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THE JOURNAL of MODULAR EMBEDDED DESIGN

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PC/104^{and} small form factors

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ARM vs x86: Is x86 dead?

The emergence and media domination of ARM technology could be a nail in the coffin for x86, but each has its own place and may continue to be useful in the future.

Though far away from the clever and polarizing subliminal-marketing tactics of retail brands, a similar battle of "brandism" is paralleled in today's embedded market in the long-fought architectural war between x86 and ARM.

There remain few users who haven't subconsciously succumbed to "fanboyism" themselves; even those who aren't actually users of either architecture have a sufficiently vested interest in either technology that their impartiality itself is long since obsolete. Thankfully my role in the UK embedded industry enables me to analyze this question in depth, without the complication of any bias of my own.

Please note: For the purposes of this article, x86 refers to both 32-bit x86 and 64-bit x64, while ARM refers to all ARM derivatives.

The answer to the question posed in the title would vary wildly depending upon on which sector and within which market you asked. Most, I suspect, would also respond with an equally blinkered insistence of their view. We'll begin with the two obvious polar opposites, which usefully highlight the key benefits of both architectures simultaneously.

The mobile/multimedia mogul would be astounded at any suggestion that x86 ever had, let alone deserves, any current or future place in his product line of – for example – smartphones and tablets. ARM's low power has enabled battery life that its x86 equivalent could merely dream of, while its built-in multimedia

decoding capabilities enable even 1080p HD video playback in the tiniest of packages relative to the substantial real estate an x86 system would require. It's easy to see how in this industry, yes, x86 would be dead – if it were ever really alive!

The scientific data processor, needing to process and analyze millions of pieces of data, would abhor replacing the blistering performance obtained from x86 with an ARM equivalent. This industry cares little about low power beyond its general environmental credentials, and certainly not in tradeoff to processing performance. While ARM may one day come close to the x86, its disparate focus would suggest this is improbable.

In which direction the scales tip is dependent upon a number of factors, but the most important in our industry today remain processing performance, power consumption, and quantity. The outlook grows increasingly murkier as time progresses, but as a general rule, if production quantities are high and processing performance and power consumption requirements are minimal, ARM is likely to be the way forward.

If the opposite scenario is true, x86 will almost certainly remain the most efficient route. Rarely will your application follow those rules precisely, and between lies a grey area. In these instances, do your research thoroughly, or contact an unbiased industry expert for advice – ensure that these experts work with both architectures to ensure impartiality.

One big problem for ARM initially was a lack of familiarity among programmers of x86 toolsets. While ARM evidently offered huge advantages in power consumption and cost, the initial cost outlays in development tools and engineering

learning curves left it to only the highest quantity applications.

Even having overcome the initial development hurdles, the unfamiliarity of ARM technology with those further down the chain – such as system integrators, installers, and maintenance engineers – may have found increased overall cost due to their own learning curves. This was exacerbated by the typically less "layman-friendly" Operating Systems (OSs) that ARM technology at the time supported. For example, even the Microsoft ARM flavor, Windows CE, offers almost zero support for retrospective modification once the image has been built and deployed.

Initially, due to entire infrastructures being x86-based, it was difficult to integrate non-x86 equipment without expensive translation requirements – a barrier for truly connected systems, especially in an enterprise environment. Thankfully, those lines have blurred so much since then that this is no longer considered an issue.

In fact, one begins to wonder: With the technological advancements that ARM technology has made to address every one of its historical shortfalls, has x86 hung on this long in what appear to be heavily ARM-suited applications only due to its engineering familiarity?

In these low-power, probably mobile applications, what has potentially held back the demise of x86 (but could also end up being the nail in the coffin for it) is the new generation of engineers brought up on ARM; for them, x86 will then assume the role of the unfamiliar, cumbersome, and inflexible architecture that ARM held for so many, for so long.

This article originally appeared online at embedded-computing.com/articles/arm-x86-x86-dead/.

PC/104 and small form factors

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ON THE COVER:

As embedded applications are swept into the Internet of Things (IoT) era, Small Form Factor (SFF) board developers and end users are faced with a new processor paradigm that emphasizes low cost, low power, and extreme connectivity. These characteristics have piqued interest in ARM-based Systems-on-Chip (SoCs) lately, but several design considerations remain before jumping into this emerging class of embedded processor boards.



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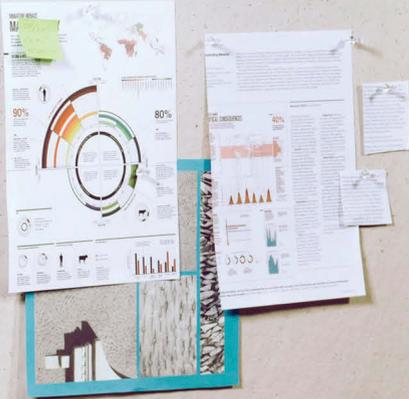
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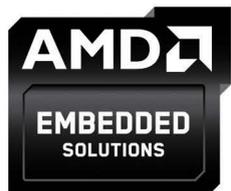


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PC/104 Consortium



By Dr. Paul Haris, PC/104 Consortium Chairman and President

PC/104: Stackable, mezzanine, card cage attributes

Choosing an embedded architecture for your system can be a daunting task. It necessitates an alignment of your short- and long-term requirements with the design tradeoffs of each available embedded architecture. Generally, you can classify these architectures as stackable, card cage, and mezzanine Computers-On-Module (COMs). Tradeoffs

can include off-the-shelf or custom PCB design requirements; I/O expandability or one-time built-to-spec; end-user maintenance or Original Equipment Manufacturer (OEM) maintenance; evolutionary architecture or time-static architecture; and backward compatibility or not. Each type of architecture has its superior attributes depending on the application and situation. None serve all, but the stackable PC/104 architecture overlaps the others (Figure 1).

Card cage systems are built on the concept of sliding individual modules on two rails into a fixed enclosure with a common bus. All I/Os are typically brought out on one side of the PCB pointing toward the front. The common bus interface allows many vendors to create multitudes of modules with varying processor and I/O capabilities. OEMs can buy these off-the-shelf modules, plug them into the card cage, and get operational quickly. Because the end user has the ability to maintain systems based on this architecture, these systems can be readily found in a variety of locations.

But as one's application becomes more embedded – and size, weight, and cost are of concern – the fixed card cage architecture becomes less optimal and efficient, especially if there are unused slots or you don't have enough of them. Additionally, as the architecture advances, backward compatibility to an already installed fixed card cage may not be realizable without replacement or upgrade.

The PC/104 architecture evolved to address these embedded issues by keeping the common backplane while eliminating the card cage. It takes the common bus and places it directly on each module in a predetermined location. Connectivity is achieved by stacking the modules together, thereby freeing up a PCB side




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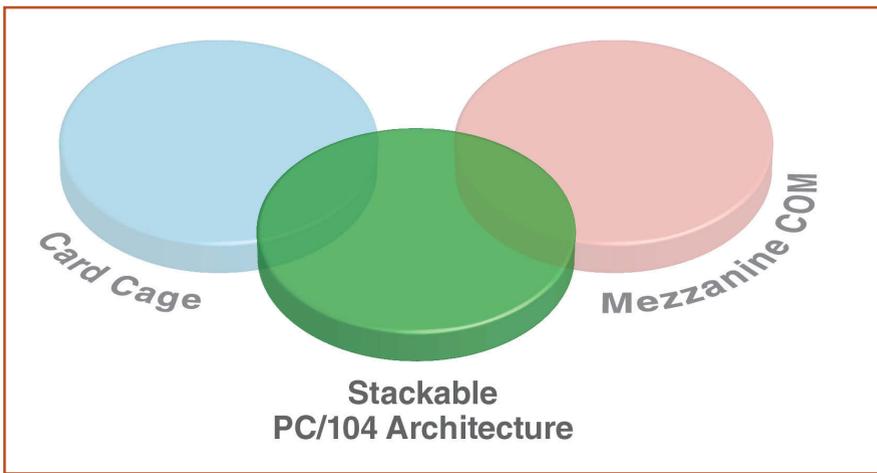


Figure 1 | Each Small Form Factor (SFF) implementation has its advantages and costs.

for complex systems that require additional functionality and I/O not found on today's processors, and for those end users who want fully operational off-the-shelf processor and I/O building blocks without the need for additional design, mezzanine COMs become less optimal.

The embedded market is a vast and rapidly growing industry. The end user has evolving, time-tested architectures to choose from. No one architecture can serve all, but understanding how your program will progress is key to the choices you make because in the end, failure is not an option. **SFF**

for additional I/O connectors. As with the card cage architecture, manufacturers and OEMs are able to create a vast array of interoperable CPU and I/O modules spanning all applications and industries. Development infrastructure is reduced since PC/104 stacks are small and can be booted up without an enclosure. Additionally, the PC/104 architecture has standalone capability and I/O connectors to allow quick out-of-the box development as Single Board Computers (SBCs). When required, enclosures can be standardized or customized to a particular need, thereby minimizing size and weight while maximizing connector location.

The stackable PC/104 architecture also has an additional feature: processor and I/O mezzanine capabilities. Since each module connects through a standard bus – such as PCI Express (PCIe) – and since each contains all of its I/O connectors, other architectures can add the stackable PC/104 connectors to create easily expandable features. As such, you will often see PC/104 expansion connectors on card cage and motherboard systems. Mezzanine COM modules evolved as a way to concentrate the complex PCB routing associated with processors on a single COM module. It is essentially removing all of the I/O connectors from a PC/104 processor module and routing the signals along with the standard bus connectivity, such as PCIe, down through a common connector to a baseboard. By doing this, the size of the complex processor PCB may be reduced, which may reduce its cost. The end user is free to create unique baseboard configurations for their applications, which may result in an optimized system. However,



your data conversion ability

The image shows a blue, rectangular MACC device with three connectors on the front panel labeled J1, J2, and J3. The device has a textured surface and the 'MACC' logo is visible on the top right.

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By Alexander Lochinger, SFF-SIG President

Rugged COM technology ascends to new lows

Computers-On-Module (COMs) have already penetrated a sizable portion of the medical device market along with slot machines, industrial automation, and various network-communication applications. The recent embedded world show in Germany revealed a clear trend toward cost-optimized COMs using gold-plated card edge connectors that plug into cheap consumer memory-style connectors. Although these devices may fit in mainstream, fixed-location commodity applications, they don't meet the demands of portable system manufacturers who need rugged, gas-tight mating connectors between their various boards.

The Small Form Factor Special Interest Group (SFF-SIG), a trade group that focuses on rugged and reliable embedded technologies rather than consumer and enterprise markets, formed a working group to fill this need. The group found that a board-to-board connector pair was needed in order to meet stringent requirements for shock, vibration, temperature, dust, corrosion, and the ever-denser computing needs of military display terminals, soldier-wearable computers, and commercial fleet vehicles. Board-to-board mated connectors – designed for high reliability and harsh environments – have substantial connector wiping during insertion and strong retention forces. The end result is a rugged-by-design module standard called CoreExpress.

Minuscule mezzanine module

A COM and carrier combo is the new popular approach to optimized custom small form factor system designs. Think of CoreExpress as a tiny mezzanine CPU module that mounts parallel to the main board or carrier board. At smaller than the size of a credit card, the 58 mm x 65 mm CoreExpress module is among

the smallest open-standard form factors for x86 processors. The two boards are joined via four mounting holes, screws, and standoffs.

The CoreExpress specification uses Tyco board-to-board connectors for all signals that pass from the processor module to the custom carrier board. CoreExpress even goes a step further as a purely digital module, reserving Ethernet PHY on the carrier board so that analog signals do not go through the additional set of connectors, unlike other COM standards. The SFF-SIG prefers to keep digital harmonics away from sensitive analog circuits.

Low-power, x86-based assurance

Intel processors are often favored for long life cycle and wide temperature operation. The Atom E620T is the current entry point for basic display and system-control processing, at 600 MHz with a -40 °C to +85 °C operating temperature range. Another obvious direction in the board space is the use of ARM processors; however, x86 Operating Systems (OSs), device drivers, and tools are still more familiar and time-tested than their ARM counterparts among OEM board users.

Many new COMs are available with only 1 GB or 2 GB RAM. CoreExpress modules also offer a lower entry point of 512 MB for basic control applications. The Atom E6xx platform provides one USB client port in addition to six USB host ports. This client port is well-suited for mobile applications. A Controller Area Network (CAN) port is useful in factory environments as well as in military and commercial vehicles, and is even used in some medical devices. LVDS provides a basic LCD interface for up to 1,280 x 768 pixel resolution, while PCI Express, SATA, and LPC bus round out the CoreExpress module feature set.

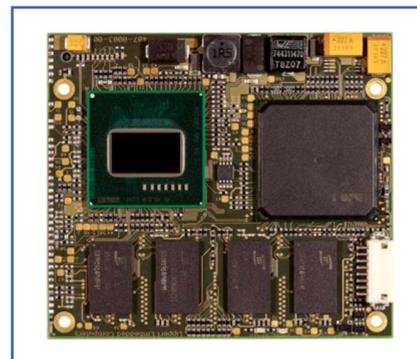


Figure 1 | ADLINK's CoreExpress-ECO2 module drives power consumption below 5 W.

The race to capture the burgeoning consumer tablet market has certainly benefitted embedded designers, giving them broader processor choices, but the latest generations of these tend to go overboard with power-hungry graphics to play streaming video. CoreExpress uses restraint and aims squarely at basic Linux and Windows applications for tiny rugged applications instead. ADLINK (Taiwan and U.S.) and Syslogic (Switzerland) are both providing Atom E6xx-based CoreExpress modules that meet these stringent specifications.

COM technology has advanced to new lows – smaller size, lower power, lighter weight, lower analog-digital noise coupling – all with less bending during shock and vibration loads. Atom-based modules like the one shown in Figure 1 are already available and have been tested in demanding applications. Unlike with most other trade organizations, SFF-SIG specifications like CoreExpress can be downloaded for free and without providing contact information. Download today or browse other specifications at www.sff-sig.org.

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Linux the popular BSP choice for PC/104 and SFF users

By John McHale

PC/104 and Small Form Factor (SFF) board users – whether in military, industrial, or transportation applications – want Board Support Packages (BSPs) that are robust, low-cost, and provide long-term support. Due to its open-source nature, the Linux Operating System (OS) is meeting these requirements while running into fewer obsolescence issues. The popular OS's flexibility also helps solve challenges with ARM processor implementations.

