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Technology Update

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Executive Summary

Commercial Buildings

The Telecommunications Industry Association (TIA) is tending to the "care and feeding" of their most widely referenced documents, such as the ANSI/TIA-568 series cabling standards, by updating the list of recognized cabling media to include copper and optical fiber cable grades that have been developed since the last revision in 2015. They are also updating the ANSI/TIA-569 pathways and spaces document by including specific requirements and recommendations to properly accommodate the new levels of PoE power previously developed as addendums to the -D version.

Single Pair Ethernet

The most talked about development taking place in IEEE, TIA and ISO/IEC revolves around Single Pair Ethernet (SPE) cabling systems. While two different SPE specifications were introduced by IEEE over the past few years for automotive environments, they were significantly distance limited. The latest IEEE Ethernet addendum (802.3cg) will extend the reach of SPE to 1000 meters. In response to this, the U.S. and European cabling standards bodies have begun work on specifications for new Single Pair Ethernet cabling and connectors that will be capable of supporting distances from 15m to 1000m in both industrial, as well as commercial building environments. TIA and ISO/IEC are actively developing intelligent building cabling standards that will incorporate SPE cabling to support the IoT device deployment that is so crucial to smart building functionality.

Fiber Polarity

For optical fiber cabling systems, TIA is developing a Technical Services Bulletin (TSB) which will provide guidelines for polarity when designing systems using duplex, single-row and multirow array connector components. Once completed this yet-to-be-numbered TSB will make it simpler for system designers to ensure proper polarity, especially for 12- and 24-fiber MPO based systems.

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New High Density Connector

With the introduction of a new small form-factor, high-density 2-fiber connector by Senko (the CS® connector), TIA is finalizing a Fiber Optic Connector Intermateability Standard (FOCIS) so that this connector form factor can be incorporated into multiple vendors' product portfolios. The new connector is 39% smaller than a duplex LC connector allowing for much higher densities in high-fiber count data center deployments.

Commercial Buildings

ANSI/TIA-568.0-E "Generic Telecommunications Cabling for Customer Premises"

ANSI/TIA-568.0-D was last revised in 2015. This standard specifies requirements for generic telecommunications cabling. It defines requirements for cabling system structure, topologies and distances, installation, performance and testing.

The updated document will incorporate content from ANSI/TIA-568.0-D-1 (Addendum 1), which added Category 8 and OM5 multimode fiber, and removed the OM1/OM2 grades of multimode and OS1 grade of single-mode fiber as recognized media. The document will also include additional updates, including content regarding 28AWG patch cords.

ANSI/TIA-568.1-E "Telecommunications Cabling for Commercial Buildings"

ANSI/TIA-568.1-D was also last revised in 2015. This standard specifies requirements for telecommunications cabling within a commercial building and between commercial buildings in a campus environment. It defines terms, specifies cabling topology, lists cabling requirements, establishes cabling distances, sets telecommunications outlet/connector configurations and provides additional useful information.

Changes to this standard will include the addition of the latest copper and optical fiber types (Category 8, 28 AWG patch cords and OM5 MMF) that were also added to the '568.0-E document.

ANSI/TIA-758-C "Customer Owned Outside Plant Telecommunications Infrastructure Standard"

Last updated in 2012. This revision will include updates to new media types (as mentioned above), references to the newest version of any standard that has been updated and incorporate general upkeep and improvement.

ANSI/TIA-569-E Telecommunications Pathways and Space updates include the additions from addendums 1 and 2 from '569-D with information on Temperature and Humidity Requirements for Telecommunications Spaces, and Additional Pathway and Space Considerations for Supporting Remote Powering Over Balanced Twisted-Pair Cabling. This document refers to bundling size restrictions for PoE power levels above 60W and the impact on pathways this may have.

