Hardware selection recommendations for the NRC Segment Wave Generator Control System

Laurich, P.

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P. Laurich, BA Technologies

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HARDWARE SELECTION RECOMMENDATIONS FOR THE NRC SEGMENT WAVE GENERATOR CONTROL SYSTEM
Final Report

AUTHOR(S)

Peter Laurich

CORPORATE AUTHOR(S)/PERFORMING AGENCY(S)

BA Technologies

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SUMMARY

In early 1991, NRC developed the second generation of its digital control system for segmented wave generators. The design used off-the-shelf technology – both hardware and software – to the extent possible at the time. The system was based on the original VME standard (VMEbus) and the pSOS real-time operating system.

The system has performed well but all of the hardware has now been discontinued. The operating system software is in maintenance-only mode and the software development environment is no longer functional or supported. It has become imperative that the control system be upgraded to use current technology – both hardware and software.

This report deals with the selection of new hardware for the control system. Hardware must be selected with an awareness of the options for the new operating system. The selection of the operating system will, however, be completed in a follow-on phase.

ADDRESS National Research Council
Institute for Ocean Technology
Arctic Avenue, P. O. Box 12093
St. John's, NL A1B 3T5
Tel.: (709) 772-5185, Fax: (709) 772-2462

National Research Council Canada
Institute for Ocean Technology

Conseil national de recherches Canada
Institut des technologies océaniques

HARDWARE SELECTION RECOMMENDATIONS FOR THE NRC SEGMENT WAVE GENERATOR CONTROL SYSTEM

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Peter Laurich
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Hardware Selection Recommendations
For the
NRC Segment Wave Generator Control System

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BA Technologies

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1. Introduction

In early 1991, NRC developed the second generation of its digital control system for segmented wave generators. The design used off-the-shelf technology – both hardware and software – to the extent possible at the time. The system was based on the original VME standard (VMEbus) and the pSOS real-time operating system.

The system has performed well but all of the hardware has now been discontinued. The operating system software is in maintenance-only mode and the software development environment is no longer functional or supported. It has become imperative that the control system be upgraded to use current technology – both hardware and software.

This report deals with the selection of new hardware for the control system. Hardware must be selected with an awareness of the options for the new operating system. The selection of the operating system will, however, be completed in a follow-on phase.

The strategy used in developing the hardware recommendations were:

- Extract the specifications from the existing control system
- Examine recent trends in backplane technology, hardware technology and operating system technology
- Develop a short list of candidate hardware choices
- Develop system costs
- Propose a final recommendation based on the information collected

2. Current System Configuration

2.1. Hardware

The current NRC segmented wave generator control system includes the following board-level products per MCU:

- Force processor board: CPU-40 B/16
- Acromag digital I/O board: AVME 9481
- One Acromag analog input board for every type of feedback device used by the control system: AVME 9330
- One Acromag analog output board for every 8 segments controlled by the MCU (the system supports a maximum of 32 segments per MCU): AVME 9210
- Custom digital board (either NRC IMD or Davis Engineering)

CPU Board (specs reflect the current board):

- 68040 CPU running at 25 MHz with a 4 Kbyte instruction cache and a 4 Kbyte data cache – the floating point component is required
- DMA controller
- 4 serial I/O channels, 2 of which are in use. One is used for terminal I/O and the second is used for synch signals (drive signal start and 100 Hz clock)
- 10 Mbps Ethernet port with 64 Kbyte data buffer
- Memory:
  - 128 Kbyte SRAM with battery backup
  - 128 Kbyte FLASH
  - 16 Mbyte DRAM
  - 1 boot EPROM for local booting
  - 2 boot EPROMs for application booting

Digital I/O Board:

- 6 digital output signals
- Sink up to 100 mA

Analog Input Boards:

- 32 single-ended channels
- High-level voltage input (+/- 10V range)
- 16-bit resolution
- Sampling rate of up to 30kHz
- External connections via a rear connector (P2)

Analog Output Boards

- 8 output channels per board
- High-level voltage output (+/- 5V range)
- 12-bit resolution
- Settling time less than 6 microseconds
- External connections via a rear connector (P2)

System Chassis:

- Sufficient slots for a controller including:
  - 1 processor board
  - Up to 3, 32-channel analog input boards
  - Up to 4, 8-channel analog output boards
  - 1 digital I/O board for up to 6 signals (handles up to 64 signals of I/O)
  - 1 custom digital board (board takes only power from the backplane)

2.2. Operating System Software

The control system software uses the pSOS operating system. The rights to the operating system have been purchased by Wind River, the developer of VxWorks. Wind River has maintained support for pSOS but there is no new investment in the software – pSOS is no longer a suitable candidate for real-time operating systems for new designs.

The operating system components used in the segmented wave generator control software are shown in the table below. The functionality provided by each of these components would be required in any replacement RTOS being considered

Component	Description	Calls	Description
pSOS	Operating system kernel	ev_receive	Wait for an event
		ev_send	Send an event
		k_fatal	Signal a fatal error
		q_create	Create a message queue
		q_delete	Delete a message queue
		q_ident	Identify a message queue
		q_receive	Wait for a message at a queue
		q_send	Send a message to a queue
		q_urgent	Put a message at the head of a queue
		t_create	Create a task
		t_ident	Identify a task
		t_setpri	Set a task priority
		t_start	Start a task
		t_suspend	Suspend a task
		tm_cancel	Cancel a timer
		tm_evafter	Generate an event after a number of ticks
		tm_evevery	Repeatedly generate periodic events
		tm_tick	Generate a tick
		tm_wkafter	Wait for a specified number of ticks
pNA	Network software	bind	Bind an address to a socket
		socket	Create a socket
		listen	Listen for messages on a socket
		close	Close a socket
pREPC	run-time C library	various	Re-entrant c-library functions
pROBE	Target component for debugger		Component to which the host portion of the debugger (XRAY) connects.

Table 1 - Operating System Components

3. Backplane Standard Analysis

Backplane summary:

- There are only two options for industrial control that make sense today – VME and CompactPCI (referred to as cPCI)
- Other standards are either not rugged enough or are too costly for the application
- Both VME and cPCI have gone through a number of evolutionary steps with each step being backward compatible with the original specifications
- Both VME and cPCI have a broad industry following with new products being announced on a regular basis
- The growth in the VME market is expected to be less than the growth in the cPCI market
- In general, the cost of the backplanes and the boards for a cPCI solution are less than those of the VME solution
- In general, there are more cPCI board-level products available than VME board-level products
- The selection of VME board-level analog I/O products has decreased
- The high bandwidth, high availability systems needed in the telecommunications industry will result in a move to the AdvancedTCA platform. This will make AdvancedTCA the platform likely to see the most growth and evolution in the near future
- In general, industrial control applications do not need the features available in AdvancedTCA. Both VME and cPCI will continue to be the standards of choice for these applications.

VME vs cPCI selection:

- Both the VME and the cPCI standards are suitable for the application
- There is no need to move away from VME due to concerns over VME being close to the end of its lifecycle
- The cost, availability and features of the required circuit packs (CPU, AIO, DIO) will likely drive the selection of the standard
- Any suitable RTOS will function with either standard

Standards recommendation:

- Develop a cost model for both cPCI and VME
- Include all costs in the model including the cost to migrate the custom digital board to the cPCI form-factor
- Factors such as the long-term availability of the board-level products and board features should drive the backplane decision

4. VME bus Options

4.1. CPU Boards

CPU boards manufactured by the following vendors were considered:

- VMIC
- Force
- SBS Technologies
- Motorola

Only boards using the 6U form-factor were considered in the primary analysis. The decision not to consider 3U options was based on the following:

- 3U is seen rarely in VME systems
- There are only limited options for 3U CPU boards in the cPCI
- A 6U chassis allows a custom lower backplane to be used for analog and digital I/O

In looking at the many options available, the selection of candidate boards from each of the vendors was based on:

- Meeting the minimum specs – DRAM, EPROM, flash boot EPROM or boot flash, at least 2 serial I/O ports preferably with front panel access, 100 BaseT Ethernet interface and industry standard PMC interface for add-on cards
- Availability of board support packages (BSPs) for major RTOS options (VxWorks, QNX, Linux)
- A board availability of at least 5 years from the date of introduction of the board
- Cost
- Minimum number of additional features that are not required for the control system

The selection of the CPU board was a two-step process. In the first step, a ranking matrix was created to provide an overall ranking of the candidate CPU boards. In the second step, more details were collected and analyzed for the top ranked boards.

4.1.1. Ranking Process

The ranking process included the criteria shown in the table below. The weights used for each criterion and the scoring system are included in the table. The ranking score for a board is the sum of the points received for each criterion multiplied by the weighting factor for that criterion. The maximum score possible for a board is 67.

Criterion	Weight	Rating			Rationale
Age (y as of 01-Mar-04)	1.0	<0.5: 10	<1: 8	<1.5: 6	Boards have a limited availability; older boards will become obsolete sooner
		<2: 4	>2: 0		
Cost (k)	1.0	< 2.5:10	< 3: 8	<3.5: 6	Lower cost is better
		<4: 4	<4.5: 2	>4.5k: 0	
Maturity of BSP (months)	0.8	>8m: 10		5 to 8m: 8	It takes at least 8 months after a board is released to get a mature BSP
		3 to 5m: 6		<3m: 4	
Backplane	0.7	VME: 10		cPCI: 8	Need to respin the custom digital boards if we move to cPCI
Features	0.7	Start at 10 points and reduce for inferior/missing features			
Processor	0.7	PowerPC: 10		Pentium-M: 8	PowerPCs run cooler and are generally supported for longer. Pentium-M is on Intel's embedded roadmap and will be around longer
		Pentium III: 6			
Front panel access	0.7	1 Ethernet & 2 serial: 10			The Ethernet i/f and the 2 serial i/f should be accessible via the front panel
		2 of 3: 8	1 of 3: 6	0 of 3: 4	
RTOS (# supported)	0.6	>=3: 10		2: 7.5	More RTOS support packages indicate the popularity of the board and maturity of the BSP
		1: 5		0: 0	
Bonus features	0.5	+3 for gigE			More is better
		+2 if feature directly usable			
		+1 if feature could be used			

Table 2 - Ranking Criteria

The ranked list of processor boards is shown in the table below. The table includes both VME and cPCI boards. The details of the board features and board ranking are shown in section 7.

Manufacturer	Model	Bus	Points
GE Fanuc (VMIC)	VMIVME-7050-1001	VME	57.6
GE Fanuc (VMIC)	VMIVME-7700-121[1]	VME	57.1
SBS	VG5	VME	57.0
Motorola	MVME5500	VME	54.1
GE Fanuc (VMIC)	VMICPCI-7806-111	cPCI	53.7
SBS	VG4	VME	53.0
Force	PowerCore CPCI-695	cPCI	51.1
Force	PowerCore CPU-695	VME	51.0
Motorola	CPN5385	cPCI	47.6
SBS	CT7	cPCI	47.5
SBS	CR9	cPCI	46.6
SBS	CT9	cPCI	45.6
Force	CPCI-745	cPCI	45.5
SBS	Power7E	VME	44.7
Motorola	MCP820	cPCI	42.4

Table 3 - CPU Ranked List

[1] This board is a newly released board but was given high points for BSP maturity since data supplied by VMIC indicates that a number of BSPs with full support are already available.

4.1.2. Top Three

The ranking process separated the top 3 boards from the rest of the group. Each of these boards are suitable candidates for use in the control system. The following table provides additional details on each of the candidates.

Model	VMIVME-7050-2000	VMIVME-7700-121	VG5	Comments
Rank	1	2	3	
Age (yrs)	0.5	0	0.9	all are less than a year
Cost (US$)	$2,756	$2,601	$3,531	**VG5:** approx 33% more than the others
Processor	PPC 750FX/GX	Intel Celeron	PPC 7455	2 PowerPC options - run cooler
Speed (GHz)	1.00	0.65	1.00	
Front Panel Access	1 serial, 2 Ethernet	2 serial, 2 Ethernet	2 serial, 2 Ethernet	**7050:** either the terminal or the synch signal will need to use the rear P2 connector
Ethernet Speed	2 gigE	2 10/100 MbitE	1 gigE, 1 10/100 MbitE	**7700:** no gigE
Board Support Packages	VxWorks: released	VxWorks: May-04	VxWorks: released	
	Linux: late summer	Linux: released	Linux: not specified	
		QNX: released	LynxOS: released	
		Windows: released		
PMC sites	2	1	1	need 1 (for digital I/O)
Memory	512 MB SDRAM, 64.5 MB chip flash, 32K NVRAM	512 MB SDRAM, 128 MB compactFlash, 32K NVRAM	512 MB SDRAM, 128 MB chip flash, 24K NVRAM	
I/O	2 serial I/O; dual gigE	2 serial I/O; 2 USB; 2 10/100 BT	3 serial I/O; 1 gigE, 1 10/100 BT	
Power Req (max)	3.8A @ 5V, 1.2 mA @ +12V	3.5A @ 5V, 1mA @ +/-12V	+5V, +3.3V	**VG5:** VMEbus does not supply 3.3V => new chassis required
Bonus Features	watchdog timer	watchdog timer	watchdog timer	Could be used to force a reboot if s/w locks up
	temp sense		temp sense	Could be used to detect overheating (fan failure)
	compactFlash	compactFlash (part of main memory)		**7050:** Allows flash to be added if necessary. **7700:** uses compactFlash for booting so flash memory could be increased on it as well
	built-in self test (BIST)		planned	Could integrate tests on RAM, COM ports and LAN into control s/w
		Enet boot		BIOS directly supports software boot from a server. Would require additional effort on other boards
			conformal coating	Additional protection in a high-humidity environment
			fanless cooling	Board will continue to work even if the fan fails
	voltage sense	byte-swapping h/w, on-board video controller, mouse & keyboard I/f	optional dual CPU	Cool, but not useful

Table 4 - CPU Board Details

Based on the additional information for each board, the VMIVMI-7050 remains the top ranked board. The only potential difficulties seen in using this board are: one serial I/O channel can only be accessed through a rear connector (P2) and the degree of BSP support available. Depending on the RTOS selected and the timing of any purchases, the BSP availability will need to be investigated further.

4.2. Digital I/O

The digital input/output requirements for the control system are minimal. Rather than look at board-level products, the recommendation is that the less expensive, carrier-card technology be used. The Acromag PMC464 PMC module provides 64 TTL I/O lines with front panel or rear connector access. The card lists for $600 US and is expected to be available for at least 10 years.

All 6U CPU boards considered – both VME and cPCI – have at least one site for a PMC module.

4.3. Analog I/O

Analog I/O board options are somewhat more limited for the VME bus than they were when the control system was first developed. The options are also more limited for the VME bus than they are for the cPCI bus. However, options remain for two analog I/O strategies. These strategies are: to use available board-level products offered by a few manufacturers or to use a carrier pack outfit with the appropriate industry pack modules for the application.

4.3.1. Carrier Packs

A number of manufacturers make carrier packs for the VME standard. The boards are simple and inexpensive so an exhaustive search for features is not necessary. The recommended carrier pack for the VME is the Acromag AVME9660. This is a 6U pack that holds up to 4 industry packs. The industry pack standard guarantees that modules from a number of vendors could be selected. All I/O signals on the pack are terminated on the front panel. The carrier pack is listed at $590 US and is expected to be available for at least 7 years.

4.3.2. Analog Input

Analog input is possible using analog input boards or analog input industry pack modules. The options available for board level products are:

- VMIVME-3122 from VMIC – 32 channels, 16-bit, single ended, new pack in 2004 so no end-of-life issues, cost of $2,662 US
- XVME-564 from XYCOM – 64 channels, 16-bit, single ended, no cost requested

The recommended analog input industry pack module is the Acromag IP330. It supports up to 32, single-ended channels, with 16-bit resolution. The module should be available for at least 7 years. The list price for the module is $975 US.

4.3.3. Analog Output

The current control system uses 12-bit digital-to-analog converters. When the hardware was selected in 1991, there were few options available. Today, there are a number of options for 16-bit analog output. The options presented below are all 12-bit resolution products but 16-bit resolution products are also available. These products tend to have half the number of channels per pack or module so the effective cost for analog output would be doubled.

Analog output is possible using analog output boards or analog output industry pack modules. The options available for board level products are:

- VMIVME-4132 from VMIC – 32 channels, 12-bit, new pack in 2004 so no end-of-life issues, cost of $2,863 US. The board incorporates a multiplexed output design with a single DAC – not ideal. The recommended configuration is 1 DAC per channel.
- XVME-531 from XYCOM – 16 channels, 12-bit, no cost requested

The recommended 12-bit analog output industry pack module is the Acromag IP221. It supports up to 16 channels, with 12-bit resolution. The module replaces the existing IP220 and is expected to be available by end of May 2004 (95% probability). Once released, the IP221 should be available for at least 10 years. The estimated list price for the module is $925 US. The IP220 has a fixed output voltage range of +/- 10 volts. Since the control software uses only +/- 5 volts, this effectively reduces the output resolution to 11 bits.

If there is the need to maintain a minimum of 12 bits of resolution in the +/- 5 volt range, the design will need to move to 16-bit modules. The recommended 8 channel, 16-bit analog output module is the Acromag IP230. The IP230 has a number of configurable voltage ranges, including +/- 5 volts. The list price for a module is $1025 US and is expected to be in production for at least 7 years.

4.4. VME Recommendation

The table below identifies the recommended choices for the system components.

Component	Recommendation	Cost (US $)
CPU Board	VMIC VMIVME-7050-2000	$2,800
Digital I/O Module	Acromag PMC464	$600
I/O Carrier Pack	Acromag AVME9660	$590
Analog Input Industry Pack	Acromag IP330	$975
Analog Output Industry Pack	Acromag IP221	$925

Table 5 - VME Board Level Hardware

The table below shows the expected cost of the off-the-shelf, board-level products for an MCU. The costs are identical for both a 24-segment MCU and a 32-segment MCU. The table includes quantities and costs for systems with active wave absorption (AWA) (3 feedback sensors) and without active wave absorption (2 feedback sensors).

Component	Unit Cost (US $)	Qty w/o AWA	Cost w/o AWA	Qty with AWA	Cost with AWA
CPU Board	$2,800	1	$2,800	1	$2,800
Digital I/O Module	$600	1	$600	1	$600
I/O Carrier Pack	$590	1	$590	2	$1,180
Analog Input Industry Pack	$975	2	$1,950	3	$2,925
Analog Output Industry Pack	$925	2	$1,850	2	$1,850
Total			$7,790		$9,355

Table 6 - Costs Per MCU for VME

5. cPCI Options

5.1. CPU Boards

The same vendors considered for the VME bus options were also considered for the 6U CPU board options for the cPCI bus. As indicated earlier, these vendors are:

- VMIC
- Force
- SBS Technologies
- Motorola

The same factors were considered in selecting board options. These factors are defined in the VME bus section of this report.

Many of the cPCI CPU boards were designed to create a PC-like environment within the chassis. These boards typically include:

- On-board graphics support (SVGA, VGA, LCD)
- On-board mouse support (PS/2 compatible)
- On-board keyboard support (PS/2 compatible)

These additional features are not required for the control system and add both cost and complexity. The ranking process accounts for any affect on cost. The affect of the increase in complexity of the BSPs to support this additional hardware is, however, more intangible and is not directly accounted for.

A 3U option (half-height) was also considered since a complete system proposal was generated by SMA Computers. Although SMA's proposal is not cost-effective, a more competitive offering can be created by using lower cost options for the analog I/O. The 3U option is presented following the evaluation of the 6U cPCI options.

