After the Maker Board phase

From Pi prototype to volume production.

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# Smoother from development to manufacturing

The Raspberry Pi has gained importance far beyond the Maker scene and is also used in professional embedded applications. In addition to the available interfaces, the very good software support is a major advantage. TQ-Systems offers solutions and support for customers who have developed their first prototype based on the Raspberry Pi and are now looking for a quick transition to a robust system with long-term availability. For example, with the new MBa8MP-RAS314, a professional maker board that is also suitable for industrial series use.

Support for a successful upgrade begins with an analysis of the existing system. Based on the Raspberry Pi used, a comparable TQ module is selected. An important point is the comparison of the interfaces: These should not only be replaced functionally, but also with the same or better performance. The use of additional interfaces, e.g. a second Ethernet, should also be considered, not only to improve performance, but also to open perspectives for further product developments/extensions. In this context, the extension of existing functionalities, e.g. by AI accelerators or security functionality integrated in the CPU, should also be considered. Suitable standard baseboards are available as hardware for all TQ modules.

TQ offers "Armbian – Linux for ARM Development Boards" so that you can start porting to an embedded system from TQ as quickly as possible or test your own application on the new hardware. Armbian describes itself as a "lightweight Debian or Ubuntu-based Linux distribution specialized for ARM development boards". The images are optimized for flash storage devices such as NAND, eMMC and USB drives. Both SSH and DHCP services are enabled out of the box. Depending on the application requirements, the developer can choose to configure the operating system for command line or GUI operation. The necessary software packages can be installed and the application tested without lengthy training. Powerful build and software development tools help create custom builds.

Armbian claims to do some of the kernel development and much of the maintenance for Arm platforms. In contrast, Debian relies on upstream sources for ARM hardware, which are often years behind and/or lack many features. For example, the Armbian system is optimized to minimize wear and tear on the SD card as mass storage.
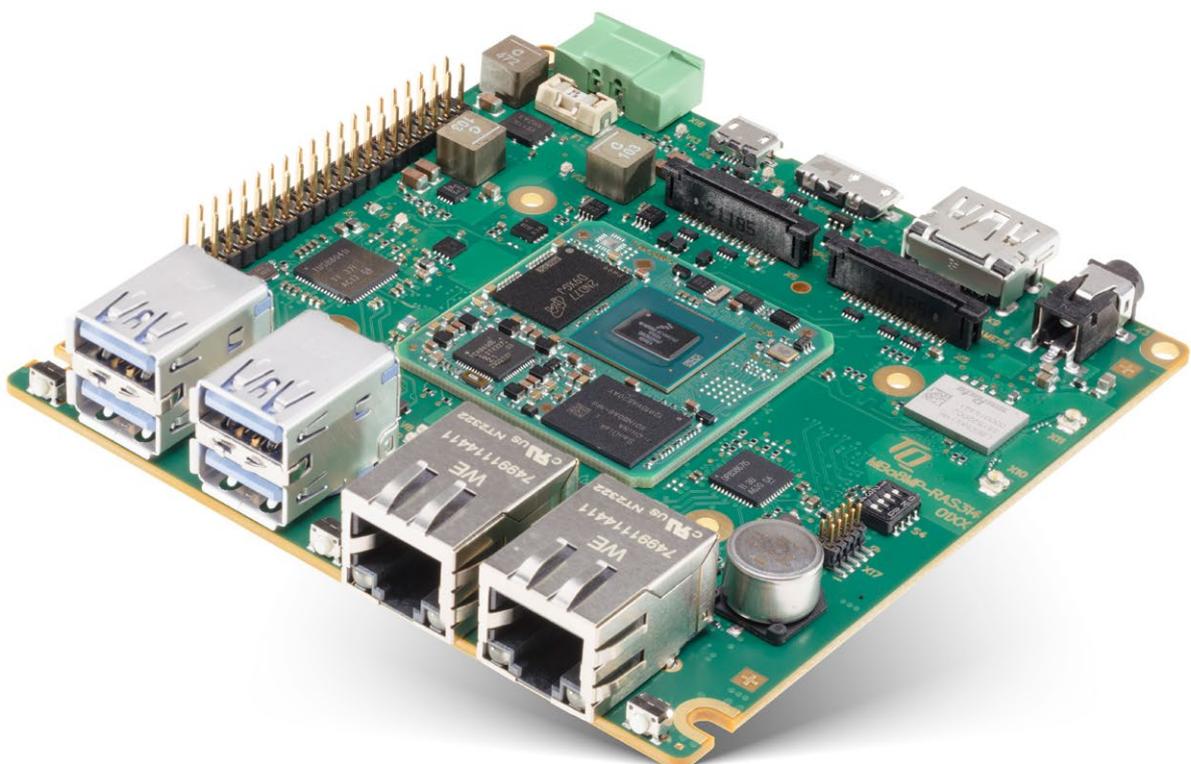
Supercharge development with a new board alternative

