

Introduction of PICMG and CompactPCI

The original idea of some of the original members of PICMG was: "the PCI Bus is used everywhere in the desk top industry and should also be used in embedded computers"

THE ORIGINAL IDEA

The PCI bus offers high performance, a very large software support, is fully adopted by the industry, completely independent of the processor, at low cost because of the mass volume production and it allows a short development time of a complete system.

But for an embedded computer it lacks from a rugged form factor (shocks and vibrations) and there are only four slots available (this is not enough for industrial controllers with a large number of I/O's). Furthermore the long term availability of components is critical.

Embedded controllers need to have a passive backplane in order to ease the maintenance procedure. Serviceability is also critical for embedded computers and mission critical systems require additional features, such as fault tolerance and hot swapping.

THE ASSOCIATION PICMG

The association PICMG has been created to develop common specifications for embedded computers such as industrial controllers, medical systems, telecom, transport equipment, military systems.

PICMG stands for PCI Industrial Computer Manufacturers Group.

This is a consortium of more than 350 members including big names like Intel, Motorola, Sun, HP, Compaq, DEC, but also a number of small and active companies.

OBJECTIVES

The initial objective of PICMG was to define a passive backplane topology for the PCI bus. In 1992 Intel defined the PCI bus as a local bus in order to directly interface a processor to some local devices, such as VGA, networking functions. A passive backplane allows easy insertion and removal of the board and therefore the maintenance procedure is shorter. This is critical for OEMs because down time must be minimum.

By defining open specifications, PICMG provides a clear upgrade path for board level manufacturers and end-user by increasing the product availability and reducing cost because of the competition on an open standard.

PICMG defines technical specifications for embedded computers and continuously develops new standards for leading edge technology

The goal of PICMG is the use of the PCI technology for embedded controllers including the unique system

approach of the PCI bus: the tremendous software support.

PICMG STANDARDS

PICMG standardized 2 major definitions:

One of these is the passive backplane PCI/ISA definition that is based on the desktop PC form factor and it includes the edge connector of the PCI bus and the ISA bus. This approach allows implementing reliable systems such as computer telephony products. Due to a passive backplane structure the maintenance and the serviceability of these systems has been improved compared to the standard desktop PC architecture. PICMG's board level manufacturers are designing passive PCI/ISA single board computers. These CPUs are used along with standard off the shelf consumer PC adapters such as Ethernet, SCSI... in order to build a complete system.

But this definition using the edge connector is not suitable for embedded controllers used in severe environments where there are shocks and vibrations. The backplane on the PCI board blocks the air flow (embedded computers are used in high and low temperature environments). The number of PCI slots is also limited using the edge connector.

All these reasons are at the origin of the definition of the CompactPCI bus for designing professional and mission critical applications.

THE CORE SPECIFICATION OF COMPACTPCI

The CompactPCI core specification 2.0 R1 has been approved by the majority of the PICMG Exec members in August 1997.

The CompactPCI core specification 2.0 defines a me-

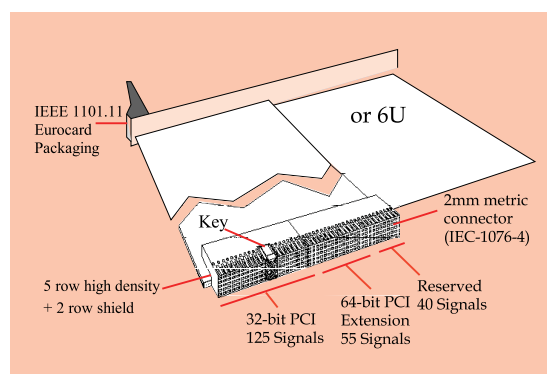


Figure 1. Core specification of CompactPCI

chanical form factor based on the Eurocard format. Both 3U and 6U form factors are defined. This mechanical form factor has been used for years in embedded computers with the VME or Multibus specifications. It is ideally suited for shocks and vibrations and also it allows very good heat dissipation because of the vertical mounting of the boards.

CompactPCI defines an IEEE 1101.11 face plate. This face plate is fully compatible with the EMC requirements and it also includes an injector/ejector mechanism for easy insertion and removal of a board. Additionally an ESD is used during the insertion process to protect the board from electrical static discharge.

The CompactPCI connector is different than the standard PCI edge connector. It is based on a 2 mm hard metric connector (IEC 1076-4 spec) with 5 rows of 47 signals and 2 rows for shielding. In the CompactPCI connector all the PCI 32 bit signals are included in the lower half of the connector (J1). On the upper half of the connector (J2) the 64 bit signals or the rear I/O signals can be implemented. On top of the J2 connector signals are reserved for future extension of the spec.

