Copper Cabling Standards

White paper

Introduction

Standard specifications are the foundation upon which most cabling and networking projects are built. Professionals in the cabling industry most often specify and deploy standards-based physical-layer infrastructures. By the early 90s, a scheme of "structured cabling" was standardized by technical committee of a trade association, the merged Electronic Industries Association and Telecommunications Industry Association (hereafter referred to as EIA/TIA) in the USA and ISO/IEC worldwide.

In copper twisted pair wire networks, copper cable certification is achieved through a thorough series of tests in accordance with Telecommunications Industry Association (TIA) or International Organization for Standardization (ISO) standards. Cabling standards are not developed for end users or installers, but for component and equipment manufacturers who need to develop products that offer interoperability and the multiple sources of supply demanded by users. The manufacturers develop products around the standards specifications and are responsible for telling installers and end users how to use these components. The designers, installers and users of networks can rely on the instructions of the manufacturers on how to utilize these "standard products" correctly.

Manufacturers assumed responsibility for standards development to ensure interoperability of their products - under the auspices of the IEEE for computer networking electronics and EIA/TIA for cabling in the US and ISO and IEC worldwide. Thus, was born the industry standards that we all depend on for today's communications networks.

This white paper explores the copper structured cabling standards and their related information.

What is Premises Cabling?

By premises cabling, we mean the cabling used inside buildings (and in restricted geographic areas like campuses or among business facilities) that follows industry standards. Mostly we are refering to structured cabling systems defined by TIA-568 or ISO/IEC 11801 and related standards that are used for LANs, telephone systems and even other systems adapted to structured cabling like CCTV, security or building management. Other systems that depend on cabling such as security and building control are migrating to structured cabLing for its widespread availability and predictability.

What are Standards?

Standards represent the minimum required to maintain compliance. Principally about achieving minimum performance from products / standards driven by applications – not end users. Standards are considered to be living documents. It is important that the region-specific standards are quoted in the design and implementation.

National Organisations & Standards

Despite the trend towards globalisation, the national codes and standards still take precedence over the international agreements and clash. This allows for local customs and language differences. Quite often there are differences in the technical terms adopted in various parts of the world. Structured cabling standards have always been in place to ensure that communications networks are designed, installed and tested to the highest level. Industry cabling standards are designed to protect the end user and they provide the building blocks of ensuring and maintaining high levels of cabling performance.

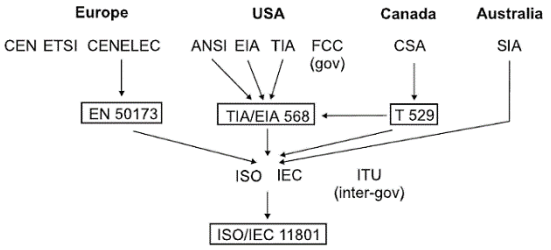
This basically ensures that all parties, from the designer, installer and of course network owner (end user) can all have confidence in the performance of the installed network.

The cabling standards address copper cabling, fibre optic, pathways and many other aspects of network design and install.

Who are the national or regional standard bodies?

Geographical areas often adhere to the standards set out by their local bodies. For example:

- USA – ANSI/EIA/TIA
- International – ISO/IEC
- Europe – EN – CENELEC



- The International Organization for Standardization (ISO) produces worldwide standards generated by country members.
- European Committee for Electrotechnical Standardisation CENELEC produces European standards generated by EU country members.
- American National Standards Institute (ANSI) produces North American standards
- Institute of Electrical and Electronic Engineers (IEEE)

The following table highlights the most relevant cabling standards and to which areas they apply to:

SCS	EIA/TIA (North America)	ISO/IEC (International)	EN (CENELEC-Europe)
Commercial	568-C	11801:2002	50173-2
Industrial	568-C	24702:2006	50173-3
Residential	570-C	15018:2005	50173-4
Data Centre	942-A	24764:2011	50173-5

These structured cabling standards have been developed to ensure cabling networks are designed, installed and tested to industry best practices. Following these standards will ensure that either copper cabling or optic fibre network performance will be at the highest level.

ANSI/EIA/TIA 568

TR-42: This Subcommittee of TIA develops and maintains telecommunications cabling standards for Premises networks primarily for North America. Most Current Published 568 Series Documents include:

- ANSI/TIA-568.0-D (2015)
  Generic Telecommunications Cabling for Customer Premises-Deals with Topologies, Lengths, Installation Practices, Testing Methods, Fibre polarity etc.

