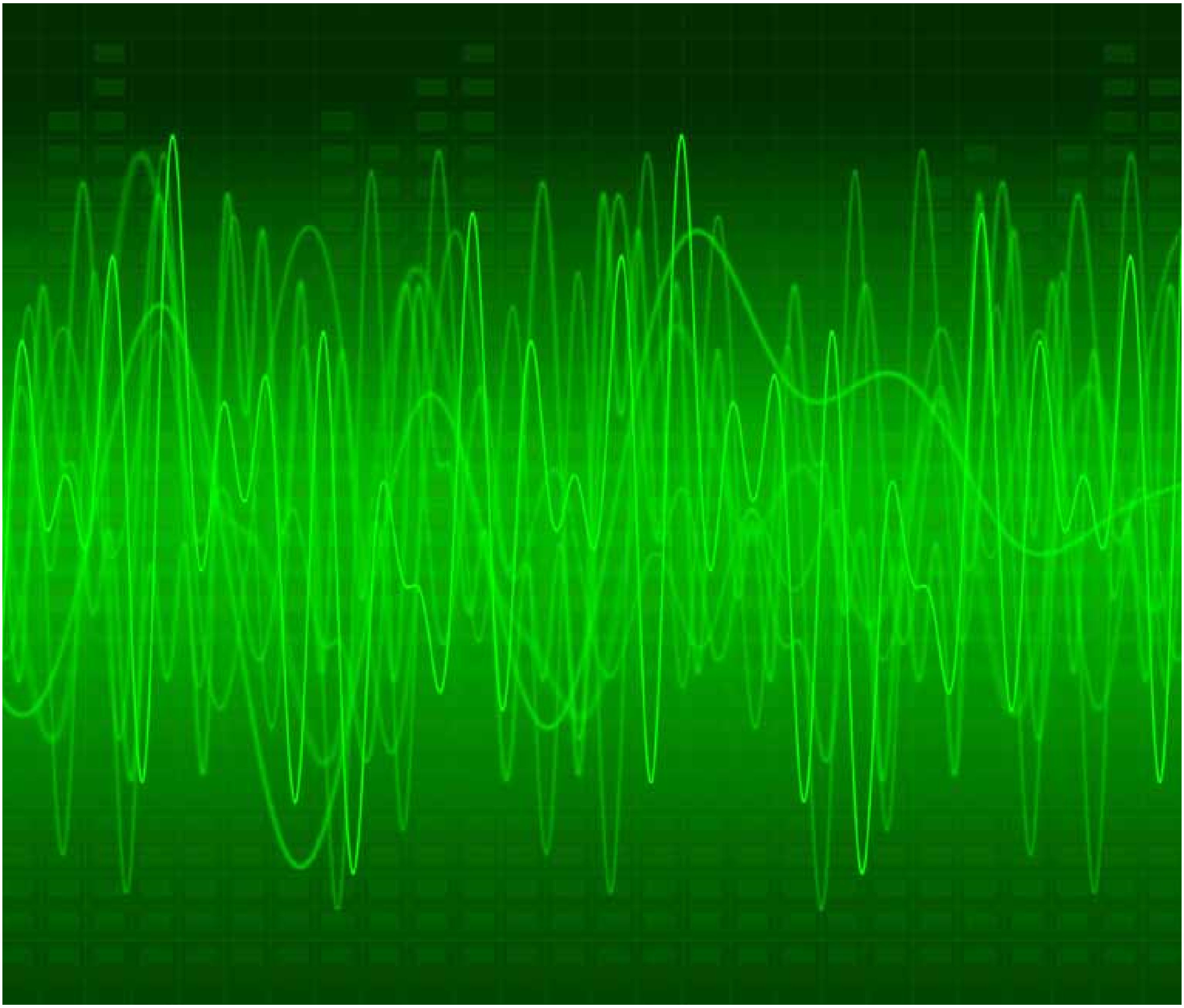


Polarity Management Methods

By David Kozischek

In the data center, keeping the electronics working correctly is a function of keeping the cabling polarity managed. As systems move from Base-2 (duplex) systems to Base-12 systems, the cabling polarity is a key component that will ensure the electronics work and operate properly. Different systems are used to manage polarity. This article will discuss TIA-942 Structured Cabling, the definition of the Base-2 and Base-12 cabling systems, and polarity management methods for Base-2 and Base-12 systems.

