



KEYS TO ADDRESSING DATA CENTER CHALLENGES

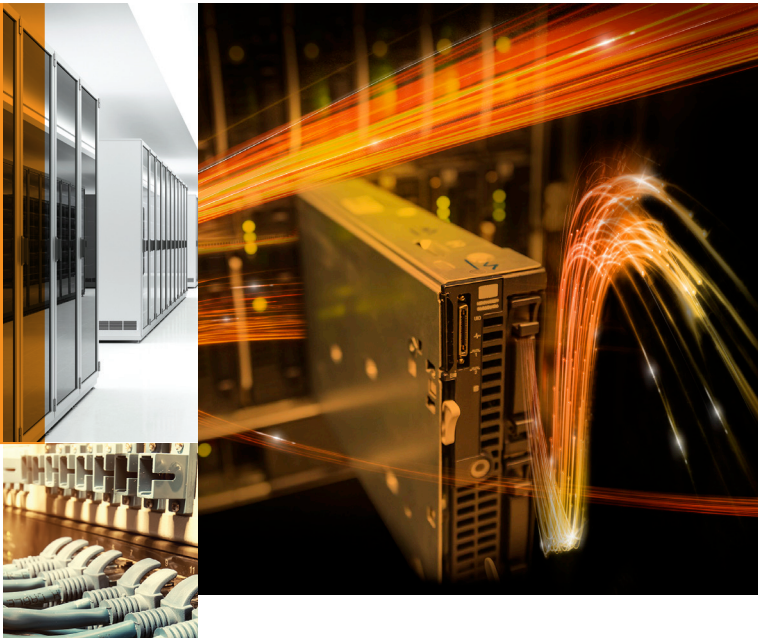
EVERY CONNECTION COUNTS



AGILE CONNECTIVITY AND POWER ARE AT THE HEART OF TODAY'S DATA CENTER DESIGN

Connectivity is reaching everywhere. Fixed and mobile Internet traffic volume and data-storage needs are growing at hard-to-comprehend rates. The Internet of Things (IoT) is promising more than 20 billion connected devices by the year 2020, according to Gartner. Cisco's Visual Networking Index for 2016 projects that monthly global mobile data traffic will be 30.6 exabytes by 2020, increasing 8-fold between 2015 and 2020.

The accelerating demand for fixed and mobile data dictates an increase in physical data center infrastructure, and this new infrastructure requires higher-speed connectivity and more electrical power. These needs are being met not only with new systems designs, but with next-generation data and power connectors that support forward-looking design requirements.



WITH A FOCUS ON DELIVERING THE BROADEST PORTFOLIO OF NEXT-GENERATION CONNECTORS FOR DATA CENTER POWER AND CONNECTIVITY NEEDS, THE CONNECTIVITY'S DATA AND DEVICES DIVISION IS A TRUSTED PARTNER FOR DATA CENTER SYSTEMS DESIGNERS.

THE NEED FOR DATA AGILITY

Within the data center, data links are being pushed to ever-higher rates. Internal data lanes at 25 Gbps and now 50 Gbps are rapidly superseding lanes operating at 10 Gbps. There are single-lane approaches as well as use of multiple higher-speed links routed in parallel for yet-higher aggregate speeds - for example, a run of 4 x 25 Gbps lanes yields 100 Gbps overall performance.

Traditionally, designers need to route signals in many ways: from each line card or chassis to the top-of-rack switch; to the end-of-row switch; from the front end-of-row switch to the core switch; and to an aggregation switch, to cite just a few of the many possible stages and transitions.

But now designers are routing signals in even more ways. Disaggregated architectures are driving innovative new ways of thinking about data flows in the new data center world. Increased east/west

traffic across racks and more server-to-server connectivity are driving leaf and spine architectures that need larger, high density switches and a greater number of overall internal and external ports.

