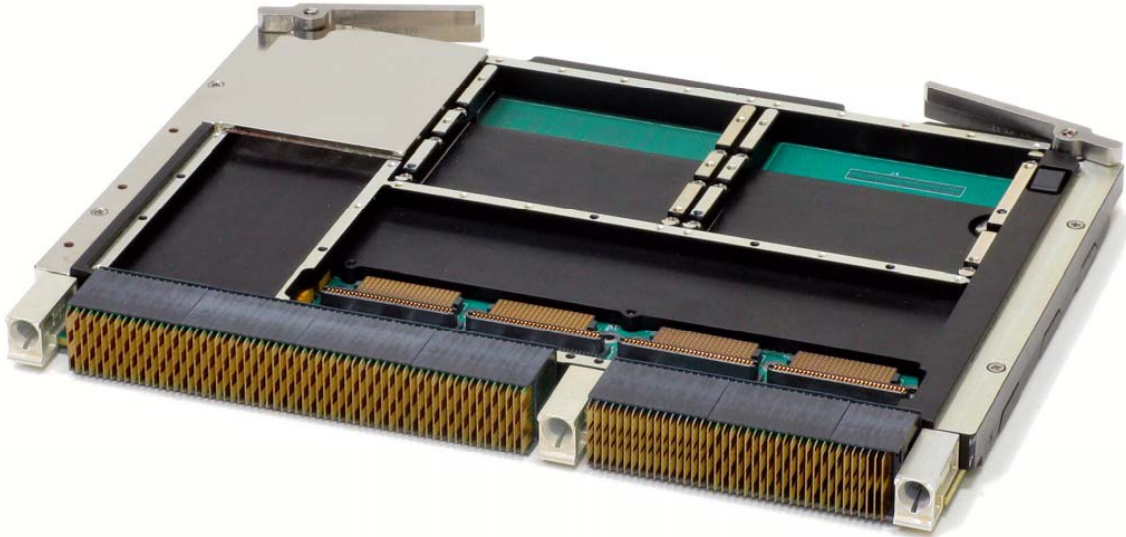
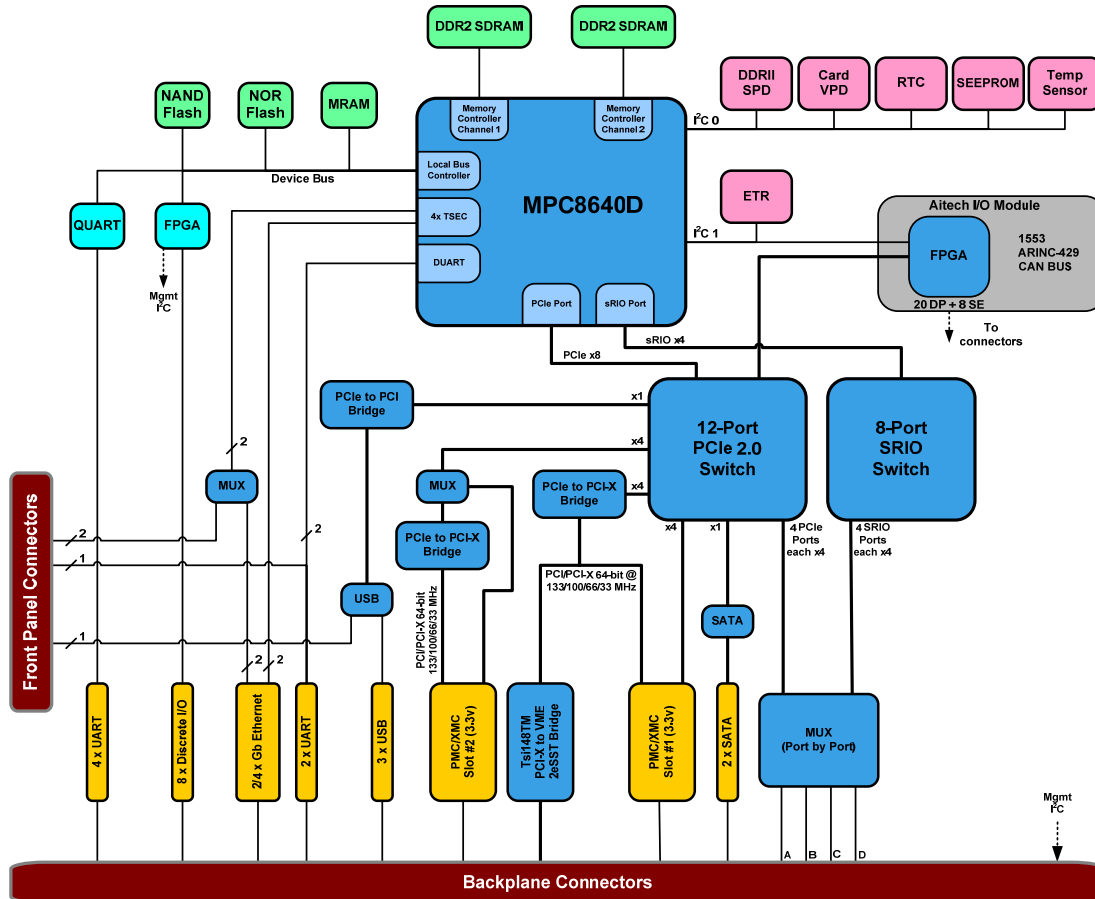