There is also a keying mechanism for differentiating +5 volt and +3.3 volt plug in boards.

8 SLOTS PASSIVE BACKPLANE

CompactPCI allows 8 slots. This 8 slot architecture has been achieved because a CompactPCI connector and its low capacitance figure compared to desktop PCI edge connector. During 1995 PICMG Executive members fully simulated this topology to ensure that 8 slots can be achieved with the PCI bus electrical specification 2.0.

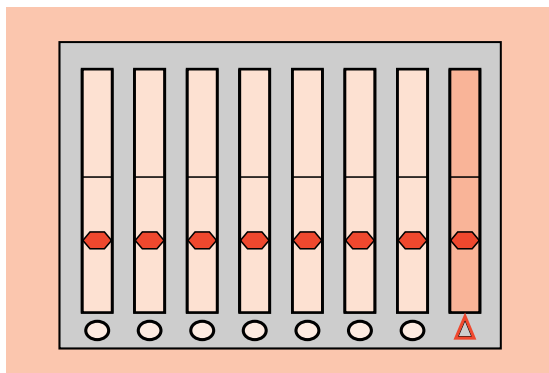


Figure 2. 8 Slots passive backplane

The CompactPCI backplane is based on a system slot for the CPU located on the right or left end of the backplane. It is identified by a triangle on the backplane. 7 additional slots are available for plug in boards such as intelligent controllers (DSP) or networking, video, mass storage (hard disc) functions.

Additionally the CompactPCI connector on the backplane includes staged pins for sequencing the operations during the insertion/removal of a board. This feature will be used by the hot swap specification.

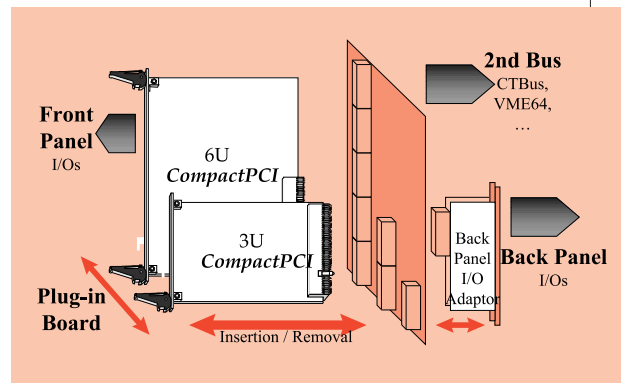


Figure 3. A modular system approach

A MODULAR SYSTEM APPROACH

Compact PCI offers a modular system approach. The connector at the bottom, called J1, contains all signals for the 32-bit PCI bus. The second connector, called J2, contains the extensions to 64 bit, or can be used for rear I/O signals. This connector also includes reserved signals for future extension of the spec. These implementations are equal for 6U and 3U sized boards. This means also that one can mix both sizes in the same system. Because of the larger size of 6U, one has access to additional connector-space. These can be used for I/O or additional busses like the Computer Telephony implementation, which I will show later. For both sizes one always has the option for front accessible I/O. This can be used for industrial I/O and maintenance interfaces.

COMPATIBILITY WITH THE PCI BUS ELECTRICAL SPECIFICATION 2.0

A CompactPCI system architecture is as follow for example: it is based on a CPU board and 7 slots for peripheral functions. But the most important point is that from an electrical point of view CompactPCI is fully compatible with the PCI bus spec 2.0. All the standard PCI silicon components (chips) can be used directly on a CompactPCI board. For example the electrical schematic of a VGA controller can be directly used to design a CompactPCI board. Furthermore because of the electrical compatibility with the PCI spec CompactPCI provides a unique system approach with a very large Software support.

