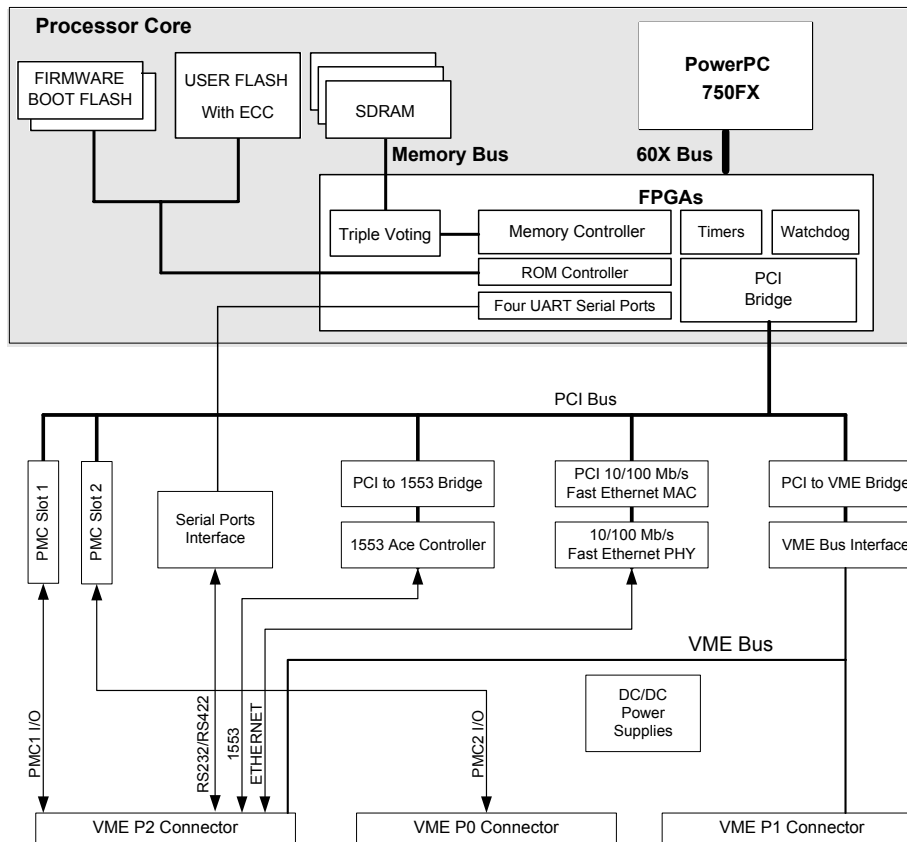




# S220 Radiation Tolerant PowerPC SBC



**S220 Block Diagram**

- **Single-Slot Conduction-Cooled VME SBC Specifically Designed for Space**
- **High performance low power PowerPC™ processor**
- **256 MB of SDRAM arranged in a triple voting architecture (3 bits per cell)**
- **ECC and parity protected on-chip L1 and L2 cache**
- **2 MB Boot & 64 MB User Flash Memory**
- **256 MB FlashFile™ Memory**
- **Ethernet Interface (10/100 Mbps)**
- **Four RS232/422 Interfaces**
- **Dual-Redundant MIL-STD-1553B**

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## ***S220 Radiation Tolerant PowerPC SBC***

Aitech's S220 Radiation Tolerant PowerPC Single Board Computer is a powerful rugged VME board, specifically designed to operate in the harsh space radiation environment.

The S220 board is powered by a high performance, low power, and Silicon on Insulator (SOI) PowerPC microprocessor. The SOI technology reduces power consumption, and significantly increases processor speed and radiation tolerance.

On-board memory resources are protected from radiation effects utilizing a number of strategies: SDRAM is triple redundant, with a voting mechanism incorporated in a radiation tolerant FPGA. Boot Flash integrity is guaranteed by dual redundancy (i.e. two independent banks of boot Flash) in combination with a watchdog mechanism. Once the board is successfully powered up, any defective boot Flash is overwritten by the contents of the intact boot Flash, to provide two successful copies for future operations.

