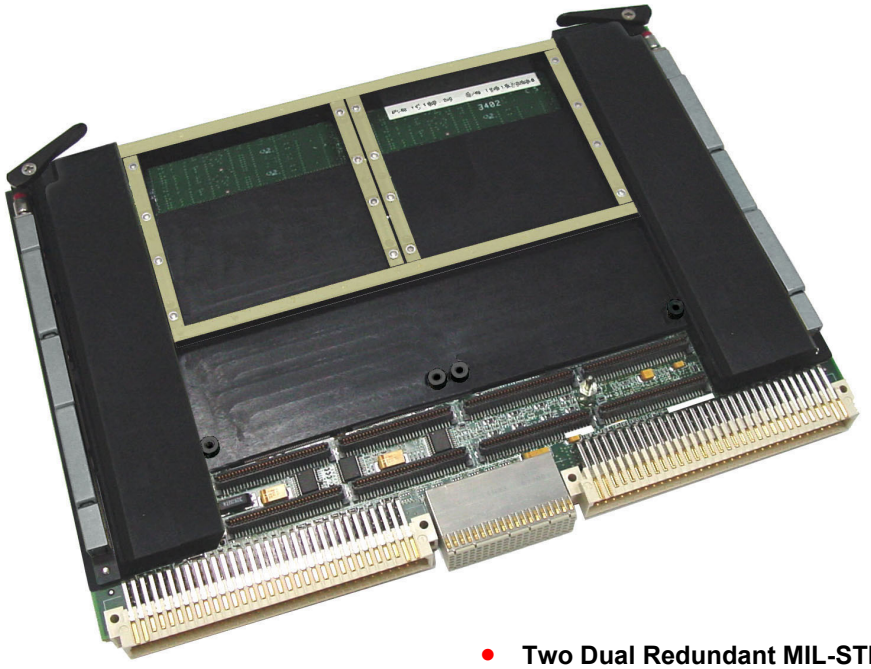
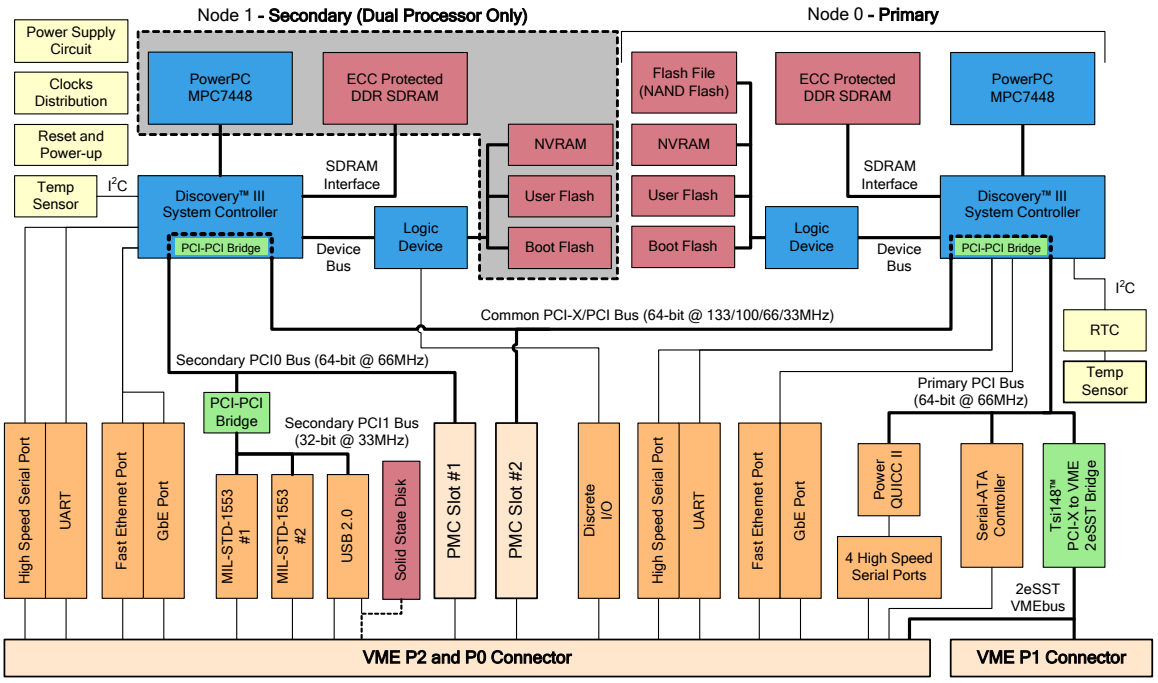
C102
Dual PowerPC® 7448 VME SBC



