PC/104 Embedded Modules The New System Components

Standards-based design is the best and most logical approach for embedding a PC into a product. PC/104 bus modules operate as system components, adhering to both hardware and software industry standards.

by: Robert A. Burckle, VP
WinSystems, Inc.

Competition is fierce. Pressure to get new products to market quickly is intense. Engineering labor is expensive. Debugging and verification are time-consuming tasks. Manufacturing processes using surface mount components are complex. Plus changes to the product specifications are inevitable. These factors have driven engineers to seek better solutions to design. One method that is growing in popularity is the use of PC/104 modules as "system components".

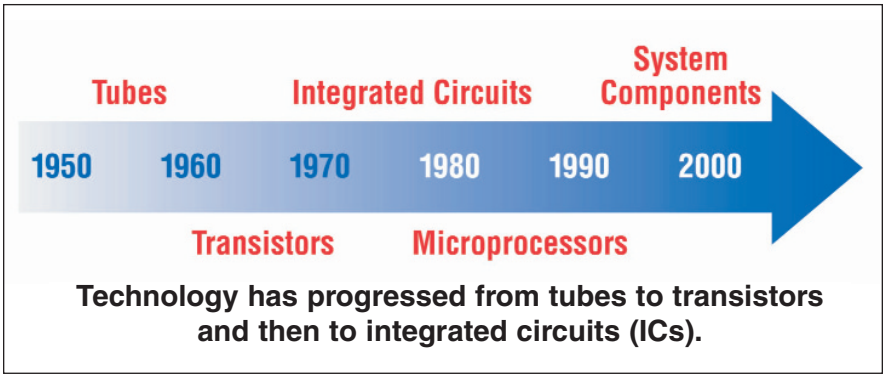
A system component is different than what is considered a "standard" electronic component. Standard components are the familiar active devices such as integrated circuits, microprocessors, memory, diodes, transistors, etc. along with passives such as resistors, capacitors, and inductors. They are the basic elements needed to mount on a circuit board for a customized, application-specific design.

A system component on the other hand, has active and passive components mounted on circuit boards that are configured for a specific task. System components can be either single- or multi-function modules that serve as highly integrated building blocks of a system. A system component can be as simple as a digital I/O board or as complex as a computer with video, memory, networking, and I/O all on a single board. System components support industry standards and are available from multiple sources worldwide.

Historical perspective

Over the last 50 years, engineers have continued to use more sophisticated technology in their system designs. The early 1980s saw the onslaught of large-scale integrated (LSI) and very large scale integrated (VLSI) components that enabled the creation of microprocessors. The result of the semiconductor advances made it possible to increase the functional density on a board while decreasing cost and power while increasing reliability. Yet as the relentless pace of technology and innovation accelerated, the complexity and difficulty to design and integrate the active and passive components to create a product has increased as well.

Consequently, system design has changed dramatically over the years. Previously the primary design factors were based on selecting the appropriate hardware components. Designing, manufacturing, testing, and software coding were relatively easy such that companies routinely designed their own systems from standard components for projects even needing just a few units. Time and money were available so that non-computer companies could spend their internal human and capital resources to design computers from the chip-level components into their end products. Final board size and shape, CPU types, expansion options and software coding techniques varied greatly. No industry-wide standards had



Technology has progressed from tubes to transistors and then to integrated circuits (ICs).

been developed or adopted and there were not a wide variety of off-the-shelf products from which to choose. The end result was a hodge-podge of hardware, software and system configurations typically based upon an engineer's preference of CPU.

But as the density, complexity, capability and packaging of the silicon progressed, so has the choice and selection methodology for components. Today software, board size, and time-to-market are key decision factors in addition to just the power and speed of the CPU. The amount of time available to develop an embedded system has decreased significantly with times now as short as 3 to 6 months.

Designers have turned to industry standards thus changing from in-house proprietary designs to open market products to speed their time-to-market. This is where system components fit best. System components are available as higher-level logic functions such as the computer, video, network, memory and I/O rather than a more elementary part. These functions are based upon industry standards to provide greater design flexibility and functionality in less volume and at a lower cost.

Open Standards

The PC architecture has become the dominant standard that has worked its way into applications never dreamed of by its designers. The reason is that an embedded PC can reduce development costs and accelerate their time to market. The popularity of embedded PCs is the ability of a user to buy off-the-shelf hardware and customize it with software. Building upon these reasons, designers have selected PCs in a variety of sizes, shapes and configurations as their system components.

The standard it brings is more than just bus timing or packaging. PC-compatibility means a definition of the internals of a system including the CPU family, DMA, interrupts, timing, serial ports, LAN interfaces, video, disk storage, etc. The vast array of compilers, debuggers, operating systems, development tools, utilities, and application program interfaces makes the PC a very attractive host platform. Also, there is a knowledgeable base of trained engineers and programmers familiar with working with PC-compatible hardware and software.

PC/104 system components are small, reliable, easy-to-use, cost-effective, scalable, and available worldwide as they provide a powerful computer system building block for a variety industrial applications.

PC/104 as a System Component

PC/104 is an ideal system component for industrial applications since it solves space- and power-sensitive constraints, yet it does not sacrifice the architecture, hardware, and software compatibility of a true PC. The modules are small, rugged, and support both the ISA and PCI expansion in self-stacking modules spaced 0.6-inches apart. PC/104 is unique in that it can serve either as a mezzanine bus expansion module, single board computer, or both. A designer can either design and build their own specialty I/O board in-house or find hundreds of vendors with thousand of products worldwide.