When choosing a Board Support Package (BSP) for PC/104 products, it is essential to pick the right one out of the gate to ensure that the development process starts efficiently, and to prevent major obsolescence and costly expenses in the long term. Windows XP going End of Life (EOL), funding cuts in defense programs, and the need for a larger developer base are all driving users toward Linux, even in military applications where a Real-Time Operating System (RTOS) is the more traditional choice.

"The ability to use a standard COTS PC design lowers both software and hardware costs, while the compact ruggedized form factor allows for deployment in space-constrained hostile environments," says John Blevins, Director of Product Marketing at LynuxWorks in San Jose, CA

(www.lynuxworks.com). "Both Linux and Windows have been popular OS choices for PC/104 systems where there are no real-time requirements. Many PC/104 vendors are including Linux with their hardware at no charge, and that may appeal to a variety of customers."

"The majority of our customers are running a version of Windows Embedded or Linux on our PC/104 products, which use x86-based processors," says Robert A. Burckle, Vice President of Sales and Marketing at WinSystems in Arlington, TX (www.winsystems.com). "Though we provide Windows and Linux drivers for the unique functions of our products, these are not typically known as BSPs. We offer preinstalled OSs on industrial flash to get developers started quickly. This approach allows a

developer to have a bootable system out of the box so they can begin testing and developing application code right away.

"Since PC/104 is traditionally PC-compatible, the BIOS and OS handles the initialization code traditionally provided in a BSP," Burckle continues. "We do have customers that require RTOSs, and they have been very successful using the generic PC-compatible BSPs from various vendors."

"A majority of the customers for Curtiss-Wright's Parvus products appear to be deploying a Linux OS in our DuraCOR mission computers, so BSP requests primarily occur when VxWorks requirements surface," says Adam Thompson, Principal Applications Engineer at

“Linux, in addition to bringing all the benefits that derive from having an open architecture, in many cases also provides a smaller OS image load, in terms of storage space requirements, than Windows.”

– Adam Thompson, Parvus Products, Curtiss-Wright Defense Solutions

Parvus Products, a Curtiss-Wright Defense Solutions company in Salt Lake City, UT (www.parvus.com). “We may also support desktop Windows and Windows Embedded OS loads.”

Linux advantages

“Linux and Free and Open-Source Software (FOSS) provide a low-cost alternative with a huge development community,” Burckle says. “For our customers, product longevity is often much more critical than the actual cost savings. Not only do they have access to the source code, they are not forced to go through a new design cycle due to licensing or EOL concerns.”

“From our vantage point, the popularity of Linux exceeds that of Windows with our DuraCOR customers, but it also seems that every customer has their own particular favorite Linux distribution, with CentOS, Red Hat, Ubuntu, Fedora, being some of the more common,” Thompson says. “But we also see ‘roll-your-own’ versions as well. Linux, in addition to bringing all the benefits that derive from having an open architecture, in many cases also provides a smaller OS image load, in terms of storage space requirements, than Windows.” Development and compiling tools are widely available for Linux and most require minimal financial investment, although some specialized distributions – for example, Wind River Linux – are exceptions.

Windows trends

The battle against obsolescence – of both hardware and software products – is probably the biggest fight engineers face in today’s electronics systems. Windows XP going EOL is a recent example, but it mostly affects the customer base of PC/104 users in the industrial world rather than in the military, as there is not much Windows use there.

“So far our customer base does not seem to be affected by Microsoft’s product

lifecycles,” says Chris Douglass, Senior Software Engineer at Orion Technologies in Orlando, FL (www.oriontechnologies.com). “We see people moving toward Linux while also still choosing VxWorks for their real-time needs.”

“The majority of our customers using Windows 7 use the Embedded Standard version, which has extended support until October 2020,” WinSystems’ Burckle says. “The concern we have seen with Windows Embedded 8 is the activation process required. Since many embedded devices may not connect to the Internet directly, the activation must be handled prior to shipment. For those using full installations of Windows 7 Professional, migration to Windows 8 is expected to be relatively smooth and they will continue to get extended support into 2020.

“We currently see a nearly even split between Windows Embedded and Linux,” he continues. “The two definitely make up the lion’s share of the OS requests that we receive, though we do receive requests for Android on the ARM products. Each solution has benefits and it really depends on the customer’s requirements and their software team’s experience. Windows Embedded continues to leverage a vast network of software developers as well as stable development tools. Some of the advantages are quick time-to-market and the ability to lock down the OS so it is more secure and resistant to file system damage from an unexpected system power loss.”

ARM challenges

The flexibility of Linux also helps, along with the Android OS, in solving problems unique to the growing implementation of ARM-based solutions.

“Unlike x86 platforms, ARM BSPs require detailed information to be provided to customers concerning the tool chain configuration and processor specifics,”

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Burckle says. "We still take the approach of providing a preinstalled OS for Linux and Android so developers can get started quickly and have a sanity check during development. However, we also provide documentation so customers can set up a development environment similar to the one used to create the images. This allows them to further leverage the development resources. This is a major time saver for engineers new to developing for ARM products, and also provides the essentials needed by those with more experience and their own method of development."

Figure 1 | WinSystems recently introduced two 3.5-inch Single-Board Computers (SBCs) that use the IO60 expansion modules – one based on the Freescale i.MX6 ARM processor and another based on the Intel Atom E3800 processor.



WinSystems recently introduced two 3.5-inch Single-Board Computers (SBCs), one based on the Freescale i.MX6 ARM processor and one based on the Intel Atom E3800 (Bay Trail-I) processor,

Burckle says (Figure 1). Both provide computing, graphical, and media capabilities while operating at an extended temperature range. "The peripheral and I/O supported on the boards are similar, including the new IO60 expansion modules. These products allow designers a solution with either an x86 or ARM solution, along with the BSPs and system designer's OS of choice," Burckle adds.

BSP choices by industry

Not every industry embraces every OS, however; unique application requirements often drive users to one particular solution, such as RTOSs being used almost exclusively for mission-critical military applications. However, Linux seems to be crossing industry boundaries.

"Many military applications using PC/104 technology are leveraging the newer PCI Express cards for networking and USB support due to the network-centric focus and situational awareness on the battlefield," Blevins says. "Industrial applications tend to be more concerned with sensor data acquisition and motor control on production lines. Transportation applications often add GPS sensors and graphical mapping applications. However, as the Internet of Things (IoT) evolution continues to add billions of new devices to the Internet, the demand on new devices may begin to span many of these traditionally specialized industries."

"We see Department of Defense (DoD) customers moving toward Linux because it can be supported long term and is more cost-effective than a typical RTOS," Orion's Douglass says. There are methods for enabling real-time functionality in a Linux-based system through partitioning, he adds. Linux has a very robust set of network capabilities and a strong set of tools that originates from

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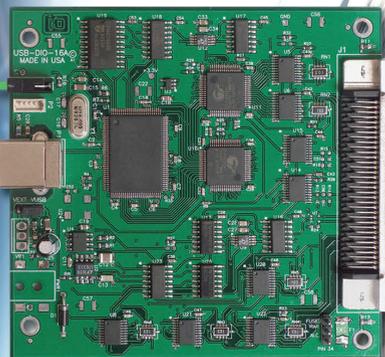
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Figure 2 | The Parvus DuraCOR mission computer product family sells with Linux CentOS and Windows 7 as standard options with Windows Embedded and VxWorks by special order.

the free effort behind the open-source OS, Douglass believes.

"Linux seems to have a healthy share in the [military] market," Thompson says. "The PC/104 SBCs we have traditionally sold go into a variety of civil and military applications and they typically had Linux and Windows Embedded as their predominant OS, but we may not always know the end application. The Parvus DuraCOR mission computer product family, which integrates PC104 Intel SBCs ranging from Intel Atom to Core i7, sells with Linux CentOS and Windows 7 as standard options, with Windows Embedded and VxWorks by special order." (See Figure 2.)

Linux has flexibility, but some still feel the determinism and long-term support of an RTOS can't be beat. An RTOS is usually better suited for military applications because it has the benefit of hard real-time deterministic performance, native POSIX (UNIX) APIs, as well as built-in security and safety certification features, Blevins says. "LynxWorks is pairing LynxOS 7.0, our next-generation deterministic hard real-time operating system, with PC/104-Plus systems such as the Atom-based ADLINK CoreModule 720 SBC."

"RTOS popularity is not exclusive to military applications, as we see customers in both industrial and transportation markets choosing VxWorks," says Nirav Pandya, President and CEO of Orion Technologies. Like the military, these customers also require products to be in the field for as long as a decade and need the long-term support an RTOS will give them, he adds.

"Wind River's approach to long-term support fits better than Microsoft," says

Jeff Van Anda, Vice President of Engineering at Orion Technologies, "especially when the customer has to

deploy the system for decades, Wind River is more accommodating." Orion Technologies offers the PCI7620 SBC that leverages the 4th generation Intel Core i7 for use in military, industrial, or commercial applications. It is available in commercial temperature ranges, and air-cooled to extended temperature ranges.

"We have not noticed a bias among the different industries that we serve," Burckle says. "Each industry uses Windows, Linux, and other OSs depending on the functionality and security concerns of each specific application." **SFF**

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COM Express mini, Qseven, SMARC meet at the crossroads of an evolving processor landscape



Dan Demers



Robert Helenius



Jack London

Interview with Dan Demers, congatec; Robert Helenius, Hectronic; and Jack London, Kontron

While ARM Systems-on-Chip (SoCs) are bringing a legacy of mobility to "mini" Computer-On-Module (COM) standards, power reductions in x86 technology have made Intel and AMD-based options increasingly suitable for the shrinking PCBs needed in ultra-portable applications. This *PC/104 and Small Form Factors* interview examines how trends in processor technology are affecting the bantamweights of the COM class with a look at the COM Express Type 10, Qseven, and Smart Mobility ARChitecture (SMARC) specifications. Edited excerpts follow.

How have advances in silicon technology affected the "mini" Computer-On-Module (COM) class?

LONDON, KONTRON: When COMs first appeared in the market, the performance attributes of a module were restricted to the thermal power dissipation. The [original COM Express] specification allows for a high level of dissipation of 100 W+, but to support this level the module would have to have a significant and unreasonably sized thermal heat sink to properly cool. Subsequently, designers tend to focus on limiting their designs to a more modest 45 W – 50 W Thermal Design Power (TDP). For this reason, most embedded module suppliers opt to use the mobile-processor SKUs that tend to have significantly more available thermal options compared with their desktop brethren.

Now that silicon lithography geometries have advanced to allow more gates, hence processing power, but at lower TDP, the overall performance capability of a given module has improved significantly without materially adding to the TDP overhead. The net result is that

designers are getting more performance without having to accommodate a higher TDP in their application.

"The developers are reaping the benefit of a broad and growing product offering from an expanding ecosystem of embedded COMs manufacturers who are committed to providing standards-based platforms and system building-block solutions."

– Jack London, Kontron

DEMERS, CONGATEC: With the introduction of the Intel Atom processors, especially the second generation and now the third, you're seeing modules that are in the \$200 range that are really fast and have a lot of memory. It's a different world. This is what's also helping modules to make sense in the higher volume designs, versus people designing their own board because we're only talking a couple hundred bucks; we're not talking \$500 – \$1,000. So that helps. That whole, "I can't get an Intel platform for less than \$500," well, now you can, and it's not a dog.

If you go back to 2008 when Qseven was first designed and the specification first gelled, everybody agreed on a 12 W ceiling for total power draw. So that kind of weeds out applications and draws a line in the sand for designers. Most applications that we're seeing people are trying to drive down [power consumption] as far as they can; people love the 5-W world, especially on the x86 side of things. On the ARM side of things, everybody would laugh at me for saying that because they're like, "no, we want 2 W, 3 W." But in the x86 world for all the guys that have done Intel and AMD for decades, if you can get 5 W, 6 W, 7 W, that's a whole new solution for them. You're talking fanless, mating the silicon directly to a cooling device that's part of the chassis. Doing designs those types of ways is something that the ARM guys have always done but the x86 guys now get to do.

Figure 1 | The conga-MA3 is congatec's first COM Express Type 10 mini form factor module, and is equipped with either a low-power Intel Celeron or 3rd-generation Intel Atom processor.



Figure 2 | The Smart Mobility ARChitecture (SMARC) supports ARM-based Systems-on-Chip (SoCs) as well as x86 processors. Pictured here is the Kontron SMARC-sXBT based on the Intel Atom processor E3800 series.



When you get into [COM Express] Type 10 or Qseven, there's still a range and there's still some scalability there (Figure 1). You could have a single-core Atom processor up to a quad-core Atom processor – but it's not always that the customer wants that quad-core because a lot of times in these smaller systems they might actually mean smaller resale prices at the Original Equipment Manufacturer (OEM) level, so they're a little more cost-conscious and they are more power-conscious. So we start seeing the mid-level SKUs being pretty popular: Things like dual-core versus quad-core, things like 2 GB of memory versus 4 GB of memory.

How has the rise of ARM-based processors impacted a space that has been traditionally x86-centric?

LONDON, KONTRON: The impact of ARM SoCs in this class of COMs for embedded platforms is not cannibalizing the other COMs so much as it is augmenting the options that designers can draw from. As SMARC continues to be adopted by other embedded manufacturers, more and more ARM-based solutions are emerging. The intent of SMARC was not to displace x86 solutions. In fact, Kontron recently announced an x86-based SMARC module to not only meet market needs but also to highlight the versatility of the SMARC specification (Figure 2).

The developers are reaping the benefit of a broad and growing product offering from an expanding ecosystem of embedded COMs manufacturers who are committed to providing standards-based platforms and system building block solutions.

HELENIUS, HECTRONIC: At the same time that ARM is moving up in performance, x86 is going in the other direction. When people understand that we are in this spot I think that most companies will begin focusing more on understanding the two ecosystems and the effort that is needed to make an ARM system versus an x86-based system.

The majority of our customers are either using Qseven [exclusively] for x86 or Qseven [exclusively] for ARM; however, there are customers that are moving in both directions. There is a large and growing number of requests for high-end ARM processors on Qseven or SMARC, and a lot of first-generation ARM-based Qseven modules have been designed according to Qseven Revision 1.2, though I'm expecting that most new modules should be designed according to Revision 2.0.

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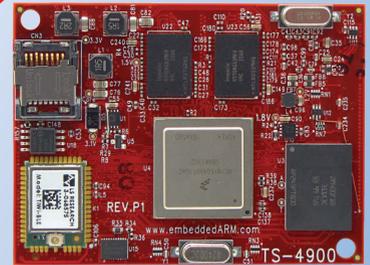


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Hectronic has designed our Revision 2.0 modules so that they in most cases will work without any problem on a Revision 1.2 carrier (Figure 3). However, there are always compatibility challenges between different revisions and different manufacturers, and supporting ARM and x86 will add additional challenges.

