General Installation Guide

October 2026 v3.02



This document is intended to provide general guidance on LAN cabling infrastructure design & installation good practices and for compliance to Aginode warranty application requirements.

It is not meant to serve as the only reference for installations requirements or be a substitute for applicable training requirements.

For further advice or support regarding installation queries please contact Aginode **https://www.aginode.net/contact**.

For more information on products please contact your local Aginode Sales office or visit: **https://www.aginode.net/products**.

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1. Aginode installation guides

Cabling Standards have been developed over the years to ensure the consistency of the installation quality irrespective of the cabling manufacturer.

Certain elements of the installation are cable vendor product specific, such as cable bend radii of the cable and component assembly detail. In these instances, the Standards refer to the cabling manufacturers product instructions.

For Aginode products, please see the relevant data sheets for specific details.

Aginode product database: **https://www.aginode.net/products**

For Aginode installation and design guidelines please see relevant documents for specific details.

Aginode installation guides: **click here**

Note: Registration on our website (which is easy) may be required to gain access to some of the documentation.

Individual countries use specific Standards. Some regions use a hybrid of them so depending on your location the relevant Standards shall be followed. It is important to always check for the latest versions of Standards as they are constantly being updated.

Additional national/local regulations can also apply (e.g. regarding power separation requirements).

In all instances where the national/local regulations exceed Aginode requirements, the national/local regulations must take priority.

2. Installation standards

Detailed below are the most commonly applicable Standards although this is not a complete list, for example EN50174-1 has several normative references that need to be read in conjunction with the standard for full reference.

2.1. International standards

2.1.1. Generic Structured Cabling – Core Series

ISO/IEC 11801 series
Information technology – Generic cabling for customer premises

Individual parts:

ISO/IEC 11801-1
General requirements - Fundamental architecture, topology, performance classes, and channel definitions.

ISO/IEC 11801-2
Office premises - Cabling requirements for commercial office buildings.

ISO/IEC 11801-3
Industrial premises - Environmental classes (MICE), robust connectors, and industrial constraints.

ISO/IEC 11801-4
Homes - Residential cabling systems (ICT distribution in dwellings).

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ISO/IEC 11801-5
Data centres - Structured cabling for data centre environments
➔ Aligned with EN 50600

ISO/IEC 11801-6
Distributed building services (DBS) - Cabling for building automation, IoT, and SPE-based services.

ISO/IEC TR 11801-9902
End-to-end (E2E) link configurations

ISO/IEC TR 11801-9911
Guidelines for the use of balanced single pair applications within a balanced 4 pair cabling system

2.1.2. Cabling Installation, Planning & Operation

ISO/IEC 14763 series
Implementation and operation of customer premises cabling

ISO/IEC 14763-1
Administration - Identification, labelling, and documentation of cabling systems.

ISO/IEC 14763-2
Planning and installation - Design rules, installation practices, pathways, and separation.

ISO/IEC 14763-3
Testing of optical fibre cabling - Test methods, limits, and acceptance criteria for OF links.

ISO/IEC 14763-4
Measurement of end-to-end (E2E) links, modular plug terminated links (MPTLs) and direct attach cabling

ISO/IEC 14763-5
Sustainability

ISO/IEC 14763-6
Best practices for installation and quality control of cabling systems

2.1.3. Grounding and bonding

ISO/IEC 30129

Telecommunications bonding networks for buildings and other structures

2.1.4. Lifecycle of data centre facilities

ISO/IEC 22237
Information technology – Data centre facilities and infrastructures

International standard series for data centre design, construction, and operation, heavily based on the European EN 50600 standard.

Individual parts:

Part 1: General Concepts
Defines the overarching principles, terminology, and classification system for data centres.

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Part 2: Building Construction
Specifies requirements for physical structure.

Part 3: Power Distribution
Covers electrical infrastructure.

Part 4: Environmental Control
Addresses cooling and air quality

Part 5: Telecommunications Cabling
Details IT and network cabling requirements

Part 6: Security Systems
Focuses on physical security measures

Part 7: Management and Operation
Operational processes, risk management and specific, specialized requirements

2.2. European standards

2.2.1. Generic Structured Cabling – Core Series

EN 50173 series
Information technology – Generic cabling systems

Individual parts:

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

EN 50173-2
Information technology – Generic cabling systems – Part 2: Office premises

EN 50173-3
Information technology – Generic cabling systems – Part 3: Industrial premises

EN 50173-4
Information technology – Generic cabling systems – Part 4: Homes

EN 50173-5
Information technology – Generic cabling systems – Part 5: Data centres

EN 50173-6
Information technology – Generic cabling systems – Part 6: Distributed building services

EN 50173-10
Information technology – Generic cabling systems – Part 10: Single pair cabling

EN 50173-20
Information technology – Generic cabling systems – Part 20: Alternative cabling configurations

2.2.2. Cabling Installation, Planning & Operation

EN 50174 series
Information technology – Cabling installation

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Individual parts:

EN 50174-1
Information technology – Cabling installation – Part 1: Specification and quality assurance

EN 50174-2
Information technology – Cabling installation – Part 2: Installation planning and practices inside buildings

EN 50174-3
Information technology – Cabling installation – Part 3: Installation planning and practices outside buildings

EN 50174-4
Information technology – Cabling installation – Part 4: Testing of installed optical fibre cabling

2.2.3. Grounding and bonding

EN 50310
Bonding and earthing for ICT installations

2.2.4. Data centre facilities and infrastructures

EN 50600 – Information technology – Data centre facilities and infrastructures

(European standard developed by CENELEC)

Individual parts:

EN 50600-1– General framework

EN 50600-2 – Building and technical infrastructure

- EN 50600-2-1- Building construction
- EN 50600-2-2 - Power distribution
- EN 50600-2-3 - Environmental control (Cooling, ventilation, thermal management)
- EN 50600-2-4 - Telecommunications cabling infrastructure
- EN 50600-2-5 - Security systems (Physical security, access control, monitoring)

EN 50600-3 – Operations and management

- EN 50600-3-1 - Management and operational information

EN 50600-4 – Key Performance Indicators (KPIs) & sustainability

- EN 50600-4-1 - Overview of and general requirements for key performance indicators
- EN 50600-4-2 - Power Usage Effectiveness (PUE)
- EN 50600-4-3 - Renewable Energy Factor (REF)
- EN 50600-4-6 - Energy Reuse Factor (ERF)
- EN 50600-4-7 - Cooling Efficiency Ratio (CER)
- EN 50600-4-8 - Carbon Usage Effectiveness (CUE)
- EN 50600-4-9 - Water Usage Effectiveness (WUE)

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EN 50600-99 – Technical Reports (guidance, non-normative)

TR 50600-99-1 - Recommended practices for energy management

TR 50600-99-2 - Recommended practices for environmental sustainability

TR 50600-99-3 - Guidance to the application of EN 50600

2.3. US standards

2.3.1. Structured cabling

ANSI/TIA-568.0-E - Generic telecommunications cabling for customer premises

ANSI/TIA-568.1-E - Commercial building telecommunications cabling standard

ANSI/TIA-568.2-E - Balanced twisted-pair telecommunications cabling and components standard

ANSI/TIA-568.3-E - Optical fibre cabling components standard

ANSI/TIA-568.5 - Balanced Single-Pair Telecommunications Cabling and Components Standard

2.3.2. Pathways and spaces

ANSI/TIA-569-E - Telecommunications pathways and spaces

2.3.3. Administration

ANSI/TIA-606-D - Administration standard for telecommunications infrastructure

2.3.4. Grounding and bonding

ANSI/TIA-607-E - Telecommunications Bonding and Grounding (Earthing) for Customer Premises

2.3.5. Data Centres

ANSI/TIA-942-C - Telecommunications Infrastructure Standard for data centres

Covers physical data-centre infrastructure, including:

- Telecommunications cabling systems
- Pathways and spaces
- Power distribution
- Mechanical / cooling systems
- Building architecture
- Fire detection and suppression
- Physical security
- Monitoring and redundancy tiers

2.3.6. 0ther commonly referenced standards

ANSI/TIA-758 - Outside Plant Telecommunications Infrastructure Standard.

ANSI/TIA-862 - Building Automation Systems Cabling Standard.

ANSI/TIA-1179 - Healthcare Facilities Cabling Standard.

ANSI/TIA-4966 - Educational Facilities Standard.

ANSI/TIA-5017 - Industrial Telecommunications Infrastructure Standard.

3. Understanding the standards

Cabling standards define performance, safety and operational requirements rather than installation methods.

The standards use the following terminology:

- SHALL: mandatory requirement
- SHOULD: recommended practice or preferred solution
- MAY: optional approach

Installations shall comply with applicable international, European, national and local regulations. Where requirements differ, the most stringent requirement shall apply.

Modern cabling infrastructure shall support:

- Current and future Ethernet applications
  - ✓ Building horizontal cabling: up to 10G and beyond
  - ✓ Building backbone cabling: up to 100G and beyond
  - ✓ Data centres: up to 400G and beyond
- High-density data centre environments
- AI and GPU cluster deployments
- Edge computing facilities
- Power over Ethernet (PoE type 4 / PoE++) applications
- Smart building and IoT infrastructure
- Sustainability and energy-efficiency objectives

3.1. Applicable Standards

The following standards should be used as the primary reference framework:

3.1.1. Generic ICT Cabling

- ISO/IEC 11801 series (latest editions)
- EN 50173 series (latest editions)
- ANSI/TIA-568 series (where applicable)

These standards define:

- Cabling architecture
- Channel performance
- Copper and fibre requirements
- Connector specifications
- Testing requirements
- Application support

Recent developments include support for:

- Category 6A / 7A
- OM4 and OM5 (where applicable) multimode fibre
- OS2 singlemode fibre
- Single Pair Ethernet (SPE) systems
- Remote power applications (PoE type 4)

Recent additions to the EN 50173 family also include dedicated requirements for Single Pair Ethernet infrastructures.

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3.1.2. Cabling Installation

Within Europe, the following standards should be used for planning, installation and quality assurance of information technology cabling:

- EN 50174-1: Installation Specification and Quality Assurance
- EN 50174-2: Installation Planning and Practices Inside Buildings
- EN 50174-3: Installation Planning and Practices Outside Buildings

These standards define:

- Planning
- Installation practices
- Separation from power systems
- Fire stopping
- Mechanical protection
- Earthing and bonding
- Electromagnetic compatibility (EMC)
- Documentation and administration requirements
- Inspection and quality assurance

For installations outside Europe, or where ISO/IEC standards are specified by the customer, the following standards may be applied as an alternative or in conjunction with the EN 50174 series:

- ISO/IEC 14763-1: Implementation and Operation of Customer Premises Cabling - Part 1: Administration
- ISO/IEC 14763-2: Implementation and Operation of Customer Premises Cabling - Part 2: Planning and Installation

These standards provide internationally recognised requirements for:

- Cabling administration
- Installation planning
- Installation practices
- Pathway and space requirements
- Cable handling and protection
- Earthing and bonding
- Separation from electrical services
- Inspection and testing
- Documentation and record management

3.1.3. Earthing and Bonding

European Standards

- EN 50310: Application of Equipotential Bonding and Earthing in Buildings with Information Technology Equipment

Requirements include:

- Common Bonding Network (CBN)
- Equipotential bonding
- Telecommunications bonding
- Protection against electromagnetic disturbances

International Standards

For installations outside Europe, or where ISO/IEC standards are specified by the customer, the following standards may be applied:

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- ISO/IEC 30129: Telecommunications Bonding Networks for Buildings and Other Structures
- ISO/IEC 14763-2: Information Technology - Implementation and Operation of Customer Premises Cabling - Planning and Installation
- ISO/IEC 11801 series (earthing and bonding requirements related to generic cabling systems)

These standards define requirements for:

- Common Bonding Network (CBN)
- Equipotential bonding
- Telecommunications bonding
- Earthing of screened cabling systems
- Protection against electromagnetic disturbances (EMC)
- Electrical safety
- Bonding of cabinets, racks and cable containment systems
- Integration with the building earthing system
- Protection against lightning-induced currents and electrical disturbances

General Requirements

The earthing and bonding system shall be designed and installed to:

- Provide a low-impedance path for fault currents.
- Minimize differences in electrical potential between interconnected equipment.
- Maintain electromagnetic compatibility (EMC).
- Support the performance of screened cabling systems and data centre infrastructures.
- Protect personnel and equipment from electrical hazards.

Where both European and international standards are applicable, compliance with the most stringent requirement shall be ensured.

Data centre Considerations

For data centres, earthing and bonding should additionally comply with:

- EN 50600-2-4 (Telecommunications Cabling Infrastructure)
- ISO/IEC 22237-2-4 (Telecommunications Cabling Infrastructure)

Special attention should be given to:

- High-density cabinet installations
- AI and HPC clusters
- Screened copper cabling systems
- Fibre-optic cable metallic components
- Raised floor and overhead containment bonding
- Lightning protection system interfaces
- Equalisation of ground potential across data halls

Note: *Modern Artificial Intelligence (AI) and High-Performance Computing (HPC) clusters environments can contain large numbers of interconnected switches, GPU servers and power distribution units. A well-designed bonding network is critical to maintaining equipment reliability, minimizing electromagnetic interference and ensuring personnel safety.*

3.1.4. Data centres

For all new data centre projects:

- EN 50600 series
- ISO/IEC 22237 series

shall be considered in addition to EN 50173 and EN 50174.

These standards define requirements relating to:

- Availability classes
- Electrical distribution
- Cooling systems
- Cabling infrastructure
- Physical security
- Energy efficiency
- Monitoring and DCIM

Important note: EN 50600 has become the primary European framework for the design, construction and operation of modern data centres.

AI and High-Density Data centres

General

The rapid growth of Artificial Intelligence (AI), Machine Learning (ML) and High-Performance Computing (HPC) has increased demands on structured cabling systems.

Cabling infrastructure shall be planned to support:

- 100G Ethernet
- 200G Ethernet
- 400G Ethernet
- 800G Ethernet
- Future 1.6 & 3.2 Tb/s applications

AI and HPC Data centre operators should favour:

- Singlemode fibre (OS2) for backbone connectivity
- MPO/MTP connectivity
- High-density fibre patching systems
- Structured spine-leaf network architectures

AI Cluster Considerations

AI clusters typically introduce:

- Higher cable densities
- Greater thermal loads
- Increased fibre counts
- More frequent infrastructure changes

Recommended practices:

- Separate AI fabric cabling from production network cabling
- Reserve at least 30% future pathway capacity
- Use modular containment systems to accommodate expansion

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Fibre-First Design

For all new high-end data centre deployments, fibre optic cabling should be considered the preferred medium for:

- Inter-switch links
- Backbone cabling
- AI/GPU fabrics
- Campus interconnections

Cat. 6A or Cat. 7A Copper balanced cabling should primarily be reserved for:

- End-device connections
- Low latency short-reach applications
- PoE devices
- Server connections where appropriate

3.2. Aginode recommendations

All Aginode installations shall be completed "in accordance with the relevant Standards. If any doubt exists, please contact your local Aginode representative for guidance.