Bottom Line: *All the information a cabling system designer needs to design an enterprise or campus network, and the pathways and spaces they will occupy, will now be located within one updated document for each area without needing to purchase and download additional addenda.*

Single Pair Ethernet

One of the hottest topics being discussed in several different committees in TIA TR-42, ISO/IEC as well as IEEE 802.3 is Single Pair Ethernet (SPE). Single pair Ethernet was originally developed for automotive and other transportation types (think aircraft, railway, busses, trucks, etc.), and industrial applications. Completed SPE standards as of this date include **802.3bp specifying 1000Base-T1 @ 15m and 40m, and 802.3bw specifying 100Base-T1 @15m.**

The current effort within IEEE is to complete two new SPE standards including **802.3ch** which specifies **2.5, 5, and 10Gbps** operation over 15m for automotive environments and **10Base-T1 802.3cg** with link lengths of **15m and 1000m** primarily targeted at industrial environments. The 802.3cg standard will also support what is called a "mixing segment" which can also be referred to as multidrop topology. This allows more than two devices or nodes in a channel. It will allow up to 8 nodes within 25m of cabling.

In support of these IEEE network transmission standards TIA, ISO and CENELEC are all working on the cabling standards needed to implement SPE channels. In fact, these groups are looking to make SPE a part of both an industrial environment as well as a commercial building. The relevant documents under development include:

- TIA-568.0-D-2, Addendum 2 to the Generic Cabling for Customer Premises document and TIA-862-B-2, Addendum 2 to the intelligent building cabling standard. These documents will provide support for 10BASE-T1, 100BASE-T1, 1000BASET-T1, and 10GBASE-T1* (*currently only an IEEE study group) in commercial buildings with a generic single pair cabling architecture. The '862-B-2 document specifically relates the use of SPE in intelligent building systems.
- ANSI/TIA-568.5 – "Single Pair Balanced Twisted-Pair Telecommunications Cabling and Components Standard" will specify the physical and electrical component requirements for single pair cables, connectors, cords, links and channels in a non-industrial telecommunications network. It will focus on a MICE1 environment and will include test procedures and will eventually address adaptations to four pair cabling.

The current draft of this document lists four different proposed "categories" of single pair cabling (with the actual names still TBD):

- SP1 with a reach of 1000m and a frequency range of 0.1 – 20 MHz
- SP2 with a reach of 100m and a frequency range of 0.1 – 600 MHz
- SP3 with a reach of 40m and a frequency range of 0.1 – 600 MHz
- SP4 with a reach of 15m and a frequency range of 0.1 – 600 MHz

These single pair "categories" are designed to support three Single Pair Ethernet transmission speeds (with 100BASE-T1 and 1000BASE-T1 published, and 10BASE-T1 anticipated in Fall 2019) at the various channel lengths as shown in the following table:

	SP1	SP2	SP3	SP4
10BASE-T1L	√ (1000m)	√(100m)	√(40m)	√(15m)
100BASE-T1	X	√(15m)	√(15m)	√(15m)
1000BASE-T1	X	√(40m)	√(40m)	√(15m)

The ANSI/TIA-568.5 document specifies a conductor size for SPE cable ranging from 18 AWG to 26 AWG. Cabling can also be shielded or unshielded.

ISO/IEC is working on SPE standards and the corresponding ISO/IEC document to the ANSI/TIA 568.5 document is **ISO/IEC TR 11801 9906** which defines the performance of the various SPE channels, including their speed and reach. They are also working on amendments to **ISO/IEC 11801** which will describe the cable, component, and cabling requirements. The ISO/IEC Working Group completed their work on **SPE connector form factor** evaluation before the TIA and selected the **IEC 63171-1** form factor that is commonly referred to as a "**copper LC**" style connector. This connector was also selected by the TIA TR42.7 committee the following month.

As the components for SPE for a commercial building (MICE1) environment are being finalized **TIA TR-42.9** is working on **ANSI/TIA-1005-A Single pair balanced twisted-pair telecommunications cabling and components standard for industrial environments.** Both the ISO and TIA committees selected the **IEC 60176-3-125** connector form factor for light and heavy industrial environments. The 1005-A document defines the cabling requirements for 1000BASE-T1 operation in MICE2 and MICE3 light and heavy industrial environments.