Given the small size and wide range of processor support, what are the pinout and connector implications in the "mini" COM module space?

LONDON, KONTRON: The SMARC pin-out is optimized to support specific I/O functionality that is more commonly identified with ARM technology. ARM has typically been employed to support more of the "non-PC-like" interfaces such as MIPI, CSI, and parallel TFT display buses found in many of today's mobile and handheld devices. The MXM3 card edge connector used on SMARC modules has 314 pins available for I/O and power connections, compared with other form factors in its class that are limited to 230 pins (Table 1).

The extra pin count on SMARC allows for greater functionality, as well as future expandability functions as the specification continues to evolve and expand. This additional pin count gives designers freedom to add more functionality into their application in less total surface when comparing SMARC with Qseven. Similarly, the MXM3 connector has more pins than the 220 on the COM Express Type 1 and Type 10

Figure 3 | Qseven Revision 2.0 added significant provisions for ARM processor support, though ARM- and x86-based modules were produced under Revision 1.2. Shown here is the Hectronic Q7-IMX6 based on Freescale's i.MX6 ARM Cortex-A9 core, which is compliant with Qseven Revisions 1.2 and 2.0.



Module	Pins	Size	Area
SMARC (short)	314 pins	82 mm x 50 mm	4,100 mm ²
COM Express mini	220 pins	84 mm x 55 mm	4,620 mm ²
Q7	230 pin	70 mm x 70 mm	4,900 mm ²
SMARC (full size)	314 pins	82 mm x 80 mm	6,560 mm ²
COM Express compact	440 pins	95 mm x 95 mm	9,025 mm ²
COM Express basic	440 pins	125 mm x 96 mm	11,875 mm ²

Table 1 | Displayed here are the various size, area, and pin metrics of several leading Computer-On-Module (COM) specifications. Table courtesy of Kontron.



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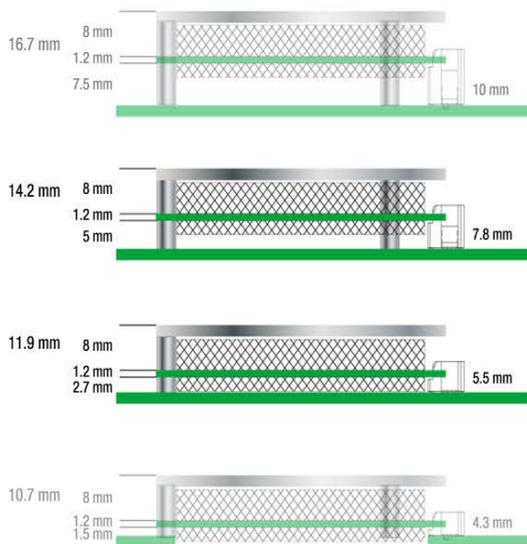
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Qseven



COM Express

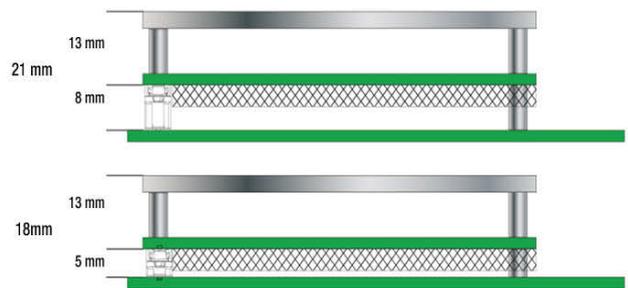


Figure 4 | A variety of connector height options in Qseven and COM Express offers design flexibility in that components can be added to the underside of a module for more functionality, or removed for an extremely low-profile carrier/module combination. Note that COM Express Type 10 employs an A-B connector, whereas Qseven uses the MXM connector developed by Nvidia. Image courtesy of congatec.

A-B connector, but has fewer compared to the COM Express Type 2 and Type 6 pinout configurations.

DEMERS, CONGATEC: If you look at the A-B connector on COM Express, which is the only connector that's on Type 10, and you look at the edge connector on Qseven or SMARC, the signals are very, very similar. Now, obviously it's a different pinout – one's a board-to-board connector, one's an edge connector, so they're not all going to be the same traces.

One of the nice things about Qseven and COM Express is there are multiple heights of these connectors, so you have an ability to scale in overall height (Figure 4). One of the ideas behind COM Express and Qseven from day one was, "let's give the user multiple heights on standoffs and connectors so they can judge whether or not they want to have components on the top side of their carrier board that would reside right under the module. So it gives some more flexibility to the designer. There's even a Qseven height connector that, if you were to use it, you would have to have a cutout in your carrier board because it's so short that the module components would actually hit your PCB even if you didn't have components on your carrier board. That's how low it is. So at the

end of the day, if you look at that sandwich, that's almost a monolithic board at that point.

How is a two-board COM approach able to meet the cost-conscious designs of the mini/mobile space?

LONDON, KONTRON: While it is true that designers can allocate cost targets to certain functions of the system, one has to consider the entire functional solution as a whole. In this case, the combination of a module and carrier board serves as a functional unit versus discrete functions. Comparing a two-board solution to a single-board solution is a valid comparison, as there may indeed be a premium for the two boards versus a single board. However, one has to offset that premium with the advantages gained by having a flexible, reusable carrier board that will scale with the application rather than requiring a dedicated PCB for each product SKU within a product line.

DEMERS, CONGATEC: I kind of equate it to the idea of a car manufacturer like Audi. They have an A3, an A4, an A5, and an A6. So there are four product families and as consumers we all know that one is better than the other because you're moving up the food chain. But if you look at those products, they put the same

engine in all four of them. They're reusing technology, which drives cost down. So, if you're an OEM designing multiple products with the same carrier board, that is cheaper than designing four products with a different motherboard in each one.

That module and carrier design takes, in many cases, six to nine months less time to design than a single monolithic board. So that's significant design time – design time is money. Getting to market quicker is money. You're saving a lot getting to market quicker and reducing the amount of effort to get there. So there are certainly cost savings involved, which, depending on your system, can be in the six figures, easy. **SFF**

Dan Demers is Director of Marketing, Americas at congatec.

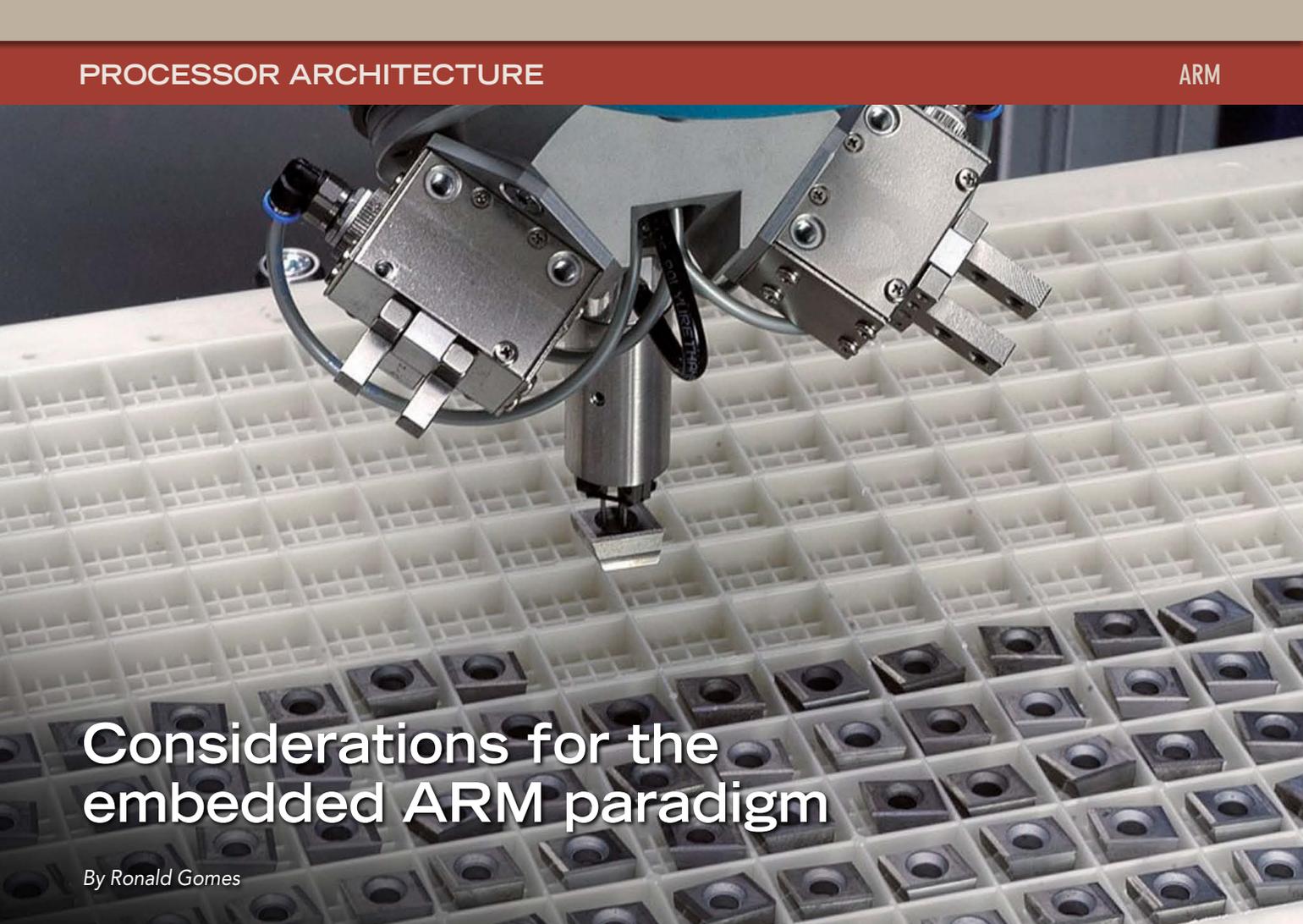
Robert Helenius is Product Manager at Hectronic AB.

Jack London is Business Development and Product Manager at Kontron.

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Considerations for the embedded ARM paradigm

By Ronald Gomes

Although defining the “embedded” market can be a point of contention, the 2000s saw significant growth of ARM-based products in a range of vertical industries. In many cases, ARM-based processors are now head-to-head with their x86 counterparts in the embedded segment, with the Small Form Factor (SFF) Computer-On-Module (COM) market being no exception. As ARM expands into promising markets such as the Internet of Things (IoT), it is also growing in the embedded development arena.

ARM and x86-based embedded systems, through efficient and compact Integrated Circuits (ICs), are enabling new Small Form Factors (SFFs) to get even smaller. In the 1980s and '90s, x86 thrived in the embedded arena as it provided a familiar software platform that allowed engineers to focus on the hardware challenges of complex digital systems. Soon after, Intel- and AMD-based SFFs like PC/104 became popular as general-purpose motherboards that simplified design and integration in a variety of highly diverse, lower volume applications, eventually leading to the rise of an x86-centric class of off-the-shelf embedded computers.

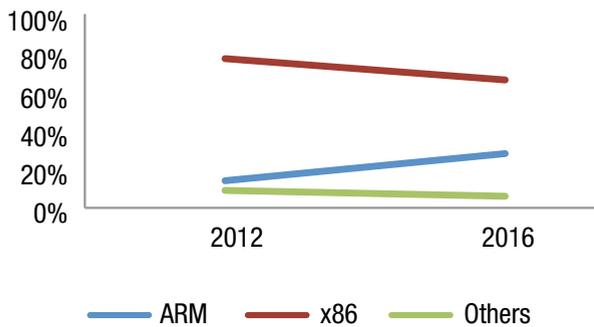
Since then, the focus of embedded system development has shifted to power, performance, and cost optimization, with a reaffirmed emphasis on reliability. This transformation suited ARM processing technology perfectly, as the license-based architecture was born with low power, low cost, and manufacturing flexibility at its core. By the late '90s, ARM began gaining visibility in embedded systems for its combination of respectful computing performance with low cost and impressively low power, as well as uptime improvements. Less heat, fewer components, and no moving parts have always been critical factors in deterministic systems, and

the flexibility of ARM made the design of such systems simpler. Current projections show that the RISC-based architecture will continue making gains in the embedded segment over the coming years (Figure 1).

Next steps for ARM in embedded

While ARM has made solid progress in the embedded space over the past decade, there are still considerable inroads to be made in enabling ARM technology for the SFF development community. Despite the implications of ARM's licensing strategy on reducing barriers to entry – which would logically result in a faster proliferation of ARM-based

Embedded Boards by CPU Arch



COMs by CPU Arch

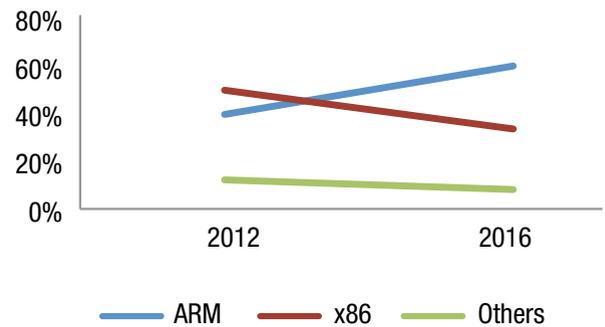


Figure 1 | Data from IHS Research projects ARM-based process technology gaining on its x86 counterparts in the embedded segment in the years to come.

products – several challenges remain to widespread dissemination of the architecture in embedded systems, including:

- Lack of a joint strategy among the ARM IC vendors
- Design diversity of embedded SFF solutions, and
- Lack of a widely accepted ARM software development platform for embedded applications.

ARM enters the battle of the boards

The merchant SFF board market is a firsthand example of the trend towards ARM architectures – as both well-established players and startups have adopted different strategies to confront an expanding class of SFF embedded computers. Some companies have stayed the x86 course while others are fully embracing ARM. It is also increasingly common to find vendors that provide both solutions, even within the same product.

This divergence from the previous norm has resulted in an interesting paradigm, particularly in the development and selection of standards-based SFFs. While SFF board standards have been the rule due to the dominance of x86, increasingly integrated ARM System-on-Chip (SoC) designs are diluting the benefits of standards to some extent.

Take an ARM SoC integrated with a user-programmable FPGA, for instance: If this compute unit is deployed on a standard motherboard, the signals that need to be extracted will likely vary from those

provided on any specification's pinout or connector, thereby resulting in a custom or semi-custom solution to fit the needs of the end user. While this architecture provides enhanced flexibility and tailored functionality for the target application, the final solution will likely be proprietary.