Listed below are some of the main topics that Aginode are often asked to comment on. All installations shall adhere to the clauses 5,6,7 and 8 of EN 50174-2:2026

3.2.1. Pathway and Containment Requirements

Capacity Planning

Containment systems shall be sized to support:

- Initial installation
- Future growth
- Moves, Adds and Changes (MACs)

Recommended spare capacity:

- Minimum 25% for enterprise buildings
- Minimum 30% for data centres
- Minimum 40% for AI facilities

Cable Support

Continuous support systems should:

- Prevent cable deformation
- Avoid excessive pressure loading
- Maintain manufacturer bend radius requirements
- Protect fibre from crushing, tension, and accidental contact

For high-density fibre installations:

- Dedicated fibre pathways should be considered
- Fibre and copper routes should be segregated where operationally beneficial

The selected pathway system shall ensure that the cabling can be installed without damage while maintaining all product-specific requirements, such as the minimum bend radius.
These requirements can be found in the relevant product data sheets available at:
Data Network Solutions | Aginode

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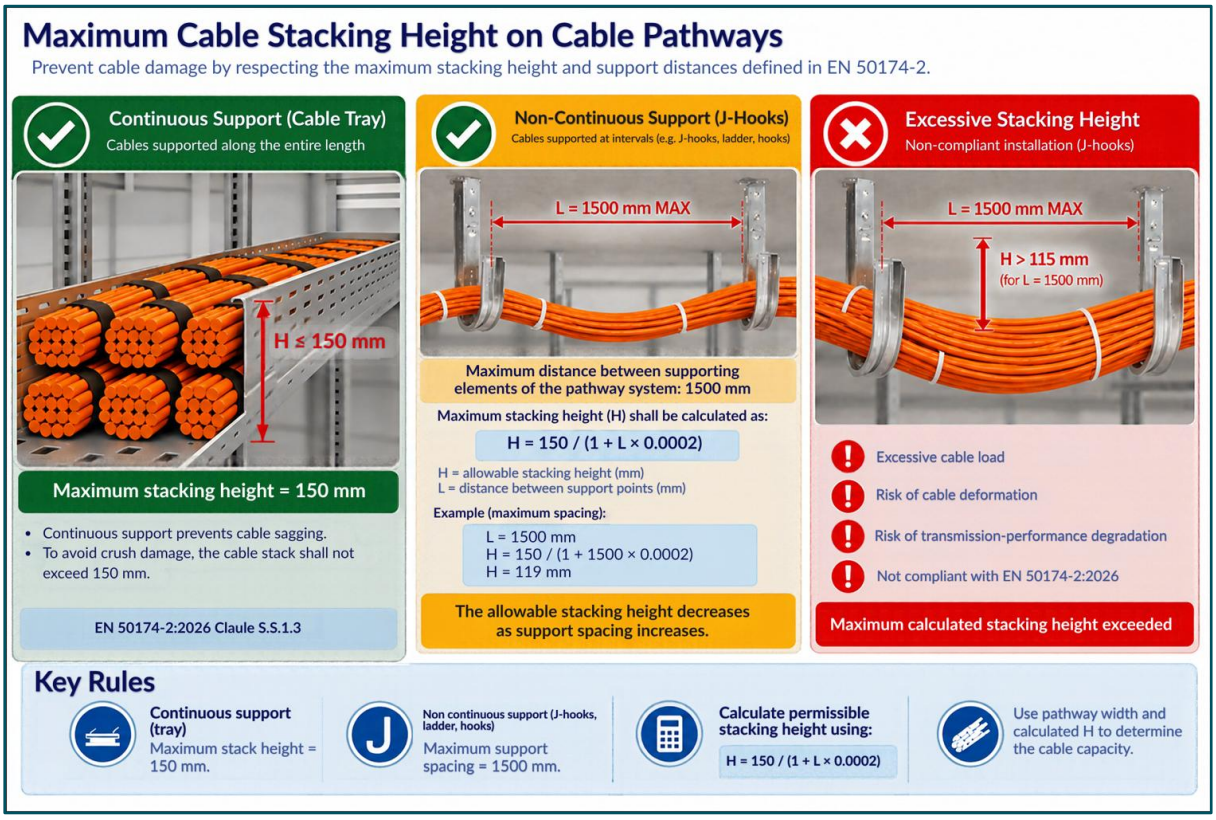
- Where the pathway system provides continuous support, i.e. trays, the cables must not be stacked more than 150 mm. This is to prevent crush damage to the cables at the bottom. EN50174-2:2026 clause 5.5.1.3.
- Where the pathway system provides non-continuous support (e.g. basket, ladder or hooks)
  - ✓ The maximum distance allowed between supporting elements of the pathway system is 1500mm
  - ✓ The maximum stacking height shall be calculated to the following formula
    - ➢ H = 150 / (1 + L x 0,0002)
      where H is the stacking height and L is the distance between points of support

    The obtained height, in combination with the cable pathway width, can now be used to calculate the amount of cables this comprehends.



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- The pathway systems shall have smooth surfaces and shall be free from burrs, sharp edges, or protrusions that could damage cable insulation. They shall also be free from pressure points that could degrade the transmission performance of the installed cabling system.
- Any selected pathway system shall consider the environmental conditions in which it will be installed.
  Note: Detailed information on MICE environmental classification can be found in Annex G of EN 50173-1.

M.I.C.E. stands for

- ✓ Mechanical: Forces that may damage the system, such as shock, vibration, crushing, impact, bending, or other mechanical stresses
- ✓ Ingress: Contamination by dust, particles, liquids, or submersion

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- ✓ Climatic and Chemical: Effects of temperature, temperature variation, humidity, and exposure to chemicals or liquids
- ✓ Electromagnetic: Effects of electromagnetic interference, magnetic fields, radio frequency transmissions, and electrostatic discharge

The standards provide detailed classifications for each of the above environmental factors, allowing a severity rating to be assigned from 1 to 3, where 3 represents the most severe operating environment. Based on this classification, the appropriate containment and cabling solution can be selected, including the choice between screened and unscreened cabling systems.



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- Other supply systems such as water, heating, HVAC, sprinklers, ceiling grids must not be used to support pathway systems because any future changes to these systems may lead to the data cables not being supported correctly
- The route of pathways should avoid localised sources of heat, humidity or vibration that increase the risk of damage to either the cable construction or performance and should not be in lightning conductor voids or lift shafts
- When it is necessary to have hidden pathways, they should be either horizontal or vertical and in logical places
- Cables to be installed in order to provide redundancy should be installed in separate pathways
- Pathways made from tray-work shall be positioned to provide a minimum clearance of 25 mm from the fixing surface and to provide as much working space as possible above the tray (minimum 150mm) to enable access during installation and accommodate the maximum stacking height of cables

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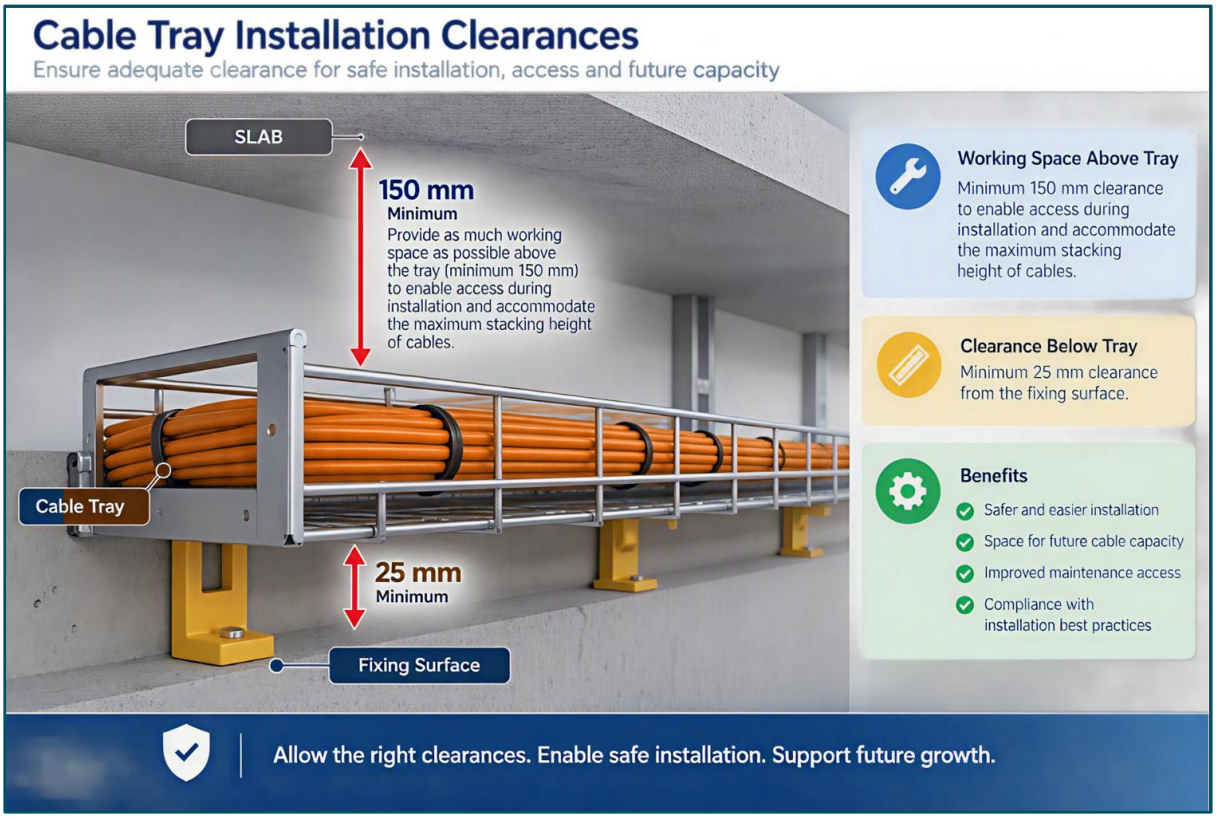

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- The following requirements apply to metallic or composite Cabling Management Systems (CMS or Pathways) – Refer to EN 50174-2 clause 6.2.3.2
  - ✓ the CMS shall be bonded in accordance with EN 50310
  - ✓ the sections shall be interconnected to ensure continuity

Fire barriers

- Installed cabling shall not reduce the effectiveness of fire barriers.
- Where cabling penetrates a fire barrier the fire barrier shall be reinstated using appropriate means.
- If the cabling installer is responsible for the re-instatement of fire barriers then the following requirements apply:
  - ✓ Fire barriers must be re-instated in accordance with local regulations
  - ✓ Only materials which are inert with respect to the cable sheath may be used
  - ✓ Re-instatement of fire barriers must allow for the installation or removal of cables
  - ✓ Cables shall be in containment where they penetrate the fire barrier
- Aginode recommended practice is to sleeve the cables where they penetrate the fire barrier and protect the penetration with an intumescent pipe choke (see diagram)
- If this requirement cannot be met and fire stopping materials must be in direct contact with cables then only gypsum-based fire stopping mortar shall be used. Under no circumstances shall Portland cement-based mortar be in contact with cables

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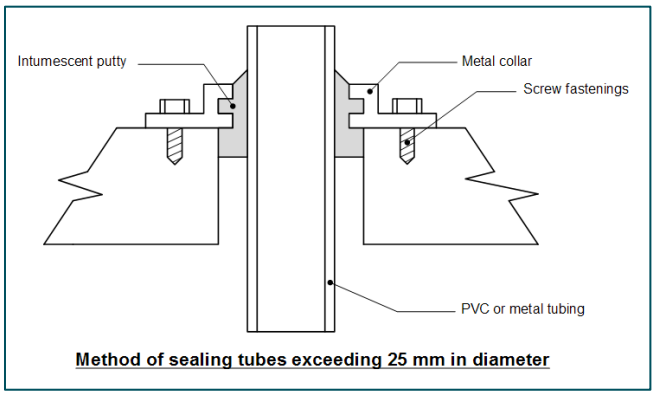
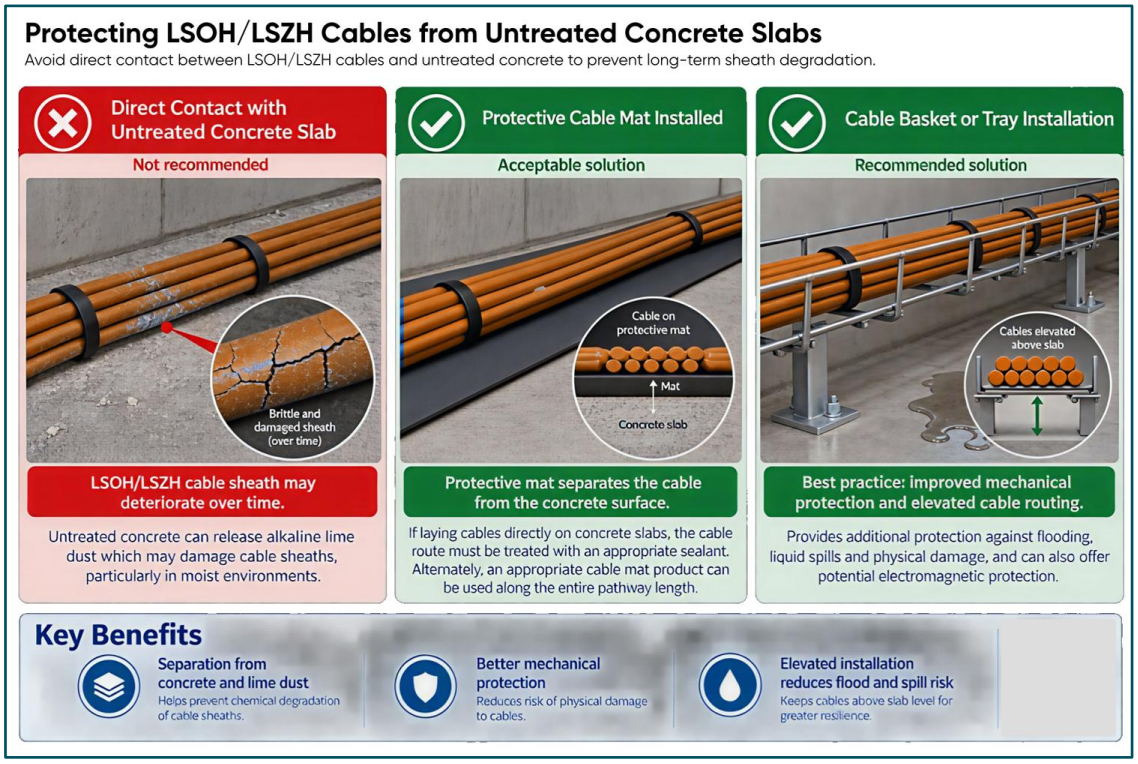


Method of sealing tubes exceeding 25 mm in diameter

Concrete/Cement is not to come into direct contact with LSOH (LSZH) cables

- Make sure that any materials used in conjunction with the cabling installation will not have a detrimental effect on cabling products themselves
- LSOH cables for example should not be laid directly on untreated concrete slabs
- Untreated concrete releases lime (as dust) over a period of time. Lime is a strong reagent (very reactive) having a deleterious effect on LSZH sheathed cables, especially in moist conditions
- When exposed to substances like lime, cable sheaths will become brittle which can subsequently affect the cable's electrical performance over time.
- If planning to lay cable directly on concrete slabs, the cable route must be treated with an appropriate sealant. Alternately, an appropriate cable mat product can be used along the entire pathway length to separate the cables from the concrete slab
- Where possible, Aginode recommend the use of appropriate cable basket or tray as this will offer better mechanical (and potentially electromagnetic) protection to cables. In addition, basket or tray raise cables above the slab level, giving further protection against the possibility of floods or liquid spills.
- With respect to fire stopping, please see above section "Fire Barriers"



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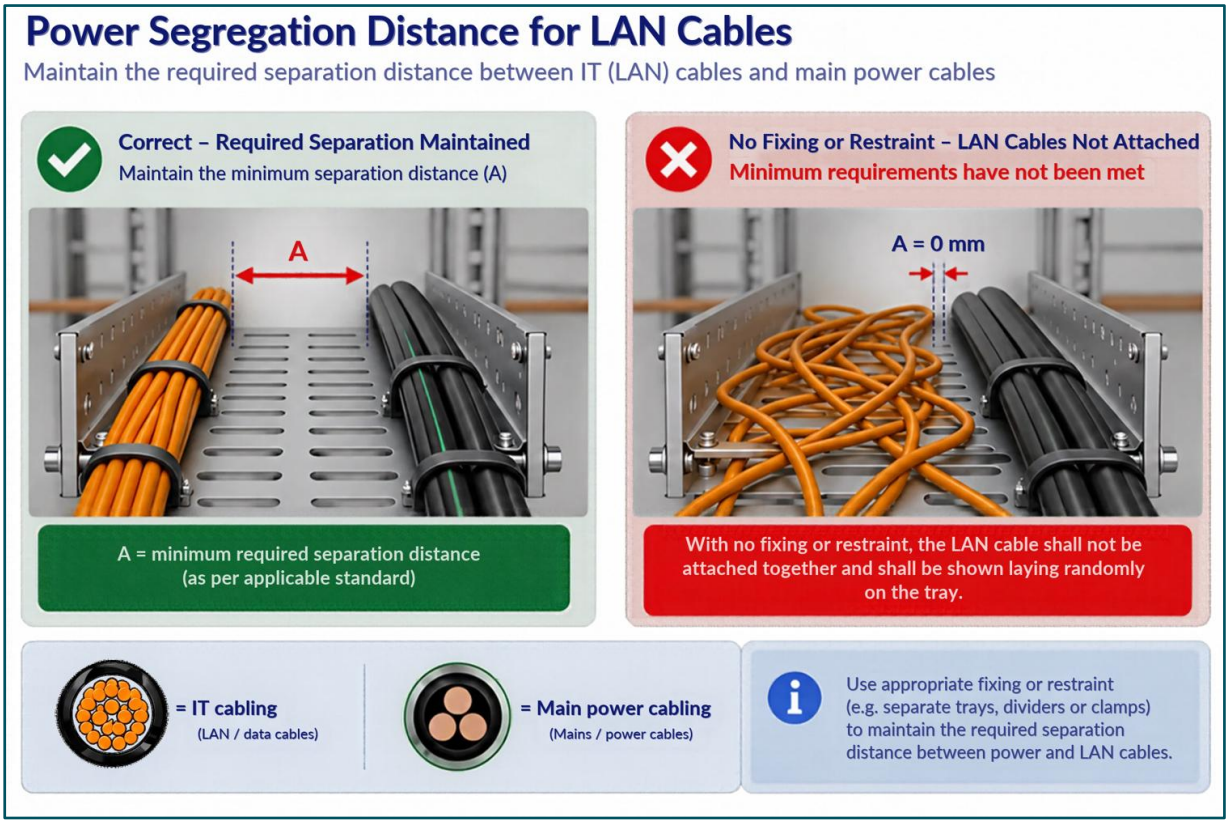
3.2.2. Power segregation

The correct segregation from power in order to protect against Electromagnetic Interference is covered in EN50174-2:2026 clause 7 and in ISO/IEC 14763-2:2019 clause 7.9

Where data cables and mains power cables are within a single pathway system, or in parallel pathway systems, without dividers (see Figure on the next page), A is the minimum separation between the information technology cables and mains power cables as calculated based on the tables in the standards, this includes all allowances for cable movement between their fixing points.
Where no fixing or restraint is present, A is considered to be 0 mm and the minimum requirements have not been met (see Figure below)



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The calculation of the segregation distance (A) is dependent on multiple factors including:

- Type of Data Cable, e.g. Screened, Unscreened, Category 5e, 6, 6A, 7 & 7A
- Number of power circuits
- Amperage of the circuits
- Phase of the circuits
- The type of containment used, e.g. tray, basket or solid (subject to being 1.5mm thick).

