

# CompactPCI<sup>®</sup> and AdvancedTCA<sup>®</sup> Systems

The Magazine for Developers of Open Communication, Industrial, and Rugged Systems  
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SEPTEMBER 2006

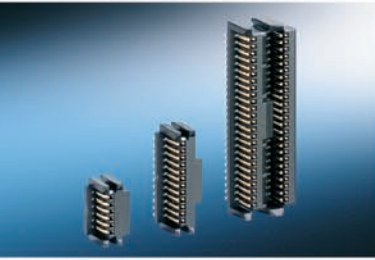
VOLUME 10 NUMBER 7

## Thermal management's liquid assets

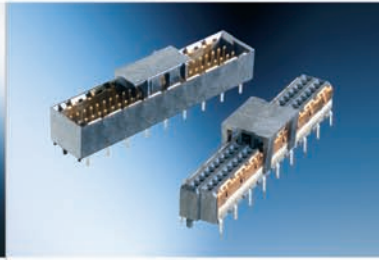
## Packaging Product Guide



**PICTURED**  
Each of the 18 slots in this cooling system prototype from Isothermal Systems Research, Inc. (ISR) is sized to deliver and cool up to 500 W with evaporative spraycooling.



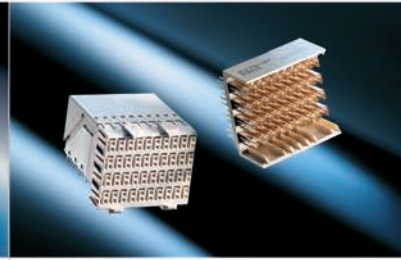
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VOLUME 10 • NUMBER 7  
SEPTEMBER 2006

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September 18-21, 2006  
Anaheim, CA  
[www.autotestcon.com](http://www.autotestcon.com)

**ESC Boston**  
September 25-28, 2006  
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**COVER:**  
A new consortium, the Liquid-Cooled Embedded Computing (LCEC) initiative, is taking on the challenge of improving watt-per-cubic-inch cooling densities by at least 500 percent over what forced air cooling achieves. See page 28.

Liquid cooling system prototype photo courtesy of ISR.



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What's riding on the shoulders of communications servers – and why  
*By John Fryer and Shreekant Raivadera, Motorola Embedded Communications Computing*

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*CompactPCI and AdvancedTCA Systems* (USPS 019-288) is published nine times a year (Jan, Feb/March, April, May, June, July/Aug, Sept, Oct, Nov/Dec) by OpenSystems Publishing LLC, 30233 Jefferson Avenue, St. Clair Shores, MI 48082. Print ISSN 1098-7622, Online ISSN 1550-0381. *CompactPCI and AdvancedTCA Systems* is free to qualified engineers or management dealing with or considering open system technologies. For others, paid subscription rates inside the US and Canada are \$63/year. For first class delivery outside the US and Canada, subscriptions are \$90/year (advance payment in US funds required).

Periodicals postage paid at St. Clair Shores, MI, and at additional mailing offices. Canada: Publication agreement #40048627. Return undeliverable Canadian addresses to: WDS, Station A, PO Box 54, Windsor, ON N9A 615.

POSTMASTER: Send address changes to *CompactPCI and AdvancedTCA Systems* 16872 E. Ave of the Fountains, Ste 203, Fountain Hills, AZ 85268



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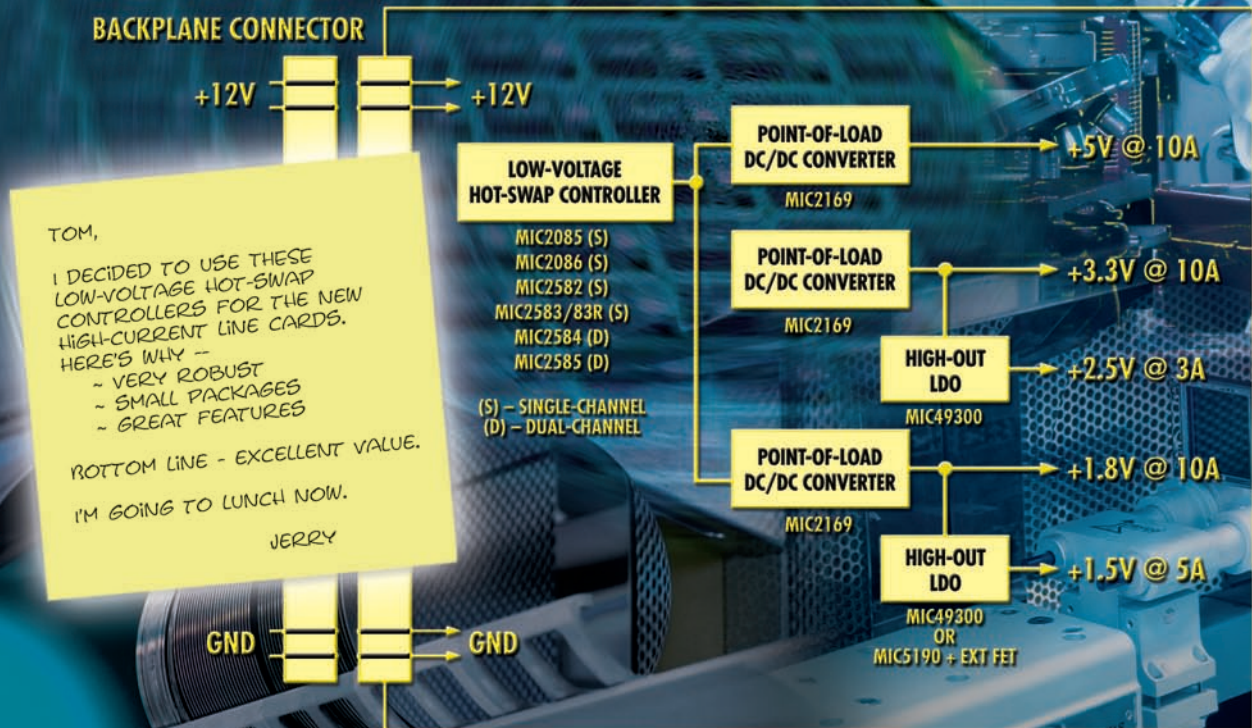
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## Editor's Foreword

By Joe Pavlat

CompactPCI & AdvancedTCA Systems

# Ultra Wideband: Quiet, fast, struggling

Wireless data transmission is at the heart of many of the advanced wireless services we've become accustomed to, including cellular telephony, Wi-Fi, and Bluetooth. WiMAX, which promises to offer high bandwidth over longer distances than Wi-Fi, appears ready for prime time. At least one major carrier, Sprint Nextel, has announced that they will spend billions of dollars deploying WiMAX infrastructure nationwide.

Another extremely interesting technology, Ultra Wideband (UWB), is slowly emerging from the shadows and offers unique advantages that will likely have a major impact on consumer, commercial, and military wireless communications.

In their new book, *Ultra Wideband Systems* (Oxford, UK, Newness Press, 2006, 315 pages), authors Roberto Aiello and Anuj Batra explore UWB technology, including ultra wideband origins, spectrum issues, antenna design, different data encoding methods, standards development efforts, and commercial applications.

### Beyond personal area networks

The book is intended for students, engineers, and marketing professionals, and it covers the subject in depth. It's a very interesting read for anyone involved in embedded system design, as ultra wideband can be used for more than personal area networks, connecting PC's, digital cameras, printers, and the like. With data rates in excess of 1 gigabit per second over distances of up to tens of meters, UWB opens up interesting possibilities for wireless board-to-board and system-to-system communications in embedded systems.

From its beginnings more than 50 years ago, UWB technology has moved from the lab, to the military, back to the lab, in and out of the standards process, and finally into commercial implementations (Figure 1). Unlike normal radio communications, which depend on modulating a specific carrier frequency, UWB works by transmitting and receiving very low power signals over a wide range of frequencies – sometimes several gigahertz – essentially simultaneously. Unlike Wi-Fi or Bluetooth, UWB doesn't require any particular piece of spectrum, licensed or unlicensed. It works on top of existing spectrum space, but the power levels are so low that interference doesn't occur. The Federal Communications Commission currently regulates UWB signals to be below 100 nanowatts per megahertz. UWB is permitted in the United States over the frequency range of 3.1 gigahertz to 10.6 gigahertz. It is this low power in any individual frequency band that allows it to coexist with licensed spectrum. This low power also makes eavesdropping and hacking very difficult, which is one of the reasons for early military interest.

Today, as we all know, industry standards are required to enable widespread technology acceptance and mass-market opportunities. Standards create confidence, reduce the importance of any single vendor, create competition in price and performance, and create critical mass. Standards tend to emerge either from the promotion and opening up of proprietary standards or from ground-up efforts intended to best meet market requirements. Often the process

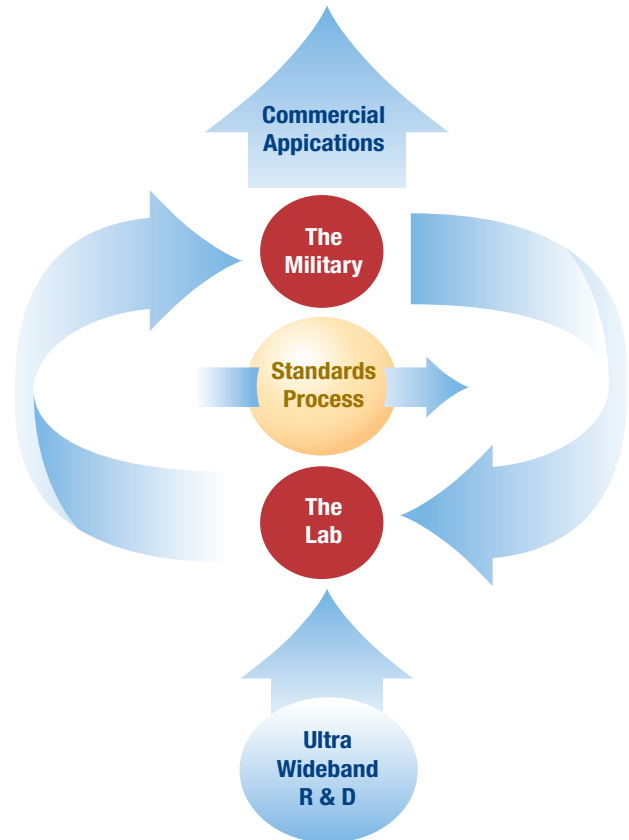


Figure 1

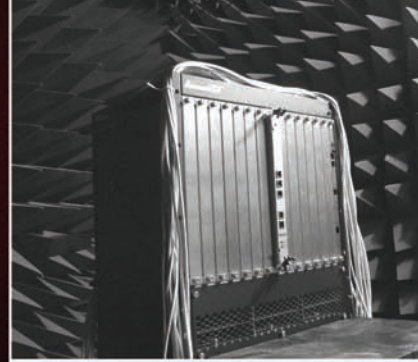
is iterative, including technology experts, market experts, and solution providers. The standards efforts surrounding UWB began in the IEEE in 2001 as IEEE 802.15.3a. Things began to go downhill sometime thereafter. Although the complete story reads like a Raymond Chandler novel, with intrigue, vested interests, shifting coalitions, and bad faith, it is sufficient to say that the standards efforts around UWB are currently in tatters and no single de facto or agreed upon approach has emerged. While commercial products began to be introduced in 2005, they are not completely interoperable and therefore have not yet achieved broad market acceptance. The original IEEE committee has failed to reach consensus, and several splinter groups, including the WiMedia Alliance ([wimedia.org](http://wimedia.org)) and the UWB Forum ([www.uwbforum.org](http://www.uwbforum.org)) have come into existence. It's really a shame, as this technology is very fast, extremely low power, robust, essentially interference free, and can be cheap. UWB is applicable to a host of embedded computing applications where its attributes of high bandwidth, very low power, robustness, and low cost can be put to use in ways that one can only begin to imagine. It may be that the technology is simply too useful and compelling to languish. I hope that the current standards woes are only temporary. UWB is really good stuff.

Joe Pavlat, Editorial Director



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## Power connector overload test has practical uses for AdvancedTCA Zone 1 connectors

When analyzing the capabilities of power connectors, users are familiar with creepage and clearance distances, voltage ratings, contact resistance, current ratings based on continuous operation, and performance values. However, a less familiar consideration is the current overload capability.

During a current overload test, the connector's contacts are subjected to current loads in excess of their normal current rating. The current overload test is often used to uncover potential weaknesses in the contact system.

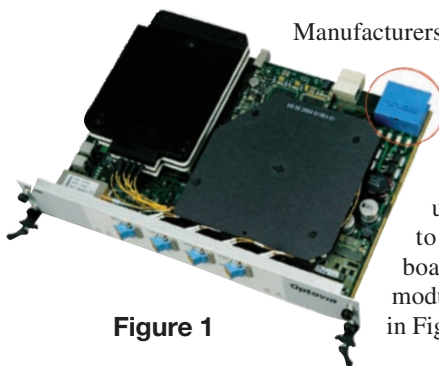


Figure 1

Manufacturers of AdvancedTCA systems are finding current overload tests useful in evaluating Zone 1 connectors. Zone 1 connectors are used to interface power to AdvancedTCA front boards such as the XT200 module from Optovia shown in Figure 1.

Zone 1 connector specifications require power contacts to carry 16 amps continuous with a maximum temperature rise of 30 °C. Although this is adequate under normal operation, conditions can occur which might result in higher currents being drawn through the Zone 1 connector.

For example, if a high impedance short occurred in an AdvancedTCA front board between the front board's overcurrent protection and the backplane's overcurrent protection (see Figure 2), the Zone 1 connector might be forced to conduct high currents for long periods of time. These currents could reach a value that is slightly less than the overcurrent protection for the entire backplane. Would the Zone 1 connector survive this type of fault?

A recent revision to PICMG 3.0 has added an overload test that requires Zone 1 connector manufacturers to demonstrate their products' capability to survive a high impedance short in AdvancedTCA front boards.

A high impedance short is often referred to as a *sizzle fault* because the backplane's overcurrent protection may not open immediately, allowing the high impedance short to *sizzle*. The Zone 1 connector sizzle fault test requires two power contacts to be energized at 50 amps while two others are energized at 10 amps. This condition is maintained for a total of 5 hours.

After being conditioned to the overload currents, the connectors are then unmated and inspected. There must be no visible

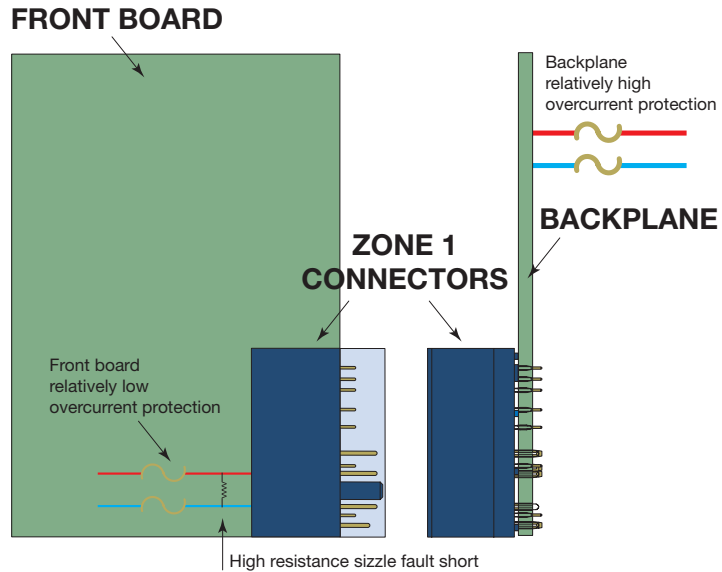


Figure 2

damage to the insulator or contacts. Next, a fresh front board connector is mated to the backplane connector. Replacing the front board connector in the test simulates replacing a faulty front board in a deployed AdvancedTCA system. Finally, the power contacts are energized at 16 amps. The temperature rise in the contact area must not exceed the Zone 1 connector specification requirement of 30 °C. Also, the contact resistance must meet Zone 1 connector specifications as well as function according to all other Zone 1 connector requirements.

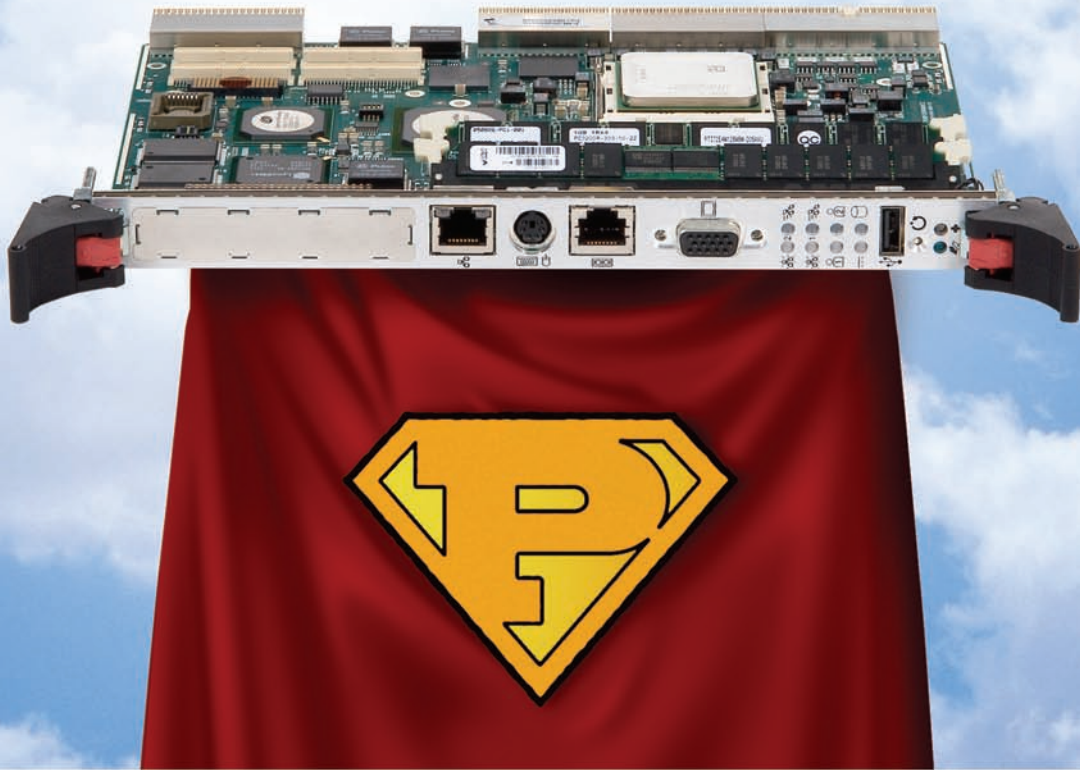
In applications where power connectors may carry currents in excess of those required in normal operation, a current overload test can be used to further evaluate a power connector's capability. A power connector's ability to survive sizzle faults could minimize the need for costly replacement of backplanes or connectors. This is the reason a Zone 1 connector overload test, Section B.4.2.4, has been added to PICMG 3.0.

*Gino Nanninga is the vice president of sales for Positronic Industries, a 40-year-old manufacturer of power, D-subminiature, rectangular, and circular connector products. Gino represents Positronic in PICMG.*

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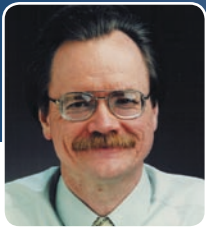
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# AdvancedTCA specification revision adds hardware platform management benefits

On May 19 2006, PICMG adopted a substantial revision of the AdvancedTCA specification, reflecting more than three years and thousands of AdvancedTCA shelves worth of experience. In this column Mark highlights this revision in the hardware platform management arena. This second revision affecting R2.0 of the AdvancedTCA specification is known informally as ECN-002.

Hardware platform management focuses on fundamental aspects of the AdvancedTCA hardware, including collecting inventory data, budgeting power, tracking and responding to temperature events, and brokering high-speed fabric connections. In the initial AdvancedTCA specification, this area was known as *shelf management*, but that term is now used primarily for the shelf-wide level, which consolidates information and control for all the Field Replaceable Units (FRUs) or boards in a shelf.

Key improvements ECN-002 brings to the table include more effective and portable system managers, finer grain thermal management, and more general topologies for radial IPMB-0.

### More effective and portable system managers

One theme of the extensions is providing more visibility to the system manager for decisions made by the shelf manager, such as in the power and cooling areas. Some system managers display the state of the shelves in a network operations center with graphics; with the ECN facilities, these displays can include more detailed information.

Another theme is improving robustness of shelf/system manager interactions. One extension ensures that multiple independent components in the system manager don't attempt to concurrently modify the shelf configuration information, possibly wreaking havoc in a shelf. Another extension informs the system manager of all the Internet Protocol (IP) addresses with which the shelf manager and its redundant

instances can be accessed. This allows the system manager to continually monitor the health of all these interfaces and initiate recovery actions if any of them go bad. On the cooling front, when a fan-related problem is being diagnosed, the system manager can temporarily remove that fan from the shelf manager's control. The system manager can then exercise that fan thoroughly without conflicting with the shelf manager.

