

Thunderbolt

VME Multiprocessor Boards and Systems



- ◆ **Best Price/Performance of High Performance Embedded Computers**
 - 16 GFLOPS per 6U VME slot, 64 GFLOPS per 9U VME slot
- ◆ **Scalable Systems: Proven and Reliable**
 - Up to 256 processors/system
 - 1.024 or 2.048 GB SDRAM per compute module
- ◆ **Integrated Lifecycle Support**
 - Proven history of software portability
- ◆ **Deployment Ready**
 - Field tested advanced packaging

For nearly 25 years SKY Computers has been building some of the world's fastest and most reliable embedded computers. We supply more than half of the computers for explosive detection systems that scan luggage at airports across the United States. SKY also builds the industry's most powerful commercial computer systems and has deployed systems that have successfully met the demanding requirements of ruggedization for airborne radar applications.

Thunderbolt™ is a new generation of embedded computers that deliver unprecedented levels of scalability, reliability and price/performance for demanding applications. Field-tested packaging and connector technologies make the new 6U and 9U Thunderbolt VME boards deployment-ready for harsh environments, leveraging advanced stiffening technologies to increase vibration tolerance. Thunderbolt is aggressively priced well below currently available high performance embedded computers.

The Thunderbolt family uses the 500 MHz PowerPC MPC7410 microprocessor and the ANSI/VITA standard SKYchannel interconnect fabric, delivering optimal computing and I/O performance. The advanced SKYvec® software development environment provides tools that simplify complex multiprocessor programming. The 6U Thunderbolt V-600 is configured with one Compute Module of four MPC7410's and one optional I/O Module. The 9U Thunderbolt V-900 can be configured with up to four Compute Modules of four MPC7410's (16 processors). The Thunderbolt V-900 includes a built-in I/O module.

The new Thunderbolt family of embedded computers is 100 percent compatible with SKY's previous SKYbolt® family of products. Customers can easily upgrade to the new Thunderbolt family without re-writing their applications.



Thunderbolt: Delivering Optimal Compute and I/O Performance

The 6U and 9U Thunderbolt boards provide all the resources required to obtain optimal performance from SKY's compute and I/O modules. The 6U VME Thunderbolt V-600 is configured with one compute module of four MPC7410 processors. The 9U VME Thunderbolt V-900 can be configured with up to four compute modules and 16 processors. The Thunderbolt V-900 uses stiffening bars and advanced packaging technology that increases its vibration tolerance. The resonant frequency of for Thunderbolt V-900 is beyond what is currently available for 9U VME boards in the COTS arena.

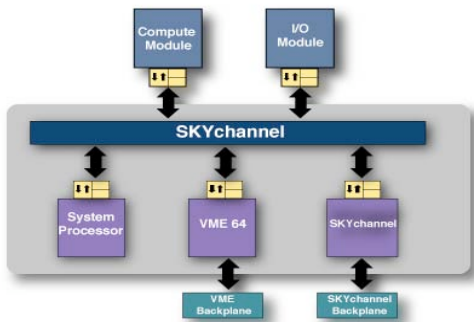
The new Thunderbolt family of embedded computers is 100 % compatible with SKY's previous SKYbolt® family of products. Customers can easily upgrade to the new Thunderbolt family without modifying their applications.

Data is transferred throughout the Thunderbolt over the SKYchannel Packet Bus at 320 MB/sec. Data moves transparently through the SKYchannel P2 interface to other boards in a SKYchannel chassis. The Thunderbolt V-900 includes a second SKYchannel at the P3 interface. System control is handled by the System Processor, which performs I/O and operating system tasks that would otherwise burden the compute processors. A full VME 64 interface provides communication to the host and other off-board communication. The application runs on the processors resident on the compute module. Front-panel I/O expansion modules are built in to the 9U and may be added to the 6U for maximum I/O performance.

