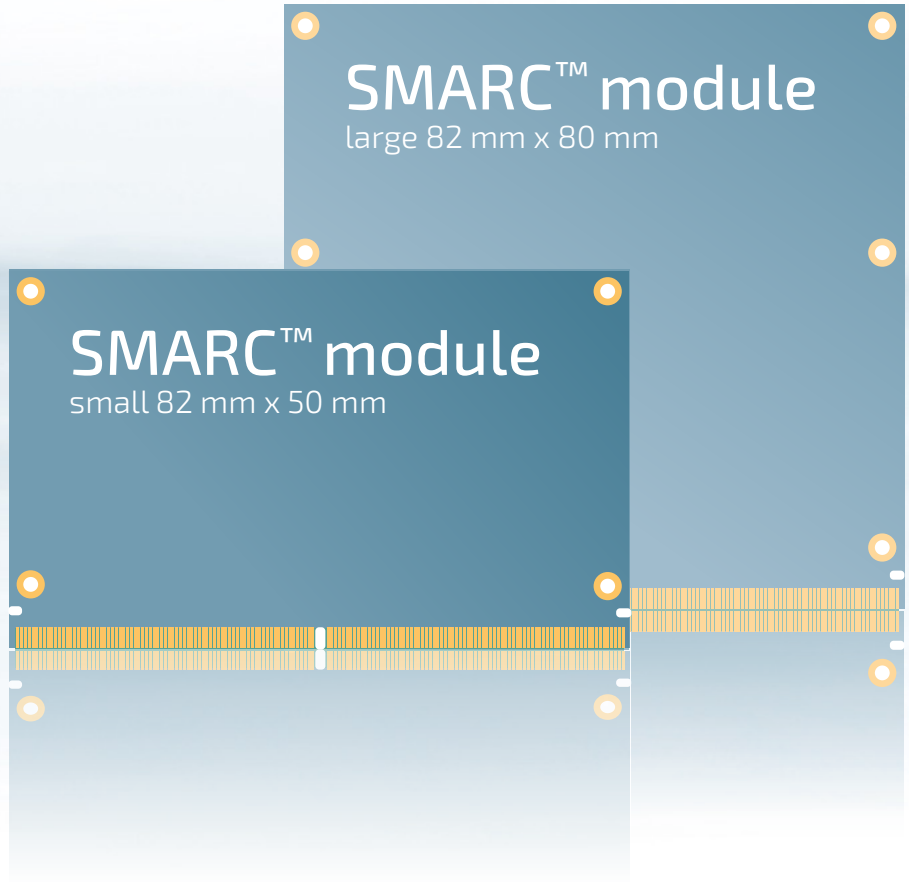
SMARC module

WHITE PAPER



SMARC™ module 2.1

Responding to the very latest IoT- and AI-driven demands on embedded computing solutions

POSSIBILITIES START HERE kontron S&T Group

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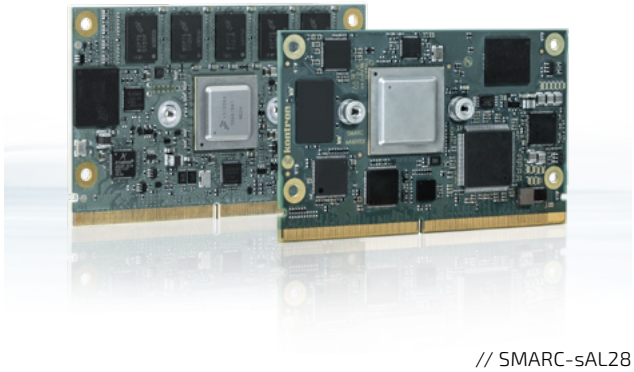
The SMARC™ (Smart Mobility Architecture) module standard is now firmly established as an enabler of innovative ultra-low-power embedded computing solutions. Entering the new decade, new embedded technology developments and market requirements are being driven more than ever by The Internet of Things (IoT) and increasingly artificial intelligence (AI).



// SMARC-sAL28
// SMARC-xAMX8X

EXECUTIVE SUMMARY

In March 2020 SGET released a further revised version of its popular Small Mobility Architecture (SMARC™) module form factor for Computer-on-Modules (COMS).