Details of these requirements are complex and you need to refer to the standard as every installation environment is different.

Annex E of the EN 50174-2 standard also provides tables showing the calculated values of distance A for various environments.

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Minimum segregation values examples according to EN 50174-2 Annex E (Distance A)			
Number of 20A circuits	No metallic barriers		
	LANmark U/UTP cables	LANmark F1/UTP & U/FTP FXTP & EXTP cables	LANmark F/FTP & S/FTP cables
	Coupling attenuation at 30 to 100 MHz		
	≥ 40 dB	≥ 55 dB	≥ 85 dB
1 to 3	20 mm	10 mm	2 mm
4 to 6	40 mm	20 mm	4 mm
7 to 9	60 mm	30 mm	6 mm
10 to 12	80 mm	40 mm	8 mm
13 to 15	100 mm	50 mm	10 mm
16 to 30	200 mm	100 mm	20 mm
31 to 45	300 mm	150 mm	30 mm
46 to 60	400 mm	200 mm	40 mm
61 to 75	500 mm	250 mm	50 mm
> 75	600 mm	300 mm	60 mm

Notes

- ✓ *"No metallic barriers" means that the data cable and the mains power cables are installed in the same cable tray without any metallic divider between the two cable types*
- ✓ *Each electrical circuit is assumed to be 250 V or less and up to 20 A, single-phase*
- ✓ *Three-phase cables shall be treated as three single-phase cables*
- ✓ *Circuits rated above 20 A shall be treated as multiples of 20 A*

Aginode Technical support department can also provide guidance for the calculation of the segregation distance.

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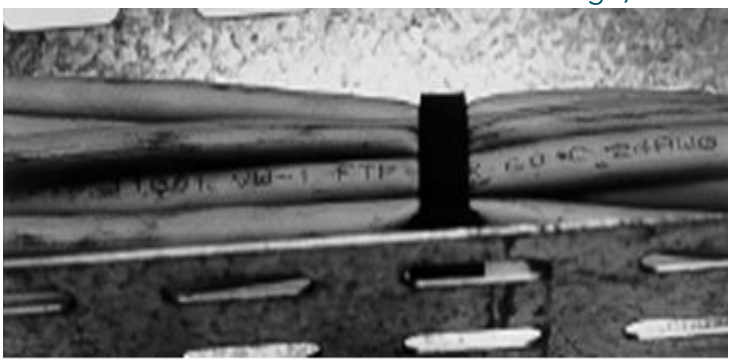
3.2.3. Cable management on tray/basket (Pathways)

EN 50174-2:2026 in section 5.5 and 6.2.3 details the requirements
Cable installation, installation of cables shall be in accordance with the instructions supplied by their manufacturers/ suppliers.

- Installation of cable shall be undertaken according to the installation schedule
- Metallic information technology cabling and mains power cabling shall be segregated in accordance with the previous requirements
- When installing cables, cords or jumpers appropriate techniques shall be applied in order to:
  - ✓ Eliminate cable stress caused by:
    - tension in suspended cable runs
    - tightly pinched cable bundles
  - ✓ Ensuring that minimum bend radii are as specified by the cable manufacturer, supplier or in accordance with the relevant product Standard (rollers or other devices shall be used to avoid damage)



Not acceptable stress

- Ensure that the tensile load applied to the cables and cable bundles as specified by the cable manufacturer, supplier or are in accordance with the relevant product Standards. Unless otherwise stated in the suppliers/manufacturers specification, the maximum tensile load applied to a bundle shall be that specified for a single cable
- Prevent pressure marks (e.g. through improper fastening or crossovers) on the cable sheath or the cable elements
- The following extract from the EN 50174-2:2026 standard is related to the pathway fill ratio:
  - ✓ During initial planning, open or openable pathway systems should not be more than 40 % full, cable entries, cable crossing each other and as to leave adequate space for future cabling
  - ✓ During subsequent planning, open or openable pathway systems should not be more than 50 % full, as to allow future addition in the lifetime of the CMS

EN 50174-2 expects you to assess separation between the various types of cables rather than simply placing everything together in a tray without considering EMC segregation.

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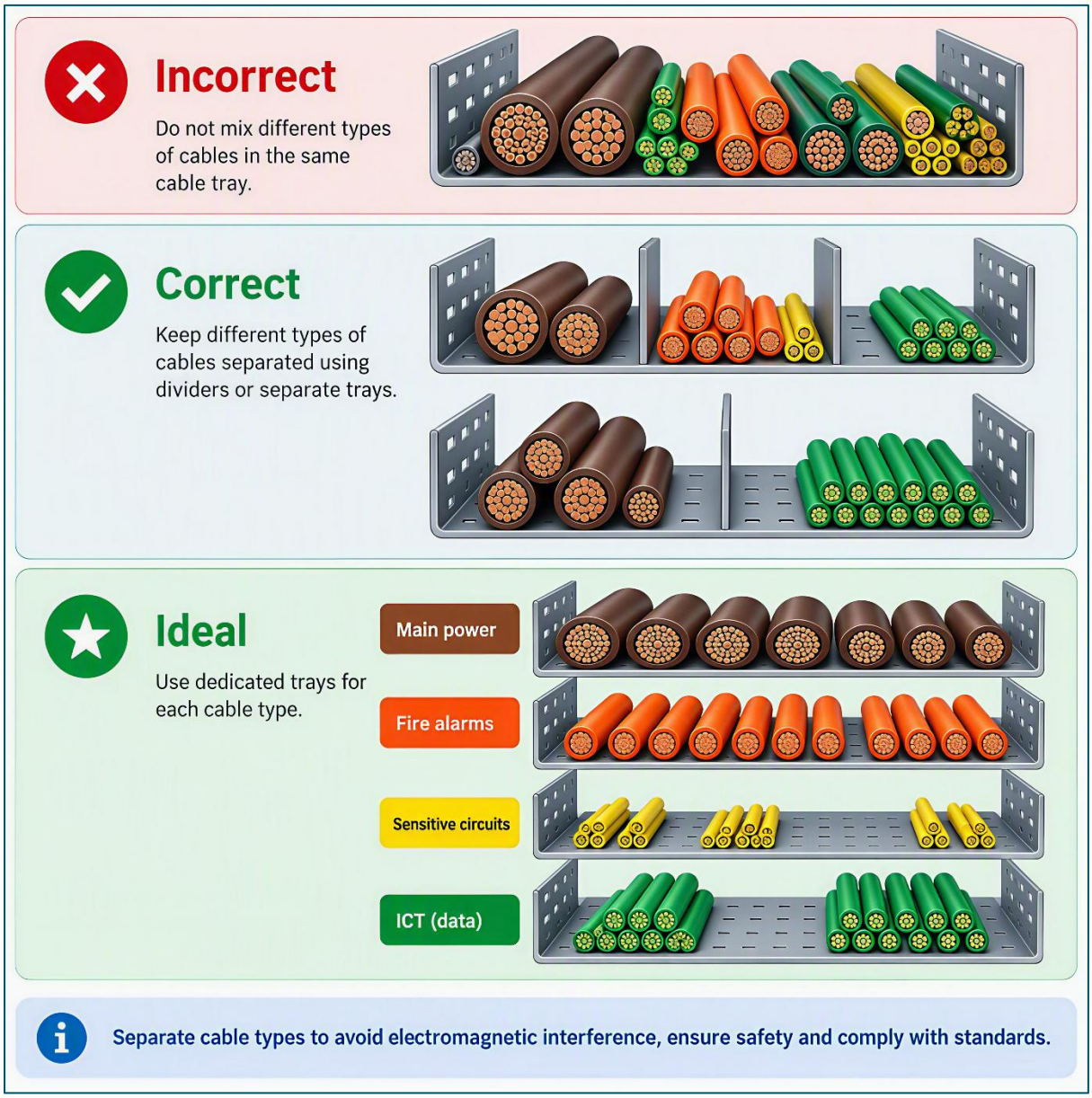

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3.2.4. Cable management inside cabinets

- Consideration to the following statement from the Standards should be given when planning your installation. Parallel runs where cables lie in a fixed physical relationship to each other should be avoided unless the impact on transmission performance has been taken into account in the specification of the cables and the installation (from EN 50174). Shielded cables are essentially immune to alien crosstalk and may be bundled according to customer requirements. UTP cables should be randomised as much as possible and therefore “messy” cable runs are desirable
- The design and the layout of the cabinets, frames and racks shall ensure that the initial quantity and any future cables can be installed whilst maintaining both the installation and operational bend radii

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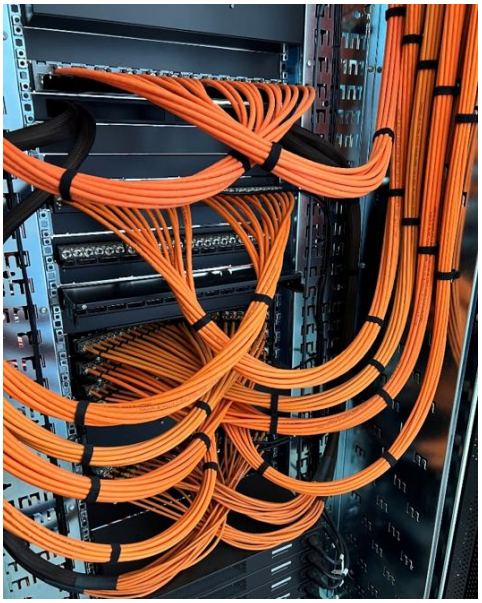
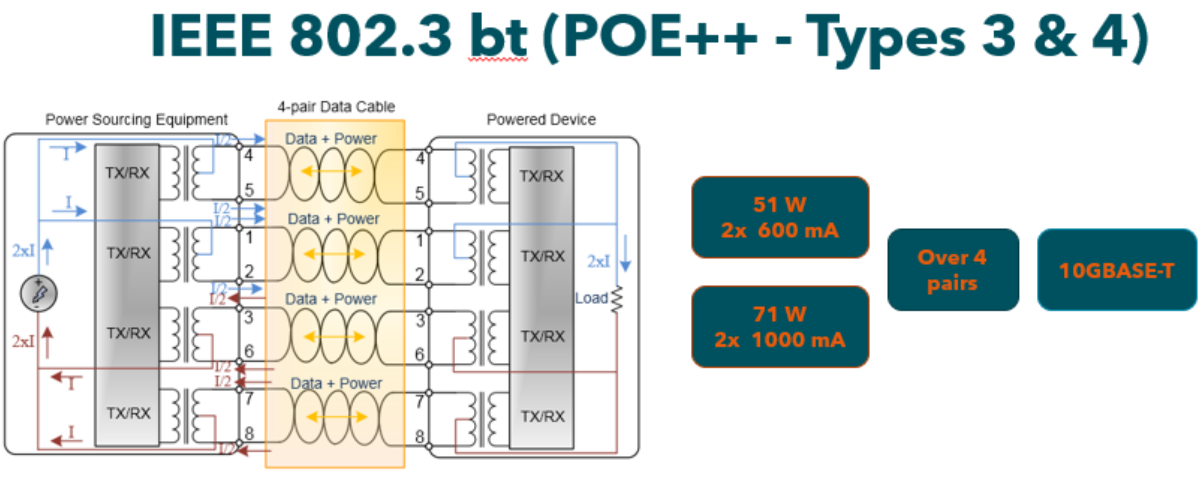
- Aginode recommend that cables are loomed in no more than 24-way bundles and are supported every 300mm minimum
- In general Aginode recommend a 1U cable management for 2 x 24way patch panels (48 ports) as a minimum, but consideration should be given to increasing this for larger diameter cables such as LANmark 7A either to 1U per 24-way panel or utilising a 2U management bar
- Before installing any cables, the building layout needs to be considered such that the numbering scheme employed enables the cables to be inserted into the rack in the right order so that the end result is a neat and easy to maintain cabinet
- For Angled panels, no horizontal cable management is used so the vertical cable management at the sides of the rack must accommodate a larger number of patch cords as shown in the illustration





3.2.5. Power over Ethernet (PoE++) and Remote Powering

Remote powering has evolved from simple VoIP telephone support into a primary method for powering building systems.
Current installations should support: IEEE 802.3bt Type 4 (PoE++) up to 90 W



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PoE Type 4 allows the transmission of up to about 100W from the PSE side and assure about 70W to the PD side. This allows the user to power large TVs, digital signage and many other devices.
Using PoE type 4, the current flowing into each of the 4 pairs is of **1 Amp or 500 mA per wire**.

Typical powered devices now include:

- Wireless Access Points (Wi-Fi 6E / Wi-Fi 7)
- IP cameras
- Smart lighting
- LED controllers
- Building automation systems
- Digital signage
- Security equipment
- Industrial IoT devices

Heat Generation Considerations



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PoE++ introduces significantly higher current levels than previous Ethernet technologies. Installers shall consider:

- Cable bundle heating
- Ambient temperature
- Pathway fill ratios

The following graphs have been generated in accordance with IEEE 802.3bt, IEC 61156-1-4 and ISO/IEC TS 29125. All pairs in every cable in the bundle are energised.

