

NXP

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CASE STUDY

# HMI with TQMa95xxSA/LA

Modern device operation –  
even contactless under control

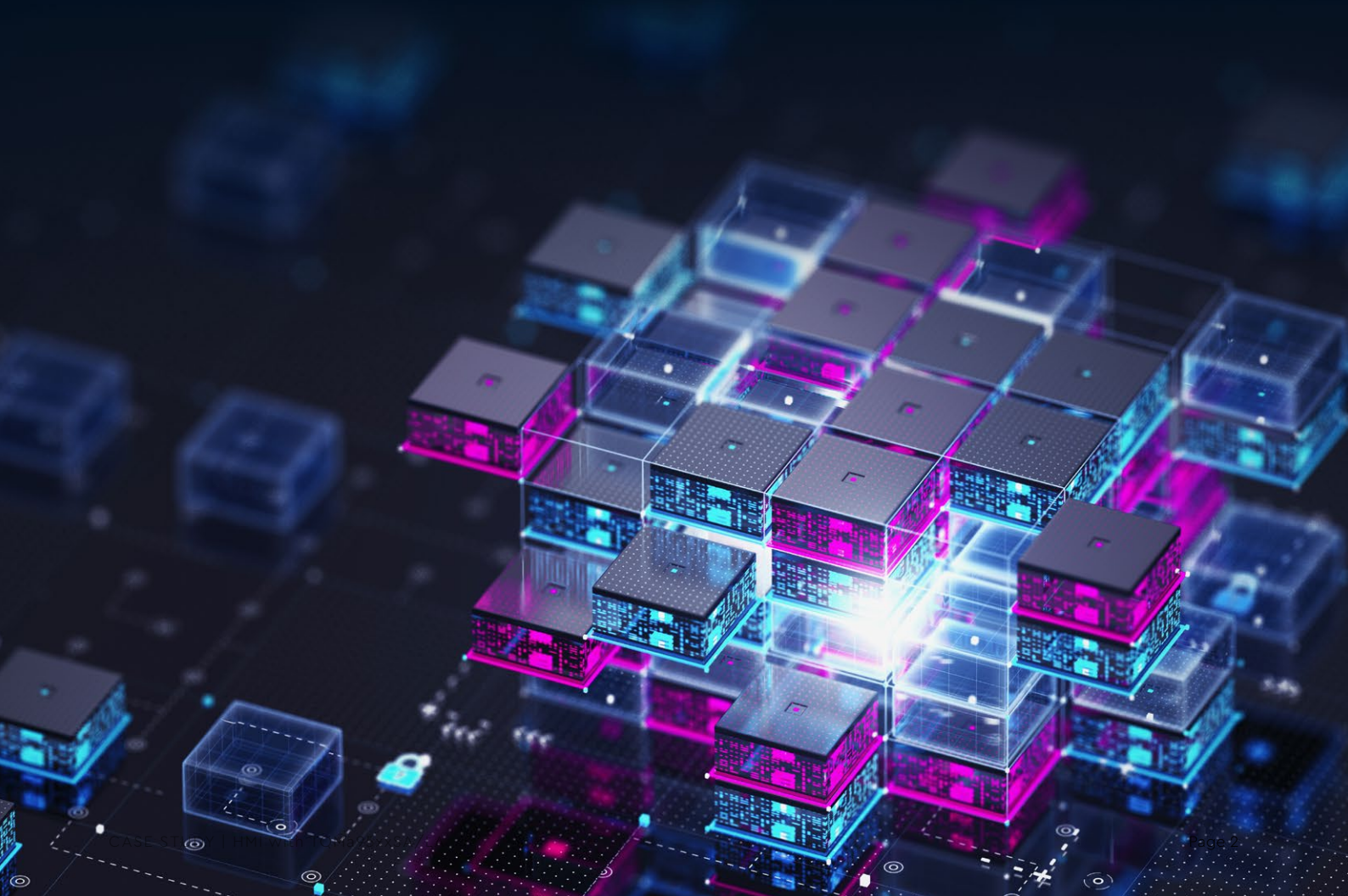


TQMa95xxSA

Smartphones have shaped the general image of a modern human-machine interface (HMI): a touchscreen with multi-finger operation. Although this intuitive interface can be used universally, there are many applications where it has its limitations: For example, when it comes to hygiene, any touch on a control surface used by more than one person is a disqualifier. Displays also reach their limits at very high ambient brightness levels. If you literally have your hands full, touch is not the answer. If the task requires precise observation of a process, such as positioning a heavy load with a crane, the distracting view of the display should be avoided for safety reasons.

