

60+

FLAVORS

of CPU cards accelerate CompactPCI design

COMPUTER-BOARD MANUFACTURERS ARE SCRAMBLING TO GET A PIECE OF THE ACTION AS MORE CUSTOMERS COMMIT TO THE COMPACTPCI PLATFORM. COMPARE THE LATEST AND HOTTEST CPU OFFERINGS FROM THE INDUSTRY, AND FIND THE ONE THAT WILL SPEED UP YOUR PROJECT.

WARREN WEBB, TECHNICAL EDITOR

The foundation of any new CompactPCI system starts with the selection of a worthy system-slot CPU board. Each CompactPCI bus segment has only one system-slot CPU board, and that board, at a minimum, contains the main processor, provides the clock, manages bus arbitration, and drives the reset line. However, CPU-board manufacturers offer a lot more in the hope of influencing your selection. Higher speed, more memory, lower cost, specialty buses, development support, and custom circuits are just a few of the features that these vendors will use to stimulate your interest. Worldwide, these manufacturers offer more than 60 varieties of Slot 1 cards, each with a custom set of onboard peripherals (**Table 1**)—just the beginning of a flood of new CompactPCI CPU boards that you can expect soon. Your job, as a CompactPCI user, is to navigate the sea of speeds, options, sizes, prices, and software to select the CPU card that fits your project specification and budget.

Selecting a form factor is one of your first decisions and affects the CPU card, the enclosure, and all the remaining cards. Unlike VME, which almost immediately gravitated to the larger 6U boards, CompactPCI has strong supporters of both the 3U and the 6U sizes. In VME, the 3U size is performance-limited to 16 bits, so users must select the 6U size to have the full 32-bit-wide bus. CompactPCI provides the same bus width of 64 bits in both the 3 and 6U sizes.

“Most of the action up to now has been for 6U boards,” says Rob Davidson, strategic account manager at Ziatech. “Initial CompactPCI customers have been datacomm- and telecomm-

@a glance

- Windows NT reigns as the CompactPCI operating system of choice.
- New CPU boards add multiprocessing power to CompactPCI.
- More than 20 CPU-board vendors clamor for the growing CompactPCI market.
- CPU-board processors range from 133-MHz 486s to 500-MHz, 64-bit Alphas.

related customers who design their own peripheral cards. These cards tend to be complex, so the 6U size is more suitable." He says that the 3U size addresses many of the same issues that smaller buses, such as STD, PC/104, and even half-sized PCs, have over the years. Also, Davidson says, "3U fits in the industrial-automation market, where size and ruggedness are more important and the number of rear I/O pins is less important."

The other size parameter is board width, or the number of slots that the card occupies. Offering a three-slot CPU card in a CompactPCI backplane that allows only eight cards sounds like a disaster. However, in practice, manufacturers can adjust the backplane-card spacing to not waste slots. Because the CompactPCI specification does not dictate location, vendors are also free to position the CPU card on the right side of the card cage to eliminate board-width problems. Some vendors list their CPU cards as one slot wide but do not account for the processor heat sink that some operating environments require. In contrast, some two-slot boards may operate in a single slot without a heat sink in efficiently cooled enclosures.

Once you settle on board size, the next critical choice is the operating system. One of the primary operating-system considerations is the amount of real-time activity in the application. If your application must provide a deterministic response to random inputs, you should look at real-time operating systems, such as those from Wind River, Integrated Systems, QNX, and others. The real-time operating system provides the scheduling and prioritization algorithms to support multiple simultaneous tasks.

Another way to handle real-time activity is to include one or more intelligent I/O boards. These boards allow you to offload the real-time portion of your application from the host-computer operating system to an embedded processor dedicated to the task. Intel (www.intel.com) developed the intelligent input/output (I₂O) protocol to standardize the interaction between the host computer and an I/O processor. According to Peter Zackin, vice president of sales at Cyclone Microsystems, many CompactPCI users would rather treat the host computer as a server running Windows NT that communicates using I₂O with distributed intelligent-I/O cards for the real-time problem. This approach eliminates the need to develop NT device drivers, although still requiring real-time I/O programming, and allows application programmers to



Photo courtesy Ziatech

work in NT. Using Windows NT has the side benefit of expanding the available programmer pool because programmers outside the embedded world can perform these tasks.

