

Solutions brief



Eaton solutions for GenAI data centers

EATON

Powering Business Worldwide

GenAI environments optimized.

During periods of transformative change in industry, experience matters. At Eaton, we understand how to navigate the disruptive forces of innovation to find success. Our vast engineering and manufacturing resources span the globe with deep expertise and experience in helping customers get the most from innovations like generative AI (GenAI) and machine learning.

The variations found in GenAI data center designs are as numerous as the ways in which businesses use artificial intelligence and machine learning. When designing the optimal solution for your GenAI environment, there are several important factors to consider. A solution that is fully customized for each data center ensures the efficiency and continuous uptime of the network.





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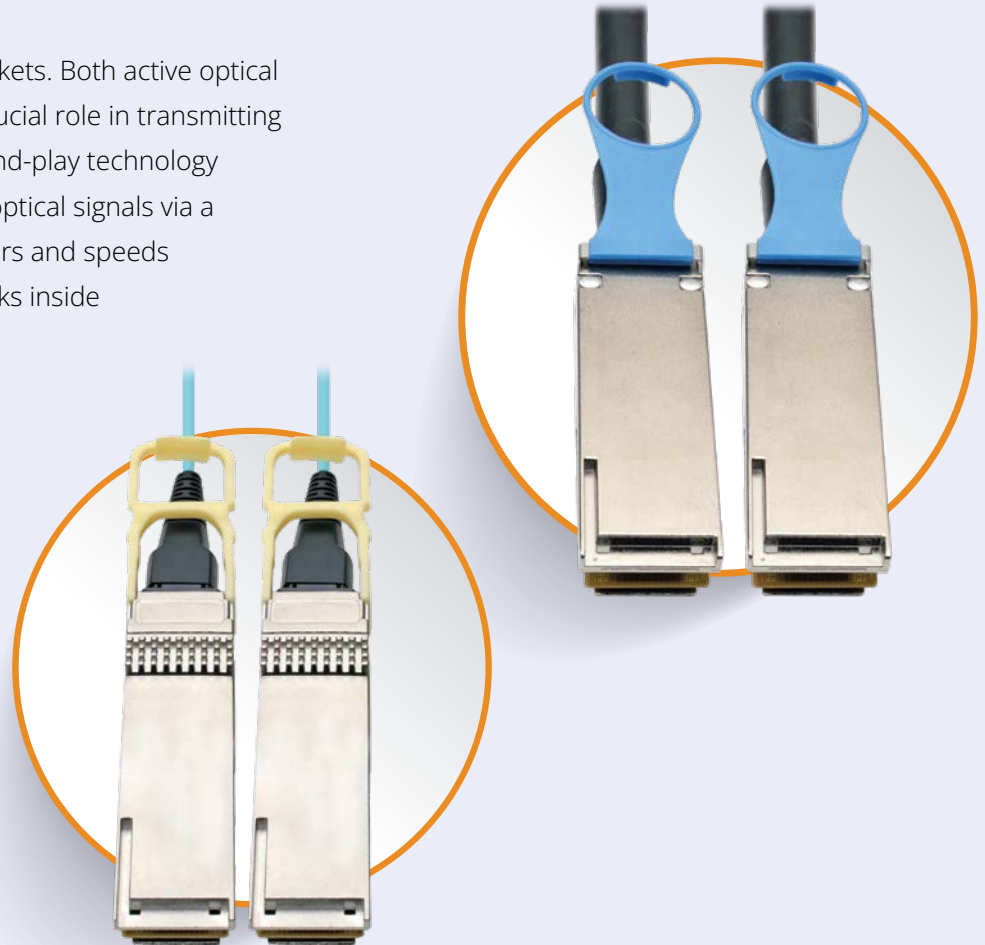
GenAI data center solutions for the front of the rack

The computing power in a GenAI rack can be twice as much as a standard high-density IT rack. With that much AI technology, computing, power and heat condensed into one location, the rest of the equipment in the rack must be given as much attention as the servers, or performance and reliability will suffer.