- ANSI/TIA-568.1-D (2015)
  Commercial Building Telecommunications Cabling Standard-Deals with details of Entrance Facilities, Equipment rooms, Telecom Closets and Rooms, Enclosures, Backbone cabling, Horizontal Cabling, Work areas, MUTOA

- ANSI/TIA-568-C.2 (2009)
  Balanced Twisted-Pair Telecommunications Cabling and Components Standards-Deals with the performance specification for components as well as channels for copper links. Defines category 5e, 6, 6e and 6A.

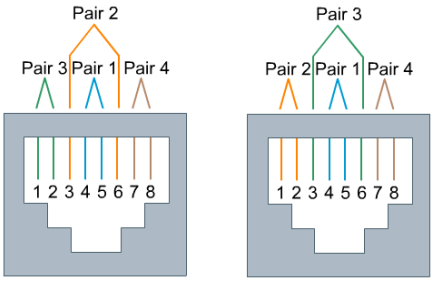
- ANSI/TIA-568-C.3-1 (2011)
  Optical Fibre Cabling Components Standard-Deals with the performance specification for components and polarity of fibre connections. Defines fibre performance specs for OM1, OM2, OM3, OM4, OS1 and OS2 cable.

- ANSI/TIA-568-C.4 (2011)
  Broadband Coaxial Cabling and Components Standard

One of the most essential elements to plan and deploy a telecommunication infrastructure is to make sure you are following the ANSI/TIA-568-C standard. This standard will ensure that your cabling system is interoperable with any networking or voice applications that have been designed to work with that standard.

Wiring Patterns

The ANSI/TIA-568-C standard introduces two wiring patterns for modular jacks and plugs: T568-A and T568-B.
The only difference between these wiring patterns is that pin assignments for pairs 2 and 3 are reversed. The two schemes are similar with two of the four pairs reversed in the termination order.



These particular standards depict the arrangement of each color conductor when terminating four-pair data cables. The wiring pattern chosen makes no difference to the applications used. They both work the same way. The most important factor is to choose one wiring configuration and stick with it. If you use T568-A at one end, you must use it at the other; likewise, with T568-B. The cable pairs are assigned to specific pin numbers. The pins are numbered from left to right if you are looking into the modular jack outlet or down on the top of the modular plug. The following picture shows the pin numbers for the eight-position modular jack (RJ-45) and plug.

Copper cabling installation is not as easy as thought. You should follow the ANSI/TIA-568-C standard to confirm the cable distance and wiring patterns.

International standard ISO/IEC 11801

The international equivalent of EIA/TIA 568 is ISO/IEC 11801. The standards are written similarly to what has been done by TR 42.

The international standard provides users with an application independent generic cabling system capable of supporting a wide range of applications. It provides users with a flexible cabling scheme, so modifications are both easy and economical. Building professionals (architects, for example) are given guidance on the accommodation of cabling at the initial stages of development.

The international standard specifies a multi manufacturer cabling system that may be implemented with material from single and multiple sources and is related to:

- International standards for cabling components developed by committees in the IEC
- Standards for the installation and operation of information technology cabling as well as for testing of installed cabling
- Applications developed by technical committees of the IEC
- Planning and installation guides that take into account the needs of specific applications.

Generic cabling defined within this International Standard:

- Specifies a cabling structure that supports a wide variety of applications
- Specifies channel and link classes C, D, E, EA, F and FA, meeting the requirements of standardised applications
- Specifies channel and link classes E and F based on higher performance components to support future applications
- Specifies optical channel and link classes OF-300, OF-500 and OF-2000
- Involves component requirements and specifies cabling implementations that ensure performance of permanent links and channels that meet or exceed the requirements for cabling classes
- Specifies a generic cabling system that is anticipated to have a usable life in excess of 10 years.