5.1.1. Ranking Process

The ranking process used to evaluate the cPCI board options was also the same as that used for the VME bus options. The ranked list of cPCI processor boards is shown in the table below. The table includes only the cPCI boards; the table including both VME and cPCI boards is shown in the section on VME CPU boards.

Manufacturer	Model	Bus	Points
GE Fanuc (VMIC)	VMICPCI-7806-111	cPCI	53.7
Force	PowerCore CPCI-695	cPCI	51.1
Motorola	CPN5385	cPCI	47.6
SBS	CT7	cPCI	47.5
SBS	CR9	cPCI	46.6
SBS	CT9	cPCI	45.6
Force	CPCI-745	cPCI	45.5
Motorola	MCP820	cPCI	42.4

Table 7 - Ranked cPCI CPU List

5.2. Digital I/O

The Acromag PMC464 PMC module is also the recommended choice for the cPCI. It provides 64 TTL I/O lines with front panel or rear connector access. The card lists for $600 US and is expected to be available for at least 10 years.

5.3. Analog I/O

Analog I/O board options for the cPCI bus are more extensive than for the VME bus. However, the trend within the VME bus community to move to carrier packs with IO modules and the availability of the carrier packs with IO modules for the cPCI led to the conclusion that that a carrier pack solution was the best strategy for cPCI bus as well.

5.3.1. Carrier Packs

A number of manufacturers make carrier packs for the cPCI standard. The recommended carrier pack for the cPCI is the Acromag ACPC8625. This is a 6U pack that holds up to 4 industry packs. The industry pack standard guarantees that modules from a number of vendors could be selected. All I/O signals on the pack are terminated on the rear connectors. The carrier pack is listed at $590 US and is expected to be available for at least 7 years. Acromag plans to up-issue this carrier pack within the next 5 months (before end of August, 2004). The up-issued carrier pack will offer a number of improvements including support for a memory-mapped interface. The current control software uses memory mapping to communicate with the I/O boards but the existing version of Acromag's cPCI carrier pack supports I/O mapping only. The existing version of the carrier pack could be used but additional software modifications would be required.

5.3.2. Analog Input

For the cPCI bus, only the industry pack module on carrier cards was considered. The recommended analog input industry pack module is the Acromag IP330. It supports up to 32, single-ended channels, with 16-bit resolution. The module should be available for at least 7 years. The list price for the module is $975 US.

5.3.3. Analog Output

For the cPCI bus, only the industry pack module on carrier cards was considered. The recommended analog output industry pack module is the Acromag IP221. It supports up to 16, single-ended channels, with 12-bit resolution and is expected to be available for at least 10 years. The estimated list price for the module is $925 US.

5.4. 6U cPCI Recommendation

The table below identifies the recommended choices for the system components.

Component	Recommendation	Cost (US $)
CPU Board	VMIC VMIVME-7806-111	$2,900
Digital I/O Module	Acromag PMC464	$600
I/O Carrier Pack	Acromag ACPC8625	$590
Analog Input Industry Pack	Acromag IP330	$975
Analog Output Industry Pack	Acromag IP221	$925

Table 8 – cPCI Board Level Hardware

The table below shows the expected cost of the off-the-shelf, board-level products for an MCU. The costs are identical for both a 24-segment MCU and a 32-segment MCU. The table includes quantities and costs for systems with active wave absorption (AWA) (3 feedback sensors) and without active wave absorption (2 feedback sensors).

Component	Unit Cost (US $)	Qty w/o AWA	Cost w/o AWA	Qty with AWA	Cost with AWA
CPU Board	$2,900	1	$2,900	1	$2,900
Digital I/O Module	$600	1	$600	1	$600
I/O Carrier Pack	$590	1	$590	2	$1,180
Analog Input Industry Pack	$975	2	$1,950	3	$2,925
Analog Output Industry Pack	$925	2	$1,850	2	$1,850
Total			$7,890		$9,455

Table 9 – Costs per MCU for cPCI

5.4.1. 3U cPCI Option

The 3U proposal submitted by SMA Computers is shown in the table below. The final cost of the board-level hardware for a system without wave absorption capabilities exceeds the cost of the other options and, therefore, is not a viable option. Also, the analog I/O board includes 16 analog input channels with 8 analog output channels. This is not a good fit for the control system since coupling analog input and output increases the cost for the Davis Engineering motor-based wave generator. It also requires more extensive software modifications since one board can no longer handle all of the analog input for the up to 32 segments per MCU.

Component	Recommendation	System Cost w/o AWA (US $)
CPU Board	CPU6.2E-1101.101	$2,190
Digital I/O Board	CCIO32-0	$490
Analog I/O	CADIO (4 required)	$8600 (for 4)
Total		$11,280

Table 10 - 3U Proposal

However, using the Acromag hardware for analog I/O reduces the cost of the hardware considerably. The tables below show the recommended components for a 3U system and the costs of the board-level hardware for 24-segment and 32-segment MCUs.

Component	Recommendation	Cost (US $)
CPU Board	CPU6.2E-1101.101	$2,190
Digital I/O Board	CCIO32-0	$490
I/O Carrier Pack	Acromag ACPC8635	$450
Analog Input Industry Pack	Acromag IP330	$975
Analog Output Industry Pack	Acromag IP221	$925

Table 11 - Revised 3U Proposal

Component	Unit Cost (US $)	Qty w/o AWA	Cost w/o AWA	Qty with AWA	Cost with AWA
CPU Board	$2,190	1	$2,190	1	$2,190
Digital I/O Board	$490	1	$490	1	$490
I/O Carrier Pack	$450	2	$900	3	$1350
Analog Input Industry Pack	$975	2	$1,950	3	$2,925
Analog Output Industry Pack	$925	2	$1,850	2	$1,850
Total			$7,380		$8,805

Table 12 - Revised Costs Per MCU for 3U cPCI

The features of the CPU6.2 board were rated to obtain a ranking score of 54.3. This score makes it the highest ranked of the cPCI options and 4th on the list including both VME and cPCI.

5.5. Custom Digital Board

The custom digital board is a relatively simple digital board designed to provide the following functionality:

- Sense the shorting of a set of sense points used in the calibration of wave probes mounted on the face of the wave generator (not currently used in the segmented wave generator)
- Sense the closing of a number of optical sense points that may have been used for the calibration of the position transducers at one time (no longer used)
- Hydraulic interlock loop – a loop including all MCUs designed to allow any MCU to disable the hydraulic power-pack in the event of a critical failure
- Hardware watchdog timer – designed to open a hydraulic interlock loop if the timer expires
- 100 Hz drive signal clock – the ability to source a 100 Hz signal or track a 100 Hz signal generated from another MCU. One MCU in the system provides the control clock (100 Hz) for all MCUs in the system
- Drive signal start/stop enable – the signal generated by a master MCU to indicate that the controllers are to start or stop following a drive signal

If the control system is migrated to the cPCI bus, this board will require a respin. Given the simplicity of the board, it should be possible to manufacture new boards in small quantities (10 to 15) at a cost of less than $200 US per board.

6. Final Recommendations

Based on the analysis above, the lowest cost alternative is the cost-reduced 3U cPCI option. This option is approximately $400 US less than the leading the VME option and the leading 6U cPCI option. The additional cost of reworking the digital board offsets part of the cost difference relative to the VME option but the 3U cPCI remains the least expensive. Chassis costs have not been included in this analysis but the cost of a 3U chassis will be less than the cost of a 6U chassis.

However, the 3U form-factor does not allow a custom backplane to be used along with the standard cPCI backplane. This limits the design for both motor-based controller installations and the custom J2 backplane used by IOT. The recommended form-factor is, therefore, a 6U form-factor.

The recommend bus standard is the VME standard for the following reasons:

- The top-ranked CPU boards are VME boards
- Given the VME CPU recommended, the existing chassis – both the vertical-oriented, rack-mounted versions currently in use and the horizontal-oriented development chassis can continue to be used.
- The custom digital signal boards (Davis Engineering and IOT) can continue to be used as they are
- The Davis Engineering custom position feedback digital board for motor-based controllers can continue to be used
- The hardware cost differential between the 6U VME and the 6U cPCI is insignificant

The recommended analog I/O hardware is the Acromag carrier-pack and industry-pack solutions presented earlier. The analog output resolution should, however, be increased to 16 bits.

The table below identifies the final recommended choices for the system components.

Component	Recommendation	Cost (US $)
CPU Board	VMIC VMIVME-7050-2000	$2,800
Digital I/O Module	Acromag PMC464	$600
I/O Carrier Pack	Acromag AVME9660	$590
Analog Input Industry Pack	Acromag IP330	$975
Analog Output Industry Pack	Acromag IP230	$1025

Table 13 - Final Recommendations

The tables below show the final expected cost of the off-the-shelf, board-level products for a 24-segment MCU and for a 32-segment MCU. The tables include quantities and costs for systems with active wave absorption (AWA) (3 feedback sensors) and without active wave absorption (2 feedback sensors).

Component	Unit Cost (US $)	Qty w/o AWA	Cost w/o AWA	Qty with AWA	Cost with AWA
CPU Board	$2,800	1	$2,800	1	$2,800
Digital I/O Module	$600	1	$600	1	$600
I/O Carrier Pack	$590	2	$1,180	2	$1,180
Analog Input Industry Pack	$975	2	$1,950	3	$2,925
Analog Output Industry Pack	$1025	3	$3,075	3	$3,075
Total			$9,605		$10,580

Table 14 - MCU Cost for a 24-Segment Control System

Component	Unit Cost (US $)	Qty w/o AWA	Cost w/o AWA	Qty with AWA	Cost with AWA
CPU Board	$2,800	1	$2,800	1	$2,800
Digital I/O Module	$600	1	$600	1	$600
I/O Carrier Pack	$590	2	$1,180	2	$1,180
Analog Input Industry Pack	$975	2	$1,950	3	$2,925
Analog Output Industry Pack	$1025	4	$4,100	4	$4,100
Total			$10,630		$11,605

Table 15 - MCU Cost for a 32-Segment Control System

6.1. Points to Note

The following notes summarize some key points in the proposal:

- Additional BSP support is required for the CPU board
- One serial connection will be via the P2 connector at the rear of the CPU board
- All analog I/O is terminated on the front panel of the analog I/O carrier packs
- The digital I/O is terminated on the front panel of the CPU board
- This is a 3-slot solution
- The cost of the chassis is not included in the cost of an MCU
- Any costs for the rework of custom backplanes is not included in the cost of an MCU
- The cost per MCU can be reduced by going to lower resolution D/A converters but Industry Pack solutions for 12-bit DACs tend to be fixed at a range of +/- 10 volts rather than +/- 5 volts

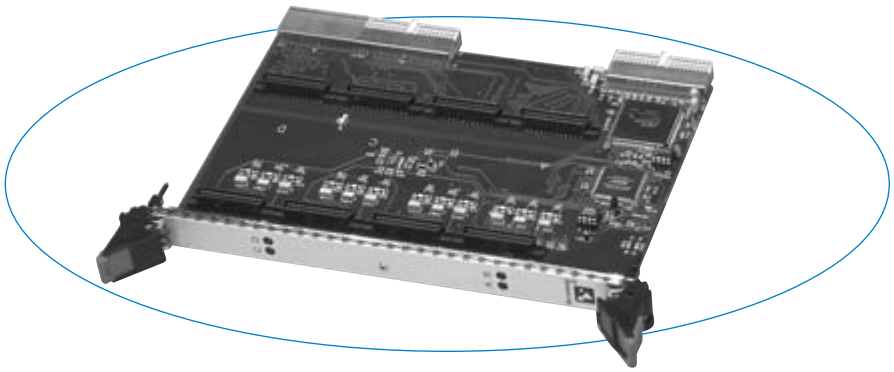
Appendix A
CPU Features and Ranking

7. Appendix A CPU Features and Ranking

Vendor	Model	Age (yrs)	Cost	Bus	Processor	Speed (GHz)	Front panel access	OS Support	PMC sites	Bonus Features	Main Features	Rank
GE Fanuc (VMIC)	VMIVME-7050-2000	0.5	$2,756	VME	PPC 750FX/GX	1.00	2 Enet & 1 serial	VxWorks, Linux	2	watchdog timer; temp and voltage sense	512 MB SDRAM, 64.5 MB bootable flash; 32K NVRAM; 2 serial I/O; dual gigE, 5V, +/-12V	1
GE Fanuc (VMIC)	VMIVME-7700-121	0	$2,601	VME	Intel Celeron	0.65	2 Enet & 2 serial	VxWorks, Linux, Windows, QNX	1	watchdog timer; byte swapping h/w, compactFlash, Enet boot	512 MB SDRAM, 128 MB flash; 32K NVRAM; 2 serial I/O; dual 10/100 Ethernet, 5V, +/-12V	2
SBS	VG5	0.9	$3,531	VME	PPC 7455/57	0.80	2 Enet & 2 serial	VxWorks, LynxOS, Linux	1	Conformal coating, temp sense, watchdog, fanless cooling	512 MB SDRAM, 64 MB flash, 24K NVRAM; 6 serial I/O; 1 gigE, 1 10/100 BT, 5V, 3.3V	3
SMA Computers	CPU6.2E-1101.101	1.5?	$2,190	cPCI	Pentium III (VIA)	1.00	1 Enet & 2 serial	Win CE, Linux, QNX	0	watchdog, CPU temp alarm, fan	128 MB SDRAM, 512 KB NVRAM, 32 MB compactFlash, 2 100 BT, 2 USB, 2 serial	4
Motorola	MVME5500	1.4	$3,295	VME	PPC 7455	1.00	2 Enet & 1 serial	VxWorks, Linux, LynxOS	2	watchdog	512 MB SDRAM, 32 + 8 MB flash; 32 KB NVRAM, 2 serial I/O; gigE & 10/100 BT, 5V	5
GE Fanuc (VMIC)	VMICPCI-7806-111	0.25	$2,925	cPCI	Pentium-M	1.10	2 Enet & 1 serial	VxWorks, Linux, Windows, QNX	2	compactFlash, bootp, watchdog	512 MB SDRAM, 128 MB flash; 0 NVRAM; 2 serial I/O; 2 USB; dual gigE	6
SBS	VG4	1.4	$2,700	VME	PPC 7410/750/755	0.50	nothing	VxWorks, LynxOS, Linux	2	Conformal coating; 16-bit TTL I/O, temp sense, watchdog	512 MB SDRAM, 64 MB flash; 512 KB bootable flash; 32K NVRAM; 4 serial I/O; single gigE, 5V, +/-12V	7
Force	PowerCore CPCI-695	0.5	$4,500	cPCI	PPC 750FX	0.80	1 Enet & 2 serial	VxWorks, Linux	2	watchdog	512 MB SDRAM, 64 MB flash, 512 KB bootflash, 64 KB NVRAM, 3 gigE, 2 serial I/O,	8
Force	PowerCore CPU-695	0.5	$4,700	VME	PPC 750FX	0.80	1 Enet & 2 serial	VxWorks, Linux	2	watchdog timers, failsafe bootflash (1MB)	512 MB SDRAM, 64 MB flash, 1 MB bootflash, 32 KB NVRAM, dual gigE, 2 serial I/O, 5V, 3.3V	9
Motorola	CPN5385	1.7	$2,995	cPCI	Pentium III-M	1.20	1 serial	Win 2k, Linux, VxWorks	1	watchdog, CPU temp alarm,	512 MB SDRAM, 2 gigE, 1 10/100 BT, 4 USB, 2 serial,	10
SBS	CT7	2	$2,700	cPCI	Celeron	0.57	2 Enet & 1 serial & 1 USB	NT, Win, QNX, VxWorks, Lynx, Linux	1	watchdog, temp sense	512 MB SDRAM, flashdrive (up to 512 MB), 2 10/100 BT, 2 serial I/O, 2 USB, 0 NVRAM	11
SBS	CR9	0.2	$4,200	cPCI	Pentium-M	0.60	2 Enet & 1 serial & 1 USB	QNX, VxWorks, LynxOS, Linux	1	watchdog, temp sense, conformal coating	512 MB SDRAM, flashdrive (up to 1 GB), 2 gigE, 2 serial I/O, 5 USB, 64 KB NVROM	12
SBS	CT9	0.2	$4,200	cPCI	Pentium-M	0.60	2 Enet & 1 serial & 1 USB	QNX, VxWorks, LynxOS, Linux	1	watchdog, temp sense	512 MB SDRAM, flashdrive (up to 1 GB), 2 gigE, 2 serial I/O, 5 USB, 64KB NVROM	13
Force	CPCI-745	1	$3,300	cPCI	Pentium-M	1.60	1 Enet		1	watchdog timer, compactFlash	512 MB SDRAM, 8 MB flash, 2 gigE & 1 10/100 BT, 2 USB, 2 serial, 0 NVRAM	14
SBS	Power7E	3		VME	PPC 750	0.53	1 Enet & 1 serial	VxWorks	1		256 MB SDRAM, 4 MB flash, 512 KB socketed flash, 32 KB NVRAM, single 10/100 BT, 2 serial, 5V, +/-12V	15
Motorola	MCP820	2	$3,995	cPCI	PPC 7410	0.50	1 Enet, 1 serial & 2 USB		1	watchdog	512 MB SDRAM, 32 MB flash, 1 MB bootflash, 32 KB NVRAM, dual 10/100 BT, 2 serial, 2 USB,	16

Vendor	Model	Age (yrs)	Age (yrs)	Cost	Cost	Bus	Bus	CPU	CPU	BSP Maturity	BSP Maturity	Front panel access	Front panel access	OS Sup	OS Sup	Bonus feat	Bonus feat	Main feat	Main feat	Points	Rank
Weight		1		1		0.7		0.7		0.8		0.7		0.6		0.5		0.7			0
VMIC	VMIVME-7050-2000	10.0	10.0	8.0	8.0	10.0	7.0	10.0	7.0	8.0	6.4	8.0	5.6	7.5	4.1	5.0	2.5	10.0	7.0	57.6	1
VMIC	VMIVME-7700-121	10.0	10.0	8.0	8.0	10.0	7.0	6.0	4.2	8.0	6.4	10.0	7.0	10.0	5.5	4.0	2.0	10.0	7.0	57.1	2
SBS	VG5	8.0	8.0	4.0	4.0	10.0	7.0	10.0	7.0	10.0	8.0	10.0	7.0	10.0	5.5	7.0	3.5	10.0	7.0	57.0	3
SMA Computers	CPU6.2E-1101.101	6.0	6.0	10.0	10.0	8.0	5.6	6.0	4.2	10.0	8.0	10.0	7.0	10.0	5.5	2.0	1.0	10.0	7.0	54.3	4
Motorola	MVME5500	6.0	6.0	6.0	6.0	10.0	7.0	10.0	7.0	10.0	8.0	8.0	5.6	10.0	5.5	4.0	2.0	10.0	7.0	54.1	5
VMIC	VMICPCI-7806-111	10.0	10.0	8.0	8.0	8.0	5.6	8.0	5.6	6.0	4.8	8.0	5.6	10.0	5.5	6.0	3.0	8.0	5.6	53.7	6
SBS	VG4	6.0	6.0	8.0	8.0	10.0	7.0	10.0	7.0	10.0	8.0	0.0	0.0	10.0	5.5	9.0	4.5	10.0	7.0	53.0	7
Force	PwrCore CPCI-695	10.0	10.0	2.0	2.0	8.0	5.6	10.0	7.0	8.0	6.4	10.0	7.0	7.5	4.1	4.0	2.0	10.0	7.0	51.1	8
Force	PwrCore CPU-695	10.0	10.0	0.0	0.0	10.0	7.0	10.0	7.0	8.0	6.4	10.0	7.0	7.5	4.1	5.0	2.5	10.0	7.0	51.0	9
Motorola	CPN5385	4.0	4.0	8.0	8.0	8.0	5.6	6.0	4.2	10.0	8.0	6.0	4.2	10.0	5.5	5.0	2.5	8.0	5.6	47.6	10
SBS	CT7	4.0	4.0	8.0	8.0	8.0	5.6	6.0	4.2	10.0	8.0	9.0	6.3	10.0	5.5	2.0	1.0	7.0	4.9	47.5	11
SBS	CR9	10.0	10.0	2.0	2.0	8.0	5.6	8.0	5.6	4.0	3.2	9.0	6.3	10.0	5.5	7.0	3.5	7.0	4.9	46.6	12
SBS	CT9	10.0	10.0	2.0	2.0	8.0	5.6	8.0	5.6	4.0	3.2	9.0	6.3	10.0	5.5	5.0	2.5	7.0	4.9	45.6	13
Force	CPCI-745	8.0	8.0	6.0	6.0	8.0	5.6	8.0	5.6	10.0	8.0	6.0	4.2		0.0	5.0	2.5	8.0	5.6	45.5	14
SBS	Power7E	0.0	0.0	8.0	8.0	10.0	7.0	10.0	7.0	10.0	8.0	8.0	5.6	5.0	2.8	0.0	0.0	9.0	6.3	44.7	15
Motorola	MCP820	4.0	4.0	4.0	4.0	8.0	5.6	10.0	7.0	10.0	8.0	9.0	6.3		0.0	1.0	0.5	10.0	7.0	42.4	16

AcPC8625 CompactPCI®, Non-intelligent, IP Carrier Card



Mix and match plug-in modules with different I/O functions to quickly create custom I/O boards with hundreds of channels.