- Rugged 6U VME Single–Slot SBC
- Dual/Single PowerPC® G4+
  - MPC7448 @ up to 1.42 GHz
  - On-chip 32 kB L1 + 1 MB L2 Cache
- Up to 2 GB Total DDR SDRAM with ECC
- 512 MB Total User Flash
- 256 MB Total Boot Flash
- 256 kB Total NVRAM
- Up to 16 GB Flash File Memory
- Up to 8 GB USB SSD (Solid State Disk)
- VME 2eSST with Legacy VME Support
- Power Saving Modes
- Two Gbit Ethernet Ports (10/100/1000)
- Two Fast Ethernet Ports (10/100)
- One Serial ATA II Port (3.0 Gbps)
- Up to 2 USB 2.0 Ports (400+ Mbps)
- Two Dual Redundant MIL-STD-1553B Ports
- Six Multi-Protocol High-Speed Serial USART Ports - RS-232/422/485
- Two Standard Serial UART Ports - RS-232/422/485
- 16 Single Ended TTL/8 Differential RS-422 Discrete I/O Lines
- Two PMC Slots
- Eight 32-Bit Timers (4 per Processor)
- Standard and Windowed Watchdog Timers
- Real Time Clock
- Elapsed Time Recorder
- On-Board Temperature Sensors
- VxWorks® and INTEGRITY® RTOS Support
- Conduction and Air-Cooled Versions
- Vibration and Shock Resistant



C102 Block Diagram

C102 – Double the Performance, Expanding the I/O

The C102 is a fully loaded Dual/Single PowerPC® MPC7448, single slot VME SBC specifically designed to endure harsh environment applications. With its distributed architecture, the C102 provides two independent, high performance processing nodes each supported by its own extensive on-board memory resources, communicating with each other over a high speed PCI bus. Complementing these powerful processing nodes, the C102 provides the industry's highest functional density feature set of memory and I/O interfaces, which positions the C102 as the best SBC in its class due to the unique combination of processing power and I/O resources.

The C102 is backward compatible with Aitech's previous generation SBCs – the C100/C101/C103 series (the only exception being that IEEE1394 FireWire ports are not available) – thus providing an easy migration path for customers using the C10x family of SBC products.

Each of the two C102 processing nodes is powered by a Freescale MPC7448 advanced PowerPC microprocessor, with integrated, on-chip, high speed L1 and L2 caches. The two independent processing nodes employ two separate Discovery™ III System Controllers. Each processing node includes dedicated memory resources designed to take full advantage of the MPC7448 processing power, eliminating bottlenecks in data flow. Memory arrays include large and fast DDR SDRAM memory, Boot Flash for firmware and application storage, User Flash for user application and data storage and NVRAM for user/application specific parameters storage. In addition, the primary processing node includes a high-density Flash File (NAND Flash) array for mass storage purposes. An optional USB solid state disk with 4GB or 8GB of NAND Flash memory is also available.

The C102 further expands the unparalleled I/O capabilities provided in the former C10x series boards. Its integrated on-board I/O resources include two Gigabit Ethernet ports, two Fast Ethernet ports, two dual redundant MIL-STD-1553B interfaces, up to two USB 2.0 ports, one Serial ATA II channel, eight serial ports (six high-speed ports and two standard UARTs) and up to 16 general-purpose discrete I/O channels.

