ADLINK TECHNOLOGY INC.



Technical Forum

SMARC: The Smart Choice for Low-Power Embedded Computing

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SMARC

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SMARC: The Smart Choice for Low-Power Embedded Computing

Background

Thirty years after the mainstream adoption of the personal computer, the industry faces another paradigm shift in information technology. The technology behind the IBM PC and similar machines not only revolutionized desktop computing, but changed the world of embedded computing, which previously was restricted to the use of expensive minicomputers or custom digital logic, with an often prohibitively high cost of non-recurrent engineering.

Embedded PC form factors have enabled systems integrators to implement a wide variety of systems, tackling many different applications. The most successful PC platforms were designed for power envelopes that run from tens of watts to more than a hundred. This puts some portable and low-energy applications out of reach. Using non-PC architectures can extend the benefits of off-the-shelf computing platforms even further.

The rise of architectures designed for mobile phones and tablets introduces a new paradigm. This shift promises to extend the reach of embedded computing into new markets, providing users with not just energy-efficient systems, but intuitive user interfaces based on touchscreens and voice recognition. These interfaces promise to revolutionize treatment in medical applications, provide more sophisticated control to industrial-equipment operators and create the opportunity to access the internet in remote and previously hard-to-reach locations.

Optimized for the mobile phone and tablet markets, the ARM architecture provides an effective alternative that extends the power envelope into low-energy applications where it has previously been difficult to adopt standard form factors, and therefore had to absorb the high up-front costs of custom board and module design. At the same time, ARM offers scalability into upcoming high-performance computing and 64-bit platforms that will make it possible to build advanced, highly energy-efficient server platforms. ARM underpins this new, third generation of embedded computing.

There are strong historical contrasts between the Intel x86 and ARM market environments. Intel has been instrumental in defining not just the core microprocessor and instruction-set architecture, but also the architecture of peripherals. Companies that provide embedded-computing products based on the x86 architecture have been able to leverage that (chip level) expertise by providing either proprietary or open-standard products that employ a common I/O interface. Through the use of common connector pinouts, it is possible for customers to select from a wide range of hardware- and software-compatible peripherals with which they can customize their end products.

COM Express v.s. SMARC

COM Express® is an example of a successful embedded computing I/O standard. It is a computer-on-module (COM) form factor that offers high integration to the degree that a complete, compact PC can be used in an end application as though it were a discrete integrated circuit component. The COM Express module itself typically comprises the core processor and memory together with the standard I/O of a typical PC, including USB ports, audio, graphics and Ethernet networking. The PCI Express lanes and all other I/O signals that provide support for custom I/O expansion are mapped to two high-density, low-profile connectors on the bottom side of the COM.

With COM Express, the emphasis is on high-speed I/O expansion. A pair of high-density connectors provide up to 32 PCI Express lanes and multiple storage, networking and graphics channels. In addition to providing a connector with a high degree of signal integrity and robustness, COM Express provides standardization, which is instrumental in building up a large portfolio of CPU modules and carrier boards from many different vendors. The road to a standard I/O pinout was assisted by the manner in which the PC form factor is itself built on a commonly accepted set of standard I/O functions.

The ARM environment is more complex and differentiated. In contrast to the PC environment, in which the core module is comprised of a processor, Northbridge and Southbridge device, the focus in the ARM market is on system-on-chip (SoC) products, each usually optimized for a particular application. Historically, there has been far less focus on building standard I/O definitions; each SoC would be used on a custom board design. There is also a wider range of I/O options provided by ARM platforms, depending on their target market, with less emphasis on standard buses such as PCI Express.

The result has been the introduction of a number of proprietary form factors and connector definitions that lock the customer into a vendor's offerings and which may not have support for more than a generation of silicon as they move to different SoCs. Some vendors claim the use of a standard form factor—sometimes piggybacking ARM support on an existing x86-focused specification—but with additional custom connectors to provide support for I/O lines that cannot be supported by the primary connectors.

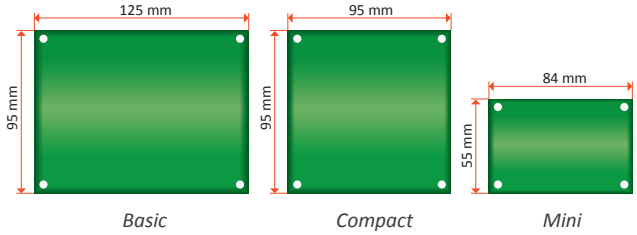
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Advantages of SMARC

Supported by a number of embedded computing module vendors, the Smart Mobility ARChitecture (SMARC) provides an open-standard definition for ARM-based embedded computing solutions, optimized for low power, cost efficiency and high performance. SMARC also provides support for systems that need more compact solutions than are offered by PC-oriented form factors. As ARM SoCs do not need the support chips of a PC platform and draw less power, the amount of board space required for power converters and power supply lines is greatly reduced. This allows the use of a smaller form factor, facilitating application of SMARC-based modules in low-power portable equipment. SMARC CPU modules are expected to have an actual power intake between 2W to 6W, allowing for passive cooling and thus further reducing subsequent design effort and overall cost. The standard allows for up to 9W continuous power draw for more demanding scenarios.

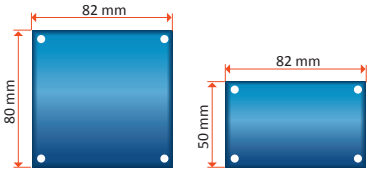
Based on the proven MXM-III connector, that since several years is employed by MXM video modules supporting up to GEN3 PCI Express transfer rates, SMARC defines two sizes of module: a full-size module that measures 82 mm x 80 mm, and a short module for more compact systems that measures 82 mm x 50 mm. The edge connector supports 314 electrical contacts. For systems that are to be used in harsh environments, shock- and vibration-proof versions of the connector are readily available. The temperature range of the connector extends from −55°C to +85°C. Competing systems such as Q7—which also lack the ecosystem advantages of SMARC due to the proprietary extensions used by its restricted group of supporters—are not specified over this temperature range.