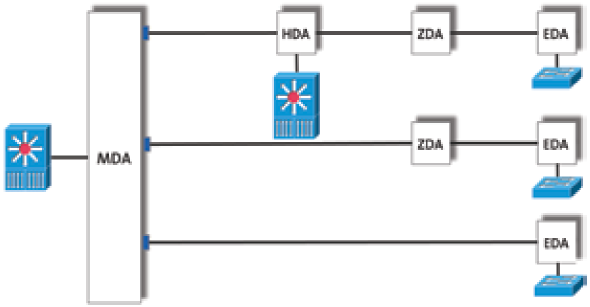


Figure 1: The Structure of the TIA-942 Architecture

cabling systems for data centers. The first area of guidance is TIA-942, Telecommunications Infrastructure Standard for the Data Center. Understanding this structured cabling standard will help to ensure proper polarity of data center electronics.

In April 2005, TIA-942 was released. The purpose of this standard is to provide information on the factors that should be considered when planning and preparing the installation of a data center or computer room. TIA-942 combines within a single document all the information specific to data center applications. This standard defines the telecommunications spaces, infrastructure components and requirements for each within the data center. Additionally, the standard includes guidance as to recommended topologies, cabling distances, building infrastructure requirements, labeling and administration, and redundancy.

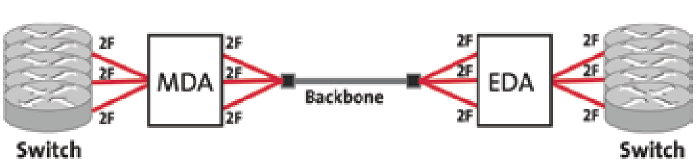


Figure 2: Base-2 Cabling System

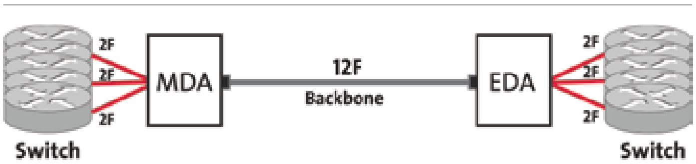


Figure 3: Base-12 Cabling System

The main elements of a data center defined by TIA-942 are the main distribution area (MDA), horizontal distribution area (HDA), zone distribution area (ZDA), equipment distribution area (EDA) and telecommunications room (TR).

The MDA includes the main cross-connect, which is the central point of distribution for the data center structured cabling system and may include a horizontal cross-connect when equipment areas are directly served from the MDA. Every data center shall include at least one MDA. The HDA serves equipment areas, and EDAs are allocated for end equipment

There are many ways that connections can be made in this example, and each of these will require proper polarity planning to ensure that all electronics will work properly. In looking at Figure 1, these types of electronic connections need to be managed:

MDA to HDA to ZDA to EDA
MDA to ZDA to EDA
MDA to EDA

All of these connections are made through a series of interconnects and cross-connects, and each will be dictated by the type of backbone cabling infrastructure and the type of electronics that are used. Systems today require duplex connections for Ethernet systems up to 10G and Fibre Channel systems up to 16G. In the future, 40G and 100G systems will require parallel connectivity. Planning the type of cabling infrastructure that can migrate to these speeds will be critical in determining electronic polarity is maintained through the system. The backbone cabling systems used in today's data center are Base-2 or Base-12 systems. Let's look at this in more detail.

DEFINITION OF BASE-2 AND BASE-12 CABLING SYSTEMS

Most legacy networks use a Base-2 cabling system. This is shown in Figure 2.

In this type of cabling infrastructure the backbone/horizontal cabling is traditionally broken out into two-fiber duplex connectors. These interconnect to the electronics, which use two-fiber duplex transmit /receive technology.