### Finer grain thermal management

Prior to ECN-002, shelf managers could control the fan speeds of different fans implemented in the shelf via generic PICMG-defined IPMI commands. However, without ECN-002, shelf managers could not discover in a standardized way which fans would affect specific FRUs' cooling states. Therefore, if any FRU reported a high-temperature exception, all the fan speeds had to be increased.

Deployed shelves must minimize the extra noise that higher fan speeds produce. With a shelf architected to take advantage of ECN-002's fan geography facility, the response to a high-temperature exception from an FRU can be an increase in the speeds of the fans for just the zone where that FRU is installed, not all the fans. The 14-slot shelf in Figure 1, for example, has three cooling zones. Slots 1-5 are in cooling Zone 1, with slots 6-10 and 11-14 in Zones 2 and 3 respectively. The pair of dedicated shelf manager slots on the right side of Figure 1 is also part of Zone 3.

A high-temperature exception in Slot 7 would result in boosted fan speeds for only Zone 2 (one third of the fans in the shelf, not all of them). Such a shelf could even have a separate fourth zone to add even more control granularity for the Rear Transition Modules (RTMs) that can be installed behind the front boards.

A key aspect of this facility is that the shelf describes its own fan geography as part of its shelf configuration information. Therefore, if the shelf managers in the example shelf were extracted and moved

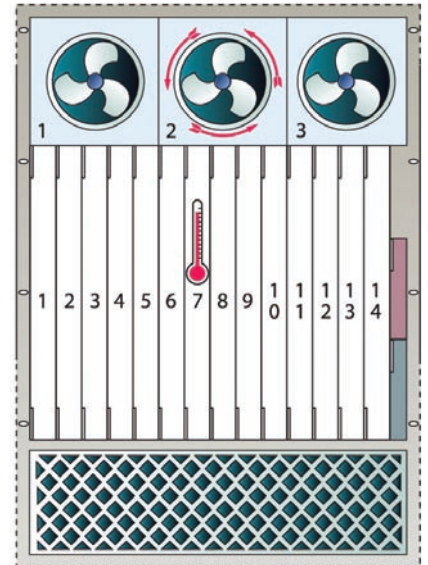


Figure 1

to a different shelf with completely different fan geography, they could automatically adapt to the new configuration.

### More general topologies for radial IPMB-0

IPMB-0 is the main communication mechanism inside the shelf for hardware platform management messages. Some AdvancedTCA users consider a radial implementation of IPMB-0 to be mandatory for certain types of deployments. As shown in Figure 2, a radial implementation can have separate IPMB-0 segments going to the IPM controller on the board in each slot. This keeps problems on one slot from affecting the other slots. Consider, for instance, the possibility of a board malfunction that brings down IPMB-0 in a remote shelf. If IPMB-0 is implemented on a radial basis, overall operation of the shelf can be preserved by disabling the IPMB-0 segment for that slot until service personnel can get to the shelf and replace the board.

On the other hand, proponents of implementing IPMB-0 on a simple based or multidrop basis note that IPMB-0 is dual-redundant, with IPMB-A and IPMB-B to back each other up. If a blocking problem

happens on IPMB-A, IPMB-B can be used until repair can be accomplished. These designers believe that the extra complexity and cost of a radial IPMB-0 implementation is not cost-effective.

Even among radial IPMB-0 enthusiasts, however, there are different favorite topologies. In one widely used topology, as shown on the left side of Figure 2, each dedicated shelf manager has a radial hub for both IPMB-A and IPMB-B. The distinct radial segments from each of these hubs come together at the A and B ports of the IPM controllers. This topology preserves dual segment access to every IPM controller even when only one shelf manager is present or operational.

Another widely used topology, as shown on the right side of Figure 2, implements an IPMB-A hub on one shelf manager and an IPMB-B hub on the other shelf manager. In this topology, both shelf managers need to be present and operational to have dual-segment access to all IPM controllers.

Prior to ECN-002, the shelf configuration records could not describe the right-hand topology in Figure 2 because the data structures in the AdvancedTCA specification had been conceived primarily to describe variations of the left-hand topology. With ECN-002, both these topologies and a wide range of others can be described, so that a portable shelf manager can automatically adapt to the specifics of a given shelf.

**Shelf manager delivers first support for ECN-002**

One example of a shelf manager that complies with ECN-002 is the widely used Pigeon Point Shelf Manager Release 2.3.0, which is shipped on an SODIMM-sized shelf management mezzanine, such as the second generation ShMM-500R shown in Figure 3.

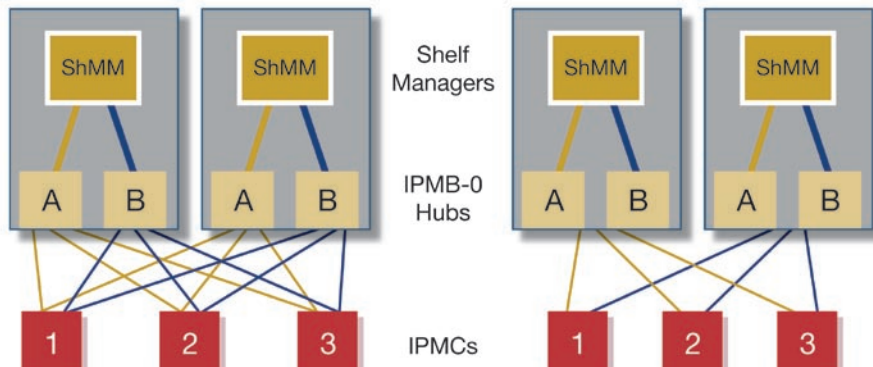


Figure 2



Figure 3

# Specification Corner

A generic shelf manager delivered by Pigeon Point in the flash memory of an ShMM-500R can automatically adapt across a wide range of shelf architectures by looking at the shelf configuration data:

- Bused IPMB-0 or radial IPMB-0 and within radial, a wide range of topologies
- Fan geographies (that is, fan-to-FRU mappings) that are completely undescribed, as in pre-ECN-002 shelves, to a wide range of fine-grained descriptions enabled by the ECN
- The number of slots and the high-speed fabric topologies implemented in those slots, which were already self-describing prior to ECN-002

The additional facilities in an ECN-002-compliant system manager interface support the needs of real system manager applications and can be used with any ECN-002-compliant shelf manager from

Key New Commands	New System Manager Capabilities	Resulting System Manager Benefits
Set/Get Fan Policy	Discover the fan to FRU mappings	Getting fan to FRU mappings without having to parse detailed records in shelf information
	Discover and control which fan devices are enabled for autonomous Shelf Manager control	Ability to temporarily disable shelf manager autonomous control of particular fan devices, say for diagnostic operations
Get Shelf Power Allocation	Discover the power allocations that have been made by the Shelf Manager for all power feeds	Visibility on allocation decisions made by the Shelf Manager
Get Shelf Manager IP Addresses	Discover all the IP addresses by which the Shelf Manager and its redundant instances can be contacted	This collection of addresses can be routinely monitored, with automatic follow-up if any address stops responding
FRU Inventory Device Lock Control and Write	Acquire and use exclusive access to shelf configuration information	Ensuring that concurrent attempts to change shelf configuration information do not cause corruption thereof

Table 1

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any source to protect the Telecom Equipment Manufacturers' and their customers' investment in the often complex system manager layer. Table 1 summarizes key system manager related extensions in ECN-002.

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## Validating IPTV service quality under realistic triple play network conditions

In this column Tara discusses the emerging test methodologies and metrics for verifying IPTV *Quality of Experience (QoE)* across the IPTV delivery network, as illustrated in Figure 1.

What happens during the converging and scaling of time/loss-sensitive video traffic with existing voice and data services contending for the same network resources? Viewers have come to expect a predictable level of service quality with their broadcast and satellite TV services, and they will not be tolerant to service interruptions, picture degradation, or long waiting periods to change channels with their new IPTV service.

### IPTV quality of experience

With so much at stake, it is not surprising that IPTV QoE has become one of the most popular buzz words within industry publications, tradeshow, and forums. IPTV QoE refers to how well the video service satisfies users' expectations. The IPTV quality subscribers experience must be equal to or better than today's cable and satellite TV services, or else service providers run the risk of significant subscriber churn.

QoE is influenced by commercial factors, such as the price, content, and features of the service, as well as technical factors including channel change response times, and the media quality itself. *Measuring IPTV QoE* refers to testing the technical aspects that influence the subscriber's service experience. Acquisition costs are estimated are at \$1,000 per subscriber, and it is important to validate IPTV QoE on a per-subscriber basis.

There are two fundamental areas of IPTV QoE testing:

- Channel zapping measurements
- Media (audio and video) quality metrics

Channel zapping measurements evaluate how quickly subscribers can change channels, and verify viewers are receiving

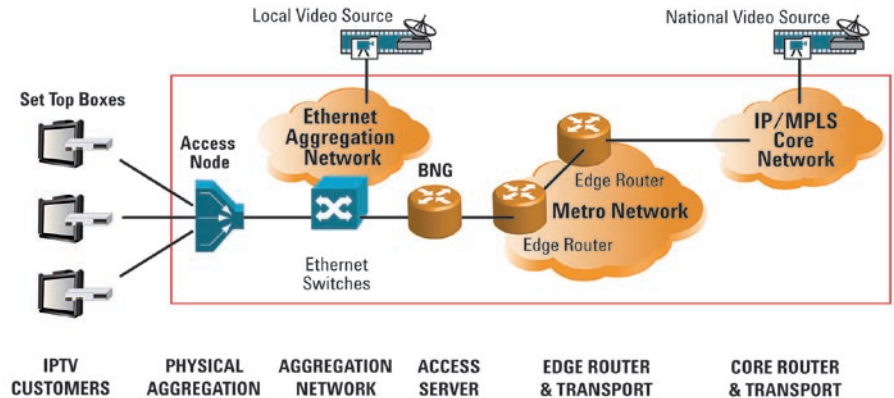


Figure 1

the correct channel. Acceptable channel zapping delay is generally considered to be around 1 second total, end-to-end. A channel zapping time of 100-200 ms is considered by viewers to be instantaneous.

Multicast protocols enable channel zapping within the network infrastructure. Internet Group Management Protocol (IGMP) or Multicast Listener Discovery (MLD) leave/join delay has a direct impact on channel zapping delay. To keep overall channel zapping delay within 1 second, the target multicast leave/join delay of each network component needs to be about 10 ms to 200 ms.

Many factors can compromise the perceived media quality, so that measuring it is a formidable challenge. The scale and behavior of IPTV subscribers and convergence of other triple play traffic contending for finite network resources have a significant impact on the timely and accurate forwarding of IPTV packets. Resulting network impairments (packet loss and sequence errors, latency, and jitter) can have various detrimental effects on visible video quality such as blocking, blurring, edge distortion, judder (choppy picture), and visual noise. Therefore, a complex network environment that accurately reflects the characteristics of triple play networks must be represented in the lab in order to sufficiently stress network equipment and evaluate IPTV media quality.

### Network characteristics and media quality

It's estimated that the number of IPTV subscribers worldwide will reach 53.7 million in 2009[1]. IPTV subscriber growth in North America alone will increase 12,985 percent between 2004 and 2009. France, the leading European country in rolling out IPTV services, had 281,000 subscribers registered to the three main IPTV services (Maligne, Free, and Neuf) at the end of 2005[2]. Digital video distributed via IP multicast (IGMP in most networks) doesn't ensure consistent video quality among all the users watching the same channel. It is therefore difficult to ensure that each and every subscriber is receiving the video properly. With IPTV delivery network bandwidth and processing resources finite, it follows that the more subscribers requesting the IPTV service, the higher the threat of compromised QoE. It is critical that network equipment be tested under an increasing scale of both subscribers and IPTV channels to identify the point at which per-subscriber QoE reaches an unacceptable level. If the access network can only accommodate, for example, 1,000 simultaneous subscribers for the World Cup in one community, user 1,001 could potentially degrade the experience for all of the 1,001 viewers.

### Dynamic subscriber behaviors

In a realistic triple play user environment, subscribers behave in a dynamic fashion.



Figure 2

A household receiving triple play services from a single provider may be simultaneously initiating channel-change and new Internet-connection requests while having multiple VoIP telephone conversations. When scaled across the subscriber base, this dynamic behavior can be very demanding on the control plane of IPTV network elements and potentially jeopardize IPTV viewers' QoE.

Take, for example, a large number of simultaneous channel change requests (channel zapping) during the commercial break of the Academy Awards. The rapid transition from a steady state of long-term viewing to a huge series of changes can significantly stress a Broadband Network Gateway (BNG) or edge router as it struggles to process thousands of IGMP group join/leave requests, update multicast forwarding tables, and replicate multicast traffic over the correct outgoing interfaces. This stress can result in packet forwarding delay and loss and affect IPTV QoE. It is therefore critical to model dynamic subscriber behaviors in the test environment in order to measure the impact on IPTV QoE metrics. Including a combination of triple play traffic within the test environment to identify how the presence (or interference) of other service traffic influences quality of service and timely forwarding of high priority video traffic is a must.

**Traditional approaches to measuring IPTV quality of experience**

The traditional, yet problematic, approach to achieving channel zapping and media quality measurements has been to build an extensive test bed of equipment in the lab, as shown in Figure 2.

This type of test environment, which incorporates hundreds of real set top boxes and video sources, along with VoIP phones and personal computers to represent voice and Internet service traffic, is not a very practical approach to testing IPTV QoE. Obvious concerns include the high capital outlay required to source the equipment, space requirements for housing the test bed, and the labor-intensive configuration required to control the tests. This methodology also has serious flaws since it doesn't scale well to reflect real-world subscriber numbers, which can reach from the thousands into the hundreds of thousands. Set top boxes overheating and requiring frequent rebooting

compromise the reliability of the tests. Within this setting, IPTV QoE is determined by individuals who watch and surf television programming for hours on end and rate the overall quality of their experience within a defined numeric scale.

While this type of subjective testing can identify when service quality expecta-

tions aren't being met, it provides little insight into what's actually causing or contributing to the service degradation. Test measurements are difficult (if not impossible) to correlate with specific problems at the network layer, thus the measurements have little value when it comes to troubleshooting and isolating network configuration problems.

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## Next generation methodology for measuring IPTV QoE

Next generation IPTV QoE test methodologies overcome the issues and limitations of traditional test approaches by using a single test system to simulate and make IPTV QoE measurements on a network environment that accurately reflects the scale and characteristics of real-world triple play networks. Figure 3 illustrates how a large test bed of equipment can be replaced with a single test tool that can:

- Simulate IPTV subscribers and channels with scalability
- Emulate dynamic subscriber behaviors
- Generate a combination of triple play traffic
- Provide relevant test metrics for thousands of individual subscribers

By emulating and scaling multiple protocols simultaneously over the same test port, such as Point to Point Protocol over Ethernet (PPPoE), Dynamic Host

Configuration Protocol (DHCP) and IGMP, a realistic (and cost effective) test environment that reflects IPTV subscriber growth expectations can be simulated. Test systems must be able to emulate and make measurements on tens of thousands of subscribers, watching hundreds of different channels, located behind a single device.

This simulated topology is much easier to manipulate and control than using real set top boxes, while providing excellent granularity. A unique channel zapping profile can be applied to each individual subscriber, or group of subscribers, to identify how different channel changing behaviors impact the performance of the device/system under test. By scaling the channel zapping activity, it is possible to saturate the device under test with thousands of individual requests for the same channel, as well as thousands of multicast group join/leave requests from subscribers flipping through channels in sequence. Developers can use a simulated

topology (Figure 4) to quickly achieve per-subscriber channel zapping measurements, as well as the average/minimum/maximum for different subscriber groups. Key channel zapping test scenarios include:

- Internet group management protocol or multicast listener discovery leave and join delay for subscribers
- Sustained channel zapping performance
- Channel zapping performance under peak load

Defining their interaction with other triple play voice and data services can further scope the behavior of each subscriber. Applying a dynamic and comprehensive profile to each subscriber allows the modeling of ever-changing network conditions, such as DHCP session-flapping and new Internet connection requests, which can put significant stress on network equipment, and impact IPTV media quality. These profiles can be used to define and generate different combinations of

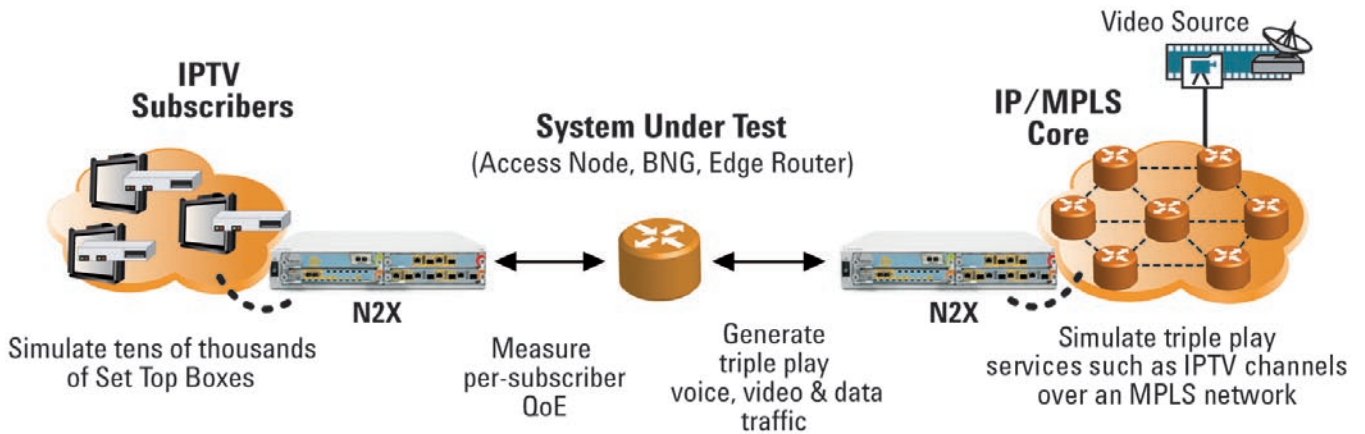


Figure 3

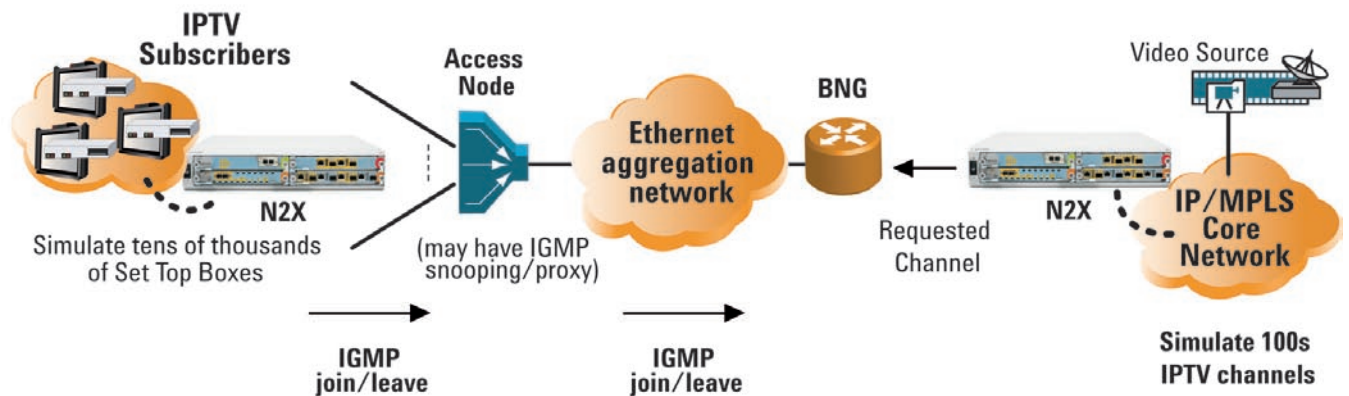


Figure 4

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# Technology Update

triple play traffic types, with corresponding priorities, including:

- Video multicast traffic (representing broadcast IPTV) with different video payloads such as MPEG-2 SD and MPEG-4 AVC/H.264 SD/HD traffic, and Windows Media 9/VC-1 and encapsulations (for example, MPEG-2 TS/RTP/UDP/IPv4, MPEG-2 TS/UDP/IPv4, and multiple VLAN tags)

- Video unicast traffic (representing Video on Demand)
- VoIP (voice) traffic
- Internet traffic

The oversubscription and convergence of this traffic over the same port will force the device/system under test to forward traffic according to service prioritizations.

---

“Already several widely publicized IPTV trials have failed to turn into actual deployments and others have been delayed for more than a year with costly results.”

