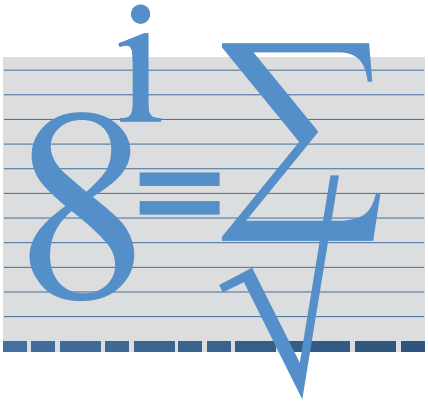
DATASHEET

Computer Systems, Inc.
MERCURY

Scientific Algorithm Library (SAL)

Optimizes Processor Resources for Ultimate Performance



- Fast signal processing library enables high processor utilization
- High throughput, low latency
- Stable API reduces product life-cycle costs

Signal, image, and data processing applications demand the greatest performance achievable from the processor. The Scientific Algorithm Library (SAL) from Mercury Computer Systems provides that performance through algorithm (primative) implementations that make the most efficient use of all processor resources.

The SAL contains more than 600 functions required for demanding processing-intense applications such as radar imaging, image exploitation, signals intelligence, image reconstruction, baggage scanning, manufacturing inspection, and others. Routines are optimized for ultimate performance on AltiVec™-equipped PowerPC® microprocessors such as the IBM PowerPC 970 and the Freescale™ MPC7447A, and the multicore Cell Broadband Engine™ (BE) processor.

The SAL function categories include vector processing, matrix operations, fast Fourier transforms (FFTs), data conversion, signal processing, image analysis, linear algebra, and a wide variety of vector math operations, including vector reduction, vector-to-vector, vector-to-scalar, vector comparison, and multioperator vector operations. The SAL also has arithmetic and logical vector functions for integer, real, double-precision, and complex data types. Recent additions include singular value decomposition (SVD), eigenvalues of Hermitian matrices, resampling, and Cholesky and QR decomposition.

High Performance

Mercury has created a high-throughput, low-latency signal processing library containing efficient algorithms with the fewest possible instructions and computing resources. Most of the library has been hand-optimized in microcode to maximize performance for the target microprocessors. The SAL represents the culmination of over 10 years of expertise in algorithm design and microcode optimization by Mercury's staff of mathematicians, computer scientists, and applications experts.

The SAL has been optimized for multiple PowerPC processor types, including the PowerPC 750, the MPC74xx, IBM PowerPC 970, and the IBM Cell BE processor. A sample listing of function timings is provided in Table 1. Timings for other functions are available upon request.

Table 1. Selected SAL Function Timings for a 1.3 GHz MPC7447 PowerPC Processor

Function	Description	L1	L2	SDRAM
convx	Real convolution/correlation, 1024 output points/32 tap filter	7.71	7.93	16.80
zconvx	Split complex convolution/correlation, 1024 output points/32 tap filter	28.09	28.77	69.77
dotprx	Real dot product, 1024 pts	0.47	1.14	7.68
zdotprx	Split complex dot product, 1024 pts	0.96	2.33	15.87
vmulx	Real vector multiply, 1024 pts	0.81	2.04	13.12
zvmulx	Split complex vector multiply, 1024 pts	2.10	4.56	29.72
fft_zriptx	Real 1D FFT, 1024 pts	3.29	3.56	16.07
fft_ziptx	Split complex 1D FFT, 1024 pts	5.80	6.33	31.18
fft2d_zriptx	Real 2D FFT, 32 x 32 pts	7.14	7.65	29.19
fft2d_ziptx	Split complex 2D FFT, 32 x 32 pts	6.66	7.53	41.18

Note: The timings given in Table 1 are for a 1.3 GHz MPC7447 PowerPC processor with a 1.3 GHz L2 cache and 150 MHz SDRAM bus. All times are given in microseconds. SAL timings depend upon where the data in process resides and where the results are to be written. The given timings are for the cases where the data source and destination memory are identical; that is, L1 to L1, L2 to L2, and SDRAM to SDRAM, but not for the mixed cases: SDRAM to L1, L2 to L1, SDRAM to L2, and so on. Mixed cases are usually the norm. This table shows best and worst case scenarios, with times for typical usage in between.

Portability and Productivity

The SAL provides a stable application programming interface (API) that reduces product life-cycle costs and eases technology insertion. Over the years, the SAL has been ported to six processor families, including i860™, SHARC®, and the AltiVec-enabled PowerPC microprocessors. The insights and techniques developed through each of these iterations have been carried forward to the next, resulting in a highly portable, high-quality signal, image, and data processing library. The SAL API is consistent across architectures and processor generations, eliminating the need to recode for different target computers. As Mercury migrates to new processors in the future, the SAL will continue to provide high performance with a consistent API.

All SAL routines can be accessed with calls from higher-level languages, improving both productivity and portability. Source files for the SAL, coded in C, are included. This allows users to develop applications with the SAL on their desktop and then rebuild with appropriate target libraries for deployment.

The SAL allows application developers to leverage the expertise of the Mercury design team to achieve better performance than they could attain by developing these algorithms on their own. By leveraging the off-the-shelf performance of the 600+ functions in the SAL, application developers increase their productivity, saving development time and cost.

Achieving the highest performance from the AltiVec's vector engine requires careful programming at the application level, as well as within the library functions. These details include data position, stride, and data alignment. The SAL Reference Manual helps simplify these tasks to ensure optimal application performance.

Comprehensive Services

The SAL is a collection of algorithm primitive routines that are most commonly used by developers in Mercury's served markets. When the optimization of custom algorithms would yield even better performance, Mercury's algorithm optimization, consulting, and training services are available to help you achieve ultimate performance for your most challenging applications.

SAL Functions

SAL functions support a wide variety of mathematical operations critical for many applications. The SAL supports real and complex data types including single- and double-precision floating point, and 8-, 16-, and 32-bit integer.

SAL function categories include:

- 1-D FFTs and associated window
- 2-D FFTs and associated window
- 1-D correlation, convolution, and filtering
- 2-D correlation, convolution, and filtering
- 2-D image processing
- Matrix arithmetic
- Data-type conversion
- Single vector generation
- Single vector scalar arithmetic
- Single vector scientific
- Single vector scalar comparison
- Single vector move
- Single vector miscellaneous
- Vector-vector arithmetic
- Vector-vector merge
- Vector-vector comparison
- Vector-vector logical

SAL System Requirements

Processors:	G4, G4A2, IBM PowerPC 970, IBM Cell BE
Operating Systems:	Linux®, VxWorks®, Windows®, MCOE™

Packaging

Distribution License:	Unlimited developers, rights to purchase run-time licenses and deploy.
Run-Time License:	Per processor license required to deploy.

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