To complement its extensive capabilities and provide extended resources and flexibility, C102 is equipped with two PMC slots allowing installation of additional modules on the board.

The C102 is VME64x compliant, and supports VME advanced protocols such as 2eSST and 2eVME while maintaining full compliance with legacy VME operation.

The C102 SBC internal interconnecting buses are PCI-X/PCI buses split into four segments, with the PCI agents I/O resources distributed between them according to their PCI operation capabilities. This architecture maintains high operation frequency for the high-speed PCI-X/PCI resources while lower capacity PCI resources are located on slower PCI segments. Most of the C102 PCI-X/PCI resources use their integrated DMA engines and take full advantage of the PCI-X/PCI protocol in order to achieve maximum bus utilization.

The C102 mechanical and electrical design guarantees its operation over the full range of rugged applications environments and is available both in industry standard conduction- or air-cooled form factors

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Functional Description

Board Architecture

Distributed Processing

The C102 is a powerful processing SBC designed as a distributed processor platform with two independent processing nodes. Each of the processing nodes is a complete sub-system that includes the processor, its local memory resources and basic I/O interfaces (Ethernet and Serial I/O). Each of the two processing nodes is designed around the Marvell Discovery™ III System Controller, a powerful, highly integrated device providing all interconnection between the processor, memory and internal PCI buses.

The two processing nodes communicate with one another through a high performance 133MHz PCI-X bus. The processing nodes communicate using shared memory regions and inter-processor message passing capabilities integrated in the Discovery™ III System Controller design such as doorbells, hardware semaphores, and mutual interrupting mechanisms in addition to other synchronization methodologies.

The C102 SBC may also be configured as a single processor board for power sensitive or less demanding applications. When configured as a single processor SBC the secondary processor and memory array resources are not populated.

Any of the SBC I/O resources may be mapped to either one of the two processing nodes allowing the distribution of the application elements and I/O handling between the two processors. This allows the user to balance the processing loads between them and achieve the highest possible performance.

Processor

The C102 features two high performance MPC7448 PowerPC processors. The MPC7448 is a RISC processor integrating both L1 (32kB instruction/data) and L2 (1MB) caches on chip to support its powerful processing core.

The MPC7448 Processor operates at up to 1.42 GHz (with higher frequency processors available in the future) and provides AltiVec support, thus allowing the user to take advantage of the processor's powerful vector processing capabilities.

System Controller

The C102 implements two MV64460 Discovery™ III System Controllers, one per node, supporting the processing node's high performance and providing a fast highway for high throughput data transfers.

The highly integrated Discovery™ III system controller performs both as the memory controller for the processor and as its interconnecting bridge to the PCI domains.

Each Discovery III System Controller is configured to support the processors MPX bus protocols at 133 MHz, and provides two separate and totally independent PCI-X/PCI bus interfaces. PCI-X/PCI buses support 64-bit operation at up to 133/100/66/33 MHz and fully comply with PCI Rev. 2.2 and PCI-X Rev. 1.0 specifications.

PCI Bus Segmentation

C102 bus architecture maximizes PCI bus utilization by employing bus segmentation. Each C102 PCI bus domain is configured with its specific bus frequency and width. High-speed PCI agents requiring high data

bandwidth are separated from slower agents that reduce the bus operation capabilities.

The four PCI bus segments are as follows:

- Common PCI bus – Interconnecting the two Discovery III System Controllers allowing for high-speed communication between the two processing nodes. This segment also includes PMC slot 2. The on-board logic is designed to detect the presence of a PMC and adjust the PCI operation mode and speed according to the PMC capabilities (this is done through the PCIXCAP and M66EN signals). With no PMC installed this segment operates as a 64-bit PCI-X at 133 MHz. If a PMC is installed that supports PCI-X the bus speed will be reduced to 100 MHz. If a PMC is installed that does not support PCI-X the bus segment will be set to PCI operation at the frequency supported by the PMC – 66 MHz or 33 MHz.
- Primary PCI bus – Connecting to the primary processing node's System Controller. This is a 64-bit PCI bus operating at 66 MHz. The segment hosts the on-board high-speed elements – PowerQUICC II, Serial ATA II controller, and Tsi148 VME 2eSST Bridge.
- Secondary PCI bus 0 – Connecting to the secondary processing node System Controller. This bus hosts PMC slot 1 and a PCI-PCI Bridge connecting to Secondary PCI bus 1, hosting lower speed PCI agents. With no PMC installed this bus operates as 64-bit PCI at 66 MHz. If a PMC is installed the bus segment operation speed will be set by the PMC capabilities – 66 MHz or 33 MHz.
- Secondary PCI bus 1 – Connecting to the PCI-PCI Bridge residing on secondary PCI bus 0. This segment hosts all the slow on-board PCI agents – USB 2.0 controller and two MIL-STD-1553B controllers. This bus employs 32-bit PCI bus at 33 MHz.

Interrupt Mechanism

For maximum flexibility and further support the capability of each of the two processors to handle any of the SBC's I/O resources, the C102 implements a unique interrupt mechanism allowing the routing of each of the on-board resources to either of the two processors.

Memory

The C102 is equipped with large memory arrays providing the user with extensive resources. These arrays are distributed between the two processing nodes and are similar for both nodes with the exception of the Flash File (NAND Flash array). The memory resources supporting each of the processing nodes include up to 1 GB fast DDR SDRAM operating at 166 MHz (DDR333), 128 MB linear Boot Flash, 256 MB linear User Flash and 128 kB NVRAM (Non-Volatile RAM).

DDR SDRAM arrays are ECC protected guarantying high data integrity.

Boot Flash is used for Aitech proprietary firmware storage as well as user application storage. User Flash is intended for user application and data storage. NVRAM can be used for application specific parameters storage and logging purposes.

The Boot Flash area containing Aitech firmware is locked and unavailable to the user. It is protected through a hardware jumper for programming and cannot be altered during normal operation of the board.

The NVRAM technology is fast Flash shadow RAM and does not require an external power supply to maintain its contents during power down. It includes Auto-store capability to automatically store RAM contents upon detection of a power down event, ensuring no data is lost when power is cycled off.

In addition to the above memory elements the C102 includes up to 16 GB Flash File (NAND Flash) for solid-state mass storage applications. Double size Flash file is available as a special option - please contact your Aitech sales representative.

USB Solid State Disk (SSD)

For convenient file storage, the C102 includes an optional USB 2.0 SSD with up to 8 GB of NAND flash memory, connected to one of the on-board USB Host controller ports. The integral controller enables high speed data transfers and provides wear leveling to ensure maximum longevity of the media.

VME

The C102 implements Tundra's Tsi148 PCI-X to VME 2eSST Bridge for interconnection to the VME bus. The VME Bridge is located on the primary fast PCI bus allowing for high-speed operation and throughput.

The VME interface provides full master and slave capabilities and supports the following:

- 2eSST and 2eVME protocol support
- Legacy traditional VME protocol support
- A64/A32/A24/A16 addressing modes
- MBLT/BLT/D64/D32/D16/D8 data transfer modes
- Interrupter and handler capability on all seven VME interrupt lines
- Four mailbox and four location monitors for in-system board communication
- Full system controller functionality – arbitration, VME clock generation, VME global timeout timer (BERR)
- Flexible register set allowing manipulation of all VME options

The Tsi148 Bridge incorporates large FIFOs for optimal usage of the two buses on which it operates (PCI and VME). In addition, it includes two DMA engines supporting high data rate transfers.

I/O Interfaces

Complementing its superior processing power, the C102 offers advanced serial I/O interfaces such as Serial ATA II and USB, in addition to the traditional Ethernet and serial I/O. These interfaces allow attachment of advanced fast peripherals and storage devices as well as pointing devices and other USB or SATA peripherals.

Ethernet

The C102 provides a total of four Ethernet ports. Two Gigabit Ethernet ports support 10BaseT/100BaseTX/ 1000BaseT, and two Fast Ethernet ports support 10BaseT/100BaseTx.