If hygiene is required, for example, then any contact with a control surface used by several people is already an exclusion criterion.

In recent years, a number of alternative operating concepts have been developed, but they have only been implemented in a few cases for cost reasons. Thanks to the performance and versatility of modern embedded computing modules, these concepts can now be implemented cost-effectively to improve the operation of devices and machines. Advances in artificial intelligence (AI) and connectivity are particularly beneficial.







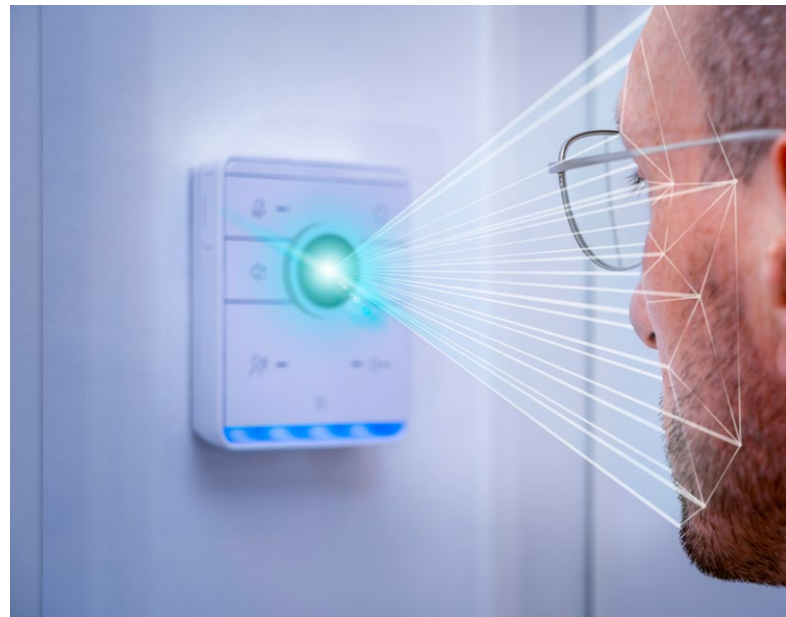
AI technologies are primarily used here, which leads to increased performance requirements for the hardware and makes the use of AI accelerators advisable - however, this must not be at the expense of the energy/heat budget, so low power consumption is required.

Optical person/situation detection can be used to initiate proactive adjustments, such as extending elevator door opening times when wheelchair users or strollers are present. This can completely eliminate the need for active user intervention, which is often interpreted as increased convenience.

## Keep an eye on

In the past, machine vision focused on monitoring processes for control and regulation in automation, but now HMI tasks are increasingly being added. Here, contactless operation comes in handy to avoid soiling of buttons and contacts. Examples can be found in bakeries, where equipment must be operated with dough-covered hands: Hand gestures can be used to adjust the oven temperature or change the stirring speed without contact.

People recognition also opens up new possibilities: Lighting can follow a person's gaze or movement, and age and gender recognition can optimize vending machines and customer guidance systems (interactive signposts). For example, an in-flight entertainment system could recognize that a child is sitting in front of it and adjust the movie selection, highlight the games on offer, and block the duty-free shop. Or coffee machines could recognize their regular customers and optimize the selection with their personal favorites.



Integrating a camera into the HMI may eliminate the need for additional devices such as barcode scanners, which can reduce costs and improve the appearance of the device - so it is definitely worth considering.

## Double-checking is better

Not every person should operate or have access to every machine. This is where facial biometric authentication comes in, because unlike keys and NFC tokens/cards, it cannot be lost and can be used with full hands.