After a successful analysis or software evaluation, the development of the customized design can begin. The customer, together with TQ or completely by TQ, can carry out the development. As an option, the MBa8MP-RAS314 can be used, which TQ developed specifically as an alternative to the Raspberry Pi.

The 100 mm x 100 mm compact mainboard is based on the NXP i.MX 8 Plus processor and offers numerous interfaces such as HDMI, LVDS, MIPI-DSI, USB, audio (MIC/headphone), MIPI-CSI, SD card or dual Ethernet (1 x TSN) with industry standard connectors – so there is no need to purchase special cables. Wireless standards such as WiFi (802.11a/b/g/n/ac) are connected internally via fast PCIe, and a 40-pin I/O header round out the interface offerings. The processor's up to four Arm Cortex A53 cores are complemented by a Cortex M7 core, 3D GPU, Dual Image Signal Processor (ISP), two audio DSPs and a Neural Processing Unit (NPU).

This opens up the MBa8MP-RAS314 to a wide range of applications:

▶ With two Gigabit Ethernet interfaces (one is TSN capable), the board not only meets the growing industry demand for more independent or re-dundant network segments, but also enables a variety of specialized network appliances such as hardware firewalls or failover edge routers. The Time-Sensitive Networking (TSN) feature primarily addresses very low latency and high availability transmission. Possible applications include conver-gent networks with real-time audio/video streams, and especially real-time control streams used for example in cars, airplanes or industrial plants.

▶ The Audio Return Channel (HDMI-ARC) allows the use of audio signals from TV sets/monitors, ope-ning up applications in consumer electronics and home theater products.

▶ Those who want to integrate a high-quality display into their product without the cost overhead of an HDMI monitor can use LVDS for improved series production.

▶ The integrated 16 GB eMMC flash eliminates the need to use easily tamperable USB memory drives or SD cards to load the operating system. In com-bination with the security functionality already in-tegrated in the CPU and an additional security chip (SE050) on the module, applications with a signifi-cantly increased security level can be realized.

▶ Thanks to the optional inline ECC memory func-tion, memory errors are less of a problem compa-red to standard boards, enabling applications with increased safety requirements.

▶ The integrated Neural Processing Unit (NPU) acce-lerates the processing of AI algorithms and machi-ne learning by a factor of 10 to 30 compared to the classic Cortex-A53 CPU core.

▶ The CPU's on-chip DSP is optimized for audio ana-lysis, making it ideal for voice-activated controls with low power consumption.

▶ Four USB 3.0 ports enhance functionality for virtu-ally any application.

▶ The MBa8MP-RAS314's 100 mm x 100 mm form fac-tor allows access to the eNUC standard package/accessory ecosystem.

▶ Power is supplied via a PCB socket with Lock & Re-lease threaded flange (Phoenix Contact) instead of an unsecured micro-USB socket. This prevents un-intentional disconnection from the power supply, even in tight spaces and under vibration.

▶ With a long-term availability of 10 to 15 years, the solution is also suitable for very long project dura-tions.

▶ Very thin devices can be realized with the passive and industrial cooling solution (optional).

Test and debug capabilities

With its features and interfaces, the MBa8MP-RAS314 goes well beyond the capabilities of common Maker boards like the Raspberry Pi and is aimed at more demanding applications.