For many of these links across racks, within racks and even inside the box, copper wire cable solutions are proving attractive due to their moderate cost, ease of use, and performance. Innovations in copper cabling are increasing capabilities and helping to deliver high-density signal and power with even greater efficiency.

But there's a difficult tradeoff to be made with data links. As the data rate goes up, the "reach" or achievable distance goes down. A gain of speed may be outweighed by the need for repeaters, which extend the data-path distance, or by the requirement for a more tightly packed design. System architects must carefully consider their options to get the best combination of several factors, including size/weight, power consumption, cost and performance.

When upgrading existing systems, it is often easy to forget the cabling resources. However, to take full advantage of any hardware upgrades made, you need to consider upgrading your cable assemblies. Legacy cables for slower data rates likely won't be able to deliver the performance required by the new speeds.

EVER INCREASING POWER DEMANDS

From a technical and engineering standpoint, providing operating power to the data center and removing the associated heat from power supplies and other components are very far removed from issues of higher data rates. Yet power and thermal-related concerns can define system design and implementation as much as the need for speed.

Power consumption (and thus dissipation) per rack has increased tremendously over the last decade. This increase results in two closely linked problems: supplying the increased amount of electrical power, and dissipating the heat from both the power supply and the active electronics away from a crowded enclosure.

Complicating the power-delivery issue is the reality of cabling and connectors. High-level conceptual schematics and block diagrams may show few power-supply blocks and interconnects in the overall path from high-voltage source to final low-voltage rails, but the situation is actually more complex. Due to the power flow within the larger data center and the physical construction of the racks (and the connections to the boards within the systems in each rack), dozens of cables and associated connectors are needed for power-path transitions.

At each connector, even a small amount of contact resistance and voltage drop (IR loss) results in lower power supply efficiency and higher heat dissipation (I²R), yet the temperature rise at the connector must be kept to a modest amount (typically under 30°C) for safety and performance. Complicating the issue is the increased demand for connectors that support "hot swapping" of boards, which are removed or plugged in with power on. This can lead to power-sequencing problems and contact degradation if the connectors are not carefully designed with optimal contact materials and features.

AGILE TE SOLUTIONS

Input/Output
Plugs and Cages

Cable Assemblies

Power Connectivity

High Speed Backplane

Internal Interconnects

IC and Memory Sockets

AGILITY AND INNOVATION OFFER IMPROVED ALTERNATIVES

Meeting the ever-growing requirements of data centers requires innovation at all levels, starting with the foundational elements of contacts and copper cable construction. TE's Data and Devices division has one of the largest portfolios of connectors, sockets, antennas, and cable assemblies on the market for a vast array of electronics applications. Whether for data center equipment or communications infrastructure, TE's engineers work closely with customers and channel partners of all sizes to rapidly develop and deploy solutions that address engineering and market needs. TE is the partner of choice for the latest innovations in data center connectivity while delivering quality products you can rely on with the service you deserve. We offer not only a broad portfolio of complementary products, but the system design expertise to help you create cutting-edge solutions for your next data center project.

A few examples make clear that a range of advances – from basic power and data connector configuration to mechanical and material innovations – are part of the solution. These are just some of the ways in which TE supports the latest data center designs.

I/O and Copper Cable Assemblies

To address the data demand, TE offers the zQSFP+ interconnect system and QSFP28 copper cable assemblies as a high-speed, cost-effective alternative to fiber optics for Ethernet, Fibre Channel, and InfiniBand technology applications (Figure 1). TE Connectivity's zQSFP+ interconnects offer an increased data rate of 28 Gbps in an industry-standard, scalable design that allows for backwards compatibility with QSFP/QSFP+ cables and transceivers, providing a simple upgrade path from 10 Gbps to 28 Gbps. The complete portfolio of interconnects delivers a large range of simple and customizable design options to meet most customer requirements.