Today, many data center infrastructures are migrating to a backbone cabling system that uses array connectors, or MPO connectors, which allow for greater density in the backbone. See Figure 3.

In this type of cabling infrastructure, the backbone/horizontal cabling is traditionally aggregated into multi-fiber array connectors. These array connectors break out into duplex connectors in the MDA, HDA, ZDA and EDA, anywhere a cross-connect is required, or when they need to terminate into electronics. A module is used in these systems to transition from a 12-fiber MPO connector to 6 duplex connectors.

Like simplex and duplex connectors and adapters, MPO connectors and adapters are keyed to ensure the proper orientation is maintained when connectors are mated. With MPO connectors, this keying establishes the orientation of one fiber array in one connector relative to the array in the mating connector but does not ensure that duplex fiber-pair polarity is maintained. Depending on the type of system that is being deployed in the data center (Base-2 or Base-12), polarity will have to be managed.

POLARITY MANAGEMENT METHODS FOR BASE-2 SYSTEMS

Base-2 cabling systems manage polarity with a grouping of A and B jumpers. In this system, the "B" patch cord is a jumper that provides a crossover in the link. This crossover ensures that the transmit signal aligns with the receive signal in both directions. The cabling system is all Base-2, so all polarity needs to be managed at the ends of the system.

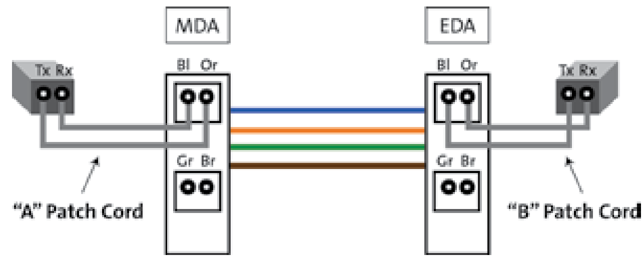


Figure 4

POLARITY MANAGEMENT METHODS FOR BASE-12 SYSTEMS

Data Center local area network (LAN) and storage area network (SAN) dense wiring requirements facilitate the use of array-style connectors like the MPO connector. These scenarios often utilize pre-assembled and field-terminated MPO-to-MPO connectorized cables, or trunks. Since there are array connectors on both ends of these trunks, and the end equipment typically has standard duplex transceiver ports, the trunks are plugged into factory-made breakout furcations, or modules, that transition from the MPO connector to a duplex connector/adapter style. Many systems use array connectors in their backbone cabling, so managing polarity takes on some different challenges.

The TIA-568-C.0 standard includes guidance on three sample methods identified as Method A, Method B and Method C. It is important to note that the standard states in paragraph B.4.1 that "While many methods are available to establish polarity, this standard outlines sample methods that may be employed for array cabling systems where the connectors have one row of fibers only." The word "may" implies that alternate polarity methods that are not discussed or included in the standard are available to accomplish the same results.

Five different methods are commonly used in the industry today, none of which are compatible with one another (Figure 5).

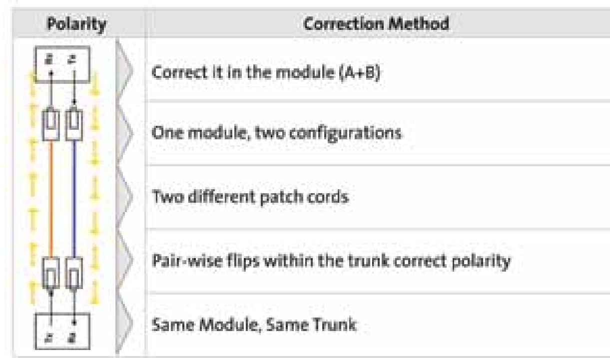


Figure 5: Polarity Methods for Array Connectors

CORRECT POLARITY IN THE MODULE

In this method, modules are wired two different ways: one with straight wiring and the other with pair-wise flips. This enables the use of standard patch cords, but this method will require advance planning for module locations due to MDA to EDA connectivity (Figure 6).