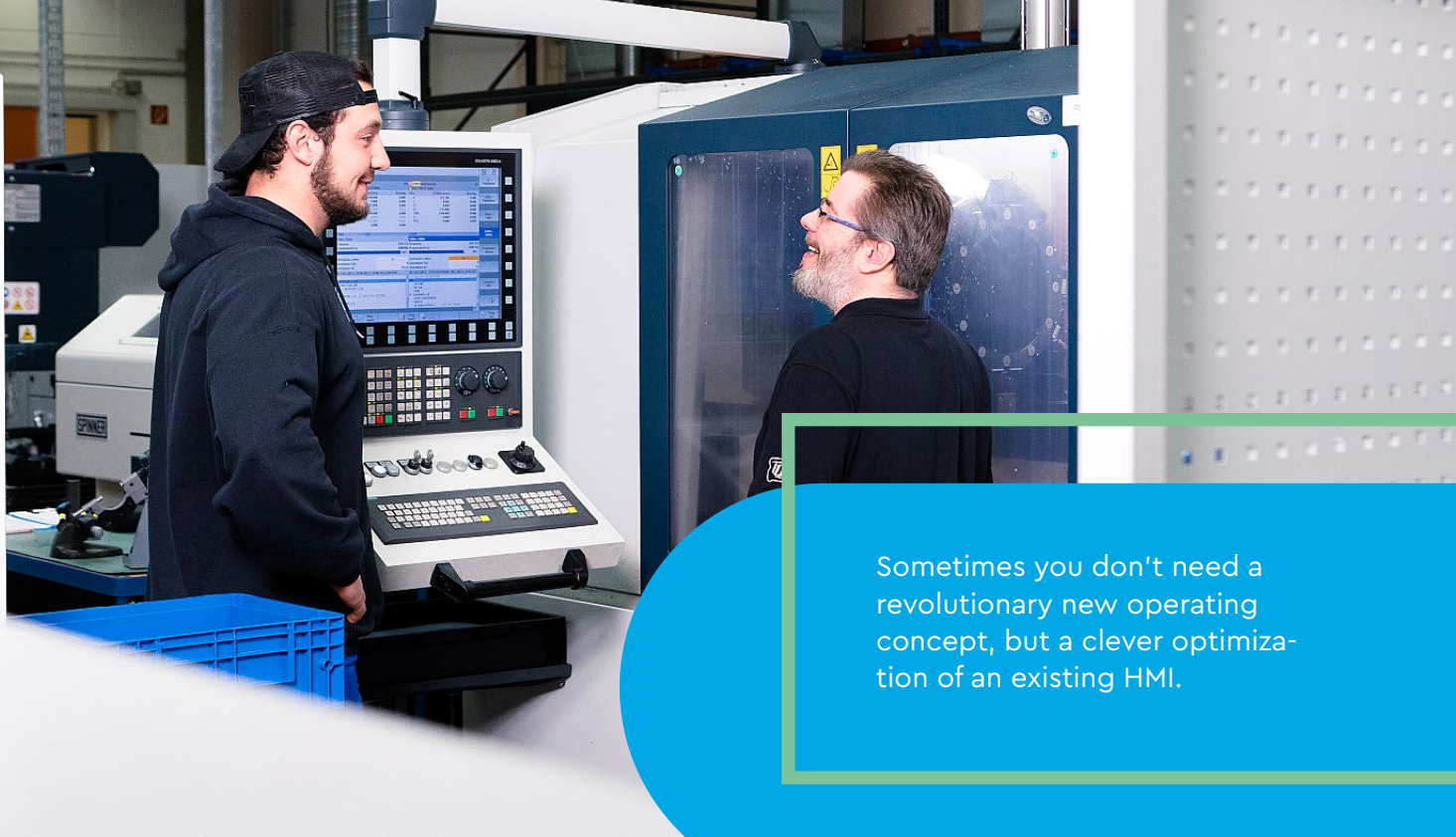
Facial recognition via camera is also suitable for two-to-ken authentication for applications with increased security requirements. Again, AI is required, but coupled with additional security features that are integrated as deeply as possible into the hardware. One possible application would be a time and attendance system that recognizes not only the NFC card but also the face to prevent employees from clocking in colleagues who are not present.



## Hear the Word

AI is not only used for image processing, but also for speech and sound recognition. Voice control is particularly useful when all hands are needed and the eyes cannot be averted - for example, in neurosurgery under a microscope. In the past, the surgeon's voice commands were used for human colleagues in the operating room, who could now also control the equipment. In this situation, it is advisable to provide the user with acoustic feedback so that the difficult work is not interrupted to read scales or display messages.