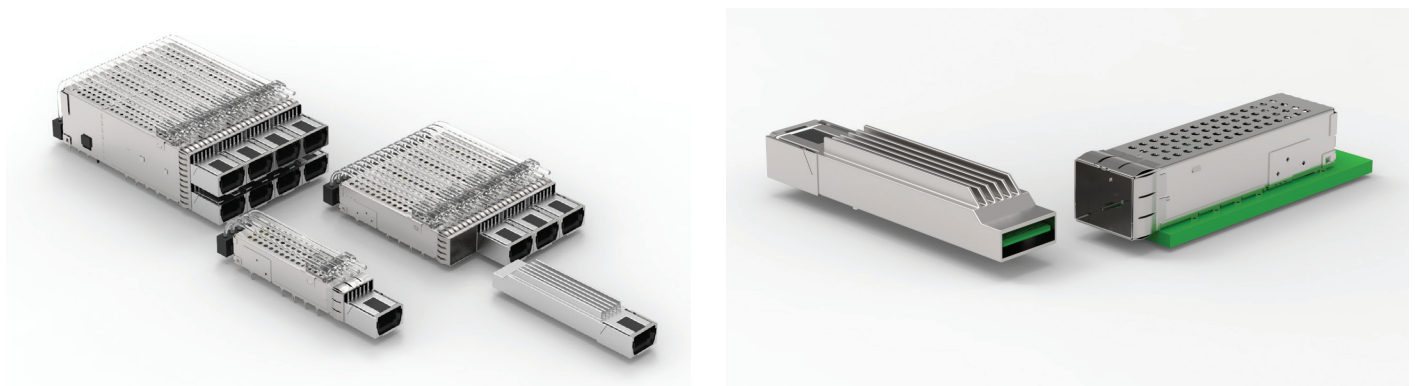


1 TE zQSFP+ direct attach copper-cable assemblies

TE has also expanded the QSFP+ cable assembly product family to include options that solve a number of data communications cabling issues. In addition to its standard 30, 28 and 26AWG QSFP+ 10 Gbps TurboTwin product offering, TE offers QSFP+ assemblies with fine wire TurboTwin 33AWG 8-pair cable. This fine wire bulk cable satisfies the need for ultra-thin, lightweight and highly flexible passive cabling solutions in high-density intra-rack applications.

For some of the highest data rates in 1 rack unit, TE's microQSFP connectors will provide QSFP28 and above functionality in a smaller, generally SFP-sized form factor, providing 30% higher density than QSFP to fit up to 72 ports on a standard line card and saving significant design space.

The integrated module thermal solution on the microQSFP product was developed by TE and offers significantly better thermal performance than any other pluggable solution on the market today, requiring less energy to cool equipment and increasing ease of overall system thermal design. The revolutionary design (Figure 2) essentially turns the entire faceplate into available airflow for the unit and improves the efficiency of cooling the connector and all the other internal components.



2 microQSFP Integrated heatsink provides lots of airflow for the connected application.

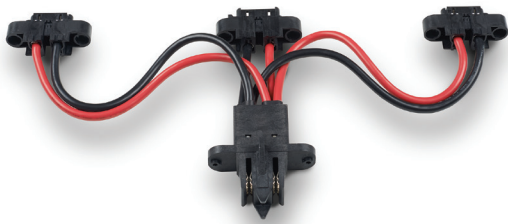
To enable standardization of microQSFP, TE Connectivity led the development of a MSA (multi source agreement) group to define the mechanical features of the plug, cage and receptacle. The microQSFP product family will enable total data center functionality and broad market adoption on networking equipment, leading to easier implementation of new technology and lower costs to designers due to higher volume production.

Power Connectivity

Often left for the latter stages of a design for many server, storage or switching applications, power requirements can sometimes be the most challenging, requiring the most agile solutions for whatever space and cost may be left to work with. Capable, space-saving products that are modular and efficient are critical.