---

The realistic simulation of triple play subscribers and services creates an ideal environment for verifying overall IPTV media quality. The media quality test metrics must be scalable, repeatable, and provide insight into the reasons behind relevant performance problems.

The Media Delivery Index (MDI) is gaining widespread industry acceptance for testing IPTV QoE over network elements in a video delivery infrastructure. MDI is an industry standard defined in RFC 4445 and endorsed by the IP Video Quality Alliance. MDI's two components, the Delay Factor (DF) and the Media Loss Rate (MLR) are based on concepts that translate directly into networking terms: jitter and loss. MDI correlates network impairments with video quality, which is vital for isolating problems and determining their root cause. A high delay factor directly indicates that increased latency, which can degrade video quality, has been introduced by the device/system under test. It also warns of possible impending packet loss, as device buffers approach overflow or underflow levels. This points to congestion in the network or inadequate buffer resources as potential reasons for the poor performance. Similarly, the MDI's media loss rate component clearly highlights packet loss events as contributors to poor video quality. This provides much greater insight into the network conditions that contribute to video quality than, say, a simple video quality score on an arbitrary scale[3].

MDI values are also more relevant for assessing network equipment performance than video quality metrics. Video quality



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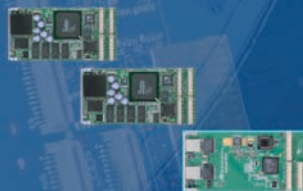


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- RS232 & SCSI boards
- PMC carrier boards
- RTOS Support (Windows, VxWorks)



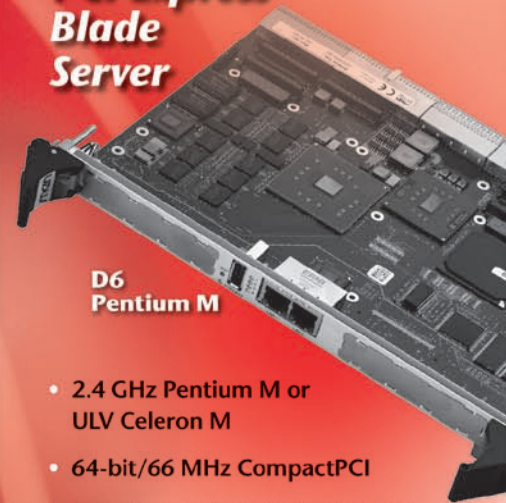
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metrics decode the video and consider compression and codec properties. Yet network devices can only switch, delay, or drop packets. Isolating network equipment's effect on IPTV QoE demands metrics based on packet-level measurements. Furthermore, as MDI does not rely on the processor-intensive activity of decoding, measurements can be scaled to tens of thousands of subscribers at once to achieve critical media quality metrics including:

- The effect of protocol stress and network instability on media quality
- Voice and data services impact on media quality
- The ramifications of channel zapping on media quality
- The number of IPTV subscribers and channels the device can support within an acceptable media quality

QoE standards for IPTV are still under debate, but the DSL Forum's WT-126 recommends a maximum loss of up to 5 consecutive IP packets per 30 minutes for SDTV and VOD, and 4 hours for HDTV. If translated into MLR terms, this assumes the loss is a single IP packet in the specified timeframe to account for the fact that the packet loss must be consecutive. Agilent Technologies' study recommends the following cumulative MDI measurements throughout the delivery network:

- Maximum acceptable DF: 9-50 ms
- Maximum acceptable MLR (all codecs): 0.004 for SDTV and VOD and 0.0005 for HDTV[4]

Figure 5 illustrates how packet loss is manifested in the viewed video quality.

### Conclusion

IPTV QoE is the critical factor underlying the success of IPTV deployments and service provider triple play service bundles. Several widely publicized IPTV trials have already failed to turn into



MLR = 0



MLR > 0

Figure 5

actual deployments, and others have been delayed for more than a year. The losses of face and impaired financials have been very costly. Ensuring customers' viewing experience meets expectations from day one mitigates this risk.

It is critical to select test tools and methodologies with the ability to test new video services in the larger context of triple play networks to verify IPTV QoE under increasing scale, and in the presence of other voice and data services. Diligent and thorough pre-deployment testing, under realistic and dynamic network conditions, will have a direct influence on subscriber satisfaction.

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- [4] Andre Dufour, Agilent White Paper: Understanding the Media Delivery Index, 2006

*Tara Van Unen is a product manager for Agilent's Data Networks Operations, focused on IPTV and triple play test methodologies. She has been working on the development of Agilent's N2X Multiservices Test Solution since 1999. Tara is an expert in IPTV, multicast, and MPLS technologies and is a member of the IPTV Interoperability Forum within ATIS. She holds a MBA degree from Simon Fraser University.*

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# Forging the interoperability link

*By Ashok Mishra, Shlomo Pri-Tal, and Karel Rasovsky*

*In 2006 the Communications Platforms Trade Association (CP-TA) was launched to drive a mainstream market for interoperable communications platforms. CP-TA members represent a broad cross-section of the modular ecosystem and consist of hardware and software building block providers, tool vendors, system integrators, and Network Equipment Providers (NEPs).*

## Interoperability – the missing link

Although AdvancedTCA is a well conceived and maturing specification, challenges to broad adoption include:

- Multidimensional open industry standards support all applications, yet a specific comms application might need only a subset
- Too many optional requirements and choices, fragmenting the market along too many specific products
- Inconsistent interpretation of mandatory requirements
- No objective criteria for conformance or certification
- Limited overall system view results in low confidence in platform interoperability

## Thermal interoperability

An AdvancedTCA integrator has to select a shelf that is capable of cooling a given configuration of boards under a broad range of operating conditions such as those defined in Network Equipment Building System (NEBS) deployment practice. The shelf suppliers may profile the cooling capacity of their shelves, expressed in volumetric airflow through each slot. However, without an industry-wide benchmark, the underlying airflow tests and simulations vary from one vendor to another, and changing slightly just one parameter of the test, such as the slot thermal impedance, will significantly influence the reported ratings. This makes objective side-by-side comparison of shelves difficult and inconsistent, adding an element of risk to the interoperability of ecosystem AdvancedTCA products.

Adding to the challenge, the shelf airflow will be redistributed under load (with boards installed) due to blade thermal impedance varying by blade type. Slots populated with low-impedance boards such as switch blades adjacent to high-density Single Board Computers (SBCs) will effectively starve the neighboring high-density slot of needed airflow, potentially exposing the SBC to thermal failures. Although PICMG 3.0 mandates that board and shelf vendors publish pressure-airflow curves, it does not mandate boards' impedance thresholds.

Without a benchmark for consistent airflow rating of shelves, and without complementary guidelines mandating blade impedance thresholds, integrating a thermally sound platform remains an art of simulating and optimizing the pressure curve of each slot to match the airflow requirements of its intended board. The industry desires a broader configuration-independent interoperability model of shelves and boards.

## Manageability

The AdvancedTCA shelf management system monitors, controls, and assures proper operation of boards and other shelf components. The shelf manager interacts with boards and other shelf resident Field Replaceable Units (FRUs) and also acts as an agent of the system manager, which usually resides outside the shelf. A shelf manager typically perceives two communication interfaces – one directed internally towards the shelf resident FRUs (such as boards) and the other directed externally towards the system manager.

The PICMG 3.0 base specification defines in great detail the interactions between the shelf manager and the management controllers located on the FRUs inside a shelf. Some requirements are absolutely essential to achieve interoperability at this interface, and must be interpreted and implemented correctly and consistently. Test procedures for validating a product's conformance to these requirements must be developed, supported by a compliance test suite.

When applying a system view necessary for seamless platform integration, interoperability areas exist that are of practical importance but have not been addressed by the existing specifications. New interoperability requirements have to be formulated to address some of these interoperability gaps, as identified by the system integrators and NEPs. Specifying the interface between the shelf manager and the system manager exemplifies one such area. A well-defined interface like the SA Forum's Hardware Platform Interface (HPI) at this layer will enable the system manager to gain a common view of different vendors' hardware systems.

## Zeroing in on the fabric menu

To date, the PICMG 3.x specifies no fewer than five fabric technologies, with many implementation options within each protocol family. This Swiss-knife-like flexibility is warranted, as it accommodates systems with different I/O needs, as well as enables platforms in separate vertical markets. However, driving a standard high-volume market for communications platforms will require narrowing the choices from the PICMG 3.x menu. The mainstream market for AdvancedTCA communications applications is already converging on Ethernet/Fibre Channel protocol, as specified in PICMG 3.1. Further mandating the most practical option choices from PICMG 3.1 will enable interoperable components to be built for systems with similar I/O profiles.

## CP-TA mission and objectives

The Communications Platforms Trade Association mission is to drive the creation of a mainstream market for open industry standards based communications platforms by actively developing an ecosystem that delivers certified interoperable building blocks from multiple vendors.

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In principle, CP-TA will develop interoperability test requirements coupled with detailed test procedures that are supported by industry-harmonized test tools and benchmarks, packaging these elements as a single release. The CP-TA road map anticipates a new release every six months to expand the scope of communications platform interoperability over time, to account for evolving open specifications, and to keep aligned with the SCOPE Alliance profile road map. To deliver on these objectives, CP-TA is organized into Technical, Compliance, and Marketing Working Groups (Table 1).

CP-TA	
Working Group	Objectives
Technical	<ul style="list-style-type: none"> <li>• Interoperability requirements</li> <li>• Test plans</li> <li>• Standards Development Organization interfacing</li> </ul>
Compliance	<ul style="list-style-type: none"> <li>• Test procedures</li> <li>• Compliance test tools</li> <li>• Interoperability plugfests</li> <li>• Certification program</li> </ul>
Marketing	<ul style="list-style-type: none"> <li>• Create CP-TA awareness</li> <li>• Create pull from NEPs and service providers for compliant building blocks</li> </ul>

Table 1

**Requirements: The blueprint for interoperability**

As a first step toward improved interoperability the Technical Working Group (TWG) architects will distill a set of interoperability test requirements based on existing open specifications from PICMG, OSDL, and the SA Forum. Conceptually, the interoperability requirements link the options promoted by these specifications with interoperable products. In addition, developers are analyzing and mapping SCOPE-developed system level profiles into interoperability requirements. The primary objective is to promote deployment of commercial off-the-shelf products that interoperate with each other. To identify interoperability test requirements, the TWG interfaces with SIGs and the SCOPE Alliance, promoting alignment across open specifications and SCOPE profiles.

For the first CP-TA release in 2006, the priority is to comprehend interoperability requirements from the just-released SCOPE Alliance profile for AdvancedTCA (Figure 1) and focus on interoperability criteria for thermal interaction of shelf and boards. This first release will also address requirements for improved interoperability in the area of manageability and fabrics. Follow-up releases will include future SCOPE Alliance profiles as well as interoperability aspects of emerging technologies such as AdvancedMC, MicroTCA, and Carrier Grade Linux.

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**Interoperability compliance**

The next step is compliance testing for these interoperability requirements. In close collaboration with the TWG, the Compliance Working Group (CWG) develops detailed test procedures and underlying test tools linked with each of the interoperability requirements. The scope of AdvancedTCA architecture, which consists of mechanical, thermal, electrical, and manageability components, makes this a significant task, with each area requiring its own kind of test environment.

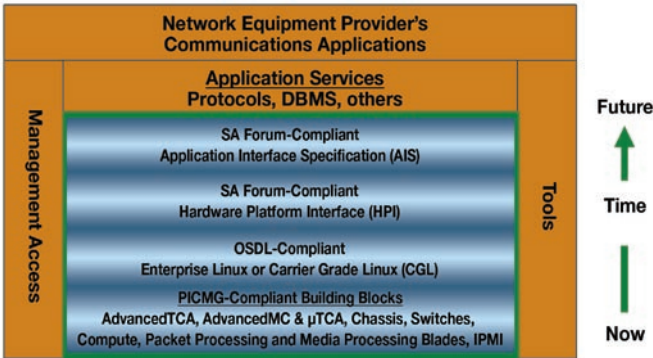


Figure 1

Test procedures for software based interactions, such as manageability testing, lend themselves well to automated test suites. Figure 2 shows a conceptual view of IPMI test architecture. In keeping with the principle of open standards, such a software test suite must be deemed impartial and be provided by a neutral vendor, one that does not own a stake in certification of its own AdvancedTCA building blocks.

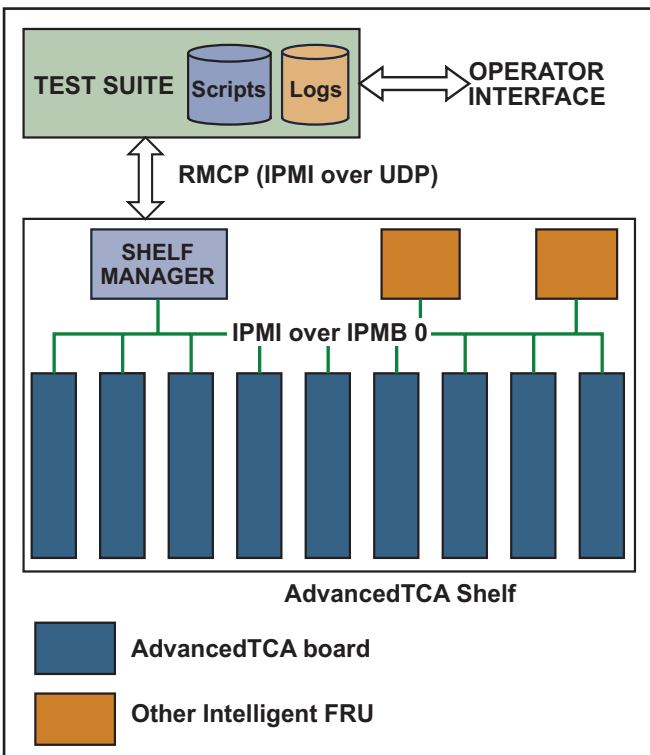


Figure 2



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Other domains of interoperability may not lend themselves to testing by the means of automated software tools, rather they require golden test platforms to be defined and instrumented. Characterizing airflow performance of AdvancedTCA enclosures will rely on these types of hardware benchmarks. The shelf under test is configured with a standard reference board in all slots, representing well-defined thermal impedance. These instrumented reference boards will facilitate a quantitative assessment of the total volumetric airflow per slot, as well as front-to-back flow distribution within each slot.

### Certification testing

CP-TA members are collaborating on the first set of interoperability requirements, detailed test procedures, and industry-harmonized test tools, planned for release in the second half of 2006. In this first phase, CP-TA members will test their products mainly in-house. Moreover, CP-TA envisions periodic interoperability plugfests that will allow the CP-TA community to align the execution of CP-TA tests as well as offer a confidential, true multivendor environment for enhanced testing.

Through 2007, CP-TA's goal is to build a cost-efficient certification program for the CP-TA community. Building block categories such as managed shelf, shelf manager, switch board, operating system, and SBC will be tested against applicable CP-TA test procedures, and compliant products will be issued a certification mark/logo to indicate improved interoperability. The CP-TA Marketing Working Group (MWG) is working to foster preference for certified interoperable products through the ecosystem by creating a strong pull from network equipment providers and service providers.

AdvancedTCA interoperability certification requires testing each type of component for electrical, mechanical, thermal, interconnect, and software attributes. The CP-TA is engaging third-party labs across the world, capable of running CP-TA certification testing for CP-TA members as well as for outside entities.

### Conclusion

Attaining interoperability at the system level, not just the component level, is the key prerequisite to mainstream adoption of open standards based AdvancedTCA carrier grade platforms.

CP-TA brings together the industry to lay out a set of testable requirements essential to platform interoperability. Equally important, the trade association is creating the complementary test procedures and underlying test tools that will validate conformance to these interoperability requirements, forming the foundation for an industry-wide interoperability certification program certified by independent test labs.

As modular components designed, tested, and certified for baseline interoperability become available, integrators will increasingly have the flexibility to cost effectively mix and match components from different vendors into base AdvancedTCA platforms. Ultimately, the success of a CP-TA certification program will be measured on the improved economics of deploying carrier grade infrastructure solutions based on open standards. 🌐



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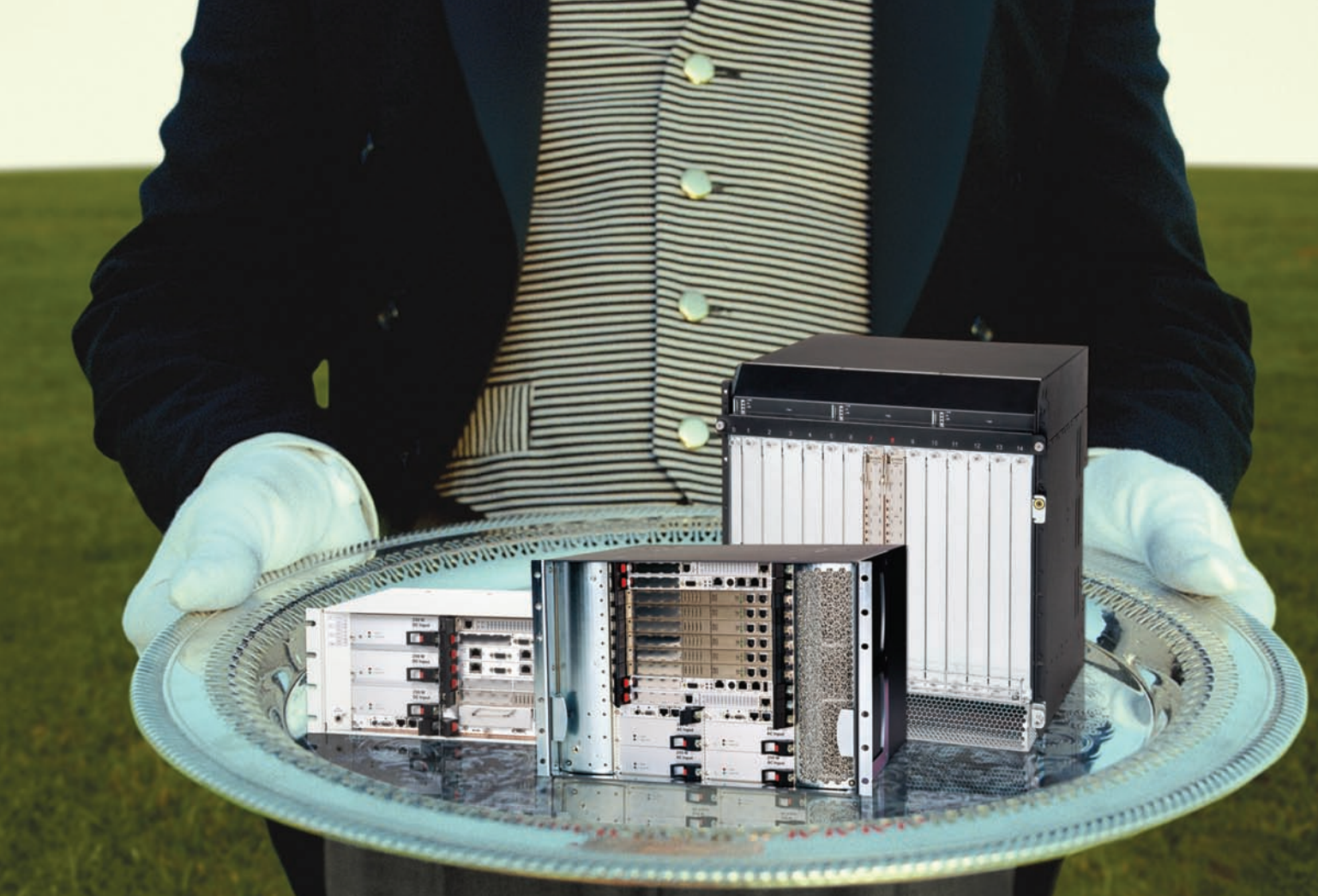
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# Liquid-cooled embedded computing initiative

By Tahir Cader, Eric Grabowski, Joe Pavlat, and John Peters

*In the first of a two-part article, which continues in the October CompactPCI and AdvancedTCA Systems, Tahir, Eric, Joe, and John introduce the objectives of the Liquid-Cooled Embedded Computing (LCEC) initiative, a privately funded group tasked with creating an open standard for liquid-cooled embedded computing architectures. The second part of this article details LCEC development of a full board cooling system.*

Since their inception, computers have been mostly cooled via either natural air convection or forced air cooling. Military or harsh environments sometimes use conduction cooling, but it is a niche technology. Air cooling is reaching its limits.

It is time for forward thinkers in the industry to develop a set of open standards and building blocks that are general purpose, affordable, and improve watt-per-cubic-inch cooling densities by

at least 500 percent over what forced air cooling achieves. LCEC has been formed to tackle this problem in a complete, flexible, and thorough manner.

## Objectives

Producing a standard that will enable architectures that result in 500 percent better compute density than any existing standard is the key objective. The LCEC initiative will also allow for the leveraging of the fastest, densest, and most commoditized silicon from other high volume markets, such as the PC server/desktop arena.