The point here is to illustrate the wide range of applications, and therefore options, in the embedded systems market that make design decisions difficult. In response, more and more engineers have begun relying on the Computer-On-Module (COM) design methodology to enable highly integrated and easily upgradeable systems through the use of application-specific carrier boards. With this approach, the design challenge begins with choosing a pinout that best meets user requirements. Qseven, EDM, and SMARC are just a few of the ARM-compatible standard options, while a multitude of proprietary options are available from companies like Technologic Systems, Toradex, Congatec, and others. Table 1 displays the relative pinout disparity between a standard Qseven module and Technologic Systems' TS-SOCKET Macrocontroller.

Linux emerges as development platform in the connected age

Embedded software is another area that can provide solid gains for ARM. While embedded designers using x86 benefited greatly from mature software development tools that made embedded development straightforward, ARM

developers have needed to go through a discovery process. In response, a rich ARM development ecosystem has emerged around Linux environments, with Android gaining visibility recently as well.

	QSEVEN (Max)	TS-SOCKET (Max)
Connectors	1 edge	2 surface
Pins	230	200
Size (mm)	70 x70	55 x 75
PCI-E	4	1
SATA	2	1
USB	10	3
Ethernet	1	1
SDIO	1	1
LVDS	2	X
LCD Port	1	1
Audio	1	1
I2C	1	1
LPC	1	X
CAN	1	2
SPI	1	1
GPIO	X	up to 81
UARTs	1	6
16-BIT BUS	X	1
ADC	X	6
SPI	X	1

Table 1 | Though the carrier board approach of Computers-On-Module (COMs) provides engineers with increased application flexibility, developers must begin by selecting from a range of platforms and pinout options. Depicted here are the pinout discrepancies between Qseven and TS-SOCKET COMs.

PRODUCT SPOTLIGHT

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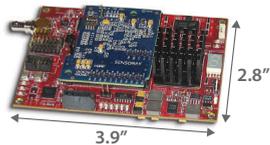
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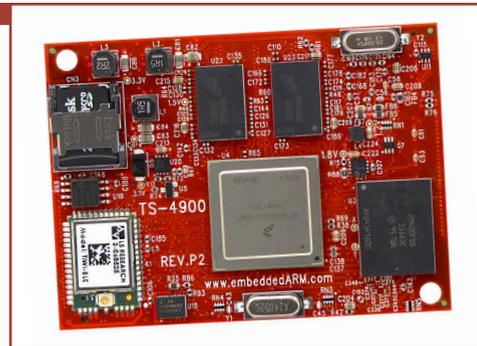
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Figure 2 | Technologic Systems' Freescale ARM Cortex-A9-based TS-4900 Macrocontroller provides default support for the 6LoWPAN protocol, enabling low-power connectivity for a range of Internet of Things (IoT) applications.



One action ARM is taking to address software challenges is the creation of a standard software development platform. Initial efforts have involved standard cross compilers, exploitation of the Linux kernel, and increased availability of Integrated Development Environments (IDEs), including a joint initiative between ARM and IC vendors to establish an open-source, Linaro-based software architecture for ARM to optimize embedded development (www.linaro.org). In addition, independent partnerships, like that between Freescale and Oracle, aim to improve Java development on ARM cores, particularly as more and more devices become Internet-enabled.

ARM and the advent of the IoT

The IoT space looks to be a promising area for ARM-enabled devices thanks to the RISC processor's history in small, low-power, integrated, and network-enabled devices. These characteristics are critical prerequisites for the majority of IoT edge applications, and although recent products like Intel's Atom processor E3800 Series and Quark SoC show potential in low-power systems, it remains to be seen whether x86 options will be financially viable in the ultra-low-power arena.

While the vast quantity of IoT devices will be small, cost-sensitive devices, in reality IoT products scale from Memory Management Unit-less (MMU-less) microcontrollers to sophisticated multicore solutions running Real-Time Operating Systems (RTOSs). Many of these higher end devices will act as communications hubs for automated wireless sensor networks (for smart grids, traffic control, and waste management, to name a few), requiring that they provide a range of

connectivity options in a low-power, industrial-grade package that can withstand rugged deployment environments.

To facilitate the rollout of these IoT "gateway" platforms, ARM's Sensinode Business Unit is spearheading development of the 6LoWPAN protocol, an IPv6-enabled software abstraction layer that runs on top of low-power radios to make them IP-enabled. For example, the Freescale i.MX6-based TS-4900 COM supports 6LoWPAN, providing IPv6 connectivity via the board's integrated Wi-Fi and Bluetooth controller (Figure 2). The board eases application development with support for Android, QNX, and Linux 3.10 and higher Operating Systems (OSs), in an industrial form factor that consumes under 2 W of power.

**Continuing integration of the
embedded ARM paradigm**

In the diverse embedded environment, no single solution will be able to fit the requirements of every end-user scenario. Whether ARM- or x86-based, standard or customized, each solution will have its place in SFF computing, a situation that will only benefit engineers as the different platforms seek to simplify embedded development. As the ARM integration continues, engineers can stay abreast of development trends by visiting the mbed.org development community or ARM's Connected Community (www.arm.com). **SFF**

Ronald Gomes is Director of Product Management and Marketing Strategy at Technologic Systems.

Technologic Systems
www.embeddedarm.com
info@embeddedarm.com

INTERNET OF THINGS RESOURCES

EMBEDDED-COMPUTING.COM/TOPICS/IOT/

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 COMPUTING
DESIGN

DISSECTING THE INTERNET OF THINGS



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IDENTIFY REQUIREMENTS
AND IMPLEMENTATIONS FOR
INTERCONNECTION, SECURITY, AND
USE CASES FOR EFFICIENT AND
SECURE UTILIZATION WITHIN THE IOT
WORLD.



ANALYZE THE CRITICAL NEEDS
OF MEDICAL SYSTEMS AND
HOW THE IOT IS AFFECTING REAL
APPLICATIONS SUCH AS 911
DISPATCH, EMS, TRANSPORT, AND
HOSPITAL INTEGRATION.



LEVERAGE NEW FEATURES TO BUILD
SMARTER AND LARGER SYSTEMS FOR
MEDICAL, ENERGY, AUTOMOTIVE,
AND OTHER INTELLIGENT AND CYBER-
PHYSICAL SYSTEMS.



MACHINE-TO- MACHINE (M2M) GATEWAY: TRUSTED AND CONNECTED INTELLIGENCE



BY FREESCALE
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COMPARE DIFFERENT M2M
SCENARIOS AND ANALYZE
HOW THE M2M GATEWAY CAN
ASSIST WITH CONNECTIVITY,
INTELLIGENCE, SCALABILITY,
AND SECURITY IN M2M
NETWORKS.



ENHANCING INTELLIGENCE IN THE IOT



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Rugged Boards & Solutions



**We know PCIe/104.
And we do it best.**

At RTD, designing and manufacturing rugged, top-quality boards and system solutions is our passion. As a founder of the PC/104 Consortium back in 1992, we moved desktop computing to the embedded world.

Over the years, we've provided the leadership and support that brought the latest signaling and I/O technologies to the PC/104 form factor. Most recently, we've championed the latest specifications based on stackable PCI Express: PCIe/104 and PCI/104-Express.

With our focused vision, we have developed an entire suite of compatible boards and systems that serve the defense, aerospace, maritime, ground, industrial and research arenas. But don't just think about boards and systems. Think **solutions**. That is what we provide: high-quality, cutting-edge, concept-to-deployment, rugged, embedded solutions.

Whether you need a single board, a stack of modules, or a fully enclosed system, RTD has a solution for you. Keep in mind that as an RTD customer, you're not just

working with a selection of proven, quality electronics; you're benefitting from an entire team of dedicated engineers and manufacturing personnel driven by excellence and bolstered by a 28-year track record of success in the embedded industry.

If you need proven COTS-Plus solutions, give us a call. Or leverage RTD's innovative product line to design your own embedded system that is reliable, flexible, expandable, and serviceable in the field for the long run. Contact us and let us show you what we do best.



RTD Embedded Technologies, Inc.

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Complete Systems: Digital Signage Platforms

smallformfactors.com/p9915652

ELMA

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SFF-IP68 Fanless Computer

Elma's SFF-IP68 is a compact, fanless, rugged computer for demanding environmental conditions. Designed to meet IP68 protection from continuous water immersion and dust penetration, it also offers high shock and vibration resistance. Standard & custom versions are available. For full configuration details, go to elma.com.

www.elma.com/en/products/systems-solutions/application-ready-platforms/product-pages/atca-systempaks/sff-noneuro-systempaks/rugged-fanless-pc-ip68/



FEATURES

- › Intel® Atom based single board computer, conformal coated
 - Up to 2 GB DDR2 SDRAM, 4 GB NAND flash
 - I/O ports: 4 PCI Express, 6 x USB, 2 x SATA, 2 x RS-232, 2 x RS-422/485, COM
 - Two Gigabit Ethernet ports
 - CompactFlash socket
 - VGA, LDVS interfaces
- › Watertight, fanless box designed to protect to IP68 / NEMA 6P
- › Temperature range from -40°C to +85°C and 0°C to +70°C
- › Conduction cooled
- › Customized versions available

It ships off the shelf with the above features; tailored configurations can be easily accommodated.

Elma Electronic Inc. | 510-656-3400

Contact: sales@elma.com

LinkedIn: linkedin.com/company/elma-electronic

Twitter: twitter.com/elma_electronic

THEMIS

www.themis.com/HD

RES-XR4 High Density (HD) Server

Function consolidation, virtualization, and big data analytics are driving the demand for increased computing density in a smaller, lighter footprint while reducing cost, energy, and space requirements. Suited for mission-critical, high-performance cluster computing environments where server Size, Weight, and Power (SWAP) is limited, Themis HD systems double compute density, enable a 50% savings on rack space, and reduce weight by 48%.

RES-XR4-HD Chassis and Modules Provide Maximum Configuration Flexibility

Providing the maximum system configuration flexibility to meet compute and storage requirements, the RES-XR4 HD Chassis houses four hot-pluggable HD compute modules:

- RES-XR4-HDC High Density Compute Module – Occupies one of four chassis slots with two processor sockets, eight DIMM, and up to three high-bandwidth I/O ports
- RES-XR4-HDS High Density Storage Module – Occupies two of four chassis slots with two processor sockets, eight DIMM, up to three high-bandwidth I/O ports, and four 3.5 inch disk slots*
- RES-XR4-HDFS High Density Flash Storage Module – Occupies two of four chassis slots with two processor sockets, eight DIMM, up to three high-bandwidth I/O ports, and four PCIe slots*
- RES-XR4-HDS8 High Density Flash Storage Module – Occupies two of four chassis slots with two processor sockets, eight DIMM, up to three high-bandwidth I/O ports, one RAID controller, and eight 2.5 inch disk slots*

* RES-XR4-HD storage modules include a companion high-density compute module. Storage modules occupy two of four HD chassis slots.

Industry Leading I/O Bandwidth

HD modules support up to three 56 Gb/sec Infiniband (IB) or 40 Gb Ethernet ports to provide industry leading I/O bandwidth. An FDR option supports 56 Gb/sec IB or 40 Gb/sec Ethernet via a QSFP connector. Alternatively a QDR option supports 40 Gb/sec IB or 10 Gb/sec Ethernet. Each module also has a PCIe expansion slot that supports two additional FDR or QDR ports. HD modules combine Intel® Xeon® E5-2600 Series processors, Supermicro motherboards, and the robust thermal and kinetic design management of the RES-XR4 rack mountable server family.

For more information, go to www.themis.com/HD



FEATURES

- › Intel® Xeon® E5-2660 Series processors, and Supermicro X9DRT-IBFF motherboards
- › Up to three 56 Gb/sec Infiniband (IB) or 40 Gb Ethernet ports to provide industry leading I/O bandwidth
- › Supports four independent hot-pluggable HD/HDS compute modules, enabling multiple options to meet computing and storage configuration requirements
- › Thermal and kinetic management design capabilities for shock, vibration, and extended temperature
- › Mounted in standard commercial racks or mobile transit cases
- › 0° C to 50° C operating temperature range
- › 8% to 90% operating humidity (non-condensing)
- › MIL-STD 810 and MIL-STD 461
- › EN60000, CE Mark
- › Reduces system weight by up to 48%

About Themis

Themis combines industry leadership, high-performance computing, and advanced thermal and kinetic management design to deliver reliable, rugged standards-based and custom embedded computing solutions for OEMs, systems integrators, and application providers. Themis products achieve a superior balance between standard commercial technology and ruggedness to keep mission-critical applications available in the most demanding environments.

Themis Computer | 510-252-0870

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Embedded Computers up to 3rd Gen. i7 Core

The PIP Family is a powerful, highly integrated, robust and fanless rugged embedded computer, based on Intel's Mobile Technology, all out of the Embedded Roadmap for long-time availability. The systems represent a unique solution for today's demanding defense requirements and are available with basically unlimited options. They are designed to operate under extreme and normal conditions without the need of fans. The MPL solutions are designed and produced in Switzerland and come with a long-term availability guarantee.

Outstanding is the extreme low power consumption. The systems have a complete set of standard PC features as well as industrial features like wide DC input power, reverse polarity protection, etc. Additional GPS, WLAN, CAN, Sound, and UPS modules are available.



FEATURES

- > Wide CPU selection up to i7 Core
- > Soldered CPU and chipset
- > Soldered ECCRAM
- > Up 5 x Gigabit Ethernet
- > Up to 4 serial ports (RS232/485)
- > Internal & external PCIe expansion
- > Internal PMC/XMC expansion
- > Fanless operation
- > Optional -40°C up to 85°C
- > Long term availability (+7 years)
- > Optional Bonding & Coating

MPL AG | +41 56 483 34 34

Contact: info@mpl.ch



NIU1A – Embedded I/O System – Nano Interface Unit

I/O Interface with optional ARM1 Processor

Configure to Customize

The NIU1A is a small, rugged, low-power system. It consists of an integrated power supply, one function slot that can be configured with a field-proven NAI intelligent I/O and communications function module and an optional ARM Cortex-A9 processor. Ideally suited for rugged Mil-Aero applications, the NIU1A delivers off-the-shelf solutions that accelerate deployment of SWaP-optimized systems in air, land and sea applications.