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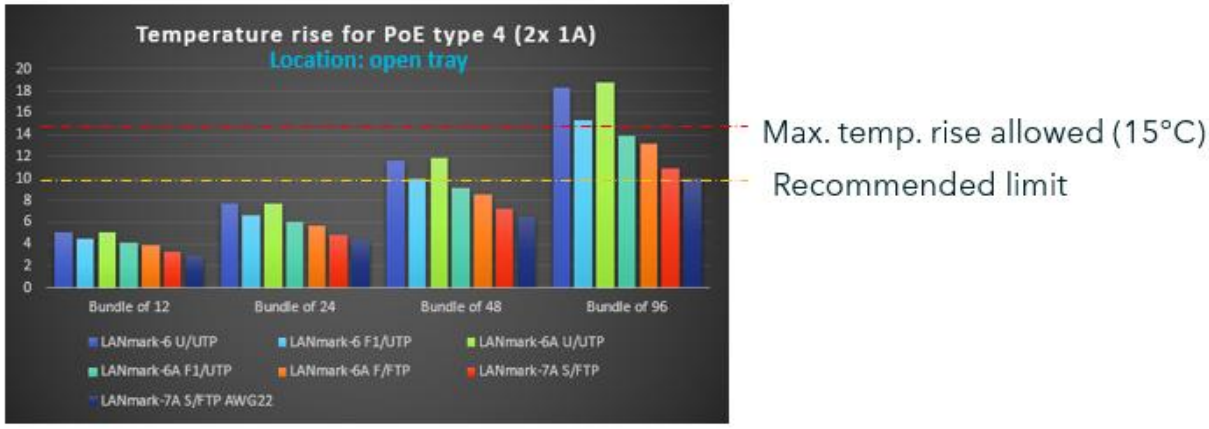


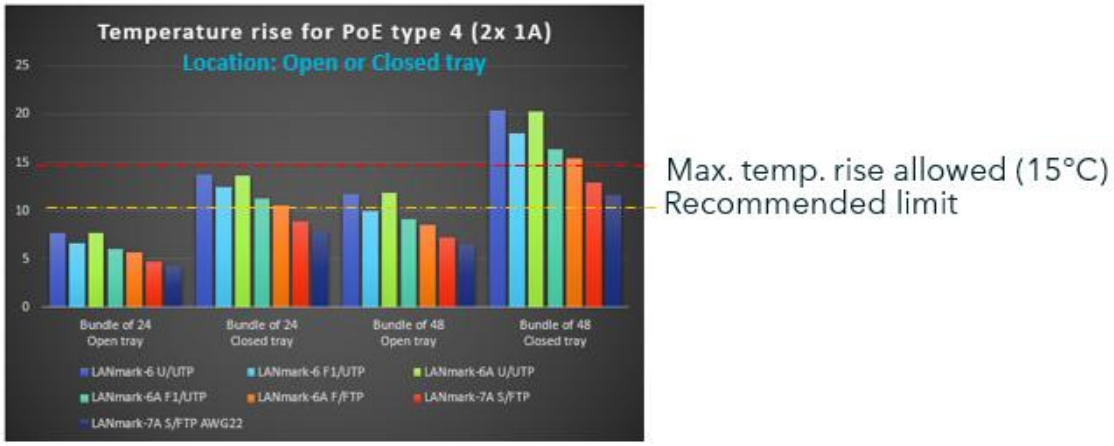
Effect of PoE type 4 on bundle size

The graph above compares the temperature rise in cable bundles of different sizes. High-power PoE applications generate a significant amount of heat in large cable bundles.

- Bundles containing 96 cables should be avoided, regardless of the cable category
- Screened cables of higher categories provide better thermal performance
- Bundles of up to 48 screened Category 6A cables, or higher-category screened cables, are acceptable
- When using unscreened cables, bundles exceeding 24 cables should be avoided

Large cable bundles can experience elevated temperatures resulting in:

- Increased insertion loss ➔ link length reduction
- Reduced transmission margin
- Accelerated cable ageing



The second chart illustrates the impact of cable installation conditions on temperature rise. Cables installed in open trays exhibit a lower temperature increase due to improved heat dissipation.
As shown in the graph, cables installed in closed trays experience a significantly higher temperature rise, even with bundles of only 24 cables.
For bundles of 48 cables installed in closed trays, the temperature rise becomes critical and may exceed acceptable limits for all but the highest-performance cable categories.
In general, a temperature rise greater than 10°C is not recommended, as it may adversely affect cable performance and system reliability.

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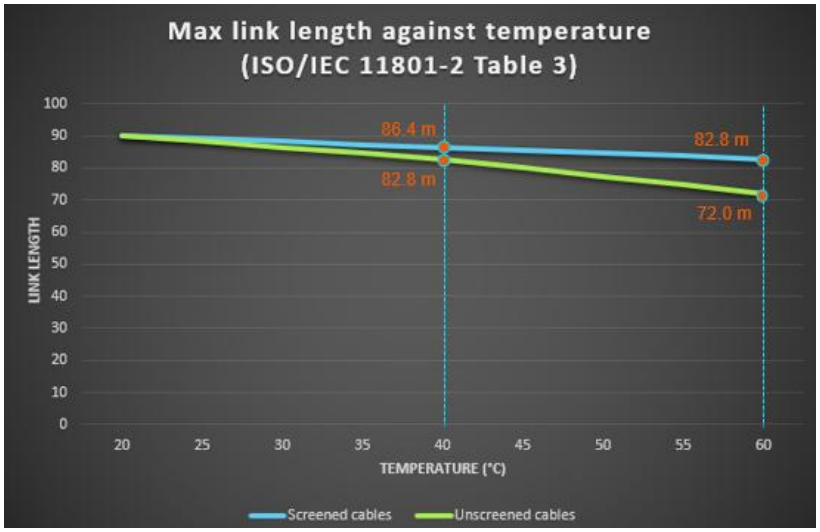
Consequently, open cable trays should be preferred for installations using high-power PoE applications.



The graph above illustrates the impact of operating temperature on the maximum allowable channel length.

As defined by both ISO/IEC and EN standards, the maximum length of a copper horizontal link is 90 m. However, this limit is only valid at a reference temperature of 20°C.

When the operating temperature increases, the maximum allowable cable length must be reduced to compensate for the higher insertion loss of the cable.

According to the ISO/IEC and EN standards, the maximum horizontal cable length shall be reduced as follows:

- Screened cables: 0.2% per °C above 20°C, up to 60°C.
- Unscreened cables: 0.4% per °C above 20°C up to 40°C, and 0.6% per °C between 40°C and 60°C.

Consequently, as cable bundle temperatures increase due to PoE, the maximum permitted channel length decreases.

For example, at an operating temperature of 40°C, the maximum length of a screened cable is reduced to 86.4 m, while the maximum length of an unscreened cable is reduced to 82.8 m.

At 60°C, the maximum length of a screened cable is reduced to 82.8 m, whereas the maximum length of an unscreened cable is reduced to only 72 m.

As shown in the graph, screened cables maintain a significantly longer allowable channel length at elevated temperatures. This provides an additional reason to recommend screened cabling, particularly for high-power PoE applications where cable bundle heating must be considered.

Installation Recommendations

For installations supporting PoE type 4 (PoE++):

Cabling Minimum recommendation:

- Category 6A / Class EA systems
- Fully shielded solutions
- Open trays or basket trays

Preferred in critical infrastructures:

- Class FA or Category 7A systems

➔ Unscreened Cat. 6 and Cat. 6A cables are not recommended because elevated operating temperatures have a greater impact on performance, resulting in a more significant reduction of the maximum channel length compared to Cat. 6A and Cat. 7A screened cables.

Bundle Management

Recommendations include:

- Avoid excessively large cable bundles.
- Maintain airflow around bundles.
- bundle size of 24 cables with a max. of 48 cables

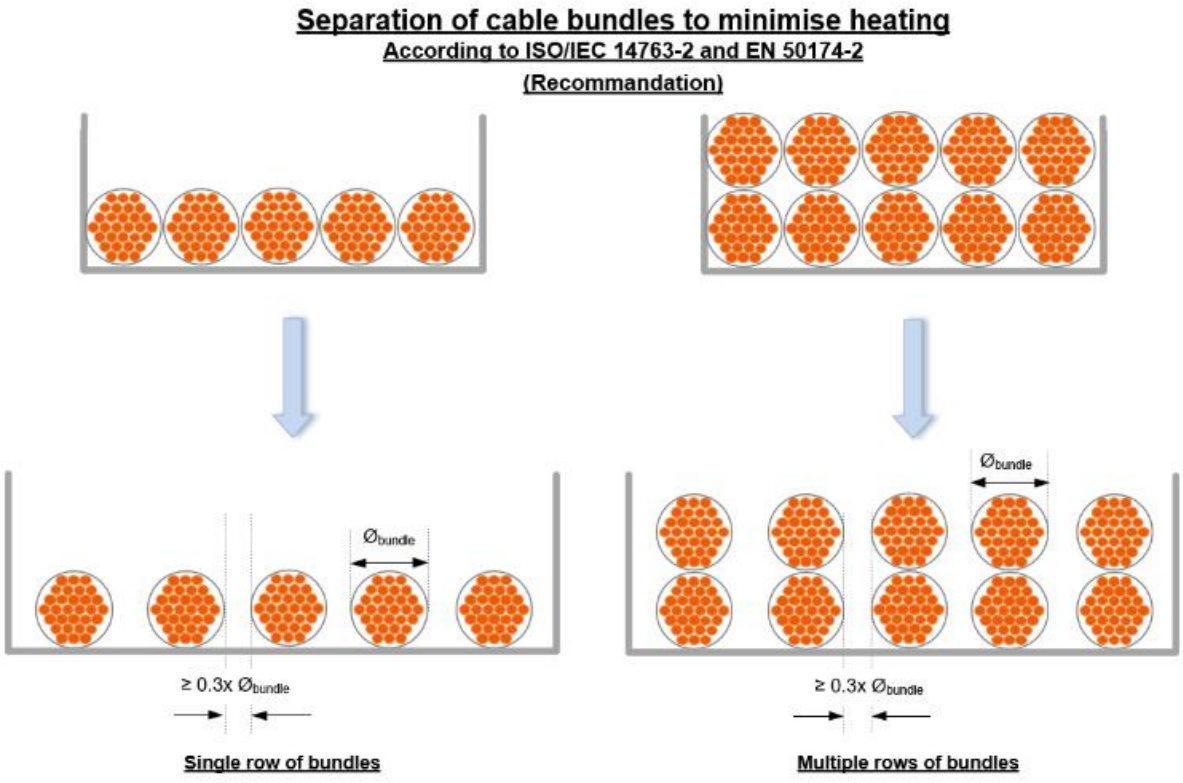
ISO and EN standards recommendation

Up to now, we have analysed the impact of PoE on a single cable bundle. In practice, however, a significant number of bundles may be installed on the same pathway.

As shown in the drawing below, bundles surrounded by several adjacent bundles may experience a higher temperature rise than a single isolated bundle.

For this reason, the relevant cabling standards recommend creating vertical "chimneys" between bundles to facilitate heat dissipation.

Please note that this is a recommendation only. The cabling standards do not mandate the creation of vertical chimneys.



ISO and EN standards requirement

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The latest editions of the ISO/IEC and EN standards also define three Remote Powering categories: RP1, RP2 and RP3 (RP stands for Remote Powering).

Remote Powering (RP) Categories define the level of power that may be delivered over balanced copper cabling to connected devices, such as IP phones, wireless access points, cameras, IoT devices, and other Power over Ethernet (PoE) powered equipment.

The RP category is used to identify cabling links that are intended to support remote powering applications and to ensure that the cabling infrastructure is designed and installed to accommodate the associated current, heat dissipation, and performance requirements.

RP categories shall be considered during the design, installation, testing, and administration of the cabling system to ensure reliable operation and compliance with applicable standards.

The RP category requirements shall be applied to all copper cabling infrastructure.

RP1

- Average PoE current limited to 212 mA per conductor
- No specific planning or installation measures are required
- Verification of compliance with the maximum average current is required when adding equipment

RP2

- Average PoE current between 212 mA and 500 mA per conductor
- Planning and installation measures shall be implemented (depending on the cabling type used)
- Verification of compliance with the maximum average current is required when adding equipment

RP3

- Average PoE current is not limited (Type 4 PoE)
- Planning and installation measures shall be implemented (depending on the cabling type used)
  - ✓ Additional equipment may be added without restriction
  - ✓ Any cabling extensions shall comply with the applicable planning and installation measures

Cabinets, rack or frames in distributors shall be labelled to indicate the Category of remote powering installation (EN 50174-1 - Clause 6.9.2.2 / ISO14763-2 – clause 9.2.2.4).

Examples of labels indicating the RP category assigned to a remote powering installation

(Source EN 50174-1 - Figure 5)

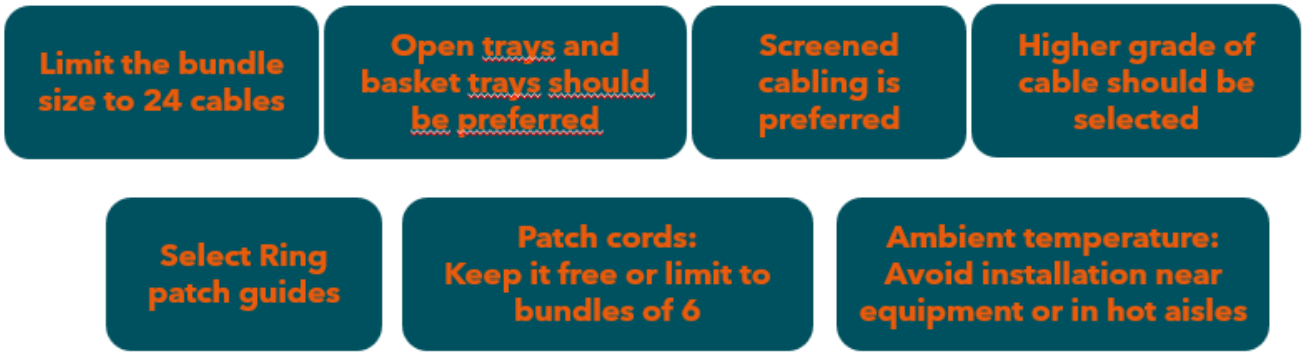


It is strongly recommended that all new copper cabling installations be designed and installed to meet RP3 (Remote Powering Category 3) requirements. This approach ensures that any device requiring Power over Ethernet (PoE) Type 1, Type 2, Type 3, or Type 4 (PoE, PoE+ and PoE++) can be connected and powered from day one.

Designing to RP3 also provides the flexibility to add, relocate, or upgrade PoE-powered devices throughout the operational lifetime of the cabling infrastructure without restrictions related to remote powering capability, cable bundle sizes, or thermal performance.

This future-ready approach minimizes the need for costly cabling upgrades and ensures continued support for evolving network and building technology requirements.

How to design and install a system being RP3 compliant?



To minimize the impact of high-power PoE on cabling systems:

- Limit cable bundles to 24 cables whenever possible
- ✓ Bundles of up to 48 cables are acceptable for Cat. 6A screened and Cat. 7A cabling
- ✓ Bundles of 96 cables shall be avoided
- In racks, use 24-cable bundles to match standard 24-port patch panels
- Prefer open cable trays and wire baskets to improve heat dissipation
- Use screened cables, as they dissipate heat more effectively than unscreened cables
- Higher-category cabling generally results in lower temperature rise
- Use open patch cord management and ring guides for horizontal and vertical routing
- Limit bundles of stranded-conductor patch cords to a maximum of six cords
- Where possible, leave patch cords unbundled
- Avoid routing cables near heat-generating equipment or through high-temperature areas

These recommendations apply to all copper cabling intended to support Remote Powering (RP) applications.

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4. Cabling Structures

4.1. General

Customer premises (Building)

The structure of a generic cabling system in a building or campus is defined in the relevant Standards listed in a former chapter as ISO 11801 or EN50173. Please refer to those Standards for further information.

Cabling infrastructure should be designed in order to support a large set of existing and emerging applications to provide the longest operational life.

A premises cabling system contains up to three subsystems:

1. Campus Backbone to link different buildings together if required. This subsystem extends from the Main Campus Distributor (CD) to every Building Distributor (BD)
2. Building Backbone to link the BD of a particular building to all the Floor Distributors (FD) of this building
3. Horizontal subsystem to link the FD to all the telecommunication outlets of the concerned floor or area



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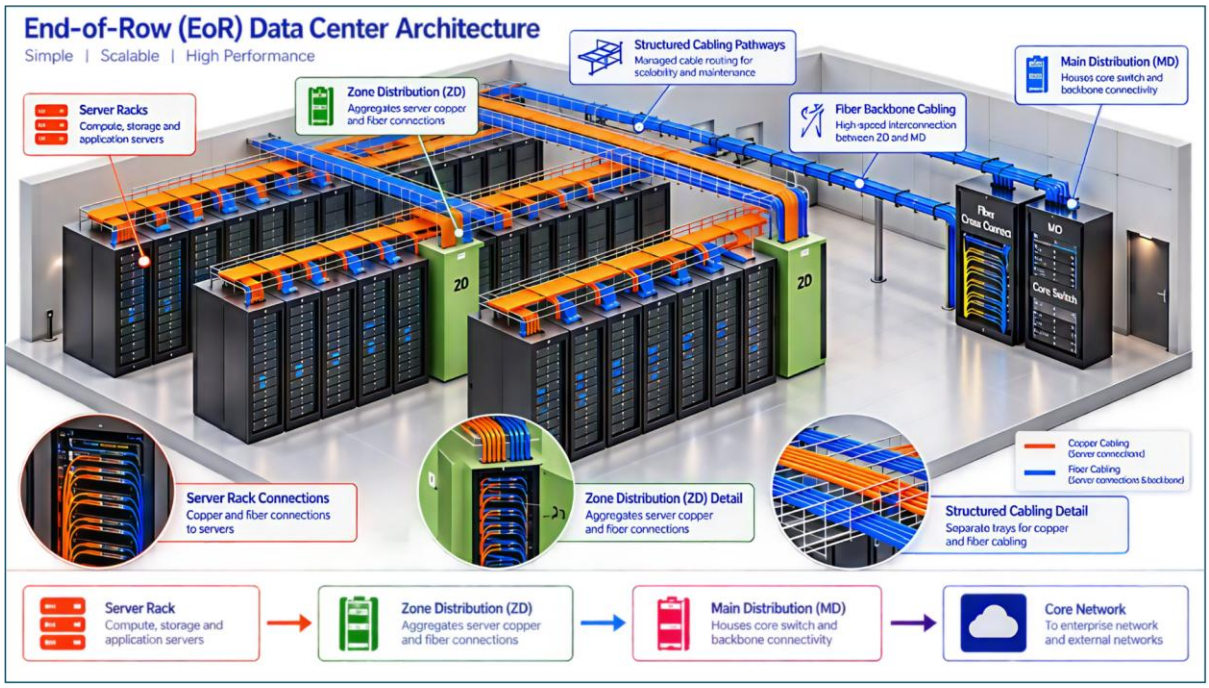
Data centres

Nowadays, data centres require a large number of copper and optical fibre (OF) links. The cabling infrastructure in a medium to large data centre is often at least as complex as that of a commercial building. However, the requirements are different. For example the traditional work area outlet serving an end user is replaced by an Equipment Outlet (EO), typically implemented as a patch panel located within a cabinet, which is used to connect servers, storage systems, or Storage Area Network (SAN) equipment.