One key consideration will be the reduction of module depth to support both 300 mm and 600 mm telecommunications environments. Provisioning for front or rear panel I/O options will also be a feature. The LCEC committee will consciously work to create a standard that limits architectural choices so as to produce an interoperable commoditized market supportable

by many hundreds of different companies. Backplane interconnect topologies, mechanical form factor, physical interface, and data link layer decisions will all be made to minimize choice and maximize market interoperability.

## Membership

The following companies are members of LCEC:

- Performance Technologies
- Yamaichi Electronics
- Harting Technology Group
- Pentair Electronic Packaging
- Isothermal Systems Research, Inc. (ISR)
- Carlo-Gavazzi
- Cypress Point Research

Membership will be expanded in the near term. 

*This article continues in the October CompactPCI and AdvancedTCA Systems.*

## Leveraging of desktop silicon

Currently, the embedded computing market is forced to use lower performance Integrated Circuits (ICs) because of an inability to effectively cool the higher performance versions. The ability of liquid cooling to effectively deal with the higher powers will enable LCEC to use commoditized, low-cost, high-performance hardware.

## Environmental isolation

LCEC currently envisions that a sealed enclosure will completely contain the electronics. This environment totally isolates the electronics from the external ambient. Such environmental isolation will afford numerous benefits. For example, the electronics will experience significantly lower thermal gradients, which will drive higher reliability. The electronics will also be isolated from the harmful effects of humidity, dust, and salt fog (the latter two being especially important in military environments). Another very significant benefit is that the sealed container will effectively contain the EMI and RFI radiation from the electronics.

## Reliability

Environmental isolation will deliver potential improvements in reliability. It is also important to note that large heat sinks are no longer needed with liquid cooling. The removal of these large masses from the ICs will dramatically reduce the stress that shock and vibration impart during shipping, handling, and operation.

## Densification

Electronics densification is one of the major advantages that will be gained from liquid cooling. Current trends are to make boards larger in order to spread the electronics out for effective air cooling. This is counter to the well-accepted computer industry objectives of providing increased performance, in smaller footprints, at lower cost. The current effort will enable a 350 W to 500 W board that fits into an approximate envelope of 6U, 1.2-inch slot pitch, and 7-inch depth. This translates into a density of 1.0 W to 1.4 W per cubic inch, as compared to the 0.3 W to 0.5 W per cubic inch afforded

by air cooling today (CompactPCI, AdvancedTCA, and ATX).

## Lower costs

Through densification, liquid-cooled system solutions will use fewer components to deliver a given level of computational performance. Fewer components will result in better MTBF and less service. Smaller systems will result in less floor space used, reduced infrastructure, fewer personnel deployed, and fewer required support services. The perceived cost adders associated with the addition of cooling loops will be more than offset by the increase in functionality, performance, reduction in size, improvement in reliability, and the capability to draw upon the most commoditized of markets. No other technological pursuit in the area of embedded computing will return as much benefit as the development of standardized liquid cooling.



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# A closer look at PICMG chassis technologies

By Eike Waltz

Several new (or relatively new) PICMG-based technologies are entering the market. Some, like MicroTCA, have only been ratified recently. Others, like CompactPCI Express, have been around awhile, but have only seen demand and/or new product introduction rise recently. Here Eike reviews important backplane, system platform, and cabinet considerations for these new technologies and the advantages of each approach.

## CompactPCI/PICMG 2.16

CompactPCI has been around since 1996, and PICMG 2.16 was introduced in 2001. The architectures are still going strong. 3U CompactPCI is particularly in demand for many mil/aero designs, where such considerations as the size, stability of the architecture, and wide range of vendors make it attractive.

One of the first questions in choosing a PICMG-based architecture is backwards compatibility. If the technology needs to be backwards compatible to CompactPCI, then PICMG 2.16 is one of the obvious choices. PICMG 2.16 uses the ubiquitous Ethernet standard, but the performance is limited to approx 830 Mbps slot-to-slot. Its simplicity, wide product availability, and wide acceptance should keep 2.16 as a solid niche technology.

## CompactPCI Express

CompactPCI Express takes 2.16 a step further, at the same time offering backwards compatibility. The 2 mm HM connector used in CompactPCI has seen performance problems above about 1.3 Gbps. (However, at least one connector manufacturer has announced new higher performance versions of the connector.) CompactPCI Express replaces the HM with the ZD connector in certain parts of the backplane. A PCI Express to PCI-X bridge accomplishes the support of legacy 32- or 64-bit CompactPCI boards. The use of CompactPCI boards of 33 MHz, 66 MHz, or 133 MHz is possible. A CompactPCI Express backplane from Elma combines Type 1,

Type 2, and legacy CompactPCI slots. (Figure 1)



Figure 1

CompactPCI Express uses a serial point-to-point bus with a read-only bandwidth of up to 16x 2.5 Gbps or 8x 2.5 Gbps full duplex bandwidth. Providing support for several different card form factors with connectivity in 1x, 2x, 4x, and 8x increments, each link represents one full duplex 2.5 Gbps interconnect path. Because the CompactPCI Express architecture continues to support the P3, P4, and P5 in all 6U slot types, CompactPCI Express can continue to support all existing CompactPCI secondary architectures such as PICMG 2.5, 2.20, 2.16, 2.17, and 2.18. They can be used as either functions on native CompactPCI Express cards or as legacy cards in the original CompactPCI format.

## AdvancedTCA

Initially targeted to be telco-centric, AdvancedTCA is expected to dominate in the Central Office (CO). However, designers are increasingly considering the AdvancedTCA form factor for applications in mil/aero, enterprise computing, research labs, and server farms. For the non-CO applications, AC power versions are popular. To save space, designers use thin power supply units in smaller horizontal chassis. For example, in the Elma 2U chassis shown in Figure 2, the power supply is just above the card cage. There is also room for pluggable shelf managers.

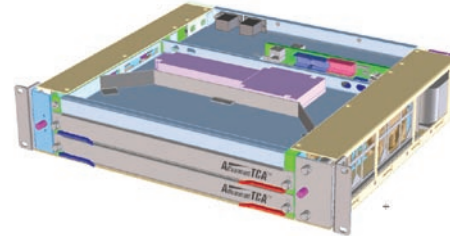


Figure 2

Versions with hot pluggable power supplies are also possible. In most non-CO applications, due to space limitations and performance requirements, the horizontal units with 2-, 4-, or 5-slot backplanes are the most commonly used. For example, a 14-slot mesh backplane in a 12U or 13U chassis can be overkill for many applications.

Redundancy is an important issue for AdvancedTCA. Even the AC versions at times require dual power supplies or dual shelf managers, for example. Proof of thermal performance is critical in AdvancedTCA as the cooling challenges can be intense. Showing thermal studies of the whole cabinet takes this concept a step further. Demonstrating a full cabinet-level thermal approach goes a step beyond proving the chassis cooling, involving thermal management of the whole system. Figure 3 is a simulation model showing the airflow in a 42U AdvancedTCA cabinet enclosure with three 13U AdvancedTCA chassis inside. The red areas have the higher airflow. Adjustments can be made

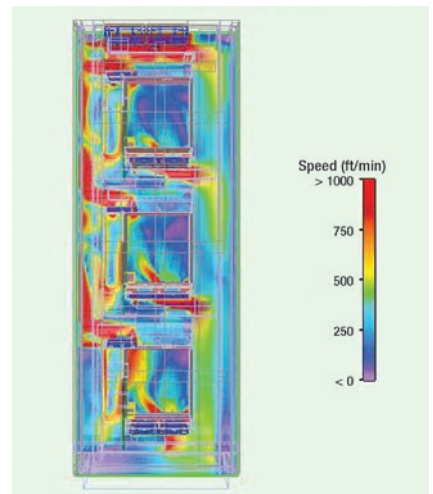


Figure 3

# CompactPCI Express

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based on the simulation to optimize the cooling. At the AdvancedTCA Summit (October 17-19, Santa Clara, California), visitors can see proof of thermal performance demonstrations.

The exact assumptions of the NEBS GR-63-CORE became unclear when new types of telecommunications equipment and air-distribution systems were introduced. GR-3028-CORE includes new Heat-Release Targets based on multiple equipment environments as well as computer modeling techniques that were not available during the original GR-63-CORE development. Due to the convergence of telecom and datacom, datacom equipment technology is advancing at a rapid pace to be on par with telecom requirements. Based on the latest information from all the leading datacom manufacturers, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHREA) special publication "Datacom Power Trends and Cooling Applications," authored by the TC9.9 committee, provides for new and expanded datacom equipment power trend charts for the datacom facility designer.

Telecom and data center equipment today are generally air-cooled. With cabinet/rack heat loss steadily climbing, the ability to deliver either adequate airflow rates, or sufficient chilled air at acceptable noise levels, is now stretched to the limit. Recognizing this issue, even traditional telecom (CO) is entertaining the thought of using *liquid* cooling solutions (to the cabinet level). The overall goal of liquid cooling is to transfer as much waste heat to the facility water as possible and to reduce the overall (redundant) airflow needed by the cabinets/racks by reducing noise levels, and in the case of AdvancedTCA, achieve higher performance levels (> 200 W per slot).

### AdvancedMC

Advanced Mezzanine Card (AdvancedMC) defines the base-level requirements for a wide range of high-speed mezzanine cards optimized for, but not limited to, AdvancedTCA carriers. AdvancedMC enables a modular building block design for both industry standard and proprietary carrier boards. Envisioned AdvancedMC modules cover

a wide range in terms of their functionality and include the following examples:

- Telecom connectivity (ATM/POS [OC-3/12/48], T1/E1, VoIP, and GbE)
- Processors (CPUs, DSPs, and FPGAs)
- Network Communication Processors (Network Processor Units)
- Network communication co-processors (classification, security, or intrusion detection)
- Mass storage

The AdvancedMC module is designed to be hot swappable and is the primary component of MicroTCA.

### MicroTCA

As MicroTCA is new, we should go into more details on the architecture. It is one of the latest significant architecture efforts from the standards-based community for embedded computing systems. The MicroTCA architecture allows large arrays of AdvancedMC modules to be used in a wide range of applications where a lower cost solution is required than could be achieved by the standard AdvancedTCA architecture. The MicroTCA backplane allows single or redundant virtual carriers to provide power management, platform management, and fabric connections to greater numbers of modules than a single physical carrier card could support in a classic AdvancedTCA application.

MicroTCA chassis will be offered in the following configurations:

- Shelf – A typical 19-inch or ETSI size rack-mount unit
- Cube – Can be placed side-by-side or stacked in a cabinet
- Pico – Cards are mounted horizontally, saving horizontal space, and chassis will likely not exceed 3U heights

Since MicroTCA supports the installation of multiple shelves in a 300 mm deep cabinet (ETSI) and MicroTCA shelves can have high power density, attention has to be paid to a cooling and wiring infrastructure.

In MicroTCA systems the MicroTCA Carrier Hub (MCH) will support up to 12 AdvancedMC modules of any form factor. In a 19-inch MicroTCA shelf there is physical space for 29 compact, 14 full size, 21 mid size, or an assortment thereof. Modules come in single- or double-width. AdvancedMC modules are targeted for such modular applications as storage arrays, firewalls, blade servers, and even home entertainment centers. See Figure 4 for some examples of cube and shelf MicroTCA chassis and backplanes.

The backplanes can have a power module slot(s), located inside the subrack, although this is not a requirement. A MicroTCA system must have an MCH.



Figure 4

“With cabinet/rack heat loss steadily climbing, the ability to deliver either adequate airflow rates, or sufficient chilled air at acceptable noise levels, is now stretched to the limit.”

the PICMG community, and should fit a multitude of market segments quite well. Overall, the future looks bright for the PICMG-based technologies. 🌐



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The MCH provides interconnect, power conversion, clock distribution, and system management functionality. The MCH would typically be plugged into a backplane slot in the card cage, but they don't necessarily have to be placed there.

**Winners and losers**

The performance of CompactPCI Express slot-to-slot (approx 5,000 Mbps) is not too far off from AdvancedTCA (approx 7,500 Mbps) and is comparable to MicroTCA (approx 5,000 Mbps). High heat-dissipation levels rely heavily on a seamless integration of equipment and room-cooling designs. Equipment manufacturers must be aware of the different telecommunications environments in which their products may be placed. It is equally important that the service providers understand the physical and environmental requirements of new and emerging equipment technologies (such as AdvancedTCA, AdvancedMC, and MicroTCA).

It is hard to predict which technologies will become the most successful and widely adopted. The technology with the highest bandwidth doesn't always win. One key factor is how much backing a technology has by key players, committees, or a group of vendors. For example, National Instruments will likely give PXI Express and CompactPCI Express a place by default. The technology has slowly gained traction and looks like it will fall into a comfortable niche. CompactPCI Express is now available with cards from companies like MEN Micro and Inova. AdvancedTCA with its wealth of early supporters and strong market need is sure to continue to have success. Also, with a wide vendor and product base and well-understood and accepted architecture, CompactPCI and PICMG 2.16 will remain important. MicroTCA is quite new, but it appears to have generated a lot of early interest, has a lot of support in



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# Fine-tuning power throughout the system development process

By Christopher Jones

Typically specifying power for CompactPCI and other systems has meant identifying products with power ratings and environmental specifications matched as closely as possible to the design requirements. Advances in digital technology have introduced flexibility to this process, as Christopher discusses in this article.

In recent years, modular designs for switching power supplies have offered some level of flexibility in popular mid-level power ranges from 500 W to 1,500 W, enabling designers to use what is optimal, not just obtainable. However, traditional analog modules still have limitations and frequently require custom engineering from the manufacturer to address such issues as:

- Special voltages
- Operating noise limitations
- Special cooling requirements
- Fan speed adjustments
- Constant current settings
- Module enable and sequencing configurations

While faster than designing a custom power supply, making these changes adds time and cost to the development cycle. In addition to these limitations, few of the modular options meet specialized standards, such as UL2601 and EN60601, commonly required for designs used in medical applications.

One approach to addressing the limitations designers face when supplying power for traditional analog modules is the use of switchers with the following characteristics:

- Microcontrollers built into the power supply modules
- Graphical User Interface (GUI) that enables designers to make adjustments to a variety of parameters

Switchers with the characteristics just noted can help designers lower the cost

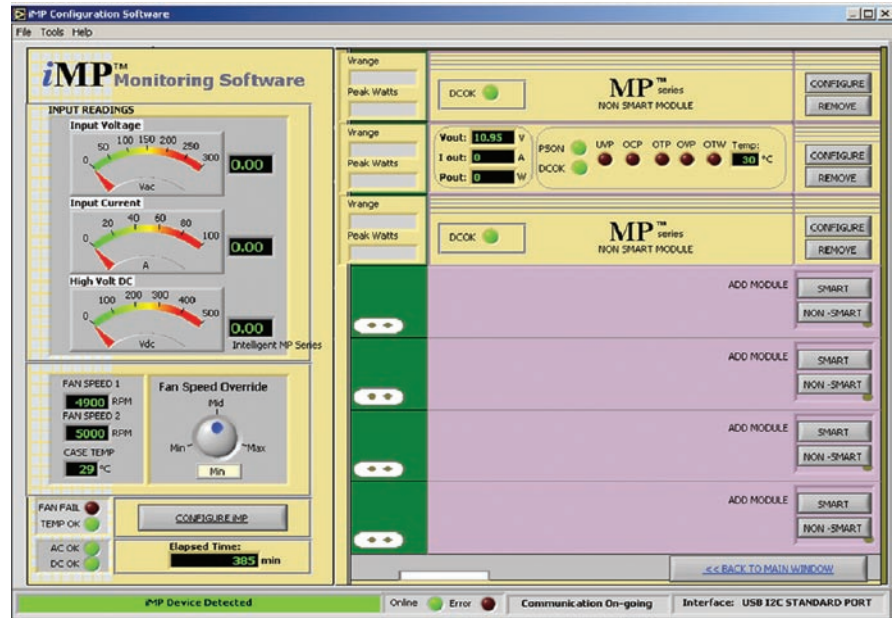


Figure 1

of specifying custom power supplies. The resulting devices, which would include customized specifications, will comply with the same worldwide safety, electrical, EMC, and RoHS standards as the base units. In many cases this approach can enable some of the biggest improvements in time-to-market by eliminating requirements for potentially expensive and time-consuming recertification.

A graphic interface shows system operating parameters to facilitate monitoring and control. Figure 1 shows a GUI that enables designers to program key features at the system level, module level, and for each individual output, including:

- Output voltage
- Output enable/sequencing
- Module inhibit/enable polarity
- DC OK thresholds
- Output current limit set point and type
- Overtemperature threshold

Along with programmable set points, designers can monitor various parameters in real time and control the response of the power supply when one of these set points is exceeded. The list of programmable possibilities is extensive. For

example, if the supply has a short circuit, the designer can program the supply to:

- Shut down with no restart until AC input is recycled
- Recover immediately when the short is removed
- Readjust the current limit during the short to prevent high current flow
- Continually try to restart after a programmable delay (*hiccup* mode)

Microcontrollers also facilitate optimization of power module *housekeeping* functions including overvoltage, overcurrent, and overtemperature protection. Using the increasingly popular I2C communication protocols, these systems will also be able to capture configuration and use information as well as parametric data for each output. In the past, supervisory control was available only with external devices that are no longer necessary with the integration of internal microprocessor control. By integrating these capabilities, designers can reduce cost and space requirements while improving overall reliability.

## Incorporating changes faster

Another digital switch characteristic that can be useful is the ability to customize or

tune a supply *in service* to align exactly with the dynamic requirements of a specific application. This capability would enable the designer to read system parameters for products in real-world situations and make any needed adjustments with no need for hardware changes. Once the adjustments are captured on the design engineer's computer, a simple upload to the manufacturer or qualified VAR will enable conversion to a production version of the exact configuration needed. During production, the manufacturer or VAR can download the specific configuration into production units prior to test and shipping. While not quite real-time, critical production changes can be incorporated in production volumes faster than has been possible. Integrating *boot loader* microcontrollers in the design allows field firmware changes to take place directly through the I2C communications bus to the outside world. Such communication can reduce service call time and make possible remote updates via the Internet.

The new digital generation of intelligent switching power supplies is price-competitive with existing technology. Recently launched digital switching supplies, such as the Astec iMP Series (Figure 2), offer up to 50 percent more power in the same package and for the same price as previous generation modular switchers. Because packaging consistency is important in the design of long life cycle products sometimes found in specialized CompactPCI applications, these new devices maintain the same form factor for backwards compatibility. They can be used *off-the-shelf* with no need for any programming and no cost premium.

Digital control adds flexibility that gives designers hundreds of millions of voltage input/output combinations available as qualified, agency-certified standard products. Specific configurations may be established by the designer using a password-protected GUI, by an approved reseller, or by manufacturers in accordance with the designer's written specifications. This approach can assure faster time to market, add flexibility without

NRE charges, reduce lead times for ongoing product availability, and provide a volume/cost advantage for lower volume and specialized products often found in medical applications.

### Conclusion

Most designers put off power supply design and power management options until near the end of the design cycle. This is partly to allow for power optimization when all of the key components are known and partly because it has often been a cumbersome and frustrating part of the process. With digital control, the process becomes simpler and gives designers new modes for optimizing power use, efficiency, and cost – all with a faster time to market. 🌐



**Christopher Jones,** Marketing Director of Standard Products, Astec Power America, has 26 years of power supply experience in technical management and technical marketing. He earned his degree in Electrical Engineering at West Coast University, Los Angeles.

To learn more, contact Christopher at:

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Figure 2

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"If you would hit the mark,  
you must aim a little above it."

