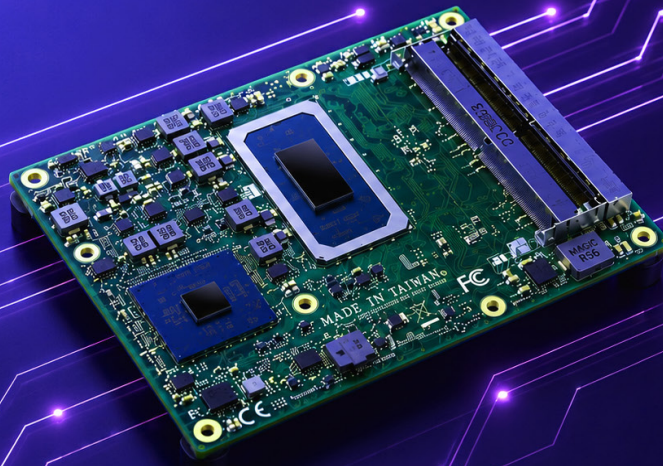


Part 02



COM Express × Edge Computing

Scalable and Upgradeable Intelligent Systems
with Modular Architecture

Presented by
Market Intelligence

2026

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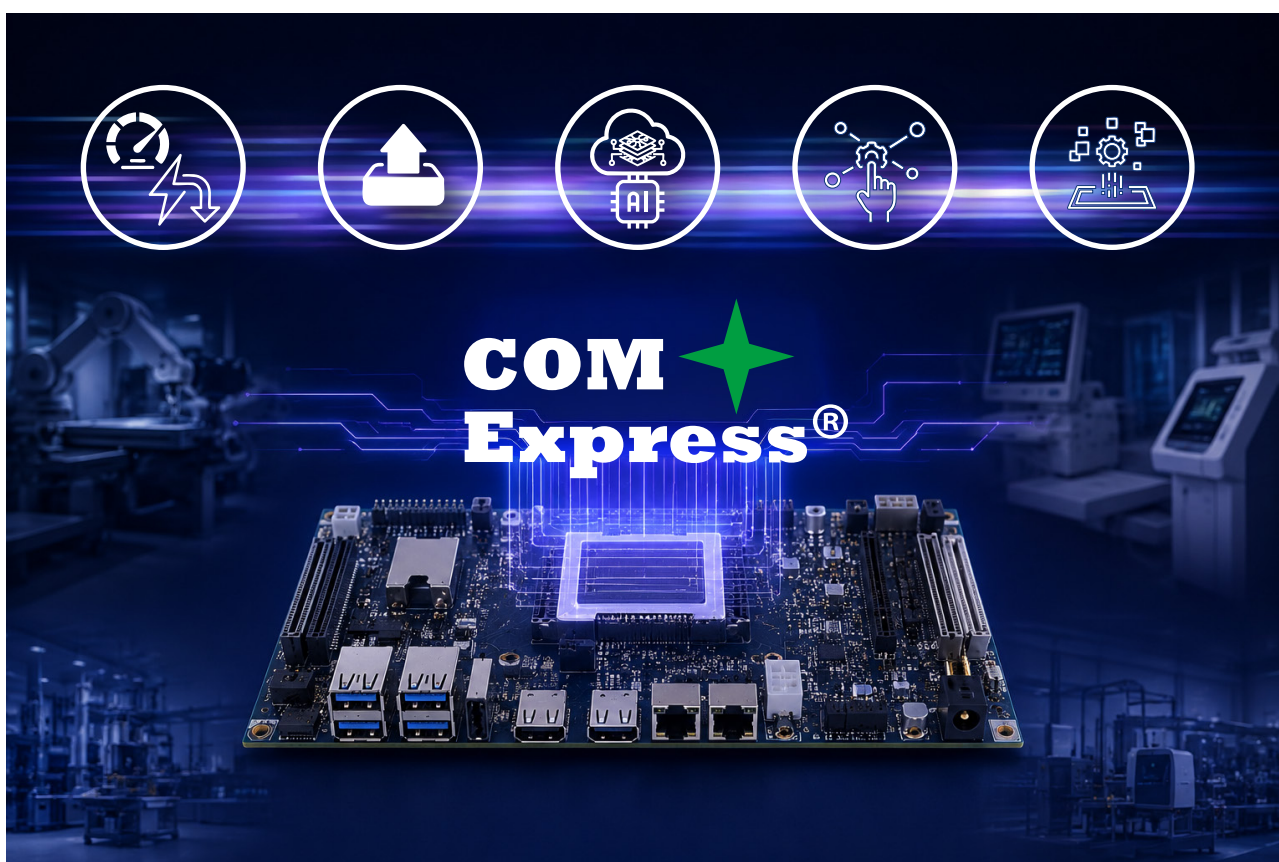
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COM Express × Edge Computing