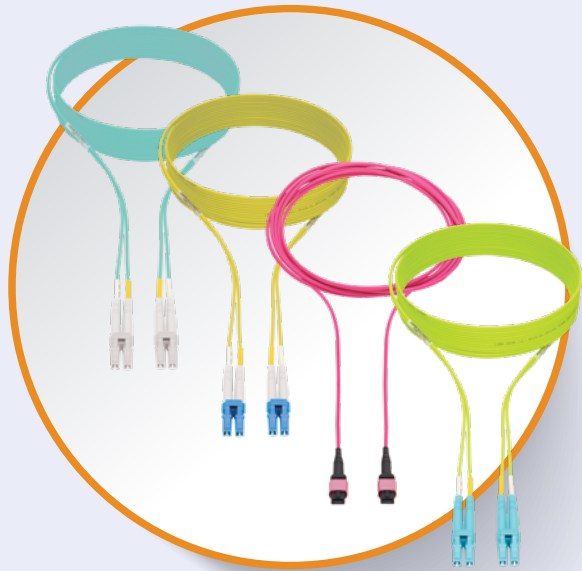
Active optical and direct attach cables

In AI applications, the volume of data being transmitted skyrockets. Both active optical cables (AOCs) and copper direct attach cables (DACs) play a crucial role in transmitting data efficiently at high speed. AOCs offer easy-to-install plug-and-play technology that converts electrical signals from computing hardware into optical signals via a factory-installed fiber-optic cable. With a range up to 100 meters and speeds up to 400GB, AOCs are ideal for linking AI servers between racks inside your data center.

For short-range transmission, copper DACs provide a cost-effective alternative to AOCs. They are often used to connect servers within the same rack. An added benefit of DACs is that less heat is generated at the connector (compared to optical transceivers), which can be an important consideration for high-density racks. DACs are also latency free, unlike AOCs.



GenAI data center solutions for the front of the rack



Fiber network solutions

In the world of high-performance computing, there is only one constant: the volume of data will keep rising and you need to meet the demand head-on. To best prepare your data center for the changing GenAI landscape and future-proof your business, it is imperative to choose the right network cabling for your needs. Fiber cables enable high-speed data transmission with minimal latency, crucial for handling large data volumes and supporting GenAI workloads. Pre-terminated cabling allows data center operators to save time and reduce splicing errors during installation. When paired with modular cassettes and high-density patch panels, our fiber solutions save rack real estate and simplify physical installation, allowing you to easily expand the network as your business grows.

Patch panels and breakout cassettes

As the volume of digital data associated with AI tools continues to expand, so does the demand for faster access to that data, contributing to the need for increased bandwidth. Designed for maximum connection density, flexibility, scalability and compatibility with both existing and emerging high-speed network standards, modular patch panels allow you to meet current connectivity needs while simultaneously investing in the future. Modular patch panel solutions support your ability to plan, deploy and upgrade your network to meet the growing demand for additional bandwidth and higher speed.

Breakout cassettes divide high-density fiber optic cables into individual connectors, making them easier to manage and connect to network devices, which is ideal for multiple connections in a tight space. As network demands grow, additional breakout cassettes can easily be added to the modular patch panel without the need for new installations.



GenAI data center solutions for the front of the rack



Transceivers

When preparing for GenAI installations, transceivers play a pivotal role in data communication, supporting high-speed, low-latency connectivity. Compared to copper-based networks, optical communications provide faster transmission speed across longer distances. When used in conjunction with fiber cables, transceivers provide the high bandwidth support needed in data-intensive operations like AI.

SFP (small form-factor pluggable) transceivers convert electrical signals to optical signals and vice versa to send and receive data at speeds from 1GB to 400GB. They are compatible with OEM brands built to multi-source agreement (MSA) standards, providing flexibility and interoperability with different vendors. Transceivers also support a wide range of Digital Diagnostic Monitoring (DDM) for features like temperature and transmission speed, helping you ensure 24/7 network uptime. Together, these components optimize space utilization, enhance security and support the growing demands of modern data centers.