Complimentary memory resources consist of 64 MB of ECC protected user Flash and 256 MB of ECC protected FlashFile™ memory.

To ensure reliability in the space radiation environment, radiation tolerant devices are used for the PowerPC System Controller (PCI bridge and Memory Controller), and other critical system functions including four 32-bit user programmable timers/counters, watchdog timer, reset mechanism, VME Bridge, and 1553 Controller.

In addition, the S220 SBC provides a latchup immune fast Ethernet controller, a fast Ethernet interface, four serial ports, and two standard conduction-cooled PMC slots.

To expedite the transition from development to deployment, Aitech provides 100% software compatible commercial level boards.

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### ***Functional Description***

#### ***Central Processing Unit***

The microprocessor selected for the S220 is a low power, high performance PowerPC that delivers unmatched computing power with maximum power dissipation of just 1.6 watts.

The proprietary SOI process used to fabricate the PowerPC microprocessor results in excellent radiation tolerance characteristics along with low power consumption and increased processing power.

In addition to its enhanced reliability and wide operating temperature range, the low power microprocessor includes several new features to boost performance.

Two integer ALU units, 32 kB L1 and 512 kB L2 on-chip data and instruction cache along with dynamic branch prediction, dramatically increase processing power.

The two cache units (L1 and L2) maintain high data integrity by protecting their data with ECC/Parity protection mechanisms.

#### ***Memory***

##### ***Memory Controller***

The PowerPC memory controller is used to control SDRAM and different types of Flash devices. The memory controller also includes the memory data integrity circuits, which are needed to enhance the system reliability in space environment applications.

##### ***SDRAM***

The board includes up to 256 MB of triple redundant SDRAM. A voting mechanism implemented in a radiation tolerant FPGA ensures integrity of SDRAM data. The three SDRAM arrays are physically located relatively far from one another on the board to reduce the probability for a single radiation event affecting more than one of them.

##### ***User Flash Memory***

The S220 includes 64 MB of non-volatile User Flash memory ensuring sufficient memory resources for numerous applications. For integrity of applications residing in User Flash, the devices are protected by an ECC mechanism implemented in a radiation tolerant FPGA.

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### **FlashFile™ Memory**

The S220 provides 256 MB of FlashFile™ memory used for solid-state mass storage. The FlashFile™ is protected by software ECC to mitigate radiation effects.

### **Boot Memory**

The S220 includes 2 MB of dual redundant boot Flash used to store the on-board BIOS. The two boot Flash devices are located far from one another to reduce the probability of a single radiation event affecting them both.

Corruption of boot Flash data results in failure of the S220 to complete the boot process or failure to service the watchdog timer implemented in radiation tolerant FPGA. In such a case, the second boot Flash becomes active resulting in a reliable boot process. Following successful boot up, data in the corrupt boot Flash is overwritten by the contents of the intact device to reestablish two good copies.

### **PCI Local Bus**

Design of the S220 is based on the 32-bits wide and clocked at 33 MHz PCI local bus. The PCI bus can be populated with peripherals requiring fast access to each other, and can be accessed by the host processor at high speeds. All read and write transfers over the PCI bus are burst transfers, with burst duration negotiated between the initiator and target devices.

Implemented in a radiation tolerant FPGA, the PowerPC local bus to PCI bus Bridge device provides the interconnection between the microprocessor to the PCI bus.

### **VMEbus Interface**

A complete VME64x bus interface is provided by a PCI to VME Bridge bus controller implemented in a radiation tolerant FPGA.

The master-slave interface includes the system controller function and high speed DMA transfer capability to support the more advanced VME modes. All VMEbus options are software programmable.

### **I/O Interfaces**

#### **Ethernet Interface**

The Ethernet interface supports either the standard 10 Mbps or fast 100 Mbps Ethernet links. The physical interface is a 10BaseT/100BaseTx twisted pair.

