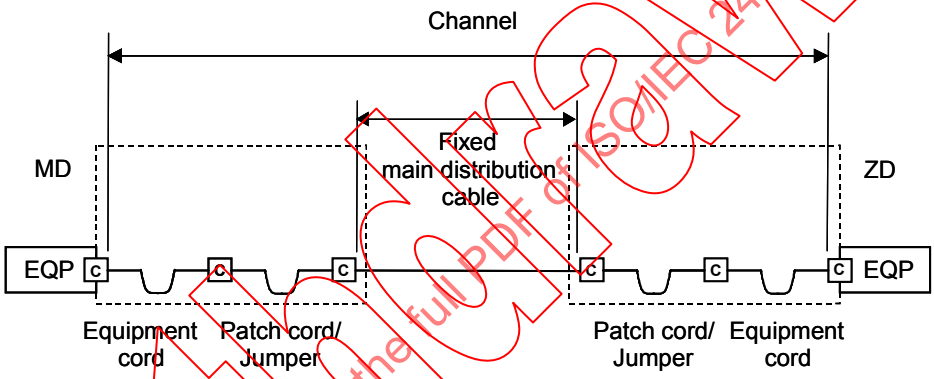

Figure 11 – Main distribution cabling models

In order to accommodate the higher insertion loss of flexible cables used for cords, the length of the cables used within a channel of a given Class (see Clause 6) shall be determined by the equations shown in Table 4.

In Table 4 it is assumed that

a) the flexible cable within these cords has a higher insertion loss specification than that used in the fixed main distribution cable (see Clause 10),

b) the cables within these cords in the channel have a common insertion loss specification.

The following general restrictions apply:

a) the physical length of the channel shall not exceed 100 m;

b) the physical length of the fixed main distribution cable shall not exceed 90 m and may be less depending on the length of cords used and the number of connections;

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Table 4 – Main distribution channel length equations

Model	Implementation equations	
	Class E_A	Class F and Class F_A
Interconnect-interconnect	$M = 104^a - F \times X$	$M = 105^a - F \times X$
Interconnect-cross-connect	$M = 103^a - F \times X$	$M = 103^a - F \times X$
Cross-connect—cross-connect	$M = 102^a - F \times X$	$M = 102^a - F \times X$
For operating temperatures above 20 °C, *M* should be reduced by 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.		
Key *M* maximum length of the fixed main distribution cable (m) *F* combined length of patch cords, jumpers and equipment cords (m) *X* ratio of flexible cable insertion loss (dB/m) to fixed main distribution cable insertion loss (dB/m)		
[a] This includes a length reduction allocation to accommodate ILD.		

7.2.4 Network access cabling

7.2.4.1 Component choice

The selection of balanced cabling components will be determined by the channel lengths required and the Class of applications to be supported. Refer to Annex F of ISO/IEC 11801for guidance.

7.2.4.2 Dimensions

Figure 12 shows the model used to correlate cabling dimensions specified in this clause with the channel specifications in Clause 5. The network access channel shown contains a cross-connect at both ends and represents the worst-case configuration for a network access cabling channel between an MD and a distributor in accordance with ISO/IEC 11801. A channel between an ENI and an MD contains an interconnect at the ENI.

The channel includes patch cords and equipment cords. For the purposes of this clause, jumpers used in place of patch cords are treated as cords.

In Table 5 it is assumed that

a) the flexible cable within these cords has a higher insertion loss specification than that used in the fixed network access cable,

b) the cables within all these cords in the channel have a common insertion loss specification.

In order to accommodate the higher insertion loss of flexible cables used for cords, the length of the cables used within a channel of a given class (see clause 6) shall be determined by the equations shown in Table 5.

When four connections are used in a channel, the physical length of the network access cable should be at least 15 m.

The maximum length of the fixed network access cable will depend on the total length of cords to be supported within a channel. The maximum lengths of cords shall be fixed for ENIs and distributors.

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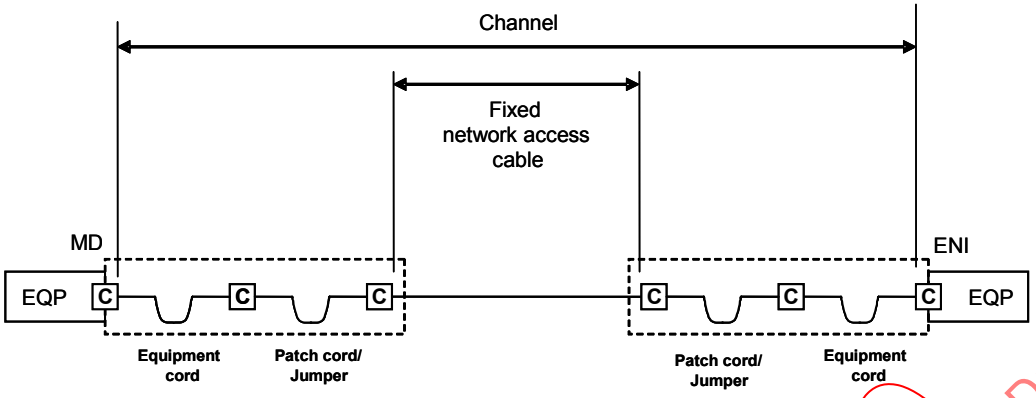

Figure 12a – Network access cabling from MD to ENI

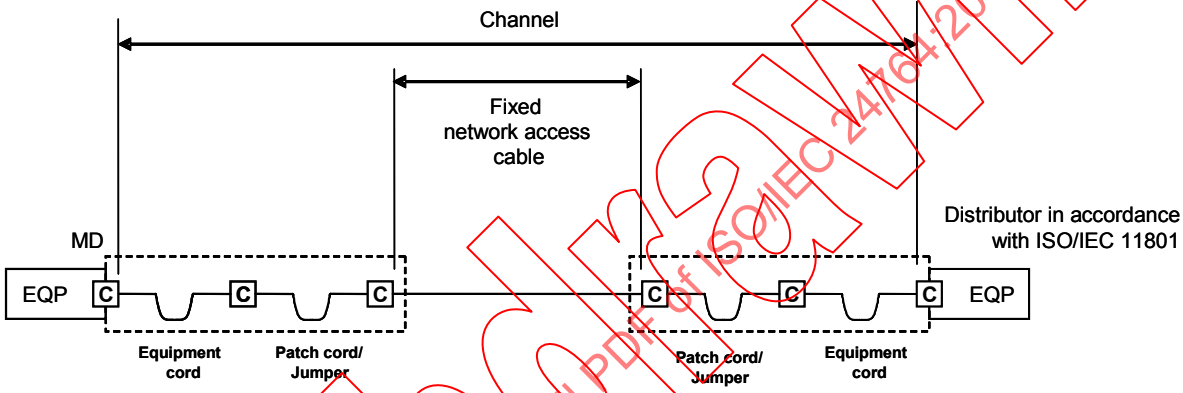

Figure 12b – Network access cabling from MD to distibutor in accordance with ISO/IEC 11801

NOTE Where the EQP connected to the ENI lies outside the premises containing the data centres, the interconnecting cord will typically comprise a combination of fixed cabling and cords that are outside the scope of this standard. In such cases the connection to the EQP may not provide a TI.

Figure 12 – Network access cabling models

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Table 5 – Network access cabling channel equations

Component	Implementation equations [a]							
Category	Class A	Class B	Class C	Class D	Class E	Class E_A	Class F	Class F_A
5	2 000	$N = 250 - F \times X$	$N = 170 - F \times X$	$N = 105 - F \times X$				
6	2 000	$N = 260 - F \times X$	$N = 185 - F \times X$	$N = 111 - F \times X$	$N = 102$[b] $- F \times X$			
6_A	2 000	$N = 260 - F \times X$	$N = 185 - F \times X$	$N = 111 - F \times X$	$N = 102$[b] $- F \times X$	$N = 102$[b] $- F \times X$		
7	2 000	$N = 260 - F \times X$	$N = 190 - F \times X$	$N = 115 - F \times X$	$N = 104$[b] $- F \times X$	$N = 104$[b] $- F \times X$	$N = 102$[b] $- F \times X$	
7_A	2 000	$N = 260 - F \times X$	$N = 190 - F \times X$	$N = 115 - F \times X$	$N = 104$[b] $- F \times X$	$N = 104$[b] $- F \times X$	$N = 102$[b] $- F \times X$	$N = 102$[b] $- F \times X$

Key

N length of the fixed backbone cable (m)

F combined length of patch cords, jumpers and equipment cords (m)

X ratio of flexible cable insertion loss (dB/m) to fixed network access cable insertion loss (dB/m)

NOTE 1 Where channels contain a different number of connections than in the model shown in Figure 12, the Equation is met when the fixed cable length is reduced (where more connections exist) or or increased (where fewer connections exist) by 2 m per connection for Category 5 connections and 1 m per connection for Category 6 and above connections. Additionally, the NEXT, Return Loss (RL) and ACR-F performance should be verified. Category 5 and Category 6 components and Class A through Class E channels may only be used for network access cabling.

NOTE 2 For operating temperatures above 20 °C, N should be reduced by 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.

[a] Applications limited by propagation delay or skew may not be supported if channel lengths exceed 100 m.

[b] This includes a length reduction allocation to accommodate ILD.

7.3 Optical fibre cabling

7.3.1 Assumptions

Optical fibre components are referenced in Clauses 8, 9 and 10. The optical fibres are defined in terms of physical construction (core/cladding diameter) and their transmission performance Category within a cable. Within the reference implementations of this clause, the cabled optical fibres used in each cabling channel shall be of the same specification.

7.3.2 Component choice

The selection of optical fibre components will be determined by the channel lengths required and the applications to be supported. Refer to Annex F of ISO/IEC 11801:2002/Amd.2 for guidance.

7.3.3 Optical fibre cabling channel lengths

The models of Figure 10, Figure 11 and Figure 12 are applicable to optical fibre cabling for zone distribution cabling, main distribution cabling and network access cabling respectively. The channel length restriction of Figure 10 does not apply, but is instead limited by channel length restrictions of the cabled optical fibre Category used. It should be noted that the connection systems used to terminate fixed optical fibre cabling may contain mated connections and splices (permanent or re-usable) and that cross-connects may comprise re-usable splices.

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8 Cable requirements

8.1 General

This clause defines the minimum requirements for

a) cables installed in the main distribution, zone distribution and network access cabling subsystems specified in Clause 5 and used in the reference implementations of Clause 7,

b) flexible balanced cables to be assembled as cords as specified in Clause 10 and used in the reference implementations of Clause 7,

c) balanced cables or cable elements to be used as jumpers.

8.2 Balanced cables

The electrical performance of balanced cables, other than for network access cabling, shall meet a minimum of Category $6_{A,}$ requirements according to 9.2 of ISO/IEC 11801:2002/Amd.2.

8.3 Optical fibre cables

See 9.4 of ISO/IEC 11801:2002 and Amendment 2 (2010).

9 Connecting hardware requirements

9.1 General requirements

9.1.1 Overview

Hardware for connecting cables shall only provide direct onward attachment for each conductor and shall not provide any contact between more than one incoming and one outgoing conductor (e.g. bridge taps shall not be used).

9.1.2 Applicability

See 10.1.1 of ISO/IEC 11801:2002 and Amendment 2 (2010).

9.1.3 Location

Connecting hardware is installed at the

a) ENI,

b) MD and ZD,

c) LDP (if provided),

d) EO.

9.1.4 Design

See 10.1.3 of ISO/IEC 11801:2002 and Amendment 1 (2008).

9.1.5 Operating environment

See 10.1.4 of ISO/IEC 11801:2002 and Amendment 1 (2008).

9.1.6 Mounting

See 10.1.5 of ISO/IEC 11801:2002 and Amendment 1 (2008).

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9.1.7 Installation practices

See 10.1.6 of ISO/IEC 11801:2002 and Amendment 1 (2008).

9.1.8 Marking and colour coding

See 10.1.7 of ISO/IEC 11801:2002 and Amendment 1 (2008).

9.2 Connecting hardware for balanced cabling

9.2.1 General requirements

See 10.2.1 of ISO/IEC 11801:2002 Amendment 2 (2010).

9.2.2 Performance marking

See 10.2.2 of ISO/IEC 11801:2002 and Amendment 1 (2008).

9.2.3 Mechanical characteristics

9.2.3.1 Connecting hardware of the type used at the ENI

Balanced cabling connecting hardware shall be in accordance with 10.2.3 of ISO/IEC 11801:2002 Amendment 2 (2010) as amended by the requirements of Table 6.

Table 6 – Connecting hardware of the type used at the ENI

Category	Standard
Category 5 unscreened	IEC 60603-7-2
Category 5 screened	IEC 60603-7-3
Category 6 unscreened	IEC 60603-7-4
Category 6 screened	IEC 60603-7-5
Category 6_A unscreened	IEC 60603-7-41
Category 6_A screened	IEC 60603-7-51
Category 7 screened	IEC 60603-7-7[a]
Category 7_A screened	IEC 60603-7-71[a]
[a] In installations where other factors such as cable sharing take preference over backward compatibility offered by the IEC 60603-7-7 and IEC 60603-7-71 interface, the interface specified in IEC 61076-3-104 may be used.	

9.2.3.2 Connecting hardware of the type used at the EO

Balanced cabling connecting hardware shall be in accordance with Clause 10.2.3 of ISO/IEC 11801:2002/Amd.2 as amended by the requirements of Table 7.

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Table 7 – Connecting hardware of the type used at the EO

Category	Standard
Category 6_A unscreened	IEC 60603-7-41
Category 6_A screened	IEC 60603-7-51
Category 7 screened	IEC 60603-7-7[a]
Category 7_A screened	IEC 60603-7-71[a]

[a] In installations where other factors such as cable sharing take preference over backwards compatibility offered by the IEC 60603-7-7 and IEC 60603-7-71 interface, the interface specified in IEC 61076-3-104 may be used.

9.2.3.3 Pin and pair assignments at the EO

For the connecting hardware in 9.2.3.2 the pin grouping and pair assignments shall be as shown in

Pair rearrangement should not involve modification of the cable terminations. If pair rearrangement is used, the configuration of the terminations shall be clearly identified.

NOTE When two physically similar cabling links are used in the same installation (for example, different performance categories and cables with different nominal impedance) special precautions are required to ensure that they are identified.

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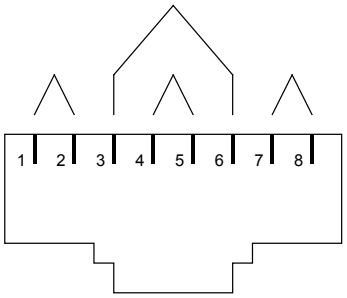
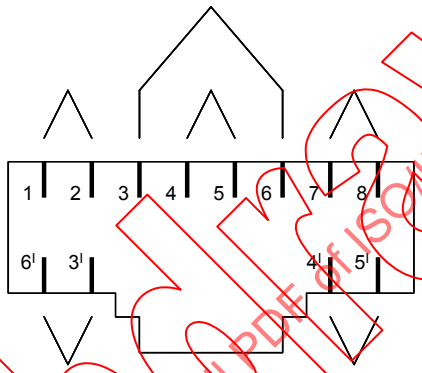
Figures 13a to 13c show a front view of fixed connector (jack).



NOTE This figure is not to scale.

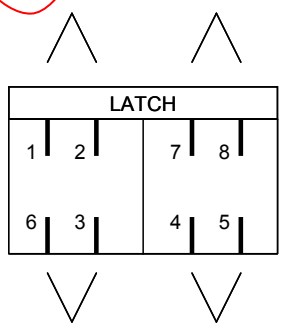
Figure 13a – IEC 60603-7 series interface for Category 5, 6 and 6_A



NOTE 1 The pin designations 1, 2, 3, 4, 5, 6, 7 and 8 for Category 7 and 7_A correspond to 1, 2, 3, 4, 5, 6, 7 and 8 for Category 5, 6, and 6_A.

NOTE 2 This figure is not to scale.

Figure 13b – IEC 60603-7 series interface for Category 7 and 7_A



NOTE 1 The pin designations correspond to those of the IEC 60603-7 series interfaces.

NOTE 2 This figure is not to scale.

Figure 13c – IEC 61076-3-104 interface for Category 7 and 7_A

Figure 13 – Pin grouping and pair assignments at the EO

If the connecting hardware type at a distributor, LDP or EO in the same link or channel is different to each other, the cabling connections shall be configured with consistent pin/pair assignments to ensure end-to-end connectivity. Pair rearrangement at the equipment outlet should not involve modification of the horizontal cable terminations.

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9.2.3.4 Electrical characteristics

9.2.3.4.1 ENI and EO requirements

See 10.2.4.1 and 10.2.4.2 of ISO/IEC 11801:2002 and Amendment 2 (2010).