1. Part 1 Key Highlights

In Part 1 of the COM Express white paper, we reviewed the evolution of industrial computers and explained why modular computing architectures are becoming a critical foundation for applications such as smart manufacturing, Edge AI, medical imaging, intelligent transportation, defense systems, networking equipment, and IoT gateways. As industrial sites deploy more sensors, collect larger volumes of data, require more complex real-time analytics, and demand stricter reliability, computing platforms are no longer limited to backend control or data logging. They have become the core foundation for on-site intelligence, equipment connectivity, and real-time decision-making.



Although traditional motherboards and fully customized single-board designs still provide application value, they often create greater pressure in terms of product lifecycle management, upgrade efficiency, long-term maintenance, and supply chain continuity. When processor generations evolve, AI computing requirements increase, or I/O and communication interfaces change, redesigning the entire motherboard each time not only extends the development schedule, but also increases validation costs and platform transition risks.

The key value of COM Express lies in consolidating core computing functions into a standardized Computer-on-Module while using a customized Carrier Board to connect the I/O, power, mechanical design, and external devices required by different applications. This architecture, which standardizes the computing core while customizing the application interface, enables equipment manufacturers to upgrade processor modules across different generations based on existing system mechanics and carrier board designs. As a result, it balances development efficiency, design flexibility, and long-term maintainability.

Therefore, COM Express is not merely a compact hardware specification. It is a platform-based design model that supports long-term product strategies. It helps industrial customers balance performance, power consumption, size, I/O, reliability, upgrade cycles, and supply stability, while laying the foundation for the next stage of technical specifications, module types, and real-world application scenarios.

2. COM Express - Technical Specifications, Architecture, and Scenarios

In the industrial computer industry, product design often faces two seemingly conflicting requirements. On one hand, end applications need to quickly adopt the latest processor, memory, display, networking, and high-speed I/O technologies. On the other hand, industrial equipment must maintain a long lifecycle, stable supply, ease of maintenance, and scalable design. Compared with consumer electronics, which typically follow short refresh cycles, applications such as industrial automation, medical equipment, transportation, semiconductor equipment, machine vision, communications equipment, and aerospace and defense usually require systems to operate reliably for many years, while maintaining stable performance under space constraints, harsh environments, and specific certification requirements.

- **COM Express Form Factor: Mini, Compact, Basic, and Extended**

COM Express defines multiple module form factors to address different system space, power design, and performance requirements. In general, smaller modules are better suited for low-power, space-constrained embedded edge devices, while larger modules can accommodate higher-performance processors, more complete memory configurations, and greater thermal design headroom.

COM Express Modules Classified by Form Factor

Form Factor	Typical Size	Typical Positioning	Key Design Focus	Representative Applications
Mini	84 x 55 mm	Ultra-compact, low-power embedded module	Small footprint, low power consumption, compact integration	Compact controllers, lightweight IoT gateways, low-power edge devices
Compact	95 x 95 mm	Balanced size, performance, and expansion	More PCB space than Mini, improved high-speed signal routing, memory, and thermal design	HMI, industrial gateways, machine vision, equipment controllers, mid-range edge platforms
Basic	125 x 95 mm	Mainstream high-performance COM Express module	Higher-performance processors, more memory, richer high-speed interfaces	AOI, semiconductor equipment, medical imaging, intelligent transportation, high-end Edge AI
Extended	155 x 110 mm	Specialized high-end module for greater thermal and expansion needs	Larger thermal area, complex high-speed signal design, higher-end processors	High-performance image processing, communications equipment, defense, specialized industrial servers

A



84 x 55 mm

Mini modules primarily serve space-constrained, low-power applications, such as compact embedded controllers, lightweight IoT gateways, and specific low-power edge devices. These systems typically do not require extensive PCIe expansion, but instead prioritize low power consumption, stable operation, and compact integration.

B



95 x 95 mm

Compact modules are a common balanced option for many industrial embedded systems. Compared with Mini modules, they provide more PCB space, enabling more complete high-speed signal configurations, memory designs, and thermal conditions, while still maintaining a relatively compact system footprint. For HMI, industrial gateways, general machine vision, equipment controllers, and mid-range edge computing platforms, Compact modules usually provide strong design flexibility.