SMARC™ 2.1 is the third incarnation of the SMARC™ module since inception in 2013, demonstrating SGET's responsiveness to ongoing technological developments and the changing requirements and priorities of embedded systems developers and system integrators (SIs). Martin Unverdorben, Kontron product manager SMARC™ module and chairman of the SDT.01 (the SMARC™ module specification group), explains the introduction of the SMARC™ 2.1 module specification: "It is therefore intended to ensure that embedded solutions addressing the exponential hyper-connectivity demands of the IoT/IIoT remain as future-proofed as possible."

"A major focus of SMARC™ 2.1 module is on enabling small form factor COMs to leverage the latest functionality, flexibility, and high-speed I/O performance provided by microprocessor manufacturers such as NXP and Intel. Further considerations include easier implementation into Cloud applications and the growing demand for artificial intelligence AI-on-Module (AIoM) solutions, the latter highlighting the need for enhanced multi-media capabilities. Last but not least, there is the constant requirement for maintaining ultra-low power consumption."

This paper discusses how SMARC™ module is continuing to evolve to ensure system designers, SIs and OEMs can meet the ongoing challenges of cost-effectively developing next generation small form factor IoT- and AI-enabled embedded systems. As part of this, it provides an update on the latest and most important features embodied by SMARC™ 2.1 module and the benefits it offers developers.

"Kontron is committed to remaining a key and active contributor to the standard, ensuring its leadership position as a provider of highly innovative SMARC™ module solutions," confirms Martin Unverdorben.

INTRODUCTION

Established by SGET in 2013, SMARC™ module is a fit for purpose form factor standard for COMs. These have rapidly emerged as highly popular scalable building blocks for allowing developers to create a new generation of embedded applications. With this, SGET is highly focused on ensuring the standard keeps pace with the speed of change that characterises the embedded computing technology industry. In such a dynamic industry, the latest SMARC™ 2.1 module specification revision will therefore be just the latest step on the development ladder.

SMARC™ module is aimed at manufacturers of carrier board and system developers requiring SoC-based ultra-low power Computer-on-Modules in miniature format. The area of application for SMARC™ modules is continually expanding as the myriad of possibilities presented by the IoT and AI technology accelerates: from manufacturing automation and industrial control solutions to image processing, multimedia and many more besides. Often the COMs at the heart of these solutions must be capable of withstanding extreme external temperatures and harsh environmental conditions.

In addition, SMARC™ COMs have excelled as building blocks for very small portable handheld devices where power consumption must not exceed a few watts and the computing power has to be particularly high. Systems integrators have been able to take full advantage of the user-interface options previously only available to mobile device OEMs, thereby providing access to the smaller, low-cost display modules employed in smart phones, tablets and advanced human machine interfaces.

SMARC™ module: Design Considerations

- Sophisticated IoT- and AI-driven customer requirements
- Size, power and cost constraints
- Faster processors/High speed I/Os
- Increased connectivity, multimedia and functionality demands
- Removable connection: Simple and easy in service and development
- Higher reliability/ extreme operating environments
- Shorter time to market
- Improved lifecycle/ROI
- Scalability from Arm® to Intel Atom® using a single carrier
- Long term availability

AN ONGOING EVOLUTION

SMARC™ 1.1 to 2.0 module

SMARC™ 1.1 module was born out of the necessity for further development of Computer-on-Modules standards for energy-saving Arm® System on Chip (SoC) processors. Utilising the proven Mobile PCI Express® Modules (MXMs) edge connector, SMARC™ module defined two sizes of module - a full-size module that measures 82 mm by 80 mm, and a short module for more compact systems measuring 82 mm by 50 mm. However, in contrast to the PCI Express® focus of COM Express®, the SMARC™ module pinout provided the flexibility for handling different types of video and graphics output, serial buses, client and host forms of USB, serial and parallel camera interfaces, and support for standard flash-memory card formats such as SD and eMMC.

Subsequently, Intel® improved the power efficiency of its processors with Intel Atom®-based SoCs, allowing x86 architecture products to also benefit from the SMARC™ module format. At the same time, The Internet of Things (IoT) was becoming a hugely significant disruptor, bringing previously unforeseen opportunities as well as challenges for vendors seeking to connect numerous devices with different technological requirements. These developments created a twofold requirement which became the catalyst for SMARC™ 2.0 module: To accommodate universal IoT connectivity and bridge the gap between the specific interface requirements of Arm® and Intel® processors.