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Various cabling configurations are possible in Data centre.

The cabling infrastructure of a data centre shall be designed in accordance with ISO/IEC 11801-5 and EN 50173-5, which define the requirements for generic cabling systems in data centre spaces. These standards are aligned with the generic premises cabling standards ISO/IEC 11801-1 and EN 50173-1, ensuring interoperability between enterprise and data centre networks.

The data centre cabling architecture is based on the following functional elements:

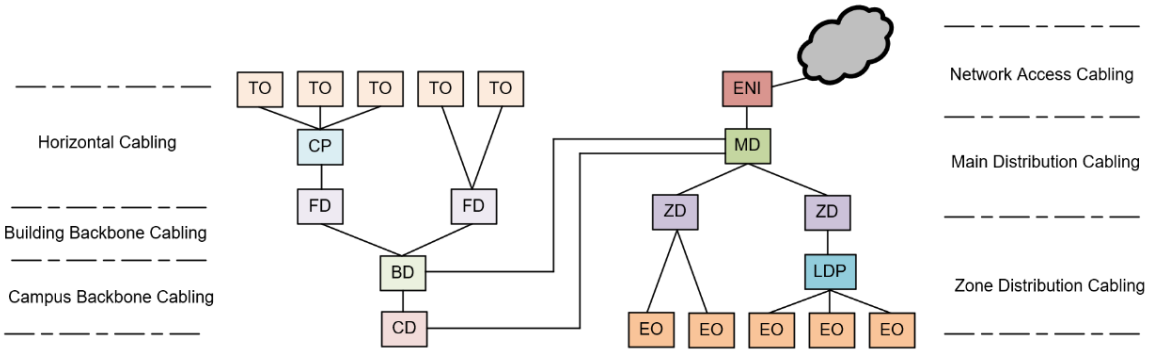
- ENI - External Network Interface
- MD - Main Distributor
- ZD - Zone Distributor
- LDP - Local Distribution Point (optional)
- EO - Equipment Outlet

These elements are connected through a hierarchical cabling structure comprising:

- Network Access Cabling
- Main Distribution Cabling
- Zone Distribution Cabling

Where a data centre is located within a building or campus, the data centre cabling infrastructure shall interface with the premises cabling system through the Main

Distributor (MD). This ensures seamless integration between the enterprise network and the data centre infrastructure.



Functional Element Mapping

Premises Cabling	Data Centre Cabling
TO - Telecommunications Outlet	EO - Equipment Outlet
FD - Floor Distributor	ZD - Zone Distributor
BD - Building Distributor	MD - Main Distributor
CD - Campus Distributor	ENI - External Network Interface

Data centre Infrastructure Standards – EN 50600 Series

This standard specifies general concepts for data centre facilities and infrastructures. It defines the common aspects of data centres, specifies a classification system (based upon the key criteria of "availability", "security" and "energy-efficiency" over the planned lifetime of the data centre), for the provision of effective facilities and infrastructure and describes the general design principles for data centres.

Note: See Chapter 2.2.4 for additional information

4.2. Cabling architecture in Building and Data Centres

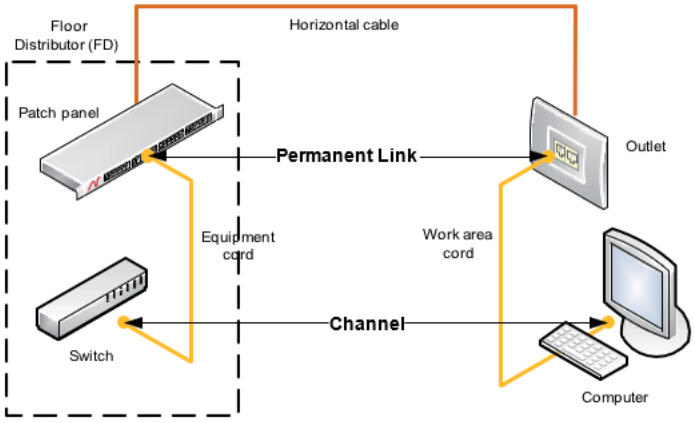
To form a communication channel between the Campus Distributor (CD) or Building Distributor (BD) (in a single-building project) and the Telecommunications Outlets (TOs), the cabling subsystems are interconnected using either active or passive connections. Active connections require application-specific equipment, such as Ethernet switches, whereas passive connections are implemented through cross-connects or interconnections, as commonly used in voice applications.

The concepts of the channel and the permanent link are defined below to facilitate the analysis of the various cabling subsystems.

Channel and permanent link

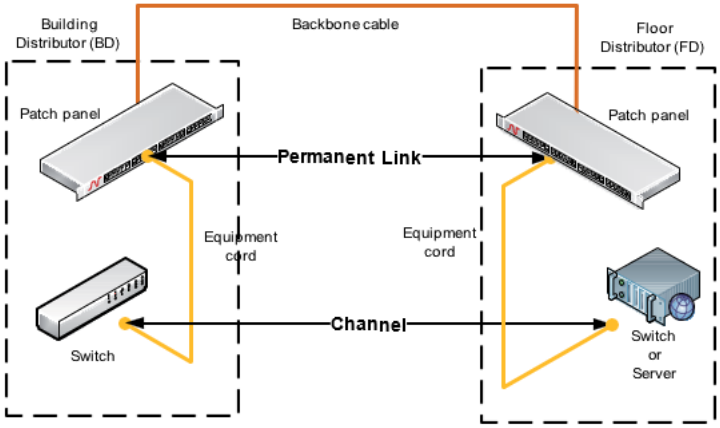
The Permanent Link (PL) is defined as the transmission path of the installed cabling and includes the horizontal cable (copper or optical fibre), the connecting hardware (RJ45 or optical fibre connectors at both the patch panel and the outlet), and, where applicable, an intermediate Consolidation Point (CP).
The Channel is defined as the complete transmission path between two interconnected pieces of active equipment. A typical channel consists of the permanent link of the subsystem together with the equipment cords and work area patch cords.

Horizontal cabling subsystem



It should be noted that these definitions apply to both copper and optical fibre (OF) communication channels. They are also applicable to backbone cabling and data centre subsystems, as illustrated below:

Backbone or DC cabling subsystem



Complete Premise configurations

The following diagram illustrates the telecommunications configuration within a building.

Several Floor Distributors (FDs), typically one per floor depending on the building size and layout, are connected to the Building Distributor (BD) via dedicated backbone cabling.

Horizontal cabling connects the Telecommunications Outlets (TOs) in the work areas to the associated Floor Distributor. Together, the backbone and horizontal cabling form an end-to-end communication channel between the active network equipment and the end-user devices.

Compared to legacy installations based on separate voice and data networks using a PABX, the modern structured cabling architecture is significantly simplified. A single, application-independent cabling infrastructure supports all communication services, including data, voice, wireless access points, building automation systems, security devices, and other IP-based applications.

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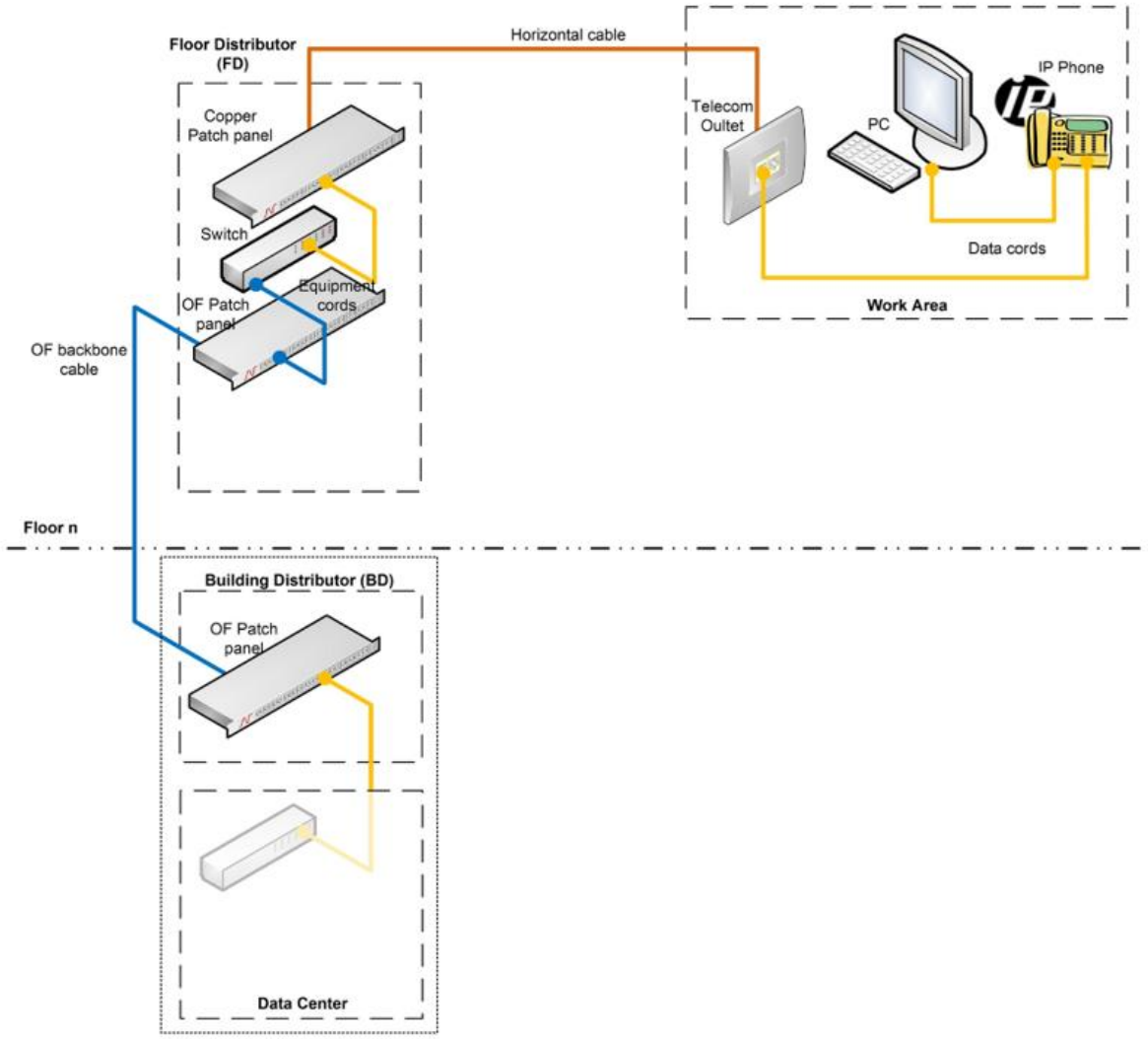
The telecommunications infrastructure shall be designed as a standards-based structured cabling system capable of supporting current and future applications independently of any specific service or technology. This approach provides greater flexibility, simplifies administration and maintenance, and facilitates future upgrades without requiring changes to the installed cabling infrastructure.

Modern building cabling system configuration



Data centres configuration

In a data centre (DC) configuration, the Telecommunications Outlet (TO) used in a work area is replaced by a copper and/or optical fibre patch panel located within a server, storage, or SAN rack. This patch panel corresponds to the Equipment Outlet (EO) defined in the ISO/IEC and EN cabling standards.
The Zone Distributor (ZD) is typically located within an End-of-Row (EoR) or Middle-of-Row (MoR) cabinet and serves the equipment outlets within the associated zone.
The Main Distributor (MD) acts as the primary cross-connect for the data centre cabling infrastructure. It provides the interface to the building cabling system through the Building Distributor (BD) and to external service providers through the External Network Interface (ENI).

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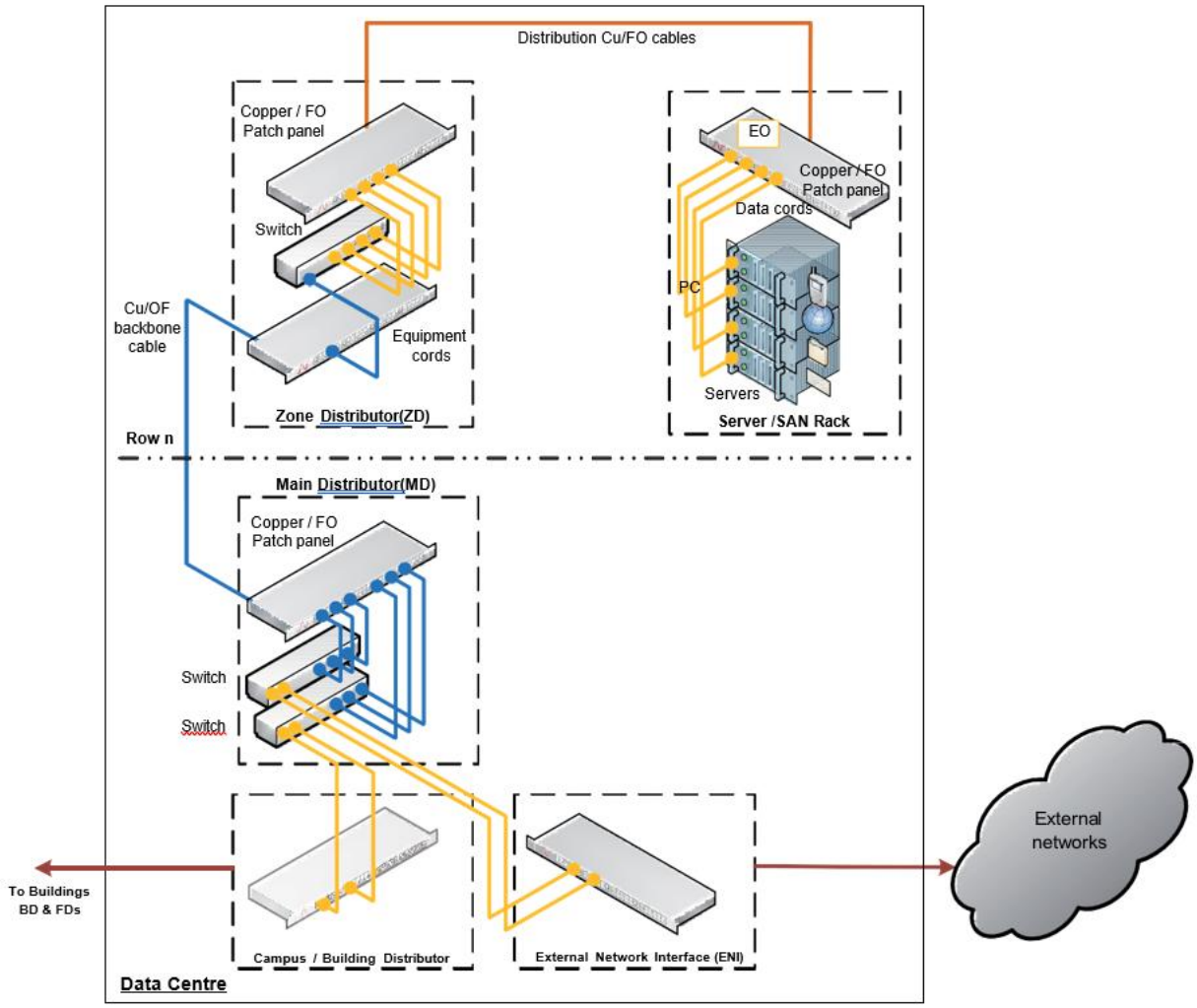
Data centre cabling system configuration

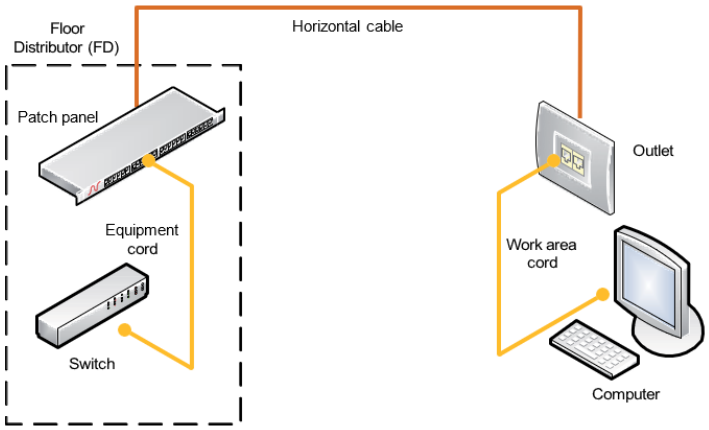


4.3. Horizontal subsystem channel configuration

4.3.1. 2 connector channel / Interconnect – TO model

In a typical structured cabling implementation, a Telecommunications Outlet (TO) is directly connected to the Floor Distributor (FD), serving a single work area.