All four Ethernet MACs are integrated in the Discovery™ III System Controller and utilize dedicated SDMA (Serial DMA) engines to support their operation.

In its dual processor configuration, the C102 assigns two Ethernet ports (one GbE and one Fast Ethernet) to each of the two processing nodes. In the single processor configuration the primary processor controls the secondary Discovery™ III ports over the common PCI-X/PCI bus.

Serial I/O

The C102 provides eight serial ports supporting RS-232/422/485 physical interfaces.

Six of these channels are high-speed multi-protocol synchronous/asynchronous ports supporting all common serial communications protocols (UART, USART, SDLC, HDLC, BISYNC, Transparent, etc.)

The remaining two serial ports implement standard asynchronous UART-based ports.

Four of the high-speed multi-protocol serial channels are implemented using a PowerQUICC II communication processor. The PowerQUICC II resides on the primary fast PCI bus allowing high-speed operation and high throughput of the serial channels. Each of the PowerQUICC II serial channels is controlled through an SCC coupled with its SDMA (Serial DMA) engines and operating with minimal host processor intervention.

Four other serial channels, two per node, are integrated in the Discovery™ III System Controller. Two of the channels are high-speed multi-protocol interfaces and two are simple UART ports.

In its dual processor configuration, the C102 assigns two serial ports (one high-speed and one UART) to each of the two processing nodes. In the single processor configuration the primary processor controls the secondary Discovery™ III ports over the common PCI-X/PCI bus.

A special feature of the C102 is its dedicated external clock oscillator that feeds the baud rate generator (BRG). This external clock oscillator enables the C102 to support a wide range of a wide range of baud rate frequencies.

The default frequency of the external clock oscillator is 29,491,200 Hz, which enables of many baud rate frequencies, including 300, 600, 1200, 2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, 76800, 115200, 307200, and 1228800 bps. Other oscillators can be installed upon specific customer request.

Serial ATA II

The C102 provides one Serial ATA II channel implemented with a Silicon Image SIL 3124 PCI-X to SATA II Controller. The controller, which integrates both the SATA link and PHY, is fully compliant with the SATA 1.0 specification and the SATA II extensions, and capable of 3.0 Gbps SATA II operation. The controller also integrates two DMA engines and advanced SRAM elements to enhance its operation and achieve high bandwidth when communicating between the local PCI bus and the external mass-storage devices. The SATA controller is located on the primary fast PCI bus allowing for high-speed operation and throughput.

USB 2.0

The C102 includes two USB 2.0 (EHCI) ports, with backward compatibility to USB 1.0 and 1.1 (OHCI). A Philips ISP1562 USB host controller integrates the USB transceivers supporting high-speed, full-speed, and low-speed signaling, and provides power to down-stream devices over the USB interface. The controller is a PCI device capable of high data transfer rates through the use of its internal FIFOs and DMA engines.

The USB controller supports 33 MHz PCI operation and thus resides on the slower secondary PCI bus segment.

The optional SSD card uses one of the USB controllers. When an SSD card is included in the configuration, only one USB port is available for I/O.

MIL-STD-1553B

The C102 provides two on board dual redundant MIL-STD-1553B ports, implemented using two separate DDC BU-65864 PCI controllers. Each of the controllers is capable of BC, RT and MT operation.

The MIL-STD-1553B controllers support 33 MHz PCI operation and therefore are located on the slower secondary PCI bus segment.

Discrete I/O

The C102 is equipped with up to 16 single-ended or 8 differential general-purpose Discrete I/O channels. The Discrete I/O controller is integrated in one of the C102 logic elements. The channels can be independently set for single-ended TTL operation or as pairs for differential RS-422 operation. Each of the channels can be independently configured as input or output. Configured as input each of these channels may be programmed to generate an interrupt on any level shift event.

PMC I/O Expansion

The C102 provides two industry standard PMC expansion slots for extended flexibility and integration of additional I/O to the board.