In early 2016, Version 2.0 of the SMARC™ module embedded computing format was announced by SGET. Essentially, the SMARC™ 2.0 module specification provided an enhanced pinout to better accommodate customer needs and processor interfaces, perfectly matching the original standard set in 2013 for low-profile form factor modules. The overall goal was to create a new pinout version while at the same time ensuring the highest possible compatibility with the V1.1 pinout. To achieve this, selected, rarely used V1.1 pins were repurposed for SMARC™ 2.0 module to recognize new interfaces. The guiding principle was that there should be no damage if a V1.1 conformant module was built into a V2.0 conformant carrier, or vice versa.

The MXM's 314 electrical contacts were re-focused on supporting and providing compatibility with both Arm® and x86 - two distinct SoC architectures. With Arm®, for example, the connector had to support a parallel TFT display, MIPI display interface, camera interface, multiple SPI connections, and SDIO interfaces. At the same time, be compatible with x86 requirements, offering more USB

and PCI Express® lines, DisplayPort and many more features. Some interfaces which were rarely used or considered outdated were removed from the specification. For example: the Parallel Camera Interface, Parallel Display Interface, PCI Express® Presence and Clock Request signals, Alternate Function Block, SPDIF, one I2S (out of 3) and the eMMC interface to the carrier.

SMARC™ 2.1 MODULE – A NEW SPECIFICATION

SMARC™ 2.1 module introduces a number of additional features as well as a few revision enhancements to the previous 2.0 specification.

At a Glance:

- SerDes signal support for increased Ethernet connectivity
- Additional MDIO interface
- Further GPIOs
- New power and sleep domains
- PCI Express® Clock Request Signals
- Additional Camera Interfaces
- JTAG connector refinement
- MIPI CSI Fill order changes
- Improved documentation

SerDes signal support for providing additional Ethernet connectivity is a notable new feature, enabling two of the four supported PCIe lanes to now be used as Ethernet ports. Further new highlights include PCIe clock request signals for switching off unused PCIe lanes to save power, and 14 GPIO instead of the previous 12.

All of the new features are backwards compatible with SMARC™ 2.0 module. This allows 2.1 modules to be integrated on 2.0 carriers. SMARC™ 2.0 modules are also compatible with SMARC™ 2.1 module via optional extensions. Redesigning existing SMARC™ 2.0 module carrier boards is only going to be required where using the new SMARC™ 2.1 module functionalities is necessary.

SMARC™ 2.1 MODULE: KEY NEW FEATURES AND CHANGES

SERDES INTERFACE SUPPORT

SMARC™ 2.1 module features SerDes in response to new processor developments such as those by NXP and soon Intel. These accommodate various functions on their high speed serial I/O lanes. SerDes support offers greater flexibility for high speed data transmission by allowing the use of previously unavailable interfaces. In addition to the existing two Ethernet ports provided, developers and SIs can use two of the four supported PCI Express® lanes for further Ethernet connectivity Or other high speed signals, that are supported by the used SOC.

The increased scope for Ethernet connectivity is especially advantageous for IoT/IIoT applications, allowing enhanced synchronicity between numerous local devices - enabling high performance IoT Gateways and WLANs for example.

ADDITIONAL MDIO INTERFACE

The additional MDIO interface has been created from previously reserved module pins in order to configure PHYs on the carrier. For example, one of Kontron's latest SMARC™ 2.1 module versions can provide up to six Ethernet ports by utilizing the additional interface for connecting a Quad-PHY on the carrier.

POWER DOMAINS/SEQUENCING AND SLEEP POWER DOMAIN

Additional power and a new sleep domain now make it easier to address low power modes, as well better utilize the sleep and standby features for optimal energy saving.

ADDITIONAL GPIOS

The number of GPIO has been increased from 12 to 14 pins. With several GPIOs having predefined functions, the addition of two more generic GPIOs further enhances the capability and use cases for the module.

PCI EXPRESS CLOCK REQUEST SIGNALS

These were present in SMARC™ 1.1 module, but subsequently removed for the SMARC™ module 2.0. In SMARC™ 2.1 module they have been redeployed for powering down PCI Express® interfaces to save energy.