Network switches

Modern data centers, including GenAI, require servers to transmit large datasets between each other with the lowest latency possible. As datasets grow, so does the need for more storage devices, quickly adding complexity to the network. Adding multiple layers of network switches to deployments ensures your data reaches its target with minimal interruptions.

A network switch connects devices to the local area network (LAN) and allows servers to communicate over the network. Network switches transmit data only to the devices designated to receive it, improving the efficiency and potential throughput of the network. Local network switches support interconnection of devices within a rack, while managed switches offer more control and configuration options for communication between racks. Managed switches allow you to configure and monitor your network, which can be useful for optimizing performance and troubleshooting issues. Advanced features such as VLANs (Virtual Local Area Networks), QoS (Quality of Service) and SNMP (Simple Network Management Protocol) help manage network traffic and ensure efficient data flow.



GenAI data center solutions for the front of the rack



KVMs

Depending on the servers in the application, there are multiple management options. If you are not using the server vendor's own remote management system, KVMs over IP provide the access and visibility needed to monitor and manage servers locally and remotely over the network. Remote access means there is no need to be onsite to access and control servers, allowing users to manage servers from the next room, across the site, or even across the globe. At the local level, models with pullout LCD consoles provide a local on-screen display for added convenience at the rack. Eaton models are brand agnostic and integrate seamlessly into applications using any combination of servers, allowing you to view applications, access BIOS and full system logs, and upload firmware.

Console servers

Redundancy and uptime are essential for any high-performance data center, and when a local network goes down, you need a fail-safe way to access critical systems. By providing in-band and out-of-band access to connected equipment, console servers offer a secure, secondary path for managing and troubleshooting systems during network outages. System administrators can use console servers to directly connect console ports located on PDUs, servers, firewalls, UPS systems, network switches and more where 24/7 connectivity is imperative.



GenAI data center solutions for the front of the rack

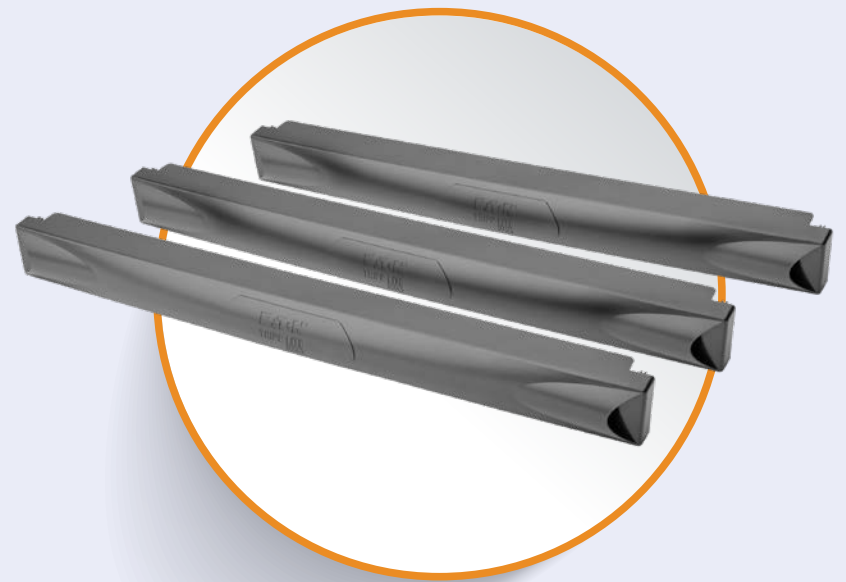


Modular access control systems

As your data center grows and more servers are added, the need to secure equipment and the sensitive data it transmits becomes more important than ever. High-density rack enclosures filled with GenAI servers represent a significant monetary and operational investment, and their security should be at the forefront of planning and implementation. A simple but effective security measure is a TANlock by Eaton door handle, providing the ideal modular access control system (MACS) for IT rack enclosures, providing the extra security required. With seven different authentication technologies, TANlock provides flexible options to effectively secure rack enclosures, including PIN pad access, fingerprint scan, touch display and remote access over remote control. In addition to versatile installation options, TANlock integrates seamlessly into any system via MS Active Directory, LDAP, RESTful API, Web API or SNMP, so even users with their own dashboards can take advantage of its security. When used in conjunction with Eaton's Brightlayer software, administrators can grant permission remotely, allowing users to access racks on demand.