However, these often come with an increased need for debugging. Therefore, in addition to JTAG, developers have powerful additional channels for debugging and programming tasks with a dedicated debug UART/USB port (via USB2.0 Micro AB) and a dedicated serial downloader / USB 3.0 device (via Micro-USB Type B).
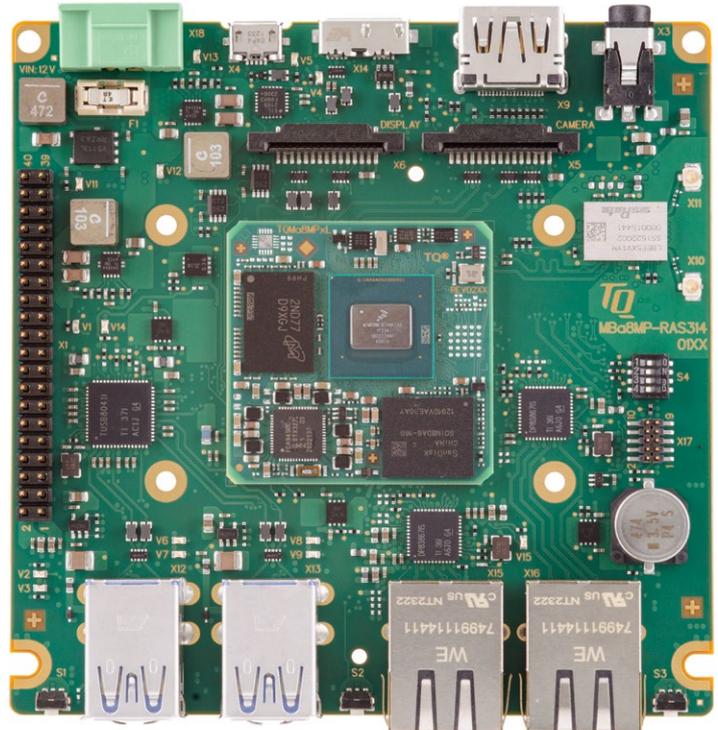
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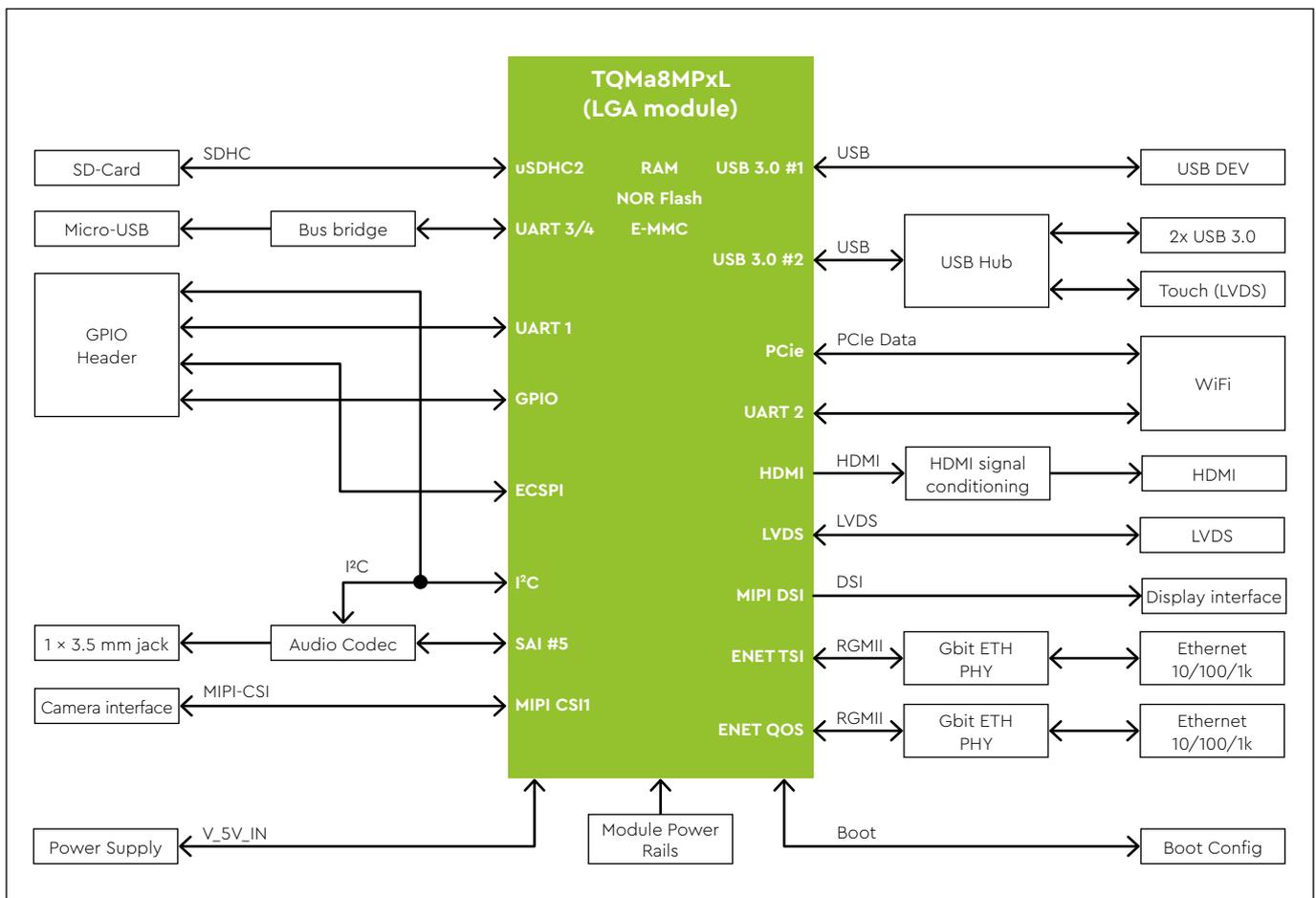
Operating systems to meet demand