## From one person to another

In some situations, especially with vending machines and pay stations, even the best programming and extensive database can reach its limits and human assistance is required - which can be provided by audio (VoIP) or video call. Audio processing, which can evaluate multiple microphones simultaneously, can help minimize background noise. In addition, reliable communications must be provided with redundancy or alternative network technology to be available in the event of line failures.

## Master of the situation

Sometimes what's needed is not a revolutionary new operating concept, but a clever optimization of an existing HMI. For example, accelerometers can be used to determine the status of a piece of equipment and the appropriate actions to take based on its position. Or Lidar sensors can be used to increase the accuracy of automatic positioning and reduce the time it takes a human to find a position - in other words, an HMI scores not by being more intuitive, but by being operated faster. However, the hardware must support the appropriate sensor interfaces.

## Master the classics

Even though the introduction of new operating concepts often involves a full replacement, i.e. a complete switch from one technology to another, it is advisable to ensure that the embedded computing technology installed can continue to support the familiar operating concepts - some advances are not accepted by customers as quickly as hoped. In addition, there is often nothing wrong with the familiar HMI, only the touch display needs to be improved, be it in size, number or resolution.

## Keep options open

So you need to keep options open to respond to customer tastes. The electronics used should also have room for upward and downward evolution to allow product development/brand management to more easily optimize the product portfolio. It is also advisable to keep an eye on long-term availability, especially for devices that require approval, to avoid time-consuming and costly re-certification.

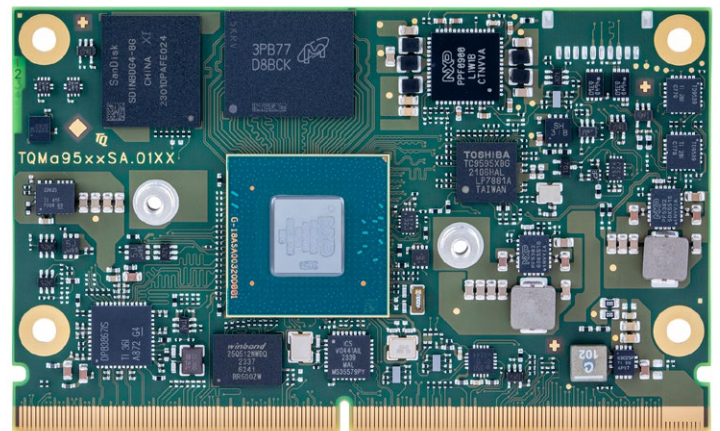
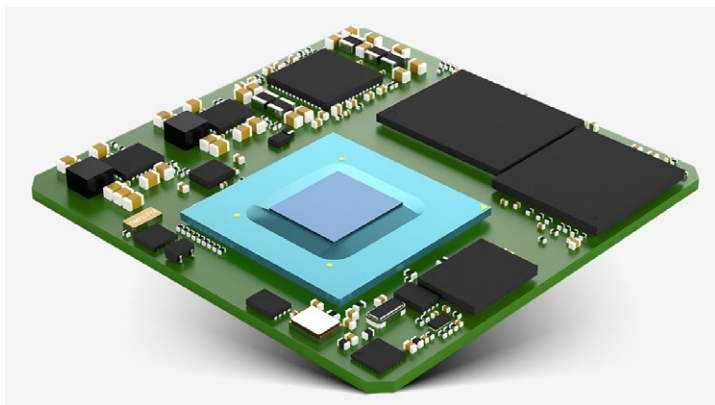
## Easy access to technology

Smartphone multi-touch is the model for many HMIs and has revolutionized the user interface of countless devices. However, the trend towards more intuitive, reliable and secure device operation is not yet over. Current semiconductor designs are picking up on these trends and integrating the necessary functionality into CPUs.

**One example is NXP's i.MX 95**, which, in addition to the popular Arm cores, features an AI accelerator with a peak performance of 2 TOPS. This component is the basis for the TQ embedded modules TQMa95xxSA (SMARC plug-in module) and TQMa95xxLA (solderable). The two software-compatible modules thus combine the necessary performance and interfaces for modern HMIs.

The modules are available with two, four or six Arm Cortex-A55 cores to match the performance requirements of the application and its HMI. The high scalability of this platform allows it to respond to the growing performance requirements of the application in the long term. Two independent real-time domains (Arm Cortex-M7 and Arm Cortex-M33) are also available for safety/low power and high performance real-time applications. With up to 16 GB of LPDDR5, up to 256 MB of Quad-SPI NOR Flash and up to 256 GB of eMMC, the modules provide enough memory for even the largest HMIs.