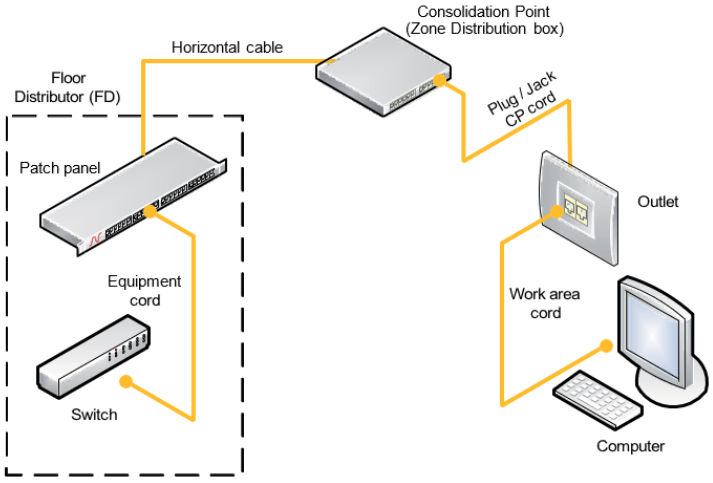
2 connector channel



4.3.2. 3 connector channel with Consolidation Point (CP) / Interconnect – CP – TO model

In an open office environment, work areas often need to be reconfigured. The installation of a Consolidation Point (CP) between the FD and the Telecommunications Outlet (TO) can provide additional flexibility when reallocating or relocating workstations.
The CP (AGINODE Zone Distribution Box) is typically installed in the plenum space above the suspended ceiling or beneath a raised floor.

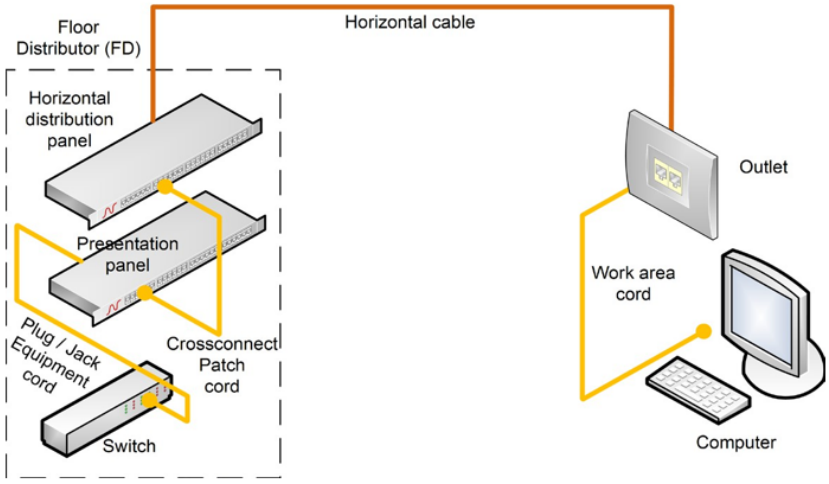
3 connector channel with CP (Consolidation Point)



4.3.3. 3 con. channel with presentation panel / crossconnect – TO model

To avoid repeatedly plugging and unplugging patch cords from switch ports during network reconfigurations, or when switches and horizontal distribution patch panels are located in different cabinets, the use of presentation panels (also known as representation panels or mirror panels) may be beneficial.
All switch ports are permanently connected to a presentation panel. Connections between the presentation panel and the horizontal distribution panel are then established through patch cords, creating a cross-connect area.

3 connector channel with crossconnect



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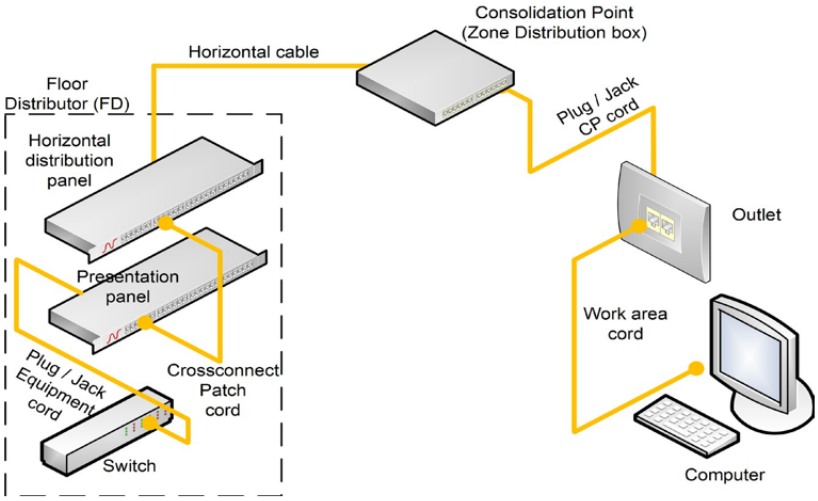
4.3.4. 4 connector channel with CP and presentation panel / crossconnect – CP - TO model

This last configuration combines both a Consolidation Point (CP) and a presentation panel. It represents the worst-case scenario from a transmission performance perspective, as the link contains four RJ45 plug-to-jack connections.
All Aginode LANmark systems are warranted to exceed the electrical performance requirements specified in the relevant standards, even when deployed in the worst-case 4-connector channel configuration.

4 connector channel with crossconnect and CP

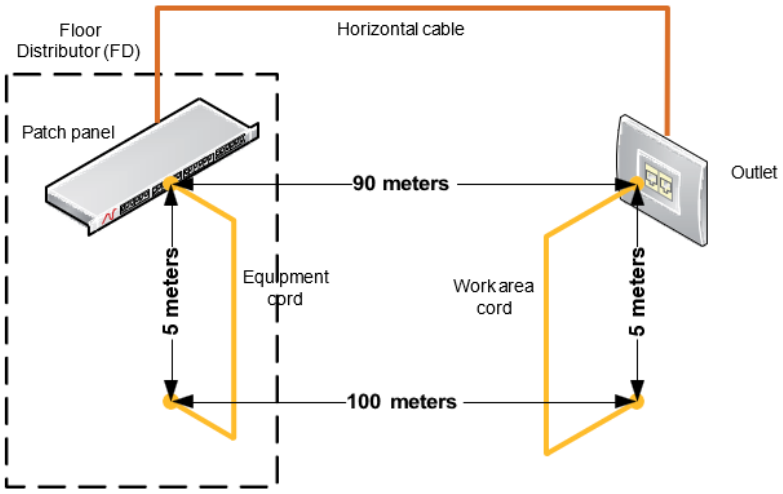


4.3.5. Link and Channel length limitations

To ensure channel and link performance, distributors shall be located so that the maximum lengths specified in ISO/IEC 11801 are not exceeded:

- The physical length of the channel shall not exceed 100 m
- The physical length of the fixed horizontal cabling shall not exceed 90 m
- The total length of stranded cords within the channel shall not exceed 10 m

2 connector channel maximum length



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3 & 4 connector channels length

In 3- and 4-connector channel configurations, the maximum allowable length of the permanent horizontal cabling shall be reduced as indicated in the table below when the total length of equipment cords, patch cords, and work area cords exceeds 10 m.
The values are derived from ISO/IEC 11801-2:2017.

Note: the latest published edition of ISO/IEC 11801-2 remains Edition 1 (2017), with subsequent corrigenda (including Cor.1 and the 2020 corrected version), and it has not yet been replaced by a newer edition.

Horizontal link length equations according to ISO/IEC 11801-2: 2017			
Model	Figure	Implementation equation	
		Class E and EA	Class F and FA
Interconnect - TO	Chapter 4.3.1	$I_h = 104 - L_a \times X$	$I_h = 105 - L_a \times X$
Cross-connect - TO	Chapter 4.3.2	$I_h = 103 - L_a \times X$	$I_h = 103 - L_a \times X$
Interconnect - CP - TO	Chapter 4.3.3	$I_h = 104 - L_a \times X - Lc \times Y$	$I_h = 104 - L_a \times X - Lc \times Y$
Cross-connect - CP - TO	Chapter 4.3.4	$I_h = 104 - L_a \times X - Lc \times Y$	$I_h = 104 - L_a \times X - Lc \times Y$
I_h is the maximum length of the horizontal cable (m) Ia is the combined length of patch cords/jumpers and equipment cords (m) Ic is the length of the CP cable (m) X is the ratio of cord cable insertion loss (dB/km) to horizontal cable insertion loss (dB/m) Y is the ratio of CP cable insertion loss (dB/m) to horizontal cable insertion loss (dB/m)			
For operation temperature above 20°C, I_h should be reduced by : 1) 0.2 % per °C for screened balanced cables up to 60°C 2) 0.4 % per °C for unscreened balanced cables up to 40°C 3) 0.6 % per °C for unscreened balanced cables betweeen 40°C and 60°C			

Link length limitations

The link length values specified in ISO/IEC 11801-2 are based on reference implementations, which represent standardized example cabling configurations used to demonstrate compliance with the required transmission performance. These values are intended as design guidance. Compliance is achieved by meeting the applicable channel or link performance requirements, taking into account the actual combination of cables, cords, connectors, and environmental conditions.

Link length guidance in reference implementation ISO/IEC 11801-2: 2017		
Segment	Minimum (m)	Maximum (m)
FD - CP	15	85
CP - TO	5	-
FD - TO (No CP)	15	90
Work area cord [a]	2	5
Patch cord	2	-
Equipment cord [b]	2	5
All cords	-	10
[a] : if there is no CP, the minimum length of the work area cord is 1m [b] : if there is no cross-connect the minimum length of the equipment cord is 1m		

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Aginode length limitations

The LANmark-6A system offers a warranted minimum link length of 5 m, which is significantly below the 15 m recommended by the standard. This feature is particularly useful in data dentre environments, where links are often installed between adjacent racks or cabinets.

For more information, please refer to the Aginode LANmark-6A and LANmark-7A Design Guidelines, available in the **library section of the Aginode website**.

Extended distance Guarantee for copper channels

Aginode recommends that LAN cabling systems be installed in accordance with the relevant structured cabling standards to ensure support for current and future applications.

However, when an application-specific warranty is required, Aginode can guarantee the operation of specific applications over the extended distances indicated, in place of the standard application and performance warranty.

Although channel lengths may exceed 100 m for certain applications, such installations become application-specific and are no longer covered by the generic cabling warranty.

Unless extended distances are specifically required for identified applications, Aginode recommends that fixed links are not designed to exceed the 90 m permanent link limit. Exceeding this limit makes the installed cabling dependent on the applications supported at the time of installation and may restrict future application compatibility.

For more information, please refer to the Aginode warranty module 'Extended distance guarantee Copper', available in the **library section of the Aginode website**.

Application Drive Distance (m)		LANmark Channel					
		Unscreened*	Screened				
		Cat.6	Cat.6	Cat.6A AWG 23	Cat.6A AWG 22	Cat.7A AWG 23	Cat.7A AWG 22
10base-T Ethernet	Without PoE	177	177	177	177	177	177
	With PoE	130	130	145	160	165	177
100Base-T Fast Ethernet	Without PoE	140	140	145	160	145	160
	With PoE	130	130	145	160	145	160
1000Base-T Gigabit Ethernet	Without PoE	100	115	145	160	145	160
	With PoE	100	115	145	160	145	160
2.5GBase-T 2.5 Gigabit Ethernet	Without PoE	100	100	125	135	125	135
	With PoE	100	100	125	135	125	135
5GBase-T 5 Gigabit Ethernet	Without PoE	100	100	125	135	125	135
	With PoE	100	100	125	135	125	135
10GBase-T 10 Gigabit Ethernet	Without PoE	N/A	N/A	105	125	105	125
	With PoE	N/A	N/A	100	100	100	100

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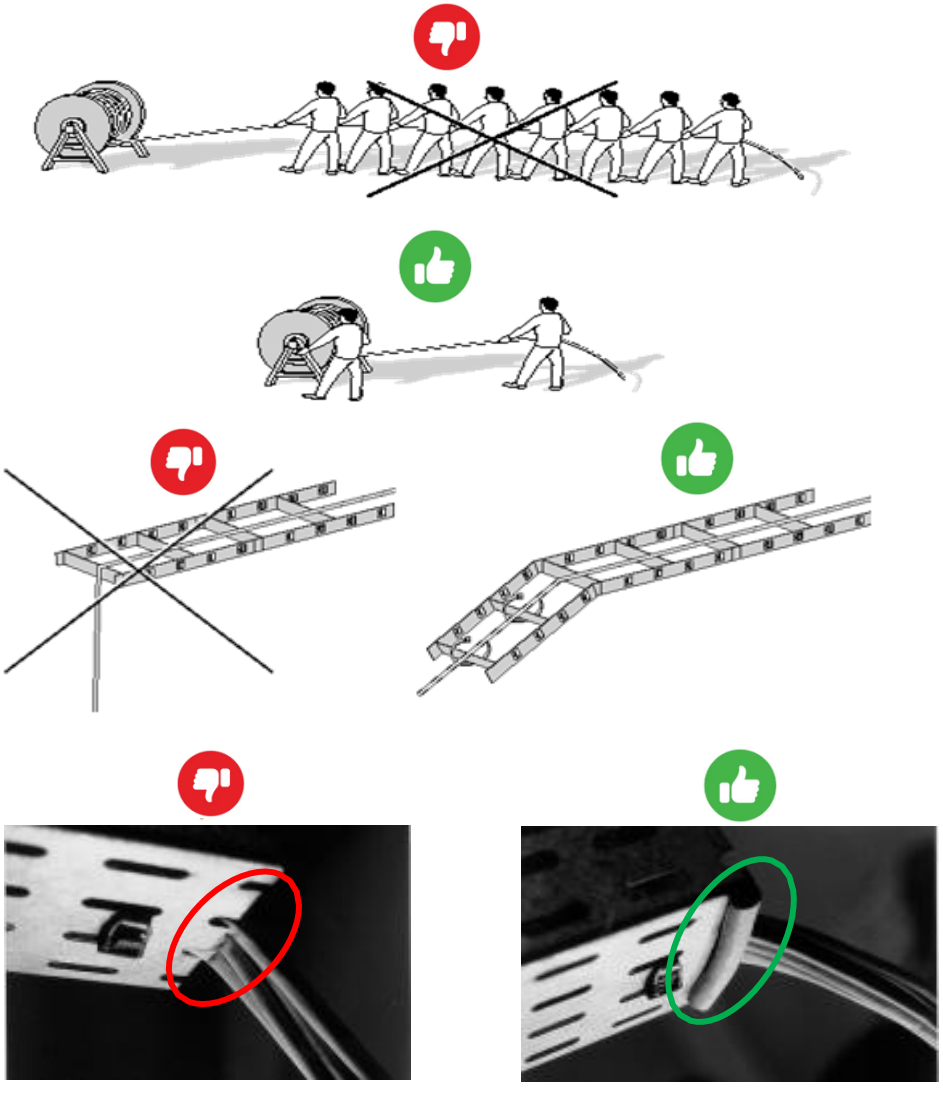
4.4. General installation recommendations

Considerations such as Cable pathway selection, fire barrier, data / power segregation and cable management on tray, on basket and inside cabinets are previously covered in previous chapters.