Finally, the IEEE is also working to finalize the **802.3bu** standard which will support remote power delivery of up to a minimum of 13.6W over 1000m of single pair cabling. The powering scheme is referred to as **Power over Data Lines or PoDL** (pronounced 'poodle') and the maximum power delivered to a device will depend on the channel resistance – associated with length and the gauge of the conductors. Since PoDL is delivered using a single pair it would not be compatible with 2-pair Type 1 and 2, or 4-pair Type 3 and 4 Power over Ethernet systems.

Bottom Line: *The TIA, ISO, and CENELEC committees and working groups working on SPE standards have identified intelligent building applications as a likely use case for this technology. With the Internet of Things (IoT) device market expected to grow significantly in the next several years it is likely that many of the intelligent building devices will be connected and powered using a SPE channel. We will likely see new SPE product announcements before the end of 2019.*

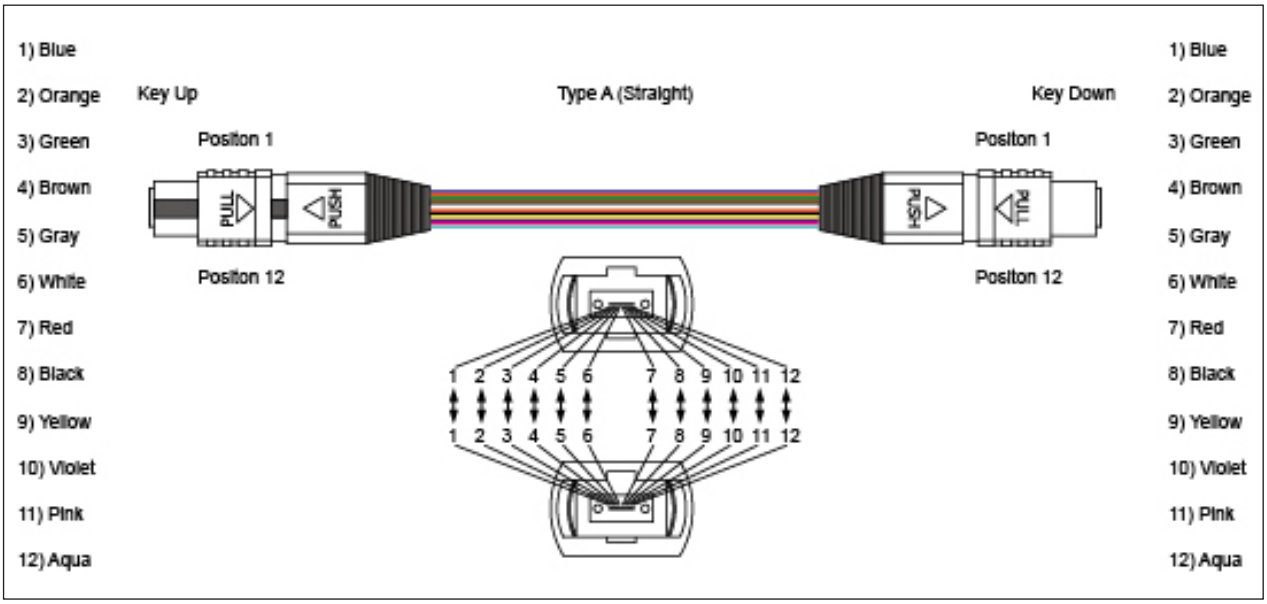
Fiber Polarity

The TIA TR-42.11 committee began work on TIA-PN-5069 which will become a TSB (number TBD) on Optical Fiber Channel Polarity. The TSB will provide guidelines for polarity when designing optical fiber cabling systems using duplex, single row and multirow array connector components and is intended to accompany the ANSI/TIA-568.3 Optical Fiber Cabling and Components Standard and is not a substitute.

