Designing Structured Cabling Systems - Ten Step Guide

Below we have provided a ten step introductory guide for the Design of Structured Cabling Systems and IT Network Infrastructures.

Step 1

Which group of standards will you conform to?

European Union	CENELEC EN standards
America	ANSI/TIA/EIA standards
Canada	CSA standards
Australia/New Zealand	AS/NZ standards
Rest of the World	ISO/IEC standards

The three principle design standards give the details of how to design and specify a structured cabling standard, they are;

ISO 11801
EN 50173
TIA/EIA 568-A

These standards in turn however refer to hundreds of other standards relating to component specifications, fire performance, testing methods, containment systems etc.

Step 2

Horizontal cabling - Basic rules

Four-pair cables are run from user positions to a patch panel. At the patch panel, patch cords link into the active LAN equipment or into backbone cabling. The user position has a wall outlet or floor outlet, and this links into the PC on your desk via another patch cord. The outlet is a called a TO (Telecommunications Outlet) and contains an eight way plug meeting IEC 60603-7, more commonly referred to as an RJ-45.

- Two outlets per work area
- Two outlets per 10 square meters of useable floor space
- Outlets to be within 3 meters of the user station
- Both outlets to be RJ 45
- Max cable run to be 90 m
- Max total length of patch cords at both ends of the link to be 10 m
- Cable and RJ45 to be Cat5e grade

Options

Cat 3 or optical fibre can be used
If optical fibre, select 50/125 or 62.5/125 multimode for your application
If using fibre select LC, MT-RJ,SC or ST connectors for your application
Cat 6/Class E can be specified

Cat 5e Cable can be unscreened, UTP, Foil screened, FTP, or Foil and Braid screened S-FTP.

Cable fire performance can be:

1) IEC 332-1
2) IEC 332-1, IEC 754, IEC 1034
3) IEC 332-3-c. IEC 754, IEC 1034
4) UL 910 plenum

Each grade, in ascending order, has a better performance in fire situations but at a correspondingly higher price.

The exact density of cables, number of outlets and their position is up to the end user, or else at the proposal of the installer/designer

Step 3

Backbone Cabling

All of the horizontal cables are star-wired back to Telecommunications Closets or Floor Distributors where they are terminated in patch panels. These patch panels are connected together via the building backbone cabling which can be up to 500 meters long. It can be copper cable but is more likely to be optical fibre, either multimode or singlemode. The kind of cables and the number of cores needs to be decided.

Step 4

Campus Cabling. The campus cabling links different buildings together. It can be up to 1500 m long. It can be copper cable but is more likely to be optical fibre, either multimode or singlemode. The kind of cables and the number of cores needs to be decided.

Step 5

Positioning and design of Telecommunications Closets to link horizontal and backbone cabling.

Positioning and design of the equipment room as a central focus for the main computing, LAN and PABX equipment.

Positioning and design of the Service Entrance facility whereby outdoor cables are terminated and the point of demarcation between customer owned equipment and the PTT cables is defined.

Step 6

Cable containment system. How will the cables be protected? Within buildings the choices are;

- -Cable trays
- -wire basket/raceway
- -cable ladders
- -J hooks
- -conduit
- -dado rails

-PVC trunking
-built-in underfloor duct
-raised floors
-suspended ceilings

The following must be taken into account:

-the density and volume of cables to be organised
-the aesthetic appearance of the cabling within offices and other visible areas
-economics of different schemes
-proximity to power cables and other potential sources of interference
-fire stopping

Useful standards are;

TIA/EIA 569	*Commercial building standard for telecommunications pathways and spaces*
EN 50174	*Information technology – cabling installation*

For external applications the choices are;

-underground cable ducts
-direct buried cable trench
-concrete cable trough
-self supporting aerial cable
-supported aerial cable, i.e. catenary or messenger wire
-fixed to building exteriors

In all cases the designer must ensure that all civils work has been carried out, rights of way established and availability of cable ducts and manholes established. Aerial cable routes must keep a minimum distance away from power cables and all external cables must be selected for the environment and temperature ranges in which they are expected to survive. External copper cables usually need to be protected by over voltage and fault current devices where they enter a building.

Step 7

Cable Administration system. The cabling and its containment system need to be clearly identified and their locations, routes and capabilities recorded in a cable administration system. This usually involves a logical numbering scheme that can be applied to all cables, outlets, patch panels and even containment systems. Various colour schemes are also available.