-Henry Wadsworth Longfellow



cPCI/2.16



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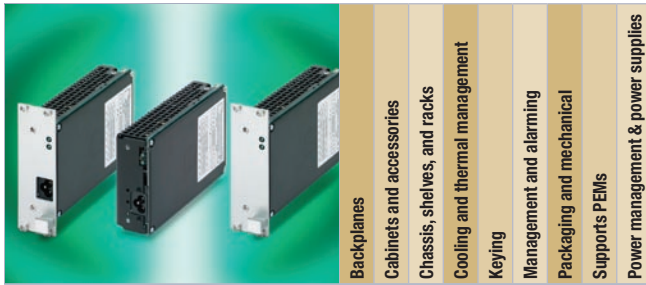
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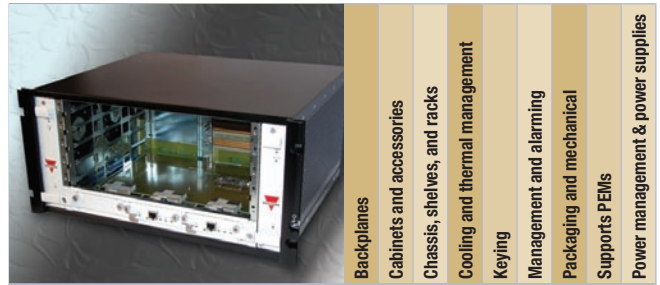
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CPCI Solder Side Covers									
<b>3M</b>									<a href="http://www.3m.com">www.3m.com</a>
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<b>Aborn</b>									<a href="http://www.aborn.com.tw">www.aborn.com.tw</a>
Eric-151									
<b>Absopulse Electronics</b>									<a href="http://www.absopulse.com">www.absopulse.com</a>
BAP 419									
BAP5500									
CSI 1.5kVA/2kVA									
CSI 5kVA									
DCW 100 Series									
DCW 150 Series									
DIC 3003									
FLP 150									
FLP 09 Series									
HOW 100									
HVI 09/HVI 109									
LPS 1000									
LSI 1000 Series									
MIW 152 Series									
MIW 100 Series									
MPS520									
PFC 4500									
PFC53									
PFC6000 Series									
PFC700 Series									
PFL 800-110 Series									
PFL 800									
POL 400 Series									
PSI 1000 Series									
PSI 500 Series									
RSI 1000 Series									
RWY 105									
RWY 200 Series									
TFS 5000									
<b>Acqiris</b>									<a href="http://www.acqiris.com">www.acqiris.com</a>
CC10X Series									
CC121									
XA200									
<b>ACT/Technico</b>									<a href="http://www.acttechnico.com">www.acttechnico.com</a>
8020 SCSI Controller									
8022 SCSI Controller									
8023 SCSI Controller									
Polaris System Chassis									
VITA 31.1 Dev. Chassis									
<b>Action Instruments</b>									<a href="http://www.actionio.com">www.actionio.com</a>
Q108									
<b>Adaptec</b>									<a href="http://www.adaptec.com">www.adaptec.com</a>
Millennium									
<b>Adas</b>									<a href="http://www.adas.fr">www.adas.fr</a>
LMCSCSI									
<b>Adax</b>									<a href="http://www.adax.com">www.adax.com</a>
Adax Signaling Products									

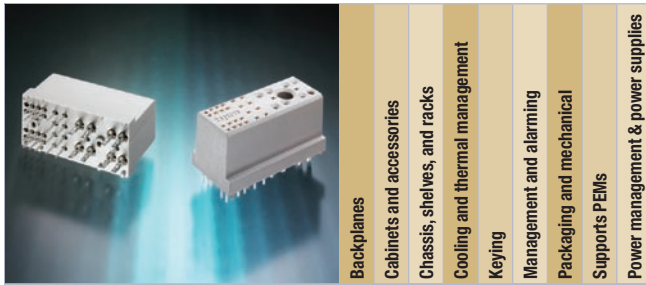


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AD-BVMFW2									
AD-BVMSCU161									
AD-BVMSCU162									
AD-BVMSCU2A									
AD-BVMSCU82									
<b>ADLINK Technology</b>									<a href="http://www.adlinktech.com">www.adlinktech.com</a>
aTCA-8506									
cBP-3061/cBP-3062									
cBP-3206									
cBP-3208									
cBP-6405R									
cBP-6408R									
cBP-6614A									
cPCI-2630 Series									
cPCI-8212									
cPCIS-2103									
cPCIS-2150									
cPCIS-2151									
cPCIS-2500 Series									
cPCIS-2501/AC									
cPCIS-2632 Series									
cPCIS-2650 Series									
cPCIS-2650/2651									
cPCIS-3120/3140 Series									
cPCIS-3300 Series									
cPCIS-3330									
cPCIS-5040/5080									
cPCIS-6230R									
cPCIS-6400U Series									
cPCIS-6400X									
cPCIS-6418U									
cPS-150R									
cPS-H325/48									
cPS-H325/AC									
cPS-H640/48									
cPS-H640/AC									
cPXIS-2150									
PXIS-2506									
PXIS-2556									
PXIS-2556T									
PXIS-2650T									
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MIC-3038									

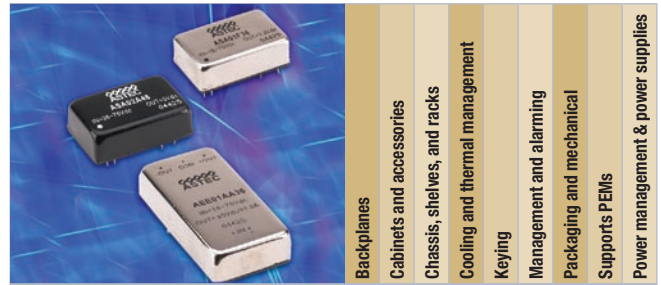
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MIC-3039	•								
MIC-3039-B									•
MIC-3041									•
MIC-3041L									•
MIC-3056									•
MIC-3081									•
MIC-3945									•
RIO-330X							•		
<b>American Rugged Enclosures</b> <a href="http://www.areinc.com">www.areinc.com</a>									
CPCI Card Cage & Fan Assembly			•						
System RHO		•							
<b>Amphenol</b> <a href="http://www.amphenol.com">www.amphenol.com</a>									
GTC-M Connectors					•				
<b>AMREL</b> <a href="http://www.amrel.com">www.amrel.com</a>									
HPS Series									•
SPS Series									•
<b>Amtelco</b> <a href="http://xds.amtelco.com">xds.amtelco.com</a>									
MC-3 MultiChassis	•								
<b>AP Labs</b> <a href="http://www.aplabs.com">www.aplabs.com</a>									
FS-1260			•						
FS-1270			•						
FS-1280									•
FS-5965									•
FS-5973									•
FS-8705									•
<b>APC</b> <a href="http://www.apcc.com">www.apcc.com</a>									
Smart-UPS 2200VA									•
Smart-UPS 3000VA									•
<b>apra-norm</b> <a href="http://www.apra.de">www.apra.de</a>									
1 U 19" CPCI Pizzabox		•							
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CompactPCI System 3U									•
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APS102VI: 100W Switcher									•
APS150Rx: 150W Indus. Switcher									•
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APS500Rx: 300W Indus. Switcher									•
APS600Rx: 600W Industrial Switcher									•
APS63VI: 60W Switcher									•
APS800Rx: 800W Industrial Switcher									•
APS93VP 100W Power Supply									•
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5U ATCA AC shelf									•
AdvancedTCA 10U Shelf System			•					•	
AdvancedTCA 12U Shelf System			•					•	
AdvancedTCA 4U Shelf System			•						
CompactPCI 9U Shelf System			•						
<b>Astec</b> <a href="http://www.astec.com">www.astec.com</a>									
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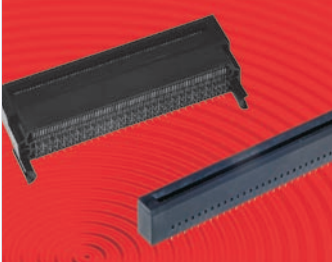
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A22320-PMC									•
A3803-cPCI									•
A3803-PMC									•
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<b>ATTO Technology</b> <a href="http://www.attotech.com">www.attotech.com</a>									
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A+ SAMP									•
<b>AVX Corporation</b> <a href="http://www.avxcorp.com">www.avxcorp.com</a>									
2mm hard metric connectors									•
8077 Series									•
Series 7200 2MM HM Connectors									•
Series 7200 J1-J4 Rt Ang Female									•
Series 8072									•
Series 8074									•
Series 8075									•
<b>Axiomtek</b> <a href="http://www2005.axiomtek.com">www2005.axiomtek.com</a>									
EM60320I			•						
<b>AZ-COM</b> <a href="http://www.az-com.com">www.az-com.com</a>									
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CompactPCI 3U Mini Extender									•
<b>Bivar, Inc.</b> <a href="http://www.bivar.com">www.bivar.com</a>									
CPCI E2 Series									•
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CPCI-2000		•							
CPCI-T Series Transition Guides		•							
GEN II CPCI E3 Series									•
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DC-8010		•							
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<b>Bus Solutions Ltd</b> <a href="http://www.bus-solutions.co.uk">www.bus-solutions.co.uk</a>									
BSL5000 Series		•							
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PMC FW1									•
PMC FW2									•
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<b>C&amp;D Technologies</b> <a href="http://www.cd4power.com">www.cd4power.com</a>									
cPCI1200DC									•
cPCI200 Series									•
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cPCI325D-1 Power Supply									•
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cPCI350 Series									•
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cPCI420DC									•
cPCI500 Series									•
PCI500 Series									•
<b>Carlo Gavazzi CS</b>									<a href="http://www.gavazzi-computing.com">www.gavazzi-computing.com</a>
2.16 Backplanes	•								
2.17 Backplanes	•								
505 Series 8U 21 Slot cPCI									•
533 Series 13U				•					
533 Series AdvancedTCA Chassis			•					•	
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544 Series 5U			•						
545 Series									•
555 Series 10U cPCI Enclosure									•
582 Series 1U cPCI Enclosure									•
585 Series CompactPCI Enclosure									•
5U ATCA System								•	•
6821 Series Rackmount PCI									•
709 Series Rugged Military									•
714 Series ATR Chassis									•
714T Series									•
AdvancedTCA Air Impedance		•							
AdvancedTCA Air Slot Blockers			•						
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AdvancedTCA Filler Panels		•							
AdvancedTCA Front Panel Kit		•							
CompactPCI Backplane Bridge		•							
CompactPCI Backplanes	•								
SMM04 4U ATCA ShMM						•			
SMM08 8U ATCA ShMM						•			
<b>Catapult</b>									<a href="http://www.catapult.com">www.catapult.com</a>
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KPCI 6U-805									•
CES									<a href="http://www.ces.ch">www.ces.ch</a>
SCSI 8465								•	
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CMP/DMP 150 & 200									•
CMP/DMP 400									•
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<b>Chroma ATE</b>									<a href="http://www.chromaate.com">www.chromaate.com</a>
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BPWR-59712									•
cPCI-5310									•
cPWR-1500A									•
cPWR-5901/cPWR-59402									•
cPWR-59401/59402									•
<b>Chroma Systems Solutions</b>									<a href="http://www.chromausa.com">www.chromausa.com</a>
PXI200									•
<b>C-MAC MicroTechnology</b>									<a href="http://www.cmac.com">www.cmac.com</a>
C-MAC Enclosures			•						
C-MAC Interconnect CompactPCI	•								

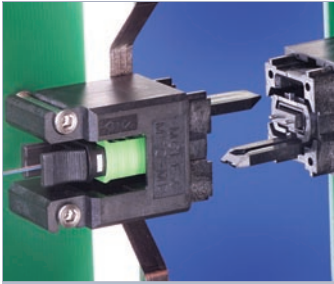


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Male cPCI Connectors									•
D-sub									•
<b>Comtel Electronics GmbH</b>									<a href="http://www.comtel-online.de">www.comtel-online.de</a>
10U Black Star AdvancedTCA		•							•
14 slot AdvancedTCA		•							
2 slot AdvancedTCA		•							
2 slot AdvancedTCA		•							
5 slot AdvancedTCA		•							
8 slot AdvancedTCA									•
AdvancedTCA Thermal Load Boards									•
CO-14 DS AdvancedTCA			•						•
CompactPCI 2 Slot 1U Horizontal			•						
CompactPCI 4 Slot 2U			•						
CO-Pizza 2-Slot Replicated Mesh			•						•
CO-Pizza 5-Slot Triple Mesh			•						•
CO-Pizza 8-Slot Replicated Mesh			•						•
<b>Concurrent Technologies</b>									<a href="http://www.gocct.com">www.gocct.com</a>
SC PMC/SA1		•							
SC PMC/SA1 4xSAS		•							
SY PCI/P10									•
SYPCI/SE8									•
<b>Conec Corporation</b>									<a href="http://www.conec.com">www.conec.com</a>
ATCA Connector Series								•	
CompactPCI Connector Series								•	
<b>Continuous Computing</b>									<a href="http://www.ccpu.com">www.ccpu.com</a>
150W Telecom Power Supply									•
CCTPS									•
Flex21 cPCI Platform								•	
FlexChassis 5U and 12U									•
<b>Cool Innovations</b>									<a href="http://www.coolinnovations.com">www.coolinnovations.com</a>
UltraCool P line								•	
<b>Cooler Master</b>									<a href="http://www.coolermaster.com">www.coolermaster.com</a>
E1U-KPESS-10								•	
E1U-KPFGS-01								•	
E1U-N7BCC-03								•	
E1U-NPESC-03								•	
E1U-NPESC-30								•	
E1U-NPFGS-02								•	
E1U-NPFGS-04								•	
E1U-NPFGS-06								•	
E1U-NPFSS-30								•	
E2U-K65CS-01								•	
E2U-KPKGS-01								•	
E2U-N65XC-01								•	
E2U-N73CC-03								•	
E2U-N7RGS-04								•	
E2U-N7WCS-04								•	
E2U-NPJCS-04								•	
E3W-KPTXS-01								•	
E3W-N7RSS-04								•	
E3W-N95LS-06								•	


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# PRODUCT GUIDE

## PACKAGING



	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
<b>Cooler Master (continued)</b>									<a href="http://www.coolermaster.com">www.coolermaster.com</a>
E3W-NPTXC-01				•					
E3W-NPTXS-01				•					
<b>CorEdge Networks, Inc.</b>									<a href="http://www.coredgenetworks.com">www.coredgenetworks.com</a>
<b>AMC Mechanicals</b>							•		
<b>Crystal Group</b>									<a href="http://www.crystalpc.com">www.crystalpc.com</a>
CS-100S									•
CTS									<a href="http://www.ctsclearone.com">www.ctsclearone.com</a>
<b>CompactPCI Terminator</b>		•							
<b>Curtiss-Wright Embedded</b>									<a href="http://www.cwembedded.com">www.cwembedded.com</a>
PFIR		•							
PSCx							•		
RC-1- 1-Slot Chassis							•		
<b>Cyberchron</b>									<a href="http://www.cyberchron.com">www.cyberchron.com</a>
CVC-130									•
<b>Cyclone Microsystems</b>									<a href="http://www.cyclone.com">www.cyclone.com</a>
PMC56							•		
<b>Dawn VME Products</b>									<a href="http://www.dawnvme.com">www.dawnvme.com</a>
767		•							
5856									•
2340 series							•		
7X7 Series									•
<b>CompactPCI 3U &amp; 6U Backplanes</b>		•							
Model 3800 CPCI Portable Encl.									•
Model 4100 Portable Dev. Tower									•
Model 426							•		
Model 6100									•
Model 710									•
PizzaBox-Plus!									•
<b>DegreeC</b>									<a href="http://www.degreec.com">www.degreec.com</a>
<b>ATCA Compliant Fan Controller</b>				•					
<b>ProntoFlow Control-ATCA</b>				•					
<b>Digital Power</b>									<a href="http://www.digipwr.com">www.digipwr.com</a>
CPCI AC-3U-200									•
CPCI AC-3U-300									•
CPCI AC-6U-400									•
CPCI AC-6U-500									•
CPCI DC-3U-200									•
CPCI DC-3U-300									•
CPCI DC-6U-400									•
CPCI DC-6U-500									•
<b>Diodes</b>									<a href="http://www.diodes.com">www.diodes.com</a>
QSBT40		•							
<b>DSPCon</b>									<a href="http://www.dspcon.com">www.dspcon.com</a>
7523									•
<b>Dynamic Engineering</b>									<a href="http://www.dyneng.com">www.dyneng.com</a>
HDE Cable 68		•							
HDE Term 68		•							
HDR Ribbon 50		•							
HDR Term 50		•							
IP Debug Bus		•							
PIM Universal IO		•							
<b>EIC Solutions</b>									<a href="http://www.eicsolutionsinc.com">www.eicsolutionsinc.com</a>
S161206			•						



	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
<b>EKF-Elektronik</b>									<a href="http://www.ekf.de">www.ekf.de</a>
CF1-SNARE									•
CF2-CYMBAL									•
CF4-HIHAT									•
CMF-1394									•
CR1-RACK									•
CR3/4/5 RACK									•
CR4-RACK									•
CR6-RACK									•
CR9-ADAPT									•
CS1-BRASS									•
CS3-FLUTE									•
CS4-SAX									•
CS5-HORN									•
<b>Electronic Solutions</b>									<a href="http://www.electronicsolutions.com">www.electronicsolutions.com</a>
16-slot Backplane		•							
1U Zephyr Chassis									•
AP-7515									•
AP-7543		•							
AP-7554								•	
ATCA Front Panels									•
ATCA Development Platform									•
ATCA Thermal Mngmt Boards				•					
ATCA Thermal Mngmt FP				•					
CompactPCI 1U/2U Zephyrs									•
CompactPCI 4U Zephyr		•							
CompactPCI Backplane		•							
CompactPCI CT Backplane		•							
CompactPCI/cPSB EtherPlane		•							
CompactPCI/PSB Backplane		•							
Conduction Cooled Assemblies				•					
CPCI Backplane		•							
cPCI Centaur Dev. System									•
cPCI Ventus Chassis									•
Horizon Chassis			•						
Low-profile cPCI Horizon Chassis									•
PICMG 2.16 Development Chassis									•
PMC EZJect & EZX									•
Reduced Width Backplanes		•							
Thermal management				•					
Vanguard Chassis									•
Ventus			•						
Ventus ATCA 014/016 Shelf			•						•
Wedge-Lok PCB Retainers		•							
<b>Elgar</b>									<a href="http://www.elgar.com">www.elgar.com</a>
ContinuousWave									•
DLM 3-4 kW									•
<b>ELMA Bustronic</b>									<a href="http://www.elmabustronic.com">www.elmabustronic.com</a>
108PS2108		•							
14-slot Dual Star AdvancedTCA		•							
16-slot cPCI Backplane		•							
16-slot cPSB		•							
16-slot H.110 Backplane		•							
2-slot AdvancedTCA Backplane		•							

Continued on page 45



d<sup>1</sup>

design.

d<sup>2</sup>

develop.

d<sup>3</sup>

deploy.

# Parts is Parts. Now What?



**design.**  
The next generation of connected devices.

**develop.**  
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**deploy.**  
Your solution faster.

Choosing the hardware is just the beginning.

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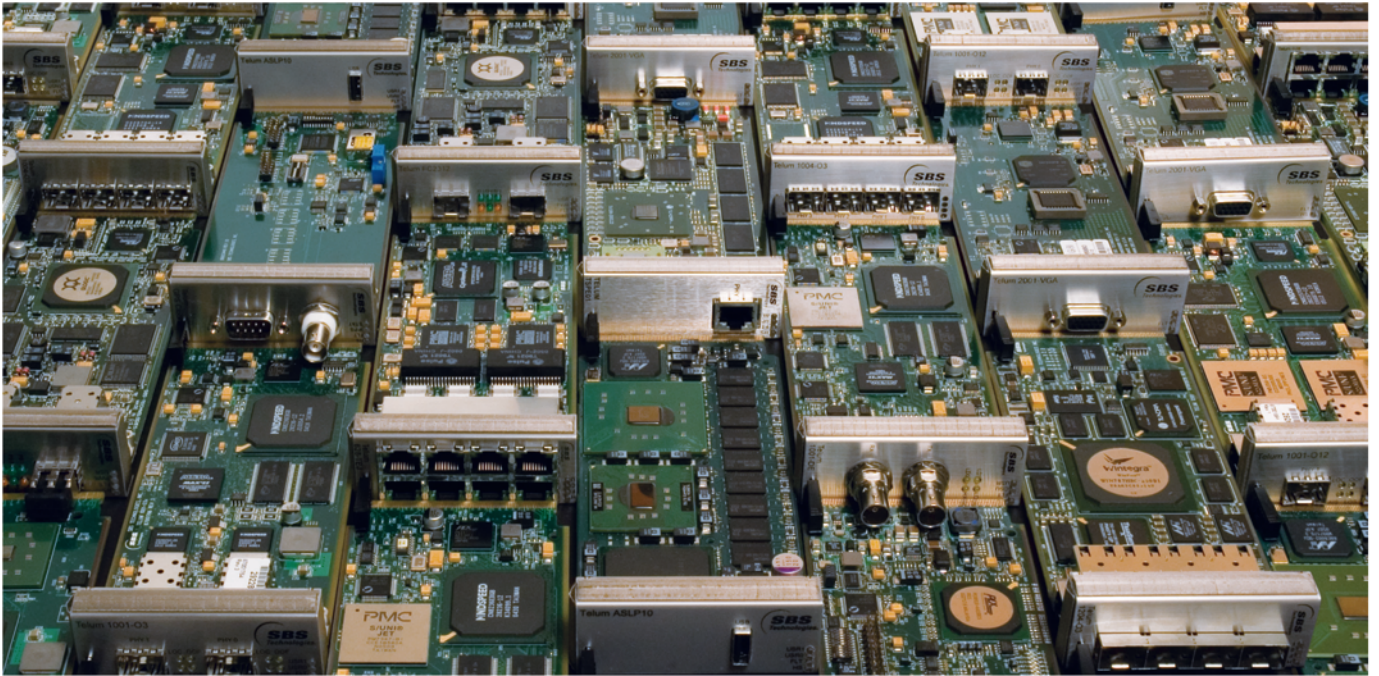
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- Creating functional prototypes.
- Ramping production manufacturing.