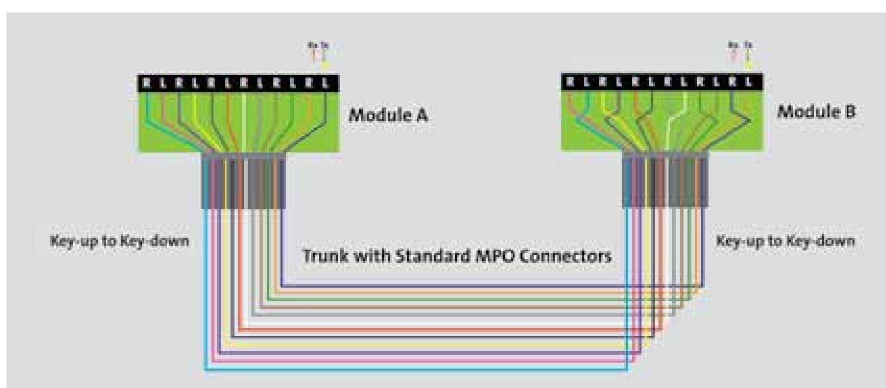


Figure 6: A+B Module Polarity Method

ONE MODULE WITH TWO CONFIGURATIONS

This method uses a single module type, wired in a straight-through configuration with standard patch cords on both ends. The difference is that all components in the system are mated key-up to key-up. When the link is configured in this fashion, physical position #1 goes to physical position #12 on the other end.