The module family enables image analysis through the integrated NXP eIQ Neutron NPU (AI accelerator) as part of a machine vision pipeline for use with network-enabled smart cameras or multi-camera sensors. The NXP ISP (Image Signal Processor) supports the latter, enabling the use of a wide range of image sensors for industrial, robotics, medical and automotive applications.



They are connected via 2 x MIPI-CSI2 (1 x 4 and 1 x 2 lanes) and one 10 Gbit Ethernet or up to two Gbit Ethernet ports (1x TSN capable). This sophisticated image processing pipeline enables various image processing functions such as gesture or person recognition.

However, image analysis is uncharted territory for many developers, so software support is particularly important. NXP's eIQ Neutron NPU and machine learning (ML) application development is supported by the award-winning eIQ ML Software Development Environment, a collection of libraries and development tools for building ML applications designed for i.MX application processors and MCUs. The eIQ toolkit is based on open source technologies and is fully integrated with Yocto development environments, making it easy to develop complete system-level applications.



The Arm Mali GPU integrated into the i.MX95, as well as 2 x LVDS (four lanes) and 1 x eDP (two lanes) on the module, provide the graphics display with resolutions up to 3840 x 1440p60. The GPU supports OpenGL ES 3.2, Vulkan 1.2, and OpenCL 3.0 for programming, allowing the graphics unit of the embedded modules to meet the requirements of larger or more touch displays. In addition, the 2D GPU is part of the real-time domain and can create graphic overlays in real time for applications that require special visual integration, such as a "mirror" that can also display a tried on garment with alternative colors and patterns.

The TQMa95xxLA offers numerous audio interfaces:

- Up to 5 x I2S
- Up to 4 x PDM microphone interface (MICFIL)
- Up to 1 x SP/DIF

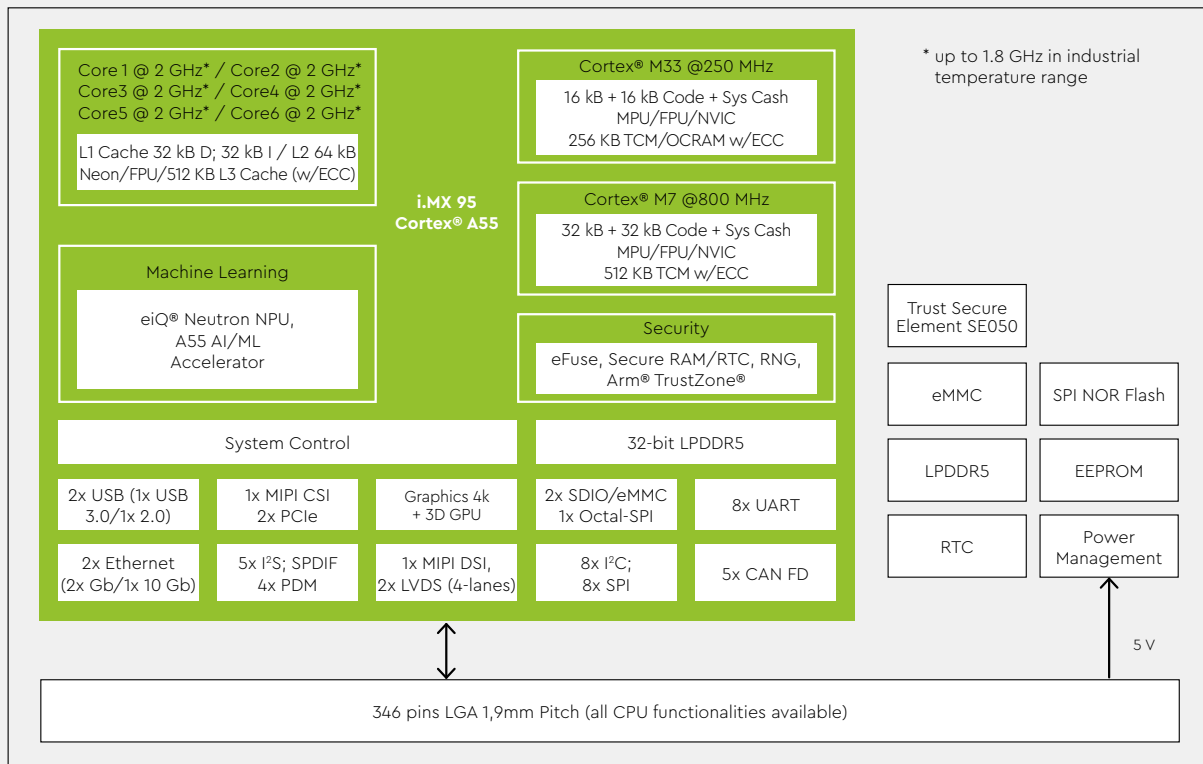
Thus, the module is also equipped for demanding tasks in the field of audio processing and signaling.

