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EMBEDDED TOOLS & SOLUTIONS

Make your next move a SMARC one:

The next platform for modular embedded solutions

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Consulting | Engineering | Testing | Training | Tools | Software Components | Systems Manufacturing

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Introduction: the news about SMARC 2.0

At the SPS Drives in November 2012, a new COM standard was announced. This was published in February 2013 by the newly created SGET Committee as SMARC ("Smart Mobility Architecture"). SGET stands for the Standardization Group for Embedded Technologies.

SMARC is a versatile, small form factor for computer-on-modules. It is suited to applications needing low energy consumption, a low profile, low cost and high performance. Typically, the computer-on-modules use both ARM and x86 SoCs, similar to those used in tablet PCs or smart phones. The maximum electrical power consumption of the module is designed for passive cooling applications.

The SMARC modules are used as components in mobile and stationary embedded systems. The module contains the processor, main memory, boot flash memory, board management controller, the CPU power supply, a Gigabit Ethernet controller and, if necessary, an LVDS display transmitter. The modules are combined with application-specific carrier boards. This allows additional functions such as audio codecs, a touch controller or a wireless link to be implemented. The modular approach provides scalability by using different modules in one device class, a faster time to market by purchasing standard modules, and expandability.

Two main criteria must be satisfied for an open industry standard. For one, the standard must be published, it must be available to anyone and it must be maintained by a neutral committee that enjoys wide support in the industry. The SGET, as the responsible committee, provides the specifications for download at its website. It currently has more than 50 members including all important module suppliers.

However, not every published standard enjoys success in the marketplace. For this reason, the second deciding factor is the availability of products that comply with the standard. In other words, the fact that the market has embraced the standard. In the meantime, interested OEMs can choose from a series of products that serve a number of platforms. For this, the SGET maintains a list of products that comply with SMARC on their website. New designs are being added daily.

The SMARC 1.0 Design Guide appeared in August 2013. This assists developers of carrier boards in designing modules that comply with SMARC 1.0. One year later, in August 2014, came SMARC 1.1, a small update. This was how the SGET reacted to the growing demand for x86 SoCs. Four years after initial publication and enormous market success, the SGET published the new SMARC 2.0 standard designed for the present and the future. The Design Guide was updated in March 2017.

SMARC 2.0: Specifications and pinout

The SMARC hardware specification defines two module sizes. One, the short-size format (82 mm x 50 mm), is about the size of a credit card and the other is the full-size format (82 mm x 82 mm), which provides more space for memory modules, flash memory or Wi-Fi modules. SMARC modules are distinguished by a very low profile (including the heat spreaders), low power dissipation and the MXM3.0 connector. This was originally designed for video cards and has been used for many years in industry. With 314 pins over a connector width of 82 mm, SMARC modules can provide more interfaces than Qseven modules (230 pins) or COM Express® Mini modules (220 pins).

In contrast to the COM Express® and Qseven, the SMARC standard was designed for both x86 and ARM architectures. As a result, it can be used on a wide range of applications.

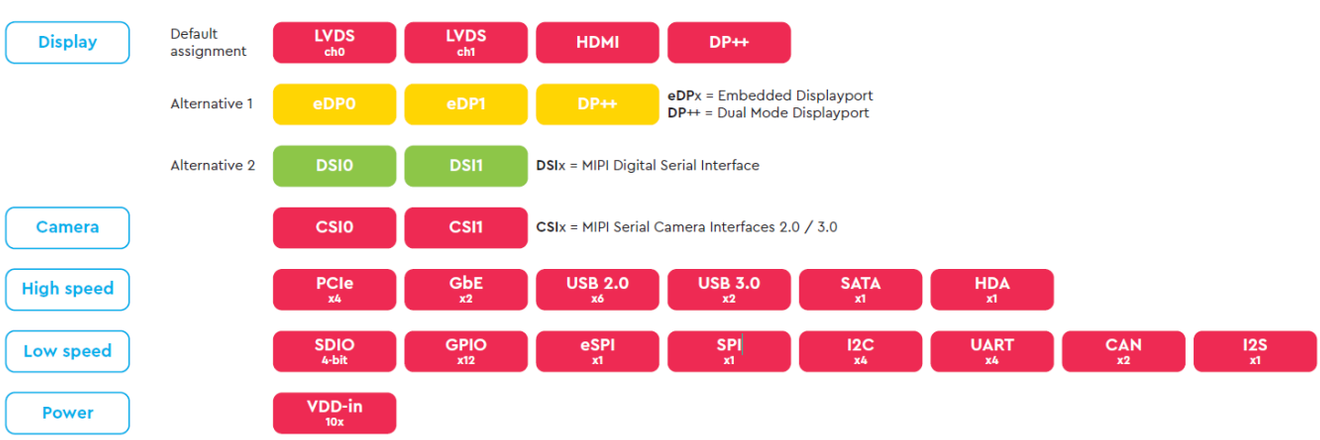
SMARC modules can operate up to three parallel independent displays. This fits ideally with the newest Intel Atom® processors from the E3900 family ("Apollo Lake-I"). They can drive one internal and two external displays with a resolution of up to 4K/UHD. Up to four displays can be driven by splitting the channels of the port for the internal display onto two displays.