TE's MULTI-BEAM XLE power distribution connector system has become a de facto connector standard for modular, hot-swappable power-distribution systems, supporting AC and DC power in the same connector and multiple pin sequencing options for each contact type, which are critical for hot-swapping. TE's MULTI-BEAM XLE connector system is a key component in the leading power solution for the Open Compute Project (OCP), and is the only solution fully compatible with Open Rack V1 specifications and forward compatible with Open Rack V2 specifications.

MULTI-BEAM XLE features a modular tooling platform that enables a high level of customization, with signal, low power, and high power contacts (Figure 3). It is based on a unique, multi-cantilever-beam design for the power contact, which offers a rating up to 75 amps (max) / 63 amps (average) per contact.

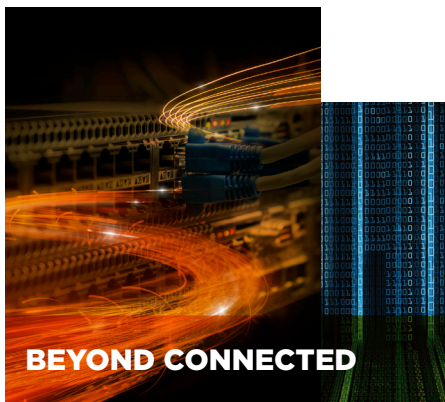


3 TE Connectivity's OCP Power cable assembly featuring Multi-Beam XLE Connectors



4 TE's modular FORGE Drawer Power Connector System

TE DESIGN IMPROVEMENT ADDRESSES CUSTOMER'S OPERATIONAL AGILITY



Demand for higher density RUs leads to application designs with higher density faceplates. A leading networking company discovered that their new 100 Gbps switch production output was less than expected and their factory team was complaining about the difficulty of inserting the new high-density bezel assembly into the faceplate of their latest design. The increased number of high-speed QSFP28 I/O ports increased the overall required insertion force of standard through-bezel cages to a level that was generating fatigue and increased assembly quality issues along the assembly line.

TE immediately engaged with the customer to resolve the problem by

tapping into TE experts in materials and mechanical engineering. The collaboration resulted in redesigned cages that provide a 55% reduction in bezel insertion force for each 1x4 assembly without negatively impacting the bezel's mechanical performance. The improved spring design was also able to better cover gaps in standard cage design delivering a 10db EMI performance improvement. More importantly, this solution greatly reduced labor fatigue and allowed the company to once again meet assembly production goals and keep their customers happy with on time deliveries of their newest equipment. These innovations are now available to the broader market.

Agility in power connectivity can also be achieved with TE's FORGE Drawer Power Connector System. FORGE drawer connectors are modular power interconnects for DC power, AC power, and signal. They are offered in 1x5 and 2x2 through 2x5 configurations, and each position can accommodate a different contact. Enabled by modular tooling, FORGE drawer product customization gives you the exact configurations you need for each application.

Backplane and Internal Connectivity

The backplane is the real spine of emerging data center applications and is another area where performance limitations can slow down the overall system. That's why the revolutionary design of TE's STRADA Whisper interconnect system is a major advance. It transfers data at 25 Gbps and offers scalability up to 56 Gbps, allowing engineers to design-in efficient future system upgrades without costly backplane or mid-backplane redesigns (Figure 5). It features extremely low noise, low insertion loss, and little to no skew.



5 TE's STRADA Whisper Interconnection System is available in a range of configurations, including cabled solutions.



6 TE Connectivity's STRADA Whisper DPO connectors.

This system simplifies and improves backplane board design while maintaining signal integrity and saving board space. Each differential pair is individually shielded, and the mating interface is surrounded by six ground connection points for excellent signal integrity and EMI performance. Insertion loss is less than 1 dB and is linear up to 20 GHz. The STRADA Whisper backplane connector system has enabled a whole new generation of high performance equipment that has the multigenerational capability to support current and future performance demands.