Architected for Versatility

NAI's Custom-On-Standard Architecture™ (COSA™) offers a choice of over 40 intelligent I/O and communications options. Pre-existing, fully-tested functions can be selected to quickly and easily meet system requirements. Individually dedicated I/O and communications processors allow mission computers to manage, monitor and control via single or dual Ethernet.

All products are designed to operate under extreme temperature, shock, vibration and EMI environments. EMI filters and gaskets meet or exceed MIL-STD-461F and MIL-STD-810G requirements.



FEATURES

- > Supports 1 Intelligent I/O function module
- > 2x 10/100/1000 Base-T Ethernet
- > 1.5"H x 1.7"D x 6.8"L @ 16 oz. (454 g) with 3 mounting options
- > 128 MB DDR3 SDRAM
- > Optional ARM Cortex™-A9 Dual Core 800MHz Processor
- > 4 GB SATA II NAND Flash (up to 32 GB option)
- > < 15 W power dissipation
- > Wind River® Linux, VxWorks®, Altera Linux OS Support
- > 1x RS232
- > Continuous Background BIT
- > Operating temp: -40°C to +71°C conduction cooled
- > 28 VDC input



North Atlantic Industries, Inc. | 631-567-1100

Contact: www.naii.com



www.acromag.com

XCOM-6400 Rugged COM Express Type 6 Module

Acromag's XCOM-6400 COM Express modules provide a high-performance processor in a package that is small, light, and very power-efficient. A variety of models are available with your choice of Intel 4th generation Core i7 or i5 CPU for enhanced graphics, security, and power management capabilities. Each unit is designed to withstand the shock and vibration of extreme industrial and defense applications with extra rigid circuit boards, extended temperature support, and conduction-cooled rails.

The XCOM-6400 features a SODIMM lock-down mechanism, allowing up to 16GB of memory to be securely fastened without the limitations of soldered-down memory. Meeting the higher standards of MIL-STD-202G shock and vibration testing, a screw-down latch holds the memory in place without a loss of connection, and also serves as a conduction plate to dissipate heat.



FEATURES

- › Intel 4th Gen (Haswell) multi-core i7/i5 processor
- › Intel 8-Series QM87 PCH chipset
- › Up to 16GB of high-speed DDR3L removable memory with SODIMM lock-down mechanism
- › Advanced heat management technologies: heat spreader plates and optional fan
- › Optional conduction-cooled frame for extreme temperatures
- › Up to -25 to +85°C extended operating range

Acromag | 248-295-7088

Contact: solutions@acromag.com



www.adlinktech.com

nanoX-BT COM Express® Mini Size Type 10 Module

ADLINK's COM Express® Computer-on-Modules (COMs) with Intel® Atom™ or Celeron® Processor-based System-on-Chips (SoCs) include the nanoX-BT, cExpress-BT, and cExpress-BT2 – PICMG COM.0 Rev. 2.1 Type 10, Type 6, and Type 2 form factors, respectively – with I/O features typical of x86 architecture: up to 3 PCIe, 2 SATA, and 8 USB ports are provided for scalability in application system layouts.

To ensure reliability and stability, all of the modules are verified with international standards for shock and vibration and have an extreme rugged operating temperature range of -40 to +85°C.

ADLINK's Smart Embedded Management Agent (SEMA), designed into all of our COMs, helps users optimize system performance and lower power consumption through remote device management.



FEATURES

- › Single, dual, quad-core Intel® Atom™ or Celeron® Processor SoC
- › Up to 4GB soldered dual-channel DDR3L at 1333MHz
- › Two DDI channels (optional LVDS)
- › Three PCIe x1, GbE
- › Two SATA 3Gb/s, one USB 3.0, seven USB 2.0
- › Extreme Rugged™ operating temperature: -40°C to +85°C
- › Supports SEMA remote management functions

ADLINK Technology, Inc. | 408-360-0200

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Connect Tech Inc.

Embedded Computing Experts

www.connecttech.com/VXG001-OSM/

COM Express + GPU Embedded System

The COM Express + GPU Embedded System from Connect Tech combines the latest generation x86 processors with high-end Graphics Processing Units (GPUs) all into a ruggedized small form factor embedded system. Choose from 4th Generation Intel® Core™ i7 or i5 (Haswell) x86 processor options and from either the AMD Radeon E6760 GPU, ideal for driving multiple displays, or NVIDIA GeForce GT 745M GPU for applications that require access to CUDA cores and the ability to process complex mathematics in parallel with the on-board x86 CPU.

This embedded system exposes all of the latest generation interconnect including: Gigabit Ethernet, USB 3.0 and 2.0, DisplayPort++, VGA, LVDS, SATA III, GPIO, I2C, mSATA, miniPCIe, PCIe/104 and SD Card Expansion. This Embedded System uses all-locking ruggedized positive latching connectors and eases the challenge of cooling multiple processors with the use of our Unified Thermal Extraction Baseplate, which can be mounted directly into an enclosure or chassis for further thermal dissipation.



FEATURES

- › Combines High-End GPUs with Latest Generation x86 Processors in a ruggedized small form factor
- › Choose from AMD Radeon E6750 or NVIDIA GeForce GT-745M
- › GPUs can be targeted for 4 independent display outputs OR for a headless GPU processing system utilizing CUDA cores
- › All thermal extraction points from COM Express and GPU are brought out to a single unified plane

Connect Tech Inc. | 519-836-1291 | 800-426-8979

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Facebook: facebook.com/connecttechinc



Connect Tech Inc.

Embedded Computing Experts

www.connecttech.com/CCG013-OSM/

COM Express Type 6 PMC/XMC Ultra Lite Carrier

Connect Tech's COM Express® Type 6 PMC/XMC Ultra Lite Carrier Board is a small form factor, feature-rich carrier that offers dual PMC/XMC and Mini-PCIe expansion. This carrier board features USB 3.0 and DisplayPort, and supports the latest high performance processors including 4th Generation Intel® Core™ i7 (Haswell).

The COM Express® Type 6 PMC/ XMC Ultra Lite Carrier Board is ideal for military and aerospace applications, and accepts a wide input voltage range from a regulated or un-regulated source of +12V to +48V DC.



FEATURES

- › COM Express Type 6 compatibility
- › Ruggedized, locking pin header connectors
- › Dual PMC/XMC & Mini-PCIe expansion
- › Supports latest processor sets, including 4th Generation Intel® Core i7™ (Haswell)
- › Small form factor (170mm x 165mm)
- › Extended temperature range, -40 to +85 degrees C

Connect Tech Inc. | 519-836-1291 | 800-426-8979

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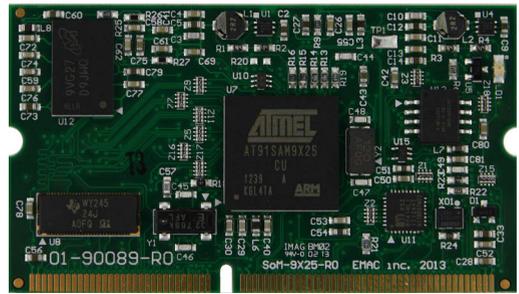


www.emacinc.com/products/system_on_module/SoM-9x25

Industrial Temperature SoM-9x25

Designed and manufactured in the USA, the SoM-9x25 is a low power industrial temperature System on Module that uses the same small SODIMM form factor utilized by other EMAC SoM modules. The SoM-9x25 is the ideal processor engine for your next design. All of the ARM processor core is included on this tiny board, including: Flash, Memory, Serial Ports, Ethernet, SPI, I2C, I2S Audio, CAN 2.0B, PWMs, Timer/Counters, A/D, Digital I/O lines, Clock/Calendar, and more. The SoM-9x25 is designed to plug into a custom or off-the-shelf carrier board containing all the connectors and any additional I/O components that may be required. The System on Module approach provides the flexibility of a fully customized product at a greatly reduced cost.

Pricing for Qty 1 is \$149.



FEATURES

- › Atmel ARM9 400MHz Fanless Processor
- › Up to 128MB of DDR2 SD RAM
- › Up to 4GB of eMMC Flash, Up to 16MB of Serial Data Flash
- › SD/MMC Flash Card Interface
- › 6 Serial ports, 3 with handshake
- › 1x USB 2.0 High Speed Host Port, 1x USB 2.0 Full Speed Host Port, 1x USB 2.0 High Speed Device Port
- › 2 SPI & 2 I2C ports, CAN 2.0B Controller, 1 I2S Audio port
- › 10/100 Base-T Ethernet with on-board PHY (2nd Ethernet Optional)
- › Access to Processor Bus
- › 4 Channels of 10-Bit A/D & 32 GPIO Lines
- › System Reset, Real Time Clock, Timers/Counters, PWM Controller
- › Small, 144 pin SODIMM form factor (2.66" x 1.50")
- › Industrial Temperature Range of -40C to +85C

EMAC, Inc. | 618-529-4525

Contact: info@emacinc.com
www.emacinc.com

I/O Boards: Data Acquisition

smallformfactors.com/p9912408



www.accesio.com

Multifunction DAQ-PACK Series (Up to 128 Channels)

The DAQ-PACK Series is a highly integrated multifunction data acquisition and control system. The system offers an ideal solution for adding portable, easy-to-install high-speed analog and digital I/O capabilities to any PC or embedded system with a USB port. It performs signal conditioning such as RC filtering, current inputs, RTD measurement, bridge completion, thermocouple break detection, voltage dividers, small signal inputs, and sensor excitation voltage supply.

The small, compact, multifunction I/O DAQ-PACK Series units provide the user with everything needed to start acquiring, measuring, analyzing, and monitoring in a variety of applications. These data acquisition and control devices can be used in many current real-world applications such as precision measurement, analysis, monitoring, and control in countless embedded applications.



FEATURES

- › 32, 64, 96, or 128-channel single-ended or differential analog inputs
- › High-speed USB 2.0 multifunction DAQ
- › Sustained sampling speeds up to 500kHz
- › 12 or 16-bit resolution A/D converter
- › Flexible, software-configured functionality
- › 18 input ranges, 9 unipolar and 9 bipolar, per 8-channel programmable
- › Wide range of flexible signal conditioning types
- › Autocalibration and oversampling for real-time accurate data
- › A/D starts via software, timer, or external trigger
- › Two 16-bit analog outputs and 16 high-current digital I/O lines
- › 16-bit programmable counter/timer

ACCES I/O Products, Inc. | 858-550-9559

Contact: contactus@accesio.com
 Follow us on Twitter @accesio



www.accessio.com

USB-104-HUB – Rugged, Industrial Grade, 4-Port USB Hub

This small industrial/military grade hub features extended temperature operation (-40°C to +85°C), high-retention USB connectors, and an industrial steel enclosure for shock and vibration mitigation. The OEM version (board only) is PC/104 sized and can easily be installed in new or existing PC/104-based systems as well. The USB-104-HUB now makes it easy to add additional USB-based I/O to your embedded system or to connect peripherals such as external hard drives, keyboards, GPS, wireless, and more. Real-world markets include Industrial Automation, Embedded OEM, Laboratory, Kiosk, Transportation/Automotive, and Military/Government.

This versatile four-port hub can be bus powered or self powered. You may choose from three power input connectors: DC power input jack, screw terminals, or 3.5" drive power connector (Berg). Mounting provisions include DIN rail, 3.5" front panel drive bay mounting, and various panel mounting plates.



FEATURES

- > Rugged, industrialized, four-port USB hub
- > High-speed USB 2.0 device, USB 3.0, and 1.1 compatible
- > Extended temperature operation (-40°C to +85°C)
- > Data transfer rates up to 480 Mbps
- > Supports bus-powered and self-powered modes
- > Three power input connectors (power jack, screw terminals, or 3.5" drive Berg power connector)
- > LED status indicators for power and overcurrent fault conditions for each downstream port
- > USB/104 form factor for OEM embedded applications
- > OEM version (board only) features PC/104 module size and mounting
- > Includes micro-fit embedded USB header connectors in parallel with all standard USB connectors
- > Industrial grade USB connectors feature high-retention design
- > Small (4" x 4" x 1"), low profile, steel enclosure
- > 3.5" front panel drive bay mounting provision

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Contact: contactus@accessio.com

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General Standards Corporation
High Performance Bus Interface Solutions

www.generalstandards.com/dataacquisition2.php

Data Acquisition I/O Boards

General Standards Corporation is a leading supplier in data acquisition I/O boards, provides a complete family of data acquisition cards for sonar, industrial, and embedded applications on several form factors/busses, and for many operating systems. Functions available include analog I/O, serial I/O, and high speed parallel I/O.

Analog I/O Boards:

- Up to 64 Input Channels per Board
- Programmable Sampling Rates to 50MSps
- GPS Synchronization
- Auto-Calibration
- Multi-Board Synchronization
- Sigma-Delta and Delta-Sigma Analog I/O
- Resolutions from 12 bits to 24 bits



Serial I/O Boards:

- Serial Mode Protocols include Asynchronous, Bisync, SDLC, HDLC, IEEE 802.3, Synchronous Telemetry, Simple Clock/Data (" -SYNC" product line), and Di-phase
- Transceivers support RS485, RS422, RS232, RS423, V.35, RS530, as well as other software-selectable mixed protocol modes
- Up to Eight Independent Serial Channels per Board
- Synchronous Serial Data Rates up to 10 Mbits/sec
- Asynchronous Serial Data Rates up to 1 Mbits/sec
- Deep Transmit and Receive FIFOs up to 128K
- PMC and cPCI rear I/O support
- Custom Protocols Available

Digital I/O Boards:

- Cable Transfer speeds up to 400 Mbits/second
- Large FPGA provides for flexible cable interface
- Several cable transceiver options including RS-422, RS-485, LVDS, PECL, and TTL

General Standards Corporation | 800-653-9970

Contact: quotes@generalstandards.com

www.generalstandards.com/support.php



V545 24-channel VME LVDT/synchro simulation/acquisition

The V545 is a generalized-DSP-based sinewave processor intended for both simulation and acquisition of LVDTs, RVDTs, synchros, and resolvers. 24 generalized, isolated channels are provided. Each channel can be a signal source or a measurement input. Users can program any desired relationship between input and output channels, allowing simulation and measurement of a wide range of inductive transducers, using internal or external excitation.

Per-channel features include true RMS AC measurement, frequency measurement, programmable phase shift, and a versatile phase-sensitive detector.

Plug-in transformers allow optional voltage input/output ranges. Software transformer ID is provided.