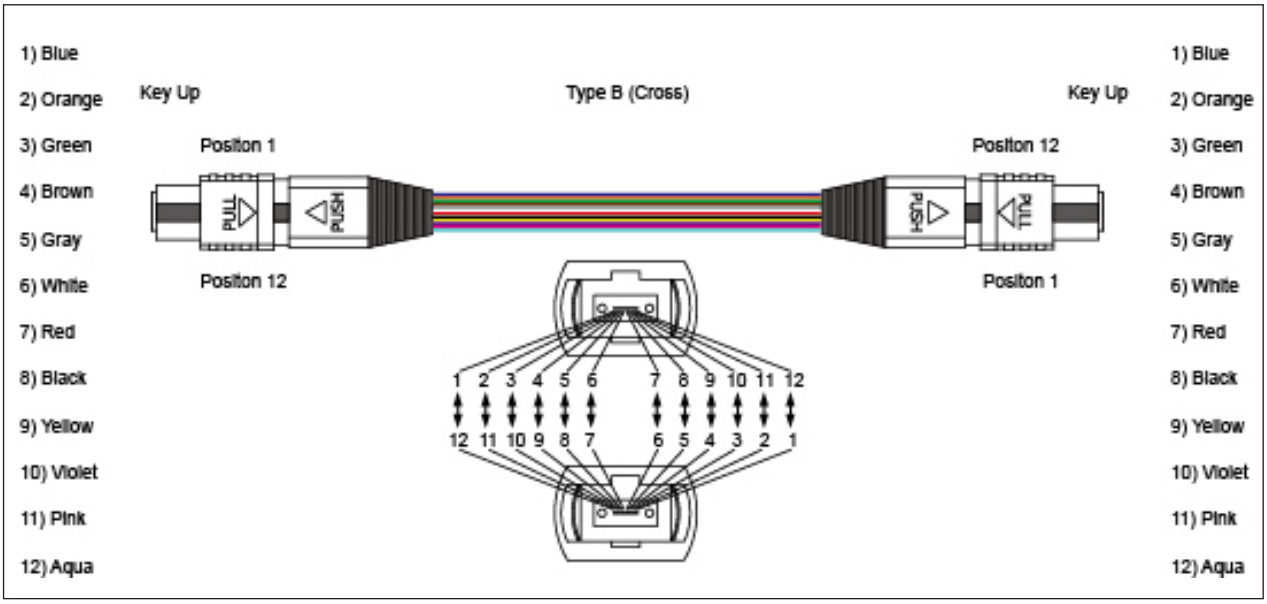
TIA-PN-5069 introduces specific nomenclature (symbols) that can be used to give the system designer a quick indication of the polarity effect of each component. There are currently three component polarity types defined; Types, A, B, and C, with each having a different effect on polarity. Type A introduces no polarity change, Type B introduces polarity change by transposing

fibers across a row, and Type C introduces polarity change with pair-wise transposition within a row. There is also a row transposition symbol for two row array connectors that can also be combined with all three types. The markings used for each type are shown below:*