Each of the PMC slots resides on a different PCI bus segment. PMC slot 1 is located on the secondary PCI bus supporting 64-bit at 33/66 MHz bus operation. PMC slot 2 is located on the common PCI bus, which is the fastest PCI bus segment available on the C102, supporting 64-bit PCI-X at 133/100MHz and PCI at 33/66 MHz bus operation. For both PMC slots the PMC installed will determine the bus operating frequency of all other PCI resources located on the corresponding PCI bus segment. The C102 provides support for the full PCI operation capabilities.

Both PMC slots are universal, capable of hosting PMCs with either 3.3V or 5.0V PCI signaling levels. All C102 on-board PCI resources are 3.3V devices with 5.0V tolerance. The keying for both slots is universal (no key).

I/O Routing

All I/O interface signals are available at the C102 P2 and P0 VME backplane connectors.

The C102 provides full backward compatibility with Aitech's previous generation C100/C101/C103 SBC I/O pin mapping at the VME connectors.

Since the I/O interfaces require more I/O pins than are available at the VME connectors, not all on-board and PMC I/O resources can be connected simultaneously. The C102 is available in two standard I/O configurations. One routes all on-board I/O resources to the VME connectors, with the remaining pins providing PMC I/O. The second configuration routes all PMC I/O to the VME connectors as per VITA 35 (PMC1 I/O routed to P2 rows A & C, PMC2 I/O routed to P0), with the remaining pins providing on-board I/O. The table below lists the I/O resources that each configuration provides.

	On-Board I/O	VITA 35
Gigabit Ethernet Ports	2	1
Fast Ethernet Ports	2	1
USB 2.0 Ports	2	1
SE/DIFF Discretes	16/8	2/1
High-Speed Serial Ports	6	5
UART Ports	2	2
SATA II	1	1
MIL-STD-1553 Ports	2	2
PMC1 Pins Available (P2)	1 – 49	1 – 64
PMC2 Pins Available (P0)	1 – 38	1 – 64

Transition Module

For convenient connection to the C102 I/O interfaces a transition module is available from Aitech.

The TM102 transition module provides accessibility to all C102 on-board and PMC I/O interfaces with industry standard connectors, eliminating the need for any custom made harnessing and complex cabling fixtures.

The TM102 may be installed in air-cooled chassis supporting front or rear plug-in units.

For more information on the TM102, refer to its product datasheet.

Timers

Each of the two processing nodes of the C102 is equipped with four 32-bit timers/counters. These timers provide high-resolution timing functionality as well as capability for long interval counting applications.

A Real-Time Clock (RTC) for time and date storage is provided in the primary node of the C102. The RTC is backed up by a large super-capacitor for long-term parameter storage.

The C102 provides two user programmable watchdog timers. The first is a standard timer, which will generate a timeout event when not serviced before the programmed time interval expires. The second timer is a windowed watchdog timer, which requires the timer toggling to be performed within a specific “window” of time; if the timer is serviced before or after the programmed time “window” it will generate a timeout event. Each of the two timers may be independently set to generate a non-maskable interrupt or reset the SBC.

Elapsed Time Recorder

An on-board electronic Elapsed Time Recorder (ETR) records cumulative operation time in dedicated NVRAM whenever the C102 is powered. The cumulative operation time can be read and reset by application software.

Temperature Sensors

The C102 contains four temperature sensors (three in the single processor version), one inside each PowerPC processor providing the die temperatures, and one adjacent to each card edge. The temperature sensor readings are output to the VMEbus.

Front Panel Connectors and Switches

The air-cooled version of the C102 SBC is provided with a front panel. The front panel includes the following:

- D-Type connector delivering two UART ports (one per node - splitter cable available separately)
- RJ-45 jack providing two Fast Ethernet ports (one per node - splitter cable available separately)
- Reset Switch

Aitech

Software

Test and Diagnostic Features

The C102 is supplied with an extensive firmware package. This package includes startup firmware (boot software), AIMon monitor/debugger tool, AIDiag diagnostic tool, and BIT. BIT may be executed during power-up or at any time after the board has been booted.