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RSC# 43 @ [www.compactpci-systems.com/rsc](http://www.compactpci-systems.com/rsc)



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Choose from our large selection of real, available products.

GE Fanuc Embedded Systems, as part of our acquisition of SBS Technologies, is in the forefront of the industry, offering a broad range of real AdvancedMC products. Our goal is to preserve and extend our existing AdvancedMC product line offering.

Over the last 12 months we have designed and launched more than a dozen AdvancedMCs, as well as a number of carriers. If you are interested in keeping up with AdvancedMC technology we invite you to subscribe to the AdvancedMC Insider monthly newsletter. It's easy to subscribe, just go to [www.advancedmcinsider.com](http://www.advancedmcinsider.com)

NAME	DESCRIPTION	AMC.1	AMC.2
TELUM TSPE01	Processor AMC module with PowerPC® 7447A processor		•
TELUM ASLP10	Intel® Pentium® M processor AMC module	•	
TELUM 624/628-TEJ	WAN Edge Access I/O, 4 or 8 port T1/E1/J1, ITDM option	•	
TELUM 1001-O12M/S	WAN OC-12 module	•	
TELUM 1001-O3	WAN OC-3 module	•	
TELUM 1004-O3M/S	WAN OC-3 module	•	
TELUM 1001-DE	WAN DS3/E3 module	•	
TELUM 1204-O3	WAN intelligent AMC.2 multi-service 4-port OC-3 module		•
TELUM GE-QT	Gigabit Ethernet AMC 4 port NIC	•	
TELUM FC2312-FF	Fibre Channel HBA cards (fiber-optic media)	•	
TELUM FC2312-CC	Fibre Channel HBA cards (copper media)	•	
AT-AMC1	AdvancedTCA® carrier for 2-4 AMC.1 modules	•	
AT-AMC2	AdvancedTCA® carrier for 2-4 AMC.2 modules		•
BCT4-AMC1	IBM® BladeCenter® T carrier for 4 AMC modules	•	•
TELUM GPSTC-AMC	GPS-based clock AMC module		•
TELUM 2001-VGA	AMC VGA module	•	



Now a part of GE Fanuc Embedded Systems

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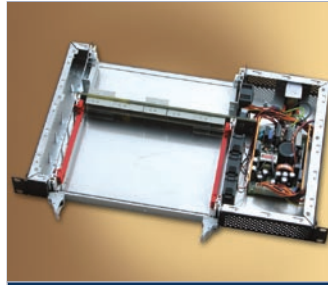
# PRODUCT GUIDE

## PACKAGING



Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
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ELMA Bustronic (continued)		www.elmabustronic.com						
32-bit CompactPCI Backplanes	•							
3-slot Backplane	•							
3U cPCI Backplane Series	•							
3U Power Interface Board	•							
5-slot mesh ATCA	•							
69-CE604-4157	•							
69-CE606-4157	•							
69-CE608-4157	•							
69-CH604-4146	•							
69-CH606-4146	•							
69-CH608-4146	•							
69-CP304-11xx	•							
69-CP304-20X0	•							
69-CP306-11xx	•							
69-CP306-20X0	•							
69-CP308-11xx	•							
69-CP308-20X0	•							
69-CX608-1101	•							
6U cPCI w/ATX Power conn	•							
6U cPCI Test Extender Board	•							
6U Extender	•							
6U Power Interface Boards	•							
7U H.110 Backplane Series	•							
7U Pluggable AdvancedTCA	•							
AdvancedTCA Chassis	•							
AdvancedTCA Dual Star	•							
AdvancedTCA Test Extender	•							
CompactPCI 3U	•							
CompactPCI 6U	•							
CompactPCI Express	•							
CompactPCI Backplane w/PXI instr.	•							
CompactPCI Backplane w/ Bridge	•							
CompactPCI backplane w/ H.110 Bus	•							
PICMG 2.16 Backplane	•							
cPSB HA Backplane	•							
Dual Star	•							
Dual-Dual Star	•							
EasyCable CompactPCI Backplanes	•							
EasyPlug CompactPCI Backplanes	•							
High-Availability Backplane	•							
Low Profile CompactPCI Backplanes	•							
PICMG 2.16 Development Backplane	•							
PICMG 3.x Custom Backplane	•							
Power Interface Boards	•							
Slim 6U 4-slot CompactPCI Backplane	•							
StarFabric Backplanes	•							
ELMA Electronic		www.elma.com						
12R1 COTS								•
12R2 - 12U System		•						
12R2 - 5U System		•						
12R2 - 7U System		•						
12R2 - 9U System		•						
12R3 Chassis								•
12U AdvancedTCA Chassis							•	•



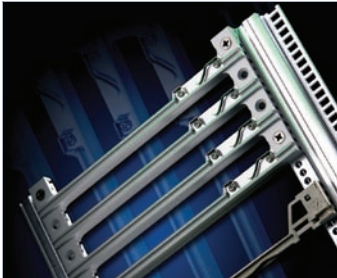
Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
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13U AdvancedTCA Chassis							•	•
CompactPCI Horiz. Enclosure								•
NEBS II, III 19" Rack-Mount								•
4U Rack-Mount/Desktop Encl.								•
6U Shielded Panel							•	
3U x 8T Device Holder	•							
4U x 8T Device Holder	•							
6U x 8T Device Holder	•							
6U x 12T Device Holder	•							
6U x 32T Device Holder	•							
2U CompactPCI System								•
2U Type 39								•
4U Portable Tower Enclosure								•
4U Tower Enclosure								•
Type 32C CompactPCI Tower Enclosure								•
Modified Type 39c sheet metal encl.								•
Type 39c HA Line								•
Type 39c EasyPlug Line								•
2U Horizontal Chassis								•
4U AdvancedTCA Chassis								•
4U RAID Drive Box								•
4U Type 39 AdvancedTCA								•
61-950-01-1								•
61-950-03-1								•
8-Slot Type 32 cPCI Chassis								•
9U Type 12 VXS Chassis								•
ATCA ESD Clips & Guide Pin Recep.	•							
AdvancedTCA Front Panels							•	
AdvancedTCA Handles							•	
AdvancedTCA System								•
ATR-Chassis								•
Cabinets	•							
Conduction Cooled ATR Enclosure								•
cPCI Filler Panel							•	
EMC Shielding Spring							•	
Handles							•	
IPM Sentry Interface Board								•
Long Telco Handle							•	
No Compromise Front Panels							•	
PICMG 2.17 chassis								•
Rugged Slide Rails	•							
Sentry I System Monitor							•	
Sentry III Diagnostic Monitor							•	
Series D								•
Sun-compatible System								•
Type 11								•
Type 11C								•
Type 15 cPCI 9U chassis								•
Type 15C								•
Type 15H 9U								•
Type 32 Enhanced Enclosure								•
Type 32C, 4U System								•
Type 32C, 6U System								•
Type 39 1U System								•

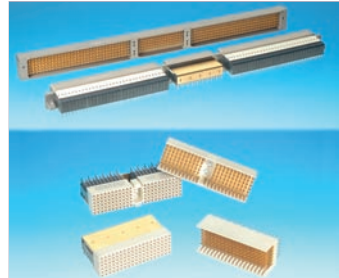
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	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
<b>ELMA Electronic (continued)</b> <a href="http://www.elma.com">www.elma.com</a>									
Type 39C chassis									•
Type 39C Elite									•
<b>Elma-Mektron</b> <a href="http://www.mektron.co.uk">www.mektron.co.uk</a>									
CompactPCI Enclosures									•
Conduction-cooled COTS			•						
Full MIL-Spec Enclosures			•						
MA Series			•						
Thermal Management CPCI Enclosures				•					
<b>EPT USA</b> <a href="http://www.ept.de">www.ept.de</a>									
AdvancedMC Connector					•				
AdvancedTCA B+/MicroTCA					•				
DIN 41612					•				
HKP Series Press					•				
hm 2.0 AB Connectors					•				
hm 2.0 Hard Metric					•				
hm 2.0 Hard Metric 8+2					•				
hm 2.0 Hard Metric A-47					•				
hm 2.0 Hard Metric AB19/22/25					•				
hm 2.0 Coding Keys					•				
hm 2.0 Female Receptacle					•				
hm 2.0 Male Connector					•				
hm 2.0 HM Shrouds					•				
hm 2.0 L, M, & N Connectors					•				
hm 2.5 HM Connectors					•				
Pin Covers						•			
Type M DIN					•				
<b>Equipto</b> <a href="http://www.equipto.com">www.equipto.com</a>									
Exact-Fit Card Cages		•							
<b>ERNI</b> <a href="http://www.erni.com">www.erni.com</a>									
AdvancedTCA Connectors					•				
eHM – Mini HM					•				
ERmet 2mm HM EXP					•				
ERmet ZD Backplane Connector					•				
ERmet-2mm Hard Metric					•				
<b>esd</b> <a href="http://www.esd-electronics.com">www.esd-electronics.com</a>									
CPCI-PS24									•
<b>EuroTech</b> <a href="http://www.eurotech.it">www.eurotech.it</a>									
CTR-7360							•		
<b>EXFO</b> <a href="http://www.exfo.com">www.exfo.com</a>									
OG-5240						•			
<b>Extreme Engineering</b> <a href="http://www.xes-inc.com">www.xes-inc.com</a>									
XIt2000							•		
XPort6000							•		
<b>F9 Systems</b> <a href="http://www.F9-systems.com">www.F9-systems.com</a>									
F9 Systems RTM ThermalBlade				•					
F9 Systems ThermalBlade				•					
<b>FCI</b> <a href="http://www.fciconnect.com">www.fciconnect.com</a>									
10046742 Connector Series					•				
2.54mm Modular Connector					•				
AirMax VS ATCA Connector					•				
Airmax VS Coplanar					•				
AirMax VS System					•				
BERGSTAK 0.8mm					•				
ExpressCard 34/54					•				

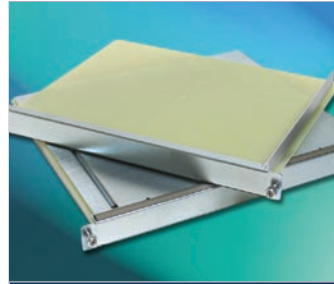


	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
<b>GIG-ARRAY</b>									
HM Series Connectors					•				
Interconnect System					•				
MicroTCA Connectors					•				
Millipacs					•				
Power Card Edge series					•				
Rt Angle Connectors					•				
Vertical PCIe Card Edge					•				
VLP DDR2 memory sockets					•				
<b>Fujikura America</b> <a href="http://www.fujikura.com">www.fujikura.com</a>									
HTC Series					•				
<b>Gage Applied Technologies</b> <a href="http://www.gage-applied.com">www.gage-applied.com</a>									
Instrument Mainframe 8000C									•
<b>Ganymed</b> <a href="http://www.ganymed.com">www.ganymed.com</a>									
GM IR11/CT				•					
<b>Gaurang</b> <a href="http://www.gaurang.com">www.gaurang.com</a>									
DIN Standard Plastic Cases		•							
FUTURA Case		•							
IC-248		•							
Modulbox-Dualmount-22.5		•							
Modulbox-Dualmount-70		•							
Tri-Mount Plastic Case		•							
UE Series		•							
UH Series		•							
<b>GD California</b> <a href="http://www.gdca.com">www.gdca.com</a>									
ZT6300									•
ZT6302									•
ZT5990						•			
ZT6310									•
<b>GE Fanuc Automation</b> <a href="http://www.gefanuc.com/embedded">www.gefanuc.com/embedded</a>									
VMICPCI-310									•
VMICPCI-7458		•							
VMICPCI-P303		•							
VMIPMC-5790								•	
VMIPMC-5795								•	
VMIPMC-5797								•	
<b>GE Fanuc Embedded Systems</b> <a href="http://www.sbs.com">www.sbs.com</a>									
1394B-3CP1-1394B/USB 2.0									•
212-2					•				
2343 - IEEE 1394 PMC HBA								•	
2344-GC – IEEE 1394 HBA								•	
234x IEEE 1394								•	
8x0 Series Bus Adapters								•	
AMC-7S								•	
AVC-cPCI 3000 Series								•	
Bio-1								•	
CompactPCI Expansion							•		
PCIE-AMC-7S								•	
PMC-ISCSI-ST								•	
RS-C100									•
SCC – 19" Starter Cages									•
<b>Globe Manufacturing Sales</b> <a href="http://www.globebrackets.com">www.globebrackets.com</a>									
CompactPCI, VME, PMC FP									•
<b>Gompf Brackets</b> <a href="http://www.bracket.com">www.bracket.com</a>									
CompactPCI Front Panels									•

# PRODUCT GUIDE

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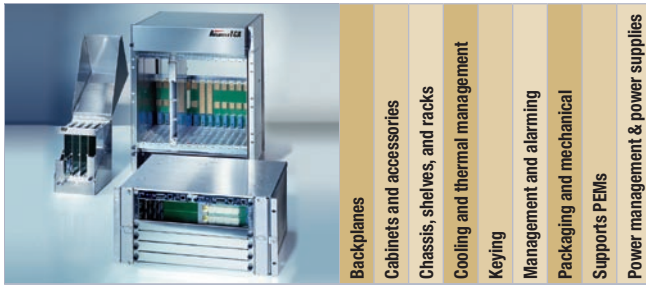
	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
									
<b>Gompf Brackets (continued)</b>									<a href="http://www.bracket.com">www.bracket.com</a>
<b>PMC Bezels</b>		•							
<b>Hapco</b>									<a href="http://www.hapco.com">www.hapco.com</a>
<b>cPCI Panels</b>		•							
<b>PC Brackets</b>		•							
<b>Harting</b>									<a href="http://www.harting.com">www.harting.com</a>
<b>AMC pressfit for AdvancedTCA</b>					•				
<b>AMC pressfit for MicroTCA</b>					•				
<b>DIN 41 612 Type M flat</b>					•				
<b>har-bus HM Series</b>					•				
<b>Hartmann Elektronik</b>									<a href="http://www.hartmann-elektronik.de">www.hartmann-elektronik.de</a>
<b>CompactPCI backplane w/ H.110</b>	•								
<b>CompactPCI backplane series RB</b>	•								
<b>CompactPCI backplane series RC</b>	•								
<b>CompactPCI Series RA-6U</b>	•								
<b>CompactPCI Series-RD</b>	•								
<b>CompactPCI to PCI Expansion</b>	•								
<b>Positronic P47 Powerbackplane</b>	•								
<b>Powerbackplane with M-connector</b>	•								
<b>Hirose Electric</b>									<a href="http://www.hirose.com">www.hirose.com</a>
<b>MCN51</b>					•				
<b>PCN21</b>					•				
<b>PO21M, PO51M, PO82M Series</b>					•				
<b>Hitek Power</b>									<a href="http://www.hitek.com">www.hitek.com</a>
<b>FM-400</b>									•
<b>FM-600</b>									•
<b>HF-10</b>									•
<b>HT9827</b>									•
<b>Hoffman</b>									<a href="http://www.hoffmanonline.com">www.hoffmanonline.com</a>
<b>4-Post Datacom Rack</b>			•						
<b>CONCEPT EMC</b>			•						
<b>INLINE</b>			•						
<b>PROLINE</b>			•						
<b>Honda Connectors</b>									<a href="http://www.hondaconnectors.com">www.hondaconnectors.com</a>
<b>NCB and NCBA Series Female</b>					•				
<b>NCB and NCBA Series Male</b>					•				
<b>Hybricon</b>									<a href="http://www.hybricon.com">www.hybricon.com</a>
<b>1 ATR Chassis</b>			•						
<b>10U Ruggedized COTS Enclosure</b>			•						
<b>350W Series cPCI Power Supplies</b>									•
<b>8U RME821 Enclosures</b>			•						
<b>9-slot Tower</b>									•
<b>Alarm Card</b>	•								
<b>CompactPCI Air Blockers</b>		•							
<b>CompactPCI Backplanes</b>	•								
<b>CompactPCI Load/test Boards</b>		•							
<b>Cool-P Pizzabox</b>									•
<b>Cool-T 6-Slot Tower</b>									•
<b>CPCI Power Planes</b>		•							
<b>EMI Tight/Quick Access Subrack</b>		•							
<b>Front Panels</b>							•		
<b>High Power Towers</b>			•						
<b>HRME 4U &amp; 6U Enclosures</b>			•						
<b>Pac-2000 Subrack</b>			•						
<b>PICMG 2.16 Packet Switching</b>	•								

	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
									
<b>PICMG 2.17 Backplanes</b>	•								
<b>PICMG 2.18 Serial RapidIO</b>	•								
<b>PRME 1U Enclosures</b>									•
<b>RME 9U &amp; 10U Enclosures</b>									•
<b>RME1021M</b>									•
<b>RME1221 12U Enclosures</b>									•
<b>RME21 10U Enclosures</b>									•
<b>RME21XC Extreme Cooling Enclosures</b>									•
<b>RME821C 8U Enclosures</b>									•
<b>RME821M Enclosures</b>									•
<b>SRME 2U Enclosures</b>									•
<b>SRME 3U Enclosures</b>							•		
<b>SRME 4U Enclosures</b>									•
<b>X721 Series Powered Racks</b>									•
<b>Hypertronics</b>									<a href="http://www.hypertronics.com">www.hypertronics.com</a>
<b>2mm Connector</b>					•				
<b>DO2 Circ. Plastic Connectors</b>					•				
<b>Hypertronics COTS</b>					•				
<b>VME64x Ruggedized Connector</b>					•				
<b>I-BUS</b>									<a href="http://www.ibus.com">www.ibus.com</a>
<b>C0406A</b>									•
<b>C0808</b>									•
<b>C0814</b>									•
<b>C0814D</b>									•
<b>C0817</b>									•
<b>C0818D</b>									•
<b>C0877</b>									•
<b>C0888D</b>									•
<b>CompactPCI Passive Backplane</b>	•								
<b>GP1013X</b>									•
<b>IBC2501</b>					•				
<b>ICP America</b>									<a href="http://www.icpamerica.com">www.icpamerica.com</a>
<b>PAC-1000/1200</b>									•
<b>PAC-1060</b>									•
<b>PAC-700</b>									•
<b>Inova</b>									<a href="http://www.inova-computers.de">www.inova-computers.de</a>
<b>84HP ICP-HOUS</b>			•						
<b>ICP-BPL-0M50</b>	•								
<b>ICP-BPL-4M50</b>	•								
<b>ICP-BPL-8M50</b>		•							
<b>ICP-HOUS</b>		•							
<b>ICP-PSU-100</b>									•
<b>ICP-PSU-120</b>						•			
<b>ICP-PSU-70</b>						•			
<b>ICP-SYSC-LC</b>							•		
<b>ICP-SYSC-VS</b>									•
<b>ICP-SYSI-CS</b>									•
<b>ICP-UPS</b>									•
<b>Rail-Man</b>							•		
<b>Integrated Device Technology</b>									<a href="http://www.idt.com">www.idt.com</a>
<b>IDT7M9502</b>	•								
<b>Integrated Power Systems</b>									<a href="http://www.ipsi.net">www.ipsi.net</a>
<b>5875</b>									•

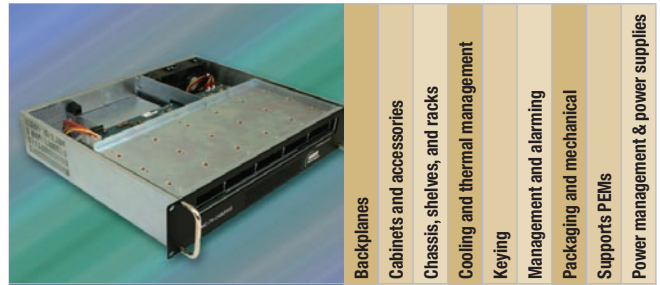
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## PACKAGING