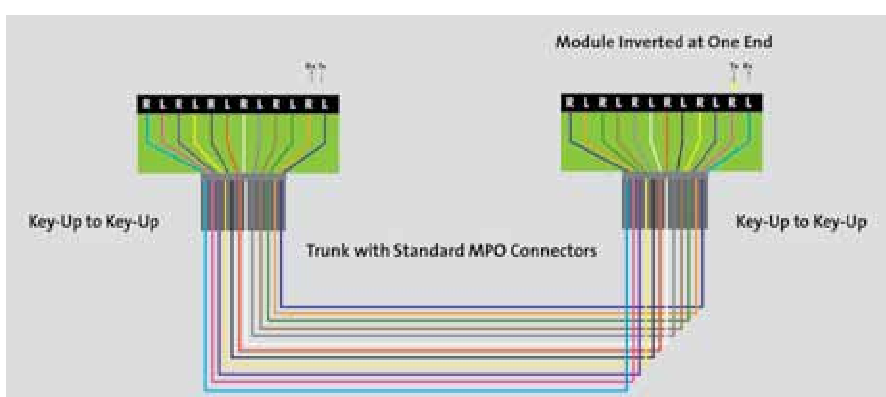


Figure 7: One Module Polarity Method

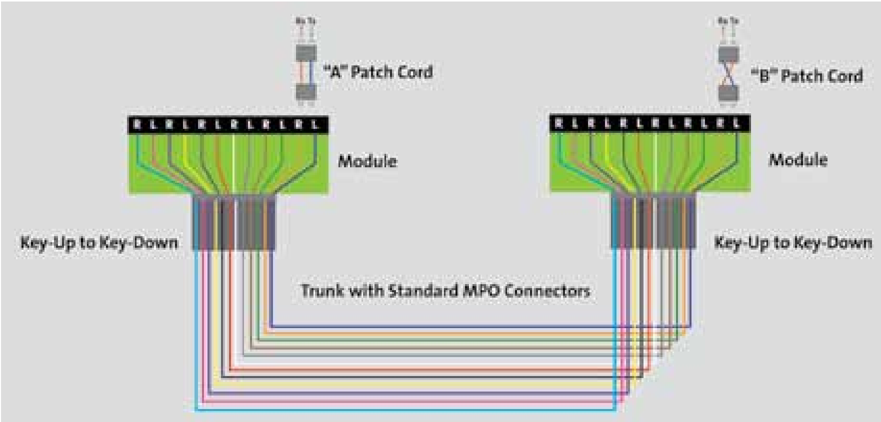


Figure 8: A+B Patch Cord Method

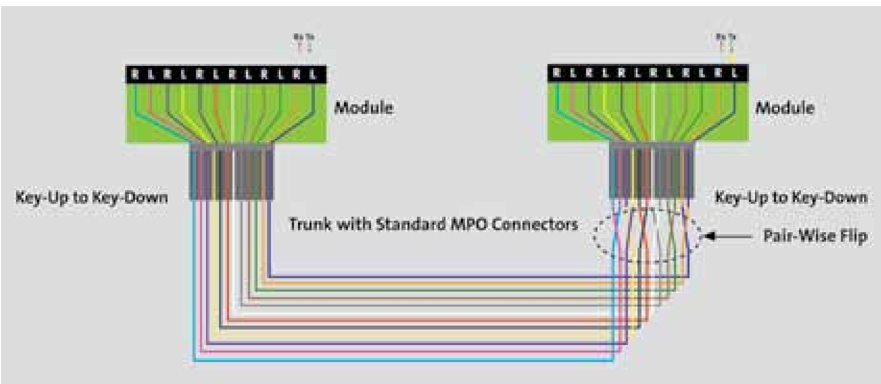


Figure 9: Pair-wise Flip in Trunk Cable Method

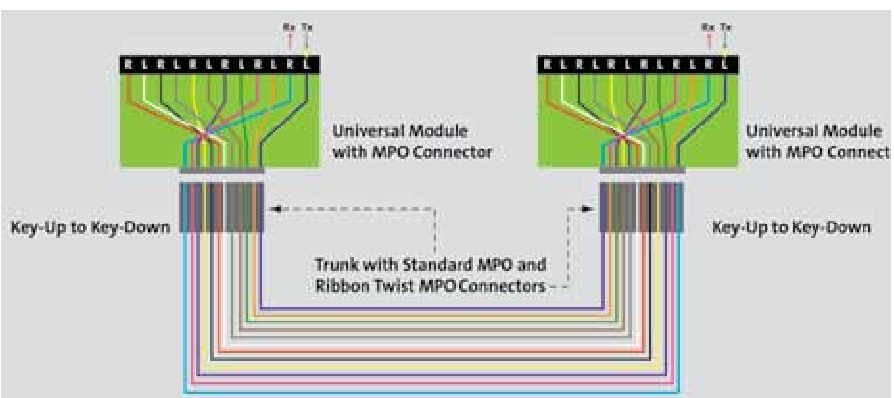


Figure 10: Same Module, Same Trunk Method (Universal Polarity)

A module on one end is inverted, so logically (label-wise), position #1 goes to position #1. This method requires advance planning for module locations in order to identify the module types and location of the inverted module in the optical link. This adds complexity to the polarity management. Using an MPO connector, key-up to key-up configuration does not allow use of an angled polished (APC) single-mode connector (Figure 7).

TWO DIFFERENT PATCH CORDS

In this method two different patch cords are used – one straight-wired and the other with a pair-wise flip. This allows use of one module type and standard trunk cables. Because polarity is addressed in the patch cords, the end-user is ultimately responsible for managing the system (Figure 8).

PAIR-WISE FLIPS IN THE TRUNK CABLE

This method uses a pair-wise fiber flip in the trunk cable to correct for polarity. This enables the use of the same module type on both ends of the channel and standard patch cords. Because polarity is managed in the trunk, extending the links requires planning of the number of trunks in order to maintain polarity. This method may require a special patch cord for parallel optics (Figure 9).

SAME MODULE, SAME TRUNK

In this configuration the same module can be used at both ends with no reconfiguration or inversion needed to maintain polarity. This enables the use of standard patch cords and allows easy concatenation of trunks without affecting polarity. This method is known as "universal polarity" (Figure 10).

Polarity methods and structured cabling create many challenges for the infrastructure. Applying these five polarity methods over a structured cabling system will explain some of these challenges. Figure 11 shows the infrastructure that will be used to analyze each of these scenarios.