C110 MPC8640D 6U VPX SBC



- **Rugged 6U VPX Single-Slot SBC**
- **Freescale MPC8640D Processor**
 - Dual e600 Cores @1.25 GHz (1.066 GHz for Low Power C110)
 - 64 kB L1 & 1 MB L2 Cache per Core
- **Memory**
 - 2 GB DDR2 SDRAM with ECC (Dual Channel)
 - 256 MB NOR Flash Memory
 - 8 GB NAND Flash Memory
 - 512 kB NVRAM (MRAM)
- **Multiple Backplane Interface Options**
 - VPX Core Fabric - PCIe or SRIO
 - VME 2eSST with Legacy VME Support
- **I/O Interfaces**
 - 4 Gigabit Ethernet Ports
 - 2 SATA 2.0 Port
 - 4 USB 2.0 Ports
 - 6 Asynchronous Serial Ports Supporting RS-232/422/485
 - 8 Single-Ended TTL/4 Differential RS-422 Discrete I/O Lines
- **Expandability**
 - 2 PMC/XMC Sites Supporting PCI/PCI-X 64-bit up to 133 MHz and PCIe x4
 - Aitech I/O Module (AIOM) Site
- **System Resources**
 - Twelve 32-Bit Timers
 - Standard and Windowed Watchdog Timers
 - Real Time Clock
 - Elapsed Time Recorder
 - On-Board Temperature Sensors
- **5 V or 12 V Operation**
- **RTOS Support**
 - Wind River - VxWorks®
 - Green Hills - INTEGRITY®
 - Linux®
- **OpenVPX Compliant**
- **VITA 48 (REDI) Compliant**
- **Conduction and Air-Cooled Versions**
- **Vibration and Shock Resistant**



C110 Block Diagram

The C110 is the first Aitech PowerPC based product targeting the new VPX (VITA 46.0) and OpenVPX (VITA 65) platforms.

Defined by the VMEbus International Trade Association (VITA), the VPX standard was developed to define a new generation of computing systems that utilize high-performance switch fabrics over a new high speed connector, as well as operate in harsh environments. OpenVPX extends the VPX standard by defining standardized profiles for card slots, backplanes, modules, and development chassis. To ensure compatibility among VPX products from different manufacturers, OpenVPX was developed jointly by the VITA 65 Technical Working Group that includes representatives from Aitech and other major VPX developers.

The C110 is a VPX SBC based on the Freescale MC8640D Integrated Dual-Core Processor with on-chip, high speed L1 and L2 caches. Memory resources include large and fast DDR2 SDRAM, NOR Flash for firmware, user application and data storage, MVRAM for user/application specific parameters storage, and a high-density NAND Flash array for mass storage.

Integrated on-board I/O resources include Gigabit Ethernet, USB 2.0 ports, SATA 2.0, serial ports, and general-purpose discrete I/O channels.



The C110 supports serial switch fabric configurable as Serial RapidIO (SRIO) or PCI Express (PCIe).

The C110 is VME64x compliant per VITA 46.1, and supports VME advanced protocols such as 2eSST and 2eVME while maintaining full compliance with legacy VME operation.

To complement its extensive capabilities and provide extended resources and flexibility, the C110 is equipped with two PMC/XMC slots and an optional Aitech I/O Module (AIOM) slot allowing installation of additional I/O interfaces on the board.