Free and fixed connectors (plugs and jacks) that are intermateable shall be backwards compatible with those of different performance categories. Backwards compatibility means that mated connections with free and fixed connectors (plugs and jacks) from different categories shall meet all of the requirements for the lower Category component. See Clause 10 of ISO/IEC 11801:2002 and Amendment 2 (2010).

9.2.3.4.2 Other connecting hardware

Connecting hardware for use in distributors and LDPs of a given Category shall meet the corresponding performance requirements specified in 10.2.4.3 of ISO/IEC 11801:2002 and Amendment 2 (2010).

The creation of Class F_A configuration PL3 permanent link (see Figure A.1), where the LDP cable is in accordance with IEC 61156-5:2009, requires the connecting hardware at the LDP to provide NEXT and PS NEXT performance that is 6 dB better than the Category 7_A requirements specified in 9.2.

9.3 Connecting hardware for optical fibre cabling

9.3.1 General requirements

See 10.3.1, 10.3.2, 10.3.3 and 10.3.5 of ISO/IEC 11801:2002 and Amendment 2 (2010).

9.3.2 ENI requirements

For single-mode optical fibre the interface shall be IEC 61754-20 (the LC interface); it shall have a minimum return loss performance of 55 dB provided by an angled face connection, in accordance with IEC 61755-3-2.

It is recommended that the interface at the other end of the network access cabling permanent link should have a minimum return loss performance of 55 dB.

For the termination of one or two multimode optical fibres, the interface shall be IEC 61754-20 (the LC interface). It shall have a minimum return loss performance of 20 dB.

9.3.3 EO requirements

For the termination of one or two single-mode optical fibres the interface shall be IEC 61754-20 (the LC interface).

For the termination of one or two multimode optical fibres, the interface shall be IEC 61754-20 (the LC interface).

For the termination of more than two optical fibres, the interface shall be IEC 61754-7 (the MPO interface). See ISO/IEC 14763-2[17] regarding optical fibre polarity management.

9.3.4 Optical fibre assignments at the EO

For the optical fibre connecting hardware in 9.3.3 the optical fibre assignments shall be as shown in Figure 14.

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[17] Until ISO/IEC 14763-2 is published, relevant information may be found in ISO/IEC 18010.

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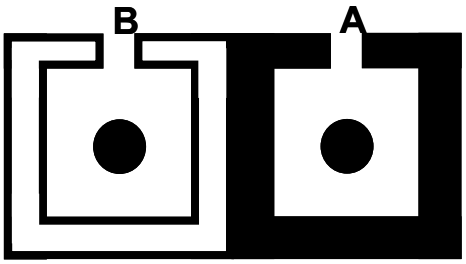
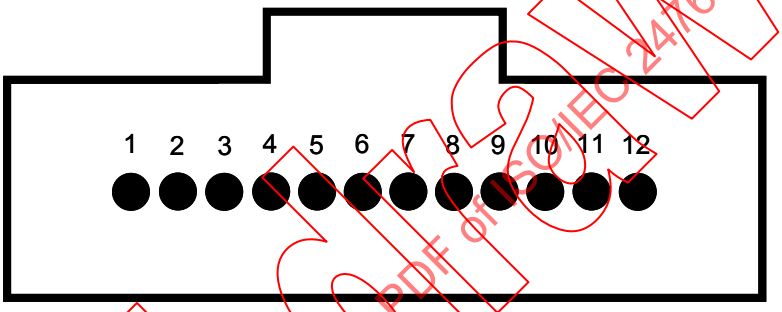
Polarity of optical fibres should be identified at the EO by means of any combination of latching, keying or labelling.



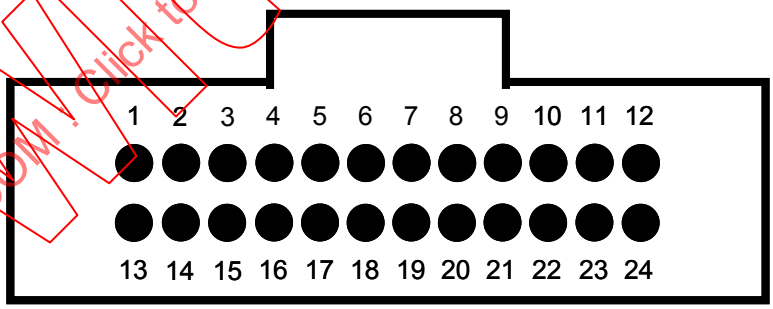
NOTE This figure is not to scale.

Figure 14a – IEC 61754-20 interface for one or two optical fibres



NOTE This figure is not to scale.

Figure 14b – IEC 61754-7 interface for 3 to 12 optical fibres



NOTE This figure is not to scale.

Figure 14c – IEC 61754-7 interface for 13 to 24 optical fibres

Figure 14 – Optical fibre assignments at the EO, front view of fixed connector

9.3.5 Other connecting hardware

Optical fibre connecting hardware at other places than the EO or ENI shall be specified by an approved IEC interface standard and comply with at least the equivalent optical, mechanical and environmental performance requirements specified in IEC 60874-19-1.

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10 Requirements for cords and jumpers

10.1 Jumpers

See Clause 8.

10.2 Balanced cords

See Clause 13 of ISO/IEC 11801:2002 and Amendment 2 (2010).

Field-terminated balanced cabling cords should not be used.

10.3 Optical fibre cords

Optical fibre cables used for cords shall meet IEC 60794-2-11.

Field-terminated optical fibre cords should not be used.

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Annex A
(normative)

Link performance limits

A.1 General

This annex contains performance requirements for permanent links and LDP links as shown in Figure A.1 and relates to Annex A of ISO/IEC 11801:2002 and Amendment 2 (2010).

The cabling under test in configurations PL1, PL2 and PL3 is termed the permanent link. Configurations PL1 and PL2 comprise fixed cabling only. Configuration PL3 comprises fixed cabling and a LDP cable between LDP and EO. If the LDP cable is changed, performance of this configuration will change. The cabling under test in configuration LDP1 contains fixed cabling only and is termed the LDP link.

In all configurations the test reference plane of a permanent link or LDP link is within the test cord. The test cord connector which mates with the termination point of the permanent link or LDP under test is part of the link under test.

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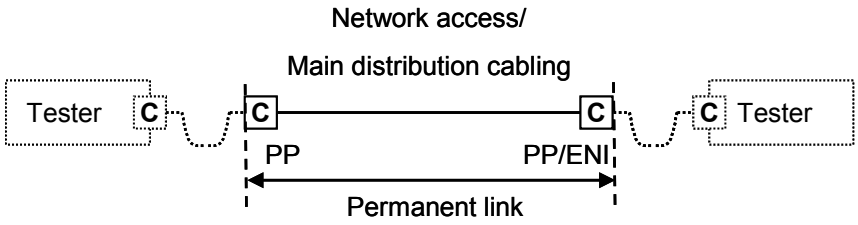

Figure A.1a – Configuration PL1

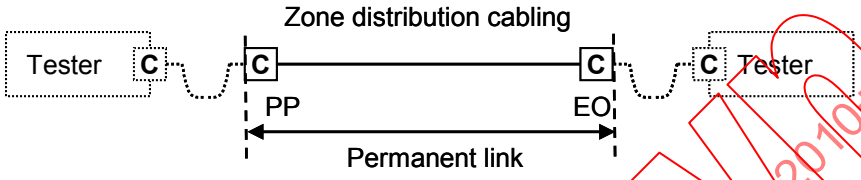

Figure A.1b – Configuration PL2

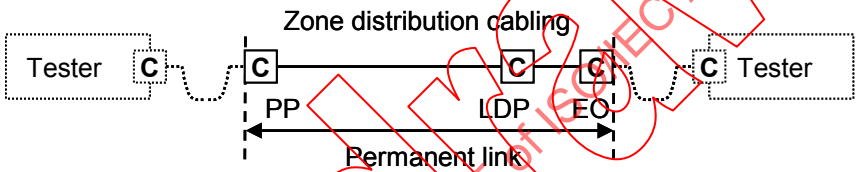

Figure A.1c – Configuration PL3

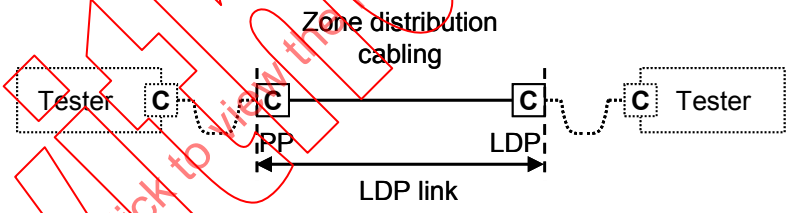

Figure A.1d – Configuration LDP1

Key

C = Connection
PP = Patch panel
ENI = External network interface
EO = Equipment outlet
LDP = Local distribution point

Figure A.1 – Link options

A.2 Balanced cabling

Consideration should be given to measuring performance at worst case temperatures, or calculating worst case performance based on measurements made at other temperatures.

Link performance shall meet the requirements of Clause A.2 of ISO/IEC 11801:2002 and Amendment 2 (2010), for Class E_A, F and F_A.

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In the case of cable sharing, additional requirements shall be taken into account for balanced cabling. The additional crosstalk requirements are specified in 9.3 of ISO/IEC 11801:2002 and Amendment 2 (2010).

A.3 Optical fibre cabling

The attenuation of a link at a specified wavelength shall not exceed the sum of the specified attenuation values for the cabling components at that wavelength (where the attenuation of a length of optical fibre cable is calculated from its attenuation coefficient multiplied by its length).

Measurements made shall be consistent with the design values of cable length and cabling materials used.

The attenuation of a link shall be measured according to ISO/IEC 14763-3.

NOTE The test methods have been developed for conventional optical fibre connection systems comprising two plugs and an adaptor. In some cases the methods are not appropriate for small form factor connectors that comprise a plug and socket.

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Annex B
(informative)

Usage of high density connecting hardware within optical fibre cabling

B.1 General

For the purposes of this Annex, the term “high density connecting hardware” refers to optical fibre connecting hardware that provides interconnection:

- of multi-element cabling (more than two optical fibres);
- at a greater density than is possible using groups of the duplex optical fibre interface as specified at the EO (see Clause 9);
- through a transition assembly, or a fan-out cord.

High density connecting hardware may be required in the following locations:

- interfaces to switchblades for high density switches;
- interfaces to equipment using parallel optical sources and detectors;
- one or both ends of equipment cords at distributors;
- one or both ends of patch cords at distributors;
- LDPs;
- interfaces that replace duplex EO connectors.

High density connecting hardware may be used as replacement or in combination with the duplex interface specified in Clause 9. Information regarding polarity maintenance is provided in ISO/IEC 14763-2[18].

B.2 Structure of cabling subsystems

Examples of high density connecting hardware within cabling subsystems in accordance with Clause 5 are shown in Figure B.1 and Figure B.2.

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[18] Until ISO/IEC 14763-2 is published, relevant information may be found in ISO/IEC 18010.

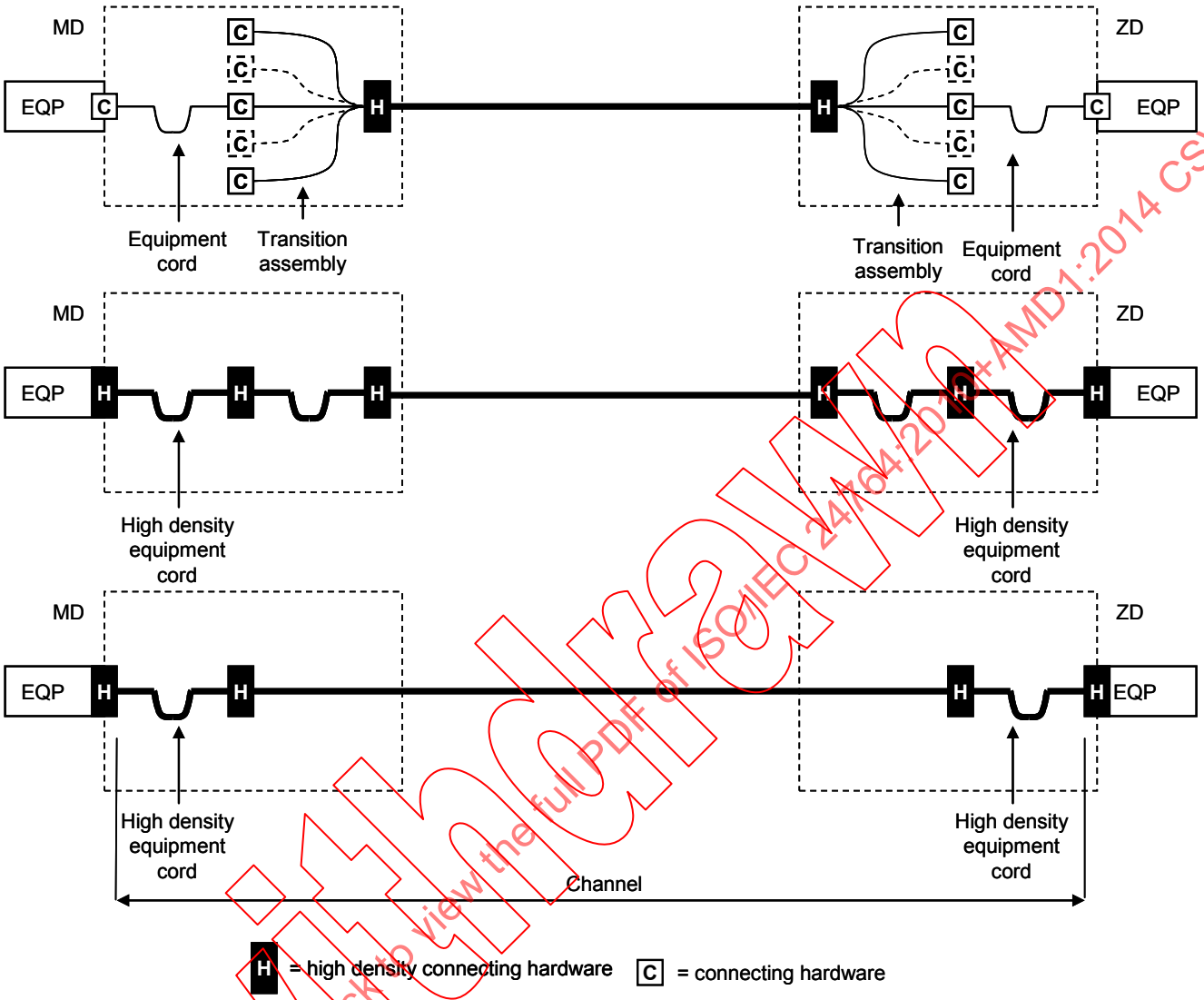

Figure B.1 – Examples of high density connecting hardware within main distribution cabling

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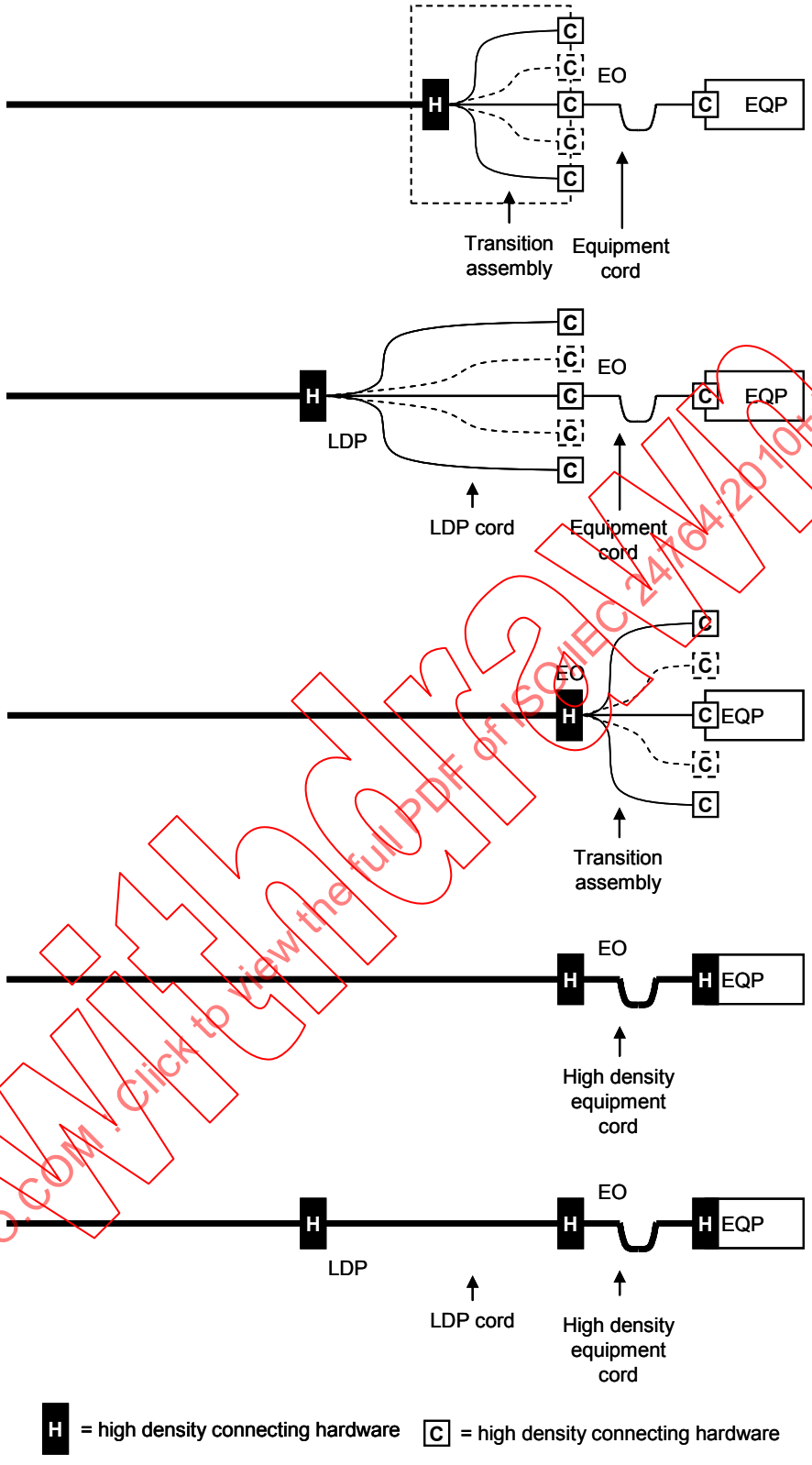

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Figure B.2 – Examples of high density connecting hardware at the LDP and EO within zone distribution cabling

Annex C
(normative)

Intermediate distribution cabling subsystem

C.1 General

Depending on the size and/or complexity of the data centres, it may require an additional subsystem in order to allow for the connection of several zone distributors. In such cases, the main distributor connects several intermediate distributors, each of which acts as local main distributors.