FEATURES

- › 24 transformer-isolated AC sinewave generator/acquisition channels
- › Generalized ADC-DAC-DSP architecture
- › Real-time voltage and frequency measurement, all signals in all modes
- › 16-bit ADC and DAC resolution
- › Internal ARM9 CPU performs macro functions



Programmable functions include:

- › Acquisition, with internal or external excitation
- › Simulation, with internal or external excitation
- › Polyphase sinewave generation from 250 Hz to 20 KHz
- › True RMS voltage measurement
- › Synchronous detection
- › Frequency measurement

Highland Technology, Inc. | 415-551-1700

Contact: sales@highlandtechnology.com

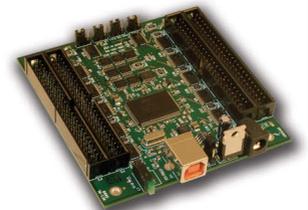


www.accesio.com

USB-DIO-96 High-Density Digital I/O

Designed for compact control and monitoring applications, this product features 96 or 48 industrial strength TTL digital I/Os. This USB device is an ideal solution for adding portable, easy-to-install digital I/O to any PC or embedded system with a USB port. The USB-DIO-96 is useful for monitoring dry contacts or generating outputs for controlling external devices such as LEDs and other indicators or system equipment. Applications include home, portable, laptop, education, laboratory, industrial automation, and embedded OEM.

These boards use 2 or 4 industry standard 50-pin IDC-type shrouded headers with 24 lines per connector. Utility 5VDC is available on pin 49 of each connector with grounds on all even numbered pins to reduce crosstalk and maintain industry compatibility. A mini USB header connector is provided in parallel with the high-retention type B connector for stacking and embedded applications. Available accessories include a wide variety of cables and screw terminal boards for quick and easy connectivity.



FEATURES

- › 96 or 48 lines of digital I/O
- › High-speed USB 2.0 device, USB 1.1 backward-compatible
- › Twelve or six 8-bit ports independently selectable for inputs or outputs
- › All I/O lines buffered with 32mA source, 64mA sink current capabilities
- › I/O buffers can be enabled or tri-stated under program control
- › Jumper selectable I/O pulled up to 5V for contact monitoring, down to ground, or floating
- › Resettable fused +5VDC outputs per 50-pin connector
- › OEM version (board only) features PC/104 module size and mounting compatibility

ACCES I/O Products, Inc. | 858-550-9559

Contact: contactus@accesio.com
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P104-WDG-CSMA PC/104-Plus Watchdog Timer Board

This feature-rich Watchdog board will vigilantly stand guard over your system and will help avoid costly system failures. The board can be used to monitor the operation of your application program as well as operating system, and will initiate a system reset in case of lockup. In addition, the P104-WDG-CSMA can monitor and control a variety of system hardware parameters such as temperature, voltage, fan speed, humidity, and more. The board was designed to allow for complete peace of mind when planning your next PC/104-based embedded system. Applications include kiosks, industrial automation, military/mission-critical, asset management and tracking, retail, medical, embedded OEM, temperature measurement, and many others that require self-reliant embedded systems.

Want more?! One general-purpose optically isolated input, two isolated digital outputs to control/switch external events, two non-isolated digital outputs, two general-purpose A/D inputs, and even a security light sensor that can be used to detect if the darkened interior of an enclosure is opened.



FEATURES

- > PC/104-Plus watchdog timer card with software-selectable timeout from 4µsec
- > Watchdog open collector reset outputs
- > Temperature measurement, monitor, and alarm
- > Fan status and speed control
- > PCI/104 power monitor/limit alarm interrupt
- > Opto-isolated input to trigger reset
- > General-purpose opto-isolated input, two outputs
- > Two general-purpose 8-bit A/D inputs
- > External fused 5V and 12V power
- > Light sensor for enclosure security
- > Extended temperature (-40°C to +85°C) available

ACCES I/O Products, Inc. | 858-550-9559

Contact: contactus@accessio.com
Follow us on Twitter @accessio



www.connecttech.com/Xtreme-GbE-OSM/

Xtreme/GbE Managed Carrier Ethernet Switch

Connect Tech's Xtreme/GbE Managed Carrier Ethernet Switch provides Carrier Grade Ethernet switching capabilities in an extremely small embedded form factor.

Excellent for high-end applications such as Mobile and Microwave backhaul, the Xtreme/GbE Managed Carrier Ethernet Switch is also a highly reliable way to communicate with 10/100/1000 devices in an embedded system. Powered by the latest generation Carrier Ethernet Switch engine the Vitesse VSC7428, its embedded 416 MHz MIPS 32-bit CPU, 1Gb DDR2 external memory and DMA-based frame extraction and insertion supports timing over packet, Ethernet OAM, and performance monitoring.

Available in models with RJ-45 or Rugged Positive Locking Headers, which makes this embedded Ethernet switch ideal for any type of environment.



FEATURES

- > 8 x 10/100/1000 Mbps Port Switch
- > Latest Generation 32-bit Switch Engine
- > Web GUI or CLI Management
- > Carrier Grade Ethernet Switching
- > Available with RJ-45 or Rugged Locking Ethernet Connectors
- > Supports PC/104, PCIe/104, or no bus options
- > Single Wide Range Input Voltage +9V to 36V
- > Extended Temperature Range -40°C to +85°C

Connect Tech Inc. | 519-836-1291 | 800-426-8979

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Connect Tech Inc.

Embedded Computing Experts

www.connecttech.com/Xtreme-GPU-OSM/

Xtreme/GPU

Connect Tech's Xtreme/GPU brings exceptional desktop-level graphics, outstanding multimedia features, and GPU processing power to the PCIe/104 form factor, with the ability to select either AMD or NVIDIA graphical solutions.

Connect Tech's AMD version of the Xtreme/GPU is a high-end graphics unit, used to drive up to four Mini DisplayPort connections for either independent use, or leveraging AMD Eyefinity technology, as a single large surface. On-board passive circuitry allows for the use of Dual-Mode DisplayPort, enabling the use of DVI or HDMI dongles if DisplayPort is not preferred.

With Connect Tech's NVIDIA solution, the Xtreme/GPU transforms into a processing powerhouse. With access to the NVIDIA CUDA™ Cores, the GPU can become a parallel computational CPU for non-graphical applications.



FEATURES

- › Choose from AMD E6760 or NVIDIA GeForce GT-745M
- › 4x Dual-Mode Mini DisplayPort Connections
- › Supports Microsoft® DirectX® 11 Technology
- › Supports OpenGL/OpenCL Technology
- › PCIe x1 Up/Down stack compatible
- › PCIe x16 Down stack compatible
- › PCIe x16 Up stack available

Connect Tech Inc. | 519-836-1291 | 800-426-8979

www.connecttech.com • sales@connecttech.com

Twitter: twitter.com/connecttechinc

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www.peak-system.com

PCAN-PC/104

CAN Interface for PC/104

The PCAN-PC/104 card enables the connection of one or two CAN networks to a PC/104 system. Multiple PCAN-PC/104 cards can easily be operated using interrupt sharing.

The card is available as a single or dual-channel version. The opto-decoupled versions also guarantee galvanic isolation of up to 500 Volts between the PC and the CAN sides.

The package is also supplied with the CAN monitor PCAN-View for Windows® and the programming interface PCAN-Basic.



FEATURES

- › Multiple PC/104 cards can be operated in parallel (interrupt sharing)
- › 14 port and 8 interrupt addresses are available for configuration using jumpers
- › Bit rates from 5 kbit/s up to 1 Mbit/s
- › Compliant with CAN specifications 2.0A (11-bit ID) and 2.0B (29-bit ID)
- › Connection to CAN bus through D-Sub slot bracket, 9-pin (in accordance with CiA® 102)
- › NXP SJA1000 CAN controller, 16 MHz clock frequency
- › NXP PCA82C251 CAN transceiver
- › 5-Volt supply to the CAN connection can be connected through a solder jumper, e.g. for external bus converter
- › Extended operating temperature range from -40 to 85 °C (-40 to 185 °F)
- › Available as single-channel or dual-channel version
- › Optionally available: galvanic isolation on the CAN connection up to 500 V, separate for each CAN channel

PEAK-System Technik GmbH

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E-Mail: info@peak-system.com

Website: www.peak-system.com



Dual Channel Isolated CAN PC/104 Module

WinSystems' **PCM-CAN-2-ISO** is built for operation in high-voltage renewable energy, industrial control, or unpredictable transportation applications.

This PC/104 module's high-speed isolated data couplers and power supplies provide 1000V protection between its two CAN controllers and the network interface. Each CAN channel can provide isolated +5VDC power or receive isolated +5 to +12VDC power from the interface for additional flexibility.

This module is offered in four off-the-shelf configurations. The PCM-CAN-2 is a dual channel, non-isolated unit. The PCM-CAN-1 is a single channel, non-isolated unit. The PCM-CAN-1-ISO is a single channel, isolated unit. Special OEM configurations are also available.



FEATURES

- › PC/104-compatible Control Area Network (CAN) card
- › Compliant with CAN specifications 2.0A (11-bit ID) and 2.0B (29-bit ID)
- › Transfer rates to 1 Megabits per second
- › Channel-to-channel and channel-to-system isolation
- › Onboard isolated 1W power supply for interface
- › -40° to +85°C operating temperature
- › Software drivers available for Linux and Windows®
- › Non-isolated and single channel versions are available
- › Long-term product availability

WinSystems, Inc. | 817-274-7553

Contact: Info@WinSystems.com

Website: www.winsystems.com/PCM-CAN-2-ISO.CFM



PC/104 DC/DC Modules

WinSystems' PC/104 and PC/104-Plus highly integrated power supply modules are built for remote applications requiring renewable power sources. The **PS394 series** of DC/DC supplies support two inputs from solar panels, wind turbines, or other DC sources. These modules include a controller for battery charging and uninterruptable power supply (UPS) operation, making them ideal for applications not able to run off the standard AC power grid.

Available in three standard configurations, each of the modules require only convection cooling for extended temperature operation and do not require a heat sink. For applications such as telemetry, pipelines, outdoor signage, military, transportation, and security, these modules are cost-effective, highly-integrated solutions.



FEATURES

- › Dual fused inputs accept solar panel, wind turbine, or other DC sources
- › Wide input range: 9V to 32VDC
- › Voltage output: +5V @ 10A (other options available)
- › UPS operation with battery pack
- › MPPT charging supported for solar panels
- › Outputs have short circuit/overload protection
- › -40° to +85°C operation supported
- › Custom configurations available
- › Long-term product availability
- › Models: PCM-PS394-500, PPM-PS394-533, and ISM-PS394-533

WinSystems, Inc. | 817-274-7553

Contact: Info@WinSystems.com

Website: www.winsystems.com/index_products_supplies.cfm



PC/104 POE-PD Power Supply Module

The **PCM-PS397-POE-1** is a PC/104 compatible Power over Ethernet Powered Device (POE-PD) DC/DC supply. Configured as either an endpoint or midspan device, it is designed to extract power from a conventional twisted pair CAT 5 Ethernet cable and conforms to the IEEE 802.3af and 802.3at POE standard with two-stage class detection.

The PCM-PS397-POE-1 accepts positive or negative polarity power in the 42 – 57VDC range from the RJ45 Ethernet interface. It converts the power to three rails: +5VDC, +12VDC, and -12VDC. These three output power rails are available to the PC/104 and auxiliary output connectors. The PCM-PS397-POE-1 can alternatively take power from an auxiliary input power connector rather than from the Ethernet POE interface. The auxiliary input power range is from 16 – 60VDC.

The PS397 is available in two additional standard configurations and can be customized for OEM applications.



FEATURES

- › PC/104 POE Powered Device power supply
- › POE input voltage: 42 – 57VDC
- › Dual Polarity Power Sourcing Equipment (PSE) supported
- › 802.3af/at compliant with support for Class 4 signature
- › Auxiliary 16 – 60VDC input supported
- › Isolated voltage outputs: +5VDC, +12VDC, and -12VDC
- › Line and load regulation $\pm 100\text{mV}$ for all outputs
- › -40°C to +85°C fanless temperature operation
- › Long-term product availability
- › Models: PCM-PS397-POE-1, PPM-PS397-POE-1, and ISM-PS397-POE-1

WinSystems, Inc. | 817-274-7553

Contact: Info@WinSystems.com

Website: www.winsystems.com/PCM-PS397-POE-1.cfm



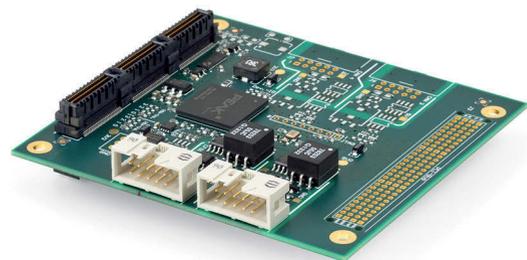
PCAN-PCI/104-Express

CAN Interface for PCI/104-Express

The PCAN-PCI/104-Express card enables the connection of one or two CAN networks to a PCI/104-Express system. Up to three cards can be stacked together. The CAN bus is connected using a 9-pin D-Sub plug on the slot bracket supplied.

The card is available as a single or dual-channel version. The opto-decoupled versions also guarantee galvanic isolation of up to 500 Volts between the PC and the CAN sides.

The package is also supplied with the CAN monitor PCAN-View for Windows and the programming interface PCAN-Basic.



FEATURES

- › PCI/104-Express card, 1 lane (x1)
- › Up to 3 cards can be used in one system
- › Bit rates from 5 kbit/s up to 1 Mbit/s
- › Compliant with CAN specifications 2.0A (11-bit ID) and 2.0B (29-bit ID)
- › Connection to CAN bus through D-Sub slot bracket, 9-pin (in accordance with CiA[®] 102)
- › NXP SJA1000-compatible CAN controller (FPGA implementation)
- › NXP PCA82C251 CAN transceiver
- › 5-Volt supply to the CAN connection can be connected through a solder jumper, e.g. for external bus converter
- › Extended operating temperature range from -40 to 85 °C (-40 to 185 °F)
- › Available as single-channel or dual-channel version
- › Optionally available: galvanic isolation on the CAN connection up to 500 V, separate for each CAN channel; PCI-104 stack-through connector

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SENSORAY

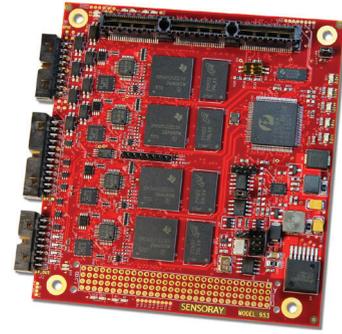
embedded electronics

www.sensoray.com/products/953.htm

Model 953-ET | PCI/104-Express 4-Channel H.264 A/V Codec

Sensoray has introduced the ultra-low latency, high-performance Model 953-ET: PCIe/104 Form Factor A/V Codec. It simultaneously captures four channels of analog video and four channels of stereo/mono audio. Each video channel captures at the full frame rate (30 fps for NTSC or 25 fps for PAL), which results in an aggregate frame rate of 120 fps for NTSC or 100 fps for PAL. The Model 953-ET compresses the A/V streams into MJPEG, MPEG-4, H.264, or MPEG-TS format for video, and G.711 or AAC format for audio.