Cable storage and handling requirements and recommendations are detailed in the next chapter.

4.4.1. Un-Reeling

- Unreel cables from the bottom of the drum for safety reasons
- Feed cables downward through risers
- Support drum axles with poles of the largest practical diameter
- Unreel a maximum of six 1000 m drums simultaneously
- Observe the maximum tensile load limits specified in the cable datasheet
- Ensure that the cable sheath is not damaged by drum edges (for example, tears, cuts, or burns)
- Maintain the minimum bend radius at all times and manually guide cables around bends
- Ensure that all cables remain within the designated cable pathways
- Ensure that all sharp edges are protected before cable installation



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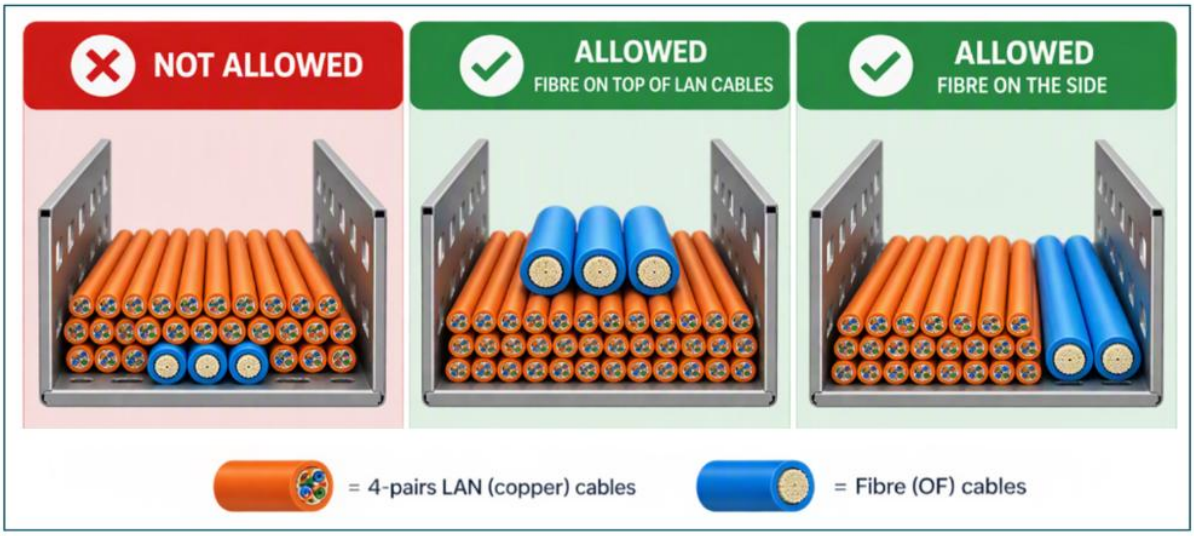
4.4.2. Cable arrangement in containment

Where applicable, different cable types should be installed in the following order: horizontal twisted-pair (TP) cables, pre-terminated copper cables, optical fibre (OF) cables, and finally pre-terminated optical fibre cables.

Important note: Under no circumstances should optical fibre (OF) cables be installed beneath copper cables in cable trays or any other cable containment system.



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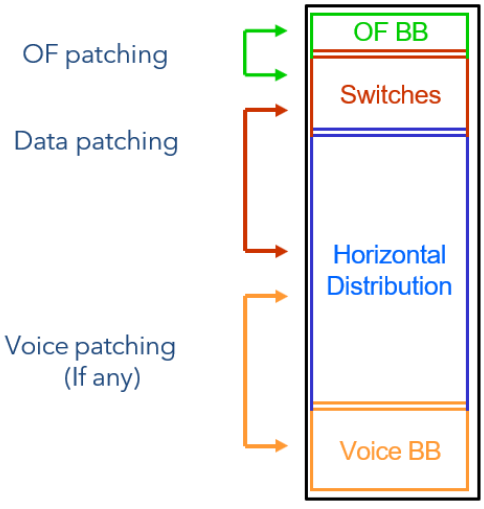
4.4.3. Floor distributors design

Floor Distributors shall be equipped with various types of equipment, including optical fibre (OF) patch panels, copper patch panels, and network switches, which must be interconnected using copper and fibre patch cords.

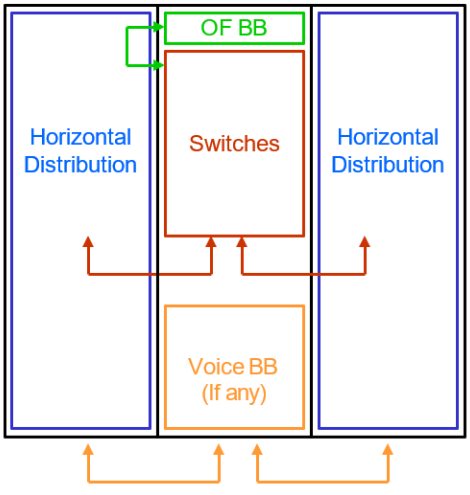
The following arrangement of these components is recommended:

- To protect sensitive equipment from dust, position the OF backbone patch panels and switches at the top of the cabinet
- To prevent the mixing of copper and fibre patch cords and to simplify patching and maintenance activities, maintain a clear separation between copper and fibre infrastructure

Typical layout for a single FD cabinet



Typical layout for a medium-size Distributor



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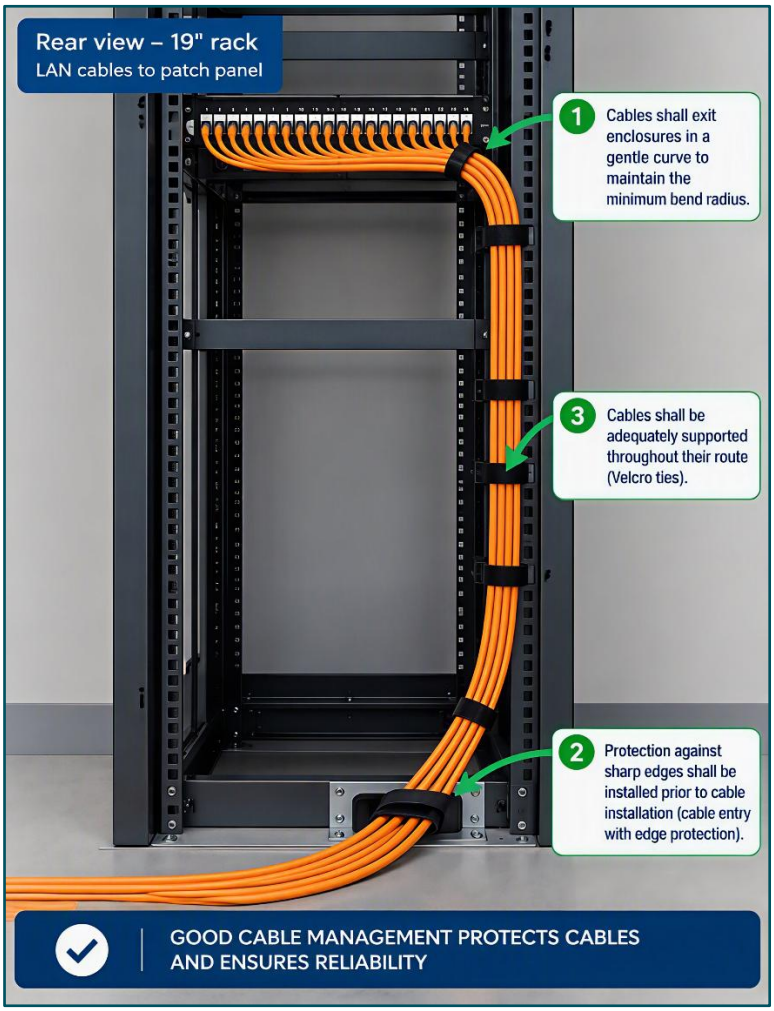
4.4.4. Cable handling at cabinets

- Cables shall exit enclosures in a gentle curve to maintain the minimum bend radius
- Protection against sharp edges shall be installed prior to cable installation
- Cables shall be adequately supported throughout their route



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Important note: DO NOT STAND ON CABLES

- Patch panels should serve logical Telecom Outlets (TOs) to facilitate fault finding
- Cable looms shall be installed in such a way that each panel can be removed without disturbing any other panel or cable management system
- Panels should be presented in bundles of 12 or 24 cables
- Looms should be installed with sufficient slack to allow connector re-termination, should the need arise
- Looms should not exceed 48 cables within cabinets
- Looms should not exceed 96 cables in sub-floor installations

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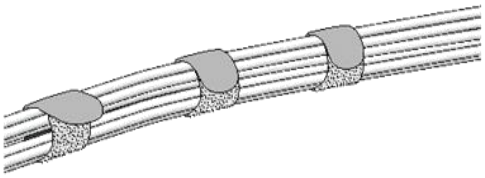
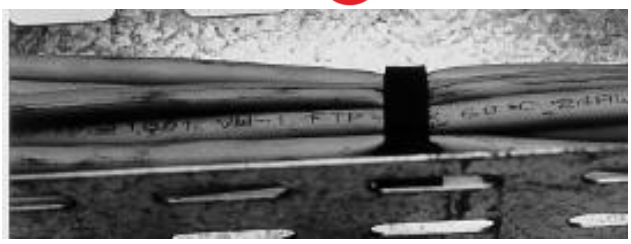
- Cable ties shall not deform the cable sheath and shall be tightened by hand only
- Hook-and-loop fastening tape (Velcro® or equivalent) are preferred
- Copper cables should ideally be secured to the containment system at:
  - ✓ Maximum intervals of 300 mm in risers
  - ✓ Maximum intervals of 300 mm within cabinets
- Maximum intervals of 1 m on all other cable pathways
- Additional fixings should be used to:
  - ✓ Maintain the minimum bend radius
  - ✓ Prevent abrasion and mechanical damage





- With regard to alien crosstalk (AXT), Cat. 6 and Cat. 6A UTP cables are recommended to be loosely bundled
- It is the installer's responsibility to consider the weight of the cable bundle when determining appropriate spacing between cable ties

4.4.5. Floor boxes

Designs of customer specific TO boxes shall incorporate strain relief at the cable entry point. This will prevent the terminations from moving when the boxes are repositioned during Moves, Adds and Changes (MACs).

Boxes of all types shall be sufficiently deep to allow the minimum cable bend radius to be maintained.



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4.4.6. Cable storage and handling

The following requirements and recommendations apply to both LAN copper and fibre cables.

Note: The Aginode warranty may be invalidated if the cables have not been properly stored or handled according to Aginode requirements.

Indoor cable storage requirements

- Indoor LAN copper cables are not waterproof and their jackets are not UV resistant
- Under no circumstances shall any indoor cable boxes or reels be stored outside or in a harsh environment
- Indoor cables shall be stored in a dry, UV-protected location, such as a room or container

  ➔ *Note: Watertight containers located outdoors may be subject to condensation and therefore cannot be assumed to be dry or to have low humidity levels*

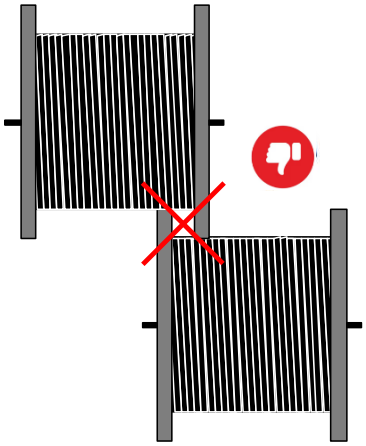
- Select a storage location where there is no risk of excessive humidity, falling objects, chemical spills (oil, grease, etc.), open flames, or excessive heat
- The storage requirements for optical fibre (OF) cables are generally less stringent, as these cables are typically designed for both indoor and outdoor use. However, the guidance provided in the remainder of this chapter shall still be observed
- The cable data sheet provides information on the permitted temperature ranges for installation, operation, and storage. It is important that these specifications are observed
- In addition to temperature, consideration shall be given to moisture and other forms of contamination, such as flooding

Aginode's policy on cable exposure to water etc can be found online: **CLICK HERE**

Note: Storing cables on pallets may help to keep cable reels dry in the event of a flood.

Cable handling requirements

- Reel flanges shall not be interleaved



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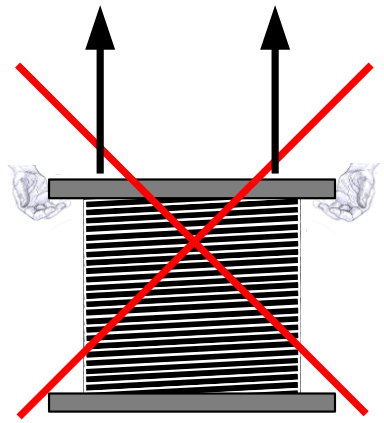
- Reels shall not be lifted by their flanges as shown below



- When it is required to rewind the cable on to another reel, the pulling force applied to the cable must be limited to:
  - ✓ 100N for all LAN copper cables
  - ✓ the maximum pulling force provided on the relevant data sheet for OF cables
- Where a cable is rewound onto another reel, the diameter of the new reel shall be compatible with the minimum bend radius of the cable. The original cable label details shall be transferred to the new reel. The new reel shall also be in good condition and free from defects that could damage the cable sheath during the rewinding process

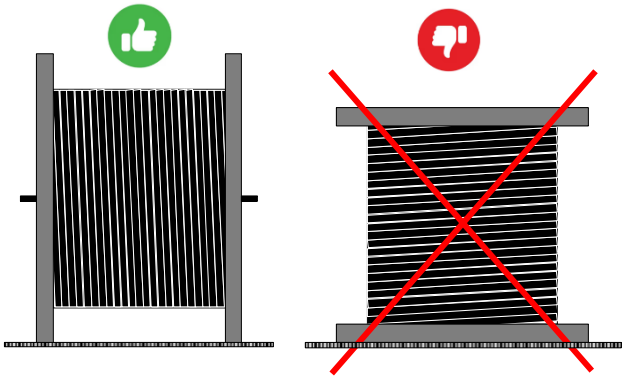
Outdoor cable storage requirements

The following requirements are only applicable to outdoor (or indoor/outdoor) OF cables and to industrial copper LAN cables.

- ✓ Ends of the cables shall be sealed during storage (Heat shrink cable end caps are recommended)
- ✓ The data sheet of the cable provides ranges of temperature for ambient installation and/or operation and/or storage. It is important that those specifications are observed

Recommendations (Optical Fibre)

- All Optical fibre reels including part used should be stored upright



Laying the reel on its side may cause damage to the reel flange and/or cause the OF cable layers to shift - This may cause cable to snag during de-reeling.

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- If Optical Fibre cable is to be stored for longer than approximately four weeks then it is recommended that cable ends are appropriately sealed. (Heat shrink cable end caps are recommended)
- Where reels are supplied with protective material fitted over the cable, the protection should remain in place until the cable is installed

  If the protection is removed prior to installation (for inspection purposes for example) then it must be re-fitted as originally supplied before the reel is placed back in storage or onward shipped.

- Storage temperature range is specified for each cable and must be respected.

Recommendations (All cables)

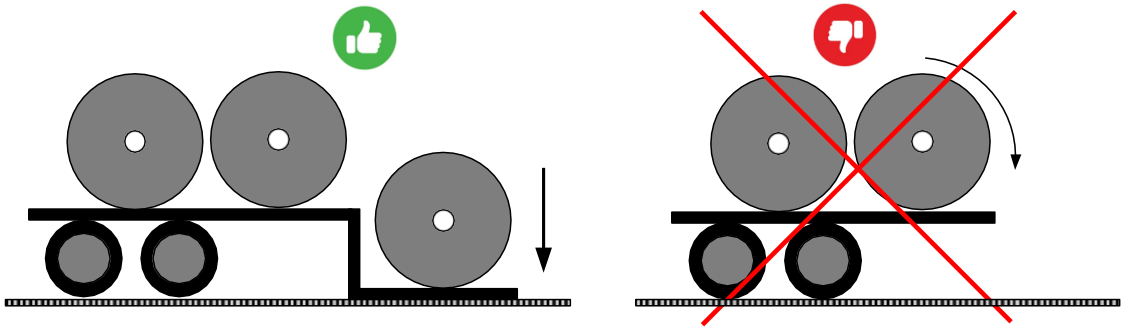
- Reels should be stored in areas with flat firm surfaces
- Use appropriate devices to secure reels to prevent reel movement during storage
- Avoid storage areas that are susceptible to flooding, or that could damage the cable, such as sharp, uneven terrain
- When rolling / moving reels do not "kick" the cables. Ensure that the route has no objects or uneven terrain that could damage the cable when the reel is being rolled
- Where it is necessary to lift reels and the cable reel is too heavy to move manually, the reel must be moved upright by lifting the cable with a forklift or reel mover. The forks must be placed under the reel with the forks always perpendicular to the reel flange



- Never drop a cable reel from any height during transportation or use. Dropping a reel could affect its structural integrity and cause de-reeling issues – it may also damage the product.