Another CPU-board-selection problem is the selection of onboard processor peripherals. CPU-board I/O features range from one RS-232C port to full desktop-equivalent peripheral support (**Figure 1**). Multiple types of serial communications exist. They include Ethernet, Universal Serial Bus (USB), RS-422/485, Firewire, and several fieldbuses. Mass-storage interfaces include floppy disks, EIDE, SCSI, and flash memory. The

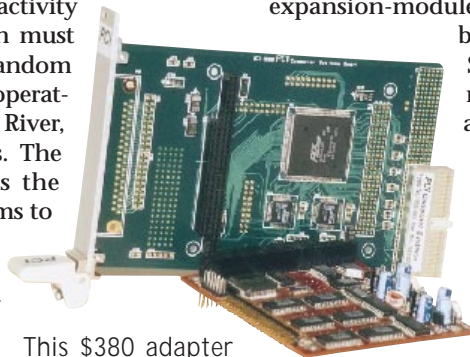
range of peripheral interfaces creates a problem for board manufacturers: No matter what combination of peripherals they select, the customer will want something else. The increased use of USB should reduce this problem because this bus removes the interface hardware from the CPU board. The practice of packing every possible peripheral interface onto the CPU board also increases the complexity, number of board layers, assembly time, and, therefore, the price.

Another way to accommodate a range of I/O ports from the CPU board is to include expansion-module sites. Users can plug mezzanine cards directly into the CPU board to allow flexible I/O customization. The most popular type of expansion-module sites are PCI mezzanine cards (PMCs)

because they are based on PCI-bus signals. Several vendors also accept smaller PCI module industry pack (PC-MIP) modules and proprietary mezzanine boards. VME boards use both PMCs and PC-MIP mezzanine boards, so a broad selection of functions is available. The exact mix of I/O functions on a CPU board may depend on the target market. As mentioned, the industrial-automation market, in which cost is more important, favors the 3U form factor.

"Cost is a big issue in the CompactPCI automation world," says Kurt Lender, an industrial-automation-application consultant at Radisys.

"Customers often ask us to strip functions out of the CPU board to save money. They want only one comm port and one Ethernet port to talk to the main factory computer." Industrial-automation customers also want higher integration. CPU vendors are starting to team with I/O-board designers to combine the CPU with other functions, such as motion control or video-signal processing. Although mezzanine boards provide these multiple functions, industrial-automation customers want even lower costs.



This \$380 adapter board from PCI Computer Systems allows a standard PC/104 or PC/104+ I/O card to operate in a CompactPCI system.

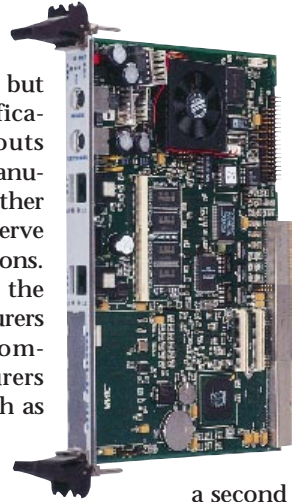
CPU CARDS FOR COMPACTPCI

Another feature beginning to appear in CompactPCI is the ability to have more than one CPU board in a system. Previously, CompactPCI CPU boards could not support multiprocessors because of PCI-to-PCI bridge-chip limitations. The C2P2 from General Micro Systems deploys Digital Equipment's (www.dec.com) new 21554 PCI Draw Bridge chip, which connects independent PCI buses while enabling data sharing. Likewise, Ziatech's ZT 5540 accommodates one processor in the system slot and as many as 31 other processors in the same CompactPCI environment.

Too much flexibility?

Both a great feature and a big problem with CompactPCI is its flexibility. A 6U board provides several hundred pinouts

through J3, J4, and J5, but the CompactPCI specification leaves these pinouts undefined. I/O-board manufacturers are unsure whether to use the pins or to reserve them for future definitions. Joe Pavlat, president of the PCI Industrial Manufacturers Group (PICMG), recommends that manufacturers use J4 for sub-buses, such as the H.110 computer-telephony bus; J5 for rear-panel I/O; and J3 for anything they like. PICMG is planning to begin a "pin registry," in which manufacturers can register J3, J4, and J5 pin definitions and request a unique IEEE 1101.10 front-panel key that prevents insertion of incompatible boards.