This extended temperature, small form factor board is ideal for applications where processor performance is critical. The Model 953-ET is well-suited for capture of multiple video sources, such as local/remote video surveillance and traffic monitoring, digital video recording/streaming, and other video processing applications.



FEATURES

- > 4 input channels: 4 NTSC/PAL composite/S-Video/4 stereo audio
- > H.264 HP@L3, MPEG-4 ASP, MJPEG video; AAC, G.711, PCM audio
- > Ultra-low latency video preview concurrent with compressed capture
- > Full duplex hardware encode/decode
- > Text overlay, GPIO
- > Supports both stack-up and stack-down
- > 40° to +85°C extended temperature range
- > SDKs for both Linux and Windows

Sensoray Co., Inc. | 503-684-8055

Contact: info@Sensoray.com



CM2-BT2 Extreme Rugged™ PC/104-Plus Single Board Computer

Our versatile CM2-BT2 is a PC/104-Plus Single-Board Computer (SBC) with the latest Intel® Atom™ Processor System-on-Chip (SoC); a PC/104 (CM1-BT1) variant for ISA bus-only support and PCI-104 (CM3-BT1 or CM3-BT4-8G) variants for PCI bus-only support are also offered to service diverse design and budget requirements. The CMx-BTx SBCs support up to 4GB-1066/1333 MHz DDR3L SODIMM memory and feature interfaces for DisplayPort and LVDS, GbE, 1x SATA 3Gb/s, 1x USB 3.0 + 2x USB 2.0, and 8x GPIO.

The CM2-BT2 is designed to withstand intense shock and vibration and supports operating temperatures from -40°C to +85°C. ADLINK's Smart Embedded Management Agent (SEMA), designed into all of our SBCs, helps users optimize system performance and lower power consumption through remote device management.



FEATURES

- > Dual-core Intel® Atom™ Processor SoC
- > Up to 4GB DDR3L at 1333MHz
- > Supports VGA and LVDS
- > GbE (optional 2x GbE)
- > 1x SATA 3Gb/s (optional 2x SATA), 1x USB 3.0 + 2x USB 2.0, 8x GPIO
- > Extreme Rugged™ operating temperature: -40°C to +85°C
- > Supports SEMA remote management functions

ADLINK Technology, Inc. | 408-360-0200

info@adlinktech.com

LinkedIn: www.linkedin.com/company/adlink-technology

Facebook: www.facebook.com/ADLINKTECH



PCAN-PC/104-Plus

CAN Interface for PC/104-Plus

The PCAN-PC/104-Plus card enables the connection of one or two CAN networks to a PC/104-Plus system. Up to four cards can be operated with each piggy-backing off the next. The CAN bus is connected using a 9-pin D-Sub plug on the slot bracket supplied.

The card is available as a single or dual-channel version. The opto-decoupled versions also guarantee galvanic isolation of up to 500 Volts between the PC and the CAN sides.

The package is also supplied with the CAN monitor PCAN-View for Windows® and the programming interface PCAN-Basic.



FEATURES

- › Use of the 120-pin connection for the PCI bus
- › Up to four cards can be used in one system
- › Bit rates from 5 kbit/s up to 1 Mbit/s
- › Compliant with CAN specifications 2.0A (11-bit ID) and 2.0B (29-bit ID)
- › Connection to CAN bus through D-Sub slot bracket, 9-pin (in accordance with CiA® 102)
- › NXP SJA1000 CAN controller, 16 MHz clock frequency
- › NXP PCA82C251 CAN transceiver
- › 5-Volts supply to the CAN connection can be connected through a solder jumper, e.g. for external bus converter
- › Extended operating temperature range from -40 to 85 °C (-40 to 185 °F)
- › Available as single-channel or dual-channel version
- › Optionally available: Galvanic isolation on the CAN connection up to 500 V, separate for each CAN channel; PC/104-ISA stack-through connector

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PCAN-PC/104-Plus Quad

Four-Channel CAN Interface for PC/104-Plus

The PCAN-PC/104-Plus Quad card enables the connection of four CAN networks to a PC/104-Plus system. Up to four cards can be operated with each piggy-backing off the next. The CAN bus is connected using a 9-pin D-Sub plug on the slot brackets supplied. There is galvanic isolation of up to 500 Volts between the computer and CAN sides.

The package is also supplied with the CAN monitor PCAN-View for Windows® and the programming interface PCAN-Basic.



FEATURES

- › Use of the 120-pin connection for the PCI bus
- › Up to four cards can be used in one system
- › Bit rates from 5 kbit/s up to 1 Mbit/s
- › Compliant with CAN specifications 2.0A (11-bit ID) and 2.0B (29-bit ID)
- › Connection to CAN bus through D-Sub slot brackets, 9-pin (in accordance with CiA® 102)
- › NXP SJA1000-compatible CAN controller (FPGA implementation)
- › NXP PCA82C251 CAN transceiver
- › Galvanic isolation on the CAN connection up to 500 V, separate for each CAN channel
- › 5-Volt supply to the CAN connection can be connected through a solder jumper, e.g. for external bus converter
- › Extended operating temperature range from -40 to 85 °C (-40 to 185 °F)
- › Optionally available: PC/104 stack-through connector

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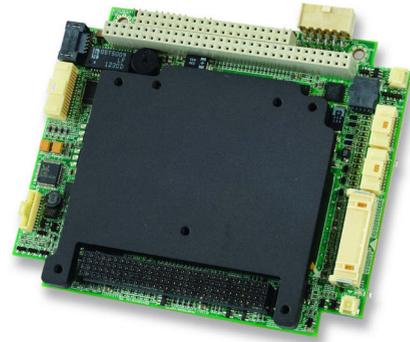


Extended Temperature Intel® Atom™ PC/104-Plus SBC

WinSystems' **PPM-C393**, featuring high-integration with PC/104-Plus expansion, provides a flexible and cost-effective solution for demanding embedded applications. This combination provides designers access to the low-power performance of Intel Atom processors and to the thousands of PC/104, PC/104-Plus, and PCI-104 modules available worldwide.

It is well suited for new applications and for upgrading existing designs. The PPM-C393's -40°C to +85°C operation and low power opens up applications such as security, Mil/COTS, medical, transportation, data acquisition, and communications in a small, rugged, form factor proven in these industries.

It supports Linux, Windows®, and other x86-compatible real-time operating systems.



FEATURES

- > 1.66GHz N455 Intel® Atom™ CPU
- > Up to 2GB of DDR3 SODIMM supported
- > Simultaneous LVDS and CRT video
- > Intel Gigabit Ethernet controller
- > Four serial COM ports (two RS-232, two RS-232/422/485)
- > Eight USB 2.0 ports with polyfuse protection
- > SATA (2.0) channel and CompactFlash supported
- > Runs Linux, Windows®, and other x86 operating systems
- > Long-term product availability
- > Model: PPM-C393

WinSystems, Inc. | 817-274-7553

Contact: Info@WinSystems.com

Website: www.winsystems.com/PPM-C393-S.cfm

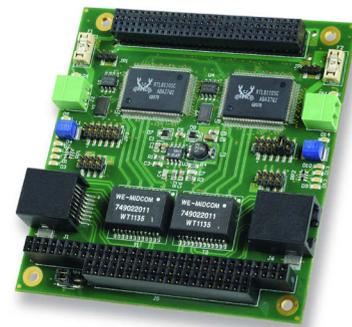


PC/104-Plus Dual Gigabit Modules with POE PSE

WinSystems' **PPM-GIGE-2-POE** is a PC/104-Plus compliant dual channel, Gigabit Ethernet module with Power over Ethernet (POE) support. The add-in module can provide power to two 802.3af/at compliant POE devices from an external DC source, supporting up to 25W each.

The module's Gigabit Ethernet controllers combine triple-speed IEEE 802.3 compliant MAC and Ethernet transceivers. It offers high-speed transmission over CAT 5 UTP cable. The device supports the 32-bit PCI v2.2 interface for host communications and is compliant with the IEEE 802.3 specification for 10/100Mbps Ethernet and the IEEE 802.3ab specification for 1000Mbps Ethernet.

WinSystems also offers single and dual channel, with or without the POE supply.



FEATURES

- > Two Gigabit Ethernet channels on a PC/104-Plus module
- > Each channel is IEEE 802.3af/at POE compliant
- > Up to 25W for single port PSE applications
- > Auto-Negotiation with Next Page capability
- > IEEE 802.3x-compliant full duplex flow control support
- > 64Kbyte Rx and 8K Tx packet FIFO per channel
- > Support for Windows®, Linux, and other x86 RTOS
- > -40°C to +85°C temperature operation
- > Models: PPM-GIGE-2-POE and PPM-GIGE-1-POE

WinSystems, Inc. | 817-274-7553

Contact: Info@WinSystems.com

Website: www.winsystems.com/ppm-gige-2-poe.cfm



www.aphitech.com

PCIe-Mini-DA4 – 4 Ch 16-bit D/A Software Programmable 2 μ Second DACs

The PCIe-Mini-DA4 is a PCI Express Mini board with a total of 4 voltage outputs D/A. Each output is followed by a buffer able to provide +/-30 mA.

Special function code allows global updates of all channels or by a group at a time. Standard ping-pong output registers for each channel or optional data RAM allows waveform generation with minimum processor involvement.

An internal register sets the sampling rate of the internal sampling rate generator. The card operates in one of 3 modes:

- State machine providing automatic update and load on sampling clock
- Manual load with update on sampling clock
- Manual load and update

FEATURES

- > 16-bit D/A converter
- > Settling time 2 μ sec, 0-5V range
- > 500 KSPS throughput
- > Six Programmable Output Ranges per channel
- > Up to 30 mA Output Drive requires +/-12V External Power Supply
- > Unipolar: 0V to 5V, 0V to 10V
- > Bipolar Mode: $\pm 5V$, $\pm 10V$, $\pm 2.5V$, $-2.5V$ to $7.5V$, ± 10 mA continuous, ± 30 mA max
- > Multiple output spans available
- > Temperature monitoring function
- > Simultaneous or single update of D/A converter outputs
- > Power-On Reset to 0V
- > Two stage buffers
- > Global output buffer with internal or external triggering



Alphi Technology Corporation | 480-838-2428

Contact: sales@alphitech.com



Embedded Solutions™

www.adl-usa.com

ADLQM87PC – Industry's Smallest 4th Gen. Intel Core i7 SBC

The **ADLQM87PC** delivers the industry's highest GIPS per in² and the most densely-packed comprehensive set of features. The ADLQM87PC's 17in² footprint features 4th Generation Intel Core processors with Intel 8-series QM87 PCH chipset, on-board Mini PCIe/mSATA socket for on-board Wi-Fi, GPS, bootable flash storage, a Trusted Platform Module (TPM v1.2), 2x USB 3.0, 8GB DDR3, 4x SATA 6 Gb/s, 2x GLAN, DisplayPort, HDMI/DVI, VGA, 8x USB 2.0, and more ... all with a smaller footprint and height than a basic COM Express module with greater temperature range and ruggedness.



FEATURES

- > 4th Generation Intel® Core™ QUAD i7-4700EQ and DC i5-4400E with up to 8GB DDR3L-1600
- > HD4600 GPU; Over 2x Performance Increase over 2nd Gen Intel Core i7 GPU
- > Onboard PCI Express Mini Card Socket v1.2 Compatible with miniPCIe and mSATA Modules
- > Integrated Trusted Platform Module (TPM) v1.2
- > USB 3.0; 4x SATA 6Gb/s; DisplayPort, eDP, HDMI, VGA, 2x GbLAN, 2x COM, 16-bit GPIO
- > MIL-STD-810 Ruggedization and -40°C to +85°C Options Available

ADL Embedded Solutions | 858-490-0597

Contact: sales@adl-usa.com



"Accessing the Analog World"

www.rtd.com/pc104/UM/power/atx3510.htm

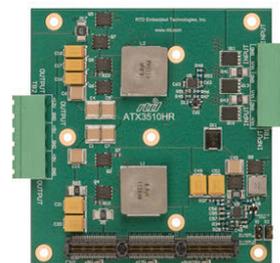
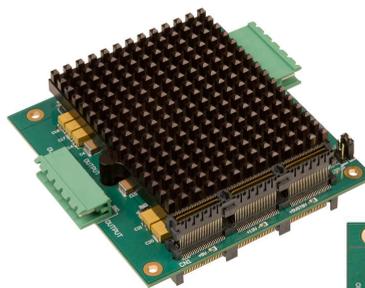
ATX3510HR-190

PCIe/104 190 Watt Power Supply

Operating Temperature -40° to +85°C

The **ATX3510HR-190** is a 190 Watt embedded power supply with a PCIe/104 stackable bus structure. With 5V standby, 5V main, and 12V, this module is also input protected against over-voltage, over-current, and reverse voltage. The ATX3510 is synchronized to reduce noise and system stress. Pin fin and flat heat sink options are available. This module is operational from -40 to +85C and available in RTD's modular, ruggedized packaging systems.

Designed and Made in the USA.



FEATURES

- › PCIe/104 stackable bus structure
- › -40 to +85C standard operating temperature
- › Input Voltage Range: 8-36V
- › 194.8 Watts maximum output power
- › Reverse voltage protection to -40V
- › ATX signals: 5V_SB, # PS_ON
- › Efficiency as high as 90%
- › Input over current protection, and input over voltage protection clamps to 36V
- › Output over current protection, remote ON/OFF function

RTD Embedded Technologies, Inc. | 814-234-8087

Contact: sales@rtd.com



Advanced Micro Peripherals

THE EMBEDDED VIDEO EXPERTS

www.amp-usa.com/stand-alone/h264/streamcorder-hd.php

StreamCorder-HD

The StreamCorder-HD is an intelligent, stand-alone, H.264 streaming solution that accepts HD-SDI input at up to 1080p30 and encodes and streams over 100/1000MBit Ethernet. The single board solution is ideal for demanding applications in Military, Communications, Transportation, Mining and Energy industries.