Re-structuring of ISO/IEC Cabling Design Standards

ISO/IEC 11801 - Cabling for customer premises - structured cabling similar to TIA 568

ISO/IEC cabling standards have been re-structured into single family:

- ISO/IEC 11801-1:
  General Requirements (structure, dimensioning, channel)
- ISO/IEC 11801-2
  Commercial Office Environment (unique aspects)
- ISO/IEC 11801-3

Industrial Environment (unique aspects)
- ISO/IEC 11801-4
  Residential Environment (unique aspects)
- ISO/IEC 11801-5
  Data Centre (unique aspects)
- ISO/IEC 11801-6
  For future use

Current standards:

- ISO/IEC 11801:2002/Amd 2:2010 Information technology – Generic cabling for customer premises. Amendment 2
- ANSI/TIA-568-C
  Generic Telecommunications Cabling for Customer Premises
- ANSI/TIA-568-C.0
  Generic Telecommunications Cabling for Customer Premises
- ANSI/TIA-568-C.1
  Commercial Building Telecommunications Cabling Standard
- ANSI/TIA-568-C.2
  Balanced Twisted-Pair Telecommunications Cabling and Components Standard
- ANSI/TIA-568-C.3
  Optical Fibre Cabling Components Standard
- ANSI/TIA-568-C.4
  Coaxial and Broadband Component

Balanced Cabling Channel Performance Classes

- Class A: Up to 100 kHz using elements Category 1 (reference only)
- Class B: Up to 1 MHz using elements Category 2 (reference only)
- Class C: Up to 16 MHz using elements Category 3, Low Speed BB Only
- Class D: Up to 100 MHz using elements Category 5e
- Class E: Up to 250 MHz using elements Category 6
- Class EA: Up to 500 MHz using elements Category 6A
- Class F: Up to 600 MHz using elements Category 7
- Class FA: Up to 1000 MHz using elements Category 7A

ANSI/TIA vs. ISO/IEC

In TIA everything is specified by “CATEGORY” •In ISO components (i.e. cables, connecting hardware, and patch cords) are specified by “CATEGORY” however LINKS and CHANNELS by “CLASS”

Frequency Bandwidth	TIA (Components)	TIA (Cabling)	ISO (Components)	ISO (Cabling)
1-100 MHz	Category 5e	Category 5e	Category 5e	Class D
1-250 MHz	Category 6	Category 6	Category 6	Class E
1-500 MHz	Category 6A	Category 6A	Category 6_A	Class E_A
1-600 MHz	n/s	n/s	Category 7	Class F
1-1000 MHz	n/s	n/s	Category $_{7A}$	Class F_A

System Performance of ISO and TIA standards are the same in terms of frequency and application.

CENELEC

For the European market the EN standards published by CENELEC are likely to best suit the needs. CENELEC standards are automatically adopted by member states. So, in the case of the UK they become BS EN XXXXX.

The EN standards, along with a couple of British Standards, offer a robust suite. For the rest of the world, with the exception of America, the ISO standards are likely to be the best “fit”.

The standards from the other bodies are good, and with care a ‘mix and match’ suite can be compiled. Infrastructure cabling products that are compliant with the ISO and EN standards are also compliant with the TIA standards.

EN 50173 Information technology – Generic cabling systems: The EN50173 series defines the design requirements for copper and fibre optic structured cabling systems in various different installation areas

- EN 50173-1:2011 Part 1: General requirements
- EN 50173-2:2007 + A1:2010 Part 2: Office premises
- EN 50173-3:2007 + A1:2010 Part 3: Industrial premises
- EN 50173-4:2007 + A2:2012 Part 4: Homes
- EN 50173-5:2007 + A2:2012 Part 5: Data centres
- EN 50173-6:2013 Part 6: Distributed Building Services

EN 50174 Information technology – Cabling installation

- EN 50174-1:2009 + A1:2011 Part 1: Installation specification and quality assurance
- EN50174-2:2009 + A1:2011 Part 2: Installation planning and practices inside buildings
- EN 50174-3:2013 Part 3: Installation planning and practices outside buildings

EN 50310:2010 Application of equipotential bonding and earthing in buildings with information technology equipment

Conclusion

The essence of standards for structured cabling is that they provide a minimum performance level for components and cabling systems that manufacturers use to develop products for the marketplace. The competition in the structured cabling marketplace requires companies to make copper solutions that are better than those standards in order to differentiate their products from competitors. Hence, using those standards, manufacturers make copper solutions that will be compatible with other copper solutions meeting the same standards but offer advantages in performance, installation or cost.

Structured cabling standards have always been in place to ensure that communications networks are designed, installed and tested to the highest level. Industry cabling standards are designed to protect the end user and they provide the building blocks of ensuring and maintaining high levels of cabling performance. This basically ensures that all parties, from the designer, installer and of course network owner (end user) can all have confidence in the performance of the installed network. The cabling standards address copper cabling, fibre optic, pathways and many other aspects of network design and install.

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