C110 mechanical and electrical design guarantees its operation over the full range of rugged application environments. It is available in industry standard 0.8", 0.85" and 1" pitch conduction-cooled or 1" pitch air-cooled form factors.

The C110 is also available in the VITA 48 (VPX REDI) format with covers to support two level maintenance LRM requirements for the 0.85" and 1" pitch versions.

Functional Description

Board Architecture

The C110 is a single slot 6U VPX SBC designed around the MPC8640D integrated dual-core PowerPC processor combining a powerful processing platform with extensive I/O capabilities.

MPC8640D Integrated Dual-Core Processor

The MPC8640D delivers an I/O intensive state-of-the-art package that combines dual low power processing e600 cores with dual DDR2 memory controllers, PCIe, SRIO, DMA, Ethernet, and local device I/O. Operating at up to 1.25 GHz, the MPC8640D includes on-chip 32k/32k (I/D) L1 and 1 MB L2 caches per core.

For power sensitive applications, the C110 is available with a low power version of the MPC8640D, operating at 1.066 GHz. Using this processor, C110 power consumption can be reduced by up to 10W.

VPX Capabilities

VPX Data Plane Fabric Interfaces

The C110 supports 4 port-4 lane (x4) serial switch fabric on P1, to allow connectivity to other VPX agents (payload and expansion cards) in the system through the switch fabric. The switch fabric ports support both SRIO and PCIe with each of the 4 fabric ports (A, B, C and D) configurable to SRIO or PCIe through software. PCIe (VITA 46.4 compliant) is suited to connecting with PCIe and PCI-based peripheral devices, while SRIO (VITA 46.3 compliant) is ideal for processor to processor communications. PCIe port B can be configured as a non-transparent port enabling connection to root-complex boards.

VPX Control Plane Switch support

The C110 is capable of connecting to a switch slot per VITA 46.9 by routing two Gigabit Ethernet ports to P4, enabling the designer to connect those ports to a switch slot per VITA 46.20.

OpenVPX Slot Profile

The C110 supports two slot profiles (see ordering information) as defined in the OpenVPX specification (VITA 65):

- SLT6-BRG-4F1V2T
BRG = bridge and payload board
4F = four PCIe/SRIO fat pipes
1V = one VME port
2T = two 1000Base-T thin pipes (control plane)
- SLT6-PAY-4F2T.
PAY = payload board
4F = four PCIe/SRIO fat pipes
2T = two 1000Base-T thin pipes (control plane)

VPX System Management

System level management monitoring of board health status information (e.g. rail voltages, board temperatures, etc.) is available over the VPX connectors via the I²C bus at P0. The system management unit is powered from the VPX +3.3Vdc Auxiliary power supply and is available even in the event of board failure or power loss.

VPX REDI (Vita 48)

The C110 is VPX REDI compliant SBC. It supports two-level maintenance with top and bottom covers shielding the complete C110 assembly including installed PMC/XMC modules per VITA 48.

VPX VME Support

The C110 supports the legacy VMEbus on P2, P3, P4, and P5 as defined in VITA 46.1.

VMEbus interconnection is provided by a Tundra Tsi148 PCI-X to VME 2eSST Bridge. The VME Bridge is located on the PCI-X bus allowing for high-speed operation and throughput.

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

- 2eSST and 2eVME protocols
- Legacy VME64 protocols
- A64/A32/A24/A16 addressing modes



- MBLT/BLT/D64/D32/D16/D8 data transfer modes
- Interrupter/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.

Memory

The C110 is equipped with large memory arrays to compliment and support the high processing power.

SDRAM

A total of 2 GB of DDR2 SDRAM is provided in two banks. Each bank is controlled by a dedicated memory controller integrated in the MPC8640D.

The DDR2 SDRAM arrays are ECC protected guarantying high data integrity.

Boot/User Flash

Boot and User Flash on the C110 are implemented in a 256 MB NOR Flash memory device. 64MB is allocated as Boot Flash for Aitech proprietary firmware storage. Boot Flash employs protection measures to assure boot code protection. 192MB of the NOR Flash is fully available to the user for application storage, data logging, file system mounting and any other use required.

NVRAM

512 kB of NVRAM memory is provided by an MRAM device. MRAM technology provides non-volatile memory with unlimited writes, fast access, and long term data retention while powered down. NVRAM is available for application specific parameter storage and logging purposes.

NAND Flash

8GB NAND Flash is provided for solid-state mass storage.