In this example, the logical network consists of three routers/switches that need to be connected in a redundant architecture. These routers/switches will be using a TIA-942 structured cabling architecture that consists of an MDA, HDA, ZDA and EDA. The MDA and HDA will be configured as cross-connects, and all other locations will be interconnects. Let's set up each polarity method to manage this system's connectivity.

A + B MODULES OR ONE MODULE, TWO CONFIGURATIONS

A + B module systems, or inverting a module at one end, perform the same function. As shown

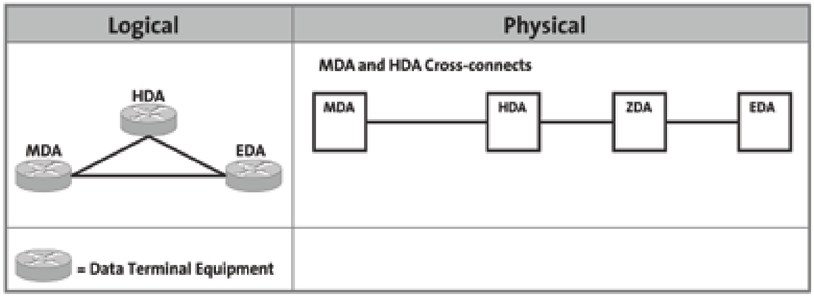


Figure 11: Logical and Physical Architecture

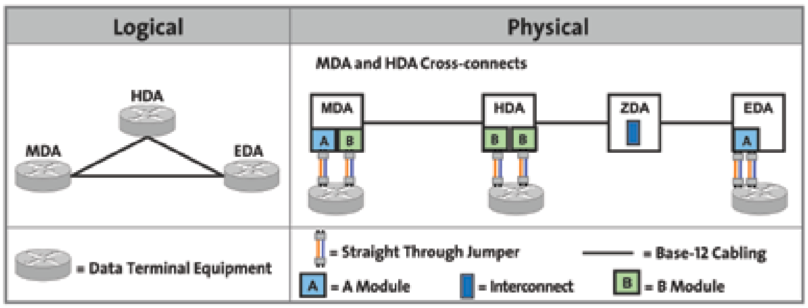


Figure 12

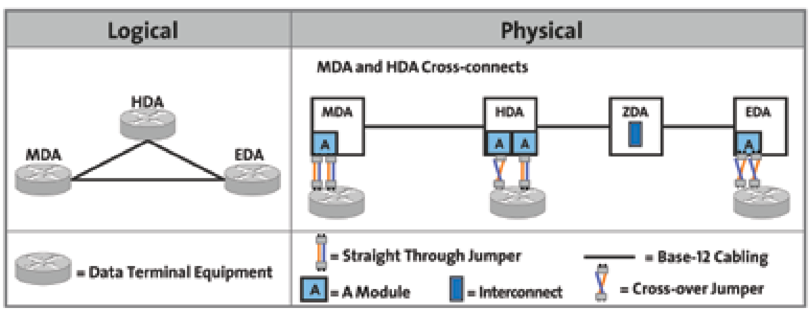


Figure 13

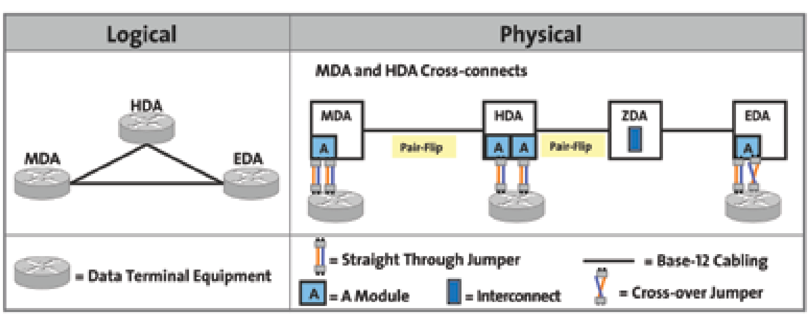


Figure 14

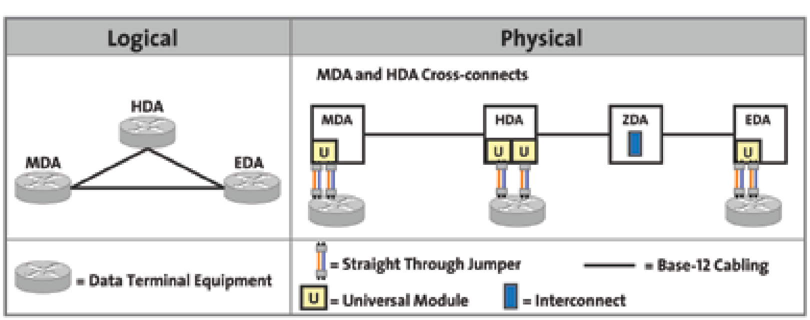


Figure 15

in Figure 12, to connect this logical architecture across this physical infrastructure, you would need an A + B module at the MDA, two B modules at the HDA and an A module at the EDA. This would ensure correct polarity for this system, and only one jumper type is needed.

EDA to HDA (A – B)
HDA to MDA (B – A)
EDA to MDA (A – B – B – B)

TWO DIFFERENT PATCH CORDS

Using two different patch cords to manage polarity allows the system to use the same module and trunks at each location. As shown in Figure 13, the jumper "crossovers" are used at the EDA, and the HDA needs a crossover and a straight-through jumper to ensure correct polarity:

EDA to HDA (crossover at EDA)
HDA to MDA (crossover at HDA)
EDA to MDA (crossover at EDA)

PAIR-WISE FLIPS IN THE TRUNK CABLES

Systems with pair-wise flips in the trunk cables are a challenge to manage. As shown in Figure 14, the pair-wise cables were used between the MDA and HDA and the HDA to ZDA. This enables the use of one module type, but trunk cables have to be managed, and cross-over jumpers are still needed to ensure correct polarity.

EDA to HDA (straight jumpers)
HDA to MDA (straight jumpers)