Blanking panels and push-through brush guards

Blanking panels and push-through brush guards are essential for maintaining efficient airflow and thermal management within data centers. Blanking panels prevent warm air recirculation by filling empty spaces in server racks and preventing hot air from bypassing the desired exhaust airflow and making its way to the front of the rack. Using blanking panels reduces cooling costs, increases efficiency and extends the lifespan of your equipment while promoting organization. Brush guards are like blanking panels but allow cables to pass through while providing an air barrier around them. In addition to providing air containment, they prevent dust and debris from entering your rack and potentially damaging your critical equipment.



GenAI data center solutions for the back of the rack



Server racks are designed for mounting, organizing and securing rack-mount IT equipment such as servers and switches, regardless of the manufacturer. Server racks come in a variety of sizes and configurations, ranging from small desktop units to large floor-standing models. Most network racks feature front-to-rear airflow that supports efficient hot-aisle/cold-aisle configurations and exceed server manufacturer airflow requirements to keep equipment operating reliably. Roof and panel fans are also available to optimize cooling efficiency. Built-in and add-on provisions for cable management reduce clutter, increase connection accuracy and optimize airflow for increased operational efficiency and prolonged equipment life. Versatile racks accommodate growing equipment density and weight. Compatibility with advanced cooling solutions helps future-proof data centers as racks continue to pack more power and heat into tighter spaces.

GenAI data center solutions for the back of the rack



Heavy-duty rack enclosures

A traditional IT rack cannot handle the weight of GenAI servers, which can exceed 100 lb. per rack unit (U space), nor the increased depth necessary to accommodate their cabinets and cabling. Eaton's heavy-duty SmartRack enclosures are made to support weights up to 5000 lb. and up to 54 inches of depth, providing ample room for GenAI servers.

These new GenAI racks are compatible with liquid-cooled coolant distribution units (CDUs) and direct-to-chip cooling units. The additional rear space allows you to mount dual PDUs and dual CDUs easily, while still leaving space for proper cable-bend radius and serviceability. GenAI servers are anticipated to continue to increase in depth as their computing power increases, so investing in deep racks allows for room to grow. These racks are also white, providing better contrast and visibility when servicing and installing equipment in the rack, unlike all-black racks that absorb light and blend in with servers.

GenAI data center solutions for the back of the rack

Power distribution units (PDUs)

Higher density racks require more power and more capabilities from rackmount PDUs. The primary concern with PDUs is that they have enough outlets to support all the equipment in the rack and handle the power requirements, with power going up to 46 kW in some cases. In addition, a managed PDU connected to the network saves time, increases visibility and reduces the need for onsite visits through outlet-level remote monitoring and control of connected devices.

Future-proofing the PDUs in your rack requires more than that, though. By deploying flexible PDUs, you can extend the useful life of your equipment. Eaton's PDU G4 platform has flexibility built in, including versatile C39 outlets that accept both C14 and C20 plugs. By not restricting yourself to specific outlet configurations, upgrading or reorganizing your rack becomes significantly easier. The universal input rack PDU (UPDU) G4 meets industry standards used all over the world, so you can source a single PDU chassis globally and combine it with a wide choice of input cables rated for the voltage and capacity requirements at each destination. Eaton PDUs are manufactured globally with regional factory ETO/CTO capabilities and expansion capacity to manage volume.