The AcPC8625 is a non-intelligent slave board that interfaces four IP modules to the CompactPCI (cPCI) bus. All 200 I/O points are brought out the rear J4 and J5 connectors. This convenience eliminates messy cables from hanging out the front of the cage. In addition to a more efficient cage wiring design, it is also much easier to insert and replace boards. And with Acromag's 80mm transition module (TRANS-C200), all 200 I/O points are easily ported out the back of the cage.

Features

- Four industry-standard IP module slots
- Board resides in memory space and
- Supports IP module I/O, ID and INT spaces
- 200 I/O points with rear access
- High-density rear connectors
- Compatible with all CompactPCI CPUs
- Plug-and-play carrier configuration and interrupt support
- Two interrupts per IP module
- Front panel LEDs
- Supervisory circuit for reset generation
- Individually filtered and fused power to each IP
- Ruggedized with ESD strip and EMC front panel
- ActiveX/OLE controls available for easy software integration (sold separately)

Benefits

- Clean system cabling.
- Easy board replacement.
- Simplified debugging with status LEDs.

Operation

Acromag's carrier boards provide full data access to the IP module's I/O, ID and interrupt spaces. With full access to the programmable registers, you can easily configure and control the operation of the IP modules from the CompactPCI bus.

Up to two interrupt requests are supported for each IP module. All board interrupts are mapped to PCI bus INTA# signal.

Individual passive filters on each IP power supply line provide optimum filtering and noise isolation between the IP modules and the carrier board.

Specifications

IP Compliance (ANSI/VITA 4)

Meets IP specs per ANSI/VITA 4-1995 (8MHz operation only) and IP I/O mapping to PICMG 2.4 R1.0.

Electrical/mechanical interface:
Supports single or double size IP modules.
32-bit IP modules are not supported.

IP Module I/O space, ID space, and INT space supported.

Memory space: Not supported.

Interrupts: Supports two interrupt requests per IP module and interrupt acknowledge cycles via access to IP INT space.

CompactPCI bus Compliance

Meets PCI spec. V2.1 and PICMG 2.0, R2.1.

Data transfer bus: Slave with 32-bit, 16-bit, and 8-bit data transfer operation 32-bit read/write accesses are implemented as two 16-bit transfers to the IPs.

Interrupts: CompactPCI bus INTA# interrupt signal. Up to two requests sourced from each IP mapped to INTA#. Interrupt vectors come from IP modules via access to IP module INT space.

Plug-and-Play: The system maps the base address into the PCI bus 32-bit memory space.

Environmental

Operating temperature: -25 to 85°C (AcPC8625) or -40 to 85°C (AcPC8625E models).

Storage temperature: -25 to 85°C (AcPC8625) or -40 to 85°C (AcPC8625E models).

Relative humidity: 5 to 95% non-condensing.

Power:
+5V (±5%): 250mA maximum.
±12V (±5%): 0mA (not used).
Plus IP module load.

MTBF: 409,808 hrs. at 25°C, MIL-HDBK-217F, notice 2.

Ordering Information

Industry Pack Carriers

AcPC8625: CompactPCI carrier. Holds four IP modules.

AcPC8625E: Same as AcPC8625 plus extended temp. range.

Software *(see Page 81)*

IPSW-API-VXW: VxWorks® software support package

IPSW-API-QNX: QNX® software support package

IPSW-ATX-PCI: ActiveX®/OLE Controls 2.0 software package

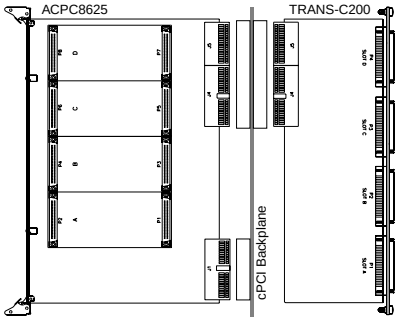
IPSW-LINUX: Linux™ support (website download only)

Accessories *(see Page 87)*

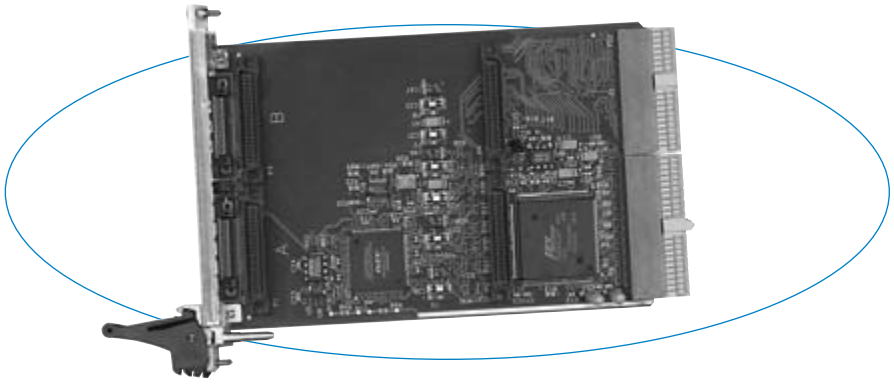
5028-438: Cable, SCSI-2 to SCSI-2, shielded.

5028-378: Termination panel, SCSI-2 connector, 50 screw terminals

TRANS-C200: Transition module



AcPC8635 CompactPCI®, Nonintelligent, 3U IP Carrier Card



Mix and match plug-in modules with different I/O functions to quickly create custom I/O boards.

The AcPC8635 is a nonintelligent slave board that interfaces two IP modules to the CompactPCI® (cPCI) bus. All 100 I/O points are brought out the rear J2 connector. This convenience eliminates messy cables from hanging out the front of the cage. In addition to a more efficient cage wiring design, it is also much easier to insert and replace boards.

Features

- Two industry-standard IP module slots
- Board resides in memory space
- Supports IP module I/O, ID and INT spaces
- 100 I/O points with rear access
- High-density rear connectors
- Compatible with 32-bit CompactPCI® backplane
- Plug-and-play carrier configuration and interrupt support
- Two interrupt channels per IP module
- Front panel LEDs
- Supervisory circuit for reset generation
- Individually filtered and fused power to each IP
- Ruggedized with ESD strip and EMC front panel
- ActiveX/OLE controls available for easy software integration (sold separately)

Benefits

- Clean system cabling.
- Easy board replacement as I/O needs change.
- Simplified debugging with status LEDs.
- Quick development of custom I/O boards.
- Flexibility to mix and match I/O functions as requirements change.

Operation

Acromag's carrier boards provide full data access to the IP module's I/O, ID and interrupt spaces. With full access to the programmable registers, you can easily configure and control the operation of the IP modules from the cPCI bus.

Up to two interrupt requests are supported for each IP module. All board interrupts are mapped to PCI bus INTA# signal.

Individual passive filters on each IP power supply line provide optimum filtering and noise isolation between the IP modules and the carrier board.

Specifications

IP Compliance (ANSI/VITA 4)

Meets IP specs per ANSI/VITA 4-1995 (8MHz operation only) and IP I/O mapping to J2 per PICMG 2.4 R1.0.

Electrical/mechanical interface:
Supports single or double size IP modules.
32-bit IP modules are not supported.

IP Module I/O space, ID space, and INT space supported.

IP Module Memory space: Not supported.

Interrupts: Supports two interrupt requests per IP module and interrupt acknowledge cycles via access to IP INT space.

CompactPCI bus Compliance

Meets PCI spec. V2.1 and PICMG 2.0, R2.1.

Data transfer bus: Slave with 32-bit, 16-bit, and 8-bit data transfer operation. 32-bit read/write accesses are implemented as two 16-bit transfers to the IPs.

Interrupts: CompactPCI bus INTA# interrupt signal. Up to two requests sourced from each IP mapped to INTA#. Interrupts come from IP modules via access to IP module INT space.

32-bit memory space: Upon power-up, the system auto-configuration process (plug & play) maps the carrier's base address (for a 1K byte block of memory) into the PCI bus 32-bit memory space.

Environmental

Operating temperature: 0 to 70°C (AcPC8635 model) or -40 to 85°C (AcPC8635E model).

Storage temperature: -55 to 100°C.

Relative humidity: 5 to 95% non-condensing.

Power:
+5V (±5%): 200mA maximum.
±12V (±5%): 0mA (not used).
Plus IP module load.

MTBF: Consult factory.

Ordering Information

Industry Pack Carriers

AcPC8635: CompactPCI carrier. Holds two IP modules.

AcPC8635E: Same as AcPC8635 with extended temp. range.

Software *(see Page 81)*

IPSW-API-VXW: VxWorks® software support package

IPSW-API-QNX: QNX® software support package

IPSW-ATX-PCI: ActiveX®/OLE Controls 2.0 software package

IPSW-LINUX: Linux™ support (website download only)

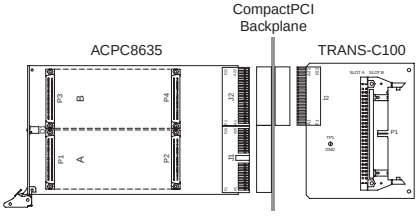
Accessories *(see Page 87)*

5025-550: Cable, unshielded, 50-pin header both ends

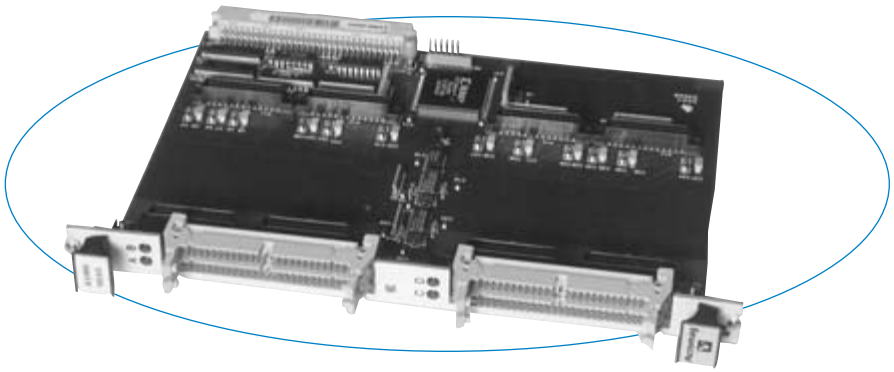
5025-551: Same as 5025-550 except shielded

5025-552: Termination panel, 50-pin connector, 50 screw terminals

TRANS-C100: Transition module



AVME9630/60 VMEbus 3U/6U, Non-intelligent, IP Carrier Cards



Mix and match plug-in modules with different I/O functions to quickly create custom I/O boards with hundreds of channels.

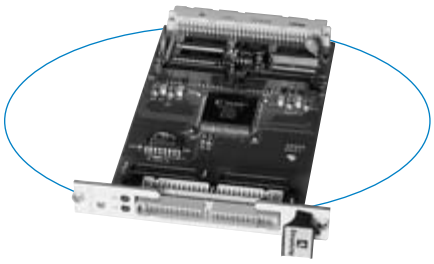
The AVME9630 and AVME9660 are non-intelligent slave boards that interface IP modules to the VMEbus. The full-height (6U) board holds four IP modules, and the half-height (3U) board holds two. All field I/O connections are made to the carrier board.

Features

- 6U VMEbus card holds four IP modules, 3U model holds two modules
- Industry-standard IP module interface
- Front panel connectors for field I/O signals
- Supports two interrupt channels per IP
- Provides individually isolated and filtered +5V, +12V, and -12V DC power lines to each IP module
- Accepts other manufacturers' IP modules
- Locking front panel connectors

Benefits

- Full IP module data access enables convenient software configuration and control of the IP modules.
- Front panel LEDs simplify debugging with a visual indication of successful IP accesses.
- Front panel connectors provide ribbon cable access to field I/O without interference from boards in adjacent slots.



AVME9630 3U Carrier

Operation

Acromag's carrier boards provide full data access to the IP module's I/O, ID and memory spaces. With full access to the programmable registers, you can easily configure and control the operation of the IP modules from the VMEbus.

Up to two interrupt requests are supported for each IP module. The VMEbus interrupt level is software programmable.

Individual passive filters on each IP module power supply line provide optimum filtering and isolation between the IP modules and the carrier board.

Specifications

IP Compliance (ANSI/VITA 4)

Meets IP specifications per ANSI/VITA 4-1995.

Electrical/mechanical interface:
Supports single or double size IP modules.
32-bit IP modules are not supported.

I/O space and ID space supported.

Memory space: Supports 1MB to 8MB per IP module.

Interrupts: Supports two interrupt requests per IP module and interrupt acknowledge cycles, D16/D08(O).

VMEbus Compliance

Meets VME specifications per revision C.1 dated October 1985, IEC 821-1987 and IEEE 1014-1987.

Data transfer bus: A24/A16:D16/D08(EO) DTB slave; supports Read-Modify-Write cycles.

Interrupts: Creates I(1-7) programmable request levels (up to two requests sourced from each IP module). D16/D08(O) interrupter (interrupt vectors come from IP modules). Carrier registers are for control and status monitoring. Interrupt release mechanism is Release on Register Access (RORA) type.

Environmental

Operating temperature: 0 to 70°C (AVME9630/60) or -40 to 85°C (AVME9630E/60E models).

Storage temperature: -25 to 85°C (AVME9630/60) or -40 to 85°C (AVME9630E/60E models).

Relative humidity: 5 to 95% non-condensing.

Power:
+5V (±5%): 275mA maximum.
±12V (±5%): 0mA (not used).
Plus IP module load.

MTBF: 453,851 hrs. at 25°C, MIL-HDBK-217F, notice 2.

Ordering Information

Industry Pack Carriers

AVME9630
3U carrier. Holds two IP modules.

AVME9630E
Same as AVME9630 plus extended temperature range.

AVME9660
6U carrier. Holds four IP modules.

AVME9660E
Same as AVME9660 plus extended temperature range.

Software *(see Page 81)*

IPSW-API-VXW
VxWorks® software support package

Accessories *(see Page 87)*

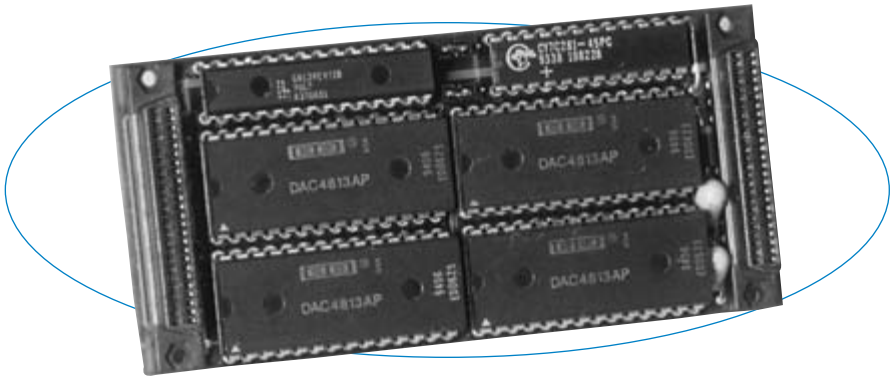
5025-550: Cable, unshielded, 50-pin header both ends

5025-551: Same as 5025-550 except shielded

5025-552: Termination panel, 50-pin connector, 50 screw terminals

TRANS-GP: Transition module

IP220-x
12-Bit D/A, Analog Output



The IP220 features individual D/A converters on each channel for better performance.

The IP220 outputs analog voltage signals to drive up to 16 devices. When used with a carrier that holds four IP modules, up to 64 voltage outputs can be obtained from a single card cage slot.

Each output channel has its own 12-bit D/A converter (DAC). Individual DACs are faster, and they eliminate glitches typically caused by the re-acquisition process of sample and holds found on multiplexed output boards.

Individual channels also have double-buffered data latches. You can select to update each output when it is written to, or to update all outputs simultaneously. Simultaneous outputs better simulate linear movements in motion processes.

Features

- 8 or 16 analog voltage output channels
- Independent 12-bit D/A converters per channel with an 8.0µS settling time
- Bipolar voltage (non-isolated) outputs: -10 to +10 volts
- Double-buffered DACs
- High load capability (5mA output current)
- Built-in calibration coefficients

Benefits

- Outputs reset to 0 volts.
- Internally stored calibration coefficients ensure accuracy.
- Software provides easy selection of transparent or simultaneous output modes.
- Double-buffered DACs allow new data to be written to each channel before the simultaneous trigger updates the outputs.

Specifications

Analog Outputs

Output configuration: 8 or 16 single-ended.

D/A Resolution: 12 bits.

Output range: Bipolar, -10 to +10V.

Maximum throughput rate:
Outputs can be updated simultaneously or individually.
One channel: 121KHz (8.25µS/conversion)
Eight channels (IP220-8): 100KHz (10µS/8 ch)
Sixteen channels (IP220-16): 83KHz (12µS/16 ch).

System accuracy: 0.025% of 20V span maximum corrected error (i.e. calibrated) at 25°C with the output unloaded.

Data format (left–justified): Bipolar Offset Binary.

Output at reset: 0 volts.

Output current: -5 to +5mA (maximum).

Short circuit protection: Indefinite at 25°C.

IP Compliance (ANSI/VITA 4)

Meets IP specifications per ANSI/VITA 4-1995.

IP data transfer cycle types supported:
Input/output (IOSel*): DAC data, control registers, DAC offset and gain calibration coefficients.
ID read (IDSel*): 32 x 8 ID PROM.

Access Times (8MHz clock): 0 wait states.

Environmental

Operating temperature: 0 to 70°C (IP220-8/16) or -40 to 85°C (IP220-8E/16E models).

Storage temperature: -55 to 100°C (all models).