This annex will describe the additional requirements that are required for such implementations.

C.2 General structure and hierarchy

C.2.1 General

The cabling subsystems are connected together to create a generic cabling system with a structure as shown in Figure C.1. The composition of the cabling subsystems is described in 5.4.2, 5.4.3 and 5.4.4. The functional elements of the cabling subsystems are connected to form a basic hierarchical topology as shown in Figure C.2.

Network access cabling subsystems may be connected directly to the intermediate distributor. Cabling subsystems, as specified in ISO/IEC 11801, may also be connected directly to the intermediate distributor.

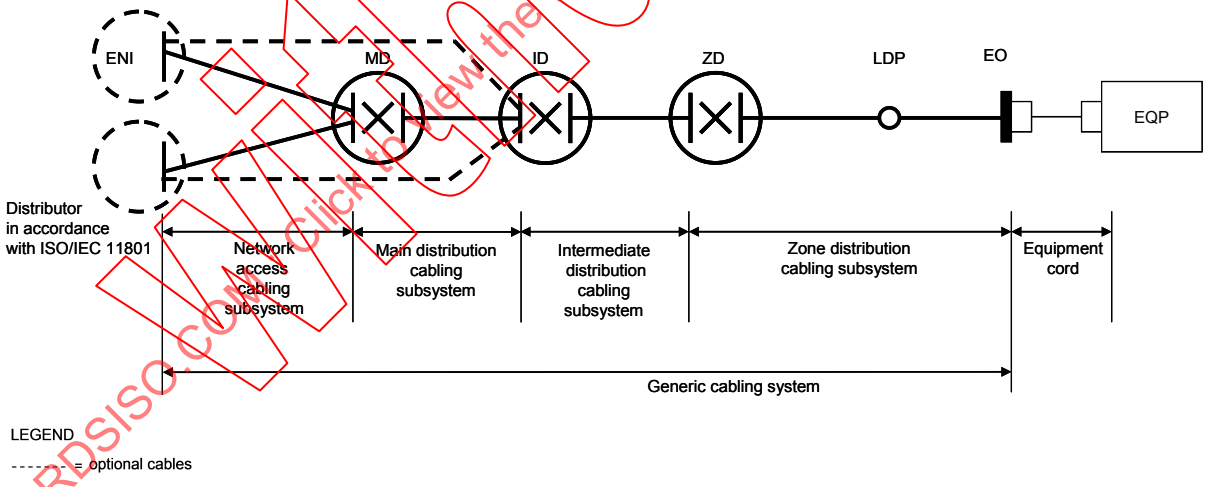

Figure C.1 – Structure of generic cabling within a data centre

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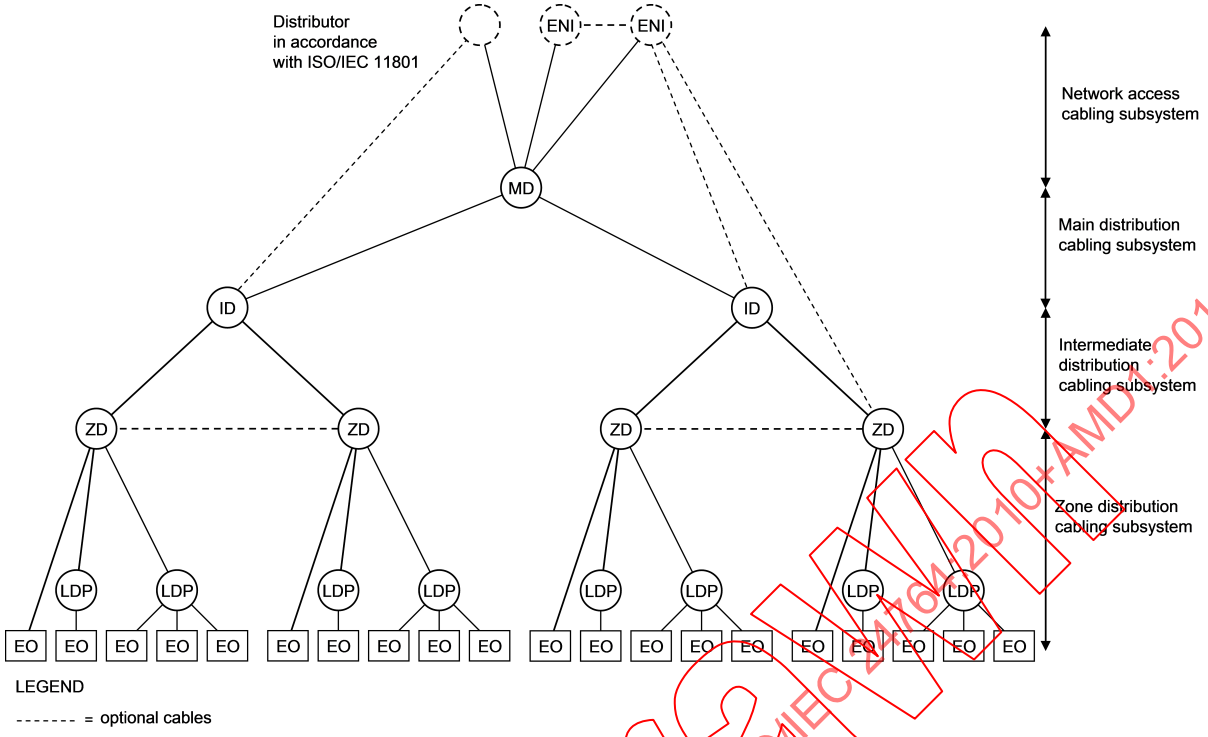

Figure C.2 – Hierarchical structure of generic cabling within a data centre

C.3 Cabling subsystems

C.3.1 Main distribution cabling subsystem

The main distribution cabling subsystem extends from an MD to the ID(s) connected to it. The subsystem includes:

a) the main distribution cables;

b) the mechanical termination of the main distribution cables at the MD together with associated patch cords and/or jumpers at the MD;

c) the mechanical termination of the main distribution cables at the ID(s).

C.3.2 Intermediate distribution cabling subsystem

The intermediate distribution cabling subsystem extends from an ID to the ZD(s) connected to it.

The subsystem includes:

a) the intermediate distribution cables;

b) the mechanical termination of the intermediate distribution cables at the ID together with associated patch cords and/or jumpers at the ID;

c) the mechanical termination of the intermediate distribution cables at the ZD(s).

C.3.3 Redundancy

Consideration should be given to the resilience of the data centre with respect to the cabling infrastructure. This may be enhanced by the provision of redundant distributors, cabling, and pathways.

In certain circumstances, for example for security or reliability reasons, redundancy may be built into a cabling design. Figure C.3 shows one of many possible examples of the

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connection of functional elements within the structured framework to provide such protection against failure in one or more parts of the cabling infrastructure. This could form the basis for the design of generic cabling for a data centre, providing some protection against such hazards as fire damage or the failure of an external network.

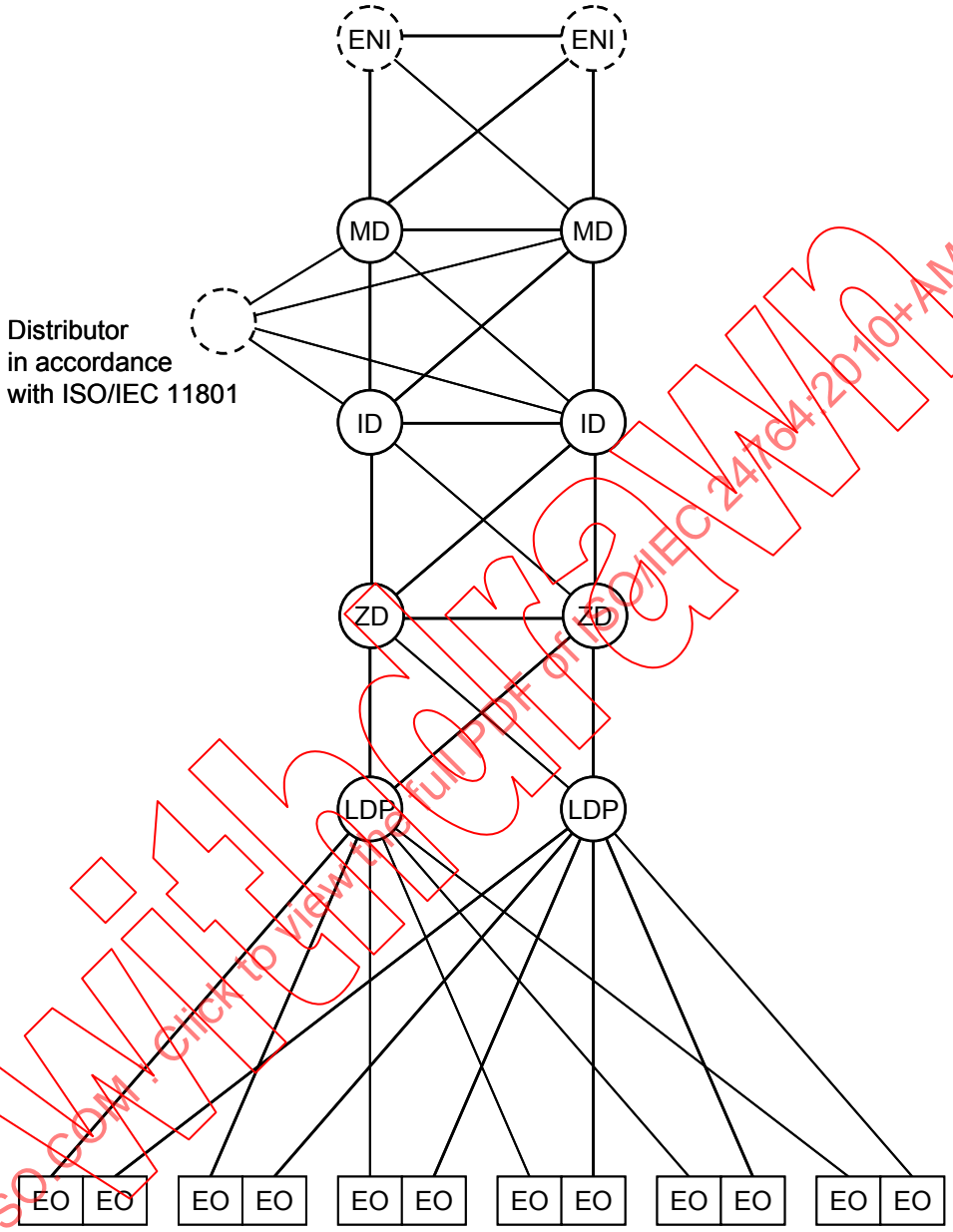

Figure C.3 – Connection of functional elements providing redundancy

C.4 Transmission performance

C.4.1 Balanced cabling

The intermediate distribution cabling shall be designed to provide a minimum of Class E_A channel performance as specified in ISO/IEC 11801.

C.4.2 Optical fibre cabling

Optical fibre cabling shall be designed using the optical fibre cables specified in Clause 8. Where multimode optical fibre is used, the intermediate distribution cabling shall provide

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channel performance as specified in ISO/IEC 11801 using a minimum of Category OM3 cabled optical fibre and optical connecting hardware, as specified in 9.3.

C.5 Reference implementations

C.5.1 Main distribution cabling

C.5.1.1 Component choice

The selection of balanced cabling components will be determined by the Class of applications to be supported by the cabling. Refer to Annex F of ISO/IEC 11801:2002/Amendment 2:2010 for guidance.

Using the models of C.5.1.2:

- Category 6_A components provide Class E_A balanced cabling performance;
- Category 7 components provide Class F balanced cabling performance;
- Category 7_A components provide Class F_A balanced cabling performance.

C.5.1.2 Dimensions

The connection of application-specific equipment to the main distribution cabling at the MD and IDs adopts either an interconnect or cross-connect approach (see ISO/IEC 11801). The channel includes patch cords and equipment cords. For the purposes of this subclause, jumpers used in place of patch cords are treated as cords.

Figure C.4 shows the model used to correlate main distribution cabling dimensions specified in this clause with the channel specifications in Clause 5. Figure C.4 shows the full configuration for the main distribution channel.

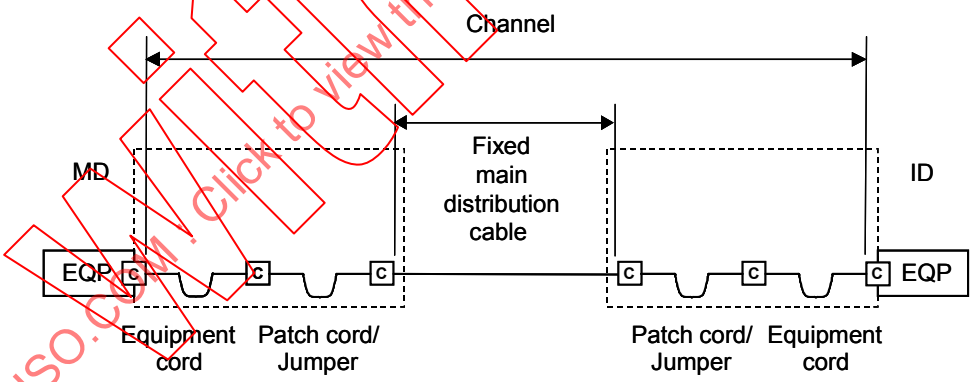

Figure C.4 – Main distribution cabling models

Table C.1 contains the length assumptions of the mathematical model used to validate channel performance using components specified in Clauses 8, 9 and 10. They do not represent absolute restrictions on the implementation of channels and permanent links, but may be used for guidance in reference implementations.

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Table C.1 – Length assumptions used in the mathematical modelling of balanced main distribution cabling

Segment	Minimum m	Maximum m
MD-ID	15	90
Equipment cord at the MD	2[a]	5
Equipment cord at the ID	2[b]	5
Patch cord	2	–
All cords	–	10

[a] If there is no cross-connect at the MD, the minimum length of the equipment cord at the MD is 1 m.

[b] If there is no cross-connect at the ID, the minimum length of the equipment cord at the ID is 1 m.

The maximum length of the fixed main distribution cable will depend on the total length of cords to be supported within a channel. During the operation of the installed cabling, an administration system in accordance with ISO/IEC 14763-2 shall be implemented to ensure that the length of cords used to create the channel conform to the design rules of this standard.