● COM Express



Basic *Compact* *Mini*

● SMARC



Full Size *Short Size*

The connection system employed by SMARC offers a number of benefits over competing systems beyond its adoption by multiple vendors, which promises to form the basis of a successful commercial ecosystem. SMARC is based on the new 314-pin MXM-III connector qualified for GEN3. The MXM-III connector guarantees a high degree of signal integrity, required by high frequency serial interfaces that are commonly supported by ARM SoCs. For example, on 2.5 GHz signals as employed by PCI Express Gen 2, the insertion loss of the MXM-III connector is just 0.5 dB.

In comparison, the insertion loss encountered on the connection scheme used by older generation MXM connectors such as the 200 pin MXM-II connector is significantly higher at 3dB.

A further advantage of SMARC over other small module formats is its support for a wider input voltage range, reducing the need to use additional DC/DC converters on the core module and resulting overall power dissipation. A SMARC module can support input voltages from 3V to 5.25V. Many other formats originally designed to support PC-class hardware are restricted to a nominal 5V input.

The SMARC module is designed to support a combined height above the carrier of less than 7mm. The PC heritage of most computer-on-modules has led to the assumption that all COM boards will be used with a heatspreader, which adds to the overall height of the package. The typical combined height of the processor board and heatspreader alone is greater than the height of a package that includes both the SMARC COM and carrier board. Many ARM SoCs do not require a dedicated heatspreader because of their lower overall power consumption. The SMARC format allows for this, making it more suitable for use in systems where space is at a premium, such as tablet computers.

To take advantage of the greater I/O diversity of the core ARM-based SoCs, SMARC uses a different mix of connection options to those offered by COM Express or Q7. In contrast to the PCI Express focus of COM Express, SMARC provides options for different types of video and graphics output, serial buses such as I2C and I2S, both client and host forms of USB, serial and parallel camera interfaces and support for standard flash-memory card formats such as SD and eMMC. Future SMARC modules will also to be enabled to support fieldbuses such as EtherCat, ProfiBus and Sercos.

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Using SMARC, systems integrators can take full advantage of the user-interface options available to mobile device OEMs; options that are not usually found in x86-based embedded-computing systems. For example, SMARC not only supports a direct parallel display bus for low-cost connection to a wide variety of thin-film transistor LCDs, but also supports a display interface compatible with the MIPI specification. This provides access to the smaller, low-cost display modules employed in smartphones or tablets as they find their way into the embedded market.

Because of its I/O flexibility and focus on ARM solutions, SMARC provides the support needed to build scalable solutions. Integrators can choose from a wide variety of processing options, from low-power single core devices such as the Cortex A8 processor provided by ADLINK's LEC-3517, to dual- and quad-core processor platforms.



ADLINK LEC-3517
(LEC stands for Low-energy Embedded Computer Computer)

Thanks to its focused support for the ARM architecture and backing from multiple vendors, SMARC is the key building block for a new generation of embedded computing applications, providing systems integrators with the ability to build their own tablet and other advanced human machine interfaces.

There are additional benefits to using SMARC modules from a vendor such as ADLINK. All ADLINK modules are fully tested and have validated bootloader and board support packages for key ARM-focused embedded operating systems, including Android, Windows Embedded Compact 7, Windows 8 and Windows RT, QNX, VxWorks and Linux. Off-the-shelf support for these key operating systems saves time in R&D and reduces overall design risk.

Conclusion

Thanks to the introduction of the SMARC platform, systems integrators can now take full advantage of the ARM SoC ecosystem without being forced to compromise on I/O options or be tied to a single-vendor standard with limited options for future growth. Through SMARC, integrators and OEMs can be sure of having access to new generations of ARM processors, including the upcoming 64-bit and advanced multi-core products.

As Intel works to improve the power efficiency of its own processors and develops more Atom-based SoCs, x86 architecture products could also benefit from the SMARC format in the near future. As those products appear, designers will have more choice and have access to backward-compatible, low energy consumption products. As the third generation of embedded computing develops, SMARC is a smart choice.

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About ADLINK Technology

ADLINK Technology provides a wide range of embedded computing products and services to the test & measurement, automation & process control, gaming, communications, medical, network security, and transportation industries. ADLINK products include PCI Express-based data acquisition and I/O; vision and motion control; and AdvancedTCA, CompactPCI, and computer-on-modules (COMs) for industrial computing. With the acquisition of Ampro Computers, Inc. and LiPPERT Embedded Computers GmbH, ADLINK also provides a wide range of rugged by design Extreme Rugged™ and Rugged product lines including single board computers, COMs and systems.

ADLINK strives to minimize the total cost of ownership (TCO) of its customers by providing customization and system integration services, maintaining low manufacturing costs, and extending the lifecycle of its products. ADLINK is a global company with headquarters and manufacturing in Taiwan; R&D and integration in Taiwan, China, the US, and Germany; and an extensive network of worldwide sales and support offices.

ADLINK is ISO-9001, ISO-14001, ISO-13485 and TL9000 certified, is an Associate Member of the Intel® Intelligent System Alliance, an Executive Member of PICMG, a Sponsor Member of the PXI Systems Alliance, an Executive Member of PC/104 Consortium, and a Strategic Member of the AXIe Consortium, a member of VMEbus International Trade Association (VITA). ADLINK is a publicly traded company listed on the TAIEX Taiwan Stock Exchange (stock code: 6166).

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