The optional gyroscope sensor of the TQMa95xxSA/LA family enables the evaluation of position changes, e.g. to activate safety functions or to automatically provide menus for position correction. Additional sensors can be integrated via up to eight I2C buses.

If very high bandwidth is required, up to two PCIe 3.0 links can be used. Up to 2 x Gbit Ethernet (TSN capable) and 1 x 10 Gbit Ethernet are available for fast communication with networks or network cameras.

The visual and audio processing requirements of modern HMIs can be demanding.





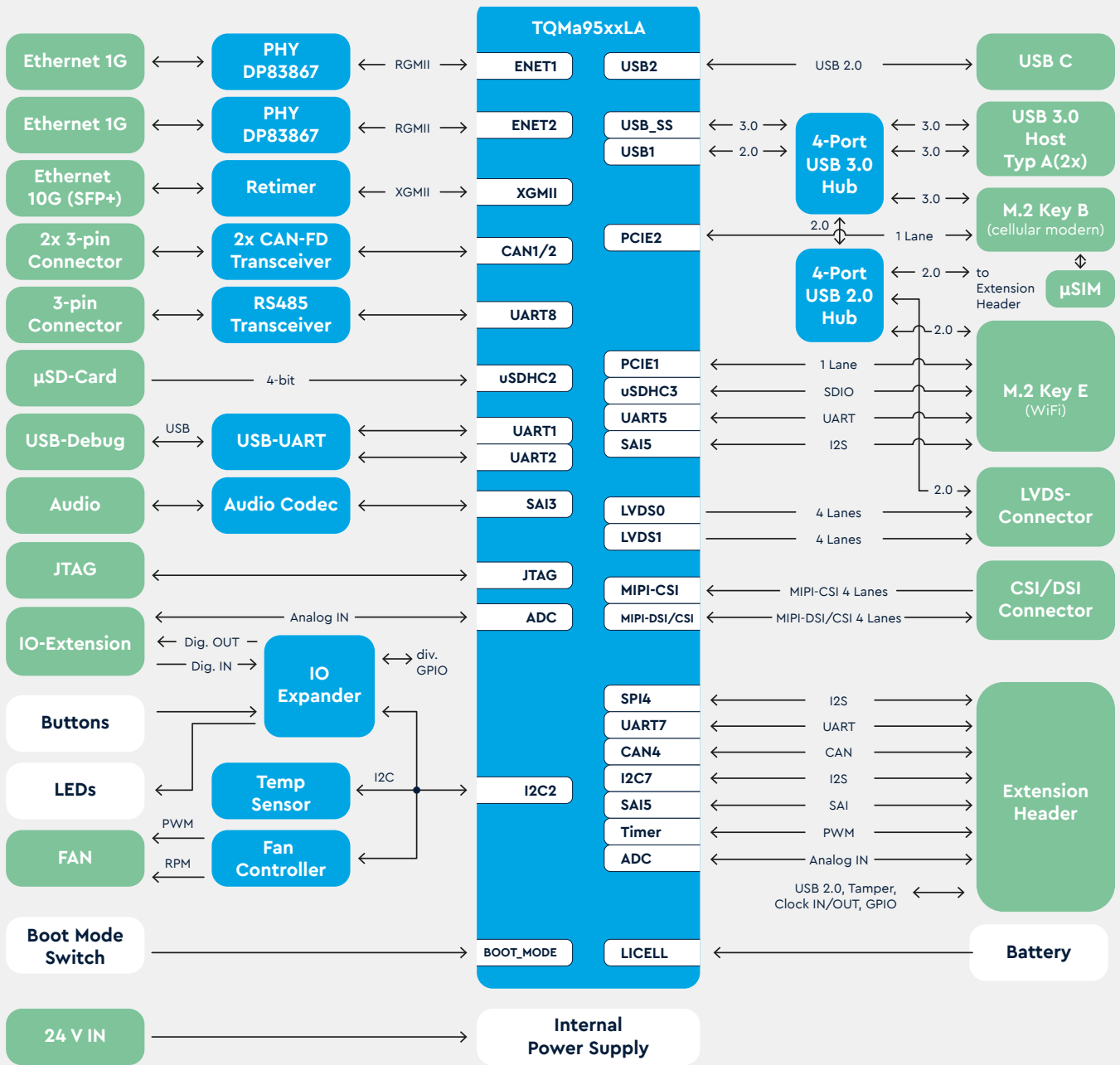
Security is an essential foundation for many edge applications and HMIs. The i.MX-95 family integrates a secure enclave to simplify the implementation of security-critical functions such as secure boot, cryptography, trust establishment, and run-time authentication. The platform has its own cryptography engine with support for a variety of standards. Optionally, the hardware security of the modules can be further enhanced with a secure element. In combination with NXP's EdgeLock 2GO key management services, the modules are suitable for secure remote management in the field, including secure over-the-air (OTA) updates.