I/O Interfaces

The C110 offers a diverse I/O feature set including Ethernet, SATA 2.0, USB 2.0, serial ports, and discrete channels. These interfaces allow attachment of a wide range of peripherals to the C110, including sensors, communication devices, storage media, pointing devices, and other peripherals.

Ethernet

Four Gigabit Ethernet ports are available, supporting 10BaseT/100BaseTX/1000BaseT. Ethernet ports are controlled through the MPC8640D integrated TSEC (Three Speed Ethernet Controller) units, configured for RGMII operation with the external PHY devices.

In air-cooled versions, two of the Ethernet ports are software configurable to be routed to front panel RJ45 connectors.

Serial I/O

The C110 provides six serial ports supporting standard asynchronous UART operation with RS-232/422/485 physical levels. The serial ports programming model fully complies with the 16550 UART model. Two of the channels (SP0 and SP1) are provided by the MPC8640D integrated DUART. These channels are naturally assigned as consoles for each of the processing cores but can of course be used for any other purpose. The other four channels (SP2 - SP5) are provided by an Exar ST16C554 Serial I/O controller.

The serial I/O controller resides on the processor's device bus.

Serial ATA (SATA) 2.0

Two SATA 2.0 channels (with backward compatibility to SATA 1.0) are implemented using a Silicon Image SIL 3132 PCIe to SATA II Bridge integrating the SATA link and the PHY. The SATA Bridge connects via a 1-lane (x1) PCIe bus and provides a transfer rate of 3.0Gb/s (may be limited due to PCIe bandwidth). The controller integrates two DMA engines and advanced SRAM elements to enhance its operation and achieve high throughput.

USB 2.0

Four USB 2.0 ports (with backward compatibility to USB 1.0 and 1.1 (OHCI)) are provided by a NEC uPD720101 USB host controller. The USB transceivers support high-speed, full-speed, and low-speed signaling.

Air-cooled versions provide one USB port at the front panel, with the remaining three ports routed to backplane connectors.

The USB controller resides on a 33 MHz PCI bus that is connected to the PCIe main switch via PCIe-PCI Bridge.

Discrete I/O

The C110 features eight general-purpose discrete I/O channels controlled through an PLD integrated controller. These channels are independently software configurable to operate as eight single-ended or four RS-422 differential channels. Each channel can be set independently as input or output. Configured as input these channels are capable of generating an interrupt on any level shift event.



Expansion Slots

PMC/XMC Sites

The C110 provides two industry standard PMC/XMC expansion sites for extended flexibility and integration of additional elements to the SBC. Each of the sites is capable of operating as PMC or XMC.

PMC1: operating in PCI/PCI-X mode, PMC1 shares a 64-bit PCI/PCI-X bus with the Tsi148 PCI-X/VME Bridge. This bus is interconnected to the SBC main PCI switch through a PCIe-PCI-X Bridge. With no PMC installed, the bus operates as PCI-X at 133MHz. With the PMC slot populated, this bus supports PCI-X operation at 100/66MHz and PCI operation at 33/66MHz bus depending on PMC capabilities.

Operating as XMC, XMC1 is connected to the main PCIe switch port through a 4-lane (x4) port.

PMC2: operating in PCI/PCI-X mode, the PMC is the only agent on this 64-bit bus segment interconnected to the SBC main PCI switch through a PCIe-PCI-X Bridge. The bus supports PCI-X operation at 133/100/66MHz and PCI operation at 33/66MHz.

Operating as XMC, XMC1 is connected to the main PCIe switch port through a 4-lane (x4) port. The PCI/PCI-X Bridge for the PMC2 site shares the same PCIe port with XMC2 through a software programmable switch.

An on-board logic control module probes the two PMC/XMC sites and automatically sets PCI/PCI-X or PCIe operation mode as well as PCI bus frequency according to XMC/PMC presence and PMC operation mode/frequency capabilities.

Both PMC slots are capable of hosting PMCs with 3.3V PCI signaling levels only.

PMC/XMC site 2 is the preferred site for high performance high power PMC/XMC modules. It is the only agent in its PCI/PCI-X segment allowing best performance with maximum of PCI-X operation at 133MHz. In addition, cooling at this site is better as it is located closer to card edge and further from the MPC8640D processor. This allows for a better heat relief path and better power distribution across the SBC.

Aitech I/O Module (AIOM)

To further expand the C110's capabilities, Aitech offers a line of proprietary I/O modules that mount to a dedicated high-speed high-density connector.