For example, appropriate module designs support one primary internal full HD LVDS display with a maximum resolution of 1920 x 1200 pixels and control signals for a power supply and backlight or, as an alternative, one embedded display port (eDP) interface with 4096 x 2160 pixels and a display refresh rate of 60 Hz. The standard also allows MIPI DSI displays, such as those primarily used in smart phones today, as a third choice for the primary display.

The secondary display can be operated with current SoCs either as an HDMI interface with 3840 x 2160 pixels at 30 Hz or as a DP++ interface with 4096 x 2160 pixels at 60 Hz. DP++, also known as the Dual Mode Display Port, also allows the connection of HDMI or DVI displays using a simple passive adapter for the connector and voltage.

The third display is also defined as DP++ in the SMARC hardware specification.

Users who wish to use one or two MIPI CSI cameras should consider SMARC because the camera signals required can uniquely be provided directly from the connector. As in modern smart phones, the standard provides a camera on the back with four MIPI CSI lanes and one on the front with two MIPI CSI lanes. This allows camera resolutions equal to modern smart phones. In typical applications, the system integrator selects the appropriate camera modules that are attached to the carrier board or the housing.



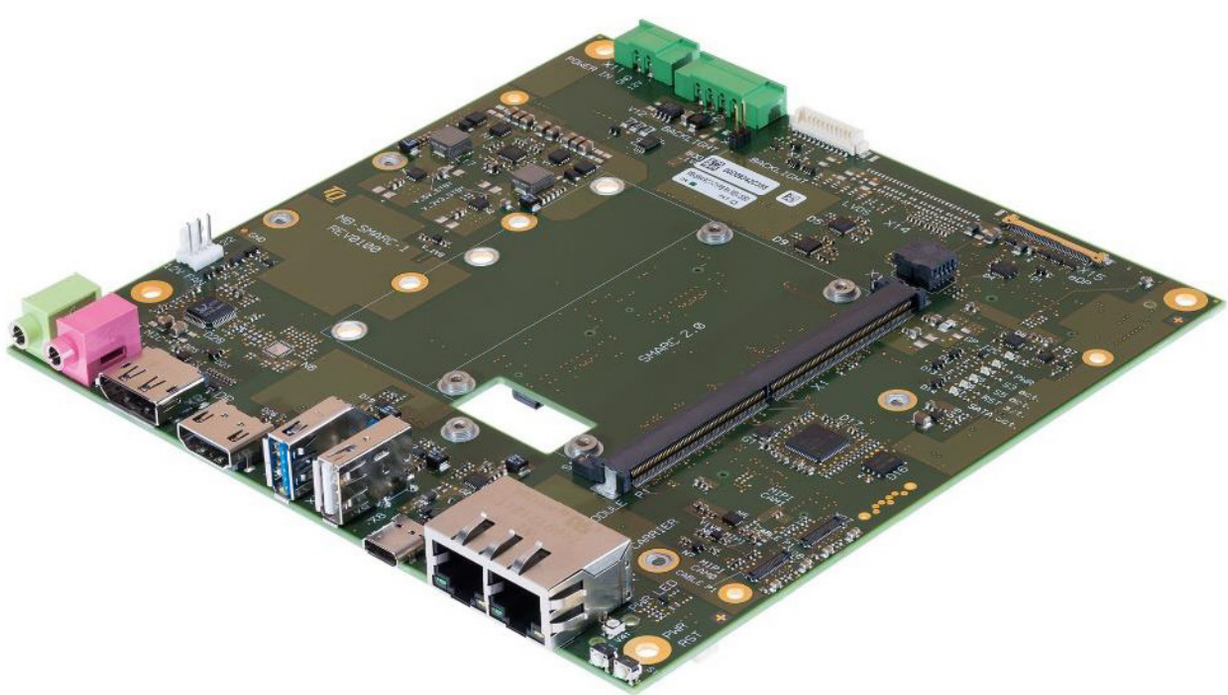
The standard supports up to four PCI Express channels for connecting additional devices such as ASICs, FPGAs, DSPs, and GbE controllers, or to implement mini-PCIe or M.2 slots, for example, for 2G/3G or 4G wireless modules on the carrier. One Gigabit Ethernet interface is provided by most SoCs, say, using the Intel® i210 controller on the module for x86 designs. If a second Gigabit Ethernet interface is needed for IoT gateway applications, this can be implemented by using one PCIe channel and an additional controller on the carrier board. In addition, the IEEE 1588 (Precision Time Protocol) signal is used by applications for time synchronization.