ADDITIONAL CAMERA INTERFACES

Adding CSI 2 and 3 on an additional connector allows up to four camera connections. This is for addressing the growing array of industrial and non-industrial AIoM (artificial intelligence on module) applications where requiring greater vision is important: In production line quality control, for example, driverless logistics vehicles and drones, medical and healthcare devices. All four camera interfaces can be used in accordance with MIPI CSI 2.0 and 3.0 specifications.

CHANGES AND REFINEMENTS

Fill order for MIPI CSI

This has been revised for helping module manufacturers decide which camera to use when the selected processor only offers one CSI interface. The new fill order is CSI1 first, then CSI0.

JTAG

The JTAG feature has been frequently requested for debugging. However, the previous connector was too cumbersome and has now been replaced by a smaller version to simplify integration.

Documentation

In order to provide greater clarity and avoid unnecessary design errors, all necessary information detailing pin number descriptions, electrical characteristics, power domains is now more concisely presented in a single table.

KONTRON AND THE SMARC™ MODULE CONNECTION

As part of the SGET manufacturer-independent initiative, Kontron has always played a leading role in its development going back to 2012 when the company completed the original SMARC™ module specification under the working title ULP-COM (Ultra Low Power Computer-on-Modules).

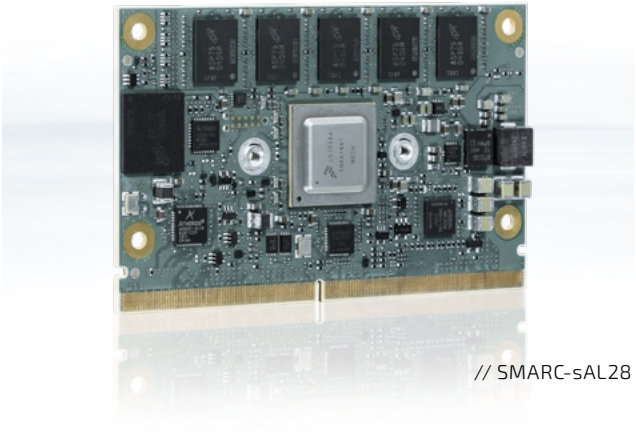
The smooth ratification of the SMARC™ module standard also underlines Kontron's ability to innovate in its role as an international technology leader and as a 'standardiser' of Computer-on-Modules, including the widely adopted COM Express® technology which has been consistently adapted to meet the increasing need for miniaturization on a high performance level. Kontron has always provided extensive support along with notably long-term product availability, allowing industrial customers, partners and module manufacturers to profit from the high level of investment security available.

Kontron was quick to address pent up market demand by launching in 2013 its first highly scalable SMARC™ module families with Arm® SoC processors including the Freescale™ i.MX 6, Texas Instruments Sitara™ 3874, and NVIDIA® Tegra™ 3. These enabled developers to begin work immediately on engineering innovative ultra-low power devices.

Further success came in 2014 when Kontron introduced the world's first ultra-low-power SMARC™ Computer-on-Modules with Intel Atom® processors E3800 series. This was significant as at that time only Arm® processors had been available and therefore the new launch opened up completely new possibilities for developers in terms of the form factor's scalability, software re-use and compatibility.

KONTRON SMARC™ COMPUTER-ON-MODULE SOLUTIONS

Kontron offers a comprehensive portfolio of SMARC™ module solutions including SMARC™ 2.1 module standard compliant versions. For example, the short size form factor Kontron SMARC-sAL28 uses the NXP Dual Cortex®-A72 LS1028A processor and a 3D GPU for powerful performance. It is able to support up to five TSN-capable 1 GByte Ethernet ports and 8 GByte memory - twice the capacity as before - for high network capability in industrial applications. The SMARC-sAL28 is available in three versions, which can be adapted to individual customer requirements. The first version has two TSN-capable 1 GByte Ethernet ports that can be used directly by the carrier; the second has one TSN-capable 1 GByte Ethernet port; the third offers six Ethernet ports with PHY on the carrier, five of which are TSN-capable.