In order to accommodate the higher insertion loss of flexible cables used for cords, the length of the cables used within a channel of a given Class (see Clause 6) shall be determined by the equations shown in Table C.2.

In Table C.2 it is assumed that

a) the flexible cable within these cords has a higher insertion loss specification than that used in the fixed main distribution cable (see Clause 10),

b) the cables within these cords in the channel have a common insertion loss specification.

The following general restrictions apply:

c) the physical length of the channel shall not exceed 100 m;

d) the physical length of the fixed main distribution cable shall not exceed 90 m and may be less depending on the length of cords used and the number of connections.

Table C.2 – Main distribution channel length equations

Model	Implementation equations	
	Class E_A	Class F and Class F_A
Interconnect – interconnect	$M = 104^{a} - F \times X$	$M = 105^{a} - F \times X$
Interconnect – cross-connect	$M = 103^{a} - F \times X$	$M = 103^{a} - F \times X$
Cross-connect – cross-connect	$M = 102^{a} - F \times X$	$M = 102^{a} - F \times X$
For operating temperatures above 20 °C, M should be reduced by 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.		
Key M maximum length of the fixed main distribution cable (m) F combined length of patch cords, jumpers and equipment cords (m) X ratio of flexible cable insertion loss (dB/m) to fixed main distribution cable insertion loss (dB/m)		
[a] This includes a length reduction allocation to accommodate ILD.		

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C.5.2 Intermediate distribution cabling

C.5.2.1 Balanced cabling

C.5.2.1.1 Component choice

The selection of balanced cabling components will be determined by the Class of applications to be supported by the cabling. Refer to Annex F of ISO/IEC 11801:2002/Amendment 2:2010 for guidance.

Using the models of 7.2.3.2:

- Category 6_A components provide Class E_A balanced cabling performance;
- Category 7 components provide Class F balanced cabling performance;
- Category 7_A components provide Class F_A balanced cabling performance.

C.5.2.1.2 Dimensions

The connection of application-specific equipment to the intermediate distribution cabling at the ID and ZDs adopts either an interconnect or cross-connect approach (see ISO/IEC 11801). The channel includes patch cords and equipment cords. For the purposes of this subclause, jumpers used in place of patch cords are treated as cords.

Figure C.5 shows the model used to correlate intermediate distribution cabling dimensions specified in this clause with the channel specifications in Clause 5. This figure represents the full configuration for the intermediate distribution channel.

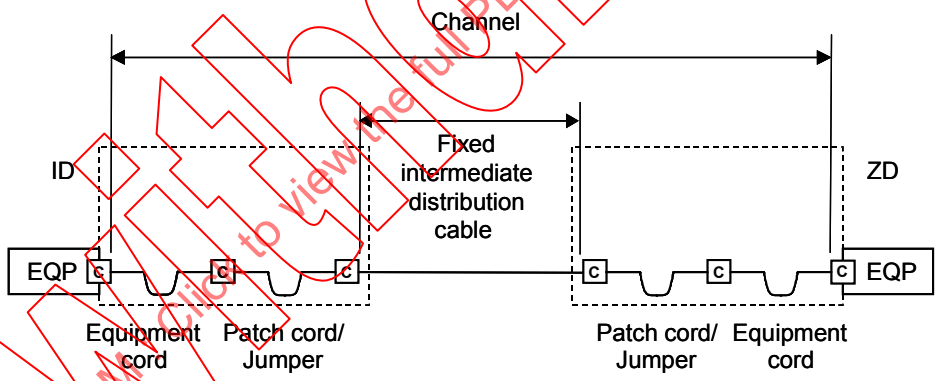

Figure C.5 – Intermediate distribution cabling models

Table C.3 contains the length assumptions of the mathematical model used to validate channel performance using components specified in Clauses 8, 9 and 10. They do not represent absolute restrictions on the implementation of channels and permanent links, but may be used for guidance in reference implementations.

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Table C.3 – Length assumptions used in the mathematical modelling of balanced intermediate distribution cabling

Segment	Minimum m	Maximum m
ID-ZD	15	90
Equipment cord at the ID	2[a]	5
Equipment cord at the ZD	2[b]	5
Patch cord	2	–
All cords	–	10

[a] If there is no cross-connect at the ID, the minimum length of the equipment cord at the ID is 1 m.

[b] If there is no cross-connect at the ZD, the minimum length of the equipment cord at the ZD is 1 m.

The maximum length of the fixed intermediate distribution cable will depend on the total length of cords to be supported within a channel. During the operation of the installed cabling, an administration system in accordance with ISO/IEC 14763-2 shall be implemented to ensure that the length of cords used to create the channel conform to the design rules of this standard.

In order to accommodate the higher insertion loss of flexible cables used for cords, the length of the cables used within a channel of a given Class (see Clause 6) shall be determined by the equations shown in Table C.4.

In Table C.4 it is assumed that

a) the flexible cable within these cords has a higher insertion loss specification than that used in the fixed main distribution cable (see Clause 10),

b) the cables within these cords in the channel have a common insertion loss specification.

The following general restrictions apply:

c) the physical length of the channel shall not exceed 100 m;

d) the physical length of the fixed intermediate distribution cable shall not exceed 90 m and may be less depending on the length of cords used and the number of connections.

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Table C.4 – Intermediate distribution channel length equations

Model	Implementation equations	
	Class E_A	Class F and Class F_A
Interconnect – interconnect	$M = 104^a - F \times X$	$M = 105^a - F \times X$
Interconnect – cross-connect	$M = 103^a - F \times X$	$M = 103^a - F \times X$
Cross-connect – cross-connect	$M = 102^a - F \times X$	$M = 102^a - F \times X$
For operating temperatures above 20 °C, M should be reduced by 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.		
Key M maximum length of the fixed intermediate distribution cable (m) F combined length of patch cords, jumpers and equipment cords (m) X ratio of flexible cable insertion loss (dB/m) to fixed main distribution cable insertion loss (dB/m)		
[a] This includes a length reduction allocation to accommodate ILD.		

C.5.2.2 Optical fibre cabling

The channel length restriction of Figure C.5 does not apply, but channel lengths instead are limited by the specific applications supported and the cabled optical fibre category used (see ISO/IEC 11801). It should be noted that the connection systems used to terminate fixed optical fibre cabling may contain mated connections and splices (permanent or re-usable) and that cross-connects may comprise re-usable splices.

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Annex D
(informative)

Combination of balanced cabling permanent links

D.1 General

Typical lengths of balanced permanent links within the data centre, allow for combination of two or more permanent links, to form one transmission channel conforming to the channel requirements, as specified in 6.2.2.

D.2 Requirements

The length of the combined permanent links, including its patch cords and equipment cords at either ends, shall not exceed a maximum of 100 m.

Channel performance shall be ensured where a channel is created by adding more than one cord to either end of a link meeting the requirements of Clause 6 and Annex A.

Figure D.1 shows examples of combinations of different permanent links.

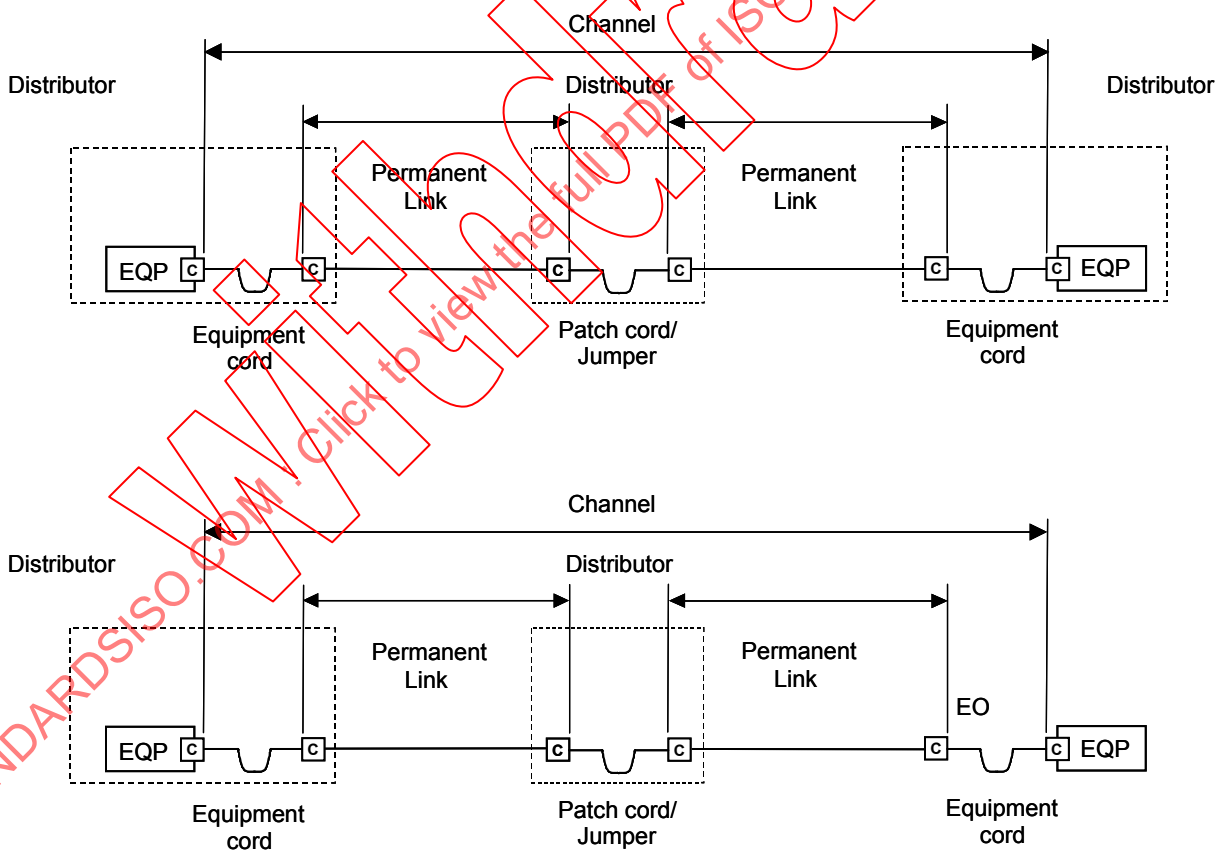

Figure D.1 – Examples of combined permanent links

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IEC 60603-7-1, *Connectors for electronic equipment – Part 7-1: Detail specification for 8-way, shielded free and fixed connectors*

IEC 60793-2-50, *Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres*

IEC 60793-2-60, *Optical fibres – Part 2-60: Product specifications – Sectional specification for category C single-mode intraconnection fibres*

IEC 60794-2-10, *Optical fibre cables – Part 2-10: Indoor cables – Family specification for simplex and duplex cables*

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

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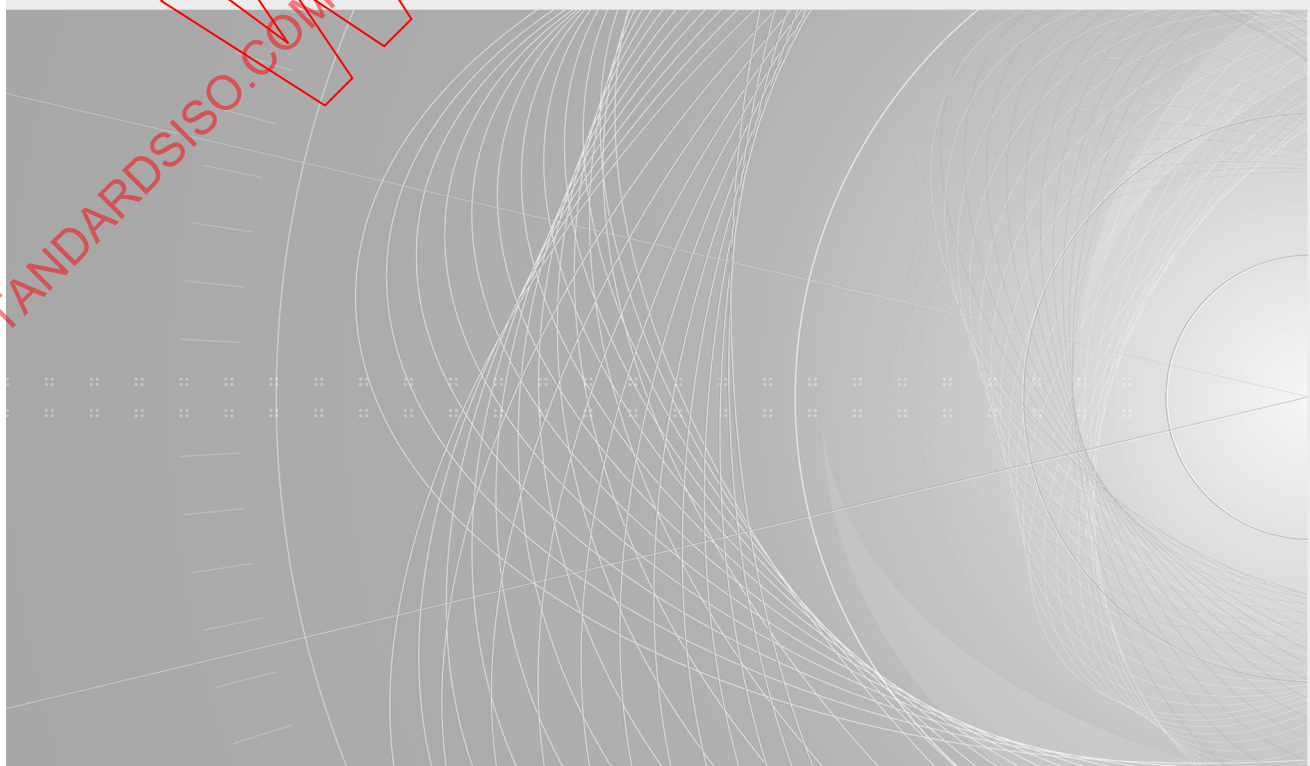
ISO/IEC 24764

Edition 1.1 2014-04

FINAL VERSION

Information technology – Generic cabling systems for data centres



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CONTENTS

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INFORMATION TECHNOLOGY – GENERIC CABLING SYSTEMS FOR DATA CENTRES

FOREWORD

1) ISO (International Organization for Standardization) and IEC (International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards. Their preparation is entrusted to technical committees; any ISO and IEC member body interested in the subject dealt with may participate in this preparatory work. International governmental and non-governmental organizations liaising with ISO and IEC also participate in this preparation.

2) In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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10) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

This Consolidated version of ISO/IEC 24764 bears the edition number 1.1. It consists of the first edition (2010-04) and its amendment 1 (2014-04). The technical content is identical to the base edition and its amendment.

This Final version does not show where the technical content is modified by amendment 1. A separate Redline version with all changes highlighted is available in this publication.

This publication has been prepared for user convenience.

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International Standard ISO/IEC 24764 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

ISO/IEC 24764 is to be read in conjunction with International Standard ISO/IEC 11801:2002, its Amendment 1 (2008) and Amendment 2 (2010).

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

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INTRODUCTION

Within premises, the importance of the information technology cabling infrastructure is similar to that of other fundamental building utilities such as heating, lighting and mains power. As with other utilities, interruptions to service can have serious impact. Poor quality of service due to lack of design foresight, use of inappropriate components, incorrect installation, poor administration or inadequate support can threaten an organisation's effectiveness.

Cabling within data centres comprises both application-specific and multipurpose networks that are mission-critical. Generic cabling designs in accordance with ISO/IEC 11801 have supported the development of high data rate applications based upon a defined cabling model. This International standard recognizes the benefit of generic cabling to provision multiple services and to connect large quantities of equipment within the limited space of data centre premises, and is to be used in conjunction with ISO/IEC 11801.

This International Standard provides:

a) data centre users with an application independent generic cabling system capable of supporting a wide range of applications;

b) data centre users with a flexible cabling scheme such that modifications are both easy and economical;

c) data centre professionals (for example, data centre architects) with guidance allowing the accommodation of cabling before specific requirements are known; that is, in the initial planning either for construction or refurbishment;

d) industry and applications standardization bodies with a cabling system which supports current products and provides a basis for future product development.

This International Standard specifies multi-vendor cabling, and is related to:

- the associated standard covering general requirements for generic cabling within premises (ISO/IEC 11801);
- standards for cabling components developed by technical committees of the IEC;
- standards for the quality assurance, installation and administration of information technology cabling (ISO/IEC 14763-2[1]) and testing of installed cabling (IEC 61935-1 and ISO/IEC 14763-3);
- applications developed by the technical committees of IEC, subcommittees of ISO/IEC JTC 1 and study groups of ITU-T[2].

It is anticipated that the generic cabling system meeting the requirements of this International Standard will have a life expectancy of up to ten years.