Examples of available modules include:

- MIL-STD-1553B - 2 dual redundant channels
- CAN Bus
- ARINC-429 channels
- Analog I/O

For a complete list of available modules, refer to the AIOM data sheet. Custom modules can be developed upon special order.

I/O Routing

PMC/XMC I/O routing on the C110 supports the P64S (PMC) and X20D38S (XMC) configurations as defined by VITA 46.9.

The following table summarizes PMC/XMC site capabilities and characteristics:

	PMC/XMC Site 1	PMC/XMC Site 2
Location	Inner Site	Outer Site
PCIe Interface	x4	x4
PCI Interface (max)	PCI-X 100MHz	PCI-X 133MHz
PCI I/O Signaling Levels	3.3V only	3.3V only
Pn4 routing (PMC)	P64S to P5	P64S to P3
Pn6 routing (XMC)	20D38S to P5, P6	20D38S to P3, P4
Max current available from +5Vdc ⁽¹⁾	2A/3A	2A/3A
Max current available from +3.3Vdc ⁽²⁾	2A	2A
+12Vdc _{AUX} ⁽³⁾	0.5A	0.5A
-12Vdc _{AUX} ⁽³⁾	0.5A	0.5A
Power per site (max)	10W	20W

Notes:
 (1) The lower figure applies when the C110 is powered by 12Vdc from the VPX backplane, and the higher figure when it is powered by +5Vdc.
 (2) +3.3Vdc is generated on-board the C110.
 (3) Taken from VPX backplane.

Transition Module

For convenient connection to the C110's multiple I/O interfaces, Aitech offers the TM110 transition module.

The TM110 provides easy access to all C110 on-board and PMC/XMC I/O interfaces through industry standard connectors, eliminating the need for any custom made harnessing and complex cabling fixtures.

The TM110 may be installed in air-cooled chassis supporting rear plug-in units.

For more information on the TM110, refer to its product datasheet.



System Resources

General-Purpose Timers

A total of 12 general-purpose 32-bit timers are available on the C110. These timers provide high-resolution timing functionality.

Real Time Clock

A Real-Time Clock (RTC) provides time and date storage. In the event of power loss, the RTC automatically switches to battery power available from the VPX backplane through VBAT line. The RTC is also backed up by a large super on-board capacitor allowing short term RTC storage in the event VBAT is not available.

Watchdog Timers

The C110 provides two user programmable watchdog timers integrated in the on-board PLD. The first is a standard watchdog timer that generates a timeout event when not serviced before the programmed time interval expires. The second is an avionics style windowed watchdog timer that requires service within a specific pre-defined time window. If the timer is serviced before or after the allowed window, it will generate a timeout event. Each of the two timers may be independently set to generate a non-maskable interrupt or to reset the SBC.

Elapsed Time Recorder

An on-board electronic Elapsed Time Recorder (ETR) records cumulative operation time and power on-off cycles in a dedicated NVRAM whenever the C110 is powered. ETR data is software accessibly by the user.

Temperature Sensors

The C110 contains three temperature sensors. One sensor is integrated in the MPC8640D to provide die temperatures, and the other two are located adjacent to the two card edges.

Status Indicators

Four hardware debug LEDs and four software debug LEDs are available on the C110 for diagnostics and debugging purposes.

In its air-cooled version the C110 includes two additional status indicators at the front panel. One is a primary/auxiliary power indicator and the second is user programmable.

Front Panel Connectors and Switches

In its air-cooled version the C110 is provided with a front panel with the following features:

- Mini D-Type connector delivering serial port 0
- Two RJ-45 connector delivering two GbE ports
- Abort/Reset push-button
- Type-A USB connector delivering one USB port
- Two Status Indicator LEDs

Software

The C110 is delivered with a comprehensive software package allowing the user to take full advantage of the SBC's capabilities.

Firmware Features

An extensive pre-burned firmware suite comprises several software entities providing the firmware infrastructure of the board:

Startup firmware is based on the open source U-Boot boot loader, and provides the following capabilities:

- Powerup sequence control
- Boot loader capabilities supporting various boot devices and file formats
- Hardware debugging tool
- Powerup BIT

Diagnostics, designed in a Linux environment, provide a powerful testing and verification tool

The C110 provides a COP/JTAG interface for debugging and development purposes.