Thunderbolt Features

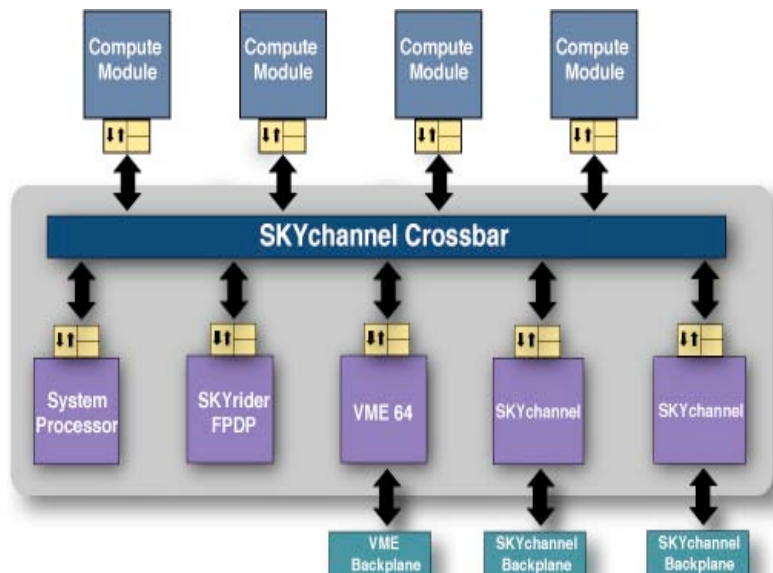
- 2 MB of 250 MHz backside L2 cache
- 2 GB/sec L2 cache bandwidth
- 1 GB/sec memory bandwidth per processor
- 1 GB/sec inter-processor communication
- High performance with superior reliability
- 320 MB/sec SKYchannel

Thunderbolt V-600 6U Architecture



- Software Standards: VSIP, MPI
- SKYvec compilers automatically optimize, strip-line, and vectorize
- Standard Math Library automatically calls hand-coded vector and low-level functions
- All hardware interfaces are open standards: VME64, SKYchannel, FPDP

Thunderbolt V-900 9U Architecture



System Processor: Offloading System-Level Functions

The Thunderbolt employs a System Processor (SP) to off-load system-level functions from the compute processors. At its' core is an Intel i960HD™ superscalar processor. SKY adds 2 MB SRAM used as zero-wait-state RAM and 32 MB Flash RAM for non-volatile storage of configurable boot code. The large flash memory of the SP provides a Fast Boot capability which results in 10 second Fast Boot for start up and initialization. On power up the software monitor, kernel, and application are loaded into the working memory of the SP and the compute modules. Because the boards all boot in parallel, the SKY fast boot capability allows an entire 16 board, 256 processor system to start a typical SAR application in 10 seconds instead of the up to 10 minutes for systems without parallel boot capability. This is key in real-time mission-critical applications, where the length of time in the start or re-start of a system can mean missing a potential threat or target. It also saves time in development environments which normally require multiple boots while debugging.

Thunderbolt Compute Module: Maximizing Performance

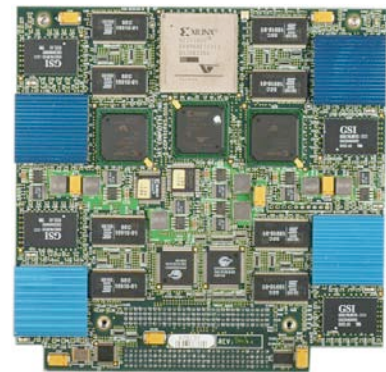
The Thunderbolt compute module capitalizes on the AltiVec technology-based 500 MHz MPC7410 PowerPCs by supporting high-speed processing with high-speed memory and communication. SKY has implemented the level 2 cache of the processor to provide developers with both high performance compute and the I/O power to maximize total computational throughput. The Thunderbolt compute module uses four MPC7410 PowerPC processors to provide up to 16 GFLOPS of performance. Each processor has its own local bank of 256 or 512 MB of SDRAM that is accessed over the processor's 125 MHz local memory bus at 1 GB/sec. The memory of other processors on the compute module can also be accessed over the 1 GB/sec local bus. Memory on other compute modules is accessible through the 320 MB/sec SKYchannel interface.

The processors are directly connected to a 64-bit SKYchannel motherboard interface. A DMA engine in the SKYchannel interface enables computing to occur concurrently with the transfer of data anywhere in the 16 Terabyte memory-mapped SKYchannel address space. The application developer can choose between memory mapped or advanced DMA access to shared memory with efficient SKYchannel access.

The Thunderbolt Compute Module has been designed to be deployment-ready using the latest high density connector technology and provides unsurpassed reliability for deployable environments. In combination with a new heat sink for the PowerPCs, the Thunderbolt boards are battle-tested.