	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
<b>Intel</b>	<a href="http://www.intel.com">www.intel.com</a>								
NetStructure MPCHC0001 14U Shelf			•					•	
MPCMM0001 Chassis Mngmt						•			
MPCMM0002 Chassis Mngmt						•			
ZT 7102				•					
<b>Intermas</b>	<a href="http://www.intermasinc.com">www.intermasinc.com</a>								
409-110-xxx			•						
409-113-xxx							•		
409-114-xxx							•		
409-115-xxx			•						
Telecom Handle		•							
<b>IQS Corporation</b>	<a href="http://www.iqscorp.com">www.iqscorp.com</a>								
Thermal Management and Design				•					
<b>ITT Cannon</b>	<a href="http://www.ittcannon.com">www.ittcannon.com</a>								
SFP-155E Electrical Transceiver					•				
<b>Jasper Electronics</b>	<a href="http://www.jasperelectronics.com">www.jasperelectronics.com</a>								
175W and 200W Series cPCI									•
200W DC Input cPCI									•
250W cPCI Power Supplies									•
300W cPCI Power Supplies									•
450W cPCI Power Supplies									•
<b>Kaparel</b>	<a href="http://www.kaparel.com">www.kaparel.com</a>								
10U cPCI Rack-Mounted									•
23000 Series	•								
3U cPCI Rack-Mounted System									•
4U cPCI Rack-Mounted System									•
6U cPCI Backplane Stiffener									•
7U cPCI Rack-Mounted System									•
9U cPCI Rack-Mounted System									•
AdvancedTCA Backplane	•								
AdvancedTCA Enclosure Family			•						
AdvancedTCA Face Plates							•		
AdvancedTCA Shelf									
cPCI Slim-Box Rack-Mounted	•								
Customizable AdvancedTCA Shelf			•					•	
High Speed Backplanes	•								
Modular Backplanes	•								
PS10xx Monolithic Series	•								
PS1220	•								
PS1221	•								
PS1222	•								
PS1227	•								
PS1247	•								
PS124x	•								
PS1257									•
PS125x									•
PS126x	•								
PS13xx	•								
PS1410B									•
PS14xx & PS14xxB Modular Series									•
PS3300									•
PS335x									•
PS3380							•	•	
PS39xx			•						
PS4410B									•



	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
<b>PS44xx Modular Series</b>									•
<b>PS47xx Horizontal Series</b>									•
<b>PS49xx Packet Switch Series</b>									•
<b>PS604x</b>									•
<b>PS607x</b>									•
<b>PS609x</b>									•
<b>PS610x</b>									•
<b>PS6620</b>									•
<b>PS66xx Series</b>									•
<b>PS6700</b>									•
<b>RiCool-2 Blower</b>			•						
<b>Ripac MPS Electronic Packaging</b>									•
<b>RITherm</b>				•					
<b>Slim-Box</b>									•
<b>KEL Connectors</b>	<a href="http://www.kel.jp">www.kel.jp</a>								
<b>CP series</b>					•				
<b>Keystone Electronic</b>	<a href="http://www.keyelco.com">www.keyelco.com</a>								
<b>Metric PC Screw Terminals</b>		•							
<b>Knurr USA</b>	<a href="http://www.knurr.com">www.knurr.com</a>								
<b>CompactPCI System Chassis 3U</b>									•
<b>CompactPCI System Chassis 5U</b>									•
<b>CompactPCI System Chassis 6U</b>									•
<b>CompactPCI System Chassis 7U</b>									•
<b>CoolBlade</b>									•
<b>DART fan</b>					•				
<b>Slim Line Enclosure 1U 3035</b>									•
<b>Slim Line Enclosure 1U 3037</b>									•
<b>Slim Line Enclosure 1U 3039</b>									•
<b>Slim Line Enclosure 2U CT bus 3036</b>									•
<b>Slim Line Enclosure 2U CT bus 3056</b>									•
<b>Slim Line Enclosure 4U CT bus 3033</b>									•
<b>Slim Line Enclosure 4U CT bus 3038</b>									•
<b>Kontron</b>	<a href="http://www.kontron.com">www.kontron.com</a>								
<b>CP360, Ultra2 SCSI Controller</b>									•
<b>CP3-BP11-M</b>	•								
<b>CP-ASM10-PSB</b>									•
<b>CP-ASM6-PSB</b>	•								
<b>CP-ASM7-P47-RIO</b>									•
<b>CP-Pocket</b>					•				
<b>PMC260</b>								•	
<b>XL2000, 6U CompactPCI</b>									•
<b>XL3000</b>									•
<b>XL8000 ATCA Chassis 12U</b>									•
<b>XL8500</b>									•
<b>XL-LP Series</b>									•
<b>XL-Pocket</b>									•
<b>Lambda Electronics</b>	<a href="http://www.lambdapower.com">www.lambdapower.com</a>								
<b>CPCI175 Series</b>									•
<b>FPS1000-48</b>									•
<b>Lanner Electronics</b>	<a href="http://www.lannerinc.com">www.lannerinc.com</a>								
<b>CP-3C1000</b>									•
<b>CP-3SL08</b>	•								
<b>CP-6C1000</b>	•								
<b>CP-6C2000</b>			•						

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# VECTOR

ELECTRONICS & TECHNOLOGY, INC.  
A FINE TECHNOLOGY GROUP

“PACKAGING SOLUTION OF CHOICE”



SERIES 800 TOWER  
ENCLOSURE



VME/VME64X CPCI<sup>®</sup>  
RACKMOUNT ENCLOSURES



790 & 792 RUGGEDIZED ENCLOSURES



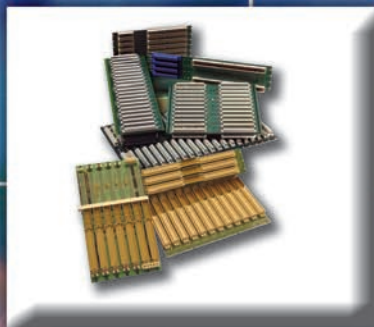
19 INCH HORIZONTAL RACKS



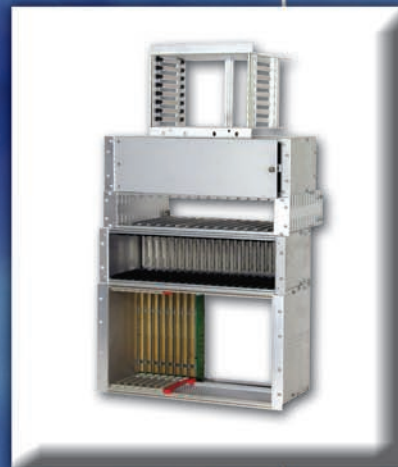
MODEL 2345 ENCLOSURE



SERIES 440 'SLIMLINE'  
ENCLOSURE



VME/VME64X BACKPLANES



SUBRACKS



Made in U.S.A.

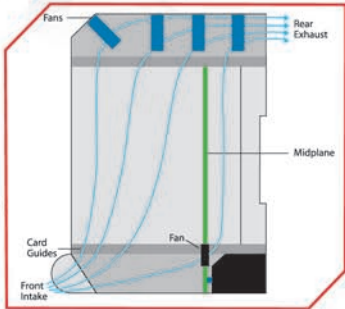
RSC# 49 @ [www.compactpci-systems.com/rsc](http://www.compactpci-systems.com/rsc)

(800) 423-5659

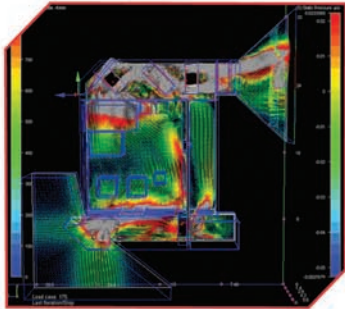
[WWW.VECTORELECT.COM](http://WWW.VECTORELECT.COM)



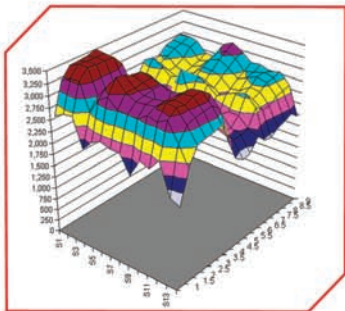
Airflow Diagram



CFD Simulation



Chassis Slot Velocity Map



## HYBRID SERIAL PARALLEL COOLING DELIVERS 99.999% HIGH AVAILABILITY

The Schroff Hybrid Serial-Parallel (HSP) cooling scheme uses axial fans in an innovative way to optimize shelf availability while minimizing downtime. Traditional fan trays contain rectangular combinations of serial and parallel fans with the goal of providing adequate bulk airflow to cool electronic components – at the design point. Fan failure conditions can compromise that ability, particularly in individual slots or regions.

Serial fan configurations, which boost air pressure, are subject to sharp pressure losses in the case of a fan failure. Such failures can cause power supplies and chips with high-fin-density heat sinks to overheat. Parallel fan arrangements push large volumes of air across multiple open surfaces – until a fan fails and recirculation occurs, substantially reducing the cooling to multiple slots.

Schroff's HSP design staggers the fans and arranges them at right-angles to the boards. The staggered fan distribution draws air from slots below and adjacent to each fan, but without the risk that a dedicated sealed channel presents. When a fan fails, the next fan upstream or downstream will continue to draw air with a marginally reduced cooling capacity until the fan is replaced. The end result is a dependable shelf with uniform slot-by-slot and front-to-rear airflow.

### FEATURES


- Patented Hybrid Serial-Parallel (HSP) fan arrangement
- Multiple arrays of offset fans provide fault-tolerant cooling
- Inexpensive axial fans deliver high-availability (99.999%) airflow
- Low-profile fan trays distribute air uniformly across the shelf, even with plug-in modules present
- High efficiency configuration draws less fan input power.

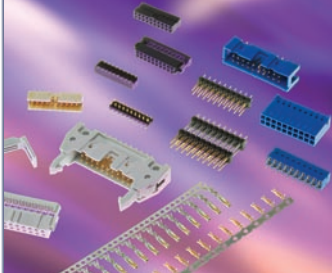
# Innovative Engineering



# PRODUCT GUIDE

## PACKAGING


	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
									
<b>Lanner Electronics (continued)</b>									<a href="http://www.lannerinc.com">www.lannerinc.com</a>
CP-6SL08	•								
CP-6SL08H	•								
<b>Leader Tech</b>									<a href="http://www.leadertechinc.com">www.leadertechinc.com</a>
719 RH		•							
<b>LSI Logic</b>									<a href="http://www.lsillogic.com">www.lsillogic.com</a>
IT13280UDCH-S						•			
IT16200U2C-S						•			
LSI22320C						•			
<b>LV Power</b>									<a href="http://www.lvpower.net">www.lvpower.net</a>
LV350DC3U1SF								•	
LV350DC3U2IPMISF								•	
LVDC200W3U2								•	
LVDC325W3U2								•	
LVDC350W3U1-X-Y								•	
LVDC350W3U2								•	
LVDC350W3U2IPMI								•	
LVDC350W6U1-X-Y								•	
<b>MKS, Control &amp; Information Technology</b>									<a href="http://www.mksinstruments.com">www.mksinstruments.com</a>
CDCG-0760 Card Cage			•						
PWRS-0720 3U Power Supply Card								•	
<b>Macrolink</b>									<a href="http://www.macrolink.com">www.macrolink.com</a>
12-Slot VME and cPCI Chassis								•	
ML-1000s Series			•						
ML-1900 Series Leopard VII								•	
ML-1900 Series Panther								•	
ML-1900 Series Puma								•	
ML-750T Series			•						
<b>MagneTek</b>									<a href="http://www.magnetekpower.com">www.magnetekpower.com</a>
HP750								•	
HP8/HD8								•	
HP850 Series								•	
PCI200								•	
PCI-3/3P								•	
PCI900/PDI Series								•	
PDI200								•	
PDI300								•	
<b>Magtech</b>									<a href="http://www.magtechind.com">www.magtechind.com</a>
cPWR-1500A								•	
cPWR-59301/59302/59303/59304								•	
<b>Mapsuka</b>									<a href="http://www.mapsuka.com.tw">www.mapsuka.com.tw</a>
2U CompactPCI Platform								•	
4U CompactPCI Horizontal Platform								•	
AdvancedTCA Backplane	•							•	
Card Guide/Aluminum Extrusions		•							
Card Guides		•							
CompactPCI Subrack		•							
CompactPCI Bridge		•							
EMC front panels						•			
Fan Units FU-1843SU				•					
M-CGA160		•							
P-784283								•	
P-984283								•	
PHT02-21610	•								
PICMG2.0R3.0 and 2.16 Backplanes	•							•	

	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
									
<b>PICMG2.5R1.0 Backplane</b>	•								
<b>PMC Bezels</b>		•							
<b>MarekMicro</b>									<a href="http://www.marekmicro.de">www.marekmicro.de</a>
CPIB1480A	•								
CPIB400/600/800A	•								
CPIB580/680/880A	•								
PXIB Series Backplanes	•								
<b>Martek Power</b>									<a href="http://www.martekpower.com">www.martekpower.com</a>
PS2316								•	
PS2318								•	
<b>Measurement Computing</b>									<a href="http://www.measurementcomputing.com">www.measurementcomputing.com</a>
PCI-Chassis								•	
STLITE-CPCI-16R			•						
<b>MEN Micro</b>									<a href="http://www.menmicro.com">www.menmicro.com</a>
cPCI Basic System 3U/3U								•	
cPCI Basic System 3U/6U								•	
cPCI Basic System 4U/3U								•	
cPCI Basic System 7U/6U								•	
Rugged CompactPCI Solution								•	
Triple-redundant CompactPCI								•	
<b>Mercury Computer Systems</b>									<a href="http://www.mc.com">www.mc.com</a>
FPDP PMC								•	
<b>Meritec</b>									<a href="http://www.meritec.com">www.meritec.com</a>
4X/12X Cable Assemblies			•						
<b>MGV Stromversorgungen</b>									<a href="http://www.mgv.de">www.mgv.de</a>
DG4120/DG4150/DG4150R Series								•	
DG4270								•	
P2060								•	
P2070								•	
P4180 Series								•	
P4190								•	
P4270								•	
PH1013								•	
<b>Mindready Solutions</b>									<a href="http://www.mindready.com">www.mindready.com</a>
IEEE-1394 a&b OHCI cPCI Board								•	
<b>Molex</b>									<a href="http://www.molex.com">www.molex.com</a>
0.50mm Pitch LaneLink I/O								•	
Circular MT Cable								•	
EMI Adapter								•	
IEEE 1386 Mezz Connector 71439								•	
MTP-CPI								•	
MZP Hard Metric Connectors								•	
<b>Motorola</b>									<a href="http://www.motorola.com/computing">www.motorola.com/computing</a>
CPX8216 Dual 8-slot Backplane	•								
CPX8216T Backplane with H.110	•								
<b>msystems</b>									<a href="http://www.msystems.com">www.msystems.com</a>
Fast Flash Disk (FFD) SCSI								•	
FFD Ultra Wide SCSI Flash Disk								•	
<b>Murrelektronik</b>									<a href="http://www.murrinc.com">www.murrinc.com</a>
<b>MCS Series</b>									•
<b>National Instruments</b>									<a href="http://www.ni.com">www.ni.com</a>
650-CCPCI 08WRHS	•								
DCP-201								•	
DCP-590								•	


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## PACKAGING




	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
<b>National Instruments (continued)</b> <a href="http://www.ni.com">www.ni.com</a>									
PXI-1010	•								•
PXI-1042									•
PXI-1045									•
PXI-8211							•		
PXI-8252							•		
SCSI-III							•		
<b>New Age Fans</b> <a href="http://www.newagefans.com">www.newagefans.com</a>									
BFT192B			•						
<b>NEXGOM International</b> <a href="http://www.nexcom.com">www.nexcom.com</a>									
MAXI 670		•							
MBP 3710	•								
MBP 6710	•								
MBP 67H110	•								
MBP 6EH110	•								
MCK 8700									•
MCK371/320A									•
NBP-14570-BX	•								
<b>Next Power Corp</b> <a href="http://www.next-power.net">www.next-power.net</a>									
CPCI D500 6U 4HP									•
<b>North Atlantic Industries</b> <a href="http://www.naii.com">www.naii.com</a>									
55PQ1									•
<b>Omni Device</b> <a href="http://www.omnidevice.com">www.omnidevice.com</a>									
USPB-2000: PICMG Backplane	•								
USPB-3000: ATCA Backplane	•								
<b>One Stop Systems</b> <a href="http://www.onestopsystems.com">www.onestopsystems.com</a>									
11U High Capacity Enclosure									•
1U CompactPCI Enclosure			•						
2U Carrier Class									•
2U High CompactPCI Enclosure			•						
4U Carrier Class									•
4U CompactPCI Enclosure									•
4U-19S-2-350									•
5- and 8-slot H.110 backplanes	•								
8U Carrier Class									•
cPCI 14/16-slot backplanes	•								
ENCL-3U-DT Series			•						
OSS-BP-3U Series	•								
OSS-BP-6U Series	•								
OSS-BRIDGE-PADDLE		•							
OSS-ENCL-6U-14-600									•
OSS-ENCL-6U-BTS-8-250									•
OSS-ENCL-6U-CC-4-300									•
OSS-ENCL-6U-CC-8-600									•
OSS-ENCL-6U-H-08-2-300									•
OSS-ENCL-PORTABLE									•
OSS-PSBP-P47-1	•								
OSS-SCSI-3							•		
OSS-SYS-MON-FE						•			
Portable Workstation									•
SysMon/SysMonWare						•			
<b>Optovia</b> <a href="http://www.optovia.com">www.optovia.com</a>									
C4000 Managed Shelf									•
<b>Oupiin</b> <a href="http://www.oupiin.com">www.oupiin.com</a>									
9111-7-1-A HM connector					•				




	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
<b>9111-7-1-B19 HM connector</b>									
<b>9111-7-1-B22 HM connector</b>									
<b>9111-7-1-B25 HM connector</b>									
<b>9111-7-1-C HM connector</b>									
<b>9111-7-1-D HM connector</b>									
<b>9111-7-1-L HM connector</b>									
<b>9111-7-1-M HM connector</b>									
<b>9111-7-1-N HM connector</b>									
<b>9111-7-2-A HM connector</b>									
<b>9111-7-2-L HM connector</b>									
<b>9111-7-2-M HM connector</b>									
<b>9111-7-2-N HM connector</b>									
<b>Performance Technologies</b> <a href="http://www.pt.com">www.pt.com</a>									
<b>12U PICMG 2.16 Platform</b>									
<b>Advanced Managed Platform</b>									
<b>ATC5210 12U AdvancedTCA Platform</b>									
<b>CPC5095 7U PICMG 2.16 Platform</b>									
<b>CPC6314 325W DC Power Supply</b>									
<b>CPC7301 Intelligent Shelf Manager</b>									
<b>MG7402 Intelligent Shelf Manager</b>									
<b>ZT 5085e 12U Platform</b>									
<b>ZT 5088e 12U Platform</b>									
<b>ZT 5091e 4U Platform</b>									
<b>ZT 6303 250W Hot-Swap AC</b>									
<b>Pericom</b> <a href="http://www.pericom.com">www.pericom.com</a>									
<b>P15L102</b>									
<b>Perlos Connectors</b> <a href="http://www.perlos.com">www.perlos.com</a>									
<b>PerForm 2.0 Series</b>									
<b>Phillips Components</b> <a href="http://www.phillipscomponents.net">www.phillipscomponents.net</a>									
<b>Enclosures and Backplanes</b>									
<b>PMC Bezels</b>									
<b>CompactPCI Air Transport Rack</b>									
<b>CompactPCI Panels and Hardware</b>									
<b>Picor</b> <a href="http://www.picorpower.com">www.picorpower.com</a>									
<b>QPI-1</b>									
<b>QPI-3 Active EMI Filter</b>									
<b>QPI-4 Active EMI Filter</b>									
<b>QPI-5 Active EMI Filter</b>									
<b>QPI-6 Active EMI Filter</b>									
<b>Pigeon Point Systems</b> <a href="http://www.pigeonpoint.com">www.pigeonpoint.com</a>									
<b>IPM Sentry Shelf Manager</b>									
<b>ShMM-300</b>									
<b>ShMM-300 Shelf Mgmt Starter Kit</b>									
<b>ShMM-500 Shelf Mgmt Mezzanine</b>									
<b>Pinnacle Data Systems</b> <a href="http://www.pinnacle.com">www.pinnacle.com</a>									
<b>Alert!Node</b>									
<b>Alert!Panel</b>									
<b>ComputeNode4U cPSB</b>									
<b>CP2040/2140</b>									
<b>CP2X60/2X80</b>									
<b>Polyonics</b> <a href="http://www.polyonics.com">www.polyonics.com</a>									
<b>XF-550/XF-552</b>									
<b>Polyrack</b> <a href="http://www.polyrack.com">www.polyrack.com</a>									
<b>19-inch 1U MPS for CompactPCI</b>									
<b>19-inch 3U/6U MPS for CompactPCI</b>									