Relative humidity: 5 to 95% non-condensing

MTBF: 581,396 hrs at 25°C, MIL-HDBK-217F, Notice 2.

Power: +5V: 200mA.
+12V from P1 or +15V from P2: 300mA.
-12V from P1 or -15V from P2: 180mA.

Ordering Information

Industry Pack Modules

IP220-8
Eight voltage outputs

IP220-8E
Same as IP220-8 plus extended temperature range.

IP220-16
Sixteen voltage outputs

IP220-16E
Same as IP220-16 plus extended temperature range.

For Industry Pack Carrier Cards, see Page 5.

Software *(see Page 81)*

IPSW-API-VXW
VxWorks® software support package

IPSW-API-QNX
QNX® software support package

IPSW-ATX-PCI
ActiveX®/OLE Controls 2.0 software package

IPSW-LINUX
Linux™ support (website download only)

For accessories information, see Page 87.

IP230-x
16-Bit D/A
Analog Output

IP230 modules have a 16-bit D/A converter (DAC) to provide highly-accurate analog voltage outputs.

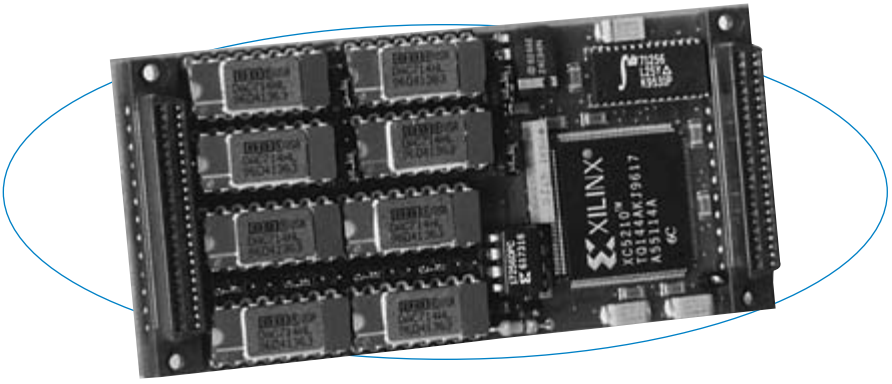
Jumper-selectable output ranges give you the choice of unipolar or bipolar voltage output. And for greater flexibility, the IP230 module accepts conversion start triggers from software commands, or from external sources for synchronization to specific events.

Features

- IP230-4: 4 analog voltage output channels
  IP230-8: 8 analog voltage output channels
- Individual 16-bit D/A converters per channel
- 10µS settling time (100KHz throughput)
- Three output ranges: ±5V, ±10V, 0 to 10V (jumper-selectable)
- Two trigger modes (software or external trigger)
- External trigger output
- Extended temperature option (-40 to 85°C)

Benefits

- High channel density saves card cage slots.
- Internally stored calibration coefficients ensure accuracy.
- Flexible output control allows single cycle updating of individual channels or all channels simultaneously.
- Hardware jumpers allow output range selection on an individual channel basis.



Independent D/A converters on each channel provide better performance and smoother operation.

Specifications

Analog Outputs

Output configuration: 4 (IP230-4/4E) or 8 (-8/8E).

D/A Resolution: 16 bits.

Output ranges: ±5V, ±10V, 0 to 10V (jumper-selectable).

Maximum throughput rate:
Outputs can be updated simultaneously or individually.
One channel: 100KHz (10µS/conversion)
Four channels (IP235-4): 100KHz (10µS/4 ch)
Eight channels (IP235-8): 100KHz (10µS/8 ch).

DAC programming: Immediate (transparently programmed to DAC output); simultaneous (input latches of multiple DACs are loaded with new data before simultaneously updating outputs).

System accuracy: 0.0061% of 20V span maximum corrected error (i.e. calibrated) at 25°C with the output unloaded.

Output at reset: 0V for bipolar output, 5V for unipolar.

Output current: -5 to +5mA (maximum).

Short circuit protection: Indefinite at 25°C.

IP Compliance (ANSI/VITA 4)

Meets IP specifications per ANSI/VITA 4-1995.

IP data transfer cycle types supported:
Input/output (IOSel*), ID read (IDSel*).

Access Times (8MHz clock):
All functions: 1 wait state (375nS cycle).

Environmental

Operating temperature: 0 to 70°C (IP230-4/8) or -40 to 85°C (IP230-4E/8E models).

Storage temperature: -55 to 125°C (all models).

Relative humidity: 5 to 95% non-condensing

Power: +5V (±5%): 200mA maximum.
±12V (±5%) from P1: 150mA maximum.

MTBF: 815,720 hrs. at 25°C, MIL-HDBK-217F, notice 2.

Ordering Information

Industry Pack Modules

IP230-4
Four high-resolution voltage outputs

IP230-4E
Same as IP230-4 plus extended temp. range

IP230-8
Eight high-resolution voltage outputs

IP230-8E
Same as IP230-8 plus extended temp. range

For Industry Pack Carrier Cards, see Page 5.

Software *(see Page 81)*

IPSW-API-VXW
VxWorks® software support package

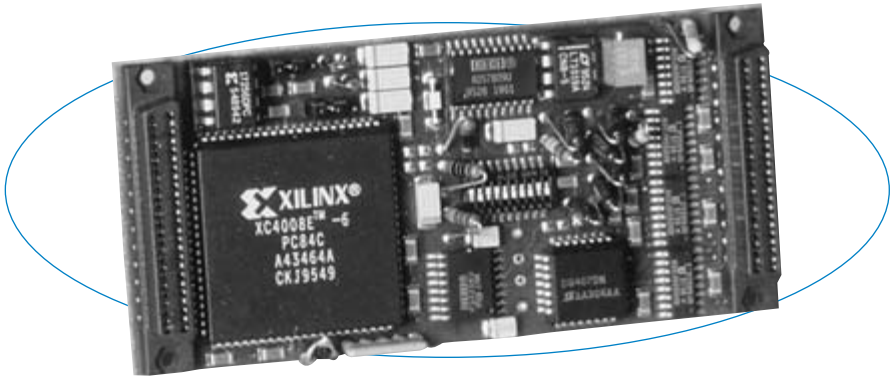
IPSW-API-QNX
QNX® software support package

IPSW-ATX-PCI
ActiveX®/OLE Controls 2.0 software package

IPSW-LINUX
Linux™ support (website download only)

For accessories information, see Page 87.

IP330
16-Bit A/D
Analog Input



Advanced memory management techniques allow the IP330 to operate with minimal interruption of the A/D converter.

IP330 Industry Pack (IP) modules provide fast, high resolution A/D conversion.

The IP330 has many features to improve your overall system throughput rate. You can scan all channels or define a subset for more frequent sampling. Burst mode scans selected channels at the maximum conversion rate. Uniform mode performs conversions at user-defined intervals. Both modes can scan continuously, or execute a single cycle upon receiving a trigger.

"Mail box" memory allows the CPU to read the latest data in 32 storage buffer registers without interrupting the A/D converter.

Features

- 16-bit A/D converter (ADC)
- 8µS conversion time (125KHz)
- 16 differential or 32 single-ended inputs (±5V, ±10V, 0-5V, and 0-10V input ranges)
- Individual channel mailbox with one or two storage buffer registers per channel
- Programmable scan control
- Four scanning modes
- User-programmable interval timer
- External trigger input and output
- Programmable gain for individual channels
- Post-conversion interrupts

Benefits

- "Mailbox" memory eliminates scanning interruptions for optimum throughput.
- Data register indicates new and missed (overwritten) data values in the mail box.
- Programmable interrupts simplify data acquisition by providing greater control.

Specifications

Analog Inputs

Input configuration: 16 differential or 32 single-ended.

A/D resolution: 16 bits.

Input ranges: ±5V, ±10V*, 0-5V, and 0-10V*.
* Requires ±15V external supplies.

Data sample memory: Individual channel mailbox with one or two storage buffer registers per channel.

Maximum throughput rate:
Only one channel can be updated at a time.
One channel: 125KHz maximum (8µS/conversion)
[66KHz (15µS/conversion) recommended]
16 channels (differential): 4.2KHz (240µS/16 ch)
32 channels (single-ended): 2.1KHz (480µS/32 ch).

Programmable gains: 1x, 2x, 4x, 8x.

A/D triggers: External and software.

System accuracy: 2 LSB (0.0030%) typical
(SW calib., gain=1, 25°C).

Data format: Straight binary or two's compliment.

Input overvoltage protection: Vss -20V to Vdd 40V with power on, -35V to 55V power off.

Common mode rejection ratio (60Hz): 96dB typical.

Channel-to-channel rejection ratio (60Hz): 96dB typical.

IP Compliance (ANSI/VITA 4)

Meets IP specifications per ANSI/VITA 4-1995.

IP data transfer cycle types supported: Input/output (IOSel*), ID read (IDSel*), Interrupt select (INTSel*).

Access times (8MHz clock):
ID PROM read: 1 wait state (375ns cycle).
Channel port/register read/write: 0 wait states.
Interrupt select cycle read: 1 wait state.
Mail box I/O read: 1 wait state. 6 wait states if ongoing internal mail box write.

Environmental

Operating temperature: 0 to 70°C (IP330) or -40 to 85°C (IP330E model).

Storage temperature: -55 to 100°C.

Relative humidity: 5 to 95% non-condensing.

MTBF: 798,625 hrs at 25°C, MIL-HDBK-217F, Notice 2.

Power:
+5V: 40mA.
+12V from P1: 20mA.
-12V from P1 or ±15V through P2: 15mA.

Ordering Information

Industry Pack Modules

IP330
32 single-ended or 16 differential inputs.

IP330E
Same as IP330 plus extended temperature range

For Industry Pack Carrier Cards, see Page 5.

Software *(see Page 81)*

IPSW-API-VXW
VxWorks® software support package

IPSW-API-QNX
QNX® software support package

IPSW-ATX-PCI
ActiveX®/OLE Controls 2.0 software package

IPSW-LINUX
Linux™ support (website download only)

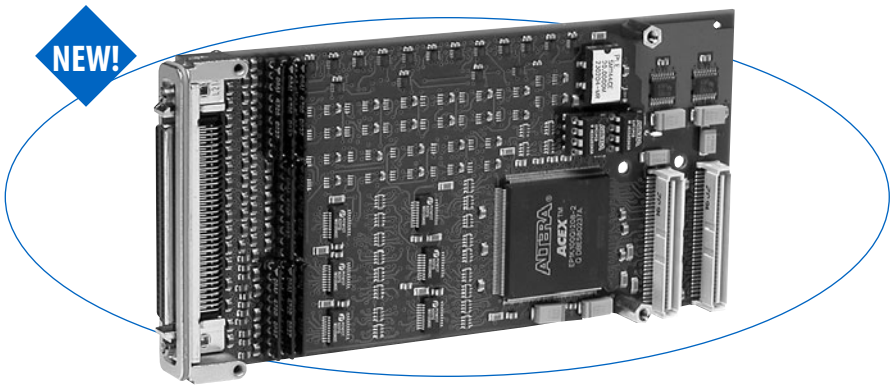
For accessories information, see Page 87.

PMC464
Digital I/O and Counter/Timers

The PMC464 module provides 64 digital input/ output channels and four 16-bit multifunction counter/timers.

Sixteen digital I/O channels can be programmed as an input or an output on an individual channel basis. The other 48 digital input/output channels are programmed as inputs or outputs on an 8-bit port basis. All inputs support change of state and high/low level transition interrupts.

Four 16-bit multifunction counters/timers can be configured for pulse width modulated output, watchdog timer, event counter, frequency measurement, pulse width measurement, period measurement, or one shot pulse output. The four 16-bit counters can also be configured into two 32-bit counter/timers.



This module saves money and PMC slots by combining digital I/O, and counter/timer functions on a single card.

Features

Digital I/O

- 64 digital input/output channels:
  - 16 individually programmable channels (15 channels for 464R
  - 48 channels configured on an 8-bit port basis
- Programmable change of state/level interrupts
- Input signal filtering debounce logic

Counter/Timer

- Four 16-bit or two 32-bit counter/timer channels (control lines shared with 16 TTL I/O channels)
- Six operating modes:
  - Pulse width modulation
  - Watchdog timer
  - Event counter
  - Frequency measurement
  - Pulse width or period measurement
  - One-shot and repetitive one-shot
- TTL-compatible thresholds
- Power-up and system reset is failsafe

Specifications

Digital I/O

I/O channel configuration:
64 bidirectional TTL transceivers.

Channels 0-47: Direction controlled on a port basis.
Channels 48-63: Direction controlled independently (shared as counter/timer control signals). (48-62 for 464R)

Reset/power-up condition: All channels default to input.

Digital Input

Input voltage range: 0 to 5V DC.

Input signal threshold (channels 0-47):
Low to high: 2.0V typical.
High to low: 0.8V typical.

Input signal threshold (channels 48-63):
Low to high: 3.5V typical.
High to low: 1.5V typical.

Input response time: 10 nanoseconds, typical.

Interrupts: 64 channels of interrupts for high-to-low, low-to-high, or any change-of-state event types.

Debounce: Selectable for each channel. User-selectable (5.6µS, 50.4µS, 408.8µS, or 3.276mS).

Digital Output

Output voltage range: 0 to 5V DC.

Output ON current range (channels 0-47): -15 to 64mA.

Output ON current range (channels 48-63): -32 to 32mA.

Output pullups: 4.7K ohm socketed resistors.

Turn on time: 10nS.

Turn off time: 10nS.

Counter/Timers

Counter/timer configuration: Four 16-bit counters can be configured into two 32-bit counters.

Functions: Pulse width modulation, watchdog timer, event counting, frequency measurement, period measurement, pulse width measurement, and one-shot/repetitive.

Counter input: Each counter has an IN_A, IN_B, and IN_C input port. These TTL input signals control start/stop, reload, event input, external clock, trigger, and up/down operations.

Counter output: Each counter has one output signal. The TTL output is used for waveform output, watchdog active indicator, or 1.6µS pulse upon counter function completion. Programmable as active high or low.

Clock frequencies: Selectable for 20MHz, 10MHz, 5MHz, 2.5MHz, 1.25MHz or external up to 8MHz.

Minimum I/P event: 100nS (debounce disabled).
Minimum pulse measurement: 100nS (debounce disabled).
Minimum period measurement: 200nS (debounce disabled).
Minimum gate/trigger pulse: 100nS (debounce disabled).

Board crystal oscillator: 20MHz.

PMC Compliance

Conforms to PCI Local Bus Specification, Revision 2.2 and CMC/PMC Specification, P1386.1.

4K Memory Space Required: One Base Address Register.

Signaling: 5V Compliant, 3.3V Tolerant.

Environmental

Operating temperature: 0 to 70°C (PMC464) or -40 to 85°C (PMC464E)

Storage temperature: -55 to 105°C.

Relative humidity: 5 to 95% non-condensing.

MTBF: 1,750,590hrs. at 25°C, MIL-HDBK-217F, notice 2.

Power: 160mA at +5V, typical.

Ordering Information

PMC464: Digital I/O and counter/timer module

PMC464E: Same as PMC464 plus extended temp. range

PMC464R: Digital I/O and counter/timer module with rear I/O connector

PMC464RE: Same as PMC464R plus extended temp. range

Software *(see Page 81)*
PMCSW-API-VXW: VxWorks® software support package
PCISW-API-QNX: QNX® software support package
PCISW-API-WIN: Windows® DLL software support

Accessories *(see Page 87)*
5025-288: Termination panel, SCSI-3 connector, 68 screw terminals

5028-432: Cable, shielded, SCSI-3 connector both ends

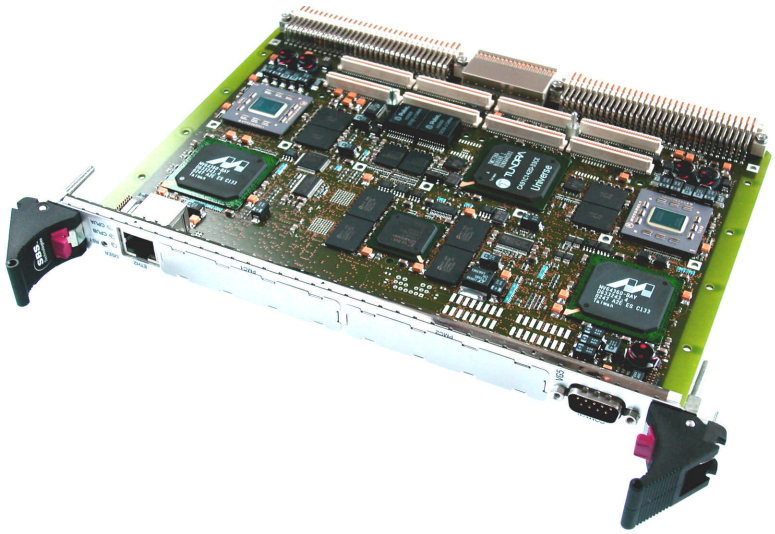
VG5

Dual PowerPC™ 7455/57 6U VMEbus Embedded Computer

Single Board Computers

Features

- Dual or single MPC7455/57 with AltiVec™, 800-1300+ MHz
- Dual chipset design for independent processor nodes
- 64kB L1 + 256/512kB L2 cache on-die, 1/2MB L3 cache
- Up to 1 Gigabyte, DDR SDRAM with ECC for each processor node
- Up to 128MB Flash per node
- 3 X 8kB NV memory
- Two Gigabit Ethernet ports 10/100/1000 Mbit
- Two 10/100Mbit Ethernet
- One S-ATA Port
- Chipset integrated ultra fast SRAM (2Mbit)
- Three 64bit PCI busses
- Two PMC extension slots
- VME64 interface
- PCI` over P0 ready
- Four multi-protocol high-speed serial controllers up to 10Mbit
  1X RS-232/422/485
  3X RS-422/485
- Two Serial I/O (RS-232)
- 8X 32bit Timer/Controller
- 8X DMA channels
- 32 general purpose I/Os
- RTC, watchdogs, temperature sensors
- Optional ext. temp -40°C/+85°C
- Single slot
- Conduction cooling
- High shock and vibration immunity with stiffener bars and wedge locks
- Conformal coating
- Custom specific assembly versions



VG5 the dual/single processor VMEbus computer board is designed to meet the needs of high-performance embedded applications. It addresses markets like imdustrial automation, medical, scientific and aerospace where real-time and/or signal processing is needed. Operating support includes VxWorks, Linux and LynxOS.

The ultra compact 6U single slot, all-in-one design with flexible DDR SDRAM and Flash configurations, and an impressive array of onboard peripherals includes up to two Gigabit and two 10/100Mbit Ethernet ports, up to four high speed multi protocol serial controllers (HDLC, BiSync,..), one serial-ATA port, two PMC extension slots, UARTS, timer/counter and general purpose I/Os. The product is available as a single or dual CPU board. Each processor node has its own DDR-SDRAM bank and its own chipset with peripherals. The two nodes are coupled via the 33MHz to 66MHz/64bit PCI(-X) bus.

Three independent onboard 64bit PCI busses are supported in the dual processor version for optimized data transfer rates:
- one for 64-bit/33 to 66MHz conncetion of the processor nodes (PCI-X)
- one exclusively for 64bit 33/66MHz (PCI or PCI-X) PMC site
- one for onboard VME bridge and the second PMC site (PCI64/33MHz)

A specific onboard programmable gate array area for peripheral functions or additional I/Os routes the signal to the P2 connector. This enables the user to add proprietary know-how or just to expand the I/O capabilities of the board. It shortens time-to-market and allows immediate reaction to functional changes without the need for a board re-design.

