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RapidIO

DATASHEET

MERCURY COMPUTER SYSTEMS™

PowerStream 7000 System

Integrated System Designed for Performance and Built for Deployment



- High-Density Computing with over 1 TeraFLOPS Peak Performance
- Support for Open Hardware and Software Standards
- RapidIO-Based Communications with 60 GB/s Bisection and 75 GB/s Aggregate Bandwidth
- 16 GB/s Streaming Fiber I/O
- Patented Air-Cooling System with ManagedAir™ Technology

The PowerStream® 7000 system from Mercury Computer Systems delivers extreme processing density with one TeraFLOPS or more of total processing power within an air-cooled, deployable chassis. Optimized for the deployment of high-end image and digital signal processing applications in the harsh, confined environments of airborne, oceangoing, or landmobile platforms, the PowerStream 7000 system provides an exceptionally powerful solution based on open hardware and software standards.

Based on PowerPC® 7447 microprocessors with AltiVec™ technology and the RapidIO® communications fabric, the PowerStream 7000 system offers performance density exceeding 150 GFLOPS per cubic foot. Fitting more processing power into tight spaces enables full signal and image processing closer to the sensor in mobile platforms.

The RapidIO switch fabric connects more than 120 processor and I/O nodes in a single system, with up to 75 GB/s of aggregate bandwidth and 60 GB/s of bisection bandwidth. This bisection bandwidth is a measure of the worst case communication bottleneck in the system. Combined with up to 60 GB of memory in the system, this high bandwidth enables the next generation of adaptive signal processing algorithms on large images and data sets.

Compact, rugged, and powerful, the Mercury PowerStream 7000 system satisfies the needs of the most demanding real-time radar and signals intelligence applications. Its unique, highly scalable architecture provides flexibility for custom configurations of processors, memory, and I/O to suit any deployment mission.

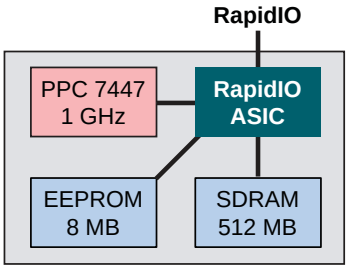
High-Performance Image and Digital Signal Processing

The PowerPC 7447 microprocessors in PowerStream systems combine a superscalar RISC architecture with an AltiVec parallel vector execution unit. These processors accelerate mathematical operations common to signal and image processing applications. For example, running at 1 GHz, a 1K complex FFT can be performed in less than 9.1 microseconds.

Each compute node (CN) includes a PowerPC 7447 microprocessor, 512 MB DDR SDRAM, and 8 MB Flash EEPROM, all connected to the RapidIO switch fabric by a Mercury RapidIO CN ASIC. The PowerPC 7447 includes a 32 KB instruction and 32 KB data L1 cache, and an on-chip 512 KB L2 cache. The double data-rate SDRAM enables overlapping memory access requests from the local processor and remote accesses over the RapidIO switch fabric. An 8 MB Flash EEPROM on each node is used for built-in test and OS booting.

The RapidIO CN ASIC acts as both a memory controller and as a network interface to the RapidIO switch fabric interconnect. The CN ASIC includes an enhanced DMA controller, a high-performance memory system with error checking and correcting, metering logic, and a RapidIO interface. By integrating memory control and the network interface, Mercury's CN ASIC provides functionality and performance not achievable from separate components. The CN ASIC also contains architectural advancements that enhance concurrency between arithmetic and I/O operations.

The true power of the PowerStream 7000 system is realized when applying many processors to a single algorithm step, working as a finely coordinated team. The processors, enhanced DMA controllers, and RapidIO switch fabric combine to drastically lower the latency while increasing the processing throughput.