OS/RTOS Support

The C110 is supported by several OS (Operating System) and RTOS (Real-Time Operating System) platforms for which complete BSPs (Board Support Packages) are available. These platforms include:

- Linux (various distributions)
- Wind River VxWorks 6.7
- Other RTOS BSPs may be available upon request.

Each BSP includes a complete set of drivers and utilities supporting all on board resources including inter-processor communication capabilities.

Mechanical Features

The C110 is available in four mechanical formats.

Features & Dimensions

- Air-cooled per ANSI/VITA 46.0
- Air-cooled REDI: per VITA 48.1
- Conduction-cooled per ANSI/VITA 46.0
- Conduction-cooled REDI: per VITA 48.2

All mechanical formats are single slot 6U modules.

Weight

- Air-cooled: < 1200g (2.7 lbs)
- Air-cooled REDI: < 1250g (2.8 lbs)
- Conduction-cooled: < 1350g (3.0 lbs)
- Conduction-cooled REDI: < 1400g (3.1 lbs)



Mechanical Design & Thermal Management

C110 Air-Cooled

The air-cooled rugged C110 fully complies with ANSI/VITA 46.0 and 48.1 (REDI). The mechanical/thermal design includes a reinforced front panel and a finned metal heatsink/rugged stiffening frame for improved thermal and mechanical properties.

The two air-cooled PMC/XMC sites are ready for installation of air-cooled PMC and XMC modules that comply with IEEE STD 1386-2001 and ANSI/VITA 42.3 respectively.

The front panel is equipped with two aluminum extraction handles suitable for VPX stresses, and with openings for the two PMC/XMC front panels.

The C110 in its air-cooled version is available in 1" pitch (slot spacing) only.

C110 Conduction-Cooled

The C110 employs a sophisticated mechanical design based on Aitech's many years of rugged SBC design experience. This design allows for optimal heat conduction across the board and heat rejection from the card edges. This design also ensures rigidity and endurance under extreme environmental conditions.

The conduction-cooled rugged C110 fully complies with ANSI/VITA 46. It includes a robust metal heatsink with built-in stiffening ribs. The geometry of the heatsink ensures efficient heat conduction to the side rails. A reverse thermal interface coupled with wedgelocks secure the board firmly in place and ensure good thermal contact with the chassis for effective heat transfer. This mechanical structure is extremely durable and particularly suited to the on-board high power components. The C110 also complies with ANSI/VITA 48.2 (REDI) supporting Two Level Maintenance. This is achieved through additional covers for the SBC bottom and over the PMC/XMC modules. 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 CPU 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.

The two PMC/XMC sites are available for hosting conduction-cooled rugged PMC and XMC modules that comply with ANSI/VITA 20-2001 and ANSI/VITA 42.3 respectively. The PMC/XMC sites provide a conduction path from the PMC/XMC primary thermal interfaces to the C110 metal heatsink for cooling of the mezzanines. Two removable ribs provide an additional

heat transfer path for PMC/XMC modules having a secondary thermal interface.

The conduction-cooled board contains no front panel and all PMC/XMC I/O signals are directed to the VPX backplane connectors.

The C110 in its conduction-cooled version is available in various mechanical formats and slot spacings: 0.8", 0.85", 0.85" REDI, 1", and 1" REDI.

Power Requirements

The C110 takes its power from the VPX backplane. It supports both +12 Vdc (at VS1 & VS2 pins) and +5 Vdc (at VS3 pins). Selection of the input power is factory configured according to the ordering information. The board requires the +3.3 Vdc_{AUX} for the operation of its on-board system management unit. It does not make use of the ±12 Vdc_{AUX} power supplies, though it does provide them to the PMC/XMC sites.

Other power supplies used by C110 resources are generated on board.

Total power consumption depends on configuration and assembly options. Fully featured, C110 power consumption is 60W nominal without PMC/XMCs, as follows:

- Primary power supply
 - +12 Vdc (±10%): VS1, VS2 5 A (nominal)
- OR
- +5 Vdc (±5%): VS3 12 A (nominal)
- Auxiliary power supplies
 - +3.3 Vdc_{AUX} ± 5% 0.5 A (nominal)
 - ±12 Vdc_{AUX} (± 5%) 0 A
(PMC/XMC use only)

Environmental Features

As with all Aitech products, the C110 is 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	-55° C to +85° C	Extreme
Rugged	-40° C to +71° C	Extreme
Commercial	0° C to + 55° C	Benign

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



Ordering Information for the C110