This International Standard has taken into account requirements specified in application standards listed in Annex F of ISO/IEC 11801:2002 and Amendment 2 (2010). It refers to International Standards for components and test methods whenever appropriate International Standards are available.

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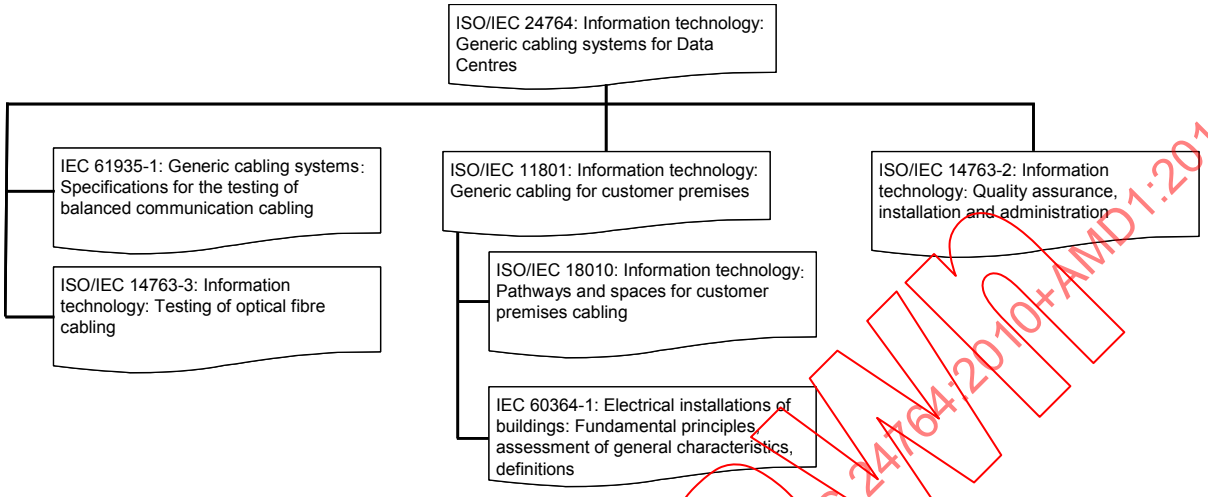
1 Until ISO/IEC 14763-2 is published, relevant information may be found in ISO/IEC 18010.

2 International Telecommunication Union – Telecommunications Standardization Sector.

Figure 1 shows the schematic and contextual relationships between the standards produced by ISO/IEC JTC 1/SC 25 for information technology cabling, namely this and other generic cabling design standards (ISO/IEC 11801), cabling installation standards (ISO/IEC 14763-2[3]), testing of installed cabling (IEC 61935-1 and ISO/IEC 14763-3).



Scheme of the relationship between cabling standards such as ISO/IEC 11801 and other standards relevant for information technology cabling systems.

Figure 1 – Relationship between generic cabling standards

INTRODUCTION to Amendment 1

Amendment 1 of ISO/IEC 24764:2010 provides an introduction to the intermediate cabling subsystem and an explanatory annex for the combination of several permanent links to form a single transmission channel.

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3 Until ISO/IEC 14763-2 is published, relevant information may be found in ISO/IEC 18010.

INFORMATION TECHNOLOGY – GENERIC CABLING SYSTEMS FOR DATA CENTRES

1 Scope

This International Standard specifies generic cabling that supports a wide range of communications services for use within a data centre. It covers balanced cabling and optical fibre cabling.

This International Standard is based upon and references the requirements of ISO/IEC 11801.

This International Standard contains additional requirements that are appropriate to data centres in which the maximum distance over which communications services have to be distributed is 2 000 m. The principles of this International Standard may also be applied to data centre installations that do not fall within this range.

In addition to the requirements of ISO/IEC 11801, this International Standard specifies:

a) a modified structure and configuration for generic cabling within data centres used to support existing and emerging applications;

b) a reference implementation specific to data centre infrastructures.

Data centres have specific pathway and space requirements that are specified in ISO/IEC 14763-2. Until ISO/IEC 14763-2 is published, relevant information may be found in ISO/IEC 18010 (see Bibliography).

Safety (electrical safety and protection, fire, optical power etc.) and electromagnetic compatibility (EMC) requirements are outside the scope of this International Standard and are covered by other standards and regulations. However, information given in this International Standard and those identified in Figure 1 can be of assistance in meeting these other standards and regulations.

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 2002, *Information technology – Generic cabling for customer premises*
Amendment 1(2008)
Amendment 2(2010)

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

ISO/IEC 14763-3, *Information technology – Implementation and operation of customer premises cabling – Part 3: Testing of optical fibre cabling*

IEC 60603-7 (all parts), *Connectors for electronic equipment – Part 7: Detail specification for 8-way, unshielded, free and fixed connectors*

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IEC 60603-7-2:, *Connectors for electronic equipment – Part 7-2: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 100 MHz*[4]

IEC 60603-7-3:, *Connectors for electronic equipment – Part 7-3: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 100 MHz*[5]

IEC 60603-7-4:, *Connectors for electronic equipment – Part 7-4: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 250 MHz*[6]

IEC 60603-7-5:, *Connectors for electronic equipment – Part 7-5: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 250 MHz*[7]

IEC 60603-7-7:, *Connectors for electronic equipment – Part 7-7: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 600 MHz*[8]

IEC 60603-7-41:, *Connectors for electronic equipment – Part 7-41: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 500 MHz*[9]

IEC 60603-7-51:, *Connectors for electronic equipment – Part 7-51: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 500 MHz*[10]

IEC 60603-7-71:, *Connectors for electronic equipment – Part 7-71: Detail specification for 8-way, shielded, free and fixed connectors, for data transmission with frequencies up to 1 000 MHz*[11]

IEC 60794-2-11, *Optical fibre cables – Part 2-11: Indoor cables – Detailed specification for simplex and duplex cables for use in premises cabling*

IEC 60874-19-1, *Fibre optic interconnecting devices and passive components Connectors for optical fibres and cables – Part 19-1: Fibre optic patch cord connector type SC-PC (floating duplex) standard terminated on multimode fibre type A1a, A1b – Detail specification*

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*

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4 Second edition in preparation.

5 Second edition in preparation.

6 Second edition in preparation.

7 Second edition in preparation.

8 Third edition in preparation.

9 In preparation.

10 In preparation.

11 In preparation.

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 61754-7, *Fibre optic interconnecting devices and passive components – Fibre optic connector interfaces – Part 7: Type MPO connector family*

IEC 61754-20, *Fibre optic connector interfaces – Part 20: Type LC connector family*

IEC 61755-3-2, *Fibre optic connector optical interfaces – Part 3-2: Optical interface, 2,5 mm and 1,25 mm diameter cylindrical full zirconia ferrules for 8 degrees angled-PC single mode fibres*

IEC 61935-1, *Specification for the testing of balanced and coaxial information technology cabling – Part 1: Installed balanced cabling as specified in ISO/IEC 11801 and related standards*

3 Terms and definitions and abbreviations

3.1 Terms and definitions

For the purposes of this International Standard the following terms and definitions apply in addition to those of ISO/IEC 11801.

3.1.1
cabled optical fibre Category
system of defining requirements for the cabled optical fibre performance within optical fibre channels and links.

3.1.2
equipment outlet
fixed connecting device for terminating the zone distribution cabling and providing the interface to the equipment cabling

3.1.3
fixed zone distribution cable
cable connecting the zone distributor to either the equipment outlet or, if present, the local distribution point

3.1.4
local distribution point
connection point in the zone distribution cabling subsystem between a zone distributor and an equipment outlet

3.1.5
local distribution point cable
cable connecting a local distribution point to an equipment outlet

3.1.6
local distribution point link
transmission path between a local distribution point and the interface at the other end of the fixed zone distribution cable including the connecting hardware at each end

3.1.7
main distribution cable
cable connecting the main distributor to the zone distributor

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3.1.8
main distributor
distributor used to make connections between the main distribution cabling subsystem, network access cabling subsystem and cabling subsystems as specified in ISO/IEC 11801 and active equipment

3.1.9
network access cable
cable connecting the external network interface to the main distributor or zone distributor

3.1.10
transition assembly
assembly of cabled optical fibres and connectors, with an array connector on one end and simplex or duplex connectors on the other end

3.1.11
zone distribution cable
cable connecting the zone distributor to the equipment outlet(s) or local distribution point(s)

3.1.12
zone distributor
distributor used to make connections between the main distribution cabling subsystem, zone distribution cabling subsystem, network access cabling subsystem and cabling subsystems specified in ISO/IEC 11801 and active equipment

3.1.13
equipment cord
cord connecting equipment to the equipment interfaces of generic cabling

3.1.14
equipment outlet
fixed connecting device for terminating the zone distribution cabling and providing the interface to the equipment cord

3.1.15
intermediate distribution cable
cable connecting the intermediate distributor to the zone distributor

3.1.16
intermediate distributor
distributor used to make connections between the main distribution cabling subsystem, intermediate distribution cabling subsystem, network access cabling subsystem and cabling subsystems specified in ISO/IEC 11801 and active equipment

3.2 Abbreviations

For the purposes of this International Standard the following abbreviations apply in addition to those of ISO/IEC 11801.

BEF	Building Entrance Facility
ENI	External Network Interface
EO	Equipment Outlet
ID	Intermediate Distributor
ILD	Insertion Loss Deviation
LDP	Local Distribution Point
MD	Main Distributor
OE EQP	Opto-Electronic EQuiPment
ZD	Zone Distributor

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4 Conformance

For a cabling system to conform to this International Standard the following applies.

a) The configuration and structure shall conform to the requirements of Clause 5.

b) The performance of balanced channels shall conform to the transmission performance and environmental requirements of Clause 6. This shall be achieved by one of the following:

   1) a channel design and implementation ensuring that the prescribed channel performance is met;

   2) attachment of appropriate components to a link design meeting the prescribed performance class of Clause 6 and Annex A. Channel performance shall be ensured where a channel is created by adding more than one cord to either end of a link meeting the requirements of Clause 6 and Annex A;

   3) using the reference implementations of Clause 7 and compatible cabling components conforming to the requirements of Clauses 8, 9 and 10, based upon a statistical approach of performance modelling.

c) The implementation and performance of optical fibre cabling channels shall meet the requirements specified in Clause 6.

d) The interfaces to the cabling shall conform to the requirements of Clause 9 with respect to mating interfaces and performance.

e) If present, screens shall be handled as specified in Clause 11 of ISO/IEC 11801.

f) Regulations on safety and EMC applicable at the location of the installation shall be met.

Test methods to assess conformance with the channel and link requirements of Clause 6 and Annex A respectively are specified in IEC 61935-1 for balanced cabling and ISO/IEC 14763-3 for optical fibre cabling. The treatment of measured results that fail to meet the requirements of this clause, or lie within the relevant measurement accuracy, shall be clearly documented within a quality plan as described in ISO/IEC 14763-2[12].

Installation and administration of cabling in accordance with this standard shall be undertaken in accordance with ISO/IEC 14763-2[13].

This International Standard does not specify which tests and sampling levels should be adopted. The test parameters to be measured and the sampling levels to be applied for a particular installation shall be defined in the installation specification and quality plans for that installation prepared in accordance with ISO/IEC 14763-2[14].

In the absence of the channel, the conformance of the link shall be used to verify conformance with this International Standard.

5 Structure of the generic cabling system

5.1 General

This clause identifies the functional elements of generic cabling for data centres, describes how they are connected together to form subsystems and identifies the interfaces at which application-specific components are connected to the generic cabling.

Applications listed in Annex F of ISO/IEC 11801are supported by connecting active equipment at the external network interfaces, equipment outlets and the distributors.

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12 Until ISO/IEC 14763-2 is published, relevant information may be found in ISO/IEC 18010.

13 Until ISO/IEC 14763-2 is published, relevant information may be found in ISO/IEC 18010.

14 Until ISO/IEC 14763-2 is published, relevant information may be found in ISO/IEC 18010.

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The structured cabling system specified by this standard is intended to restrict the use of cords for point-to-point cabling within data centres, which can be detrimental to the administration and operation of the data centre. Exceptions are permitted between equipment located in close proximity or between equipment that cannot communicate over the generic cabling system.

5.2 Functional elements

In addition to the distributors specified in ISO/IEC 11801, this standard specifies the following functional elements and interfaces of generic cabling:

a) external network interface (ENI);
b) network access cable;
c) main distributor (MD);
d) main distribution cable;
e) zone distributor (ZD);
f) zone distribution cable;
g) local distribution point (LDP);
h) local distribution point cable (LDP cable);
i) equipment outlet (EO).

NOTE This standard includes additional functional elements, the intermediate distributor and the intermediate distribution cable. The requirements for these functional elements are defined in Annex C.

Groups of these functional elements are connected together to form cabling subsystems.

5.3 General structure and hierarchy

Generic cabling systems in data centres contain up to three cabling subsystems: network access cabling, main distribution cabling and zone distribution cabling. Where present within the premises, a distributor in accordance with ISO/IEC 11801 is connected to the generic cabling within the data centre using the network access cabling.

The cabling subsystems are connected together to create a generic cabling system with a structure as shown in Figure 2. The composition of the cabling subsystems is described in 5.4.2, 5.4.3 and 5.4.4. The functional elements of the cabling subsystems are interconnected to form a basic hierarchical topology as shown in Figure 3.

The functions of multiple distributors may be combined, see 5.7.1.

NOTE This standard includes an additional cabling subsystem: the intermediate cabling subsystem. The requirements for this additional cabling subsystem and the modifications to the cabling subsystems of this clause are defined in Annex C.

Connections between cabling subsystems are either active, requiring application-specific equipment, or passive. Connection to application-specific equipment at an MD or a ZD adopts either an interconnect or a cross-connect approach (see ISO/IEC 11801). Connection to application-specific equipment at an ENI and EO adopts an interconnect approach (see ISO/IEC 11801). Passive connections between cabling subsystems adopt either a cross-connect approach, by way of either patch cords or jumpers, or an interconnect approach.

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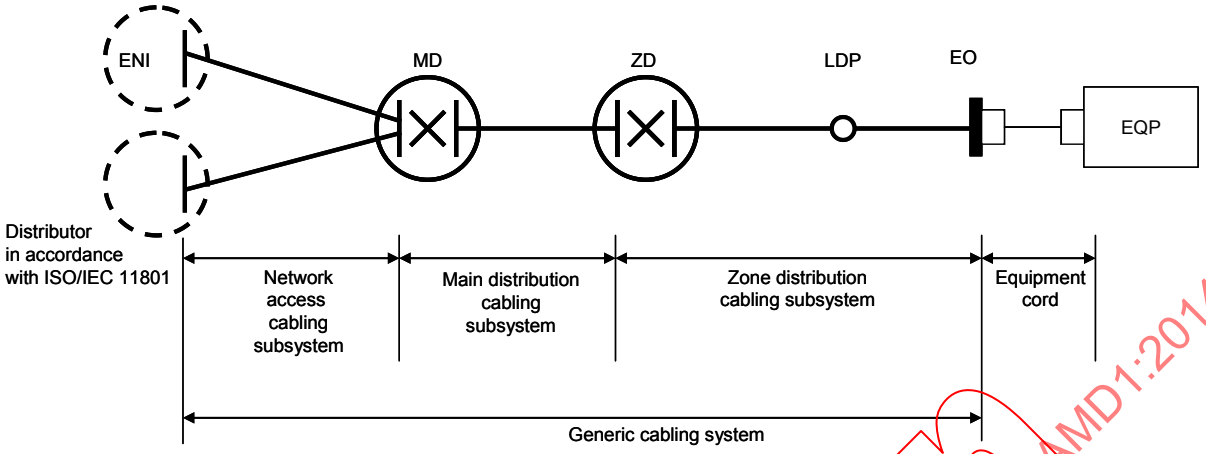
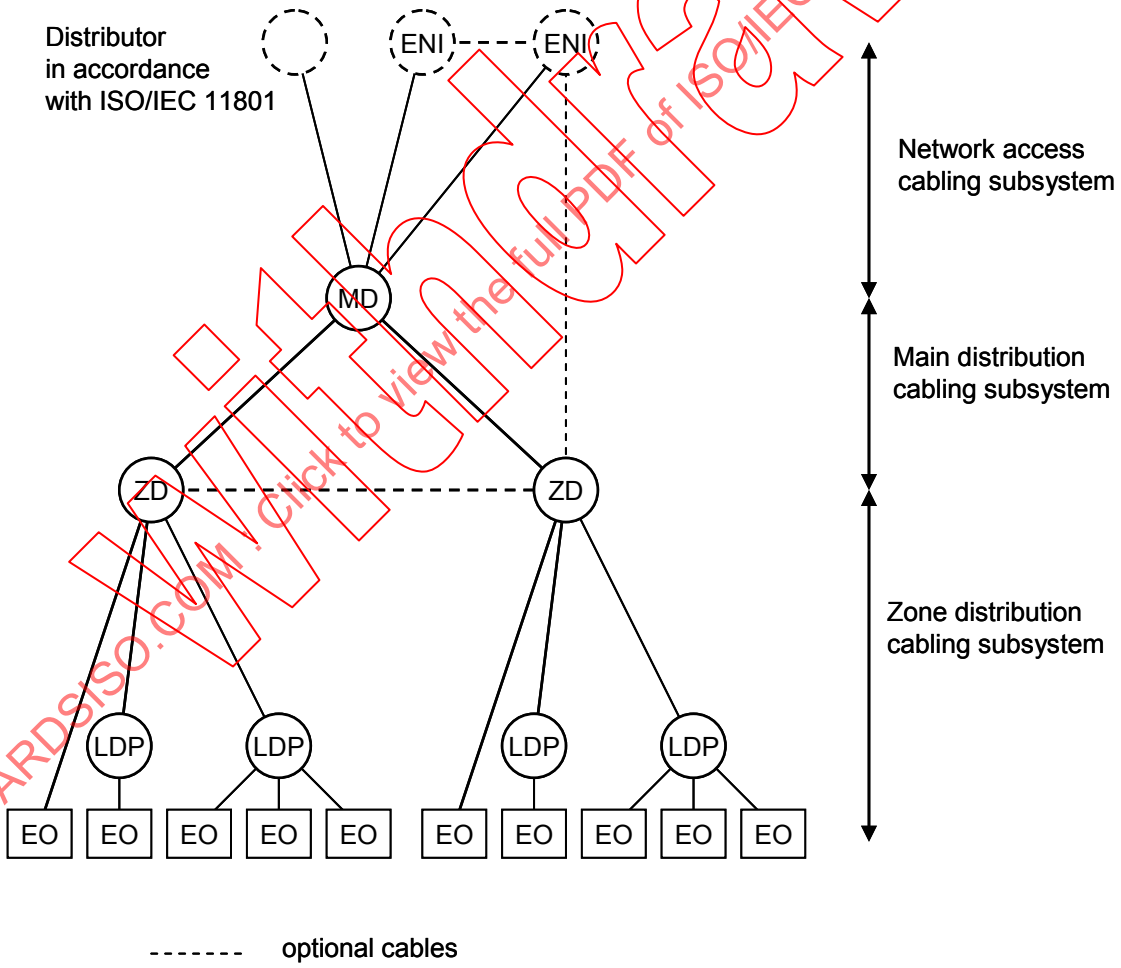