The \$2413 CPCI-7593 from VMIC is a 6U Pentium-based CPU board supporting Windows NT, RTX, and VxWorks operating systems.

CompactPCI vendors have also found other uses for J4 and J5. Ziatech and Pep Modular Computers increase the number of adapter-card slots by using the J4 and J5 connectors for a second set of independent CompactPCI bus signals. A special backplane routes the second set of bus signals to the corresponding J1/J2 pins in slots 9 through 15. The single CPU card may then accommodate two separate bus segments for a total of 14 adapter cards.

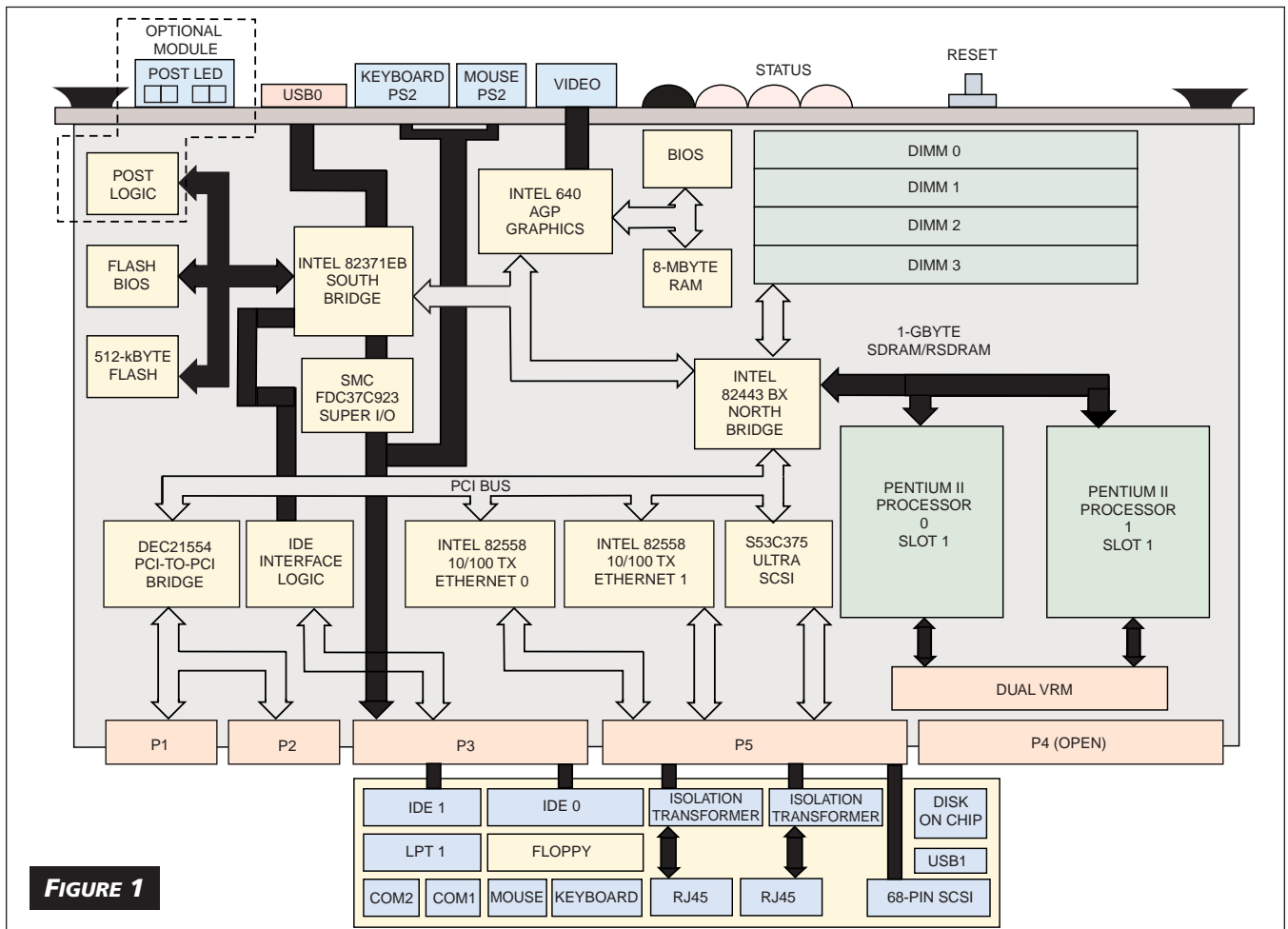


FIGURE 1

General Micro Systems' \$5400 C2P2 CPU board includes dual Pentium II processors, dual 10/100 Ethernet ports, and a range of onboard I/O ports.