Combined with a custom specific assembly device it provides optimum price/performance for all kinds of OEM applications. Rugged needs are addressed with optional conduction cooling and extended temperature range of up to -40°C to +85°C, increased shock and vibration immunity using stiffener bars and wedge locks, and conformal coating.

Specifications

VME64 - Tundra Universe IID
- Industry standard CA91C142D PCI to VMEbus controller
- 60-70 MB/S transfer rate, full VMEbus system controller
- FIFOs for write posting, DMA controller with linked list support
- Master/slave transfer modes: BLT, ADOH, RMW, LOCK, RETRY
- A32/A24/A16 and D64(MBLT)/D32/D16/D8
- Geographical addressing

Single/Dual Processor - MPC7455/57
- Scaleable processor power from 800-1300MHz and beyond
- Node A/B: 7455/57 PowerPC with AltiVec™ technology
- Contact factory for latest CPU version
- High efficiency onboard switching regulator (DC/DC)
- Fanless cooling with heatsink

Performance (Estimated)

CPU	Frequency	SPECint95	SPECfp95
MPC7455 (dual)	800MHz	2 x 35	2 x 26
MPC7457 (dual)	1000MHz	2 x 44	2 x 33
MPC7457 (dual)	1300MHz	2 x 57	2 x 42
MPC7455 (single)	800MHz	35	26
MPC7457 (single)	1000MHz	44	33
MPC7457 (single)	1300MHz	57	42

Cache	**Level 1**	**Level 2**	**Level 3**
Node A/B 7455	32+32 kB	256 kB	1/2 MB
Node A/B 7457	32+32 kB	512 kB	1/2 MB

Single/Dual Chipset- Marvell MV-64360 for each of two chipsets:
- 133MHz, 64-bit wide system bus
- Two 64-bit wide PCI busses (PCI 2.2/PCI-X) (33/66/133MHz)
- 32-bit up to 133MHz device bus for Flash, RTC, I/O
- 512 byte posted write and 512 byte read buffer for unlimited DMA bursts between PCI busses and main memory
- 4X DMA controllers for memory and PCIbus transfers
- 4X 32-bit timer/counter for system timing or periodic interrupts
- I_2O intelligent I/O support with message and door bell registers
- 2 Mbit SRAM

External Synchronization
- The internal system clock can be synchronized by external clock source (16.66MHz)

Memory - DDR SDRAM
- 256MB to 1 GB*, 72-bit wide with error correction (ECC) for each processor node
- Rugged design with onboard soldered chips

*NOTE: *Currently 512MB, 1GB available later*

Flash (Boot ROM Integrated)
- Up to 128MB, 32-bit wide, high speed for processor node 1
- Up to 128MB, 32-bit wide, high speed for processor node 2
- Boot device select for node A/B (Bank 1 of 2)
- Hardware write protection
- Rugged design with onboard soldered chips

Non Volatile Memory
- 3 X 8 kB non volatile memory realized with serial EEPROM

One Serial ATA Channel
- One serial ATA with rear I/O at P0 (rear I/O of PMC1 only, partially available)

Ethernet - Marvell MV-63360
- Two integrated Ethernet controllers per chipset, connected via internal crossbar (main memory, PCI busses, DMA controllers)
- One or two***** Gigabit Ethernet ports: 10/100/1000Mbit/s auto-negotiation interface
- One or two***** fast Ethernet ports: 10/100Mbit/s auto-negotiation interface
- Ready for AFDX
- One or two***** Gigabit channels available at P0 rear I/O
- One or two***** 10/100Mbit channels at P0 rear I/O or one front I/O

*****NOTE: *Second Gigabit and second 100Mbit channel only w/ dual node*

Dual PMC Extension Slot - IEEE P1386/1386.1
- PMC1 64-bit/33MHz, 66MHz and full rear I/O at P0 (PCI or PCI-X)
- PMC2 64-bit/33MHz and full rear I/O at P0 (not available with front I/O COM and Ethernet) (PCI)
- Ready for PCI over P0
- Supports ccPMC draft standard Vita 20-200x with N-style

High Speed Serial I/O - RS-232/422/485
- Four multi protocol serial controllers (MPSC) MV-64360 up to 10Mbit each
- HDLC, BiSync, FM0/1, UART, transparent protocols NRZ, NRZ1, FM0/1, Manchester, differential Manchester
- Dedicated DPLLs for clock recovery and data encoding
- Three internal Baud rate generators or external clocks
- RxD, TxD, RTS, CTS, CD, TxClk (in/out), RxClk (in/out)

Serial I/O - RS-232/422/485
- Two assync. 16550 compatible full duplex serial RS-232 channels
- High speed transfer up to 115.2kBaud with 16 byte FIFOs
- Four high speed multi protocol serial controllers (MPSC)
- COM2 interface software selectable between RS-232 and RS-422/485

COM1	UART	RS-232*[1] (rear I/O P2) RxD, TxD (front) RxD, TxD, DCD, DSR, RTS, CTS, DTR, RI
COM2	MPSC	(rear)*[1] full RS232 or RS422/485 sync/assync (front)*[3] full RS232 or RS422/485 sync/assync
COM3	MPSC	(rear)*[1] RS242/485 sync/assync
COM4	UART	RS232*[2] (rear I/O P2) RxD, TxD\
COM5	MPSC	(rear)*[2] RS242/485 sync/assync
COM6	MPSC	(rear)*[2] RS242/485 sync/assync

*NOTE: [1] From processor node A
[2] From processor node B
[3] PMC2 not useable

General Purpose I/O*[1] and User Programmable Logic
- Up to 32 general purpose inputs/outputs (TTL)*[1] with flexible programmable routing to node A or B
- All inputs can generate interrupt
- User programmable gate array for additional I/O capabilities
- Routes signals to the P2 connector

*NOTE: [1] PMC2 rear I/O not available in this case

Real Time Clock
- Backed up by +5V standby from VMEbus backplane

One Watchdog Per Node
- 32-bit counters (16-bit useable), 500us....32s
- Activates NMI and/or Reset after a programmable period

Three Temperature Sensors
- SW readable from -55°C to +125°C, in 0.5°C increments
- One sensor at CPU A near top card edge
  One sensor at CPU B near bottom card edge
  One sensor near center of card

LED Indicators
- Two system LED indicators, 1 User LED indicator

JTAG Interface
- Processor, VMEbus controller and others
- Onboard and rear I/O

COP Interface
- Debug interface for external emulator
- Front panel and rear I/O for each processor

BIT (Planned)
- A BIT will be performed to provide confidence that the hardware is operating correctly
- The BIT hardware includes EDAC and internal Ethernet loopback

Style

Front Panel	C	I	R	N
Front Panel	✓	✓	✓	-
Front stiffener	-	-	-	✓
Middle stiffner	-	-	✓	✓
Wedge locks	-	-	-	✓
Parts soldered	✓	✓	✓	✓
Extended Temperature	-	✓	✓	✓
Conformal coating	-	-	✓	✓
Conduction cooled	-	-	-	✓

Front Panel and Rear I/O (Transition Module VGTM2)
- PMC I/O slot 1 with full rear I/O support or partial configuration with serial ATA feature
- PMC I/O slot 2 available in full or partial configuration

Function	Full PMC2-I/O	Partly PMC2-I/O	Front Panel I/O
COM 1	Yes	Yes	Yes
COM 2	Yes	Yes	Yes*
COM 3 to 6	Yes	Yes	-
Gigabit Eth. Ch 1	Yes	Yes	Yes*
Fast Et. Ch 2	Yes*2	Yes*2	Front*2
Gigabit Eth. Ch 3	Yes	Yes	-
Fast Et. Ch 4	Yes	Yes	-
PMC 1	64-pin	64-pin	Yes
PMC 2	64-pin	-	Yes
Reset	Yes	Yes	-
Watchdog	-	Yes	-
BootSel	Yes	Yes	-
CardFail	Yes	Yes	LED
UserLED	-	-	LED
COP node A/B	-	Yes	-
GPIO	-	Yes	-

*NOTE: *PMC slot 2 not available with optional front I/O*
*2 *Front or Rear I/O*

Power Requirements
- +5V Required
- +3.3V Required
- ±12V Only if required by mounted PMC module

Power Allowances - PMC Slots
- +5V, +3.3V Total Power max. 15W (7.5W / PMC slot)
- +3.3V Max. 4A per PMC site (5A both)
- ±12V 100mA each

Power Consumption
- +5V, +3.3V, typical current (estimated)
- Power measured at VxWorks prompt
- 256MB memory, w/o PMC module

CPU	Frequency	+5V	+3.3V
7455 (dual)	800 MHz	tbd	tbd
7457 (dual)	1000 MHz	tbd	tbd
7457 (dual)	1300 MHz	tbd	tbd
7455 (single)	800 MHz	tbd	tbd
7457 (single)	1000 MHz	tbd	tbd
7457 (single)	1300 MHz	tbd	tbd

Mechanical
- 6U, 1 slot wide (233 x 160 x 20 mm)

Temperature - (Except N-Style)
- Highest reachable operating temperature depends on processor type, speed and ambient conditions (airflow)
- All values under typical conditions w/o PMC module

	Operating	Storage
Standard	0°C to +70°C	-40°C to +85°C
Extended	-40°C to +85°C (TBC)	-40°C to +85°C

Temperature - (N-Style)
- Highest reachable operating temperature depends on processor type, speed and card edge temperature
- All values under typical conditions w/o ccPMC module

	Operating	Storage
Extended	-40°C to +85°C	-55°C to +105°C

Humidity
- Operating 5 - 95% @ 40°C
- Storage 5 - 95% @ 40°C
- Non condensing

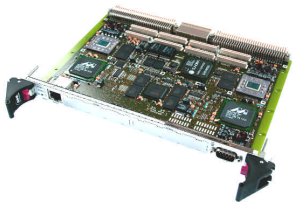
Altitude
- Operating 15,000 ft. (4.5 km)
- Storage 40,000 ft. (12 km)
- Vacuum for conduction cooled board

Shock
- C, I Style 12g/6 rms, 3 axis, up & down, 5 hits/direction
- R Style 20g/6 rms, 3 axis, up & down, 5 hits/direction
- N Style 100g/6 rms, 40g/11 ms, 3 axis, up & down, 5 hits/direction

Vibration
- C, I Style 2g rms @ 5 to 100 Hz, 30 minutes each axis
- R Style 2g rms @ 5 to 2000 Hz, 30 minutes each axis
- N Style 14g rms @ 5 to 2000 Hz, 30 minutes each axis

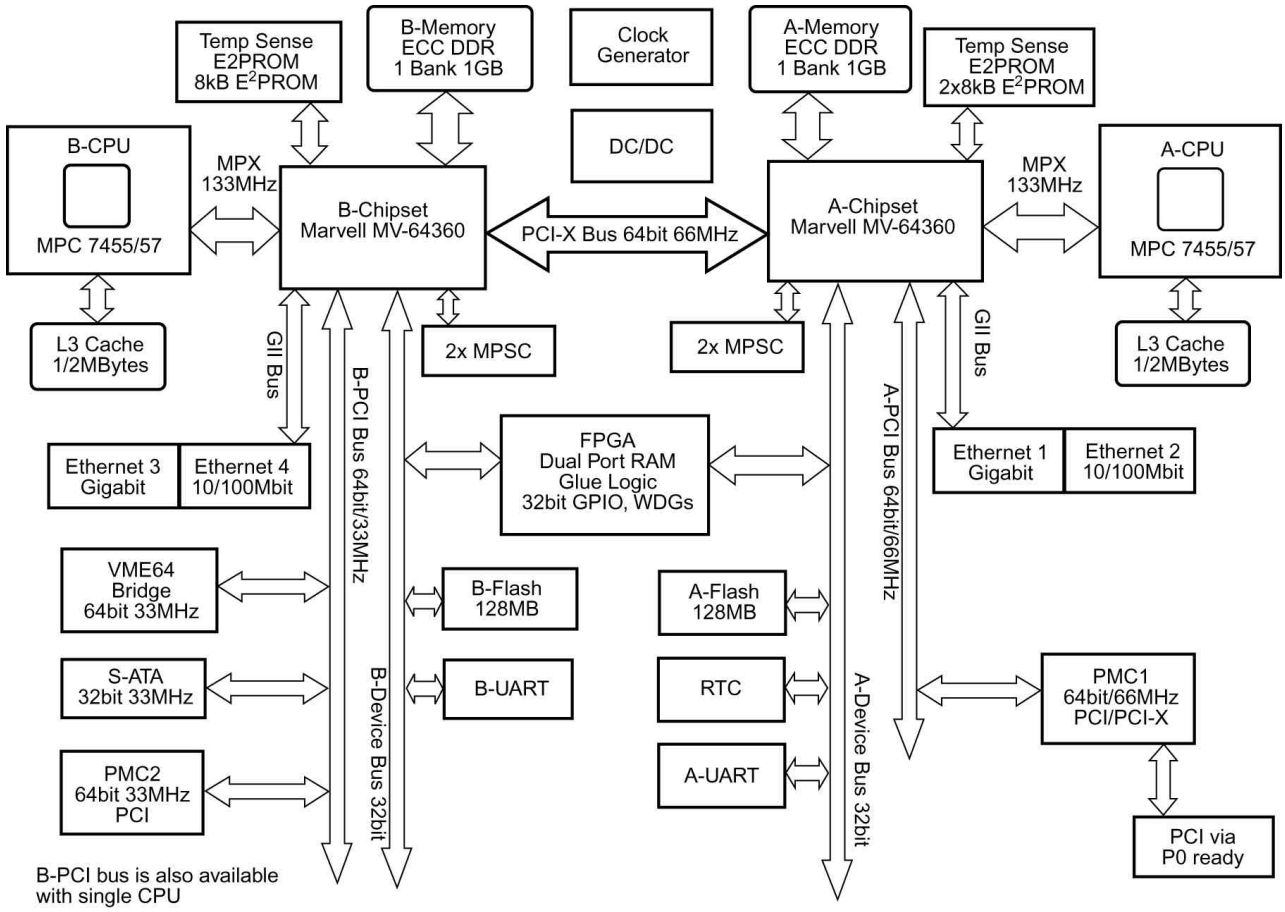
MTBF
- Calculations are available in accordance with MIL-HDBK-217

Safety
- All PWBs are manufactured with flammability rating of 94V-0 by UL recognized manufacturer



VG5

Block Diagram



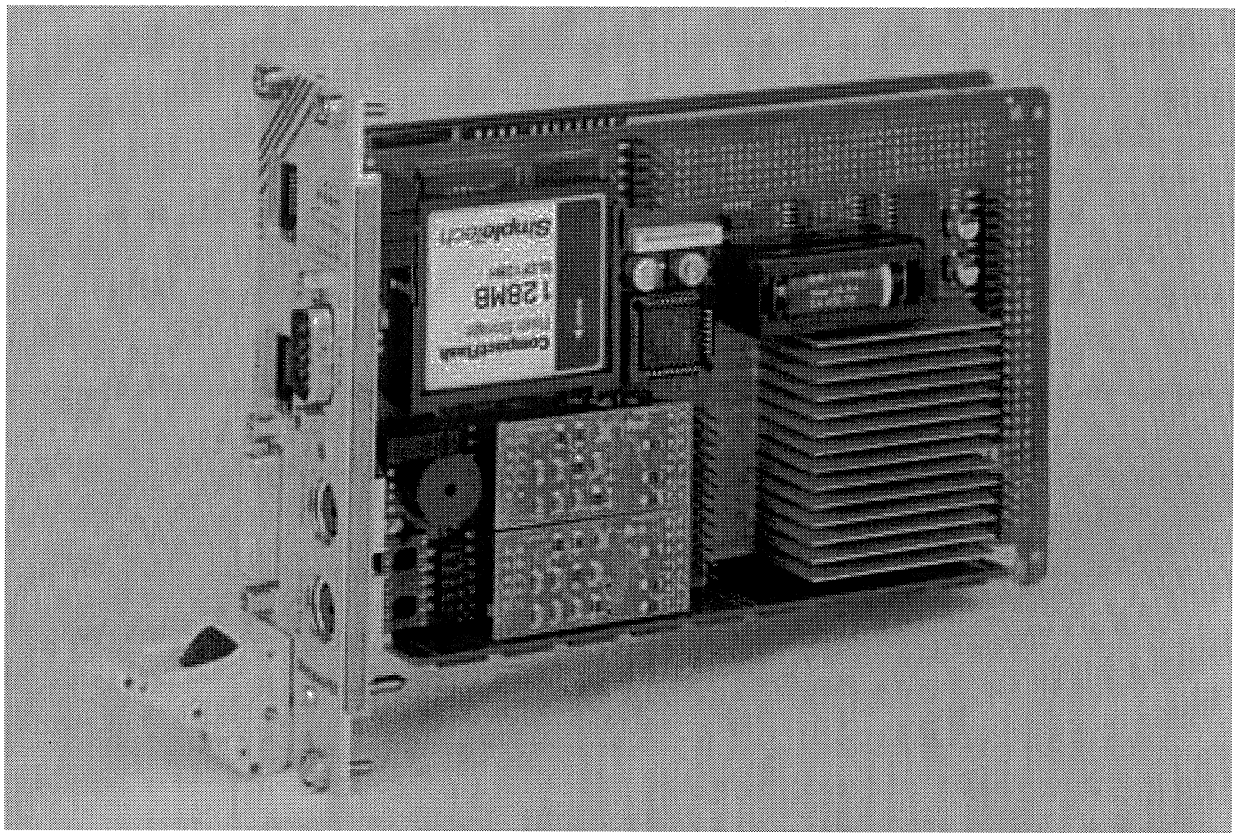
Corporate Headquarters
2400 Louisiana Blvd. NE, #5-600
Albuquerque, NM 87110-4316
Tel 505.875.0600 Fax 505.875.0400
Email info@sbs.com

European Headquarters
Memminger Str. 14
D-86159 Augsburg, Germany
Tel +49-821-5034-0 Fax +49-821-5034-119
Email aug-info@sbs.com

For additional contact information, please visit our web site at ***www.sbs.com***

CompactMAX

CPU6.2 - Industrial Features and 1.4 GHz Pentium Power



The CompactMAX CPU6.2 is a PC-compatible, Pentium-based 3U CompactPCI CPU module that offers all the industrial features you need and the options you want. These features include:

- Choice of Pentium III (866 MHz - 1.4 GHz) or low power VIA-C3 Nehemia (866 MHz)
- Up to 1 GB SDRAM with 133 MHz FSB
- Dual 10/100 Ethernet, dual USB 1.1, and dual IEEE 1394 interfaces
- Both SVGA and DVI/flat panel interface
- Dual COM ports, independently configurable and electrically separated
- Extended temperature options
- Hard drive or CompactFlash, fixed or removable

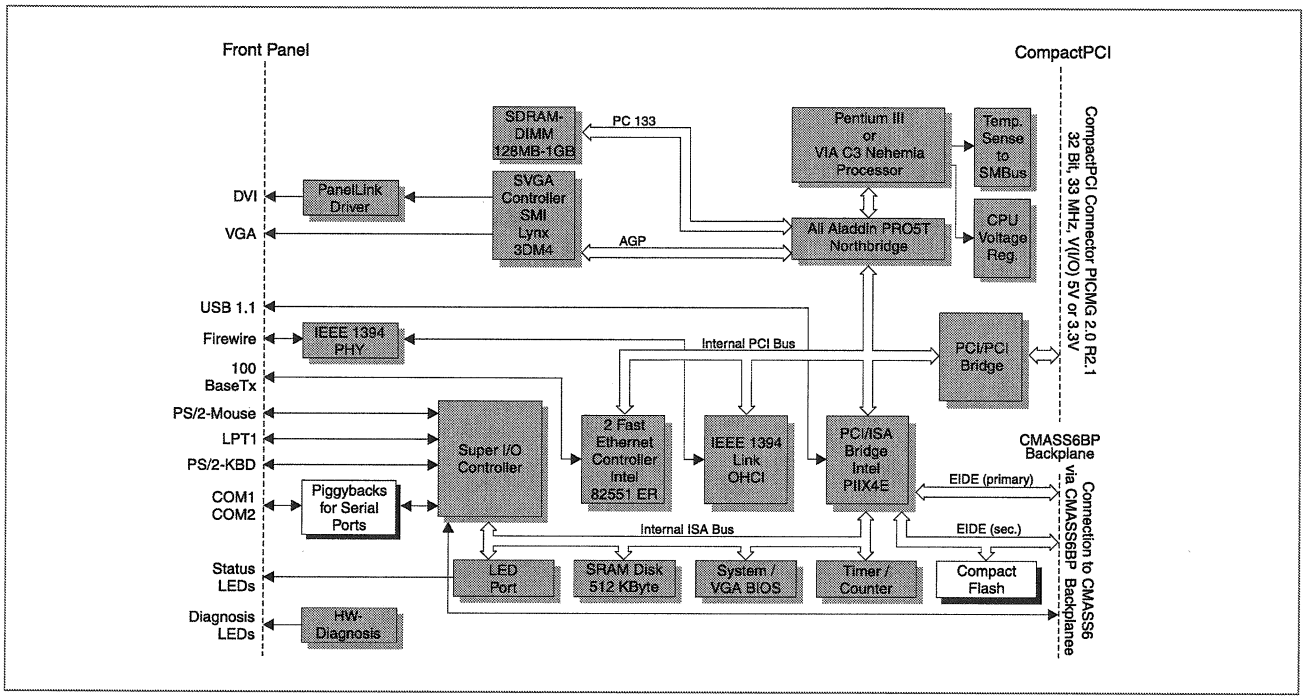
The CPU6.2 includes integrated safety features such as 3-level watchdog timer, voltage, temperature, and fan monitoring. It's easy to configure the CPU6.2 the way you want it. Choose from several different front panels. Use the 3-channel timer with non-maskable interrupt generation. Include a temperature compensated real time clock. Extended temperature versions are also available. All the features and flexibility you need to implement your system.