The C102 provides a COP/JTAG interface for each of the two processing nodes processors for debugging and development purposes.

RTOS Support

A BSP (Board Support Package) for the C102 is available for several RTOS (Real-Time Operating Systems), including WindRiver VxWorks 5.5 and VxWorks 6.x and Green Hills INTEGRITY®.

Other RTOS BSP may be available upon request.

The BSP includes drivers for all on board resources including inter-processor communication capabilities allowing the user to take full advantage of the board's powerful features.

Mechanical Features

The C102 is available in two mechanical formats:

- Air-cooled per ANSI/VITA 1-1994
- Conduction-cooled per IEEE 1101.2

Both mechanical formats are single slot 6U modules.

Custom metal frame provides excellent rigidity and shock resistance. In addition, a custom metal frame provides an array of stiffeners to support rugged PMC boards.

Dimensions

- Air-cooled: per ANSI/VITA 1-1994
- Conduction-cooled: per IEEE 1101.2

Weight

- Air-cooled: < 800 g (1.75 lbs)
- Conduction-cooled: < 900 g (2.0 lbs)

Mechanical Design & Thermal Management

The C102 employs a sophisticated and advanced mechanical design based on years of experience. The mechanical design allows for optimal heat conduction across the C102 and relief off the SBC, for both convection and conduction mechanical formats. This mechanical design also ensures the C102 rigidity and endurance under extreme environmental conditions.

C102 Air-Cooled

The air-cooled rugged C102 VME board fully complies with ANSI/VITA 1-1994. This includes a reinforced front panel, and add-on 3D monolithic finned heatsink/rugged stiffening frame for improved thermal and mechanical properties.

The two air-cooled PMC sites are ready for installation of commercial and rugged air-cooled PMCs that comply with IEEE STD 1386-2001.

The front panel is equipped with two insertion/extraction handles suitable for the VME64x forces, and with openings for the two PMC front panels. The board is shipped with easily removable filler panels in the PMC front panel openings.

C102 Conduction-Cooled

The conduction-cooled rugged C102 fully complies with IEEE 1101.2. It includes a thick 3D monolithic hard anodized aluminum heatsink with built-in stiffening ribs. The geometry of the heatsink ensures efficient heat conduction to the side rails. Wedgelocks attached to the heatsink hold the board firmly in place and ensure good thermal contact to the chassis for effective heat rejection from the board. This mechanical structure is extremely durable and particularly suitable to the high power BGA and SMT components mounted on the board. Low profile SMT components on the bottom side dissipate their heat to the card edges by an additional heatsink. This structure also creates a closed faraday cage structure, for superior EMI/RFI performance. Board extractors integral to the heatsink facilitate removal of the board from its enclosure.

For high efficiency cooling, the CPUs and other high power components are located near the card edges for short thermal paths to the chassis sidewalls. Component locations in combination with heatsink design result in balanced heat dissipation via the two card edges. PC board edges are trimmed so the one-piece heatsink is in direct contact with the chassis sidewall rails without interface of the PC board.

Two sites for conduction-cooled rugged PMCs meet the ANSI/VITA 20-2001 standard for assembly on the board. The PMC sites utilize a conduction path to the aluminum heatsink to transfer their heat to the carrier board's heatsink. Two removable ribs provide an additional heat transfer path for PMCs having a secondary thermal interface.

The conduction-cooled board contains no front panel and all PMC I/O signals are directed to the P2 and P0 I/O connectors of the board.

Power Requirements

The C102 takes all its power from the VME64x backplane. It should be provided with +5.0V, +3.3V and ±12V as defined by the VME64x specification (±12V are required for PMC compliance only, the C102 does not require ±12V for its own operation).

All other power sources required by C102 resources are generated on board.

Total power consumption of the C102 depends on its configuration and assembly options.