With the integrated gigabit network module (GNM), which has UL 2900-1 and IEC 62443-4-2 cybersecurity certifications, you can manage and monitor your PDU G4 remotely with zero-touch provisioning. Cascading allows up to 32 PDUs to share the same physical network connection in your data center, reducing associated network infrastructure costs. Each cascaded PDU is assigned its own unique IP address. (See below in the *Cybersecure network management cards* section for more information about network management capabilities.)



GenAI data center solutions for the back of the rack

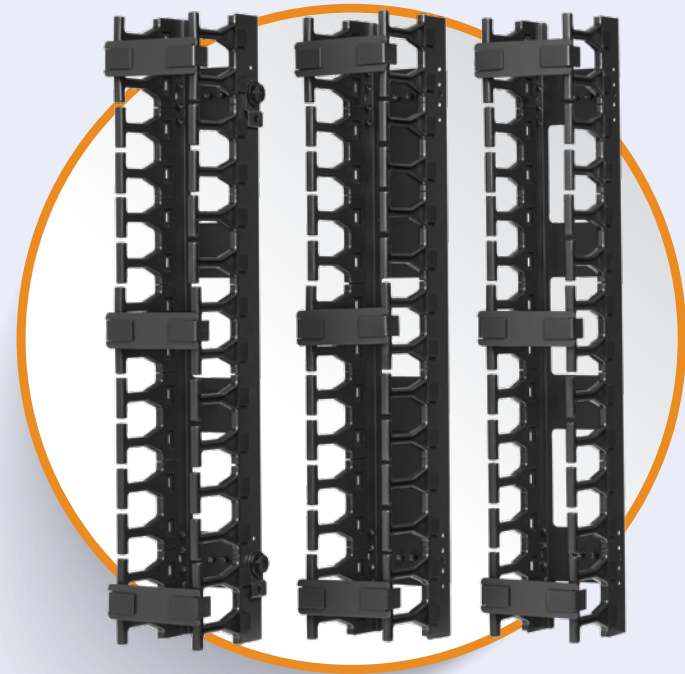


Power cords

Power cords are essential components in GenAI and data center white space configurations, with the latest GenAI configurations requiring C20 and C21 connections. Because GenAI generates lots of heat, the cables used need to be designed for high temperatures. Many power cords now have a C21 connector, which is designed for high-temperature applications. These power cords are customizable in a variety of colors and lengths to match their respective PDUs, saving time in installation and maintenance, while also improving airflow throughout the rack. It is important to consider the lengths and cord bend radius needed to save space within your rack and avoid accidental disconnects, which is why customizable cords are beneficial.

Vertical cable managers

Vertical cable managers are compatible with Eaton's heavy-duty SmartRack enclosures. They allow you to organize the power, network and other cabling in the rack, especially when adding equipment leads to a corresponding increase in cable requirements.



GenAI data center solutions for the back of the rack



Next-gen cooling compatibility

Advanced cooling is essential in GenAI data centers that are packed with high-density rack servers requiring vast amounts of power. More power means more heat that could damage sensitive equipment and an increased need for monitoring to prevent downtime.

The new heavy-duty SmartRack enclosures are compatible with multiple advanced cooling methods including cooling distribution units (CDUs), direct-to-chip cooling and rear-door heat exchangers (up to 40 kVA).

For a power-dense environment, CDUs use liquid cooling instead of air cooling because liquid transfers heat much better than air does. Direct-to-chip cooling relies on liquid circulation throughout the rack through a cold plate located directly on top of major heat-producing components, targeting hot spots within your systems. The new heavy-duty SmartRack enclosures provide multiple options to customize your rack cooling to your specific application, whether you are enabling GenAI in a hyperscale data center or supporting machine learning in a mid-size data center.

Important note: CDUs need to be protected with UPS battery backup. Without proper backup, your GenAI servers can fail if the CDUs stop for mere seconds, resulting in costly downtime.