Figure 2 – Structure of generic cabling within a data centre



NOTE Network access cabling is also used to connect ENI to ZD.

Figure 3 – Hierarchical structure of generic cabling within a data centre

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5.4 Cabling subsystems

5.4.1 General

Although equipment cords are used to connect the equipment to a cabling subsystem, they are not considered part of the cabling subsystem.

5.4.2 Network access cabling subsystem

The network access cabling subsystem extends from an MD (or ZD) to the ENIs and/or other distributors (in accordance with ISO/IEC 11801) connected to it.

The subsystem includes:

a) the network access cables;

b) the mechanical termination of the network access cables at the ENI(s);

c) the mechanical termination of the network access cables at the MD, ZD(s) or other distributors in accordance with ISO/IEC 11801.

5.4.3 Main distribution cabling subsystem

The main distribution cabling subsystem extends from an MD to the ZD(s) connected to it. The subsystem includes:

a) the main distribution cables;

b) the mechanical termination of the main distribution cables at the MD together with associated patch cords and/or jumpers at the MD;

c) the mechanical termination of the main distribution cables at the ZD(s).

5.4.4 Zone distribution cabling subsystem

The zone distribution cabling subsystem extends from a ZD to the EO(s) connected to it. The subsystem includes:

a) the zone distribution cables;

b) the mechanical termination of the zone distribution cables at the EO(s) and the ZD together with associated patch cords and/or jumpers at the ZD;

c) LDP(s) (optional);

d) LDP cable(s) (optional)

e) the EO(s).

Zone distribution cables shall be continuous from the ZD to the EO(s) unless (an) LDP(s) is (are) installed (see 5.7.8).

5.4.5 Design objectives

In order to provide the longest operational life while minimising the disruption and cost associated with re-cabling, the fixed installed cabling should be designed to:

- support the broadest set of existing and emerging applications;
- accommodate the anticipated growth in volume of supported applications throughout the predicted lifetime of the installation.

In addition the provision of redundancy within a cabling design should be considered (see also 5.7.1).

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5.5 Accommodation of functional elements

Figure 4 shows an example of how the functional elements are accommodated in a building (only a single floor of the building is shown for simplicity).

The MD, ZD and LDP shall be housed in permanent and accessible locations within the data centre.

The ENI shall be housed in permanent and accessible location either internal or external to the data centre.

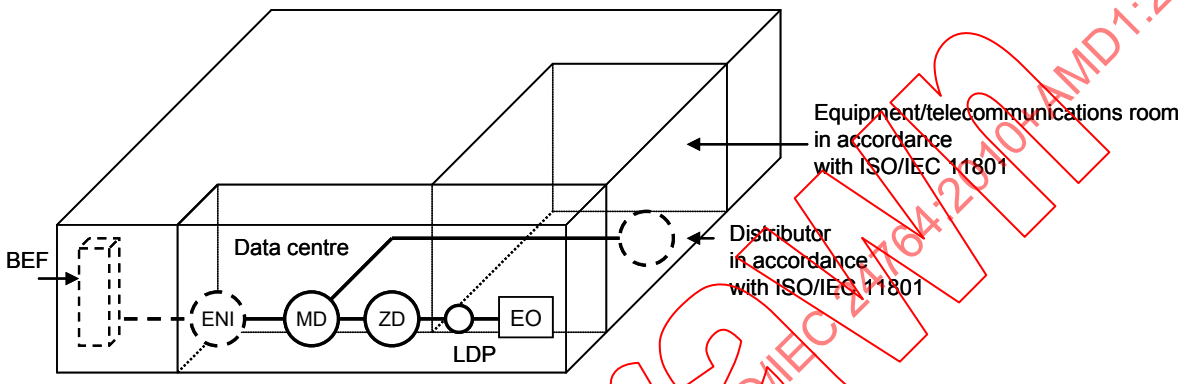

Figure 4 – Example of accommodation of functional elements

5.6 Interfaces

5.6.1 Equipment interfaces and test interfaces

Potential equipment interfaces for data centres are located at the ends of the cabling subsystems (as shown in Figure 5). An LDP does not provide an equipment interface to the generic cabling system.

Potential test interfaces for data centres are located at the ends of the cabling subsystems and at the LDP, if present (as shown in Figure 5).

5.6.2 Channels and links

The transmission performance of generic cabling is detailed in Clause 6 for channels and Annex A for links.

The channel is the transmission path between data centre equipment such as a switches and servers (EQP in Figure 5). A typical channel in a data centre would consist of the zone distribution cabling subsystem together with an equipment cord at each end. For longer reach services, the channel would be formed by the connection of two or more subsystems (including patch cords and equipment cords), see Annex D. The performance of the channel excludes the connections at the application-specific equipment.

The permanent link is the transmission path of the fixed cabling subsystem, including the connecting hardware at the ends of the installed cable. In a data centre zone distribution cabling subsystem, the permanent link consists of the EO, an optional LDP cable, an optional LDP, the zone distribution cable and the termination of the zone distribution cable at the zone distributor. The permanent link includes the connections at the ends of the installed cabling.

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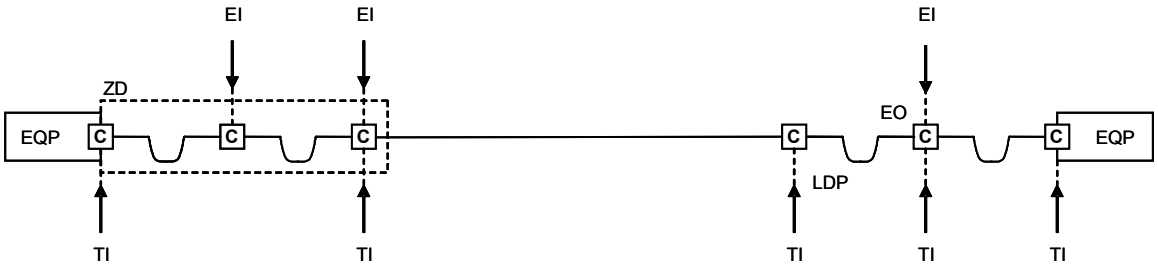

Figure 5a – Zone distribution cabling

Figure 5b – Main distribution cabling

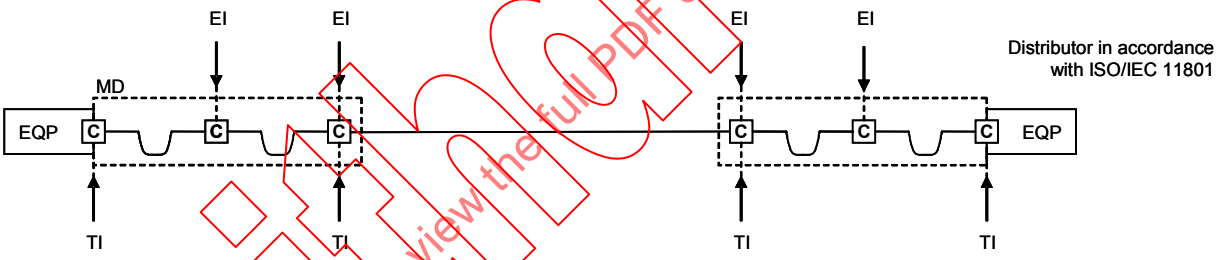

Figure 5c – Network access cabling from MD to distributor in accordance with ISO/IEC 11801

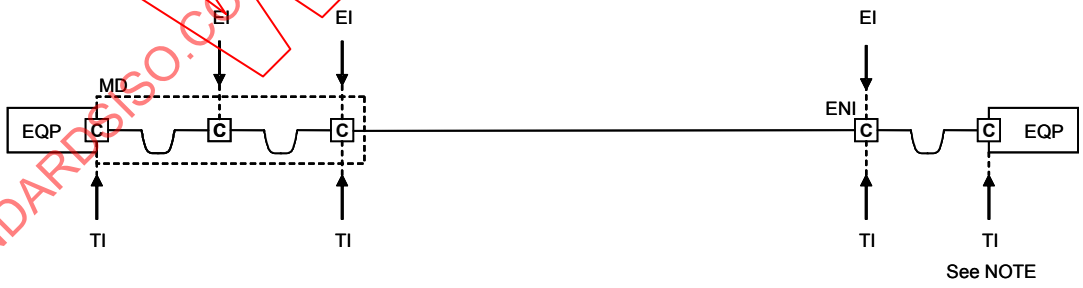

Figure 5d – Network access cabling from MD to ENI

NOTE Where the EQP connected to the ENI lies outside the premises containing the data centres, the interconnecting cord will typically comprise a combination of fixed cabling and cords that are outside the scope of this standard. In such cases the connection to the EQP may not provide a TI.

Figure 5 – Test and equipment interfaces

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5.7 Dimensioning and configuring

5.7.1 Distributors

The number and type of subsystems that are included in a generic cabling implementation depends upon the layout and size of the data centre and upon the strategy of the user.

The design of distributors shall ensure that the length of patch cords, jumpers and equipment cords are minimized, and administration should ensure that the design lengths are maintained during operation. Administration should ensure that the requirements of ISO/IEC 11801 are observed regarding the mixing of optical fibre types at the distributors. Distributors should be located in such a way that the resulting cable lengths are consistent with the channel performance requirements of Clause 6.

Where the components of Clauses 8, 9 and 10 are used, the distributors shall be located in accordance with the reference implementations of Clause 7. Where other components are used, the distributors shall be located so that the desired performance Class of Clause 6 is delivered.

The functions of multiple distributors may be combined into a single distributor. For example, an MD may serve the function of a ZD. However, every data centre must have at least one MD.

5.7.2 Redundancy

Consideration should be given to the resilience of the data centre with respect to the cabling infrastructure. This may be enhanced by the provision of redundant distributors, cabling, and pathways.

In certain circumstances, for example for security or reliability reasons, redundancy may be built into a cabling design. Figure 6 shows one of many possible examples of the connection of functional elements within the structured framework to provide such protection against failure in one or more parts of the cabling infrastructure. This might form the basis for the design of generic cabling for a data centre providing some protection against such hazards as fire damage or the failure of an external network.

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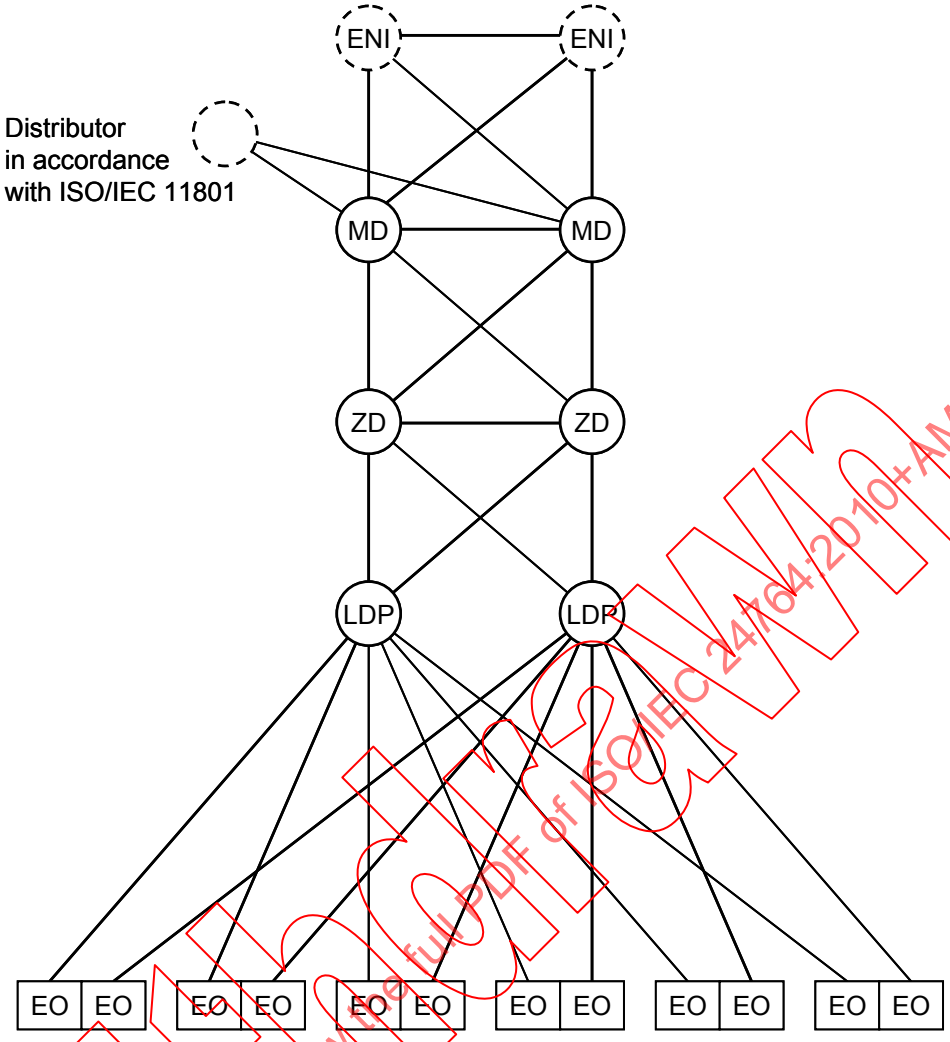

Figure 6 – Connection of functional elements providing redundancy

Additionally, redundancy may be provided by utilizing multiple cables between distributors, with cables following different routes.

NOTE Connections between ZD and ZD are in addition to the connection between MD and ZD and not a replacement for the MD to ZD connection.

5.7.3 External network interface

The ENI provides a termination of the network access cabling that allows connection of external services to the network access cabling as shown in Figure 7.

NOTE The multiple service providers should have diverse routes to each of the multiple ENIs.

The ENI shall be in accordance with Clause 9.

Where the components of Clauses 8, 9 and 10 are used, the ENIs shall be located in accordance with the reference implementations of Clause 7.