Based on the standard TQ baseboards, such as the new MBa8MP-RAS314, the customer-specific hardware can be quickly derived and created in the desired form factor. Prototyping as well as commissioning and verification ensure that all desired characteristics are met.

For application software, the customer can continue to use the Armbian distribution or switch to a Yocto distribution. The advantage of the Armbian distribution is the low customization effort compared to prototype development. However, for those who want to retain full control over their Linux system, TQ recommends using Yocto. On the one hand, the operating system images can be kept relatively small, and on the other hand, the installed packages can be precisely determined and their version numbers specified. This is especially helpful for subsequent processes such as creating an SBOM (Software Bill of Material) or CVE (Common Vulnerabilities and Exposures) tracking.

When the operating system and application software are running together successfully, there is often an unexpected surprise: the system gets warmer than expected. The cause is often the software, which has been enhanced during development with new ideas and customer requests: Although it is now a more complete and better product, it consumes more resources. Thanks to scalable embedded modules, the increased performance requirements can be easily met. Unfortunately, this comes at the cost of higher power consumption and more heat.

Installing noisy fans is often not the answer, as they may not fit into the enclosure or may even be prohibited in applications such as medical electronics or hazardous locations. Developing a passive cooling solution is time consuming and expensive.

It is much cheaper for the board supplier to develop a suitable cooling concept for the mainboard from the very beginning. This also defines all mechanical mounting points and optimizes them for installation. For example, TQ offers options for an optimized cooling concept for the MBa8MP-RAS314 with headspreader and flat heat sink.
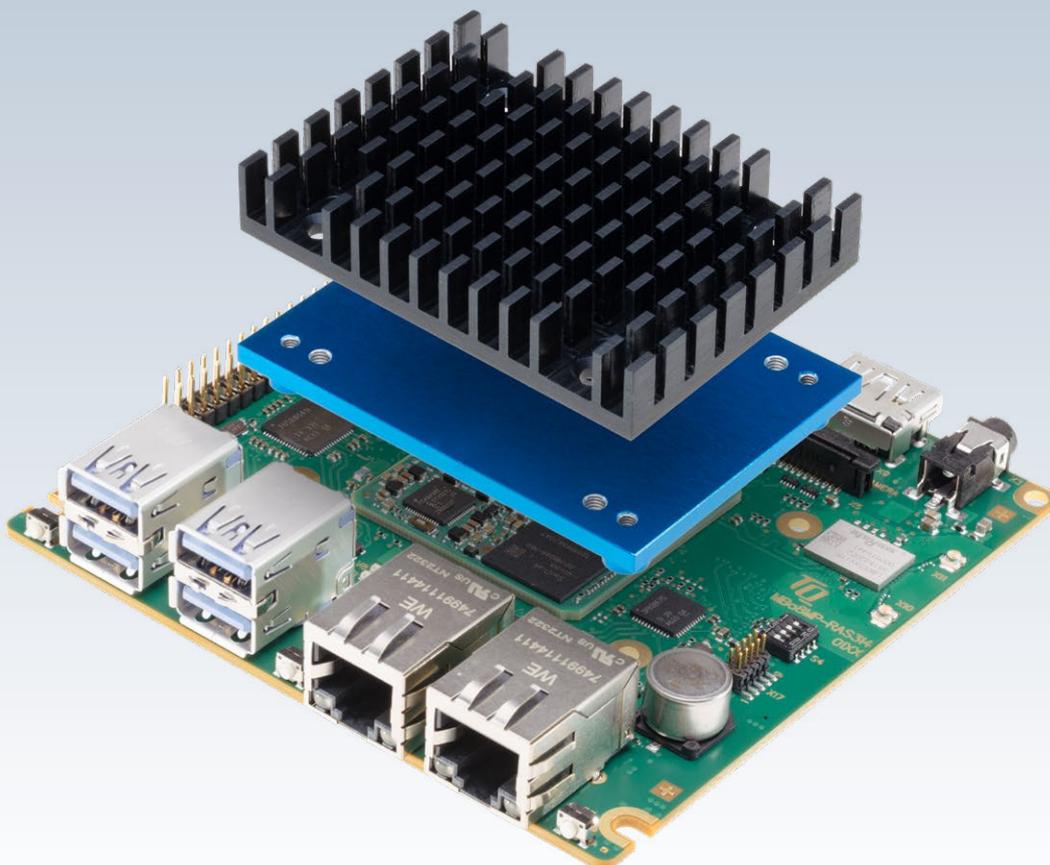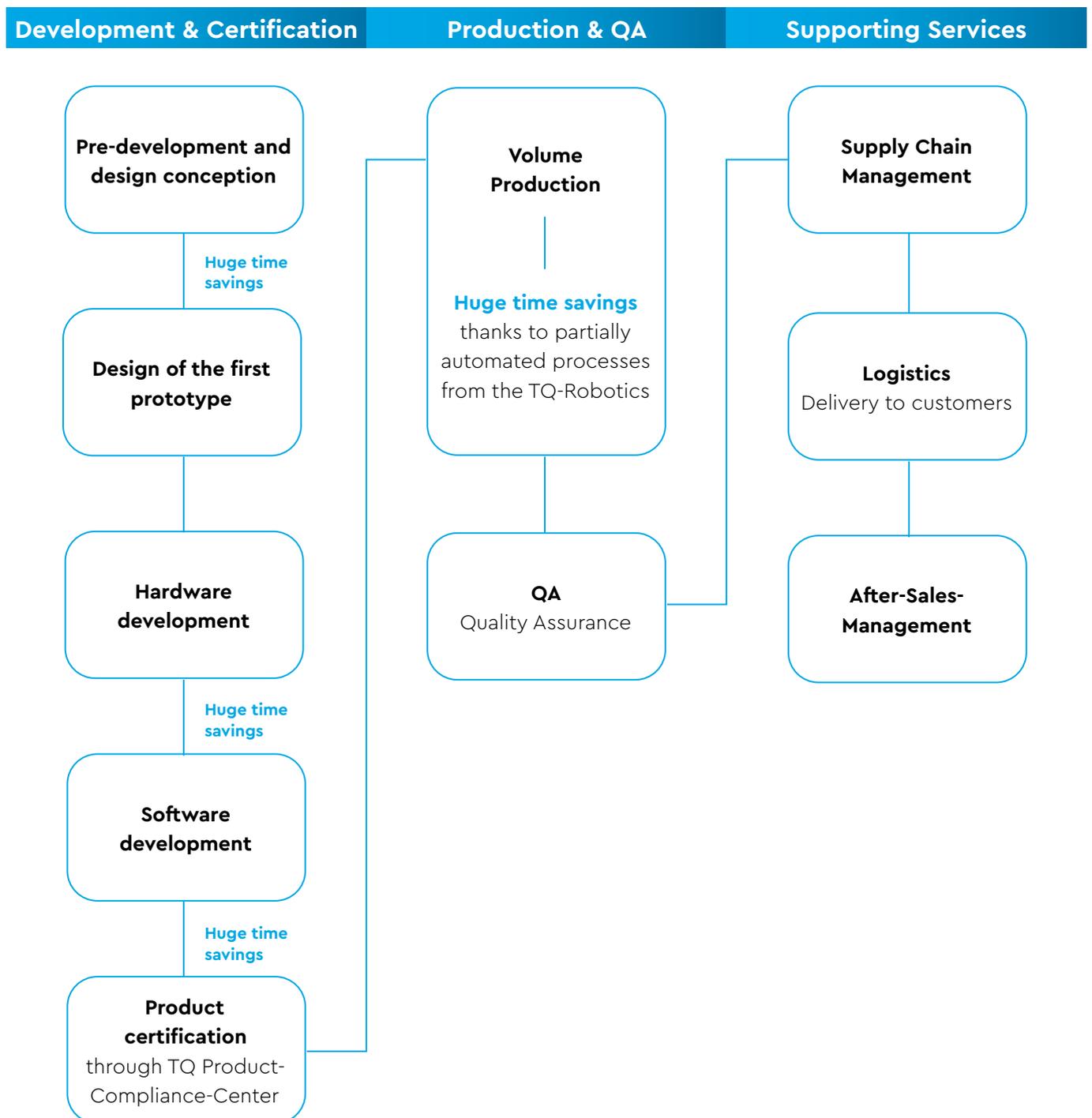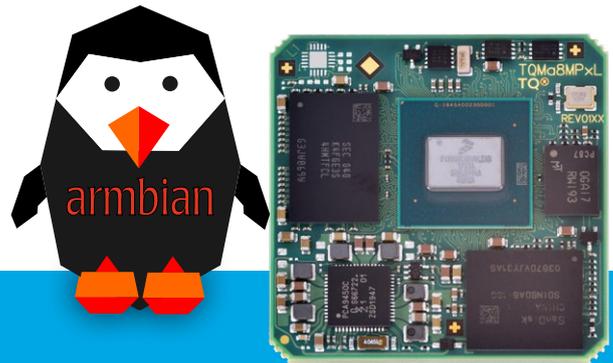
A well-rounded portfolio