C**125 x 95 mm**

Basic modules are a mainstream choice for high-performance COM Express designs. With a larger board area, they can accommodate higher-performance processors, more memory, and more complete high-speed interfaces. They are suitable for equipment that requires high computing performance, high data throughput, or multi-I/O integration. Examples include AOI systems, semiconductor equipment, medical imaging systems, intelligent transportation controllers, and high-end Edge AI systems. These applications typically require a balance among computing power, image processing, data transmission, and long-term stability, making the Basic form factor a more complete design foundation.

D**155 x 110 mm**

Extended modules are designed for more advanced and specialized applications. These applications may require a larger thermal area, more complex high-speed signal design, or higher-end processors and system expansion. Although Extended modules are less common than Compact and Basic modules in general industrial applications, they remain valuable for high-performance image processing, communications equipment, defense applications, and specialized industrial server architectures.

- **COM Express Type: Type 6, Type 7, and Type 10**

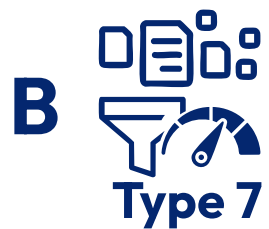
In addition to form factor, Type is another important classification for COM Express. A Type defines the signal assignment on the module connector, namely which I/O and system functions the module can provide. For system designers, selecting a Type determines the signal configuration, expansion direction, and product positioning of the entire carrier board. Type 6, Type 7, and Type 10 are currently the most common choices in industrial applications.

COM Express Modules Classified by Type

Type	Typical Size	Primary Positioning	Key Characteristics	Suitable Applications
Type 6	Compact / Basic	Versatile embedded computing interface	Display output, general-purpose I/O, high-speed storage, PCIe expansion	Industrial control, machine vision, HMI, medical devices, transportation, Edge AI
Type 7	Basic / Extended	High-throughput networking and edge server interface	More PCIe and high-speed Ethernet resources; display output is not the main focus	Cybersecurity gateways, SDN, 5G edge communications, edge servers, data acquisition
Type 10	Mini	Compact and low-power embedded interface	Small size, low power, simplified I/O for lighter workloads	IoT devices, data acquisition, compact controllers, lightweight HMI



Type 6 is currently the most versatile COM Express interface type. It is suitable for industrial applications that require display output, general-purpose I/O, high-speed storage, and PCIe expansion. For example, in machine vision systems, Type 6 modules can expand frame grabbers, AI accelerator cards, or motion control cards through PCIe, while providing operating displays through DisplayPort, HDMI, LVDS/eDP, and other interfaces. In automation equipment, Type 6 can also integrate common industrial I/O such as USB, SATA, Ethernet, COM, and DIO, forming a stable control and data processing core



The design logic of Type 7 differs from Type 6. It primarily targets high data throughput, high-speed networking, and edge server applications. As a result, it places less emphasis on display output and allocates more resources to PCIe and high-speed Ethernet connectivity. As industrial sites generate rapidly increasing volumes of data, such as multi-channel video streams, centralized sensor data, 5G edge communications, cybersecurity gateways, and software-defined networking, Type 7 provides a modular architecture closer to server-class computing.



Type 10 is better suited for low-power and compact markets. For edge devices with limited space, strict power constraints, and lighter computing workloads, Type 10 provides sufficient embedded computing capability while reducing system size and thermal pressure. It is generally not used for high-end AI or large-scale image processing, but it is practical for IoT, data acquisition, lightweight control, and compact HMI applications.

• Differences between COM Express and COM-HPC, Qseven, SMARC, and SBC

When selecting an embedded computing platform, COM Express is not the only option. It is often compared with COM-HPC, Qseven, SMARC, and SBC platforms. These platforms do not simply replace one another; instead, each corresponds to different requirements for performance, power consumption, expansion, cost, and customization.