The flexible streaming engine can stream the compressed video direct from the on-board Ethernet port, as well as save directly to local storage for later retrieval. Stereo audio embedded in the input HD-SDI source can also be captured and streamed, synchronized with the video.

Designed for mobile, UAS and Vetrnix applications, the StreamCorder-HD supports extraction of KLV (MSB 0605.3 compliant) embedded data contained within the HD-SDI that can be synchronized and streamed with the compressed video. The StreamCorder-HD also features optional on-board Controller Area Network (CAN), 3-Axis Accelerometer, High-Sensitivity GPS Receiver, Altimeter, and 3-Axis Digital Magnetometer (e-compass). These can integrate with other vehicle systems and data from these sources can be used as meta data embedded within the video and streamed to clients or saved for later analysis.



FEATURES

- › HD-SDI input up to 1080p30
- › Real-time HD H.264 encode at 1080p30
- › Stereo audio capture from HD-SDI
- › Single board capture, encode, stream solution
- › RS-485 port for Camera PTZ control
- › USB 2.0 OTG support for extended local storage
- › Low power operation for long endurance
- › Stand-alone operation
- › Operating system neutral
- › Standard PCIe/104 mechanical form factor
- › Optional CAN, GPS, Altimeter, Accelerometer, Compass

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Contact: sales@amp-usa.com

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ELMA

Your Solution Partner
<http://bit.ly/F-Series-SFF>

F-Series PCIe/104 Platform

A fanless, rugged mission computing platform combines a highly configurable system with Intel's 4th Gen i7.

Using expandable sidewalls and PCIe/104 I/O cards, the F-Series Platform is easily modified for more I/O including video & frame grabbers, ARINC & 1553, Ethernet, FPGA and GPGPUs.

Designed to meet MIL-STD-810F, the F-Series Platform is useful where performance is needed in space-constrained, rugged or extended temperatures.

This computer enables unparalleled performance for countless applications including radar and sonar processing, hyperspectral imaging, transportation, mining and industrial applications.



FEATURES

- › The F-Series PCIe/104 Platform's base board configuration supports:
 - Intel's 4th generation Quad or Dual Core processor
 - Up to 8 GB DDR3
 - Type 1 Bottom-Stacking PCIe/104 with Gen2 PCIe x1 Lanes and Gen3 PEG x16
 - SATA with RAID capability
 - 2x Gigabit Ethernet ports
 - 2x RS232 COM ports
 - 13x USB 2.0 total, 2x USB 3.0, backward USB 2.0 compatible
 - Onboard audio and video for , three independent displays
 - Discrete 16-bit GPIO Port
 - PCI Express Mini Card 1.2 Socket

Elma Electronic Inc. | 510-656-3400

Contact: sales@elma.com

LinkedIn: [linkedin.com/company/elma-electronic](https://www.linkedin.com/company/elma-electronic)

Twitter: twitter.com/elma_electronic

SBCs and Boards: Other SBCs and Boards

smallformfactors.com/p9916866

EMAC, inc.

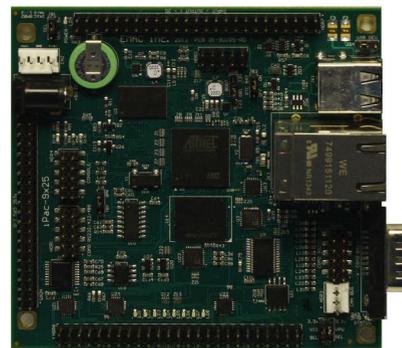
EQUIPMENT MONITOR AND CONTROL

www.emacinc.com/products/pc_compatible_sbcs/IPAC-9X25

Industrial Temperature iPac-9X25

Designed and manufactured in the USA, the iPac-9X25 is a Web-enabled microcontroller with the ability to run an embedded server and to display the current monitored or logged data. The Web connection is available via two 10/100-Base-T Ethernet ports or 802.11 wireless Wi-Fi networking when using the proper Linux modules and adapters. This microcontroller has all connectors brought out as headers on a board and has the same footprint of a standard PC/104 module at 3.77" x 3.54". The iPac-9X25 is perfectly suited for Industrial Temperature Embedded Data Acquisition and Control applications.

Pricing for Qty 1 is \$198.



FEATURES

- › Atmel AT91SAM9x25 400 Mhz Processor
- › 128MB DDR2 RAM, 4GB eMMC, 16MB Serial Data Flash, Micro SD
- › 20 General Purpose Digital I/O lines, 16 SPI I/O Expander Based Digital I/O, and 8 High Drive Digital Outputs
- › 1x USB 2.0 (High-Speed) Host, 1x USB (Full-Speed) Host, 1 USB 2.0 (High-Speed) Device Port, 1x CAN Bus
- › 3x RS232, 1x RS232/422/485, 2x 10/100 Ethernet
- › Up to 7 channels of 10 bit A/D, Up to 4 16-bit PWMs
- › Industrial operating range of -40C to +85C

EMAC, Inc. | 618-529-4525

Contact: info@emacinc.com

www.emacinc.com



www.VersaLogic.com

Falcon (VL-EPU-2610) – Embedded Processing Unit

Extremely small and rugged embedded computer.

Overview:

The Falcon is an extremely small and rugged embedded computer. It has been engineered and tested to meet the Military and Medical industries' evolving requirements to develop smaller, lighter, and lower power embedded systems while adhering to stringent regulatory standards. Roughly the size of a credit card and less than one inch thick, the Falcon is the embedded industry's smallest, lightest, ultra-rugged embedded x86 computer. This embedded computer, equipped with an Intel Atom E6x0T processor, is designed to withstand extreme temperature, impact, and vibration.

Details:

Driven by an Intel Atom E6x0T processor, the Falcon provides a lot of performance, lower power consumption (9–11W typical), and a very compact package. The Falcon provides compatibility with a broad range of standard x86 application development tools for reduced development time.

The integrated Intel GMA600 graphics core provides hardware-accelerated MPEG-4/H.264 and MPEG-2 video encoding and decoding. A standard LVDS output supports flat panel displays. An optional adapter converts the LVDS output to VGA.

Industry-standard system interfaces include Gigabit Ethernet with network boot capability, four USB 2.0 ports, four serial ports, and Intel High-Definition Audio (HDA). A SATA 3 Gb/s interface supports high-capacity storage. Dual microSD sockets and a Mini PCIe socket with mSATA support provide flexible Solid-State Drive (SSD) options. The Mini PCIe socket also accommodates plug-in Wi-Fi modems, GPS receivers, MIL-STD-1553, Ethernet, Firewire, and other mini cards. The Falcon supports an optional Trusted Platform Module (TPM) for applications that require enhanced hardware-level security functions.

Designed and tested for industrial temperature (-40° to +85°C) operation, the rugged Falcon also meets MIL-STD-202G specifications for shock and vibration. Soldered-on RAM and latching SATA, Ethernet, power, and main I/O connectors provide additional ruggedization for use in extremely harsh environments. Heatsink or heat plate versions provide fanless heat dissipation. Falcon is manufactured to IPC-A-610 Class 2 (modified) standards. For extremely-high-reliability applications, IPC-A-610 Class 3 versions are available.

A wide input voltage range of 8 to 17 volts (12V typ.) simplifies system power supply requirements. It is fully compatible with 12V automotive applications.



FEATURES

- › **Embedded Processing Unit:** A complete embedded computer in an extremely small/rugged format
- › **Intel Atom E6x0T Processor:** 1.6 GHz performance. Low power consumption
- › **Industrial Temperature Operation:** -40° to +85°C operation for harsh environments
- › **MIL-STD-202G:** Qualified for high shock/vibration environments
- › **Fanless Operation:** No moving parts required for CPU cooling
- › **Wide Input Voltage Range:** Accepts 8 to 17 volts (12V typ.)
- › **High-performance Video:** Graphics core supports MPEG-4/H.264 and MPEG-2 encoding and decoding
- › **Network:** Gigabit Ethernet (GbE) with remote boot support
- › **RAM:** Up to 2 GB soldered-on DDR2 RAM
- › **SATA:** Supports SATA hard drives and mSATA flash storage options
- › **Mini PCIe Card Socket:** Supports Wi-Fi modems, GPS, MIL-STD-1553, Ethernet, solid-state storage, and other plug-in devices
- › **Device I/O:** Four serial ports, four USB ports, Intel High-Definition Audio
- › **Trusted Platform Module (optional):** On-board security option defends against attacks from unauthorized hardware and software
- › **OS Compatibility:** Windows 7/XP, Windows Embedded Standard 7/XPe/CE, Linux, VxWorks, QNX, DOS.

Falcon is compatible with a variety of popular x86 operating systems including Windows, Windows Embedded, Linux, and VxWorks.

Product customization is available, even in low quantities. Options include a Trusted Platform Module, conformal coating, BGA underfill, IPC Class 3 assembly, BIOS/splash screen configuration, application specific testing, BOM revision locks, labeling, etc.

VersaLogic Corp. | 503-747-2261 • 800-824-3163

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Industrial ARM® Single Board Computers with Expansion

Designed for demanding industrial applications and long-term availability, WinSystems' **SBC35-C398** SBCs feature Freescale i.MX 6 processors with options for expansion and customization. The combination of processing power and industrial I/O provides flexible solutions for security, industrial control, SCADA and other systems. The low-power design operates from -40° to +85°C without a fan or heatsink for improved reliability.

The IO60 connector supports I2C, SPI, TTL-UART, and PWM signals, allowing stackable module expansion. When coupled with the MiniPCIe socket, the 4 x 5.75 inch SBC35-C398s are among the most expandable ARM Single Board Computers currently on the market.

Linux and Android™ OS images and expert technical support are available to get your design started quickly.



FEATURES

- › ARM Cortex™-A9 Processors: Quad, Dual, or Single Core
- › High-Performance Graphics with Multiple Video Interfaces
- › Powered by PoE or 10-50VDC Input
- › MIPI Capture and Display, with CMOS Camera Input
- › Gigabit Ethernet with IEEE-1588™
- › USB 2.0 and USB On-The-Go Ports
- › FlexCAN and RS-232/422/485 Serial Ports
- › 24 GPIO tolerant up to 30VDC
- › Mini-PCIe and IO60 (I2C, SPI, TTL, and PWM) Expansion

WinSystems, Inc. | 817-274-7553

Contact: Info@WinSystems.com

Website: www.winsystems.com/SBC35-C398Q.cfm

VITA SFFs: VITA 74

smallformfactors.com/p9916911



www.samtec.com/standards.aspx

SEAM/SEAF Series

VITA 74 Small Form Factor (SFF) standard was designed to meet the requirements of high performance systems in rugged environments. Developed in response to a growing need for a small form factor packaging standard, VITA 74 Nano-ATR is also modular, scalable and low cost.

Samtec's rugged, high speed/high density SEARAY™ SEAM/SEAF Series arrays (as qualified in VITA 57 FMC) have been specified as the backplane connectors for VITA 74 Nano-ATR standard.

Samtec's family of SEARAY™ high speed, high density arrays offer ultimate design flexibility that is unmatched in the connector industry. SEARAY™ products allow for maximum grounding and routing flexibility with up to 500 I/Os. They are available in vertical, right angle and press-fit board-to-board orientations, in standard and low profile designs, on a choice of two pitches (1.27mm and 0.80mm). Mating high speed cables are also available.



FEATURES

- › High performance: to 25 Gbps (3db IL)
- › High density: 4 or 8 rows, 200 or 400 pins
- › 1.27mm x 1.27mm pitch grid array
- › Rugged contact system with 1.5mm wipe
- › Mating cycles > 1000
- › Low power consumption
- › Straight and right angle orientations

Samtec | 800-726-8329 • 812-944-6733

Contact: sig@samtec.com

Industrial ARM® Single Board Computers

High-Performance Graphics with Industrial I/O and Expansion

-40° to +85°C Operating Temperature

Designed for demanding applications and long-term availability, WinSystems' SBC35-C398 single board computers feature Freescale i.MX 6 industrial application processors with options for expansion and customization.

Features

- ARM Cortex™-A9 Processors;
Quad, Dual, or Single Core
- Multiple Graphics Interfaces
- Wide Range DC or PoE Power Input
- Gigabit Ethernet with IEEE-1588™
- USB 2.0 Ports and USB On-The-Go
- Dual FlexCAN Ports
- Multiple Storage Options
- Mini-PCIe and IO60 Expansion
- Linux and Android™ Supported

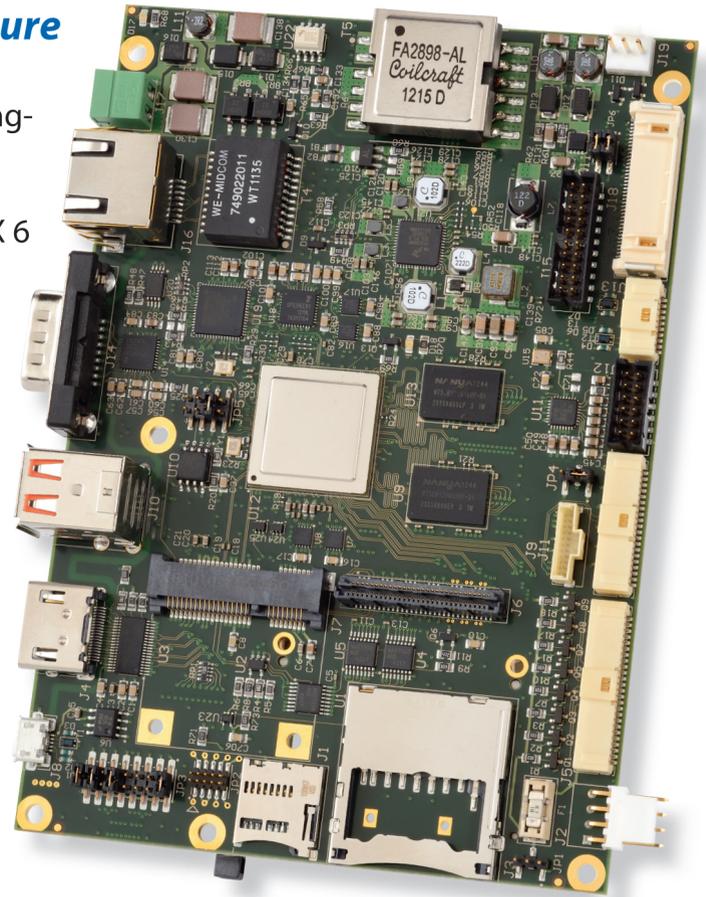
Learn more at

www.WinSystems.com/ARMP



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