As an experienced E²MS company, the TQ Group can offer numerous services in addition to modules and boards, and can support you in many phases of product development, obsolescence management, certification and manufacturing. This is particularly important for start-up companies that have limited manufacturing resources and whose core competence lies more in product conception and software – the hardware part of their projects is gladly taken over by TQ. This way, there is hardly anything standing in the way of transferring a proof of concept to series production.

From the idea to the successful series

Development & Certification	Production & QA	Supporting Services
Pre-development and design conception	**Volume Production**	**Supply Chain Management**
Huge time savings	**Huge time savings** thanks to partially automated processes from the TQ-Robotics	**Logistics** Delivery to customers
Design of the first prototype		
Hardware development	**QA** Quality Assurance	**After-Sales-Management**
Huge time savings		
Software development		
Huge time savings		
Product certification through TQ Product-Compliance-Center		

Armbian for TQMa8MPxL and MBa8MP-RAS314

Armbian provides a build system for customizing the Linux kernel, which allows the integration of custom development boards. The build system can be downloaded from Github:

https://github.com/armbian/build.git

Even though the patch to add the TQ boards to the current "master" branch should be possible, it is recommended to start from one of the provided tags. By calling the ./compile.sh script, a menu-driven build can now be executed. Alternatively, the variables to be set can be specified in the command. Once the build process is complete, the SD card image is located in the /output/images folder and can be written to an SD card using the usual options.
Detailed build instructions for MBa8MP-RAS314, additional documentation and downloads are available on TQ's support wiki:

https://support.tq-group.com/en/arm/tqma8mpxl/mba8mp-ras314/

The first time you boot with a newly built image, there are a few more steps to complete. These (e.g. assign root password) are described in the documentation:

https://docs.armbian.com/User-Guide_Getting-Started/#how-to-boot

Not all distribution/desktop environment combinations can be built without errors, so the "jammy" + "cinamon" combination is recommended to start with.