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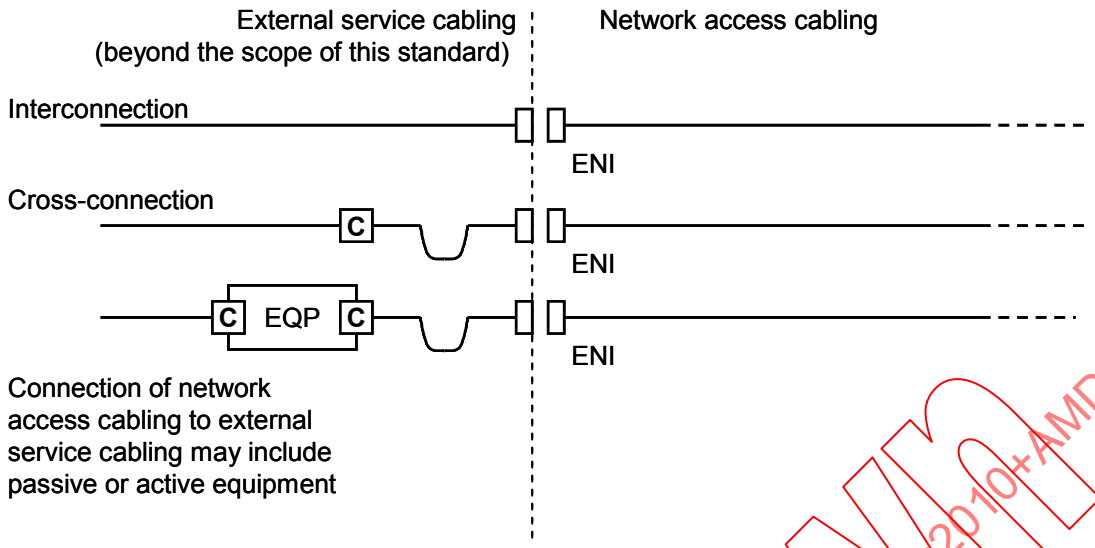

Figure 7 – Examples of external service cabling connections to the ENI

5.7.4 Cables

Cable types used in the reference implementations of Clause 7 are specified in Clause 8.

5.7.5 Equipment cords

Equipment cords are non-permanent and can be application-specific.

5.7.6 Patch cords and jumpers

Patch cords and jumpers are used within cross-connect implementations at distributors. The performance contribution of these cords shall be taken into account in the design of the channel. Clause 7 provides guidance on cord/jumper lengths for reference implementations of generic cabling.

5.7.7 Equipment outlets

The design of generic cabling should provide for EOs to be installed with a high density and located in close proximity to the application-specific equipment to which they are to be connected. The number of cable elements presented at the EO is not restricted by this standard.

A group of EOs can be served directly by multiple ZDs, or by multiple ZDs via multiple LDPs.

The EO interface presented shall be in accordance with Clause 9.

5.7.8 LDP

The installation of an LDP in the zone distribution cabling between the ZD and the EO may be useful where frequent additions or movements of equipment are required. One LDP is permitted between a ZD and any EO. The LDP shall be an interconnect, not a cross-connect, because the LDP adds one connection per channel or link. There shall be no active equipment in the LDP area with the exception of DC powering equipment.

Where an LDP is used, it shall have sufficient capacity to support the area of the data centre which it is designed to serve during its intended operational life. The area served may be defined in terms of number of frames/cabinets/closures to be supported and should include allowance for growth.

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Provided that the requirements of 5.5 are met, LDP(s) may be located in ceiling voids or under floors.

For balanced cabling, the effect of multiple connections in close proximity on transmission performance should be taken into consideration when planning the cable lengths between the ZD and the LDP.

5.7.9 Building entrance facilities

See 5.7.8 of ISO/IEC 11801:2002 and Amendment 1 (2008).

5.8 Earthing and equipotential bonding

See ISO/IEC 14763-2[15].

6 Channel performance

6.1 General

This clause specifies the minimum channel performance of balanced and optical fibre cabling in terms of the Classes as specified in 6.2. The transmission performance of channels is specified at and between the connections to active equipment as shown in Figure 8. The channel comprises only passive sections of cable, connections, equipment cords, patch cords and jumpers.

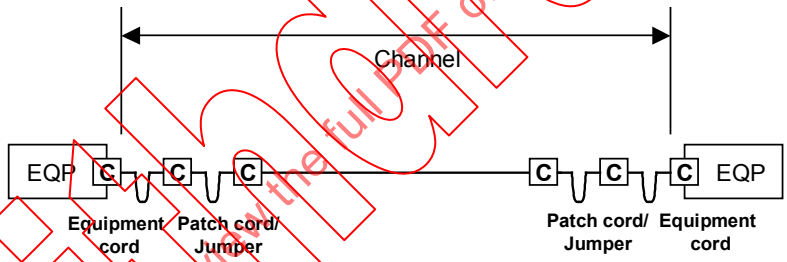

Figure 8 – Example of a channel with 4 connections

Application support depends on channel performance only, which in turn depends on cable length, number of connections, connector termination practices and workmanship.

Channels are implemented using either:

- network access cabling only;
- main distribution cabling only;
- zone distribution cabling only;
- a combination of the above, see Annex D.

Figure 9 shows an example of equipment at the MD connected to equipment at the EO using two channels, an optical fibre cabling channel and a balanced cabling channel. The optical fibre and balanced cabling channels are connected together using an optical fibre to balanced cable converter. There are four channel interfaces; one at each end of the balanced cabling channel, and one at each end of the optical fibre cabling channel.

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15 Until ISO/IEC 14763-2 is published, relevant information may be found in ISO/IEC 18010.

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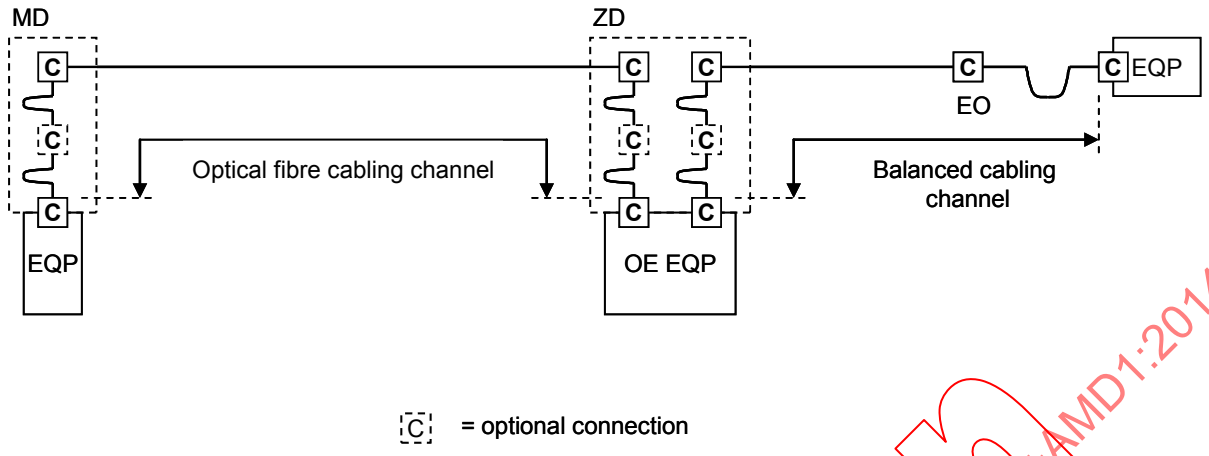

Figure 9 – Example of a system showing the location of cabling interfaces

6.2 Transmission performance

6.2.1 General

The channel transmission performance specifications are separated into Classes that allow for the transmission of the applications in Annex F of ISO/IEC 11801:2002.

The channel performance requirements described in this clause shall be used for the design and may be used for verification of any implementation of this International Standard, using the test methods defined, or referred to, in this clause. In addition, these requirements can be used for application development and trouble shooting.

The channel specifications in this clause allow for the transmission of defined Classes of applications over distances other than those of Clause 7, and/or using media and components with different transmission performance than those of Clauses 8, 9 and 10.

Consideration should be given to measuring performance at worst case temperatures, or calculating worst case performance based on measurements made at other temperatures.

Link performance requirements are specified in Annex A.

6.2.2 Balanced cabling

The main distribution and zone distribution cabling shall be designed to provide a minimum of Class E_A channel performance as specified in ISO/IEC 11801.

6.2.3 Optical fibre cabling

Optical fibre cabling shall be designed using the optical fibre cables specified in Clause 8. Where multimode optical fibre is used, the main distribution and zone distribution cabling shall provide channel performance as specified in ISO/IEC 11801 using a minimum of Category OM3 cabled optical fibre and optical connecting hardware as specified in 9.3.

7 Reference implementations

7.1 General

This clause describes implementations of generic cabling that utilise components referenced in Clauses 8, 9 and 10. These reference implementations meet the requirements of Clause 5

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and, when installed in accordance with ISO/IEC 14763-2[16], comply with the channel performance requirements of Clause 6.

7.2 Balanced cabling

7.2.1 Assumptions

Balanced cabling components referenced in Clauses 8, 9 and 10 are defined in terms of Category. In the reference implementations of this clause, the components used in each cabling channel shall have the same nominal characteristic impedance in accordance with 7.2 of ISO/IEC 11801:2002 and Amendment 2 (2010).

Cables and connections of different Categories should not be mixed within a channel. If different Categories are mixed, the resultant cabling performance will be determined by the Category of the lowest performing component.

The implementations are based on component performance at 20 °C. The effect of temperature on the performance of cables shall be taken into account as shown in Table 2, Table 4 and Table 5.

7.2.2 Zone distribution cabling

7.2.2.1 Component choice

The selection of balanced cabling components will be determined by the Class of applications to be supported by the cabling. Refer to Annex F of ISO/IEC 11801for guidance.

Using the models of 7.2.2.2:

- Category 6_A components provide Class E_A balanced cabling performance;
- Category 7 components provide Class F balanced cabling performance;
- Category 7_A components provide Class F_A balanced cabling performance.

7.2.2.2 Dimensions

Figure 10 shows the models used to correlate zone distribution cabling dimensions specified in this clause with the channel specifications in Clause 6.

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16 Until ISO/IEC 14763-2 is published, relevant information may be found in ISO/IEC 18010.

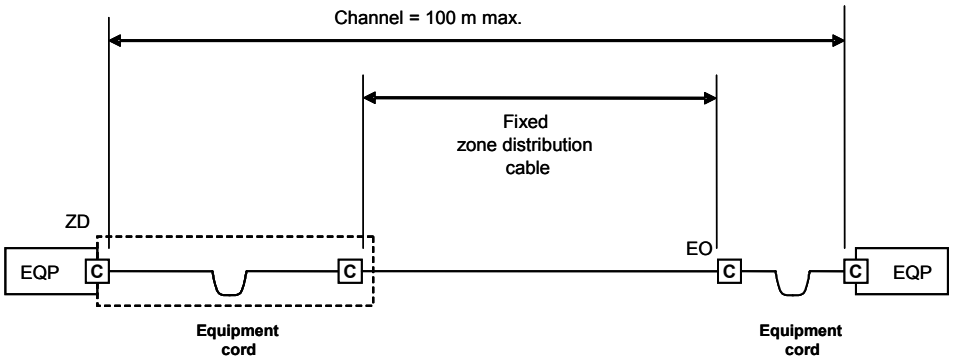

Figure 10a – Interconnect – EO model

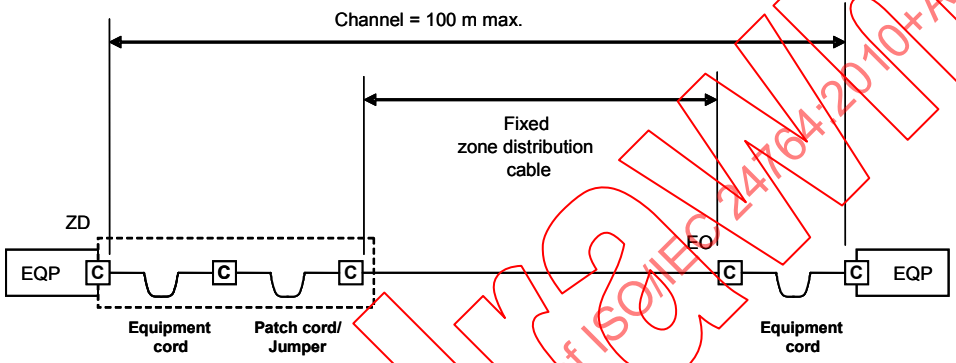

Figure 10b – Cross-connect – EO model

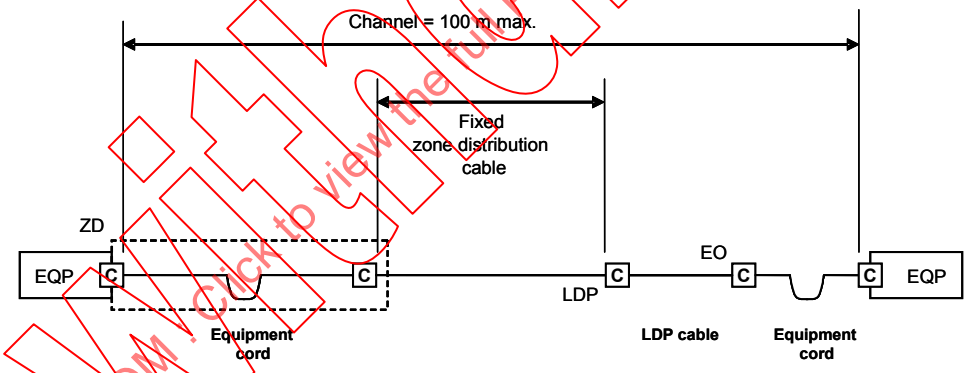

Figure 10c – Interconnect – LDP – EO model

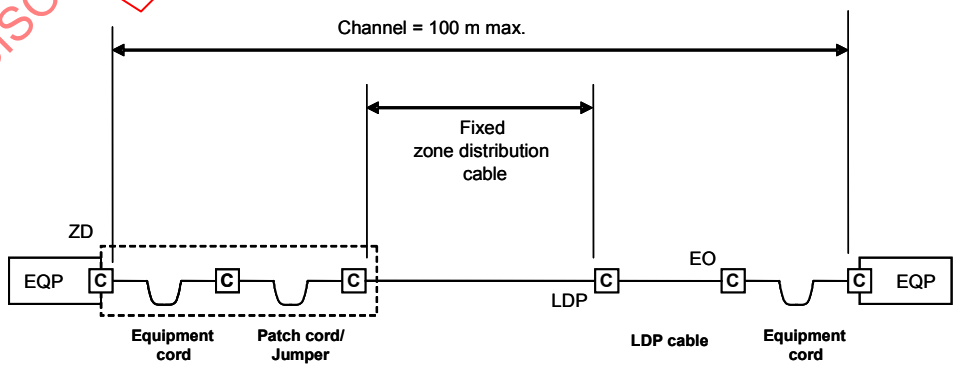

Figure 10d – Cross-connect– LDP – EO model

Figure 10 – Zone distribution cabling models

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Figure 10a shows a channel containing only an interconnect and an EO. Figure 10b contains an additional connection as a cross-connect. In both cases the fixed horizontal cable connects the ZD to the EO. The channel includes patch cords and equipment cords. For the purposes of this subclause, jumpers used in place of patch cords are treated as cords.

Figure 10c shows a channel containing an interconnect, an LDP and an EO. Figure 10d contains an additional connection as a cross-connect. In both cases the fixed zone distribution cable connects the ZD to the LDP. The channel includes patch cords and equipment cords. For the purposes of this subclause, jumpers used in place of patch cords are treated as cords.

In addition to the cords, the channels shown in Figure 10c and Figure 10d contain an LDP cable. The insertion loss specification for the LDP cable may differ from that of both the fixed zone distribution cable and the flexible cables. The channel of Figure 10d is recognized as the maximum implementation used to define the channel performance limits of Clause 6.

In order to accommodate cables used for LDP cables, patch cords, jumpers and equipment cords with different insertion loss specifications, the maximum cable length used within a channel shall be determined by the equations shown in Table 2.

In Table 2 it is assumed that

a) the flexible cable within these cords has a higher insertion loss specification than that used in the fixed zone distribution cable (see Clause 10);

b) the cables within these cords in the channel have a common insertion loss specification.

The following general restrictions apply:

a) the physical length of the channel shall not exceed 100 m;

b) the physical length of the fixed zone distribution cable shall not exceed 90 m and may be less depending on the length of LDP cables and cords used and the number of connections.

Table 1 contains the length assumptions of the mathematical model used to validate channel performance using components specified in Clauses 8, 9 and 10. They do not represent absolute restrictions on the implementation of channels and permanent links, but may be used for guidance in reference implementations. Table 1 gives the length assumptions used in the mathematical modelling of balanced zone distribution cabling.