Comparison between COM Express and COM-HPC, Qseven, SMARC, and SBC

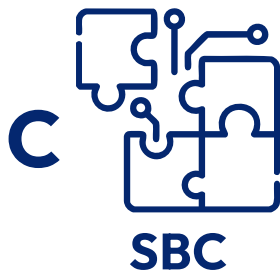
Platform	Architecture	Performance Positioning	Customization Flexibility	Typical Advantages	Suitable Applications
COM Express	Module + Carrier Board	Mid- to high-end embedded computing	High	Mature standard, long lifecycle, strong x86 ecosystem, flexible I/O	Industrial automation, medical, transportation, machine vision, Edge AI
COM-HPC	High-performance module + Carrier Board	High-end edge server / HPC	High	Higher bandwidth, higher power support, server-class expansion	High-end AI, edge servers, 5G, communications, data-intensive applications
Qseven	Low-power module + Carrier Board	Low-power embedded computing	Medium	Compact, low power, cost-oriented	IoT, lightweight controllers, low-power devices
SMARC	Low-power module + Carrier Board	Arm/x86 low-power platform	Medium to high	Multimedia support, low power, Arm ecosystem	IoT, multimedia terminals, smart devices, low-power edge equipment
SBC	Single-board integration	Depends on board design	Lower	Fast development, simple integration, no carrier board required	Standard industrial computers, controllers, HMI, general embedded systems



COM-HPC can be viewed as a next-generation COM standard for higher performance and higher bandwidth requirements. It is especially suitable for high-end edge servers, AI, high-speed networking, and data center edge nodes. Compared with COM Express, COM-HPC can support more high-speed signals, higher power consumption, and greater data bandwidth. However, system design complexity, cost, and carrier board development barriers are also higher. Therefore, when an application requires server-class performance or higher PCIe/Ethernet bandwidth, COM-HPC is the more suitable option. However, if the application prioritizes maturity, industrial deployment experience, supply chain stability, and a broad ecosystem, COM Express remains a very robust choice.



Qseven and SMARC are generally positioned for low-power, compact Arm/x86 embedded applications. Qseven is an earlier low-power module standard, suitable for simplified I/O, cost-oriented designs, and low-power systems. SMARC is more suitable for modern low-power multimedia and IoT applications, and is commonly seen with Arm-based processors while also supporting selected x86 solutions. In comparison, COM Express offers stronger advantages in high-performance x86 computing, PCIe expansion, long industrial lifecycles, and high-end embedded applications.



SBC, or Single Board Computer, represents a different design logic. An SBC integrates the CPU, memory, I/O, and connectors on a single motherboard and does not require a separate carrier board. This makes development faster and the system architecture simpler, making it suitable for applications with higher standardization and lower customization requirements. However, the limitation of SBCs is that when the processor is updated or I/O requirements change, the entire board often needs to be replaced. Mechanical design, thermal design, and certification may also be affected. COM Express is therefore more suitable for equipment manufacturers that require long-term product platform planning, carrier board customization, and an upgradeable computing core.

From a product strategy perspective, the core value of COM Express lies in balance. It is not as fixed as an SBC, not as high-end and cost-intensive as COM-HPC, and not as focused on low-power applications as Qseven or SMARC. COM Express sits at the intersection of maturity, performance, expandability, and customization flexibility, making it highly suitable for platform-based product lines that must support long-term industrial equipment development.

• The Value of COM Express in Industrial Applications

The value of COM Express can be understood from four perspectives: product development, system upgrades, supply chain management, and market competitiveness.



In product development, COM Express can significantly reduce the complexity of core computing design. The core computing module is provided by a professional IPC supplier, allowing customers to focus development resources on the carrier board, I/O, mechanical design, software, and end-application integration. This not only shortens development cycles, but also reduces project risk.



In system upgrades, COM Express enables longer product platform continuity. When equipment needs to upgrade from a previous-generation processor to a new CPU, GPU, or NPU platform, the system can complete the upgrade by replacing the module, provided that carrier board design, power, thermal, and signal compatibility have been properly planned. This is especially important for customers in medical, transportation, semiconductor equipment, and industrial automation markets, where redesigning an entire device simply because of processor generation changes is usually undesirable.



In supply chain management, COM Express helps reduce long-term maintenance pressure. Industrial equipment lifecycles often extend for five, seven, or even more than ten years. Through standardized modules and carrier board architecture, COM Express provides a more flexible path for replacement and upgrades.



In market competitiveness, COM Express helps customers respond more quickly to emerging requirements. As AI, machine vision, data acquisition, edge analytics, and intelligent control become key differentiators for industrial equipment, system platforms must provide greater expansion flexibility.

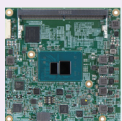
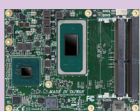
3. Portwell COM Express Products

Portwell has long been committed to industrial computers and embedded computing platforms. Its COM Express product line comprehensively covers Type 6, Type 7, and Type 10 positions, supporting platforms ranging from low-power Intel Atom to high-performance Intel Core, Intel Core Ultra, and Intel Xeon D. This enables Portwell to help customers achieve the right balance among performance, power consumption, size, I/O, networking, AI computing, and long-term supply according to actual application requirements.