CPU CARDS FOR COMPACTPCI

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The only drawback of this approach is that the CPU-card I/O signals go through J3 instead of the PICMG-recommended J4.

The CPU board you select affects other parts of your system as well. For example, several CPU boards require only 5V and derive any other needed

voltages onboard, whereas others need additional power supplies to provide the 3.3, 12, and -12V. Power-supply current requirements range from 1.5A for a 486

TABLE 1—REPRESENTATIVE SLOT 1 COMPUTER BOARDS

Manufacturer	Board/model number/ price	Board size	Board width (slots)	Processor type	Maximum processor speed (MHz)	Maximum DRAM size (Mbytes)	Maximum SRAM size	Maximum external cache (kbytes)	Maximum onboard flash memory (Mbytes)
Alta Technology Circle No. 302	SBC-A500/\$5750	6U	Two	Alpha 21164	500	1024		2048	1
Creative Electronic Systems Circle No. 303	RIOC 4064/NA	6U	One	PowerPC Mach 5	300	128	64 kbytes	1024	8
Eurotech Circle No. 305	ETH0996/\$1395	3U	One	Pentium	233	64		512	128
	ETH7621/Q4 98	6U	Two	Pentium	233	512		512	128
	ETH7631/Q1 99	6U	Two	Pentium II	233	768		512	128
Force Computers Circle No. 306	CPCI 520G/\$7200	6U	Two	UltraSPARC-IIi	300	1024		1024	4
	CPCI 522/\$8800	6U	Two	UltraSPARC-IIi	300	512		1024	4
	CPCI 522G/\$8800	6U	Three	UltraSPARC-IIi	300	1024		1024	4
	CPCI-720/\$1670	6U	Two	Pentium MMX	200	256		512	60
	CPCI-721/\$3130	6U	Two	Pentium	200	256		512	60
	CPCI-730/\$2350	6U	One	Pentium II mobile	266	384		512	16
	CPCI-3603/\$2995	3U	One	PowerPC	166	8			2
	CPCI-3740/\$3995	3U	One	PowerPC	233	8			4
General Micro Systems Circle No. 307	C2P2/\$5400 ¹	6U	Two	Dual Pentium II	550	1024		1024	540
	V155/\$3400 ¹	6U	Two	Pentium II mobile	300	750		512	24
Gespac Circle No. 308	PCIPPC-1/\$3495	3U	One	PowerPC 603e	100	32	4 kbytes		0.5
	PCISYS-57/\$1795	3U	One	Pentium MMX	233	64		256	2
Inova Computers Circle No. 309	ICP-K233/\$1420	3U	One	K6	300	64		512	4
	ICP-S86133/\$1000	3U	One	Thompson 5ST86	133	64		8	2
MEN Mikro Elektronik Circle No. 313	D1/\$2200	6U	One	Pentium	200	128	4 Mbytes	512	48
	D2/\$3000	6U	One	Pentium, K6 II	350	128	4 Mbytes	512	48
	F1/\$1500	3U	One	PowerPC	350	64			16
	F2/Q1 99	3U	One	Pentium, K6 II	350	128	4 Mbytes	512	48
Motorola Circle No. 316	CPV5000/\$1895	6U	Two	Pentium MMX	266	512		512	0.5
	CPV5300/\$2395	6U	Two	Pentium II mobile	266	512		512	0.5
	MCP750/NA	6U	One	PowerPC MPC750	233	256		1024	9
PCI Computer Systems Circle No. 317	CPU-6U-001/\$1400 ¹	6U	Two	Pentium MMX	266	512		512	8
	CPU-6U-002/\$1600 ¹	6U	Two	Pentium	266	512	72 Mbytes	512	8
	CPU-6U-003/\$1900 ¹	6U	Three	Dual Pentium II	450	512	72 Mbytes	512	8
	CPU-3U-001/\$990 ¹	3U	Two	Pentium MMX	233	64	74 Mbytes	512	4
Pep Modular Computers Circle No. 319	CP310/\$2109	3U	One	Pentium	166	64		512	1
	CP312/\$1789	3U	One	Pentium MMX,K6	300	128		512	4
	CP610/\$2500	6U	One	Pentium MMX,K6	300	128		512	4
RadiSys Circle No. 321	EPC100/NA	6U	Two	Pentium	200	256		512	1
	EPC200/NA	6U	Two	Pentium II	266	256		512	1
Sanritz Automation Circle No. 322	SC150/NA1	6U	One	Pentium MMX	200	128		512	72
SBS Embedded Computers Circle No. 323	CC4/NA	3U	One	AMD 486DX3	133	8			4
	CC5/NA	3U	Three	Pentium MMX	233	64		256	
	CC7/NA	3U	Three	Pentium II	450	256		512	
	CP5/NA	6U	Two	Pentium MMX	300	128		512	
	CP7/NA	6U	Two	Pentium II	450	256		512	
	CR6/NA	6U	One	Pentium MMX	300	128		512	
Smart Modular Technologies Circle No. 324	50cPCI-3U/NA	3U	One	MIPS R5000	200	128		64	4
	603cPCI/NA	6U	One	PowerPC 603e	240	128		512	0.5
	50cPCI/NA	6U	One	MIPS R5000	200	128		64	16