PC/104 is simply a repackaged, modular version of the PC. A PC/104 module is an Industry Standard Architecture (ISA) bus board reduced to 3.6 x 3.8-inch (90 x 96-mm) which is approximately the size of a 3.5-inch diskette. The bus signal definitions and timing are the same. PC/104's P1 bus has 64 pins just like the PC-XT and is combined with 40-pins on P2 for full AT-compatibility. The sum of the pins (64 + 40 = 104) is the origin of the name PC/104. For applications requiring greater throughput, PC/104-*Plus* was defined and adopted.

PC/104-*Plus* is a PCI implementation on a stackable board that maintains the 3.6" x 3.8" form factor. PC/104-*Plus* modules can also include original PC/104 connectors to allow the most system configuration flexibility. PCI was chosen for a number of reasons. First it is the de-facto standard for desktop 32-bit transfers that significantly improves throughput between cards. Next PCI is a known and proven standard. It is an open architecture that is well documented with no licensing requirements. Finally PCI is sup-

A PC/104 system component is about the same size as a 3.5-inch diskette.

ported by current and next generation ICs and software.

One of the cleverest features of both PC/104 and PC/104-*Plus* is its reliable pin-and-socket connector that allows the modules to be stacked on top of each other. Multiple modules permit more flexibility in a design as well as further expansion capability while having freedom from backplanes buses. This reduces cost and bulk and increases mounting and packaging options.

In addition to the self-stacking nature of the bus, four corner-mounting holes are included to attach metal or plastic threaded standoffs. They form a sturdy mechanical construction that adds rigidity for industrial applications subject to shock and vibration.

System Component Selection

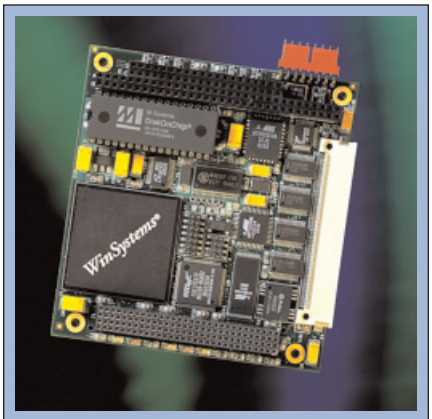
Remember that software is the driving issue with embedded system design. Whether it is a Microsoft Windows-based product, Linux, a real-time operating system or even just DOS, the software strategy needs to be made before CPU selection. Program speed, man-machine interface, networking, data storage, I/O acquisition and data manipulation, plus development and debugging tools should be decided upon before work has begun on selecting the system components.

Availability of software application programs and drivers, product documentation and stability, support and service are also factors into the decision.

The advantage of selecting PC/104 system components is that the same standard PC software environment is also available on boards optimized for deeply embedded applications. A programmer can use their existing knowledge base with a wide variety of software options. This increases productivity and shortens product development time.

A designer has the choice of CPUs from an entry-level 386sx to high-speed Pentium™ depending upon the level of performance needed. Just as with "standard" components, PC/104 system components are available with different functions, features, power, and operational temperature ranges.

Standard PC/104 modules will operate from 0 to +60°Celsius. Off-the-shelf modules are also available that operate from -40° to +85° Celsius even with Pentium processors. Computer modules can be selected with just a processor, memory and simple I/O to complete, standalone single board computers with integrated video and networking.



The PPM-TX is a web-enabled, PC/104-*Plus,* Pentium-based system component.

In addition to processors, there are a wide variety of PC/104 system components for I/O and memory. These include digital, analog, standard and special function serial I/O, networking, data acquisition, motion controllers, video controllers, solid state disks, and field bus interfaces. For an expanded list go to http://www.pc104.org and click on the Products' Tab.

Applications

The beauty of using a system component is the ability to use the same part in a variety of different applications. For example, WinSystems makes a web-enabled PC/104-*Plus* compliant single board computer called the PPM-TX. It contains a Pentium CPU, 10/100 Ethernet controller, 4 COM channels, USB, SSD, SDRAM memory, and the standard compliment of PC controllers on a single card that operates from -40° to +85° C. This same system component has been designed into different applications that include machine controllers, medical instruments, telecommunications diagnostic equipment, remote network monitoring and reporting devices, security systems, weighing systems, and semiconductor processing equipment. Even though the companies and products differ, they all depend upon the same system component. The software and any specialized I/O cards customize the system to suit their requirements.

The Bottom Line

With the shortage of skilled, knowledgeable hardware and software engineers to work on an ever-growing number of embedded systems projects, companies are moving from proprietary in-house designs to PC/104 modules as system components. The reason for this design approach methodology is that a company can focus upon its core competency by emphasizing areas where they can add value rather than reinvent the computer hardware again and again. Choosing a PC/104 system component increases reliability and gets the product to market quicker while leveraging the vast software infrastructure supporting PCs. The bottom line is that the PC/104 module has become firmly established as a standard design component in a wide variety of industrial applications.

WinSystems, Inc.
Telephone: 817-274-7553
WebSite: www.winsystems.com