- A. For Type 10 products, the PCOM-BA03 adopts the Intel Atom platform and features low power consumption, a compact form factor, and high integration. It is suitable for IoT gateways, compact controllers, smart sensing devices, and space-constrained embedded applications.
- B. For the Type 6 product line, Portwell offers a complete selection from entry-level to high-performance solutions. The PCOM-B646 adopts Intel Atom x7000E/RE series processors and is suitable for low-power applications such as industrial controllers, HMI, and IoT gateways. The PCOM-B657, PCOM-B658, and PCOM-B659 adopt Intel Core processor platforms and can meet the needs of mid- to high-end applications such as industrial automation, machine vision, intelligent transportation, and edge computing.
- C. As AI and edge computing demands grow rapidly, Portwell has introduced Intel Core Ultra platform products, including the PCOM-B65B and PCOM-B65A. These modules integrate a heterogeneous CPU, GPU, and NPU computing architecture to support real-time AI inference, image analysis, intelligent monitoring, and industrial AI applications, helping customers build next-generation Edge AI systems.
- D. For Type 7 products, Portwell provides high-performance modules such as the PCOM-B701, PCOM-B706, and PCOM-B707. These modules offer PCIe lanes, high-speed Ethernet, and server-class computing capability, making them suitable for

cybersecurity appliances, SD-WAN, 5G infrastructure, edge servers, and high-data-throughput applications.

Portwell COM Express Series

Photo	Product	Type	Form Factor	Size	Processor	Key Features	Suitable Applications
	PCOM-BA03	Type 10	Mini	84 x 55 mm	Intel Atom	Compact size, low power consumption, high integration	IoT endpoints, smart sensors, compact controllers
	PCOM-B646	Type 6	Compact	95 x 95 mm	Intel Atom	Industrial-grade low-power platform, long-term supply	Industrial gateways, HMI, equipment control
	PCOM-B657	Type 6	Basic	125 x 95 mm	Intel Core	Balanced performance and power consumption, rich I/O	Industrial control, smart manufacturing, edge computing
	PCOM-B658	Type 6	Basic	125 x 95 mm	Intel Core	High-speed PCIe and DDR5 support	Machine vision, AOI, medical equipment
	PCOM-B659	Type 6	Compact	95 x 95 mm	Intel Core	DDR5, PCIe Gen4, high-speed connectivity	Industrial automation, intelligent transportation, Edge Computing
	PCOM-B65B	Type 6	Compact	95 x 95 mm	Intel Core Ultra	CPU + GPU + NPU heterogeneous computing	Edge AI, smart manufacturing, image analytics
	PCOM-B65C	Type 6	Compact	95 x 95 mm	AMD Ryzen	High-performance computing	IoT 、 smart monitoring 、 machine vision
	PCOM-B65A	Type 6	Basic	125 x 95 mm	Intel Core Ultra	Next-generation AI computing platform, DDR5, PCIe Gen4	AOI, medical imaging, intelligent transportation
	PCOM-B701	Type 7	Basic	125 x 95 mm	Intel Atom	High-speed networking, high expansion capability	Cybersecurity, SD-WAN, communications equipment
	PCOM-B706	Type 7	Basic	125 x 95 mm	AMD Ryzen	Multi-core computing, high-bandwidth I/O	Edge servers, data acquisition, 5G applications
	PCOM-B707	Type 7	Basic	125 x 95 mm	Intel Xeon D	Server-class performance and networking capability	Telecom equipment, networking equipment, Edge Server

The advantages of Portwell COM Express products come not only from hardware specifications, but also from comprehensive design service capabilities. From carrier board design, BIOS customization, thermal planning, and system validation to long-term supply management, Portwell helps customers establish stable product platforms that can be continuously upgraded. For industrial equipment manufacturers that require long lifecycles and a high degree of customization, Portwell COM Express solutions can effectively reduce development risk, shorten time to market, and enhance product competitiveness.

- **Multi-Scenario Applications**



Medical Equipment and Medical Imaging

Medical equipment places extremely high demands on reliability, stability, and product lifecycle. The modular architecture of COM Express helps medical equipment manufacturers quickly integrate high-resolution image processing, multi-display output, AI-assisted diagnosis, and data storage functions. Applications include ultrasound equipment, endoscopy systems, medical imaging workstations, patient monitoring equipment, and intelligent diagnostic platforms. Through module upgrades, medical equipment can improve computing performance while maintaining existing certification and mechanical designs.