The SMARC also contains a 4-bit SDIO interface so as to be able to boot from the SD card on the carrier, twelve GPIO pins, one SPI, one eSPI and four I^2C interfaces. Four serial ports complete the picture.

As the SMARC 2.0 standard no longer supplies an eMMC interface to MXM3.0, a corresponding flash memory component must be incorporated on the module. The design of the TQMxE39S SMARC module by TQ Systems is prepared for eMMC sizes of 4, 8, 16, 32 and 64 gigabytes and all current CPU versions of the Intel Atom® E3900 series, the Pentium® N4200 and the Celeron® N3350.

Carrier Board Design

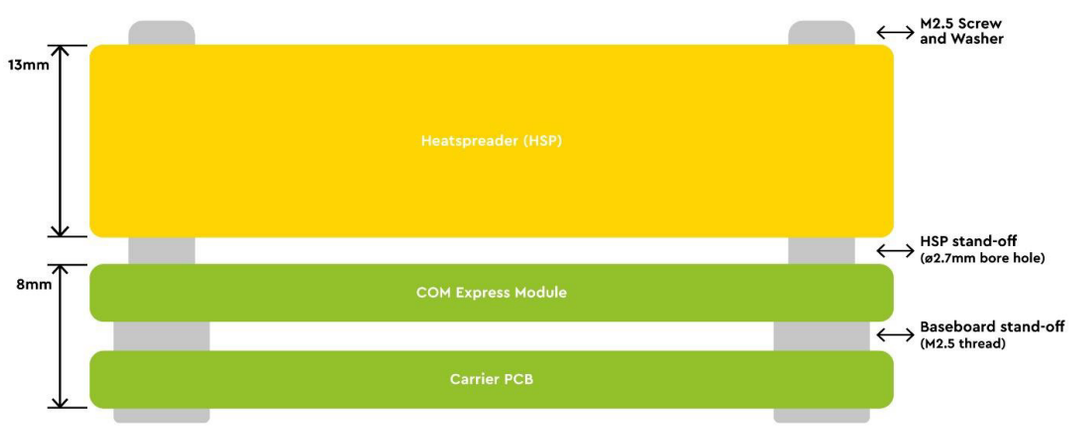
If using a standard module and the application-specific design of a carrier board, the complex portion of the work has already been handled by the module supplier. While a typical module design consists of 12 to 16 circuit board layers, the suitable carrier board has only 8 to 10 such layers because the design for the peripherals is not as complex. In the design of carrier boards, TQ Systems offers services such as circuit testing, signal integrity simulation and measurement or will even directly perform the design tasks.



Heat spreader and height

The SMARC standards are intended for applications that place great importance on a low profile, for example, portable industrial devices, medical tablet PCs or notebooks. The following figure shows the structure of the SMARC carrier board, the module and the heat spreader. A heat spreader with a height of 3 mm is mounted on the module. This serves as a link to the passive cooling system. The minimum height of the MXM3 connector is 1.5 mm. This results in the overall minimum possible height of 5.7 mm plus 3.0 mm from the top edge of the carrier to the heat spreader.

There is a significant height difference compared to the COM Express® Mini. According to the COM Express® specifications, the connector height is either 5 mm or 8 mm (typical example) and the standard height of the heat spreader is 13 mm. This results in an overall height between 18 mm and 21 mm. If a heat spreader with a lower profile of 8 mm is used, a height of between 13 mm and 16 mm can be achieved.



USB 2.0 and USB 3.0

SMARC 2.0 provides six USB 2.0 high-speed ports and two USB 3.0 super-speed ports. USB OTG and USB client functionalities are also supported. USB 3.0 is supported at the USB ports 2 and 3. USB3 can be used for implementing USB 3.0 OTB or USB 3.0 host. The USB0 port is to be available as the USB 2.0 client. This can also be used as the OTG port (and, as an extension, as a host). Some SoCs allow one USB port to be configured either as a client or as a host but do not support all OTG functionalities.

	USB 2.0	USB 3.0	OTG/VBUS	Client Capability
USB0	X		X	X
USB1	X			
USB2	X	X		
USB3	X	X	X	X
USB4	X			
USB5	X			

PCI Express

One SMARC module can implement up to four PCI Express (PCIe) lanes. The links for this can belong to the first, second or third PCIe generation, depending on what the module chip or the chipset allows. This varies from module to module. The PCIe links of the module are mainly PCIe with control function (root complex). If allowed by the chipset, the PCIe links may optionally also be configured as PCIe targets. In this case, each module vendor has its own specifications. The modules should support the PCIe link A port at the very minimum. The support of B, C and D ports is optional.