  When unloading from a vehicle, use either the tail-lift / elevator (if fitted) or a suitable mechanical aid such as a forklift truck.

  Never let reels drop from the vehicle to the ground.



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- Before de-reeling cable, the reel should be visually inspected for possible damage caused during storage
- It is recommended to record the data provided on the labelling tags of all the drums/reels/boxes in case of any subsequent issues
- Aginode recommend that cable reels should be stored in a safe, locked location

Health & Safety

When manually handling a reel, ALWAYS make sure correct manual handling techniques are used and that consideration to mechanical lifting aids is given.

Where local requirements for cable storage & handling and/or Health & Safety are more stringent than the above, those requirements must also be followed.

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5. Copper cables construction

5.1. NVP guidelines

Nominal Velocity of Propagation (NVP) is the speed at which an electrical signal travels through a LAN copper cable, expressed as a percentage of the speed of light in a vacuum. NVP is determined by the cable's insulation materials and construction and is used by cable testers to accurately calculate cable length and locate faults.

Typical LAN copper cables have an NVP value between 60% and 80%.

When using cable certification or troubleshooting equipment, the correct NVP value should be selected according to the cable manufacturer's datasheet to ensure accurate length measurements.

The NVP values provided in the table are typical.
Always use the actual NVP value specified in the cable's print legend.

Cable type						Nominal NVP (%)
Brand	Construction	References	Single/ Dual	Conductor section (AWG)	Category	
Essential-6	U/UTP	N100.161-OE	Single	24	Cat.6	69
		N100.164-OE				
		N100.166-LE				
LANmark-6	U/UTP	N100.605-Ox	Single	23	Cat.6	68
		N100.607-OE				
		N100.617-DE				
LANmark-6	F1/UTP	N100.624-OD	Single	24	Cat.6	70
LANmark-6A	U/UTP	N100.634G-Ox	Single	24	Cat.6A	68
LANmark-6A	U/UTP	N100.638G	Single	23	Cat.6A	69
		N100.639G				
LANmark-6A	F1/UTP	N100.622G-OC	Single	23	Cat.6A	70
		N100.624G-OD				
		N100.623G-Ox	Dual			
LANmark-6A	F/FTP	N100.692G-Ox	Single	23	Cat.6A	82
		N100.694G-Ox				
		N100.693G-Ox	Dual			
LANmark-6A	S/FTP	N100.684G-Ox	Single	23	Cat.6A	82
LANmark-6A	FXTP	N100.654G-Ox	Single	23	Cat.6A	82
LANmark-6A	EXTP	N100.964G-Ox	Single	22	Cat.6A	79
LANmark-7	S/FTP	N100.365-Ox	Single	23	Cat.7	82
		N100.366-Ox				
		N100.367-Ox	Dual			
LANmark-7A	S/FTP	N100.371-Ox	Single	23	Cat.7A	82
		N100.372-Ox				
		N100.373-Ox	Dual			
LANmark-7A	S/FTP	N100.381-Ox	Single	22	Cat.7A	76
		N100.383-Ox	Dual			

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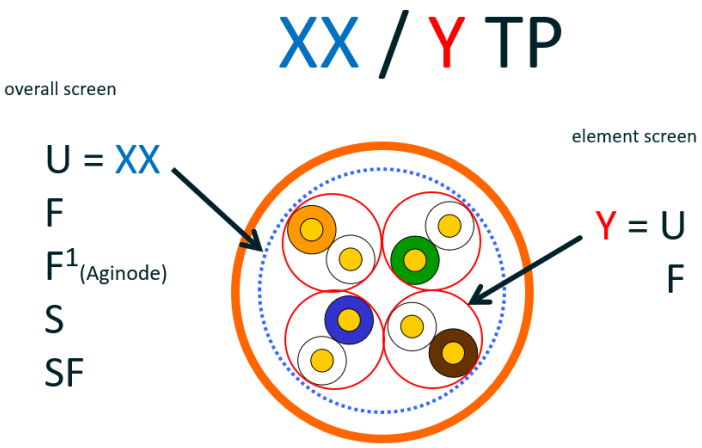
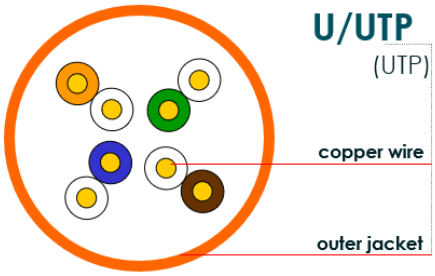
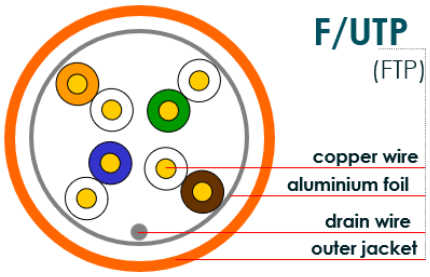
5.2. Twisted Pair cable constructions

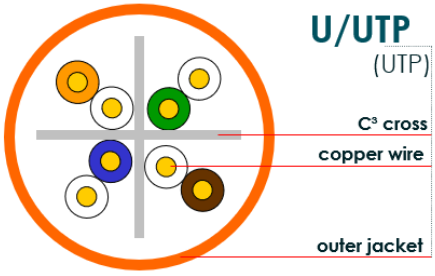
International Cable Naming

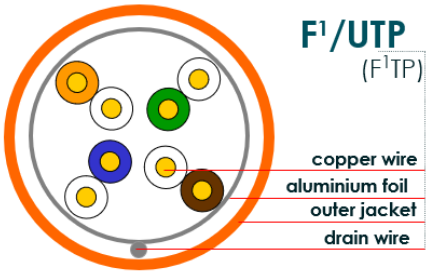


- U = No metallic protection
- F = Foil (metallic side facing inwards)
- F1 = Reversed foil
  The metallic side faces outwards, allowing the cable to be automatically grounded during the termination process without requiring the foil to be folded back. This provides an immediate 360° grounding contact, ensuring immunity to Alien Crosstalk and other external interference.
- S = Braid. A woven mesh of tinned copper wires
- SF = Combined foil and braid shielding.
  Dual shielding layers consisting of both a foil and a braid









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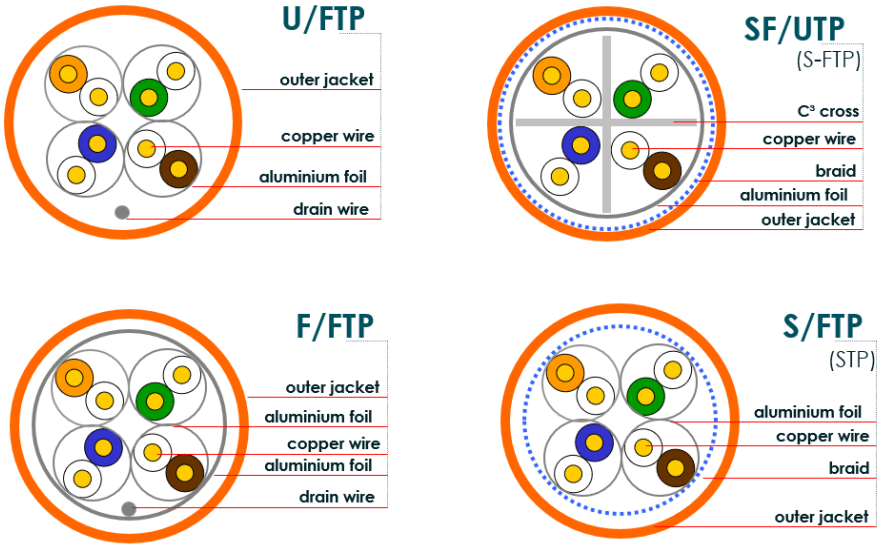

6. Termination of connectors

Key Considerations

- During the installation of LANmark-6, LANmark-6A and LANmark GG45 products, great care is required. The specified performance levels can only be guaranteed if the installation procedures are strictly followed. Particular attention must be paid to minimising the untwist length of the cable pairs. The use of appropriate professional tools is also essential to ensure high-quality terminations.
- Each box of 24 connectors contains a Product Manual with illustrated instructions explaining how to correctly install the connector. Full-colour versions of these Product Manuals are available on the LAN systems website.
- Appropriate labels must be applied to both ends of every cable.
- All LANmark ULTIM, EVO and LANmark GG45 connector performance levels are available for use with both solid and stranded conductor cable types.

The following connectors are intended for use with AWG26 to AWG22 solid and stranded conductor cable types:

- LANmark-6 EVO Snap-In Connector Category 6 Unscreened - N420.660-03
- LANmark-6 EVO Snap-In Connector Category 6 Unscreened APAC - N420.660
- LANmark-6 EVO 2.0 Snap-In Connector Category 6 Screened - N420.686-01
- LANmark-6A EVO 2.0 Snap-In Connector Category 6A Screened (24 PCS/BOX) - N420.68A-01
- LANmark-6A EVO 2.0 Snap-In Connector Category 6A Screened APAC 48PCS/BOX - N420.68A-02
- LANmark-6A ULTIM Snap-In Connector Category 6A Screened – N420.960

The following connectors are intended for use with AWG26 to AWG23 solid and stranded conductor cable types:

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- LANmark-6A Keystone Connector Category 6A Unscreened - N420.216
- LANmark-6A Field Terminable Plug Category 6A Screened APAC - N490.001S

The following connectors are intended for use only with 26-24 AWG solid-conductor cable types:

- LANmark-6A Field Terminable Plug Category 6A Screened - N490.001

The following connectors are intended for use only with 26-24 AWG solid-conductor cable types:

- Essential-6 Keystone Connector Unscreened – N420.116

The following connectors are intended for use only with 24-22 AWG solid-conductor cable types:

- LANmark GG45 Snap-In Connector Cat. 7A/8 2000MHz Screened Solid Wire – N420.735

The following connectors are intended for use only with 26-24 AWG stranded wire and 26-25 AWG solid wire patch cable types:

- LANmark GG45 Snap-In Connector Cat. 7A/8 2000MHz Screened Stranded Wire – N420.736

Connector Termination Guidelines

The following guidelines shall be followed when terminating a connector:

- Always follow the prescribed colour-coding requirements
- A maximum pair overlength of 3 mm is permitted after cutting at the IDC
- Use the Universal Comfort Tool to ensure a reliable termination
  ➔ *Only usable for Essential-6, LANmark-6 Unscreened and LANmark-7A GG45 connectors*
- Use connectors designed for solid conductors only with solid-conductor installation cables
- Use connectors designed for stranded conductors only with 26-24 AWG stranded patch cables or 26-25 AWG solid-conductor patch cables
- After installation, maintain the minimum bending radius specified in the cable data sheet
- Ensure that the foils (where present) remain closed after trimming
- Where present, both the foil and the drain wire must make contact with the metal body of the screened connector
- The connector can only be removed using the Comfort Tool (for Essential-6 and LANmark-6 Unscreened connectors version only)

An optional clip can be fitted to convert the Snap-In connector into a Keystone format.

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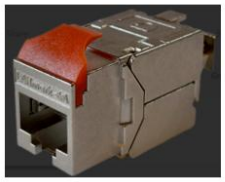
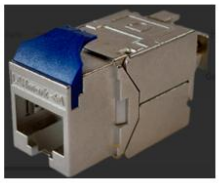
Three different plastic clips are available for ULTIM connectors.

- Red – Wall thickness 1.5-1.75mm, height 20.5mm
- Blue – Wall thickness 2.0-2.25mm, height 20.5mm
- Yellow – Wall thickness 2.0-2.25mm, height 19.7mm

A metal clip is available for GG45 connectors.



NOTE

Cables that require service loops or additional spare length should be coiled using the largest possible bend radius, and always with a radius greater than the specified minimum. The cable coil should be secured to a nearby support at the base and on both sides of the coil. Securing the coil only at the top may cause damage to the cable.

Coiling U/UTP cable should be avoided whenever possible.

*Please refer to our Installation and **Design Guidelines** for more detailed information.*

Termination videos

- *LM6A ULTIM connector onto FXTP cable termination video:* **Link**
- *LM6A ULTIM connector onto S/FTP cable termination video:* **Link**
- *LM6A ULTIM connector uninstall video:* **Link**
- *LM7A GG45 connector termination video:* **Link**

Installation instruction documents

- *LM6A ULTIM installation instructions:* **Link**
- *LM6A EVO 2.0 installation instructions:* **Link**
- *LM6A field termination plugs installation instructions:* **Link**
- *LM6A field termination plugs APAC installation instructions:* **Link**

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7. Field testing

7.1. Copper systems

To qualify for the Aginode warranty, all Permanent Links and/or Channels within an installation shall pass testing in accordance with Aginode test set-up requirements.

Prior to the start of the project, it should be agreed with the client how marginal pass results will be handled, as they may not be aware that a marginal result can be caused by the accuracy and tolerance limits of the test equipment.

Aginode will consider a *PASS result acceptable for warranty purposes when specific conditions apply, as outlined in the table below.

However, a *FAIL result shall be investigated, as it is not acceptable.

*PASS Acceptance for Warranty Certification

Warranty Module requested	Channel limits	Permanent link limits
LANmark-5	CLASS D	CLASS D
LANmark-6	CLASS E	CLASS E
LANmark-6A	CLASS EA / CAT 6A	CLASS EA / CAT 6A Only if length >5m and <15m
LANmark-6A MPTL	Not Supported	TIA CAT 6A MPTL
LANmark-7A	CLASS FA >15m PL length	Not supported
LANmark-8	CLASS II	Not Supported

Only PASS test results accepted
*PASS possible, conditions noted
Test configuration not supported

7.1.1. Copper field testing procedure

To qualify for an Aginode warranty, the Aginode field testing procedure shall be followed.

Detailed requirements can be found in the Field-Testing Guidelines document, available **here**.

7.1.2. Certified Cabling testers

The following testers are qualified for use in support of an Aginode warranty application.

For each certified tester, the table indicates the cabling systems for which the tester is approved, as well as the supported test limits: Permanent Link (PL) and/or Channel (CH).

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Authorised Testers / Systems



Certified Tester Overview			LANmark-6	LANmark-6A	LANmark-6A MPTL	LANmark-7A	LANmark-7A + 25G	LANmark-8
FLUKE NETWORKS								
	DSX-5000	PL	•	•	•	x	x	x
		CH	•	•	x	•	x	x
	DSX-8000	PL	•	•	•	x	x	x
		CH	•	•	x	•	•	•
TREND/IDEAL INDUSTRIES								
	LANTEK III 500	PL	•	•	x	x	x	x
		CH	•	•	x	x	x	x
	LANTEK III 1000	PL	•	•	x	x	x	x
		CH	•	•	x	•	x	x
VIAVI/JDSU								
	Certifier 10G	PL	•	•	•	x	x	x
		CH	•	•	x	x	x	x
	Certifier 40G	PL	•	•	•	x	x	x
		CH	•	•	x	•	•	•
SOFTING/PSIBER DATA								
	WIREXPERT 500	PL	•	•	•	x	x	x
		CH	•	•	x	x	x	x
	WIREXPERT 4500	PL	•	•	•	x	x	x
		CH	•	•	x	•	•	•
AEM								
	TestPro CV100	PL	•	•	•	x	x	x
		CH	•	•	x	•	•	•

For additional requirements and testing procedures, please refer to the Field Testing Guidelines document mentioned above.

7.2. Fibre systems

To qualify for an Aginode warranty, the Aginode field-testing procedure shall be followed.

Detailed requirements can be found in the Field-Testing Guidelines document, available **here**.

To correctly test optical fibre (OF) links, each connector in the link, as well as the test cords, shall be inspected and cleaned if necessary. For more information, please refer to the OF Connector Inspection and Cleaning document, available **here**.

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