Defense and Military Applications

Defense and military equipment is often deployed in environments with high vibration, wide temperature fluctuations, high humidity, and severe electromagnetic conditions. As a result, system reliability and long-term supply capability are critical. COM Express can be used in tactical command systems, radar control equipment, unmanned vehicles, military communications equipment, and border surveillance systems. Through customized carrier board design, military-grade communication interfaces, GPS, encryption modules, and specialized sensors can be integrated to meet defense application requirements.



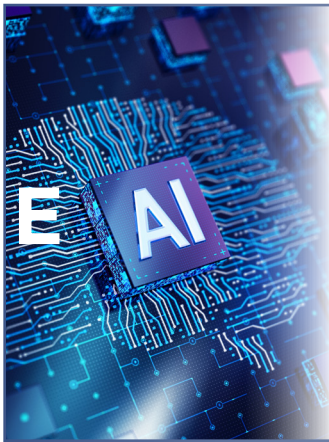
Networking, Communications, and Cybersecurity Equipment

With the rapid development of 5G, SD-WAN, cybersecurity, and edge data centers, networking equipment requires higher data throughput and stronger network processing capability. COM Express Type 7 modules provide extensive PCIe lanes and high-speed Ethernet support, making them suitable for firewalls, UTM, SDN, telecommunications equipment, network switches, and edge servers. The modular architecture also enables equipment manufacturers to quickly adopt next-generation processor platforms and improve product competitiveness.



Intelligent Transportation and Railway Systems

Transportation and railway equipment must operate reliably for long periods while providing resistance to vibration, interference, and wide-temperature conditions. COM Express can serve as the core computing module for in-vehicle computers, Passenger Information Systems (PIS), intelligent signal controllers, traffic monitoring systems, and fleet management platforms. Through customized carrier boards, GPS, CAN Bus, PoE, LTE/5G, and multiple network interfaces can be integrated to meet intelligent transportation application requirements.



Edge AI and Intelligent Analytics

AI technology is being rapidly adopted across industrial and commercial environments. New-generation COM Express modules based on the Intel Core Ultra platform can use the CPU, GPU, and NPU to execute real-time AI inference. Applications include intelligent monitoring, anomaly detection, image recognition, smart retail, predictive maintenance, and industrial AI analytics. Through modular design, systems can quickly upgrade computing capability according to AI model requirements.



Industrial Automation and Industrial Control

Industrial automation equipment requires long-term stable operation and must integrate large numbers of sensors, PLCs, motion control systems, and HMI systems. COM Express can integrate EtherCAT, CAN Bus, RS-232/422/485, DIO, and industrial network interfaces through customized carrier boards, forming a highly customized control platform. Its modular architecture also helps equipment manufacturers build shared platforms, reducing product maintenance and upgrade costs.



Intelligent Transportation Infrastructure

Beyond in-vehicle and railway systems, COM Express is also widely used in smart city and transportation infrastructure, including smart parking management, electronic toll collection systems, road monitoring, traffic flow analysis, and intelligent Roadside Units (RSUs). With high-performance computing and AI analytics capabilities, it can help city management authorities improve traffic efficiency and public safety.



IoT and Intelligent Internet of Things

IoT applications cover smart factories, smart buildings, energy management, environmental monitoring, and remote equipment management. COM Express can serve as the core computing platform for IoT gateways or edge gateways, responsible for data collection, protocol conversion, edge analytics, and cloud connectivity. Through standardized modules and customized carrier board design, equipment manufacturers can quickly build IoT solutions that meet the requirements of different industries.

4. Part 2 Conclusion

Through a design that separates the module from the carrier board, COM Express enables customers to gradually upgrade processors, memory, high-speed interfaces, and AI computing capability while maintaining existing mechanical, I/O, and certification designs. Compared with SBC, it provides greater customization and upgrade flexibility. Compared with COM-HPC, it offers a more mature industrial deployment foundation and broader application adaptability. Compared with Qseven and SMARC, it is better suited for mid- to high-end x86 industrial computing and high-expansion requirements.

For Portwell, COM Express is an important foundation for helping customers build long-term embedded computing platforms. With a complete product portfolio covering Type 6, Type 7, and Type 10, Portwell supports a broad range of requirements, from low-power embedded control to high-performance Edge AI, and from general industrial automation to server-class networking applications.





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