GenAI data center solutions for the back of the rack

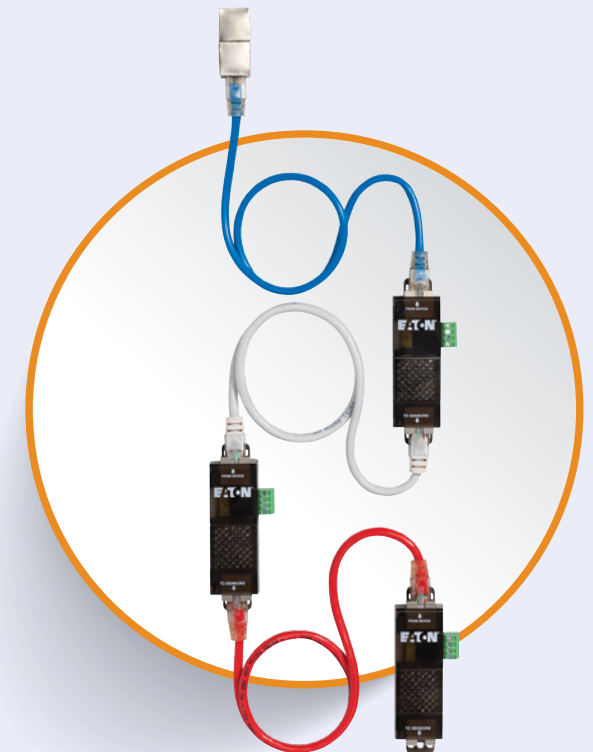


Cybersecure network management

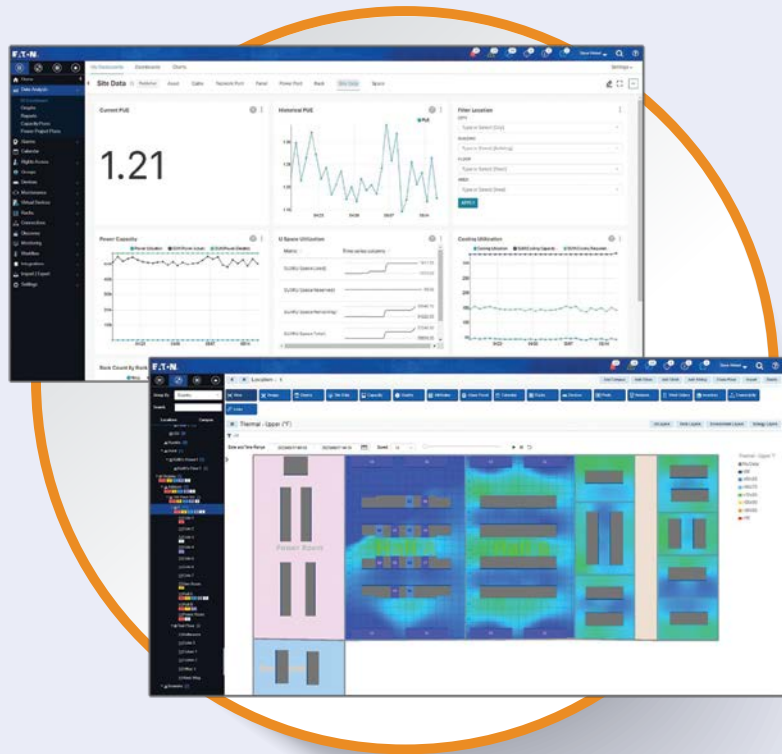
Arming your equipment with secure network management adds an extra layer of security to your IT infrastructure and the sensitive information it handles, while also providing remote monitoring capabilities. The Gigabit Network Card M3 has cybersecurity certifications from independent authorities (UL 2900-1 and IEC 62443-4-2), zero-touch provisioning and Brightlayer Data Centers suite software integration. This allows an IT manager to monitor and manage fleets of Gigabit Network Cards in UPS systems, as well as the embedded network interfaces of rack PDU G4. It also enables remote automated actions during power events, including graceful shutdown and reallocation of virtual machines to protect data and preserve business continuity. REST API support allows organizations to easily integrate the network card with native systems and automate M2M interactions.