PowerStream 7000 compute node

RapidIO-Based Solutions from Mercury

The RapidIO interconnect is an open standard certified by ISO and IEC, but only Mercury has the experience to deliver it as a reliable, low-risk, high-performance embedded multiprocessing solution. As the pioneer of heterogeneous switch fabric-based computing and co-developer of RapidIO technology, Mercury is uniquely equipped with system expertise, application expertise, and support and consulting resources to craft RapidIO-based systems that achieve unprecedented performance for individual customer requirements.

In PowerStream 7000 systems, the RapidIO fabric is formed by switch modules within the chassis card cage. Each module provides 24 connections across the passive backplane to processing module slots, and up to four switch modules can be interconnected within a system. The full configuration provides 60 GB/s of fully connected communication through the backplane and switch modules.

Standards-Based Mezzanines

Switch modules also provide the sites for mezzanine cards that support standards-based extensibility for functionality such as sensor I/O and interchassis communications. The four mezzanine sites along the front panel of each switch module can accept IEEE 1386.1 standard PMCs, or XMC cards. (The pending VITA 42.1 standard addresses XMC cards with RapidIO communications.) The four mezzanine sites at the back of the modules are XMC sites, with optical connections available to the front panel.

Switch modules include PowerPC 440GX microprocessors running VxWorks for I/O control and driver support for the PMC sites, plus 64 MB of flash memory for fast booting.

Each switch card also provides four 1 Gbit Ethernet connections for standard I/O, and four 100 Mbit Ethernet connections for system communication. All of the 1 Gbit Ethernet connections and one of the 100 Mbit Ethernet connections are accessible at the rear of the chassis. The three remaining 100 Mbit connections from each switch module go to each of the other three switch modules.



PowerStream 7000 sub-chassis

Sensor Data FPDP I/O

The PowerStream 7000 system provides streaming sensor data I/O through serial front panel data port (FPDP), ANSI/VITA 17.1-2003 connections. This industry standard enables FPDP communications over fiber media.

RapidIO-connected Serial FPDP XMC mezzanine cards can be mounted in both front and rear positions on the switch module in the PowerStream 7000 system, for up to 32 cards. Each XMC card provides two bi-directional I/O ports per card, each with peak data rates of 250 MB/s and sustained data rates of 247 MB/s per port. With up to 16 GB/s of streaming I/O in the system, the PowerStream 7000 system matches I/O performance to its exceptional computational power. The XMCs can also be used to provide additional output bandwidth.

Built for Deployment

The PowerStream 7000 system is designed to satisfy the reliability, availability, and serviceability (RAS) needs of field applications. Internally, PowerStream 7000 systems use the industry-standard Intelligent Platform Management Bus IPMB) and PICMIG 2.9 IPMI over LAN (100 Mbit Ethernet) as the out-of-band fabric for system control and monitoring, and fault isolation and recovery. System configuration, monitoring, and reset can also be accessed by the application software through a Mercury API. Warnings and failures are indicated locally through frontpanel lights. The system automatically monitors fan failure, power supply failure, and chassis intrusion. Optional monitoring is available for under/over temperature and airflow. Normally, faults cause the system to power down immediately or after a warning, or prevent system power-up. The system can be configured to override certain of these faults, or allow the user to override them using the "battle short" switch.



PowerStream 7000 commercial environment rack configuration with door removed

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Serviceability features include a passive backplane with RapidIO fabric switches implemented on switch modules accessible from the front of the system. Processing modules, power supplies and peripherals can also be installed and removed through the front. During power-on self-test (POST), diagnostics run out of the flash on each module. The results of these diagnostics are available out-of-band before the modules are joined together to form a multicomputer. This testing from the inside out provides excellent fault isolation. Slot keying ensures proper replacement of boards during service. Built-in-Test (BIT) software ensures system integrity at startup and continuously during operation.