¹Quantity pricing.

²A25C=ChorusOS, E=Windows CE, L=Linux, N=Nucleus, O=OS9, P=pSOS, Q=Q NX, R=RTX, S=Solaris, T=Windows NT, U=unix, V=VxWorks, W=Windows 3.x/ 95/ 98 or MS-DOS, X=C-Executive, Y=Lynx-OS.

³10-Mbyte Ethernet ports.



Suggested software ²	No. of 100-Mbyte Ethernet ports	RS-232C serial ports	RS-422/485 serial ports	Parallel ports	USB ports	Onboard video interface	EIDE interface	Floppy interface	SCSI interface	Expansion-module sites
L, T		Two		One			Two	Yes		One PMC
C, Y	One ³	Two		One						Two PMC
E, P, Q, T, U, V, W		Two	One	One			Two	Yes		
L, P, Q, T, U, V, W	One	Two	Two	One	One	Yes	Two	Yes		One PMC, one PC-MIP
L, P, Q, T, U, V, W	Two	Three	One	One	Two	Yes	Two	Yes	One	
S	One	Two	One			Yes		Yes	Two	
S	Two	Two	One					Yes	Two	Two PMC
S	Two	Three				Yes			Two	Two PMC
T, V	One	Two		One	One		Two	Yes		
T, V	One	Two		One	One		Two	Yes	One	One PMC
T, V	One	Two	One					Yes		Two PMC
P, V		One								
P, V		One								
P, V, Y	One	Two								Two PMC
L, Q, T, V	Two	Two	One	One	Two	Yes	Two	Yes	One	
L, Q, T, V	Two	Four	One	One	Two	Yes	Two	Yes	One	
P, V		Two		One		Yes	One	Yes		
O, P, Q, T	One ³	Two			One		One	Yes		
O, T, V, W	One	Two	Two	One	One	Yes	One	Yes		One other
O, T, V, W	One	Two	Two	One	One	Yes	One	Yes		One other
T, V	One ³	Two		One	One		Two	Yes		One PMC
T, V	One	Two	One	One	One		Two	Yes		Three PC-MIP
E, V		Two								Two PC-MIP
T, V	One	Two	Two							Two PC-MIP
Q, S, T, Y	One	Two		One	Two	Yes	Two	Yes	One	
Q, S, T, Y	Two	Two		One	Two	Yes	Two	Yes	One	
O, P, V, Y	One	Four		One	Two		Two	Yes		One PMC
T, W	One	Two		One	Two	Yes	Two	Yes		
T, W		Two	Two	One	Two	Yes	Two	Yes		
T, W		Two	Two	One	Two	Yes	Two	Yes		
T, W	One ³	Two		One		Yes	Two	Yes		
Q, T, V, W		Two		One			Two	Yes		
Q, T, V, W		One	One	One	Two	Yes	Two	Yes		
Q, T, V, W	One	One	Three	One	Two	Yes	Two	Yes		One PMC
T, V, W	One	Two		One	Two		Two	Yes	One	Two other
T, V, W	One	Two		One	Two		Two	Yes	One	Two other
T	One	Two		One	One	Yes	One	Yes	One	One PMC
Q, T, V, W		Four	Two	One			One	Yes		One other
Q, T, V, W	One ³	Four	Two	Two	Two	Yes	One	Yes	One	One other
Q, T, V, W	One	Four	Two	Two	One	Yes	One	Yes	One	
Q, T, V, W	One	Four	Two	Two	Two	Yes	One	Yes	One	
Q, T, V, W	One	Four	Two	Two	Two	Yes	One	Yes	One	
Q, T, V, W	One	Four	Four	Two	Two	Yes	One	Yes	One	
N, P, V	One ³	One		One						
N, P, V	One	Two		One					One	One PMC
N, P, V	One	Two		One					One	One PMC