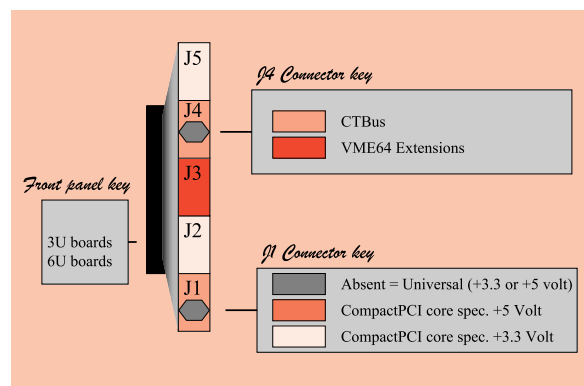


Figure 5. Keying Mechanism

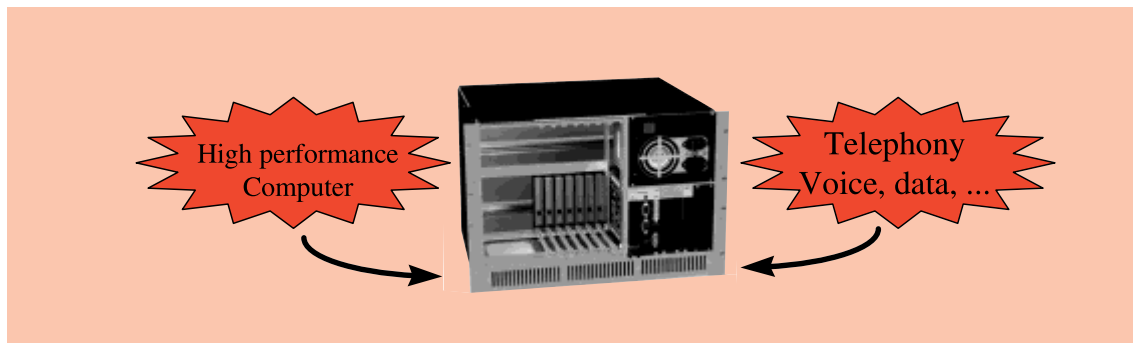


Figure 6. Computer telephony

KEYING MECHANISM

The IEC 1076 connector incorporates a keying scheme, providing physical safety for different implementations. The CompactPCI spec requires the use of a key on the lowest/J1 connector, to prevent damage to cards, which are incompatible with the power signals on the bus. This keying mechanism also can be used on the J4 connector to differentiate between modules designed for different implementations on this connector, e.g. CT bus.

COMPACTPCI BENEFITS

CompactPCI offers high performance: 132 megabytes per second bandwidth, 33 megahertz synchronous clock signals.

Furthermore, CompactPCI is not only dedicated to Pentium CPUs, it also supports the PowerPC and the Alpha CPU for example. Therefore CompactPCI is fully independent of the processor.

Because it is fully compatible with the PCI electrical spec, it benefits from a mass volume production of PCI components (VGA controller, SCSI controller) and also from the latest developments of the desk top industry. Therefore embedded CompactPCI controllers are at low cost with advanced features.

But certainly the most important benefit of CompactPCI is the software support. CompactPCI systems benefit from the plug and play technology and from a very large support of drivers, libraries, OSs and applications used in the PCI desk top market. Therefore CompactPCI offers a complete system approach with a wide availability of hardware components and software tools. Overall this architecture allows decreasing the development time of embedded systems. And as everybody knows time to market is critical for the success of a product.

COMPUTER TELEPHONY

A good example of this complete system approach is shown in this picture. It even goes one step further. The standard system, based upon standard hardware and software components, provided the telephony industry an excellent basis / platform to add their particular requirements. This means a combination of high performance computer power with the telephony requirements on voice and data. These requirements were not re-invented by PICMG, but instead they teamed with the leading organization ECTF, the Enterprise

Computer Telephony Forum.

This telephony bus is an addition to the standard CPCI backplane, and is implemented on the J4 and J5 part of the connector. This separation is key. By implementing the telephony data on a secondary bus one has these data independently from the management and control data.

The H110 standard specifies the J4 connector routing of the TDM bus. The J5 connector is specified for additional Telephony I/O.

This computer telephony integration is currently one of the key markets of CompactPCI. A technical committee has defined the extensions to the CompactPCI backplane with a specific telecom bus based on the H100 standard, which is recently approved by PICMG.

PICMG TECHNICAL COMMITTEES

The CompactPCI specification is continuously evolving. PICMG technical committees are formed in order to define specific technology points, e.g. hot swapping, mixing VME and CompactPCI,... After approval of the technical subcommittee the result of the work is inserted in the CompactPCI core specification.

The most active technical committee today is the Hot Swap group. The hot swapping technology is definitely a key feature for the telecom industry. This specification is now being voted upon.

Another active technical committee is the definition of the CompactPCI spec for Test & Measurement following the proposal of National Instruments of the PXI bus. CompactPCI is not limited to 8 slots; A technical committee is working on the PCI to PCI bridge technology for defining the system architecture of a 14 slot or more backplane. This becomes necessary for large telecom systems or industrial controllers.

A technical committee is in charge of a dual bus implementation mixing VME64 and CompactPCI.