CPU6.2 is the latest version of our powerful CompactMAX CPU line and is 100% compatible with previous versions. You can upgrade your processor without changing your software. The CPU6.2 supports all major operating systems.

For more information:
www.SMAcomputers.com

CompactMAX

Block circuit diagram



Technical Data

System Bus
CompactPCI PICMG 2.0 R2.1
32 Bit-Bus / 33 MHz
PCI signal voltage V(I/O):
3.3V or 5V

Processor and RAM
SMA-SMMC2 Embedded
Processor Module (VIA C3 Nehemia, Pentium III) 800 to 1400 MHz with
64 to 512 kByte L2 Cache and
128 MByte to 1 GByte SDRAM-DIMM

Interfaces
- SVGA- and DVI-Interface
- PS/2 keyboard and mouse
- dual 10/100 Ethernet
- primary EIDE interface on CMASS6-Backplane or front panel
- secondary EIDE interface for CompactFlash Type I und II
- floppy disk interface
- one parallel port (LPT1)
- two serial interfaces (COM1; COM2) interface standard definable per piggyback
- two USB 1.1 interfaces
- two IEEE1394 interfaces

Additional Features
- Hardware monitor for temperature, fan and voltage
- 512 KByte battery-backed, buffered static RAM
- Three DIP switches, function definable by user
- An additional 3 channel timer including NMI generation
- Three staged watchdog
- 8 LEDs for POST status display and user defined displays
- 4 LEDs for status display
- Temperature compensated real time clock (optional)

Power Supply
+3.3 V ±5%; typ. 2 A
+5 V ±5%; typ. 2 ... 8 A
+12 V ±5%; typ. 0.1 A
depending on processor and piggybacks

Ambient Temperature
0 ... 55 °C
-20 ... 70 °C optional

Size
Eurocard 100 mm x 160 mm
8-layer PCB

Front Panel
8 HP / 12 HP / 16 HP / 20 HP all 3 U

Front Panel Connectors
depending on chosen front panel

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Phone 714 - 593 - 2338 • Fax 714 - 593 - 2368
www.SMAcomputers.com • E-mail: info@SMAcomputers.com

SMA Regelsysteme GmbH Hannoversche Strasse 1-5, 34266 Niestetal, Germany
Tel. (+49) 5 61 95 22 - 0 Fax (+49) 5 61 95 22 - 100
www.SMA.de E-mail: info@SMA.de

VMICPCI-7806
Pentium® M Universal CompactPCI® Single Board Computer

A GE Fanuc Company

- Intel®'s Pentium® M processor at 1.1 GHz and 1.6 GHz
- Standard features include:
  - Up to 2 GB DDR SDRAM
  - Two Ethernet controllers supporting 10/100/1000BaseTX interfaces
  - IDE and floppy drive interfaces
  - Serial ATA support
  - Two high performance 16550-compatible serial ports
  - Fully supports PICMG® 2.16
  - Two PMC expansion sites
  - 64-bit/66 MHz CompactPCI® bus interface
  - User programmable Watchdog timer
  - IPMI support
  - Passive processor heat sink
  - Integrated video controller
  - USB 2.0 support
- Operating system compatibility
  - Windows® 2000/Windows XP
  - QNX
  - Linux®
  - VxWorks®

MICROPROCESSOR — The VMICPCI-7806 is based on the Pentium M processor. The enhanced Pentium M processor has 1 MB of L2 cache. The Pentium M processor offers thermal characteristics that are well suited for embedded systems operating over a wide range of temperatures.

DRAM MEMORY — The VMICPCI-7806 accepts one 200-pin SODIMM DDR module for memory configurations of 512 MB and 1 GB. Memory can also be supported onboard for a total of 2 GB.

BIOS — The VMICPCI-7806 System BIOS and video BIOS are provided in reprogrammable memory.

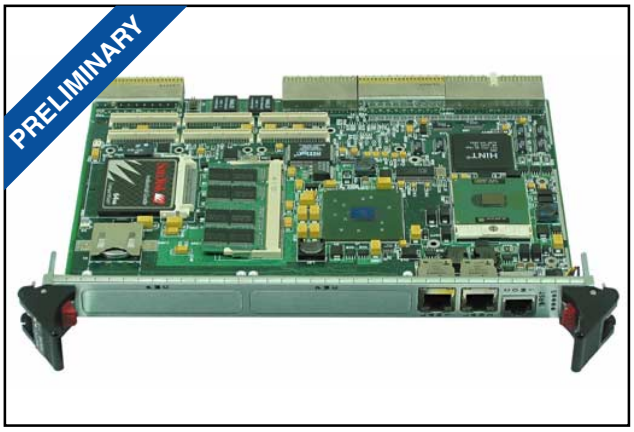
VIDEO GRAPHIC CONTROLLER — High-resolution graphics and multimedia-quality video are supported on the VMICPCI-7806 by an internal graphics controller. A fully functional, integrated 2D/3D graphics accelerator provides pixel processing and rendering, with display resolutions of up to 1600 x 1200 supported. The video output is provided through the CompactPCI connector. Support is provided for both analog and LVDS digital video.

CompactFlash — The VMICPCI-7806 includes a CompactFlash socket on the assembly. The CompactFlash may be configured as the boot device through the BIOS boot device set up. See the CompactFlash ordering options for the available sizes.

IDE Interface — The VMICPCI-7806 provides an IDE interface for hard disk drive support. The IDE interface allows support of several types of data transfers: Programmed I/O (PIO), 8237 style DMA, Ultra ATA/33, Ultra ATA/66 and Ultra ATA/100.

NOTE: Ultra DMA IDE modes require a high performance 80 conductor cable.

Ethernet CONTROLLER — The VMICPCI-7806 provides a dual connection for 10/100/1000BaseTX LAN using the Intel 82546EB Ethernet controller. Two standard RJ45 connectors are provided on the front panel with two network status indicators. Both LAN ports supporting PICMG 2.16 Rev 1.0 are also available via the CompactPCI backplane.



SERIAL ATA — The VMICPCI-7806 provides a serial ATA interface via the CompactPCI backplane connector.

REMOTE Ethernet BOOTING — The VMICPCI-7806 utilizes an Expansion ROM BIOS which enables processor booting from a network server. The facility supports PXE and a variety of network boot protocols including BOOTP and DHCP (TCP/IP).

USB PORTS - The VMICPCI-7806 provides two high speed universal serial bus (USB 2.0) ports. The ports are available on the CompactPCI backplane connectors.

SERIAL PORTS —The VMICPCI-7806 provides two 16550-compatible serial ports. Each serial port has an independent 16-byte FIFO supporting baud rates up to 115 Kbaud. Connection for one serial port is provided by an RJ45 connector located on the front panel. Both serial ports are available via the compactPCI connector.

Ordering Options

August 18, 2003 SSS-657806-000	A	B	C	–	D	E	F
VMICPCI-7806	–				–	0	0	

A = Processor
- 0 = Reserved
- 1 = 1.1 GHz Pentium M Processor
- 2 = 1.6 GHz Pentium M Processor

B = DDR SDRAM Memory
- 1 = 512 MB
- 2 = 1 GB
- 3 = 2 GB (Contact factory for availability)

C = CompactFlash
- 0 = No CompactFlash
- 1 = 128 MB CompactFlash
- 2 = 256 MB CompactFlash
- 3 = 512 MB CompactFlash
- 4 = 1 GB CompactFlash

D = 0

E = 0

CompactPCI Rear Transition Utility Board

VMIACC-0584

The VMIACC-0584 installs in the rear transition area of the CompactPCI backplane and provides access to IDE, floppy, LAN, USB, video and keyboard/mouse functions. The VMIACC-0584 is sold separately.

For Ordering Information, Call:
1-800-322-3616 or 1-256-880-0444 • FAX (256) 882-0859
E-mail: info@vmic.com Web Address: www.vmic.com

PMC EXPANSION SITES — The VMICPCI-7806 provides two individual IEEE 1386.1 PCI mezzanine card (PMC) expansion sites. This expansion capability allows the addition of peripherals offered for PMC applications. One PMC site is 3.3 V 64-bit, 66 MHz, while the second site is 5.0 V 32-bit, 33 MHz.

KEYBOARD AND MOUSE PORTS — The VMICPCI-7806 supports a PS/2 keyboard and mouse through the CompactPCI connector using the optional VMIACC-0584 backplane adapter.

HARDWARE RESET — A hardware reset switch is accessible from the front panel.

WATCHDOG TIMER — The VMICPCI-7806 provides a software-programmable Watchdog timer. The Watchdog timer is enabled under software control. Once the timer is enabled, software must access the timer within the specified time period, or the output of the Watchdog timer will either interrupt or reset the unit. The reset or interrupt operation is programmable.

ANNUNCIATORS — Indicators for the primary IDE interface activity, board status, power good and a blue LED for hot swap are provided on the front panel. In addition, two indicators for the Ethernet adapter activity are located on each RJ45 network connector.

THERMAL MANAGEMENT — The VMICPCI-7806 utilizes a passive heat sink that relies on forced air cooling within the equipment rack at the specified flow rate. Please refer to the environmental specifications for more information.

CompactPCI BUS BRIDGE — The VMICPCI-7806 is a universal CompactPCI single board computer (SBC) supporting applications as both a system slot controller or a peripheral slot controller. The PCI-to-PCI bridge interface to the CompactPCI bus is automatically configured to operate as either a transparent or non-transparent bridge. This implementation is fully compliant with PICMG 2.0 Rev 3.0, PICMG 2.1 Rev 2.0, and PCI-to-PCI Bridge Architecture Rev 1.1.

IPMI — The VMICPCI-7806 provides PICMG 2.9 Rev 1.0 IPMI support via the Zircon PM Peripheral Management Controller.

HIGH AVAILABILITY HOT SWAP — The VMICPCI-7806 complies with PICMG 2.1 Rev 2.0 standard for CompactPCI hot swap. The VMICPCI-7806 complies with the high availability provisions of this standard. The processor may be removed and replaced while the system is operational. Processing can automatically be switched to a backup SBC that was previously installed in the system.

CMOS BATTERY — The VMICPCI-7806 uses a holder that permits field replacement of the CMOS battery. A header and jumper allows the battery to be disconnected from the circuitry for long-term storage.

BACK PANEL CONFIGURATION — The VMICPCI-7806 provides support for several peripherals using the CompactPCI backplane connectors. These signals are routed to the CompactPCI J3 and J5 connectors. This permits connection of the external IDE disk drive, floppy drive, USB, LAN, video, and keyboard and mouse via the VMIACC-0584 backplane adapter. Connection to these signals is provided to facilitate application development.

OPERATING SYSTEMS AND SOFTWARE SUPPORT — The VMICPCI-7806 supports a variety of operating systems including Microsoft® Windows 2000, Windows XP, QNX, Linux and VxWorks.

SPECIFICATIONS

Single Slot 6U (4HP) Eurocard Form Factor:

Height	9.2 in (233.4 mm)
Depth	6.3 in (160 mm)
Thickness	0.8 in (20.3 mm)

Power Requirements:

Pentium M Processor:

+5 VDC (±5 percent), <TBD>, <TBD> maximum

+3.3 VDC (±5 percent), <TBD>, <TBD> maximum

+12.0 VDC (±5 percent), <TBD> maximum

-12.0 VDC (±5 percent), <TBD> maximum

Airflow:

Forced air cooling required, 300 LFM minimum

Altitude:

Operating, 0 – 10,000 ft (3,000 m)

Storage, 0 – 40,000 ft (12,000 m)

Temperature:

Operating, -0 °C to +50 °C

Storage, -40 °C to +85 °C

Humidity:

Operating, Relative Humidity 5 to 95% non-condensing

Storage, Relative Humidity 5 to 95% non-condensing

Vibration:

6 Gs RMS (20 - 2000 Hz) random, .0185 G2 per Hz spectrum

Shock:

10 Gs, 16 ms half sine, 6 axis, 10 pulses each

MTBF: <TBD>

TRADEMARKS

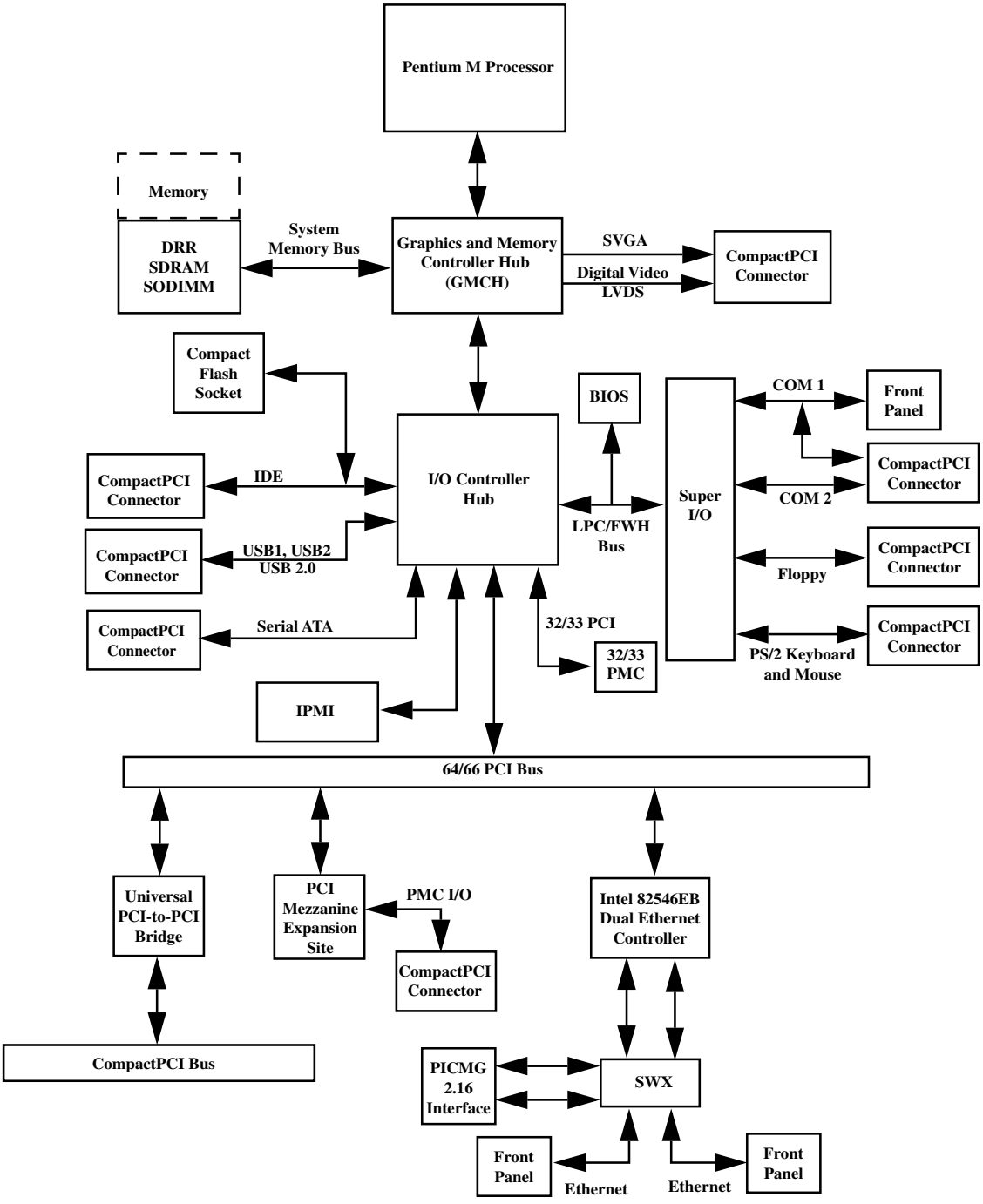


Figure 1. VMICPCI-7806 Functional Block Diagram

VMIVME-7050
PowerPC-Based VMEbus Single Board Computer

- High performance PowerPC-based single board computer (SBC)
- IBM® 750FX/GX PowerPC processor (733 MHz to 1.0 GHz)
- Marvell MV64360 system controller with 2 MB integrated SRAM
- Dual 64-bit PCI-X on PMC expansion sites (backward compatible) with support for doublewide PMC card
- Features include
  - — Up to 2 GB of DDR SDRAM with ECC running at 133 MHz, PC2100 (without losing any PMC expansion capabilities)
  - — 512 KB on-chip L2 cache
  - — 64.5 MB total Bootable Flash (64 MB soldered down, 512 KB in PLCC32 socket)
  - — Ultra-DMA IDE Controller to Compact Flash Socket (Type 1)
  - — 32K NVRAM
  - — Real time clock
  - — Built-in self-test
  - — Two high performance (up to 10 MB/s per channel) 16550-compatible serial ports (supporting synch/asynch RS-232, RS-422, and RS-485!)
  - — Dual 10/100/1000 Ethernet (two on front panel RJ45, two out P2)
  - — Four 32-bit programmable timers
  - — One 32-bit Watchdog Timer
  - — Full 64-pin PMC I/O support for both PMC sites through VMEbus P0 & P2 (P0 offers controlled-impedance for high speed connectivity such as Firewire and Ultra320 SCSI)
  - — 64-bit PCI board-to-board connector for PMC and feature expansion
  - — Monitoring of temperature and voltages
  - — Passive heatsink
  - — No moving parts to fail (excluding optional microdrive)
- Operating system support available:
  - — VxWorks®
  - — Linux®

INTRODUCTION — The VMIVME-7050 is the flagship of the VMIC PowerPC VMEbus architecture line. The features listed above represent our commitment to offer a robust product in a single slot VMEbus form factor.