Compute Module Features

- *Four MPC7410s provide 16 GFLOPS per module*
- *256 or 512 MB SDRAM per processor*
- *125 MHz local memory bus*
- *1 GB/sec local bus*
- *Latest technologies provide high temperature tolerances*
- *Optional 2MB L2 cache*





SKYchannel Features

- *64-bit Packet Bus transfers data at 320 MB/sec*
- *Split Transaction design uses FIFOs and DMA capability at each interface to maximize throughput and minimize blocking on the bus*
- *Global addressing simplifies programming by addressing memory from any interface*
- *Modular interface makes heterogeneous processing easy and ensures a future migration path*

SKYchannel Backplane

- *Connects to boards and expansion ports*
- *5 independent SKYchannel buses at 320 MB/sec for a total of 1600 MB/sec*
- *Attaches to the VME P2 and P3 backplane*

SKYchannel Packet Bus: Increasing System Bandwidth

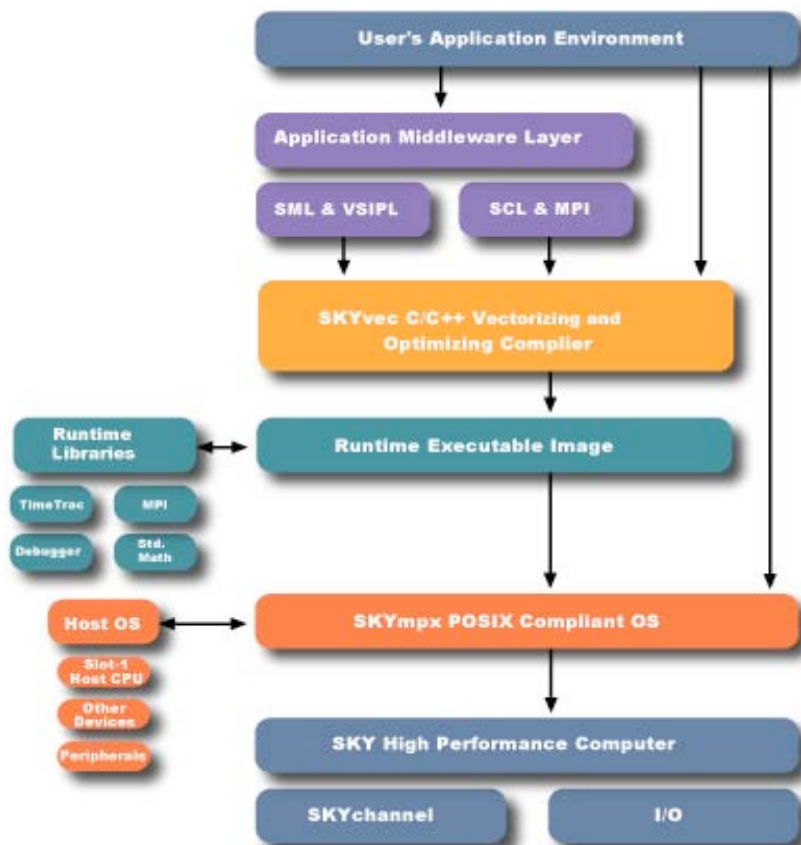
At the heart of the Thunderbolt motherboards is the 64-bit ANSI/VITA standard SKYchannel Packet Bus. SKYchannel is the on-board communication path connecting the VME64 interface, the SKYrider parallel I/O, the System Processor, the compute modules, and high speed communication between Thunderbolt boards. The 320 MB/sec bandwidth coupled with SKY's crossbar architecture provides for multiple, simultaneous operations increasing available system bandwidth.

SKYchannel's 44-bit address field delivers increased functionality and ensures ease of use. The large address field provides a 16 terabyte linear address space that can be used by any device interface to directly access any address in the system with simple loads and stores. This global addressing simplifies programming and enables data to be transferred easily between processors. The packet switched technology used by SKYchannel reduces transfer latency and blocking by using high-speed bidirectional FIFOs combined with local node DMA engines and packet controllers at every SKYchannel interface. All transfers to FIFOs are zero-wait-state writes from source to destination, providing a data transfer rate of 320 MB/sec. The asynchronous nature of these transfers provides the foundation for performance upgrades.