Another technical committee is currently working on the definition of a dual CompactPCI backplane implementation.

COMPACTPCI ADOPTED BY THE INDUSTRY

CompactPCI can be used in a large variety of applications. The typical applications of CompactPCI are for embedded controllers. Telecom is a fast growing market because of the information technology age. Time

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to market is critical, therefore industry leaders are using the latest technology for "off the shelf" boards. CompactPCI has been widely accepted for building the next generation of servers, routers, gateways and Computer Telephony Integration. These systems are using all the benefits of CompactPCI: High performance, software support, hot-swapping and the large number of user free I/Os.

Industrial controller system designer have welcomed the CompactPCI definition because it allows to build in a single system a high performance system controller (CPU, VGA, LAN, SCSI) and high performance I/O functions profiting from a complete software support with low cost components.

Military systems must now used of the shelf sub-components (COTS). CompactPCI offers an unique opportunity to design high performance functions using a small factor designed for rugged environment.

More and more electronic systems are used in trains, ships and airplane. CompactPCI offers high performance, a rugged form factor and long term availability for these applications.

Medical systems needs to have high reliability, and ease of maintenance board level product. CompactPCI fits perfectly.

Image processing is becoming more and more used in the industry for live video, operator graphical user interface, pattern recognition, ... CompactPCI offers a rugged form factor, software support and serviceability. These are just examples where CompactPCI is a perfect fit now and in the future.

THE BOARD LEVEL MARKET

The board level market is a very large and fragmented market based on proprietary and standard designs. This market is still growing significantly because embedded computers are now used everywhere.

The VME bus has been defined 15 years ago and it represents the majority of the so-called standard board level market. The VDC studies foresee the VME market as a 2B\$ by the year 2000. This is very significant compared to the PMC market.

CompactPCI is picking up very rapidly. The analysis demonstrates that it will reach the 1 B\$ size by the next millennium. Today the only real data on this market are the number of design-ins based on the CompactPCI technology. The battle " CompactPCI versus VME" is ridiculous. VME will still continue to be very successful due to the very large basis of installed applications. But for new projects CompactPCI could be an excellent alternative in order to use the latest silicon and software technology in embedded controllers. CompactPCI has been widely adopted by system designers who were previously designing on proprietary architecture.

MARKET OPPORTUNITIES

CompactPCI benefits from the industrial PC market because it provides high performance hardware with a complete set of software tools at low cost. But CompactPCI also benefits from the VME technology

because it is ideally suited for professional and mission critical systems where rugged and compact form factor, serviceability, long term availability, number of slots, industrial connections and packaging are essential.

A very large number of OEMs were previously designing all their electronics by them selves. Today outsourcing using COTS is becoming a major part of their strategy toward cost reduction and shorter product life cycle. These industries are now adopting CompactPCI.

THE GOAL OF PICMG EUROPE

The goal of PICMG Europe is to support in Europe the supply and usage of products conform to the PICMG specifications. The European organization is heavily involved in the review and the approval of new specifications. The marketing of PICMG Europe is focused on promoting these technical implementations as a potential solution for the next generation of industrial control systems. The role of PICMG Europe is to make the users aware of this solution, and to give them access to technical specifications and potential suppliers in an independent way.

MARKETING COLLATERAL OF PICMG EUROPE

The marketing of PICMG Europe is focused on promoting the PICMG US technical implementations as a potential solution for the next generation of industrial control systems. The role of PICMG Europe is to make the European users aware of this solution, and to give them access to technical specifications and potential suppliers in an independent way. PICMG Europe publishes 4 times a year a newsletter containing new product developments specialized for the industrial automation market and dedicated articles for those who are active in these markets as well as advertisements of the members. This newsletter is integrated in the CompactPCI Systems Europe Magazine to which European users and manufacturers can subscribe for free at PICMG Europe. PICMG Europe also sends out press releases per year to the European press and attend important industries fairs, like the Embedded Systems Show in Germany and the UK, SysComms '98 at CERN in Switzerland and will be present at the PC Developers Conference and Expo in Paris with on 6 October a day of CompactPCI related conferences and an special PICMG isle of exhibitors. From 20-22 October PICMG Europe will be present in London on Voice Europe 98. PICMG Europe makes a product guide available to the European users including the product information of the European members. PICMG Europe has a specific European web site for its members including product descriptions, press releases and articles, events, information on the European market etc. (www.picmg.org and www.compactpci-systems.com). ■

Manon Kienjet is the Managing Director of PICMG Europe.