// SMARC-sAL28

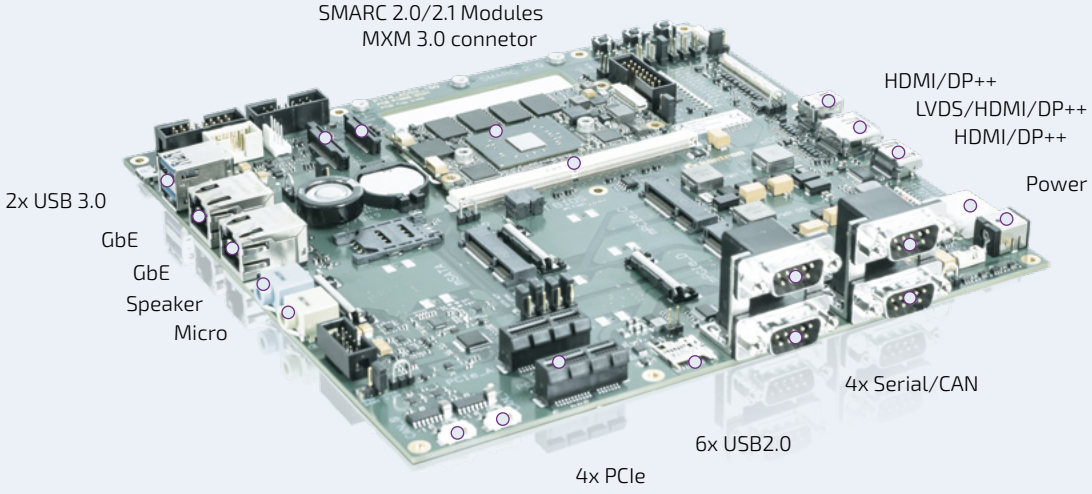
A further SMARC™ 2.1 module solution will be available later this year which uses the low power NXP I.MX8X series processor. Features include dual channel LVDS interface, HDMI, DP, up to 2x GBit Ethernet, 3x PCIe, 6x USB 2.0, 1x USB 3.0.

// SMARC-xAMX8X

The existing range of Kontron SMARC™ 2.0 modules are based on the latest generation Intel and Arm® processors including the highly scalable SMARC-sXAL module, covering the entire range of Intel's latest IoT-ready embedded processors. This includes the Intel Atom® processor E3900 series, as well as Intel® Pentium® processor N4200 and Intel® Celeron® processor N3350. The SMARC-sXAL module is available in both dual-core and quad-core configurations.

Further examples include the extreme low power SMARC-sAMX7 modules with single or dual core NXP i.MX7 processors. These cover an extremely wide performance range and are intended for small and power critical applications. Based on the Arm® Cortex®-A7 technology, they enable an efficient development of smart devices in an extremely compact, fanless design with balanced processor and graphics performance. An integrated Cortex®-M4 can save cost in carrier design by bringing simple control tasks to the module. In addition, The SMARC™ Evaluation Carrier 2.0 offers a head start on total system design by simple selection and installation of the SMARC™ module best suited for the required application. It supports a broad range of interface options for low power applications including 2x Gigabit Ethernet support, SD-card socket, USB 2.0 and 3.0, mSATA, PCIe and many more.

Rapid prototyping - Kontron SMARC™ Carrier 2.0



// All of the new features of Version 2.1 are backwards compatible with SMARC™ module 2.0. This allows 2.1 modules to be integrated on 2.0.carriers.

Kontron SMARC Use Cases

Kontron's well-established range of SMARC™ module COMs is at the heart of a growing number of scalable, high-performance IoT/IIoT embedded computing solutions. The following use case examples serve to illustrate just a few of the numerous embedded computing applications and solutions that are possible due to their high flexibility and cost-effectiveness.

Communication

A telecommunications company in Poland recently specified Kontron's very first SMARC™ 2.1 module as part of the development of a new Network Testing solution. The reasons for selecting Kontron's small format SMARC™-sAL28 COM included the multiple TSN Ethernet connections available and the excellent performance of its NXP Dual Cortex®-A72 LS1028A processor.

Factory Automation

An engineering firm in Germany is using Kontron's SMARC-sXALi module for CNC Control applications. Combining high performance in a small format, these COMs are at the very heart of enabling the automated control of the company's various machining tools including drills and lathes. With state-of-the-art image processing and graphics capabilities, the SMARC-sXAL provides extensive real-time computing power, and very low energy consumption.

Furthermore, a German manufacturing company recognized the sheer price performance of Kontron's SMARC-sAMX6i COM solution. This was one of the main drivers behind its utilization in a Power Wall solution.