TYPE-A Components: No polarity change – straight through

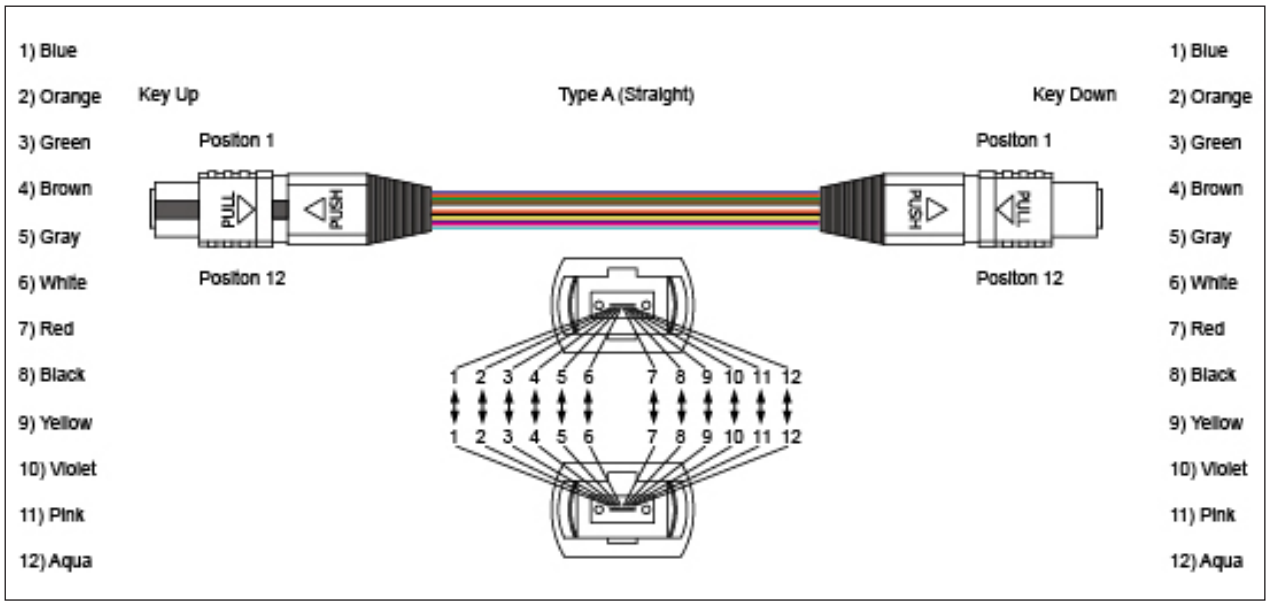


TYPE-B Components: Transpose fibers within the row (1 to 12 and 12 to 1, 11 to 2 and 2 to 11, etc)



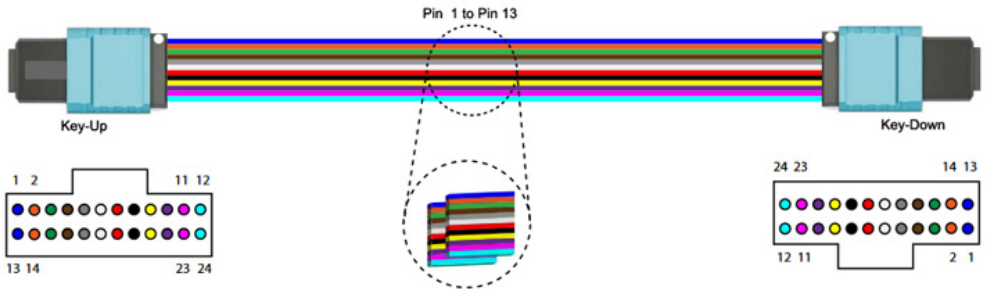
*Images courtesy of www.mtp-mpo-cables.com

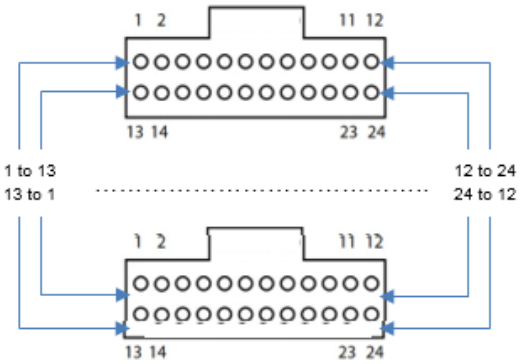
TYPE-C Components: Pair-wise transposition within the row (1 to 2 and 2 to 1, 3 to 4 and 4 to 3, etc)



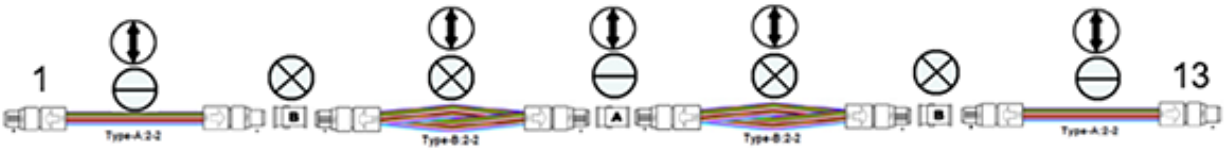
Row Transposition: Transpose fibers between the top row and bottom row. Can be combined with Type A, B, & C Components. (1 to 13 and 13 to 1, 2 to 14 and 14 to 2, etc.)