SKYvec: Accelerating Software Development

The SKYvec software development tools simplify code development for large multiprocessor systems by automating many of the processes which otherwise would have to be designed or managed by the programmer. SKYvec eliminates the need for complex and costly software migration and extensive training classes by making development easier than ever before. Depending upon the complexity of the application the software development effort can be reduced 30-50% using the standard SKYvec API. And future technology insertions will only require a simple recompile and run, virtually eliminating recoding efforts. Imagine the impact on software efforts across the lifecycle of your program and the financial payback that will be realized.

The SKYvec Software Development Environment is a robust toolkit including OS, compilers, vector/image processing and math libraries, and unique facilities such as event analyzers and multiprocessor debuggers that provide high performance, portability and ease of use. Building on industry standards, SKY has pioneered the use of intelligent compilers and libraries that stripmine and vectorize application code to automatically optimize performance.



SKYvec tools make the programming challenge easier. Standards-based, flexible, and scalable facilities result in faster application development and validation. A sophisticated event analyzer enables multi-process performance monitoring and analysis. Standard Math, and Vector Signal, and Image Processing (VSIPL) libraries provide easy-to-use, high-level vector functions that are architecture independent. The full implementation of industry standards, innovative tools, and guaranteed portability are the result of SKY's pioneering excellence in software.



Complete Application Solutions

SKY delivers fully integrated subsystems built from commercial-off-the-shelf components, but designed specifically for your application. SKY configures the rugged chassis, CPU boards, standard interconnect fabrics, high performance multiprocessor boards, compilers, middleware, and software development tools, as well as the storage and peripherals, as the total solution configured for your application – complete, tested, and ready to run.



SKYvec chains across vector functions, optimizing between functions, not just inside of them. This applies to hand-vectorized code as well as to scalar C code, optimizing and vectorizing globally, not just locally for each function. The result is that the application code takes maximum advantage of the hardware architecture and runs at the highest level of efficiency and performance available with little or no hand coding.

SKY Computers has reduced the learning curve and the time to develop application code by simplifying and automating low-level optimizations and tasks.

SKYvec provides a suite of development tools that simplify the programming effort without compromising performance. Sophisticated porting and development tools virtually eliminate complex tasks and training. Thunderbolt systems make full use of SKYvec including intelligent compiler technology that automatically optimizes and vectorizes application code. The SKY Standard Math Library contains hundreds of math, image, and signal processing functions. SKY/VSIDL simplifies multiprocessor development and ensures portability across platforms. The TimeTrac™ Multiprocessor Event Analyzer provides insight into the dynamic interactions between processors for multiprocessor optimization and debugging. With full MPI support, the complexity of multiprocessor implementation is reduced. SKY provides portability while simplifying the complexities of creating high performance multiprocessor code.

SKYrider: Enabling High-Speed Data I/O

SKYrider is a 32-bit parallel interface I/O module that enables high-speed data I/O directly through the SKYchannel bus. SKYrider is built into the Thunderbolt V-900 and optional on the Thunderbolt V-600. This open system interface provides an easy-to-implement gateway into the Thunderbolt from other COTS products or customer-supplied devices. SKYrider is 100% compatible with the industry standard Front Panel Data Port (FPDP). When receiving data, the SKYrider interface syncs to the clock rate of the data source, up to 40 MHz. When transmitting data, the speed of the SKYrider interface is switch selectable at 20 or 40 MHz. For multicast applications SKYrider can drive multiple receiving devices. SKYrider is configurable for either input or output. It has a direct connection to the SKYchannel bus and includes a 128 KB data FIFO interface. It is controlled as a peripheral device by the System Processor so that the compute processor doesn't stop computing to control the I/O. SKYrider is programmed in the application running on the compute processors.

VME 64 Interface

The Thunderbolt includes a fully featured VME 64 Master/Slave interface. Data transfers using multiplexed block mode transfers (MBLT) provide high performance communication with other VME boards. The fully programmable master/slave interface supports Read-Modify-Write (RMW) cycles, three programmable release methods, requester on all levels, interrupter on all levels, and VME Retry. A special communication buffer RAM enhances performance of VMEbus RWM cycles. Programs have the flexibility of accessing the VME interface directly or handing off the communication task to the System I/O processor.

Technical Support and Warranty Programs

SKY's commitment to quality begins with the standard one year hardware warranty. Throughout your development and deployment, SKY's experienced technical support engineers follow up with the support you need when you need it.

Analogic Corporation

SKY Computers is a subsidiary of the \$471M Analogic Corporation. Every SKY Computers customer benefits from the combined expertise of both companies. Analogic is world renowned for engineering innovation, manufacturing quality, and sound business practices. The Company and its founders hold thousands of patents and have been profitable every year of the 30+ year history of the company.