Medical

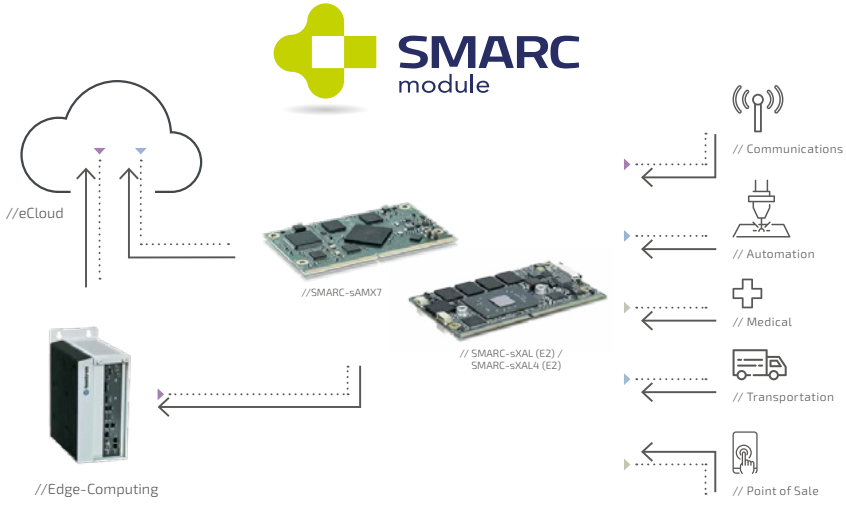
A laboratory diagnostic device for an Austrian medical company features an integrated Kontron SMARC-sAMX6i COM. Managing control and instrumentation, the Kontron module's high versatility was especially well-suited to this application due to the small footprint and ultra-low power NXP i MX6 processor, enabling an extremely compact, fanless design with balanced processor and graphics performance.

Transportation

Price and versatility were two particularly important reasons why a major transportation company in France chose the latest SMARC™ 2.1 module compliant COM from Kontron. In this case, Kontron's SMARC-sAMX8X solution was considered essential for delivering the company's new Hub System, a real-time management information platform used for managing transportation operations. The new Kontron SMARC™ module features the low power NXP I.MX8X series processor combined with dual channel LVDS interface, HDMI, DP, up to 2x GBit Ethernet, 3x PCIe, 6x USB 2.0, 1x USB 3.0.

Point of Sale / Point of Information

The high scalability, I/O performance and extreme low power of Kontron's SMARC-sAMX7 module made it the perfect fit in the development of a German manufacturer's custom-design diagnostic system. Based on Arm® Cortex®-A7 technology using NXP i.MX7 processors, this SMARC™ module covers a wide performance range and is intended for small and power critical applications such as this.



SUMMARY

SMARC™ modules are being rapidly adopted in both industrial and non-industrial markets. With the The IoT/IIoT - and increasingly AI - presenting many new possibilities the latest SMARC™ 2.1 module revision ensures the standard will remain perfectly in step with the needs of developers and SIs. They can be confident of taking full advantage of the increased connectivity options as well as additional performance and functionality available.

Kontron will continue to play an instrumental part in the further development of the SMARC™ module standard. As one of the world's leading embedded computing technology manufacturers, it remains at the forefront of SMARC™ module innovation with a comprehensive range of SMARC™ modules and as evidenced by its first SMARC™ 2.1 module products. Next planned modules will come with Rockchip CPUs to gain a never seen performance/price ratio and with the upcoming new Intel Atom® platform. These, as with all Kontron embedded boards and controllers, are IoT-ready and benefit from deep software integration, extended lifecycle, and global technical support.

SMARC™ 2.0 module	SMARC™ 2.1 module
2x Gigabit Ethernet	4x Gigabit Ethernet*
eSPI	eSPI/QSPI
4x PCIe	4x PCIe*
HDA/2x I²S	HDA/2x I²S
LVDS 2x24/eDP/MIPI DSI	LVDS 2x24/eDP/MIPI DSI
2x MIPI CSI	4x MIPI CSI**
HDMI & DP++	HDMI & DP++
1x SATA	1x SATA
6x USB 2.0/2x USB 3.0	6x USB 2.0/2x USB 3.0
12x GPIO/SDIO	14x GPIO/SDIO
4x SER/CAN	4x SER/CAN
SPI/I²C	SPI/I²C
Power	Power