Commercial-Environment Systems

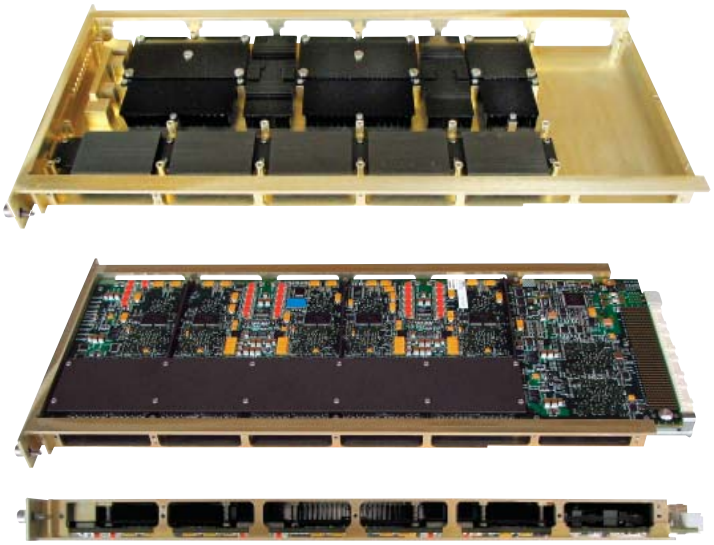
Mercury delivers the PowerStream 7000 as a rack-based system for commercial environments. The commercial environment chassis is mounted in a rack with external, rack-mounted power supplies and peripherals. The full system is tested to commercial temperature, EMC, and safety specifications.

Rugged Sub-chassis

The structural ruggedness of the PowerStream 7000 system comes from a combination of the rugged sub-chassis and the structural support in the board covers. The rugged sub-chassis includes the card cage, chassis sides, backplane, and power bus bars. Together, the sub-chassis and boards provide the infrastructure to meet shock, vibration, humidity, temperature, and altitude requirements. Deployed programs may use the design of the rugged sub-chassis as a foundation for adopting PowerStream 7000 systems to the power, air movement, and the shape of their platform.

Patented Air Cooling System with ManagedAir Technology

The PowerStream 7000 system utilizes patented** ManagedAir™ cooling technologies to provide sufficient cooling to satisfy extreme performance density requirements. ManagedAir technology is a system-level approach to meeting the challenges posed by the escalating power consumption of today's processors and infrastructure chips, especially in military environments.



Example of ManagedAir board cover and mounted board

Implemented at all levels from the component through the chassis, ManagedAir cooling maximizes the effectiveness of unconditioned moving air, allowing the system to support higher-performance processors and their associated circuitry without conduction cooling, liquid cooling, or other exotic cooling techniques. The result is a simpler, lighter system that is easier to deploy and maintain.

For example, ManagedAir technology encloses each printed circuit board assembly with a custom-designed cover that is tailored to the profile, placement, and airflow requirements of the board's components. The cover's topography manages the airflow for that board by directing air through the heat sinks, increasing their cooling capacity.

At the slot level, ManagedAir technology manages the airflow to get an even distribution from front to back and across all the slots. The covers for each board regulate the airflow and stay with the board as it is moved or replaced.

For high-temperature rugged systems, ManagedAir technology optionally enables an air intake in the middle of the chassis, between the two rows of processor boards. This arrangement achieves two leading edges of inlet air, enabling high density without resorting to "columns" of the hot components, such as processors, heating one another. The board covers also provide a degree of inherent ruggedness for PowerStream 7000 systems. In addition to increasing cooling efficiency, board covers and other features add rigidity to the boards, eliminating the need for stiffeners and other ruggedizing techniques to protect against shock and vibration.

Optimized for Programmability

Existing RACE Series® and RACE++® Series applications readily move to the PowerStream 7000 environment, protecting customer investments and providing a smooth growth path for fielded systems. Mercury also helps developers of new applications overcome the challenges of programming real-time multicomputers through its commitment to industry standards and leading-edge tools.

The Mercury SAL math library performs complex digital signal processing operations, taking full advantage of the AltiVec architecture's built-in vector processing enhancements. SAL's simple API lets developers work with logical operations such as vector transformations and FFTs with a single command, rather than laboriously hand-coding each routine for the target processor. When necessary, a single SAL function generates multiple AltiVec commands and lines of optimized assembly-language code to complete the operation.