Flexibility is also offered for integration on the carrier board: Either pluggable as SMARC module (TQMa95xxSA) or solderable as LGA module (TQMa95xxLA). The standard operating temperature range is -25°C to +85°C. The extended temperature range is -40°C to +85°C. A typical power consumption of the modules of only 6 W contributes to easier integration due to reduced cooling requirements. This makes the TQMa95xxSA/LA family ideal for a wide range of demanding HMIs, even in harsh environments.

In order to develop an optimal HMI, the motto "the proof of the pudding is in the eating" applies, i.e. experience must be gained through tests and experiments. TQ offers suitable evaluation boards to support this task. The MB-SMARC-2 carrier board is available for the TQMa95xxSA. For the TQMa95xxLA, the MBa95xxCA offers a highly interesting interface mix, so that even unusual combinations can be evaluated. Both mainboards provide an important basis for new developments based on qualified interfaces and can thus lead pioneering products to success more quickly.

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## 15 Years

Many modules are even available for more than 15 years.

**As an experienced E<sup>2</sup>MS company and system provider, the TQ Group can also offer numerous services for the modules and thus provide support in many phases of product development and production.**

All modules and SBCs from TQ-Embedded are designed for long-term availability of at least seven years - many modules are even available for more than 15 years. With a sophisticated obsolescence management strategy, TQ protects the products from unexpected changes and discontinuations - an indispensable part of the product life cycle measures in a changing market situation. As a result, the products are available even with very long project durations. In addition, TQ supports its customers with various obsolescence management services.

This is particularly important for start-up companies with limited manufacturing resources - TQ is happy to take over the embedded hardware part of their projects. In addition, the company's own Product Compliance Center is approved to carry out electromagnetic compatibility, product safety and environmental tests.







## About the author

Konrad Zöpf is Product Manager for ARM-based embedded modules and systems and systems at TQ-Systems GmbH in Seefeld near Munich. He is also deputy director of TQ Embedded.

He is the author of several specialist articles on the topics of ARM modules and systems in connection with IOT, security and wireless.

The **technology company TQ-Group** offers the complete range of services from development, production and service to product lifecycle management. The services cover assemblies, devices and systems including hardware, software and mechanics. Customers can obtain all services from TQ on a modular basis as individual services or as a complete package according to their individual requirements. Standard products such as prefabricated micro-controller modules (mini modules), drive and automation solutions complete the range of services.

The TQ Group employs a total of around 2,000 people at its locations in Delling, Seefeld, Inning, Augsburg, Peiting, Durach im Allgäu, Wetter an der Ruhr, Chemnitz, Leipzig, Fontaines (Switzerland), Shanghai (China) and Chesapeake (USA).

## Your contact with TQ

Would you like to find out more about how TQ-Systems can support you with i.MX 95?

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🌐 [www.tq-group.com/i.mx9](http://www.tq-group.com/i.mx9)