* 4x Ethernet + 2x PCIe or 2x Ethernet 4x PCIe
** 2x at Flatfoil Connector

▶ For more information about Kontron SMARC™ module embedded systems visit https://www.kontron.com/products/boards-and-standard-form-factors/smarc/

BOARDS & MODULES – SMARC™ module

	SMARC-sXBTi	SMARC-sXAL(4) (E2) SMARC-sXAL (E2)	SMARC-sAMX6i	SMARC-sAMX7	SMARC-sAMX8X	SMARC-sAL28
					 NEW!	 NEW!
COMPLIANCE	SMARC 1.1 module	SMARC 2.0 module	SMARC 1.1 module	SMARC 2.0 module	SMARC 2.1 module	SMARC 2.1 module
DIMENSIONS (H x W x D)	82 mm x 50 mm	82 x 50 mm	82 mm x 50 mm	82 x 50 mm	82 x 50 mm	82 x 50 mm
CPU	Intel Atom® E3845, 4C, 1.91 GHz, 10 W TDP Intel Atom® E3827, 2C, 1.75 GHz, 8 W TDP Intel Atom® E3826, 2C, 1.46 GHz, 7 W TDP Intel Atom® E3825, 2C, 1.33 GHz, 6 W TDP Intel Atom® E3815, 1C, 1.46 GHz, 5 W TDP	Intel Atom® x7-E3950, 4C, 1.6 / 2.0 GHz, 12 W TDP Intel Atom® x5-E3940, 4C, 1.6 / 1.8 GHz, 9.5 W TDP Intel Atom® x5-E3930, 2C, 1.3 / 1.8 GHz, 6.5 W TDP Intel® Pentium® N4200, 4C, 1.1 / 2.5 GHz, 6 W TDP Intel® Celeron® N3350, 2C, 1.1 / 2.4 GHz, 6 W TDP	NXP i.MX 6 Single, Dual and Quad Core ARM Cortex-A9 800 MHz, 1.0 GHz, 1.2 GHz	NXP single/dual i.MX7 processor	NXP dual/quad i.MX8X processor	NXP Dual Cortex®-A72 LS1028A processor
MAIN MEMORY	Up to 8 GByte DDR3L-1333 memory down (ECC optional)	Up to 8GB ECC DDR3L (SMARC-sXAL) Up to 8GB LPDDR4 (SMARC-sXAL4)	Up to 2 GByte DDR3 memory down	Up to 2 GByte DDR3	Up to 3 GByte LPDDR4	up to 8 GByte DDR3L (ECC)
GRAPHICS CONTROLLER	Intel® HD Graphics (Gen7)	Intel® HD Gfx Gen9	Dual Displayz HD 1080p Decode/Encode, 2D/3D acceleration	integrated	integrated	integrated
ETHERNET CONTROLLER	Intel® i210IT	Intel® I210IT / I211AT	Integrated	integrated	1x integrated, 1x on request	integrated
ETHERNET	1x 1 GByte Ethernet	1x 1 GByte Ethernet (SMARC-sXAL) up to 2x 1 GByte Ethernet (SMARC-sXAL4)	1x 1 GByte Ethernet	up to 2x 1 GByte Ethernet	up to 2x 1 GByte Ethernet	up to 2x 1 GByte Ethernet (TSN capable)
SATA	1x SATA 3Gb/s	1x SATA 3 Gb/s	1x SATA (dual/quad core)-solo	-	-	-
FLASH ONBOARD	Up to 64 GByte eMMC	Up to 64 GByte e MMC	Up to 64 GByte eMMC	Up to 64 GByte eMMC	Up to 64 GByte eMMC	Up to 64 GByte eMMC
PCI EXPRESS® / PCI SUPPORT	3x PCIe Gen2 x1	3x PCIe x1	3x PCIe Gen2 x1	1x PCIe with dual core processor up to 3x PCIe (on request)	Up to 3x PCIe	Up to 2x PCIe x1 or 2x PCIe x2 or 1x PCIe x4
PANEL SIGNAL	LVDS Single Channel 18/24 bit or eDP HDMI or DP	1x HDMI (on request DP), 1x DP++, 1x LVDS dual channel (on request eDP)	Parallel LCD 18/24 bit LVDS Single Channel 18/24bit HDMI	1x LVDS dual channel	1x LVDS, 1x HDMI, 1x DP	LVDS dual channel, eDP or DP as BOM option on request
USB	3x USB 2. 1x USB 3.0 (via AFB)	2x USB 3.0 (incl. USB 2.0) + 4x USB 2.0, alternatively USB #0 as OTG	2x USB 2.0, USB OTG	up to 5x USB 2.0	1x USB 3.0, 6x USB 2.0	up to 6x USB 2.0, 1x USB 3.0
SERIAL	1x RX/TX (Ser0) 2x UART (Ser1/3)	4x serial interfaces (2x RX / TX only)	2x RX/TX (Ser1/3) 2x UART (Ser0/2)	4x serial interfaces (2x RX / TX only)	4x serial interfaces (2x RX / TX only)	3x serial interfaces (2x RX / TX only)