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## PACKAGING


	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
									
<b>Polyrack (continued)</b>	<a href="http://www.polyrack.com">www.polyrack.com</a>								
19-inch 4U MPS for industrial									•
3U CompactPCI backplane	•								
CompactPCI backplane H.110	•								
CompactPCI packet switching	•								
<b>Positronic Industries</b>	<a href="http://www.connectpositronic.com">www.connectpositronic.com</a>								
Combination Thermocouple Contact					•				
Environmental WD Series					•				
Goldfish Series					•				
Infinity Power Connector Series					•				
PCD/PCDD Press-fit Series					•				
PICMG 2.11 Connector, P47					•				
Power Connection Systems					•				
Sumo High Power					•				
VP Series					•				
VPB Series, ATCA Zone 1					•				
<b>Potenia Semiconductor</b>	<a href="http://www.potentialsemi.com">www.potentialsemi.com</a>								
PS-1624									•
PS-1648									•
PS-1648 for ATCA									•
PS-1650									•
PS-2405									•
PS-2610									•
<b>Power Sources Unlimited Inc</b>	<a href="http://www.psui.com">www.psui.com</a>								
CPCIAC-6U-400									•
DPCI204-1022									•
DPCI254-1022									•
PCI204-1022									•
PCI254-1022									•
PCI354-1022									•
<b>Power-One</b>	<a href="http://www.power-one.com">www.power-one.com</a>								
CPA200-4530									•
CPA250-4530									•
CPA500-4530									•
CPD200-4530									•
CPD250-4530									•
<b>Pulse</b>	<a href="http://www.pulseeng.com">www.pulseeng.com</a>								
J1501F21					•				
PB0025/26/27 DC/DC Transformer									•
Volta Series Squaroid SMT									•
<b>Purcell Technologies</b>	<a href="http://www.purcellbrackets.com">www.purcellbrackets.com</a>								
cPCI Brackets	•								
cPCI, PMC, PCI Panels							•		
PMC Brackets	•								
<b>Radian Heatsink</b>	<a href="http://www.radianheatsinks.com">www.radianheatsinks.com</a>								
ATCA BGA Heatsinks				•					
ATCA Thermal Analysis				•					
cPCI BGA Heatsinks				•					
cPCI Thermal Analysis				•					
Removable BGA Heatsinks				•					
<b>RadiSys Corp</b>	<a href="http://www.radisys.com">www.radisys.com</a>								
SYS50									•
<b>Radstone Embedded Computing</b>	<a href="http://www.radstone.com">www.radstone.com</a>								
ATR		•							
Conduction-cooled ATR chassis									•

	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
									
<b>RT4 PowerPact</b>									•
<b>Rancho Technology</b>	<a href="http://www.rancho.com">www.rancho.com</a>								
RTLVD-HVDPCI							•		
RTLVD-HVDR4E							•		
<b>Raycon Technology</b>	<a href="http://www.raycontech.com">www.raycontech.com</a>								
Type A Female Receptacle					•				
Type AB19 Female Receptacle					•				
Type AB19 Male Header					•				
Type AB22 Female Receptacle					•				
Type AB22 Male Header					•				
Type AB25 Female Receptacle					•				
Type B19 Male Header					•				
Type B22 Female Receptacle					•				
Type B22 Male Header					•				
Type B25 Female Receptacle					•				
Type B25 Male Header					•				
Type C Female Receptacle					•				
Type C Male Header					•				
Type L Female Receptacle					•				
Type M Female Receptacle					•				
Type M Male Header					•				
Type N Female Receptacle					•				
Type N Male Header					•				
<b>Red Rock Technologies</b>	<a href="http://www.RedRockTech.com">www.RedRockTech.com</a>								
RRTC-1SFA-LW									•
<b>Renesas Technology America</b>	<a href="http://www.renesas.com">www.renesas.com</a>								
H8S/2168 IPMI Microcontrollers								•	
<b>Rittal</b>	<a href="http://www.rittal.com">www.rittal.com</a>								
1U RiCool Blower tray				•					
Backplane Stiffener	•								
Cable Management System	•								
COMPACT-I							•		
CompactPCI Power Supply									•
CompactPCI System							•		
CompactPCI 3U and 6U Backplanes	•								
CompactPCI Developer Subrack							•		
Fibre-optic Backplane	•								
MicroTCA System							•		
Multiple Key Insertion Tool									•
Power Cooling System									•
RiBox							•		
Ripac TC Series									•
RiTherm System									•
TE 7000							•		
Type IVx CPCI xtra Handle									•
Type VII Telecom Handle									•
<b>SAE Power</b>	<a href="http://www.saepower.com">www.saepower.com</a>								
1U Power Systems									•
6U/8HP 600W cPCI									•
PF600 PCI									•
<b>Saelig</b>	<a href="http://www.saelig.com">www.saelig.com</a>								
K2									•
<b>Sanmina-SCI</b>	<a href="http://www.sanmina.com">www.sanmina.com</a>								
C4000								•	•


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	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
<b>Sanmina-SCI (continued)</b>									<a href="http://www.sanmina.com">www.sanmina.com</a>
C6000-12-14DS								• •	
C6000-12-16DS								• •	
SC6000 AdvancedTCA 12U								• •	
<b>SBE</b>									<a href="http://www.sbei.net">www.sbei.net</a>
scsiPCI-2U4WL								•	
<b>Schaefer</b>									<a href="http://www.schaeferpower.com">www.schaeferpower.com</a>
C4700 Series									•
C5600 Series									•
<b>Schroff</b>									<a href="http://www.schroff.us">www.schroff.us</a>
11098-088 400 W Power Supply	•								
14-Slot AdvancedTCA System	•								
19" cPCI Power Supplies	•								
CompactPCI Backplane 6, 7 U, 64 Bit	•								
23006-601 PICMG 2.16 Ethernet	•								
CompactPCI 3U, 32/64 bit	•								
CompactPCI System Subracks									•
3U, 6U Shielded Front Panels									•
31591-454 Al Extrusion Front Panel								•	
AdvancedTCA Adapter Board									•
AdvancedTCA Chassis 14 slot									•
AdvancedTCA Chassis 5 slot								• •	
AdvancedTCA Dev. Chassis 2 slot								•	
AdvancedTCA Filler Panels								•	
AdvancedTCA Front Panel								•	
AdvancedTCA Front Panel Kits								•	
AdvancedTCA Handle								•	
AdvancedTCA Hot Swap Handle								•	
Backplanes	•								
BPL000333	•								
BPL000479	•								
BPL000763	•							•	
BPL001091	•								
Card Guides								•	
CBL000001								•	
CDPC DC/DC Converters									•
CompactPCI Backplane Series	•								
CompactPCI Backplanes w/Bridging	•								
CompactPCI/VME64X Front Panel								•	
Custom Stamping								•	
Deployment Ready AdvancedTCA	•								
Europac Subrack Systems			•						
Europac Integral enclosure			•						
europacPRO			•						
Fan controller/shelf manager 14-slot								•	
FPL000602								•	
FPL000603								•	
Front Panel Express								•	
Front Panel w/ Gasket								•	
HF front panel								•	
IET Handle								•	
Insertion/Ejection Handle								•	
Modular cPCI Backplanes	•								
PEN-6003								•	
PEN-6045 Schroff cPCI Enclosure			•						

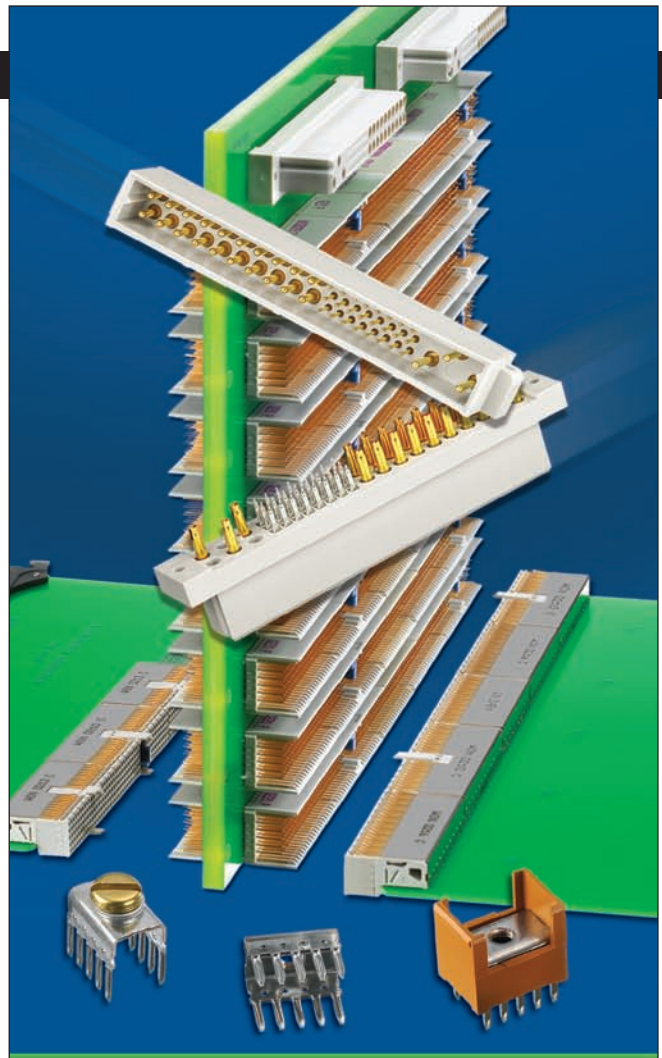


	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
<b>PEN-6105</b>			•						
Pro Series Subrack Platform			•						
Propac, Multipac, Compac Cases			•						
Rear-mount I/O Subrack			•						
SEISMIC Cabinets		•							
Shelf manager for 5U chassis							•		
SYS000235									•
SYS000766									•
<b>Simon Industries</b>									<a href="http://www.simonindustries.com">www.simonindustries.com</a>
Front Panels, Heatsinks		•							
Conduction Cooled Heat Frames			•						
<b>SMA</b>									<a href="http://www.SMAcomputers.com">www.SMAcomputers.com</a>
Backplanes	•								
CDI32			•						
CMT104			•						
Cool Box				•					
CPU1.2RIO			•						
Enclosures			•						
Power Supplies									•
SR6570									•
<b>South Coast Technology</b>									<a href="http://www.scoasttech.com">www.scoasttech.com</a>
SCTAC-150W AC/DC									•
<b>SOUTHCO</b>									<a href="http://www.southco.com">www.southco.com</a>
47 ATCA Captive Retention Screws									•
4C ATCA Captive Retention Screws									•
5T Heat Sink Captive Screws									•
77-0-40552 ATCA Safety Grnd Pins									•
ADVANCED-TCA Faceplate Hardware									•
P7-A-503-11 ATCA Ejector Handle									•
P7-A-513-11 ATCA Ejector Handle									•
P7-A-523-11 ATCA Ejector Handle									•
P7-A-533-11 ATCA Ejector Handle									•
P7-A-543-11 ATCA Ejector Handle									•
<b>StacoSwitch</b>									<a href="http://www.stacoswitch.com">www.stacoswitch.com</a>
M723									•
<b>Star Case Manufacturing</b>									<a href="http://www.starcase.com/rack.htm">www.starcase.com/rack.htm</a>
Star Case Modular Racks			•						
Stratos Lightwave									<a href="http://www.stratoslightwave.com">www.stratoslightwave.com</a>
Rack-mount Packaging			•						
<b>Sun Microsystems</b>									<a href="http://www.sun.com">www.sun.com</a>
Netra AdvancedTCA System	•								
<b>Suntron</b>									<a href="http://www.suntroncorp.com">www.suntroncorp.com</a>
CompactPCI Packet Switching	•							•	
cPCI Communications Platform									•
SNMP Alarm Board								•	
<b>Switching Power</b>									<a href="http://www.switchpwr.com">www.switchpwr.com</a>
CPCI-210Q-DC-47									•
CPCI-350Q-DC-38									•
CPCI-350Q-DC-47									•
CPCI-350Q-P-38									•
CPCI-350Q-P-47									•
CPCI-600Q-P-47									•
HDX-1200S-P									•
HDX-600Q-P									•

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	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMS	Power management & power supplies
									
<b>Targa Systems</b>									<a href="http://www.targasystems.com">www.targasystems.com</a>
cPCI-SCSI Flash Module									•
<b>Team Solutions</b>									<a href="http://www.teampctechnology.com">www.teampctechnology.com</a>
<b>TE3200</b>									•
<b>Technobox</b>									<a href="http://www.technobox.com">www.technobox.com</a>
2043 SCSI Adapter									•
2238 RS-232 Async									•
2316 RS-422 Async									•
2876 RS-485/422 Async									•
3761 SCSI Controller									•
3954 PMC-to-PMC extender		•							
3145/3156 SCSI PMC Adapter									•
Transition Pnls and Paddle Cards		•							
<b>Teka Interconnection</b>									<a href="http://www.tekais.com">www.tekais.com</a>
2.0mm Headers		•							
2.0mm Receptacles		•							
<b>Telkoor Power Supplies Ltd.</b>									<a href="http://www.telkoor.com">www.telkoor.com</a>
CPCI-AC-3U-200									•
CPCI-AC-3U-250									•
CPCI-AC-6U-400									•
CPCI-DC-3U-200/24									•
CPCI-DC-3U-200/48									•
CPCI-DC-3U-250/48									•
CPCI-DC-6U-350/24									•
CPCI-DC-6U-400/48									•
<b>Teradyne</b>									<a href="http://www.teradyne.com">www.teradyne.com</a>
GRPX1030									•
VHDM RAM									•
<b>Tracewell Systems</b>									<a href="http://www.tracewellsystems.com">www.tracewellsystems.com</a>
6U Backplane	•								
cPCI Card Cage			•						
cPCI Power Supply									•
Custom Backplanes	•								
H.110 Backplane	•								
Horiz. 5-slot Full Mesh			•						•
PCI350 Power Supply									•
S31									•
S32									•
S32-RH									•
S33 for CompactPCI									•
S33-1U									•
S34 for CompactPCI									•
S36 Rugged System Platform									•
S36-10U									•
T-Frame for CompactPCI									•
TPS600									•
TTX 400									•
TTX Series									•
<b>Trenton Technology</b>									<a href="http://www.trentontechnology.com">www.trentontechnology.com</a>
BPX6571		•							
<b>Triple E</b>									<a href="http://www.tripleEase.com">www.tripleEase.com</a>
901 Series Cluster									•
D+/1600 Enclosure									•
Max-Air.10 Microchassis									•



The embedded systems industry's  
**only source for both CompactPCI®  
 signal and power connectors**

### Featuring:

- **47-Position Power Connectors**
  - cULus recognized
  - Reliable C-Press® compliant contacts
- **MetCon-2® 2 mm Hard Metric Connectors**
  - Designed to IEC 61076-4-101
  - Designed to minimize pin stubbing
- **121-Series C-Press® Power Terminals**
  - 6- and 10-position press-fit PCB terminals



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 Fax: 203-741-5500  
[www.winchesterelectronics.com](http://www.winchesterelectronics.com)




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	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
									
<b>Triple E (continued)</b>	<a href="http://www.tripleEase.com">www.tripleEase.com</a>								
Metal Handles									•
Rugged Eurocage Enclosure									•
Unbreakable Handle									•
Various									•
<b>Twin Industries</b>	<a href="http://www.twinhunter.com">www.twinhunter.com</a>								
2000-BPNL	•								
2500-EXTM						•			
<b>Tyco Electronics</b>	<a href="http://www.tycoelectronics.com">www.tycoelectronics.com</a>								
AdvancedTCA Zone 1						•			
AMC.0 Connector						•			
ATCA Power Connector						•			
CHAMP Series 1 SCA-2						•			
COM Express						•			
Connector for SCSI						•			
Databus Couplers						•			
Drawer Series						•			
Eurocard Connectors						•			
Guide Hardware							•		
Half-height RJ-45s						•			
HTS heavy duty						•			
MicroTCA Backplane Connector						•			
MINIPAK						•			
MINI-SC Fiber Optic						•			
MultiGig RT						•			
Multimode LC Conn Plug Kits						•			
PIM200 200W Power Supply									•
PolyCrimp Splices		•							
POWERPAK						•			
QBW018A0B1									•
RAYCHEM NT-MIL		•							
Stacked Modular Jacks						•			
Z-PACK 2mm HM AB Receptacle						•			
Z-PACK 2mm HM Type AB Shroud							•		
Z-PACK 2mm HM cable connector						•			
Z-Pack HM-Zd						•			•
Z-PACK MAX Connectors						•			
<b>Unipower</b>	<a href="http://www.unipower-corp.com">www.unipower-corp.com</a>								
DC Input									•
Gravitas IX12.5-115									•
Gravitas X100									•
Gravitas X75-48S									•
Magellan Series									•
Power Cassette									•
TMH Series									•
TMP Series									•
TPCHR1U2			•						
TVN-3U									•
TWR Series									•
Vanguard RVN Series									•
Vanguard TVN									•
<b>United Electronic Industries</b>	<a href="http://www.ueidaq.com">www.ueidaq.com</a>								
PDXI-4									•
<b>Universal Air Filter Co.</b>	<a href="http://www.uaf.com">www.uaf.com</a>								
Broadband EMI Filters			•						

	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
									
<b>V Rose Microsystems</b>	<a href="http://www.vrosemicrosystems.com">www.vrosemicrosystems.com</a>								
VRM-CR7-X									•
<b>Vector Electronics</b>	<a href="http://www.vectorelect.com">www.vectorelect.com</a>								
2145 6U Enclosure									•
2345 3U Enclosure									•
2371 19" Chassis									•
2375 Desktop/Rack-Mount Enclosure									•
2372 Series Desktop Enclosure									•
2377, PICMG 2.16, PICMG 2.0 R3									•
2600-300 Power Supply									•
300 Watt with M DIN Connector									•
350 watt, 3U cPCI Power Supply									•
3U Subracks							•		
6U Subracks							•		
CCAxx Cardrack/Subrack							•		
cPCI Chassis/Enclosures 3U/6U									•
CPCIBP8-6	•								
CPCIBP8-3	•								
DIN Subracks							•		
Hybrid Subracks							•		
Series 445 8U Chassis for 6U									•
Tower-style Enclosure							•		
Ruggedized Enclosures									•
Slimline' Chassis									•
<b>Visionpower Ltd.</b>	<a href="http://www.visionpower.co.uk">www.visionpower.co.uk</a>								
IPSY200-12-47									•
<b>VMETRO</b>	<a href="http://www.vmetro.com">www.vmetro.com</a>								
SANcab		•							
<b>Voiceboard</b>	<a href="http://www.voiceboard.com">www.voiceboard.com</a>								
CM256									•
<b>VX Instruments</b>	<a href="http://www.vxinstruments.com">www.vxinstruments.com</a>								
VX6620									•
VX6625									•
<b>Westek</b>	<a href="http://www.westekuk.com">www.westekuk.com</a>								
P1100									•
P11400									•
P1414ATCA									•
P5100									•
P8100 8U cPCI System									•
P9100									•
<b>Winchester Electronics</b>	<a href="http://www.winchesterelectronics.com">www.winchesterelectronics.com</a>								
47-position cPCI Power									•
ATCA Zone 1 Power Connector									•
CPCI47P52x101									•
CPCI47S43x104									•
MetCon-2 10929513									•
MetCon-2 NX5									•
MetCon-2 NX5SH									•
MetCon-2 NX6									•
<b>Wind River</b>	<a href="http://www.windriver.com">www.windriver.com</a>								
EUXXPCI-XXXX									•
<b>Wolf Industrial Systems</b>	<a href="http://www.wolf.ca">www.wolf.ca</a>								
Fan Tray							•		
SCAMP Power Panel									•
<b>XILINX</b>	<a href="http://www.xilinx.com">www.xilinx.com</a>								
ATCA Platform	•								

	Backplanes	Cabinets and accessories	Chassis, shelves, and racks	Cooling and thermal management	Keying	Management and alarming	Packaging and mechanical	Supports PEMs	Power management & power supplies
XP Power									<a href="http://www.xppower.com">www.xppower.com</a>
RTC 150 Watts									•
RTC200									•
XTech									<a href="http://www.xtech-outside.com">www.xtech-outside.com</a>
AdvancedTCA Front Panels									•
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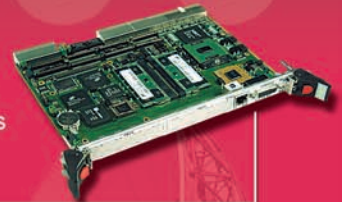
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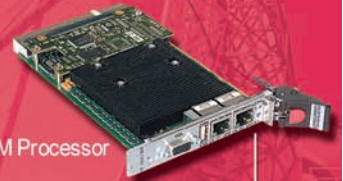
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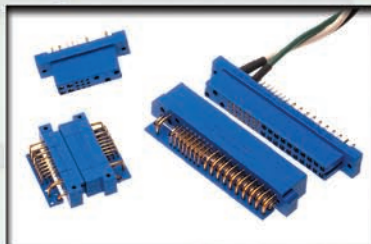
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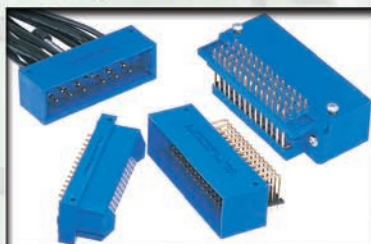


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