Table 1 – Zone distribution cabling – length assumptions for balanced cabling

Segment	Minimum m	Maximum m
ZD-LDP	15	85
LDP-EO	5	–
ZD-EO (no LDP)	15	90
Equipment cord at the EO	2[a]	5
Patch cord	2	–
Equipment cord at the ZD	2[b]	5
All cords	–	10

[a] If there is no LDP, the minimum length of the equipment cord is 1 m.

[b] If there is no cross-connect, the minimum length of the equipment cord is 1 m.

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Table 2 – Zone distribution channel length equations

Model	Figure	Implementation equations	
		Class E_A	Class F and Class F_A
Interconnect-EO	10a	$Z = 104^a - F \times X$	$Z = 105^a - F \times X$
Cross-connect-EO	10b	$Z = 103^a - F \times X$	$Z = 103^a - F \times X$
Interconnect-LDP-EO	10c	$Z = 103^a - F \times X - L \times Y$	$Z = 103^a - F \times X - L \times Y$
Cross-connect-LDP-EO	10d	$Z = 102^a - F \times X - L \times Y$	$Z = 102^a - F \times X - L \times Y$

For operating temperatures above 20 °C, Z should be reduced by 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.

Key

Z maximum length of the fixed zone distribution cable (m)

F combined length of patch cords, jumpers and equipment cords (m)

L length of the LDP cable (m)

X ratio of flexible cable insertion loss (dB/m) to fixed zone distribution cable insertion loss (dB/m)

Y ratio of LDP cable insertion loss (dB/m) to fixed zone distribution cable insertion loss (dB/m) - see

[a] This includes a length reduction allocation to accommodate ILD.

7.2.3 Main distribution cabling

7.2.3.1 Component choice

The selection of balanced cabling components will be determined by the Class of applications to be supported by the cabling. Refer to Annex F of ISO/IEC 11801for guidance.

Using the models of 7.2.3.2:

- Category 6_A components provide Class E_A balanced cabling performance;
- Category 7 components provide Class F balanced cabling performance;
- Category 7_A components provide Class F_A balanced cabling performance.

7.2.3.2 Dimensions

The connection of application-specific equipment to the main distribution cabling at the MD and ZDs adopts either an interconnect or cross-connect approach (see ISO/IEC 11801). The channel includes patch cords and equipment cords. For the purposes of this sub clause, jumpers used in place of patch cords are treated as cords.

Figure 11 shows the model used to correlate main distribution cabling dimensions specified in this clause with the channel specifications in Clause 5. This figure represents the full configuration for the main distribution channel.

Table 3 contains the length assumptions of the mathematical model used to validate Channel performance using components specified in Clauses 8, 9 and 10. They do not represent absolute restrictions on the implementation of channels and permanent links, but may be used for guidance in reference implementations. Table 3 gives the length assumptions used in the mathematical modelling of balanced main distribution cabling.

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Table 3 – Main distribution cabling – Length assumptions for balanced cabling

Segment	Minimum m	Maximum m
MD-ZD	15	90
Equipment cord at the MD	2[a]	5
Equipment cord at the ZD	2[b]	5
Patch cord	2	–
All cords	–	10

[a] If there is no cross-connect at the MD, the minimum length of the equipment cord at the MD is 1 m.

[b] If there is no cross-connect at the ZD, the minimum length of the equipment cord at the ZD is 1 m.

The maximum length of the fixed main distribution cable will depend on the total length of cords to be supported within a channel.

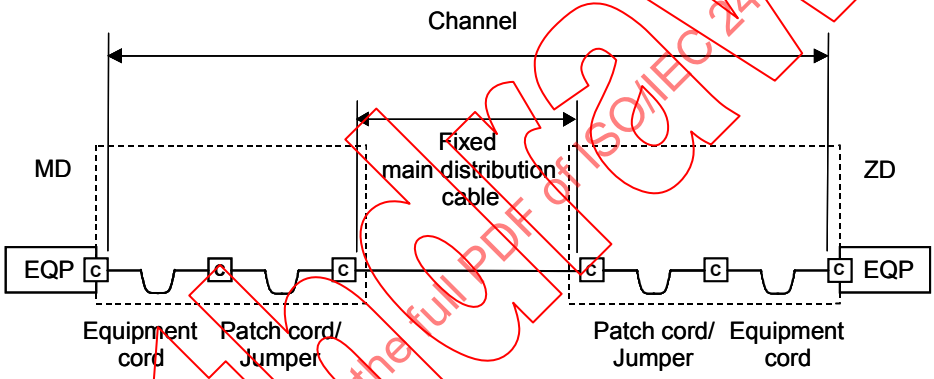

Figure 11 – Main distribution cabling models

In order to accommodate the higher insertion loss of flexible cables used for cords, the length of the cables used within a channel of a given Class (see Clause 6) shall be determined by the equations shown in Table 4.

In Table 4 it is assumed that

a) the flexible cable within these cords has a higher insertion loss specification than that used in the fixed main distribution cable (see Clause 10),

b) the cables within these cords in the channel have a common insertion loss specification.

The following general restrictions apply:

a) the physical length of the channel shall not exceed 100 m;

b) the physical length of the fixed main distribution cable shall not exceed 90 m and may be less depending on the length of cords used and the number of connections;

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Table 4 – Main distribution channel length equations

Model	Implementation equations	
	Class E_A	Class F and Class F_A
Interconnect-interconnect	$M = 104^a - F \times X$	$M = 105^a - F \times X$
Interconnect-cross-connect	$M = 103^a - F \times X$	$M = 103^a - F \times X$
Cross-connect—cross-connect	$M = 102^a - F \times X$	$M = 102^a - F \times X$
For operating temperatures above 20 °C, *M* should be reduced by 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.		
Key *M* maximum length of the fixed main distribution cable (m) *F* combined length of patch cords, jumpers and equipment cords (m) *X* ratio of flexible cable insertion loss (dB/m) to fixed main distribution cable insertion loss (dB/m)		
[a] This includes a length reduction allocation to accommodate ILD.		

7.2.4 Network access cabling

7.2.4.1 Component choice

The selection of balanced cabling components will be determined by the channel lengths required and the Class of applications to be supported. Refer to Annex F of ISO/IEC 11801for guidance.

7.2.4.2 Dimensions

Figure 12 shows the model used to correlate cabling dimensions specified in this clause with the channel specifications in Clause 5. The network access channel shown contains a cross-connect at both ends and represents the worst-case configuration for a network access cabling channel between an MD and a distributor in accordance with ISO/IEC 11801. A channel between an ENI and an MD contains an interconnect at the ENI.

The channel includes patch cords and equipment cords. For the purposes of this clause, jumpers used in place of patch cords are treated as cords.

In Table 5 it is assumed that

a) the flexible cable within these cords has a higher insertion loss specification than that used in the fixed network access cable,

b) the cables within all these cords in the channel have a common insertion loss specification.

In order to accommodate the higher insertion loss of flexible cables used for cords, the length of the cables used within a channel of a given class (see clause 6) shall be determined by the equations shown in Table 5.

When four connections are used in a channel, the physical length of the network access cable should be at least 15 m.

The maximum length of the fixed network access cable will depend on the total length of cords to be supported within a channel. The maximum lengths of cords shall be fixed for ENIs and distributors.

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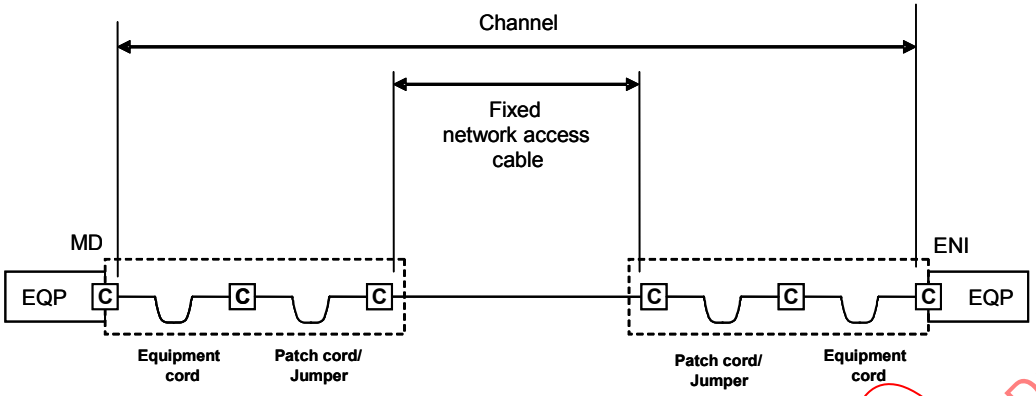

Figure 12a – Network access cabling from MD to ENI

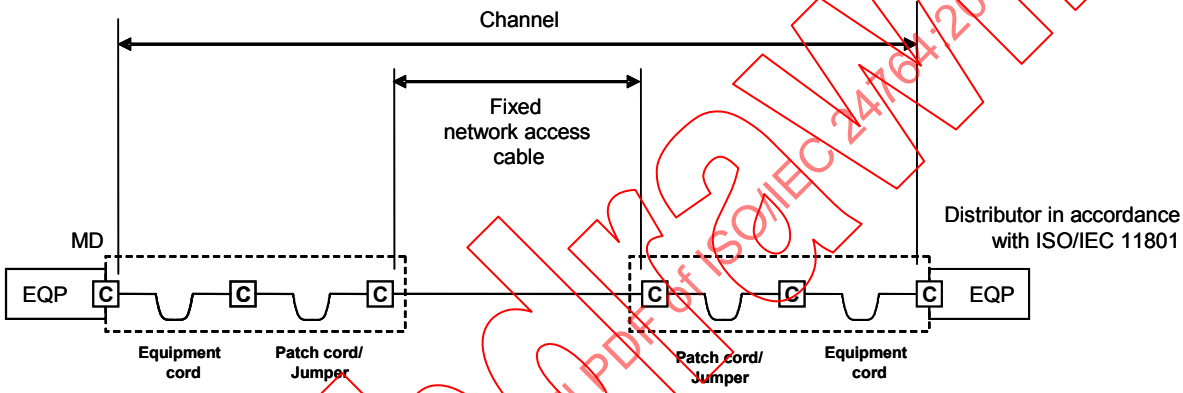

Figure 12b – Network access cabling from MD to distibutor in accordance with ISO/IEC 11801

NOTE Where the EQP connected to the ENI lies outside the premises containing the data centres, the interconnecting cord will typically comprise a combination of fixed cabling and cords that are outside the scope of this standard. In such cases the connection to the EQP may not provide a TI.

Figure 12 – Network access cabling models

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Table 5 – Network access cabling channel equations

Component	Implementation equations [a]							
Category	Class A	Class B	Class C	Class D	Class E	Class E_A	Class F	Class F_A
5	2 000	$N = 250 - F \times X$	$N = 170 - F \times X$	$N = 105 - F \times X$				
6	2 000	$N = 260 - F \times X$	$N = 185 - F \times X$	$N = 111 - F \times X$	$N = 102$ [b] $- F \times X$			
6_A	2 000	$N = 260 - F \times X$	$N = 185 - F \times X$	$N = 111 - F \times X$	$N = 102$ [b] $- F \times X$	$N = 102$ [b] $- F \times X$		
7	2 000	$N = 260 - F \times X$	$N = 190 - F \times X$	$N = 115 - F \times X$	$N = 104$ [b] $- F \times X$	$N = 104$ [b] $- F \times X$	$N = 102$ [b] $- F \times X$	
7_A	2 000	$N = 260 - F \times X$	$N = 190 - F \times X$	$N = 115 - F \times X$	$N = 104$ [b] $- F \times X$	$N = 104$ [b] $- F \times X$	$N = 102$ [b] $- F \times X$	$N = 102$ [b] $- F \times X$

Key

N length of the fixed backbone cable (m)

F combined length of patch cords, jumpers and equipment cords (m)

X ratio of flexible cable insertion loss (dB/m) to fixed network access cable insertion loss (dB/m)

NOTE 1 Where channels contain a different number of connections than in the model shown in Figure 12, the Equation is met when the fixed cable length is reduced (where more connections exist) or or increased (where fewer connections exist) by 2 m per connection for Category 5 connections and 1 m per connection for Category 6 and above connections. Additionally, the NEXT, Return Loss (RL) and ACR-F performance should be verified. Category 5 and Category 6 components and Class A through Class E channels may only be used for network access cabling.

NOTE 2 For operating temperatures above 20 °C, N should be reduced by 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.

[a] Applications limited by propagation delay or skew may not be supported if channel lengths exceed 100 m.

[b] This includes a length reduction allocation to accommodate ILD.

7.3 Optical fibre cabling

7.3.1 Assumptions

Optical fibre components are referenced in Clauses 8, 9 and 10. The optical fibres are defined in terms of physical construction (core/cladding diameter) and their transmission performance Category within a cable. Within the reference implementations of this clause, the cabled optical fibres used in each cabling channel shall be of the same specification.

7.3.2 Component choice

The selection of optical fibre components will be determined by the channel lengths required and the applications to be supported. Refer to Annex F of ISO/IEC 11801:2002/Amd.2 for guidance.

7.3.3 Optical fibre cabling channel lengths

The models of Figure 10, Figure 11 and Figure 12 are applicable to optical fibre cabling for zone distribution cabling, main distribution cabling and network access cabling respectively. The channel length restriction of Figure 10 does not apply, but is instead limited by channel length restrictions of the cabled optical fibre Category used. It should be noted that the connection systems used to terminate fixed optical fibre cabling may contain mated connections and splices (permanent or re-usable) and that cross-connects may comprise re-usable splices.

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8 Cable requirements

8.1 General

This clause defines the minimum requirements for

a) cables installed in the main distribution, zone distribution and network access cabling subsystems specified in Clause 5 and used in the reference implementations of Clause 7,

b) flexible balanced cables to be assembled as cords as specified in Clause 10 and used in the reference implementations of Clause 7,

c) balanced cables or cable elements to be used as jumpers.

8.2 Balanced cables

The electrical performance of balanced cables, other than for network access cabling, shall meet a minimum of Category $6_{A,}$ requirements according to 9.2 of ISO/IEC 11801:2002/Amd.2.

8.3 Optical fibre cables

See 9.4 of ISO/IEC 11801:2002 and Amendment 2 (2010).

9 Connecting hardware requirements

9.1 General requirements

9.1.1 Overview

Hardware for connecting cables shall only provide direct onward attachment for each conductor and shall not provide any contact between more than one incoming and one outgoing conductor (e.g. bridge taps shall not be used).

9.1.2 Applicability

See 10.1.1 of ISO/IEC 11801:2002 and Amendment 2 (2010).

9.1.3 Location

Connecting hardware is installed at the

a) ENI,

b) MD and ZD,

c) LDP (if provided),

d) EO.

9.1.4 Design

See 10.1.3 of ISO/IEC 11801:2002 and Amendment 1 (2008).

9.1.5 Operating environment

See 10.1.4 of ISO/IEC 11801:2002 and Amendment 1 (2008).

9.1.6 Mounting

See 10.1.5 of ISO/IEC 11801:2002 and Amendment 1 (2008).

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9.1.7 Installation practices

See 10.1.6 of ISO/IEC 11801:2002 and Amendment 1 (2008).

9.1.8 Marking and colour coding

See 10.1.7 of ISO/IEC 11801:2002 and Amendment 1 (2008).

9.2 Connecting hardware for balanced cabling

9.2.1 General requirements

See 10.2.1 of ISO/IEC 11801:2002 Amendment 2 (2010).

9.2.2 Performance marking

See 10.2.2 of ISO/IEC 11801:2002 and Amendment 1 (2008).

9.2.3 Mechanical characteristics

9.2.3.1 Connecting hardware of the type used at the ENI

Balanced cabling connecting hardware shall be in accordance with 10.2.3 of ISO/IEC 11801:2002 Amendment 2 (2010) as amended by the requirements of Table 6.

Table 6 – Connecting hardware of the type used at the ENI

Category	Standard
Category 5 unscreened	IEC 60603-7-2
Category 5 screened	IEC 60603-7-3
Category 6 unscreened	IEC 60603-7-4
Category 6 screened	IEC 60603-7-5
Category 6_A unscreened	IEC 60603-7-41
Category 6_A screened	IEC 60603-7-51
Category 7 screened	IEC 60603-7-7[a]
Category 7_A screened	IEC 60603-7-71[a]
[a] In installations where other factors such as cable sharing take preference over backward compatibility offered by the IEC 60603-7-7 and IEC 60603-7-71 interface, the interface specified in IEC 61076-3-104 may be used.	

9.2.3.2 Connecting hardware of the type used at the EO

Balanced cabling connecting hardware shall be in accordance with Clause 10.2.3 of ISO/IEC 11801:2002/Amd.2 as amended by the requirements of Table 7.

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