(Table continued on pg 60)

TABLE 1—REPRESENTATIVE SLOT 1 COMPUTER BOARDS (CONTINUED)

Manufacturer	Board/model number/price	Board size	Board width (slots)	Processor type	Maximum processor speed (MHz)	Maximum DRAM size (Mbytes)	Maximum SRAM size	Maximum external cache (kbytes)	Maximum on-board flash memory (Mbytes)
Smart Modular Technologies Circle No. 324	iPC-3cPCI/NA	6U	One	Pentium	233	128		512	8
Sun Microsystems Circle No. 325	CP1200/\$990 ¹	6U	Two	microSPARC llep	100	128			8
	CP1500/\$4000	6U	One	UltraSPARC-III	333	256	1 Mbyte	1024	4
Teknor Industrial Computers Circle No.326	CPCI-1000/\$1620	6U	Two	Pentium MMX	233	512		512	4
	CPCI-1003/\$2795	6U	One	Pentium II mobile	300	768		512	24
	CPCI-1004/\$2155	6U	One	Pentium MMX	233	768		512	24
VI Computer Circle No. 328	Shasta/\$4995	6U	One	PowerPC 750	366	384		1024	8.5
	Lassen/\$995	3U	One	PowerPC 603e	200	64		512	0.5
VMIC Circle No. 329	CPCI-7593/\$2413	6U	One	Pentium MMX	233	128	32 kbytes	512	16
	CPCI-7594/\$2713	6U	One	Pentium MMX	233	128	32 kbytes	512	16
	CPCI-7696/Q1 99	6U	One	Pentium II	266	128	32 kbytes	512	16
	CPCI-769/Q1 99	6U	One	Pentium II	266	128	32 kbytes	512	16
Ziatech Circle No. 331	ZT5510/\$1695	6U	Two	Pentium	200	512		512	8
	ZT5512/\$1695	6U	Two	Pentium	233	512		512	8
	ZT5520/\$2150	6U	Two	Dual Pentium Pro	200	512			8
	ZT5530/Q1 99	6U	One	Pentium II	266	512		512	4
	ZT5540/Q1 99	6U	One	Pentium II mobile	266	128		512	4
	ZT6500/\$1240	3U	Two	Pentium	200	48		256	4
	ZT6501/Q1 99	3U	One	Pentium	266	128		512	8

¹Quantity pricing.

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³10-Mbyte Ethernet ports.

to 18A for a dual Pentium II, depending on the processor and speed. A high-power CPU board may also force special cooling techniques in the enclosure.

Long MTBF, short life

Although CPU-board vendors tout MTBF specifications that sometimes exceed 50 years, the actual life will probably be much shorter. Rapidly changing technology is a reality that CPU manufacturers and their customers must face. Although CompactPCI system developers want a design life of five to seven years, the CPU board may need to be updated in less than two years to accommodate higher speeds, new software, and end-of-life components. IC manufacturers look at profits to determine when to stop producing a component. Although manufacturers may target a processor for long-life embedded systems, they stop production if profits fall. CPU-board vendors must then scramble to produce an alternative design.