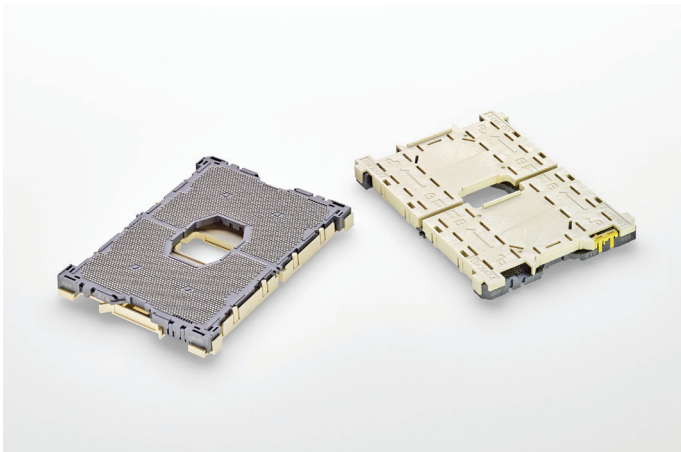
To simplify implementation, the STRADA Whisper system is installed with a conventional press-fit process, but with superior electrical performance compared to other press-fit products. It is one of the most robust backplane connector systems in the market due to its use of folded signal pins surrounded by strong, protective C-shaped shields, minimizing any contact damage as line cards are installed and removed from equipment.

In addition to traditional backplane, co-planar, orthogonal, and cabled options, TE's latest STRADA Whisper connector configurations are its direct plug orthogonal (DPO) connectors (Figure 6). The robust DPO design allows designers to eliminate midplane connectivity, reduce costs and improve vital cooling airflow in denser switches, servers, base stations and other types of communications equipment.

Increased data flow and density plus disaggregated designs throughout the data center have also created new challenges inside the box. PCB traces struggle to perform as well in high-speed applications at 25 Gbps and above. TE is currently working with customers to develop our new line of Sliver connectors: high speed copper cable solutions that eliminate the need for retimers and reduce space used on more costly, lower-loss PCB materials. The flexible design along with the inherent flexibility of high-speed copper cable helps TE customers extend their reach and achieve their disaggregated designs. The internal cabling also supports reducing overall power required for the same system using traditional PCB traces. TE's Sliver connectors will soon provide many new options for card-edge, mid-board, backplane and PCIe connectivity.

IC and Memory Sockets

The larger and more powerful processors found in today's emerging data center designs require a new generation of socket solutions. Solderless and robust, reliable solutions are a must. TE's new LGA 3647 socket (Figure 7) is specifically designed to meet these requirements for the next generation of server processors. This land grid array is the first to feature a two-piece design that reduces warpage issues and offers better coplanarity and reliability.



7 Figure 7: TE's LGA 3647 Socket

TE's DDR4 DIMM product line provides a smaller pitch and higher pin count than the DDR3 DIMM product line and is designed for critical, always-on applications like data centers. This product portfolio is designed to the JEDEC industry standard and is an efficient solution for high-speed data and cloud platforms. Compared to the DDR3 DIMM product line, the DDR4 DIMM product line offers additional benefits, including a 20 percent (maximum) space savings on a PCB, a connector height reduction of 10 percent (maximum), improved power consumption, and higher data rate support.