Fully featured, dual processor configuration, C102 power consumption is approximately 40 W, as follows:

+3.3 V	(± 5%)	3.8 A (nominal)
+5.0 V	(± 5%)	5.4 A (nominal)
+12 V	(± 10%)	0 A (no PMC mounted)
–12 V	(± 10%)	0 A (no PMC mounted)

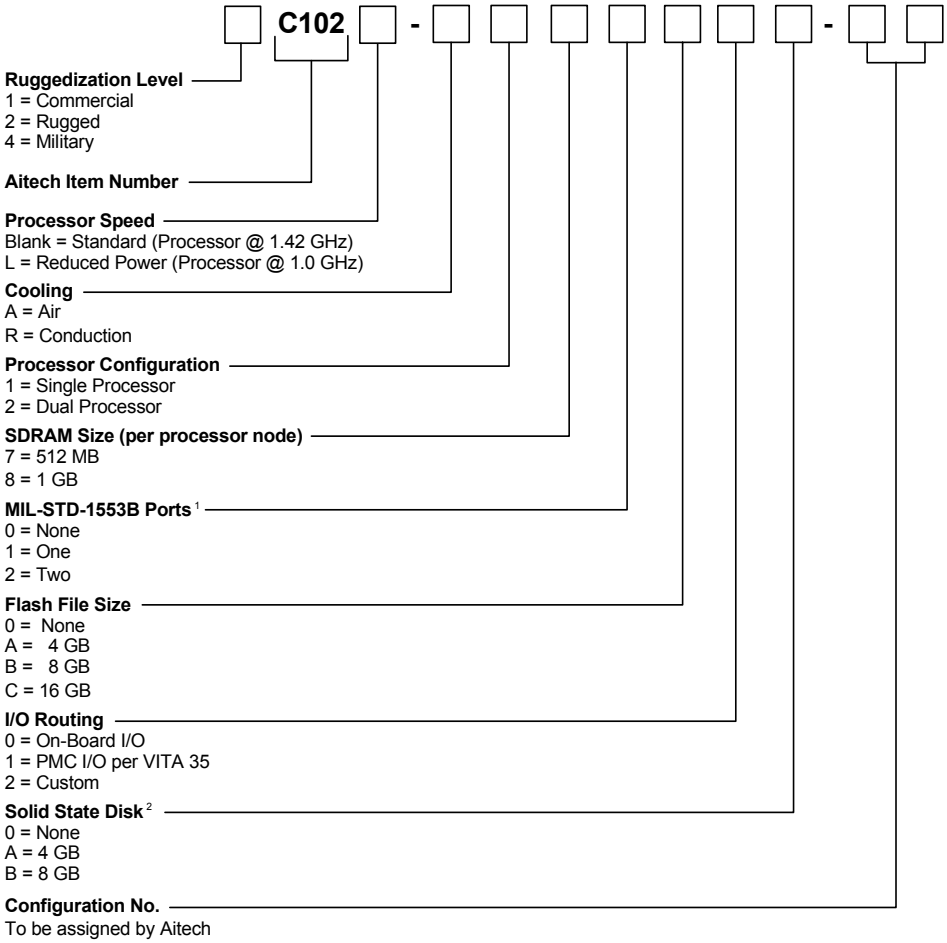
Environmental Features

All Aitech products are available in three levels of ruggedization and two mechanical formats. The ruggedization levels differ mainly in operating temperature, and resistance to shock, vibration, and humidity:

Ruggedization	Operating Temperature	Environmental Conditions
Mil Spec	–55º C to +85º C	Extreme
Rugged	–40º C to +71º C	Extreme
Commercial	0º C to + 55º C	Benign

All Aitech products at all levels of ruggedization are also available in both air-cooled and conduction-cooled mechanical formats. Please see the *Aitech Ruggedization Levels* data sheet for more information on selecting the ruggedization level that meets your specific needs.

Ordering Information for the C102



Example: 4C102-R272B0A-00

[1] Default configuration of MIL-STD-1553B controllers is transformer coupled. Direct coupling is optionally available.

[2] The solid state disk uses one of the USB ports. When a solid state disk is included in the configuration, only one USB port is available for I/O.