One problem that you face with CompactPCI computer boards is find-



Intel's mobile Pentium II processor in Teknor's \$2795 CPCI 1003 yields a high-performance, low-power-consuming CompactPCI CPU board.

ing a second source. Most CPU boards are unique, and even if two vendors provide the same processor, memory, and I/O complement, the rear pinouts probably will differ. Rear transition boards solve a portion of this problem. The purpose of rear transition boards is to route all of the I/O boards to the back of the chassis so that cabling does not interfere with easy board replacement. The CPU-board and rear-transition-board combination from two vendors is

more likely to be compatible even if the J4/J5 pinouts are different. You can also design your own rear transition board that works with multiple CPU boards to solve the second-source problem.

Most CPU-board manufacturers agree that the primary factor limiting the widespread use of CompactPCI is too few I/O boards. Customers moving from the ISA-bus market are used to hundreds of low-cost I/O boards. To date, ISA vendors have found too little demand to justify the investment necessary to convert many of these cards to CompactPCI. The VME market also offers many I/O functions, but the design translation is not straightforward because many cards use sub-buses that the higher speed CompactPCI world does not define or even require. VME vendors are also reluctant to enter the CompactPCI market, in which the pricing structure would result in much lower margins. One unusual solution to the dearth of I/O cards is a carrier board from PCI Computer Systems, which allows virtually any PC/104 or PC/104+ card to operate in a 3U CompactPCI system.



Suggested software ²	No. of 100-Mbyte Ethernet ports	RS-232C serial ports	RS-422/485 serial ports	Parallel ports	USB ports	Onboard video interface	EIDE interface	Floppy interface	SCSI interface	Expansion-module sites
E, T	One	Two		One			One	Yes		Two PMC, one other
C, V	One	Two		One					One	
C, S, V	Two	Two		One				Yes	One	Two other
P, Q, T, U, V, W	One	Two	One	One	Two		Two	Yes		
L, N, P, Q, S, U, V, W	Two	Four	One	One	Two	Yes	Two	Yes	One	One PMC
L, N, P, Q, S, U, V, W	Two	Four	One	One	Two	Yes	Two	Yes	One	One PMC
O, P, V, Y	Two	Two	Two	One	One				One	Two PMC
O, P, V, Y	One	One								
E, R, T, V	Two	Two		One			One	Yes		One PMC
E, R, T, V	Two	Two		One			One	Yes		One PMC
E, R, T, V	One	Two		One		Yes	One	Yes		One PMC
E, R, T, V	One	Two		One		Yes	One	Yes		One PMC
Q, T, V	One	Two		One	Two		One	Yes		Two PMC
Q, T, V	One	Two		One	One		One	Yes		Two PMC, one other
Q, T, V	One	Two		One	Two		One	Yes		One PMC, one other
Q, T, V	Two	Two		One	One	Yes	One	Yes		Two PMC, one other
Q, T, V	One	Two		One	Two		One	Yes		Two PMC, one other
Q, T, V	One	Two		One				Yes		
Q, T, V, W	One	Two		One	One		One	Yes		One other

CPU-board vendors are experimenting to find the best way to serve their customers. Some vendors choose not to compete directly with the volume-board-production houses. One business formula is to provide a CompactPCI CPU reference design that customers can change as needed.

"Not a single customer has liked the reference design as is," says Terry Furtado, an application consultant at Radisys. "They want something tweaked, some software that is not supported, a funny little driver on the board, or another interface. We don't assume that any of our standard products will go into volume production because the customers will change the design."

Customers also report that I/O boards from different vendors do not necessarily work together. This critical problem results from the necessary evolution of the CompactPCI specification. Boards designed at early stages of the specification may require updates to work with later designs. Older boards are not 100%-compatible with the lat-



This 3U-form-factor CPU board, the SMARTengine/50cPCI-3U from Smart Modular Technologies, includes a 64-bit MIPS R5000 processor.

est backplanes. To solve these problems, some CPU vendors offer certification programs to verify that their boards operate with the products from other vendors. You avoid many headaches when you are building your first CompactPCI system by selecting boards that manufacturers have tested together.

Despite a number of early development problems, CompactPCI is growing in popularity. CPU-board vendors have taken the lead and are guiding the industry through this early formation period. More than 20 vendors offer an array of CPU boards that include the latest processors and any combination of onboard peripherals your project

may need. Recent innovations, including multiprocessing, dual processors, 64-bit processors, and dual buses, will provide you with all the processing power you need. So go ahead, pick a CPU card, and get ready for your next CompactPCI project. **EDN**

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