

# Solution Brief

Embedded Edge  
SMARC Modules



## TQ-Group and Intel Enhance Flexibility and Performance for the Embedded Intelligent Edge

**TQMxE4IS SMARC modules with Intel Atom® processors x7000E Series, Intel® Core™ i3 processors, and Intel® Processors N-Series help OEMs and solution builders deliver new embedded compute capabilities.**



Embedded compute powers game-changing devices and edge PCs across industrial, healthcare, and smart building applications. In these industries, devices such as human-machine interfaces (HMIs) for temperature control systems, industrial PCs, autonomous mobile robots, and patient monitoring/diagnostic solutions take advantage of powerful compute capabilities deployed in the field to enhance results and connect operations.

Increasingly, embedded technologies rely on AI, analytics, and graphically intense workloads to deliver more value at the far edge of customer environments. In doing so, they're helping organizations become more agile, responsive, and transparent while also enhancing safety, efficiency, and overall results.

*"SMARC modules have never been as powerful as with the new processor solutions from Intel. In addition to the performance increases, they also enable new and exciting embedded systems projects."*

—Harald Maier, product manager, x86 at TQ-Group

### **Challenge: Delivering flexible performance in a space-constrained package**

To unlock new possibilities through embedded computing, OEMs and solution builders need to deliver powerful performance in a small form factor. As edge use cases evolve to deliver real-time insights and take advantage of AI-based intelligence, the computational demands placed on the embedded compute components rise dramatically. Because of the nature of these devices, there is often not enough physical real estate to incorporate accelerators or discrete graphics processing units.

At the same time, customers demand both future flexibility and stability from their technology spend. They're looking for embedded devices that enable their success today and tomorrow, with the ability to upgrade capabilities as needs change or technologies evolve. With these devices, they can avoid costly and time-consuming technology refreshes and get a longer life for their investment. Manufacturers or solution builders working in highly regulated industries such as healthcare need ways to continue to deliver this critical flexibility without going through lengthy recertification processes. They also need to find ways to easily diversify their product offerings without reworking the overall system design.



## Solution: Deliver accelerated, modular performance with TQMxE41S SMARC module and Intel® processors

To help OEMs and solution builders deliver advanced capabilities in their embedded edge offerings, the TQMxE41S SMARC module from TQ supports Intel Atom® processors x7000E Series, Intel® Core™ i3 processors, and Intel® Processors N-Series. This computer-on-module solution, built on the cross-industry SMARC standard, can be combined with a compatible carrier board of your choosing to enable simplified upgrades in embedded systems. With a very small form factor—only 82 mm x 50 mm—and low power consumption, this solution brings high performance compute, graphics, and virtualization capabilities to your embedded offerings without limiting future flexibility for customers.

Paired with Intel processors featuring integrated acceleration for AI inference and support for time-sensitive applications, the TQMxE41S SMARC module delivers an ideal platform for your next innovation in embedded computing devices for industrial, healthcare, or smart building applications. Plus, when OEMs and solution builders take advantage of the modular SMARC approach, they can more easily diversify their product lines by offering different processor SKUs, with different capabilities such as core counts and frequencies, all attached to the same basic design.

### Built for critical needs in your industry



#### Industrial

Support the latest technologies and real-time capabilities alongside legacy interfaces such as universal asynchronous receiver-transmitters (UARTs) and low voltage differential signaling (LVDS).



#### Healthcare

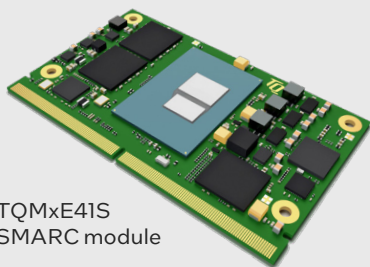
Deliver design longevity with a fixed bill of materials and traceability while also supporting multiple high-resolution displays and AI.



#### Smart buildings

Reduce power consumption and improve heat dissipation while using a fanless design.

### A modular solution for embedded systems



TQMxE41S SMARC module

#### TQMxE41S SMARC module

- Dimensions: 82 mm x 50 mm
- Low power consumption
- Up to 16 GB LPDDR5 and 256 GB industrial iNAND eMMC
- Three simultaneous high-resolution display outputs (up to 4K60), including eDP/LVDS, DP++, and HDMI
- High-speed interfaces, including 2x USB 3.2, 4x PCIe, and 2x 2.5GbE



TQMxE41S SMARC module and carrier board

#### Intel® processors for the edge

##### PC-client use conditions:

- Intel® Core™ i3-N305 processor
- Intel® Processor N200
- Intel® Processor N97
- Intel® Processor N50

##### Embedded use conditions:

- Intel Atom® x7425E processor
- Intel Atom® x7213E processor
- Intel Atom® x7211E processor

## Power advanced use cases with robust high-speed connectivity and storage support

To support a wider range of use cases and enable portfolio diversification, the TQMxE41S SMARC module provides capacity for up to 16 GB LPDDR5 memory and 256 GB industrial-grade iNAND eMMC. Additionally, the module gives solution designers a range of connectivity options and three high-resolution display outputs, allowing it to support more use cases across medical, smart building, and industrial applications.

## Deliver powerful performance for next-generation embedded applications with Intel processors

TQ's TQMxE41S SMARC module uses Intel Atom processors x7000E Series, Intel Core i3 processors, and Intel Processors N-Series to support emerging use cases such as AI, media processing, and intelligent automation in your embedded systems. TQ supports the Intel® Distribution of OpenVINO™ toolkit and Intel® oneAPI toolkits to provide optimized AI inference performance and image quality as well as high media encode/decode performance. These features make the solution from TQ ideally equipped for the high-resolution demands of medical imaging applications and other graphically intensive use cases.