EDA to MDA (need crossover jumper at EDA to correct polarity)

UNIVERSAL POLARITY

Universal polarity systems are very easy to manage. As shown in Figure 15, one module type is used with no special trunk cables, and all jumpers are straight through. This system ensures correct polarity due to the universal module's ability to correct polarity in any configuration.

EDA to HDA (correct)
HDA to MDA (correct)
EDA to MDA (correct)

Many different methods can be used to manage polarity in Base-12 cabling systems. Figure 16 summarizes the advantages and disadvantages of each method.

In the end, the type of backbone cabling system will affect the method used to manage polarity. Proper planning and understanding of the requirements for your data center's structured cabling are critical factors to ensure the system operates today and in the future. ■

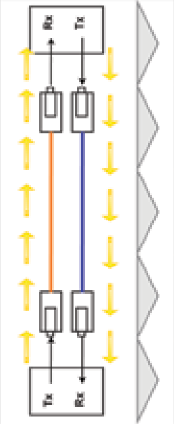
Polarity	Correction Method
	**Correct it in the module (A+B)** This method requires advance planning for module locations
	One module, two configurations While this is a "single module solution," it still requires advance planning of the modules
	Two different patch cords Because polarity is addressed in the patch cords, the end-user is ultimately responsible for managing
	Pair-wise flips within the trunk correct polarity Extending links requires planning of the number of trunks in order to maintain polarity
	Same Module, Same Trunk Universal polarity, no advanced planning required

Figure 16: Base-12 Polarity Management Methods

With more than 15 years of experience in communications technology, David Kozischek currently serves as market manager, Data Centers for Corning Cable Systems. Kozischek joined Corning Cable Systems in 1990 and has held positions in Engineering Services as a Senior Field Engineer and Senior Systems Engineer; Strategic Planning and Business Development as Technology Manager; and Global Strategic Growth as a Technology Discovery Manager. He can be reached at david.kozischek@corning.com.