MICROPROCESSOR — The VMIVME-7050 utilizes the IBM 750FX or 750GX PowerPC Microprocessor, offering processor speeds up to 1.0 GHz.

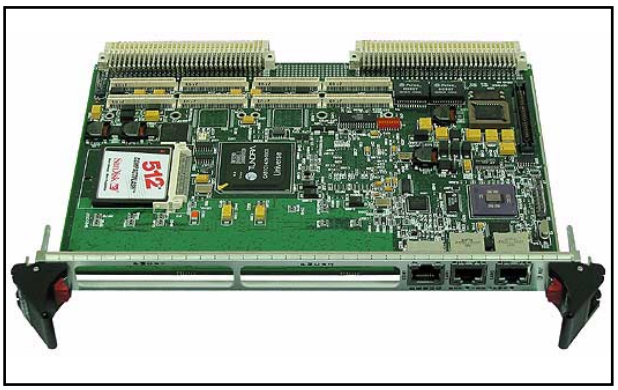
DRAM MEMORY — The VMIVME-7050 provides up to 2 GB of PC2100 DDR memory with ECC support.

FLASH MEMORY — The VMIVME-7050 provides up to 64.5 MB of Flash, one PLCC32 socket populated with 512 KB x8 Mirrorbit Flash, and 64 MB soldered down. Choice of socketed versus soldered down banks of Flash are jumper-selectable for booting purposes.

Ethernet CONTROLLER — The VMIVME-7050 supports dual Gigabit Ethernet LANs. 10BaseT, 100BaseTX, and 1000BaseTX options are supported via a front panel RJ45 connector and two rear I/O P2 connections. A Gb LAN switch is used to allow a single channel to support a front or rear connection (only one at a time).

SERIAL PORTS — The MV64360 chip integrates two Multi-Protocol Serial Controllers (MPSCs), that support synchronous, asynchronous RS-232 and RS-422/485 protocols (RS-232 @ 230 Kbps, RS-485 @10 Mbps).

Each serial channel has an independent SDMA to support baud rates of up to 10 Mbps per channel (RS-232 @ 230 Kbps, RS-485 @10 Mbps). One serial port is available



from both the front panel through an RJ45 socket (an adapter will be supplied), and the rear P2 connector. The second port is available through P2 only.

RESET SWITCH AND ANNUNCIATORS — A small push-button switch on the front panel will reset the VMIVME-7050. LEDs available on the front panel:

- PWR On
- CPU OK
- Comm 1 activity
- Comm 2 activity
- IDE Activity
- Reset
- Gb#1 Link Activity
- Gb#1 Speed
- Gb#2 Link/Activity
- Gb#2 Speed

Ordering Options								
Oct. 28, 2003 800-007050-000 B	A	B	C	D	E	F		
VMIVME-7050	–					0		

A = Processor
0 = Reserved
1 = 733 MHz Processor
2 = 1.0 GHz Processor

B = System DDR SDRAM with ECC
0 = 512 MB
1 = 1 GB
2 = 2 GB

C = Loading of VMEbus P0
0 = P0 not populated (No PMC#1 I/O)
1 = *P0 populated for high speed PMC#1 I/O

D = CompactFlash/Microdrive
0 = No CompactFlash or Microdrive
1 = 64 MB CompactFlash
2 = 512 MB CompactFlash
3 = 1 GB CompactFlash
4 = 1 GB Microdrive

E = 0 (Reserved)

NOTE: **Before ordering a P0 populated option, ensure that the VMEbus chassis is P0 compatible.*

VMEbus Rear Transition Utility Board

VMIACC-7050

The VMIACC-7050 installs in the rear transition area of the VMEbus backplane and provides access to two Gigabit Ethernet ports, two serial ports and an optional CompactFlash or Hard Disk Drive. The VMIACC-7050 is sold separately.

For Ordering Information, Call:
1-800-322-3616 or 1-256-880-0444 • FAX (256) 882-0859
E-mail: info@vmic.com Web Address: www.vmic.com

General Purpose I/Os (GPIOs) can be software controlled to toggle certain debug LEDs.

DEBUG FEATURES — An 8-pole single-throw switch is connected to two spare GPIOs for the customer to use for debug/programming. A 2x5 header is routed to the same GPIOs and switch to allow the customer to connect external equipment for debug purposes. The GPIOs can be used to toggle LEDs, read switch positions, or read/write to the 2x5 SMT header.

PMC EXPANSION SITES — The VMIVME-7050 supports IEEE P1386 common mezzanine card specification with two mezzanine card expansion sites. Two single or one doublewide PMC module can be accommodated. Both sites automatically support every possible PMC device configuration from "5 V I/O, 32-bit/33 MHz" through "3.3 V I/O 64-bit/133 MHz PCI-X." Proper VIO and bus capabilities are automatically set!

Support for high speed I/O is accomplished by routing all 64 pins of PMC#1's J4 to the VMEbus P0 in "P4V0-64" fashion ("P4V0-64" is a mnemonic used in the ANSI/VITA-35-2000 specification to show a compliant PMC-P4 to VME-P0 mapping on the host). Unlike the standard VME P1/P2 open-wire connectors, P0 is a high-density, high-quality, impedance-controlled connector which maintains the integrity of extended bandwidth signals. Ultra320 differential SCSI, firewire and Gigabit Ethernet are just a few examples of the interfaces that can benefit from using this high-quality pathway. Since this pathway is simply PMC#1's I/O channel, changing high speed interfaces is as easy as changing out a PMC card!

There are several PMC cards on the market supporting high speed interfaces through the J4 I/O connector, including VMIC's dual Ultra160 SCSI PMC card.

TIMERS — The VMIVME-7050 provides four 32-bit timers and a 32-bit Watchdog Timer. These timers are software programmable, can be combined to make 64-bit timers, and are programmable to generate non-maskable interrupts (NMI).

BUILT-IN SELF-TEST (BIST) — When the VMIVME-7050 is powered up, the board will run a built-in self-test. The BIST tests many of the board functions upon bootup, including DDR memory with ECC, COM ports, LEDs, RTC (real time clock), PCI space, DMA, LAN MAC loopback with valid address check, and NVRAM with a check of the battery low flag. More extended tests are also available to the user.

VMEbus INTERFACE — Unlike many competing products, the VMIVME-7050 utilizes the FULL 64-bit PCI pathway of the Tundra Universe IID VMEbus interface. The following VME64 modes are supported: A32/A24/D32/D16/D08(EO)/MBLT64/BLT32.

SYSTEM CONTROLLER — The VMEbus system controller capabilities allow the board to operate as a slot 1 controller, or it may be disabled when another board is acting as the system controller. The system controller may be programmed to provide the following modes of arbitration:

Round Robin (RRS)
Single Level (SGL)
Priority (PRI)

The system controller provides a SYSCLK driver, IACK* daisy-chain driver, and a VMEbus access timeout timer. The system controller also provides an arbitration timeout if BBSY* is not seen within a specified period after a BGOUT* signal is issued. This period is programmable for 16 or 256 µs.

VMEbus REQUESTER — The microprocessor can request and gain control of the bus using any of the VMEbus request lines (BR3* to BR0*) under software control. The requester can be programmed to operate in any of the following modes:

Release-On-Request (ROR)
Release-When-Done (RWD)
VMEbus Capture and Hold (VCAP)

MAILBOXES — The VMEbus interface provides four 32-bit mailboxes, which are accessible from both the microprocessor and the VMEbus, providing interprocessor communication. The mailboxes have the ability to interrupt the microprocessor when accessed by VMEbus.

INTERRUPT HANDLER — The interrupt handler monitors, and can be programmed to respond to any or all VMEbus IRQ* lines. All normal-process VMEbus-related interrupts can be mapped to PCI INTA# or SERR# interrupts. These include:

Mailbox interrupts
VMEbus interrupts
VMEbus interrupter IACK cycle (acknowledgment of VMIVME-7050 VMEbus-issued interrupts)

All error processing VMEbus-related interrupts can be mapped to PCI INTA# or SERR#. Note: PCI SERR# initiates an SBC NMI. These include:

ACFAIL* interrupt
BERR* interrupt
SYSFAIL* interrupt

The interrupt handler has a corresponding STATUS/ID register for each IRQ* interrupt. Once the handler receives an

IRQ*, it requests the VMEbus and, once granted, it performs an IACK cycle for that level. Once the IACK cycle is complete and the STATUS/ID is stored in the corresponding ID register, an appropriate interrupt status bit is set in an internal status register and a PCI interrupt is generated. The PCI interrupt can be mapped to PCI INTA# or SERR#.

INTERRUPTER — Interrupts can be issued under software control on any or all of the seven VMEbus interrupt lines (IRQ7* to IRQ1*). A common ID register is associated with all interrupt lines. During the interrupt acknowledge cycle, the interrupter issues the ID to the interrupt handler. The interrupter can be programmed to generate a PCI INTA# or SERR# interrupt when a VMEbus interrupt handler acknowledges a software-generated VMEbus interrupt.

MASTER INTERFACE — MA32:MBLT32:MBLT64 (A32:A24:A16:D32:D16:D8 (EO):BLT32)

The VMEbus master interface provides nine separate memory windows into VMEbus resources. Each window has separate configuration registers for mapping PCI transfers to the VMEbus (that is, PCI base address, window size, VMEbus base address, VMEbus access type, VMEbus address/data size, etc.). The maximum/minimum window sizes for the nine windows are as follows:

Window	Minimum Size	Maximum Size
0, 4	4 KB	4 GB
1 to 3, 5 to 7	64 KB	4 GB
Special Cycle	64 MB	64 MB

SLAVE INTERFACE — Memory Access SAD032:SD32:SBLT32:SBLT64 (A32:A24:A16:D32:D16:D8 (EO): BLT32)

The VMEbus slave interface provides eight separate memory windows into PCI resources. Each window has separate configuration registers for mapping VMEbus transfers to the PCI bus (that is, VMEbus base address, window size, PCI base address, VMEbus access type, VMEbus address/data size, etc.). The maximum/minimum window sizes for the eight windows are as follows:

Window	Minimum Size	Maximum Size
0, 4	4 KB	4 GB
1 to 3, 5 to 7	64 KB	4 GB

In addition, each window can be programmed to operate in coupled or decoupled mode. In decoupled mode, the window utilizes a write-posting FIFO and/or a read prefetching FIFO for increased system performance. In coupled mode, the FIFOs are bypassed and VMEbus transactions are directly coupled to the PCI bus (that is, transfers on VMEbus are not completed until they are completed on the PCI bus).

OPERATING SYSTEM and SOFTWARE SUPPORT — The VMIVME-7050 is available with a Linux and VxWorks Tornado/AE BSP. The BSP provides support for the VMEbus interface, Ethernet and timers.

VxWorks OS SUPPORT

VMISFT-7443 BOARD SUPPORT PACKAGE — The VMISFT-7443 is Wind River Systems, Inc.'s board support package (BSP) for VMIC's series of VMEbus PowerPC-based processor SBCs, which is required to run the VxWorks OS. With the SBC, VxWorks, the BSP, and other VMEbus equipment from VMIC, implementations can be created for a wide variety of applications including real time factory automation, simulation, instrumentation and control, and process control and monitoring.

The BSP is linked with VxWorks OS, thus allowing software applications created with Wind River Systems, Inc.'s development system to load and run on the particular VMIC SBC hardware being used. Serial ports, parallel ports, keyboard, text mode video and Ethernet transceivers are all supported, as well as floppy and IDE hard disk drives that can be connected to the computer boards. The BSP provides Flash boot, NVRAM and timer support. The BSP allows VxWorks applications to have access to the VMEbus. When hardware includes single cycle and block transfers using DMA devices, they are supported by the BSP, as well as interprocessor communications with mailbox registers. VMEbus interrupt handling and error handling are supported. Since the VMEbus environment often contains a mixture of devices from various manufacturers, the byte-swapping feature is provided to allow big-endian and little-endian devices to share data correctly.

SPECIFICATIONS

6U Single Slot Eurocard Format:

Height	9.2 in. (233.4 mm)
Depth	6.3 in. (160 mm)
Thickness	0.8 in. (20.3 mm)

Power Requirements:

+5 VDC (±5 percent), TBD (typical), TBD maximum

+12 VDC (±5 percent), TBD (typical), TBD maximum

-12 VDC (±5 percent), TBD (typical), TBD maximum

Note: The currents at +12 and -12 VDC are specified with the serial connectors open.

Operating Temperature: 0 to 60 ˚C
(Air flow requirement as measured with heatsink is to be greater than 200 LFM)

Storage Temperature: -25 to 80 ˚C

Relative Humidity: 10 to 90 percent, noncondensing

PMC #1 Expansion Site Connector:
3.3 V signaling, 5 V tolerant, auto-VIO
64-bit PCI-X bus, 133 MHz maximum
(backward compatible to 5 V, 33 MHz PCI)

PMC #2 Expansion Site Connector:
3.3 V signaling, 5 V tolerant, auto-VIO
64-bit PCI-X bus, 133 MHz maximum
(backward compatible to 5 V, 33 MHz PCI)

MTBF: <TBD>

COMPATIBLE PRODUCTS

The VMIVME-7050 can be used with a number of VMIC PMC bus and VMEbus products.

Hard Disk: The VMIACC-7050 converts P2IDE signals to two 40-pin headers for use at the rear of the VMEbus backplane. The VMIACC-7050 transitions two Gigabit Ethernet ports, two serial ports (COM1 and 2), IDE signals from the VMEbus P0 and P2. The secondary IDE is routed to a 40-pin IDE connector located internally and a 40-pin IDE connector located on the back panel. IDE is also routed to a CompactFlash socket.

VMEbus: The VMIVME-7050 enables access to VMIC's wealth of VMEbus products. If you have real world control, monitoring and real time networking requirements, VMIC has a solution for you. Today's system requirements demand state-of-the-art solutions. Our advanced I/O features such as built-in-test, self-test, isolation, digital autocalibration, and intelligent DSP processing give our customers those solutions.

The I/O Solution for Your I/O Problem: VMIC's 16 years of experience in supplying high performance deterministic controllers for multiple markets has led to the development of IOWorks software with features, benefits and capabilities to solve just about any I/O problem. From PLC alternatives to data servers that support the seamless interconnection of dissimilar systems, VMIC has the solution for simple to complex high speed deterministic requirements. IOWorks PC platforms, target, OS and I/O independency provide the flexibility for solutions.

RAMiX's PMC237CM1 Expander Card: The PMC237CM1 Expander card is a 6U form factor board that adds three PMC slots or two PMC slots and one PCMCIA/CardBus socket. The two PCI-X on PMC sites on the VMIVME-7050 mainboard are not used for the connection and are still accessible. This allows up to five PMC sites to be available in just two VMEbus slots. Compatible with many VMEbus SBCs, it provides an extension of PCI and PCMCIA capacity within the VMEbus form factor. The PMC237CM1 has the option for the PCMCIA/CardBus cards to be mounted outside the chassis using an 18" (inch) cable. Functionally, the PMC237CM1 consists of a PCI/PCI bridge (assuring compliance with PCI loading) and an optional PCI/PCMCIA Host Bus Adapter (see the RAMiX PCMCIA/PC Card Host Bus Adapters). Full PCI bandwidth can be maintained to PMC devices installed on the PMC237CM1. The PMC237CM1 offers several configurations tailoring functionality and host SBC connections. The board can either be populated with three PMC modules, or two PMC modules and a PCMCIA/PC Cardbus socket. The PMC237CM1 generates the +3.3 V for the devices. The PMC237CM1 uses only Power and Ground from the VMEbus.

SUMMARY

The powerful IBM Processor is mated with the industry's most powerful system controller (Marvell Discovery II) to yield one of the most impressive designs on the market. The bandwidth through the system controller is maximized by using 2 MB of SRAM as a revolutionary "cross-bar fabric switch" to allow "any-to-any" connectivity of up to **100 Gbps** of aggregate throughput, with non-blocking **concurrent** connections among all of the peripheral channels at **full** bus speeds!

All of this adds up to a top-performance single board computer. 133 MHz PCI-X is a 2.5x improvement over 66 MHz. The PCI DDR266 SDRAM is 266 Mbps and is a 2x improvement over 133 MHz SDRAM. Each Gigabit Ethernet is 10x faster than standard 100 Mb Fast Ethernet.

RS-422/485 support yields much faster and reliable communications over longer distances (see Figure 1). The VMIVME-7050 features speed, expansion and upgradability and built-in support for several RAMiX products including their PMC237CM1 expander card. The PMC237CM1 adds three PMC sites to this product for a total of five PMC sites using only two VMEbus slots.