## Select the right Intel processor for your solution

### Intel Atom® processors

Best suited for real-time applications such as robotics, industrial automation, and autonomous transport systems

### Intel® Core™ i3-N305 processor

Best for high-performance but low-power applications such as AI, machine vision, workload consolidation, and hypervisor solutions

### Intel® Processor N-Series

Ideal for PC-like applications that need strong performance and graphics capabilities at low power budget, including healthcare applications, smart building HMI's, and mobile battery-powered devices

## Take advantage of the right integrated optimizations and features for your system

The Intel Atom processors x7000E Series, Intel Core i3 processors, and Intel Processors N-Series offer several integrated features and accelerations that OEMs and solution builders can use to optimize performance for embedded system designs. Take advantage of the right optimization for your target use case or industry to ensure you meet customer expectations and support the capabilities they require. Critically, these optimizations make it possible for OEMs and system builders to deliver advanced AI capabilities without relying on a discrete graphics accelerator.

### Integrated Intel® UHD Graphics driven by Intel® X<sup>e</sup> architecture

To help OEMs and solution builders support graphically demanding workloads such as imaging and diagnostics in healthcare, the TQ SMARC module leverages Intel processors equipped with an improved integrated GPU with a high count of integrated graphics execution units (EUs) that allow for parallel processing of graphics workloads and scales up based on the number of EUs integrated into the chip design.

### Intel® Advanced Vector Extensions 2 (Intel® AVX2)

Intel AVX2 helps OEMs and system builders achieve higher throughput for certain integer and floating-point operations. The 256-bit integer vectors can be deployed via the SMARC module to enhance math, codec, image, and digital signal processing software. Fused multiply-add instructions improve performance in object detection, professional imaging, and high performance computing.

### Intel® Deep Learning Boost (Intel® DL Boost)

With Intel DL Boost, the TQMxE41S SMARC module can more easily support AI capabilities in embedded systems and devices. Based on Intel AVX2, the Intel DL Boost Vector Neural Network Instructions (VNNI) delivers a

significant performance improvement by combining three instructions into one—thereby maximizing the use of compute resources, using the cache better, and avoiding potential bandwidth bottlenecks. OEMs and system builders can use Intel DL Boost to accelerate inference performance for deep learning workloads—including image classification, speech recognition, language translation, and object detection.

### Intel® Time Coordinated Computing (Intel® TCC) and Time-Sensitive Networking (TSN)

Many embedded edge workloads require time-sensitive, real-time capabilities, especially in the industrial sector. The Intel Atom® processors supported by TQ's TQMxE41S SMARC module offer a set of timing capabilities across multiple IP blocks that keep the platform's clocks tightly synchronized, enabling deterministic I/O within the compute node. Equipped with Intel® 2.5 Gbit Ethernet controllers, the TQMxE41S SMARC module also supports TSN—an evolution of the IEEE Ethernet standard that adds network-based time synchronization, orchestrates data flow, and prioritizes time-sensitive data. With TSN, IoT closed-loop systems like process and machine controls can be precisely synchronized over the network so they can operate with minimal latency and jitter.

## Get help bringing your next innovation to market

TQ offers a practical starter kit to accelerate your development efforts with the SMARC module solution. The kit is designed to help OEMs and system builders create very compact IoT devices for DIN rail mounting without limiting their expansion options. The development kit supports up to three M.2 slots to provide flexibility, even for unusual and demanding applications. System developers can use it to kick-start RFP kits for solutions such as IoT edge gateways, machine vision platforms, or AI-based applications. The kit functions as a reference platform to create application-specific hardware and quickly verify your software implementation.

In addition, TQ can support customers in all phases of product development and manufacturing, including proof of concept. The TQ team has capabilities to help customers develop, certify, and produce their complete devices. The TQMxE41S SMARC module can be customized in areas including screening, coating, and BIOS configuration. Delivery options include both cooling solutions and accessories as well as services like custom labeling and advanced traceability.

## Conclusion: Accelerate time to market with TQ and Intel

Embedded compute at the edge of industrial, healthcare, and smart building environments offers amazing opportunities to enhance efficiency, productivity, safety, and overall outcomes. Making the most of these opportunities requires embedded systems that can support today's most demanding workloads within tight space constraints—as well as system architectures that support long-term flexibility for customers. TQ delivers an Intel-enabled SMARC module solution that's ready to help OEMs and solution builders quickly deliver the advanced solutions that their customers need.

## Learn more

### TQ-Group TQMxE41S SMARC module

Quickly bring edge AI inferencing hardware solutions to market with optimal flexibility, performance, and cost.

Learn more at [tq-group.com/en/products/tq-embedded/x86-architecture/tqmxe41s](https://tq-group.com/en/products/tq-embedded/x86-architecture/tqmxe41s).

### Intel Atom processors x7000E Series, Intel Core i3 processors, and Intel Processors N-Series

Deliver performance for embedded systems at the edge with powerful AI, media processing, and virtualization capabilities.

Learn more at [intel.com/atomx7000e-iot](https://intel.com/atomx7000e-iot).

## About TQ-Group

As a leading technology company in the electronics industry, TQ offers a complete range of services and products alongside proven expertise in embedded computing. Whether you're a small-sized or medium-sized company or corporate group, TQ offers support for every company in every phase of the product life cycle.

[tq-group.com](https://tq-group.com)



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