Type A 24F MTP to MTP with row transposition





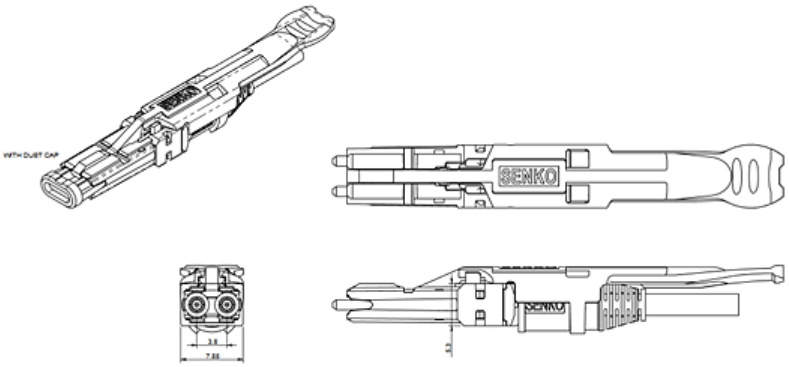
By creating a diagram of a channel with the component type symbol marked at each component, including cables, cords, and adapters, and considering their effect along the length of the channel, you can predict the polarity outcome and determine operability. The designer would strive to ensure that there are an odd number of transpositions of the same type across the channel so that Tx goes to Rx from end to end.



In this example there are four Type B devices which would result in no transposition of Tx and Rx since there are an even number of them. But there are five row transposition devices, which would result in a having the top and bottom row fibers transposed and therefore this system would function properly supporting 100G-SR10 channels.

Bottom Line: *Parallel Optics transmitting over 8 to 32 fibers are used in 40, 100, 200, and 400G Ethernet systems. This document will help system designers assure the functionality of the installed cabling by readily identifying the effect on polarity of each component.*

New High-Density Connector



The TIA TR-42.13 committee is working on the **FOCIS 19** document. This will be the intermateability standard for simplex and duplex connectors with the commercial designation SEN-01. It will be issued as an addendum to TIA/EIA 604, Fiber Optic Connector Intermateability Standards. If you are unfamiliar with the SEN-01 reference, you may not have heard about the **Senko CS®** connector. This new optical fiber connector is smaller in size then the LC connectors we are all familiar with. In fact it is 39% smaller than an LC Duplex connector. It also doubles the density in a patch panel compared to the LC. The connector also incorporates a push-pull tab at the back of the connector to allow for easier insertion and removal in high density installations. It is also compatible with the 2X200G CWDM 4 QSFP-DD/OSFP switch ports used for 400G transmission.

Bottom Line: *The new CS® connector will offer an unparalleled level density for next generation data centers with the latching mechanism making it easier to manage individual connections as well as support 400G Ethernet through the double duplex connection (two CS connectors side by side) in the 2X200Gig QSFP-DD/OSFP transceivers.*

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Located in New Holland, PA, The TEK Center at Berk-Tek is comprised of several labs and a technology showcase. By employing industry-leading research, advanced testing procedures, and sophisticated modeling for emerging technologies, the applications and system labs translates expanding network requirements into leading edge cabling solutions that perform beyond the standard. Similarly, to exceed your expectations in real world applications, the materials lab develops advanced proprietary materials and process technologies that result in superior application performance that you can see and hear. The technology showcase displays the results of these labs along with industry-available equipment shown in actual segment usage, such as data center, security, and enterprise spaces. The TEK Center is a part of an extensive global R&D network with similar laboratories found throughout Nexans Inc.