Battery operation

The SMARC standard is also suitable for battery-operated applications. The pins for batteries and charge management are provided in the MXM3 pin assignment. The charge controller can be implemented on the carrier board. As a result, the charging process of the attached batteries and the supply of power during battery operation can be controlled.

Passive cooling

One design goal for many applications is to avoid the use of rotating components such as fans to achieve passive cooling. This reduces the noise level and decreases energy consumption. In addition, no components subjected to a high degree of wear and tear are used. Ten pins are defined for supplying power to the module. The rated current of the connecting pins is 0.5 A per pin. This results in a total of 5 A for all ten pins. For practical reasons, most ARM module designs use 6 W or less. The x86 designs are expected to range between 3 W to 12 W, depending on the CPU model. This makes passive cooling possible.

MIPI CSI camera

MIPI CSI is a simple high-speed protocol designed for point-to-point transfer of images and videos between cameras and host devices. The SMARC specifications support two camera interfaces: MIPI CSI 0 (two lanes) and MIPI CSI 1 (two or four lanes). With these, SMARC provides added value compared to Qseven (here, an additional feature connector is necessary) and the COM Express® Mini (not supported). Depending on the SoC, an integrated signal processor here receives the camera signal and processes it.

OS support

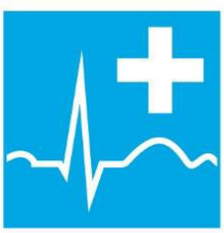
The SMARC 2.0 specification defines the pin assignment of the MXM3 connector. However, there is no standardization with regard to the operating system (OS) or driver support. For this reason, the module supplier is responsible for providing a complete board support package for the product. This package contains all the necessary drivers and tools to construct an individual OS kernel. TQ Systems works very closely with semiconductor suppliers to ensure the support of embedded operating systems such as Linux (Yocto, Fedora, Debian and Ubuntu), Windows 10 IoT, Android and real-time operating systems such as VxWorks and QNX. Even so, not all devices and all functions are supported by every operating system.

Potential applications for SMARC modules

The SMARC standard was developed for application in numerous industries and areas:

IoT

Smart Grid



Medical

Industrial

Building Automation

Telecom-munication

Shipping

Gaming

Transportation

The SMARC module from TQ Systems

TQ is now offering the new TQMxE39S SMARC 2.0 module with the latest-generation Intel Atom® E3900 processors (codename: Apollo Lake). The technical properties of the module are optimized for harsh industrial applications. The combination of high-speed RAM with 2 to 8 GB of dual-channel LPDDR4 and available eMMCs ranging from 4 to 64 GB for an expanded temperature range, optimized cooling solutions and an optional conformal coating stake out new potential applications for the module under extreme environmental conditions.

The best possible utilization of the display interfaces provided by the processor such as Dual Channel LVDS or Embedded DisplayPort 1.4 (configuration options), HDMI 1.4b and DP 1.2a, a GbE port that can be expanded to two ports using the available MB-SMARC-1 carrier, four USB 2.0 ports, two USB 3.0 ports and up to 4 PCIe lanes offer a broad bandwidth for additional functions on the carrier board. The MB-SMARC-1 from TQ is a carrier board that can be used both for ARM and x86 SoCs. It is an example of how the SMARC form factor connects both ecosystems.

Equipped with the newest Intel® graphics processor core, 4K screen resolution for three different frame rates, 3-D video processing and significantly increased video encoding/decoding performance are possible. Two native MIPI CSI camera interfaces and a variety of new functions form the basis for image capture applications and IoT solutions. The integrated on-board controller supports thermal management, a multi-stage watchdog and 'Green ECO-Off' mode for minimal standby consumption. It also gives customers configuration options (flexiCFG) for a high degree of flexibility. In this way, the TQMxE39S is suitable as a SMARC 2.0 module for mobile, battery-operated, low-profile applications over an expanded temperature range.

In the TQMa8Xxs, TQ also offers a SMARC module with a Cortex A35 processor based on i.MX8X with high computing power in combination with high-speed interfaces. It supports graphics with resolution of up to 4K and a DSP for audio processing. In this unit, the most important interfaces are 2x Gigabit Ethernet, 1x PCIe and 2x USB 3.0. Security functions and a Cortex M4 for real-time applications are also integrated.

Contact Us

To find out more about the SMARC module, or any other TQ embedded products, please contact Paul Roberts using the details below.

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