The Ethernet Interface uses latchup-protection circuit to mitigate its soft radiation characteristics.

#### **Serial Interface Ports**

The S220 features four standard RS232/RS422 serial ports implemented in a radiation tolerant FPGA. These ports provide maximum asynchronous baud rate of 115.2 kbps. The electrical interface is a standard RS232 and RS422 interface.

#### **Mil-STD-1553B Interface**

The 1553B interface includes a space level 1553B-interface controller featuring a transceiver, encoder/ decoder, complete 1553B protocol, 64K words of shared RAM and memory management logic for all three modes (BC\RT\MT).

#### **Two PMC interfaces**

To allow for a high degree of flexibility and I/O expansion the S220 is equipped with two PMC sites (VITA 20-199x). The PMC cards mount rigidly along the card's stiffening ribs to ensure reliable operation in high shock and vibration environments. This also provides a low resistance thermal path for heat removal in conduction-cooled applications.

The two PMC interfaces are connected directly to the local 32-bit, 33 MHz PCI bus. 32-bit wide PMC units are also supported by the S220 architecture. Standard rugged off the shelf PMC mezzanine modules may be purchased from Aitech or from third party vendors allowing easy enhancement of the S220 functionality.

#### **Timers/Counters**

Four 32-bit counters/timers are implemented in a radiation tolerant FPGA. These timers/counters are software programmable and may be programmed at regular intervals or act as general-purpose timers/counters.

#### **Watchdog Timer**

The S220 incorporates an on-board hardware watchdog timer implemented in a radiation tolerant FPGA. The watchdog timer provides a fail indication or resets the CPU if an execution failure is detected. It is programmable and may be enabled or disabled through software.



## Software

### Test and Diagnostic Features

- The S220 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 S220 provides a COP/JTAG interface to the processor for debugging and development purposes.
- On board firmware upgrade is possible via the RS-232 console port.

### Operating Systems

- The S220 is supplied with a complete Board Support Package (BSP) for WindRiver VxWorks.
- Other Real-Time operating systems (RTOS) support may be available upon request.
- The BSP includes drivers for all on board resources allowing the user to take full advantage of the board's powerful features.

### Mechanical Features

- The S220 is available in conduction cooled format per IEEE 1101.2 single slot 6U module.
- Custom metal frame provides excellent rigidity and shock resistance. In addition custom metal frame provides an array of stiffeners to support rugged PMC boards.

### Dimensions

- Conduction cooled: per IEEE 1101.2

### Thermal Management

- A careful mechanical design including custom heatsink modules, wedge locks and extractors combined by a metal frame allow for optimal heat dissipation and strength of the board.

### Power Requirements

- The S220 may be configured to receive all its power from the VME backplane +5.0V supply and generate +3.3V using on board power circuits or it may be configured to take the +3.3V also from the backplane supply as defined in the VME64x specification.
- Total power consumption of the S220 depends on its configuration and assembled options.
- Fully featured and configured to take all its supply from the +5.0V power supply, its power consumption is estimated as follows:

+5V ( $\pm 5\%$ )	3.0A (typical)	3.5A (max)
+12V ( $\pm 10\%$ )	0.05A (typical)	0.1A (max)
-12V ( $\pm 10\%$ )	0.05A (typical)	0.1A (max)
+3.3V (optional)		

### Radiation Performance

- Radiation Tolerant with a Minimum Total Ionization Dose of 20 krad (Si)
- Latch-up Immune with a high LET of 37 MeV $\cdot$ cm<sup>2</sup>/mg
- Low SEU Rate – less than 1 upset per 25 years of operation
- Design for Short and Long-Term LEO and Mars Terrestrial Environments

### Environmental Features

Please Refer to Aitech Ruggedization Datasheet

For more information about the S220 or any Aitech product, please contact Aitech Defense Systems sales department at (408) 980-6200.

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