TRADEMARKS

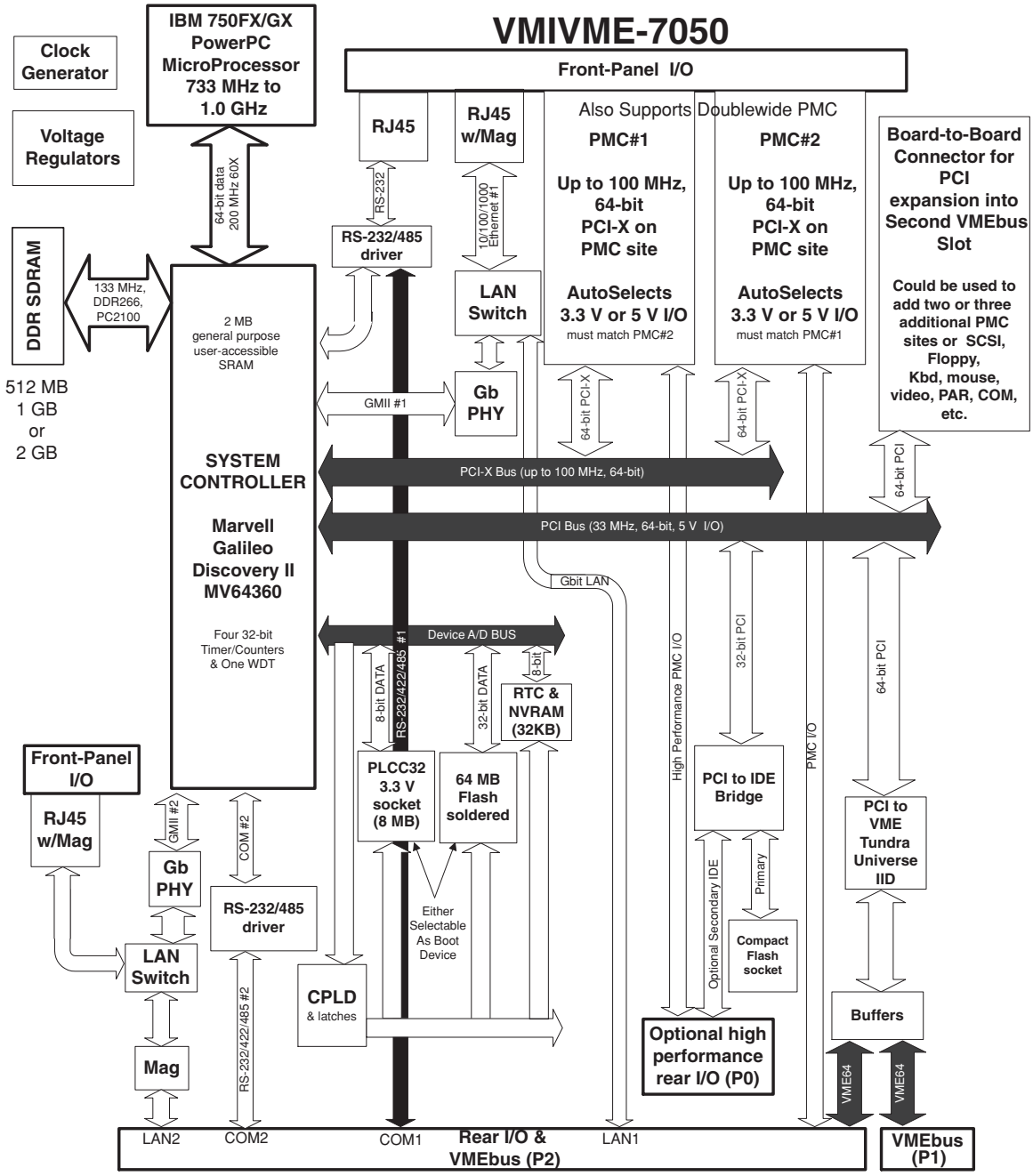


Figure 1. VMIVME-7050 Functional Block Diagram

A GE Fanuc Company

VMIVME-7700

Ultra Low Voltage Intel® Celeron® VMEbus

- Intel®'s Ultra Low Voltage Celeron® 400 MHz/650 MHz processor
- Special features for embedded applications include:
  - Up to 1 GB bootable Flash on secondary IDE (optional)
  - Two 16-bit and two 32-bit programmable timers
  - 32 KB of nonvolatile SRAM
  - Software-selectable Watchdog timer with reset
  - Remote Ethernet booting
  - One PMC expansion site (IEEE-1386.1 PCI mezzanine card standard, 5 V)
  - VME64 modes supported: A32/A24/D32/D16/D08(EO)/MBLT64/BLT32
  - VMEbus interrupt handler, interrupter, and system controller
  - Includes real-time endian conversion hardware for little-endian and big-endian data interfacing (patent no. 6,032,212)
  - Enhanced bus error handling
  - Passive heat sink
  - Real-time clock and miniature speaker included
  - Dual front panel universal serial bus (USB) connections
- Standard features include:
  - Up to 512 MB PC100 SDRAM
  - 100 MHz system bus via Intel 815E chipset
  - Dual Ethernet controllers supporting 10BaseT and 100BaseTX interfaces
  - Ultra DMA/100 hard drive and floppy drive controllers (uses VMEbus P2 for connection to IDE/floppy)
  - Two high performance 16550-compatible serial ports
  - PS/2-style keyboard and mouse ports on front panel
  - VMEbus backplane interface
  - User programmable Watchdog timer
  - Passive processor heat sink

MICROPROCESSOR — The VMIVME-7700 is based on the Intel Ultra Low Voltage Celeron processor. The enhanced Celeron processor has 256 KB of on-die L2 cache. The µFCBGA package processors offer thermal characteristics that are well suited for embedded systems operating over a wide range of temperatures.

DRAM MEMORY — The VMIVME-7700 accepts one 144-pin SODIMM PC100 module for a maximum memory configuration of 512 MB.

BIOS — The VMIVME-7700 System BIOS and video BIOS are provided in reprogrammable memory.

VIDEO GRAPHIC CONTROLLER — High resolution graphics and multimedia-quality video are supported on the VMIVME-7700 by an internal 815E AGP graphics controller. A fully functional, integrated 2D/3D graphics accelerator provides pixel processing and rendering, with display resolutions of up to 1600 x 1200 supported. The video output is provided through the front panel.

CompactFlash — The VMIVME-7700 includes a CompactFlash socket on the assembly. The CompactFlash may be configured as the boot device through the BIOS boot device set up. The CompactFlash, as an ordering option, is available up to 1 GB of storage space.

IDE Interface — The VMIVME-7700 provides an IDE interface for hard disk drive support. The IDE interface allows support of several types of data transfers: Programmed I/O(PIO), 8237 style DMA, Ultra ATA/33, Ultra ATA/66 and Ultra ATA/100.

ETHERNET CONTROLLER — The VMIVME-7700 provides two front panel connections to either 10BaseT or 100BaseTX LAN using two Intel 82551ER Ethernet controllers. Standard RJ45 connectors are provided on the front panel with two network status indicators.

PHOTO NOT AVAILABLE

REMOTE ETHERNET BOOTING — The VMIVME-7700 utilizes an Expansion ROM BIOS which enables processor booting from a network server. The facility supports PXE and a variety of network boot protocols including BOOTP and DHCP (TCP/IP).

UNIVERSAL SERIAL BUS (USB) — The VMIVME-7700 provides front panel dual connection hub host controllers for the USB. Supported USB features include: isochronous data transfers, asynchronous messaging, self-identification and configuration of peripherals, and dynamic (hot) attachment.

SERIAL PORTS — The VMIVME-7700 provides two 16550-compatible serial ports. Each serial port has an independent 16-byte FIFO supporting baud rates up to 115 kbaud. Connection for both serial ports is provided by

Ordering Options

May 02, 2003 800-007700-000 A	A	B	C	–	D	E	F
VMIVME-7700 –				–			

A = Processor
- 0 = 400 MHz Ultra Low Voltage Celeron Processor
- 1 = 650 MHz Ultra Low Voltage Celeron Processor

B = SDRAM Memory
- 1 = 128 MB
- 2 = 512 MB

C = CompactFlash
- 0 = No CompactFlash
- 1 = 128 MB CompactFlash
- 2 = 256 MB CompactFlash
- 3 = 512 MB CompactFlash
- 4 = 1 GB CompactFlash

D/E = Reserved

Connector Adapter

VMIC Part Number 360-010050-01. The connector adapter is a 9-pin Micro-D to standard D serial adapter. The 360-010050-001 connector adapter is sold separately.

For Ordering Information, Call:
1-800-322-3616 or 1-256-880-0444 • FAX (256) 882-0859
E-mail: info@vmic.com Web Address: www.vmic.com

two micro DB-9 connectors located on the front panel. The micro DB-9 connectors require two micro DB-9 to standard DB-9 adapters, VMIC P/N 360-010050-001.

PMC EXPANSION SITE — The VMIVME-7700 provides one IEEE 1386.1, 5 V PCI mezzanine card (PMC) expansion site. This expansion capability allows the addition of peripherals offered for PMC applications. The PMC site provides for standard I/O out the VMEbus front panel. An optional I/O connection to the VMEbus P2 connection can be provided.

KEYBOARD and MOUSE PORTS — The VMIVME-7700 supports a PS/2 keyboard and mouse through the front panel.

HARDWARE RESET — A hardware reset switch is accessible from the front panel.

PROGRAMMABLE TIMER — The VMIVME-7700 provides the user with two 16-bit timers and two 32-bit timers. These timers are mapped in PCI memory space, are completely software programmable and can generate PCI bus interrupts.

WATCHDOG TIMER — The VMIVME-7700 provides a software-programmable Watchdog timer. The Watchdog timer is enabled under software control. Once the timer is enabled, software must access the timer within the specified time period, or the output of the Watchdog timer will reset the unit.

NONVOLATILE SRAM — The VMIVME-7700 provides 32 KB of nonvolatile SRAM. The contents of the SRAM are preserved when +5 V power is interrupted or removed from the unit.

CMOS BATTERY — The VMIVME-7700 uses a holder that permits field replacement of the CMOS battery. A header and jumper allows the battery to be disconnected from the circuitry for long-term storage.

ANNUNCIATORS — Indicators for the board status, +5 V power good, are provided on the front panel. In addition, two indicators for the Ethernet adapter activity are located on each RJ45 network connector.

THERMAL MANAGEMENT — The VMIVME-7700 utilizes a passive heat sink that relies on forced air cooling within the equipment rack at the specified flow rate. Please refer to the environmental specifications for more information.

VMEbus INTERFACE — The VMIVME-7700 VMEbus interface is based on the Universe IID high performance PCI-to-VMEbus interface from Newbridge/Tundra.

SYSTEM CONTROLLER — The VMEbus system controller capabilities allow the board to operate as a slot 1 controller, or it can be disabled when another board is acting as the system controller. The system controller may be programmed to provide the following modes of arbitration:

Round Robin (RRS)

Single Level (SGL)

Priority (PRI)

The system controller provides a SYSCLK driver, IACK* daisy-chain driver, and a VMEbus access timeout timer. The system controller also provides an arbitration timeout if BBSY* is not seen within a specified period after a BGOUT* signal is issued. This period is programmable for 16 or 256 µs.

VMEbus REQUESTER — The microprocessor can request and gain control of the bus using any of the VMEbus request lines (BR3* to BR0*) under software control. The requester can be programmed to operate in any of the following modes:

Release-On-Request (ROR)

Release-When-Done (RWD)

VMEbus Capture and Hold (VCAP)

MAILBOXES — The VMEbus interface provides four 32-bit mailboxes, which are accessible from both the microprocessor and the VMEbus providing interprocessor communication. The mailboxes have the ability to interrupt the microprocessor when accessed by theVMEbus.

INTERRUPT HANDLER — The interrupt handler monitors, and can be programmed to respond to any or all VMEbus IRQ* lines. All normal-process VMEbus-related interrupts can be mapped to PCI INTA# or SERR# interrupts. These include:

Mailbox interrupts

VMEbus interrupts

VMEbus interrupter IACK cycle (acknowledgment of VMIVME-7700 VMEbus-issued interrupts)

All error processing VMEbus-related interrupts can be mapped to PCI INTA# or SERR#. Note: PCI SERR# initiates an SBC NMI. These include:

ACFAIL* interrupt

BERR* interrupt

SYSFAIL* interrupt

The interrupt handler has a corresponding STATUS/ID register for each IRQ* interrupt. Once the handler receives an IRQ*, it requests the VMEbus and, once granted, it performs an IACK cycle for that level. Once the IACK cycle is complete and the STATUS/ID is stored in the corresponding ID register, an appropriate interrupt status bit is set in an internal status register, and a PCI interrupt is generated. The PCI interrupt can be mapped to PCI INTA# or SERR#.

INTERRUPTER — Interrupts can be issued under software control on any or all of the seven VMEbus interrupt lines (IRQ7* to IRQ1*). A common ID register is associated with all interrupt lines. During the interrupt acknowledge cycle, the interrupter issues the ID to the interrupt handler. The interrupter can be programmed to generate a PCI INTA# or SERR# interrupt when a VMEbus interrupt handler acknowledges a software-generated VMEbus interrupt.

BYTE SWAPPING — The Intel 80x86 family of processors uses little-endian format. To accommodate VMEbus modules that transfer data in big-endian format, such as the 680x0 processor family, the VMIVME-7700 incorporates byte-swapping hardware. This provides independent byte swapping for both the master and slave interfaces. Both master and slave interface byte swapping are under software control. The VMIVME-7700 supports high throughput DMA transfers of bytes, words and longwords in both Master and Slave configurations. If endian conversion is not needed, we offer a special "bypass" mode that can be used to further enhance throughput. (Not available for byte transfers.)

MASTER INTERFACE — MA32: MBLT32: MBLT64 (A32:A24:A16:D32:D16:D8 (EO):BLT32)

The VMEbus master interface provides nine separate memory windows into VMEbus resources. Each window has separate configuration registers for mapping PCI bus transfers to the VMEbus (that is, PCI bus base address, window size, VMEbus base address, VMEbus access type, VMEbus address/data size, etc.). The maximum/minimum window sizes for the nine windows are as follows:

Window	Minimum Size	Maximum Size
0,4	4 KB	4 GB
1 to 3, 5 to 7	64 KB	4 GB
Special Cycle	64 MB	64 MB

SLAVE INTERFACE — Memory Access SAD032:SD32:SBLT32:SBLT64 (A32:A24:A16:D32:D16:D8 (EO): BLT32)

The VMEbus slave interface provides eight separate memory windows into PCI resources. Each window has separate configuration registers for mapping VMEbus transfers to the PCI bus (that is, VMEbus base address, window size, PCI base address, VMEbus access type, VMEbus address/data size, etc.). The maximum/minimum window sizes for the eight windows are as follows:

Window	Minimum Size	Maximum Size
0,4	4 KB	4 GB
1 to 3, 5 to 7	64 KB	4 GB

In addition, each window can be programmed to operate in coupled or decoupled mode. In decoupled mode, the window utilizes a write-posting FIFO and/or a read prefetching FIFO for increased system performance. In coupled mode, the FIFOs are bypassed and VMEbus transactions are directly coupled to the PCI bus (that is, transfers on VMEbus are not completed until they are completed on the PCI bus).

ENHANCED BUS ERROR HANDLING — Enhancements over the Universe chip's bus error handling features are provided. A latch and register are provided to allow the SBC to read the VMEbus address that caused the bus error in all modes. The Universe chip's support is limited to decoupled mode. Support for bus cycle timeout and assertion of bus error is provided. The board may be configured to assert bus error upon timeout regardless of its status as system controller. The Universe chip asserts bus error only if it is the system controller. In addition, this board may be configured to assert an interrupt upon bus cycle timeout.

BACK PANEL CONFIGURATION — The VMIVME-7700 provides support for external IDE disk drive and floppy drive through the VMEbus P2 backplane connector and the VMIACC-0562 backplane adapter.

OPERATING SYSTEM AND SOFTWARE SUPPORT — The VMIVME-7700 provides embedded features beyond PC/AT functionality. These features are supported by VMIC software products aimed at developers who are incorporating VMIC SBCs, I/O boards and workstations into systems. The VMIVME-7700 supports a variety of operating systems including Microsoft® Windows NT®, Windows® 2000, Windows XP, QNX, Linux® and VxWorks®.

SPECIFICATIONS

Single Slot 6U (4HP) Eurocard Form Factor:

Height 9.2 in. (233.4 mm)

Depth 6.3 in. (160 mm)

Thickness 0.8 in. (20.3 mm)

Power Requirements:

+5 VDC (±5 percent), <TBD> (typical), <TBD> mA maximum

+12 VDC (±5 percent), <TBD> (typical), <TBD> mA maximum

-12 VDC (±5 percent), <TBD> (typical), <TBD> mA maximum

NOTE: The currents at +12 and -12 VDC are specified with the serial connectors open.

Airflow:

Forced air cooling required: <TBD> LFM minimum

Temperature:

Operating: -20 to +70 ˚C
Storage : -40 to +80 ˚C

Altitude:

Operating: 0 – 10,000 ft (3,000m)
Storage: 0 – 40,000 ft (12,000m)

Humidity:

Operating, Relative Humidity 5 to 95% non-condensing
Storage, Relative Humidity 5 to 95% non-condensing

VMEbus Interface:

DTB Master: BLT32/BLT64, A32/D32, A24/D32, A16/D32
DTB Slave: BLT32/BLT64, A32/D32, A24/D32, A16/D32
Requester: Programmable, BR(3 to 0), ROR, RWD, BCAP
Interrupt Handler: IH(1 to 7) D8(O)
Interrupter: Programmable, IRQ7* to IRQ1*
Arbiter: SGL, PRI, RRS

BTO: Programmable (4 to 1,024 µs)
Compliance: ANSI/VITA 1-1994

PMC Expansion Site Connector: 5 V signaling, types 1 and 2 32-bit PCI bus, 33 MHz maximum

MTBF: <TBD>
Regulatory: CE Mark

TRADEMARKS

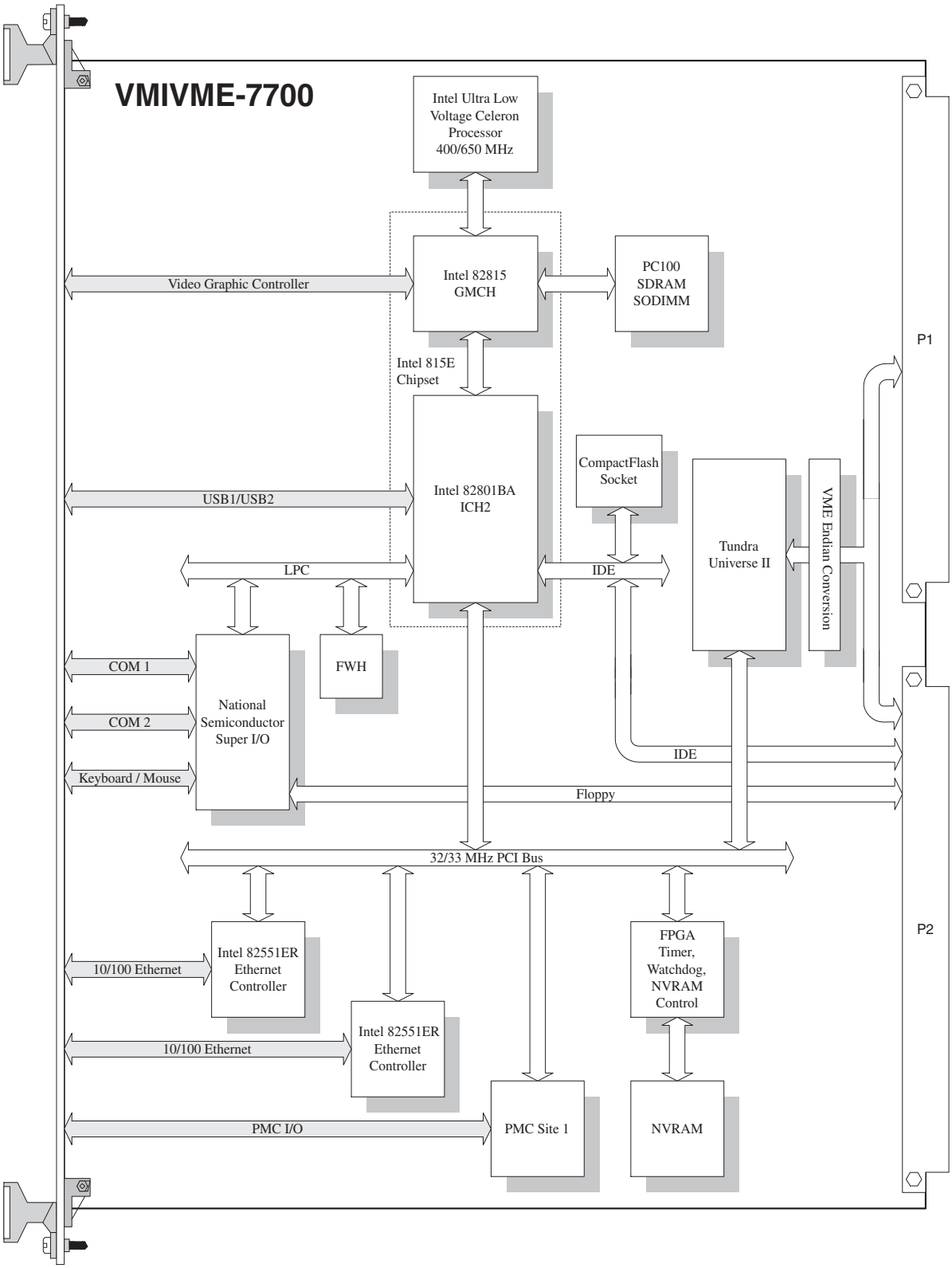


Figure 1. VMIVME-7700 Block Diagram