Environmental monitoring probes

With the increased power draw needed to keep AI systems running, it is imperative to have systems in place to monitor the heat generated by all that power. Working in conjunction with the Gigabit Network Card, the Environmental Monitoring Probe (EMP) Gen 2 monitors heat, humidity, water/smoke alarms and door opens, providing configurable alerts via email. It easily mounts within an enclosure and connects to a rack PDU or UPS network card. The EMP allows you to receive environmental notifications and set up automated actions when used in conjunction with Eaton's Brightlayer Data Centers suite. You can also daisy chain up to 3 EMPs to monitor temperature and humidity levels at the top, middle and bottom of rack enclosures.



Eaton software solutions for GenAI data centers



Data Center Performance Management (DCPM) software

As the power consumption of your data center continues to increase, having access to the information you need, when you need it, is essential for maintaining uptime and optimizing performance. With Eaton's Data Center Performance Management (DCPM) software, you can realize significant staff and operational efficiencies via its data center infrastructure management (DCIM) capabilities. The web-based, intuitive user interface (UI) allows you to monitor and manage your end-to-end power chain from point of entry to IT device power supply; track asset locations, warranties, service histories and environmental conditions; view real-time and historical data for trends and anomalies; and receive customized alerts when unexpected issues arise.

But DCPM goes beyond traditional DCIM, with tools, reports and visualizations that will help you take your data center's performance to the next level. You can build user-defined 2D and 3D digital twin representations for temperature and humidity, electrical utilization, critical power chain and more, allowing you to proactively identify looming issues and mitigate unexpected downtime. You can also access more than 90 standard reports, with an optional business intelligence dashboard for user-defined report tools and flexible visualizations. You will gain quick access to key performance indicators, such as power usage effectiveness (PUE) and capacity utilization, to track sustainability metrics and ensure your data center is operating as expected.

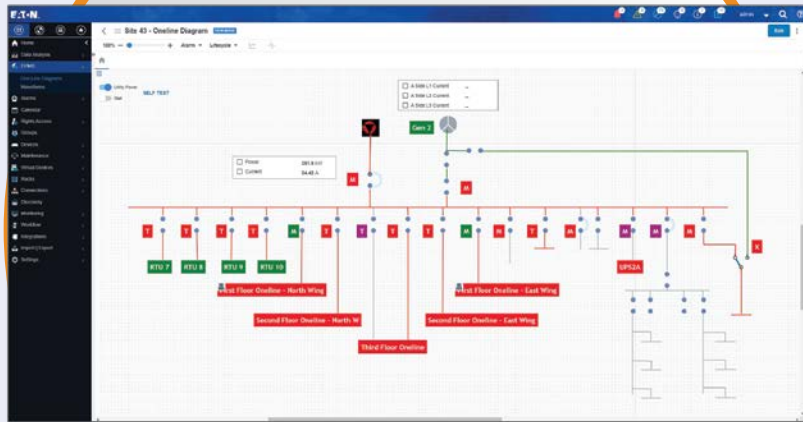
Eaton software solutions for GenAI data centers

Energy Performance Management System (EPMS) software

DCPM can be used with Eaton's Energy Performance Management System (EPMS) software to unite asset management, IT and operational technology (OT) device monitoring, power quality metrics and advanced electrical supervision in a single application. This enables customers to leverage a single, native application with one UI to manage, monitor and control a wide range of infrastructure assets, regardless of the manufacturer, while providing seamless integration with other software and a simplified way to expand software capabilities as your needs grow. By adding EPMS, you will have real-time and historical visibility into your data center's electrical power system, so you can quickly resolve and identify the root cause of unexpected issues, understand your facility's use of water, air, gas, electricity and steam (WAGES) to reduce operating costs, and meet sustainability goals.

By integrating DCPM and/or EPMS into your building management system (BMS), you can access comprehensive device-specific reports and insights. This knowledge allows quicker reactions to unexpected events, enhancing overall data center efficiency and power usage management capabilities.