ADDITIONAL INTERFACES	HD Audio and I2S, 5x I2C, 2x SPI, Camera Interface (MIPI CSI)	12x GPIO, SDIO, 5x I²C, MIPI-CSI	12x GPIO, SDIO, 5x I²C, 2x I²S, 2x SPI, SPDIF, WDT,	12x GPIO, SDIO, 5x I²C, MIPI-CSI, 2x CAN	12x GPIO, SDIO, 5x I²C, MIPI-CSI 2x CAN	12x GPIO, SDIO, 3xI2C, 1x CAN
OPERATING SYSTEM	Windows® 8, Windows® 7, WE8S, WES7, WEC7, Linux, VxWorks	Windows® 10, Enterprise, Windows 10 IoT, Linux, VxWorks	Linux, Android, WEC7	Yocto Linux	Yocto Linux	Yocto Linux
POWER SUPPLY	3 V - 5.25 V Operates directly from single level Lithium Ion from single level Lithium Ion cells or fixed 3.3 V or 5 V power supplies	3V – 5.25 V operates directly from single level Lithium Ion cells or fixed 3.3 V – 5 V power supplies (SMARC-sXAL) 5V only (SMARC-sXAL4)	3 V - 5.25 V Operates directly from single level Lithium Ion from single level Lithium Ion cells or fixed 3.3 V or 5 V power supplies	3 V – 5.25 V operates directly from single level Lithium Ion cells or fixed 3.3 V – 5 V power supplies	3 V – 5.25 V operates directly from single level Lithium Ion cells or fixed 3.3 V – 5 V power supplies	3 V – 5.25 V operates directly from single level Lithium Ion cells or fixed 3.3 V – 5 V power supplies
TEMPERATURE	Operation: -40 °C to 85 °C	SMARC-sXAL(4): Commercial temperature: 0 °C to +60 °C operating, -30 °C to +85 °C non-operating SMARC-sXAL(4) E2: Industrial temperature: -40 °C to +85 °C operating, -40 °C to +85 °C non-operating	Operation: -40 °C to 85 °C	Operating: extended consumer -20 °C to + 85 °C Non-Operating: -30 °C to +85 °C	Operating: -40 °C to 85 °C	Operating: -40 °C to + 85 °C Non-Operating: -40 °C to +85 °C
SPECIAL FEATURES	Industrial temperature version, ECC, WIndows® 8	Trusted Platform Module TPM 2.0 Security Solution (APPROTECT) on request, Ind. Temp. Grade versions	Ultra low-power, 2x CAN Interfaces	Security Solution (APPROTECT) on request	Security Solution (APPROTECT) on request	Alternate function on PCIe C/D: SXGMII or UXGMII to connect Ethernet bridge phy directly on the carrier (allows up to 5x TSN capable 1 GByte LAN ports), (Support of Kontron APPROTECT) on request

About Kontron – Member of the S&T Group

Kontron is a global leader in IoT/Embedded Computing Technology (ECT). As a part of technology group S&T, Kontron offers a combined portfolio of secure hardware, middleware and services for Internet of Things (IoT) and Industry 4.0 applications. With its standard products and tailor-made solutions based on highly reliable state-of-the-art embedded technologies, Kontron provides secure and innovative applications for a variety of industries. As a result, customers benefit from accelerated time-to-market, reduced total cost of ownership, product longevity and the best fully integrated applications overall.

For more information, please visit: www.kontron.com

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