Analogic employs the most advanced manufacturing systems and technologies at its Peabody, MA headquarters facility where the EXACT (shown above) explosive detection systems (EDS) are manufactured. SKY provides the reconstruction engine for the EDS.

Thunderbolt V-600 and V-900 Specifications

System Processor Intel i960 HD, 40 MHz
 External Memory 2 MB SRAM
 16 MB Flash RAM 6U
 32 MB Flash RAM 9U

SKYchannel Interface Specification ANSI/VITA 10-2002
 Location Motherboard system bus and P2/P3 backplane interface
 Data Size 64 bits data per word Up to 256 data words per packet
 Throughput 320 MB/sec
 Addressing 44-bit addressing, 16 Terabyte address space

VME64 Interface Specification ANSI/VITA 1-1994
 Interface Capabilities A16 and A24 (master only), A32, D8, D16, D32 (single), D16, D32(BLT), D64 (MBLT), RMW and VME Retry

Configuration Options
 P2 Interface SKYchannel Backplane
 P3 Interface for 9U SKYchannel Backplane

Environmental Requirements
 Temperature 0° to 55°C, operating; -40° to 85°C, non-operating
 Humidity 5%–95%, non-condensing
 Air Flow at least 300 LF/min

Electrical Requirements
 DC Voltage 5.0 Volts ± 5%
 Power Consumption 6U Motherboard Up to 20 Watts
 9U Motherboard Up to 40 Watts
 Compute Module Up to 45 Watts
 SKYrider Up to 8 Watts

Physical Dimensions
 6U Motherboard 6.3" x 9.2"
 9U Motherboard 13.8" x 15.7"
 Compute Module 6"x6"
 SKYrider 3"x6"
 Slot-to-slot Spacing 0.80 inches

Weight
 6U Motherboard .980 lbs.
 9U Motherboard 3.510 lbs.
 Compute Module .450 lbs.
 SKYrider .185 lbs.

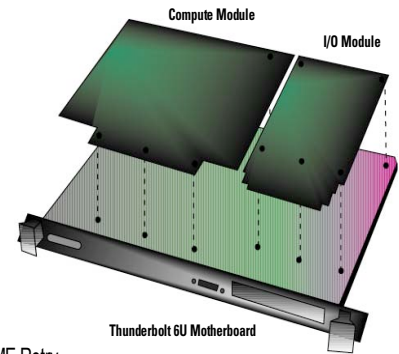
Thunderbolt Compute Module Specifications

Performance 16 GFLOPS per module (peak)
 Processors 4 MPC7410 processors per module
 Clock Frequency 500 MHz
 L1 Cache 32k instruction, 32k data
 L2 Cache 2 MB Backside, 64-bits wide @ 250 MHz
 Floating Point Unit IEEE 754 single- and scalar
 Fixed Point Units Dual 32-bit Integer Units
 Vector Instructions Full 128 bit Altivec implementation 8, 16, 32 bit integer, single -precision floating point
 Memory 256 or 512 MB SDRAM per processor, 64-bits wide @ 125 MHz
 Module Interface SKYchannel Packet Bus (ANSI/VITA 10-1995)

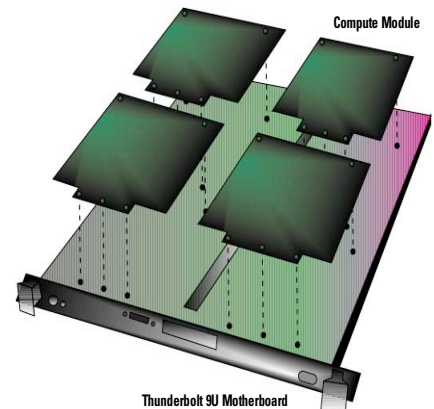
SKYrider Specifications

Peak Transfer Rate 160 MB/sec (32 bits @ 40 MHz)
 Sustained Receive Rate 156 MB/sec (maximum)
 Sustained Transmit Rate 122 MB/sec (maximum)

Thunderbolt V-600



Thunderbolt V-900



Specifications subject to change. SKY Computers is a registered trademark of SKY Computers, Inc. Thunderbolt is a trademark of SKY Computers, Inc. All other product names are the trademarks of their respective holders. Doc. #300-702, Rev 2, 06/05



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