Besides the Ubuntu based images, a Debian based image can also be built. You can also build images with different kernel versions for the BRANCH=legacy uses "hardknott".

Armbian How To

Armbian is very different from the Yocto-based Linux approach. A good starting point for general information is the Armbian documentation:

https://docs.armbian.com/User-Guide_Getting-Started/

Examples using the MBa8MP-RAS314 motherboard explain the Armbian approach:

▶ Connecting HDMI/LVDS - With Armbian, the devicetree files are located in the /boot/dtb/ folder. The default device tree is imx8mp-tqma8mpxl-hdmi.tdb. If a monitor is connected via HDMI, a console is displayed on it. The armbian-config tool can be used to modify the U-Boot environment. The menu items "System" → "Bootingv" lead to the editor.

▶ System Information - If a monitor or display is connected, a splash screen with information about the board is displayed after logging in. A similar screen appears when logging in via SSH.

▶ Updating software - Updating packages is done with apt like in Ubuntu.

▶ Package management - Using apt it is also easy to install and remove additional packages.

▶ Python - Python and PIP are already installed.

▶ GPIO - To give the user access to the GPIOs, the user must be added to the gpio group. Then the change must be applied by logging out and logging in again. To get an overview of the available GPIOs, first install the "gpiod" package and then run the "gpioinfo" program. If you want to access the GPIOs with Python, you have to install the appropriate package with PIP. This package also comes with some tests to demonstrate the possibilities. Typically, the first parameter is the GPIO chip number and the second parameter is the offset of the corresponding GPIO. You can get this information with "gpioinfo".

▶ Audio - If speakers (or a monitor with speakers) are connected, audio files can also be played. An audio player can be installed using apt.

```
                      armbian-config

Configure Ubuntu jammy based Armbian for the TQMa8MPxL

SoC runs between 1200 and 1600 MHz using ondemand governor.

Support: https://forum.armbian.com


    System      System and security settings
    Network     Wired, wireless, Bluetooth, access point
    Personal    Timezone, language, hostname
    Software    System and 3rd party software install
    Help        Documentation, support, sources


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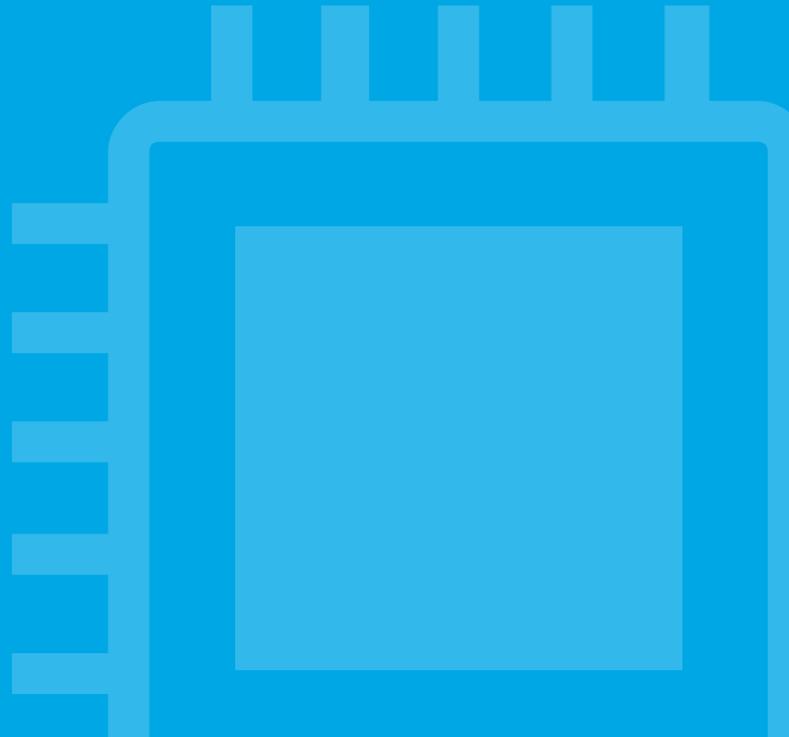
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