These schemes can be paper based but for the larger installations then a computer based system is advisable. There are several proprietary solutions on the market which offer various database and graphical methods for keeping track of cabling assets. Some systems are also active in that they can detect moves and changes and automatically update the database.

Useful standards are;

TIA/EIA-606	*Administration standard for the telecommunications infrastructure of commercial buildings*

EN 50174 *Information technology – cabling installation*

Step 8

Earthing Scheme. All exposed metallic elements of the cable system and cable containment system need to be earthed (grounded) for safety and also electromagnetic compatibility requirements. If screened cables are used then special attention must be given to effective bonding of the screening elements. Poorly earthed screened cabling may behave worse than unscreened cabling.

An electrically 'clean' earth must be available at all points where the cabling is terminated, but especially within telecommunication closets, equipment rooms and service entrances. A clean earth is usually defined as a conductive element with not more than 1 volt rms potential difference between it and the real earth down below. Copper cabling linking two different buildings can suffer from earth loops if the ground potential is different. Non-metallic optical cabling is usually picked for problem areas such as these.

Some useful standards are;

PrEN50303	*Application of equipotential bonding and earthing at premises with information technology equipment*
PrEN50174-2	*Information Technology, Cabling installation, part 2, Installation, planning and practices inside buildings*
TIA/EIA-607	*Commercial Building Grounding and Bonding Requirements for Telecommunications*

Step 9

Testing regime. All cables must be tested to demonstrate compliance with the standards and specification to which they were bought. Testing can be split into copper cable testing and optical fibre testing. Ideally all cables should be 100% tested.

Copper cables.

There are five manufacturers of hand held copper cable testers that will automatically test the installed cable plant for all the expected parameters. By the use of a remote injector, the cabling is tested from both ends, which is a condition of the standards. The cabling has to pass the entire suite of tests to be awarded and overall pass. Points to remember are;

What is being tested? The channel (i.e. end-to-end including all the patch cords) or the basic link (i.e. the permanently installed cable from outlet to patch panel). The test figures are different for each setting. It is usually more practical to test the basic link (also referred to as the permanent link).

What level is being tested? The tester should normally be set to Cat5e link or Class E link if Category 6 cable is being used.

The results are stored electronically and must be in a format recognizable by the cable management software that comes with the tester. There are now numerous test standards and draft standards. The most influential is likely to be;

IEC 61935 *Generic specification for the testing of balanced generic cabling in accordance with ISO/IEC 11801*

The tests required are;

	IEC 61935
Wire Map	X
Attenuation	X
NEXT pair to pair	X
NEXT Powersum	X
ELFEXT pair to pair	X
ELFEXT Powersum	X
Return Loss	X
Propagation Delay	X
Delay Skew	X
DC Loop Resistance	X

Cable length and ACR are also useful additions to this set of tests.

Optical cables

All that needs to be tested with short distance multimode optical cables is attenuation. This can be achieved by a device called a light source and power meter. This device will simply measure the absolute loss across the optical link. This then has to be compared with the design value of attenuation. If the tested value is less than the design value then the link can be seen to be acceptable.

Optical Time Domain Reflectometers can give a great deal of information about optical fibres, but for short haul multimode fibre they are an expensive overkill that gives results that need expert interpretation. An OTDR remains an essential tool for fault finding.

Step 10

Final thoughts

Is the design of the cabling system in-step with the LAN aspirations of the end user? For example, Cat5e is the minimum performance grade suitable for gigabit Ethernet. Standard Cat5 cable may not have sufficient delay skew performance for RGB video systems however. Cat 6 cabling will give a longer service life due to its higher performance, but at an initial higher cost.

Some optical fibre LANs, e.g. gigabit Ethernet cannot transmit over the full distance allowed in standards based optical structured cabling. These LAN limitations have to be taken into account. The next generation of 10 gigabit Ethernet will need a new generation of optical fibre to make it work.

The best way to ensure success in a structured cabling installation is to use properly trained people (Systimax, FIA or City and Guilds) to design, implement and test the system.

The above information is offered as a summary of ISO 11801 and related standards. It is not a definitive design guide and does not replace study and implementation of the Standards themselves. The publisher accepts no responsibility for inaccuracies or omissions. To purchase the full Standards go to your national standards body, e.g. British Standards Institution, Nederlands Normalisatie Instituut etc. or ISO.