A subset of SAL has been restructured to conform to the Vector Signal and Image Processing Library (VSIPL) standard. VSIPL-Lite implements the VSIPL Core Lite function profile of the standard, which contains the 125 most common functions for real-time signal processing. With performance that nearly equals SAL, VSIPL-Lite is a prime example of how Mercury maintains a focus on performance while achieving portability through standards.

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Mercury systems are designed to work with multiple processors across the switch fabric network. The MCOE™ multicomputer operating environment includes multiprocessor services such as the global resource manager, system name server, and a kernel. Through the leading-edge performance of the Mercury Parallel Acceleration System (PAS™), Mercury's multiprocessor communication software is designed to reduce the time to deployment for complex systems.

PAS reduces programming time and maximizes system performance through a library of C functions used to develop parallel applications in a distributed-memory multicomputer system. These functions manage the details of implementing highly parallel applications. They also increase software scalability by making it easy for developers to add or reassign processors with minimal changes to the application code. PAS also fully supports the Data Reorganization Interface (DRI) standard. DRI allows users to efficiently reorganize data during interprocessor data movements, and the standard API improves the portability of user applications.

Mercury also provides application development tools, including the TATL™ Trace Analysis Tool and Library, which creates a graphical representation of multiprocessor operations without disrupting process flow. Unlike other process monitoring tools, TATL is minimally intrusive, so the effects of data collection are usually negligible. This allows developers to test and tune applications with confidence that the testing will not adversely affect operation.

The MULTI® Integrated Development Environment (IDE) enables programmers to use familiar, mainstream tools to develop real-time processing routines. The MULTI IDE source-level debugging, profiling, error checking, and version control facilities streamline development of complex multiprocessor software.

Mercury also provides software tools that help monitor system operation, and detect and isolate system problems. The CheckMC suite is a flash-resident, onboard hardware diagnostic utility. It provides power-up testing and user controlled offline testing using an inside-out testing model. With both power-on and offline testing modes of operation, users can have both speed and thoroughness.

Mercury Customer Support

Mercury provides a full range of support services that include customized system design and integration, application software development, phone and field technical support, third-party product certification and integration, training, and senior-level consulting. Mercury also provides online support tools, technical publications, and training registration that can be accessed through the Mercury customer web site.

Power for Leading-Edge Applications

The PowerStream 7000 solves the embedded real-time computing industry's need for exceptional performance in a limited space. Designed for deployment and programmability, PowerStream systems are the ideal platform for next-generation image and digital signal processing applications. Contact Mercury for more information about PowerStream, RapidIO, and RACE++ hardware and software solutions.

Specifications

Electrical

External Communication Ports

(16) 1 Gbit Ethernet interfaces

Availability and Serviceability

Internal Bus: I2C/IPMB, 100 Mbit Ethernet

External Bus: 100 Mbit Ethernet

Power Input

180 - 264 VAC, 47 - 63 Hz, 3Ø

NEMA L21-30P inlet

Note: max power draw for fully configured system with 1.0 GHz processor boards is estimated as 4.2 kW

Commercial Environment*

Humidity	
Operating	5-90% non-condensing
Non-operating	5-95% non-condensing
Temperature	
Operating	5 to 35°C at max of 6,000 ft.
Non-Operating	-40 to 70°C at max of 35,000 ft.

Contact Mercury for rugged system specifications.

Configuration Options

Processors	20 to 120 compute nodes
Bandwidth	15 to 60 GB/s bisection bandwidth
Mezzanines	2 to 64 serial FPDP interfaces

*As altitude increases, air density decreases, hence the cooling effect of a particular CFM rating decreases. Notice that the above operating temperature is specified simultaneously with an altitude. Different limits can be achieved by trading among altitude, temperature, performance, and airflow.

** U.S. Patent No. 6,661,657

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