Alongside its software, Eaton's team of design engineers prioritize white glove service and care, ensuring that our software seamlessly integrates with your data center's existing products and systems—including assets from other manufacturers.



GenAI data center solutions outside the rack

Computing may happen in the rack, but data does not stop when it reaches the top of the rack. Everything that goes on around the rack – behind and above it, especially – impacts the operations of the data center.

Containment and conveyance systems

Previous trends in data center design have dictated that cable conveyance systems are one thing, and hot and cold air containment systems are another. In hyperscale GenAI data centers, though, containment and conveyance are being handled by one system.

Hot-aisle containment (HAC) systems, such as Eaton's structural steel independent containment system (ICS), with integrated cantilever or trapeze arms for cable conveyance, are becoming increasingly common. Raised floor cable conveyance systems have always tended to become disorganized. With the increased weight on top of the floor in GenAI applications, combined with the need to reconfigure cables as technologies change or environments need to scale, raised floors are no longer ideal. Floor-standing or ceiling-mounted HAC systems are quicker to deploy than cabinet-mounted systems. They also offer built-in-future-proofing by enabling easier cabinet changes without time-consuming uninstallations and field customizations, making room for future growth.

Attaching directly to the steel structures on the vertical sides of a floor-standing HAC are cantilever arms. In ceiling-mounted aluminum HACs, trapeze arms are suspended from the ceiling, but not directly attached to the HAC. These arms, which can be customized by length, height and number of support bars, hold all the cable conveyance systems. Fiber routing trays and wire mesh baskets are mounted directly to these arms for easier deployment and maintenance compared to raised-floor cable routing. These arms can also support busway, which typically would be deployed on the lowest level arm closest to the rack.

In the RapidPod HAC system, hot air from the back of the rack is routed up to the vented ceiling. The improved temperature control of the panels means that there is less temperature transference through the sides, helping to maintain efficiency of the cooling system. In high-density computing environments like GenAI, the amount of heat has increased along with the amount of power used, so effectively containing and venting hot air away from equipment is top of mind.



GenAI data center solutions outside the rack



Busway

Supplying enough power to feed the equipment in the rack is a big job that not just any busway product can handle. Track-style busway systems, such as the Eaton Powerwave 2, are preferred for white space applications. It provides complete visibility into power usage with billing-grade accurate metering at the end feed and tap-off boxes to see the power consumption of the whole aisle and the connected equipment in each rack. When connected to a managed rackmount PDU within the rack, you gain end-to-end visibility into every level of power usage for immediate alerts and quick issue response times.

End-of-row and facility UPS systems

With GenAI data centers requiring up to two times as much power as a standard data center, the UPS systems deployed in these environments need to be able to keep pace.

Though typically found in the gray space, some AI applications utilize UPSs in the white space alongside their networking equipment. In that case, an end-of-row UPS, such as the Eaton 93PM, is an excellent choice. This floor-standing three-phase UPS, which takes up the same floor space as a standard IT rack and can be easily integrated into a floor-standing or ceiling-mounted HAC system, runs up to 400 kW. The 93PM is compatible with lithium-ion batteries, which can be deployed in side-by-side battery cabinets. Lithium-ion batteries are the best choice for GenAI data centers because of their smaller footprint, faster recharge time and high discharge limit before replacement. They save valuable floor space over traditional VRLA batteries to make room for more networking equipment.

For facility power within the gray space, a large UPS like the Eaton 9395XC UPS is the best choice. This monolithic UPS, which can support up to 1500 kW, has the smallest footprint with the highest power density on the market, making it ideal for maximizing the efficiency of the gray space. This UPS is also compatible with lithium-ion batteries, which further adds to its space-efficient design.





We make innovation work. *

* Your investment in AI represents a huge opportunity, but it's also a journey into the unknown. When you build your GenAI data center, choose a partner that can help you save money, save time and reduce risk to get the most from your investment. Eaton has the experience and expertise to help you navigate disruptive change successfully and enjoy all the competitive advantages offered by innovation.

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