ADVANCING DATA CENTER DESIGNS

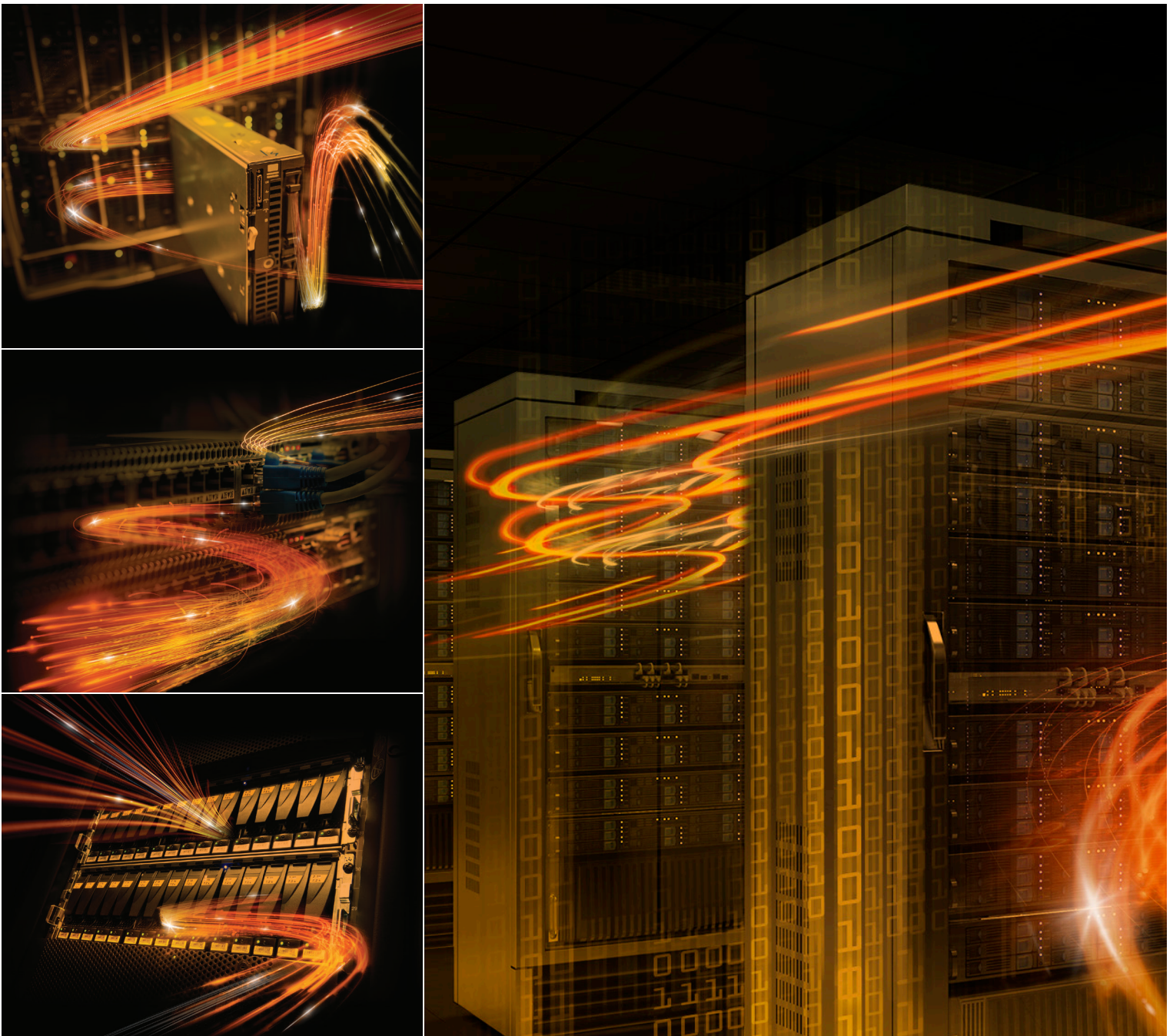
TE's innovative solutions are making it possible for designers to meet the aggressive demands for higher data speeds and new power connections in the data center. Solutions like the examples cited exemplify TE's ongoing commitment to advancing the state of the art in component design. In addition to advanced and proven off-the-shelf products, TE is an industry leader that provides unparalleled customer service and support for the customized solutions your data center needs.

Engage with TE early in your data center designs. Our engineers, material specialists, and signal integrity experts offer a collaborative working relationship that can deliver optimized solutions for your next system.

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