FOXBORO®

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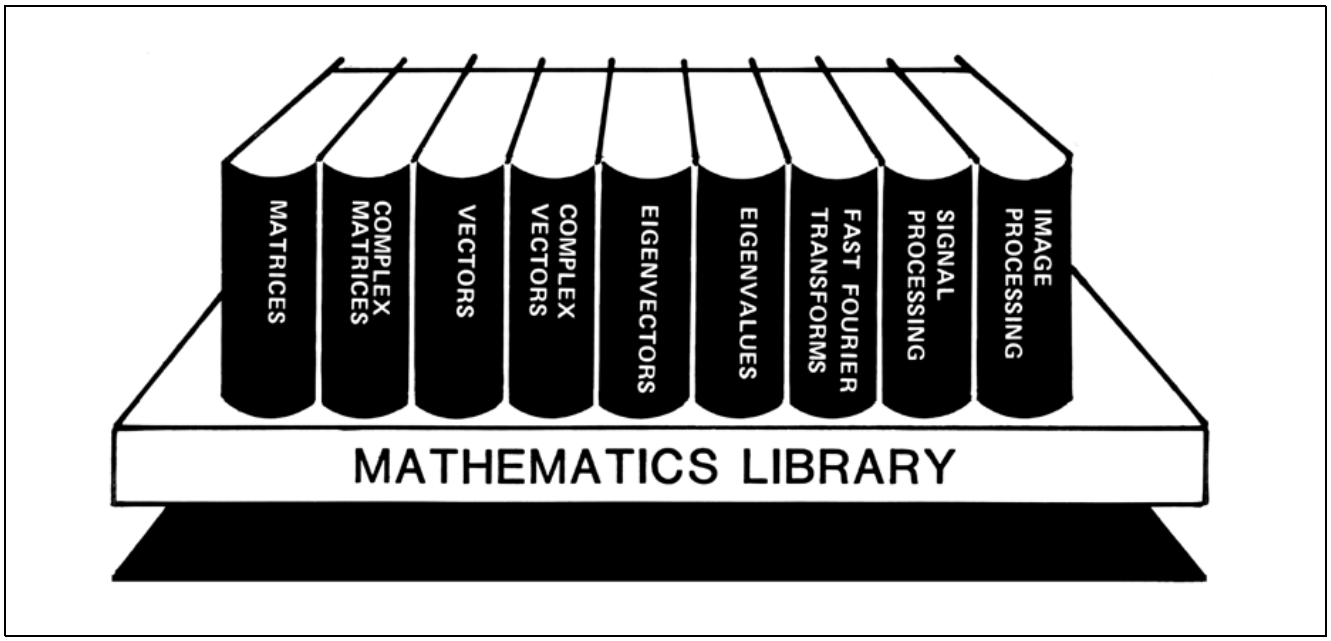
I/A Series® Software
Mathematics Library



The Mathematics Library is a collection of mathematical subroutines designed to facilitate the development of application programs.

The Mathematics Library includes the following operations:

- Fast Fourier Transforms
- Signal processing
- Image processing
- Vector
- Matrix

Application programs that require extensive mathematical calculations can incorporate routines from this library, enabling the engineer to concentrate on application development rather than tool development. Examples of some applications that would use this tool are:

- Curve-fitting
- Simulation
- Filtering
- Process Optimization
- Mathematical Modeling
- Statistical Analysis

The Mathematics Library, which is based on the Math Advantage licensed from the Quantitative Technology Corp., is offered in C and FORTRAN language versions for the UNIX System V Solaris and UNIX System V VENIX operating systems. Each version is available in either single-precision or double-precision.

A large selection of functions is available for the C and FORTRAN versions. For UNIX System V Solaris, there are 365 functions in the C version and 388 functions in the FORTRAN version. For UNIX System V VENIX there are 176 functions in the C version and 209 functions in the FORTRAN version.

The Mathematics Library consists of a set of object modules that can be installed on an I/A Series Application Processor (AP) or Personal Workstation (PW). The 50 Series APs use the UNIX System V Solaris operating system, and the AP20 and PW's use the UNIX System V VENIX operating system.

The subroutine names are easy to interpret, for example, VSMUL calls the vector scalar multiply operation. The call arguments are arranged in a consistent format that is easy to understand and remember. Argument knowledge acquired while working with one routine transfers easily to the other routines.

An example of a C call statement is:

```
dotpr(a,ia,b,ib,c,n)
```

An example of a FORTRAN call statement is:

```
CALL DOTPR(A, IA, B, IB, C, N)
```

Documentation provided with the Mathematics Library describes the arguments. After the program is completed, you simply compile and link it to the Mathematics Library.

THE MATHEMATICAL OPERATIONS

Examples of operations included in the Mathematics Library and their call names are listed below. The FORTRAN calls require uppercase letters. The C language calls permit lowercase letters.

Basic Real Vector Operation Examples

Operations that find scalar values from a single vector:

- Maximum element of a vector (MAXV)
- Mean of vector elements (MEANV)
- Sum of vector elements (SVE)

Operations on the elements of a single vector:

- Vector absolute value (VABS)
- Vector square (VSQ)
- Vector sine (VSIN)
- Vector natural logarithm (VLOG)
- Vector base 10 exponential (VEXP10)

Operations involving a scalar and a vector:

- Vector scalar multiply (VSMUL)
- Simpson's Rule integration (VSIMPS)

Operations involving two scalars and a vector:

- Vector clip to specified range (VCLIP)
- Vector scalar multiply and scalar add (VSMSA)

Operation involving four scalars and a vector:

- Vector scale, offset, clip, and fix to integer (VSOCFX)

Operation involving a polynomial relation and a vector:

- Vector polynomial evaluation (VPOLY)

Operations that create a vector from scalars:

- Vector fill with constant (VFILL)
- Vector fill with ramp (VRAMP)

Operations involving two vectors:

- Vector divide (VDIV)
- Dot product (DOTPR)
- Vector maximum of two vectors (VMAX)
- Logical vector greater than or equal (LVGEl)
- Vectors arctangent—2 arguments (VATAN2)

Operations involving two vectors and a scalar:

- Vector add and scalar multiply (VASM)
- Vector scalar multiply and subtract (VSMSB)

Operations involving three vectors:

- Vector multiply and add (VMA)
- Vector logical merge (VLMERG)

Operations involving four vectors:

- Vector add, vector add, and multiply (VAAM)
- Vector multiply, vector multiply, and subtract (VMMSB)

Basic Complex Vector Operations Examples

Operations involving a single complex vector:

- Complex vector conjugate (CVCONJ)
- Complex vector reciprocal (CVRCIP)
- Rectangular to polar conversion (POLAR)

Operation involving a single complex vector and a scalar:

- Complex vector scalar multiply (VCSMUL)

Operations involving a complex vector and a real vector:

- Complex and real vector add (CRVADD)
- Complex and real vector divide (CRVDIV)

Operation that creates a complex vector from a complex scalar:

- Complex vector fill (CVFILL)

Operations that create a complex vector from a real vector:
- Complex vector exponential (CVEXP)
- Form complex vector from a real vector (CVREAL)

Operations that Create a Real Vector from a Complex Vector:
- Extract reals of a complex vector (VREAL)
- Extract imaginaries of a complex vector (VIMAG)

Operations that Create a Complex Vector from Two Real Vectors:
- Complex vector combine (CVCOMB)
- Complex vector exponential and multiply (CVMEXP)

Operations Involving Two Complex Vectors:
- Complex vector add (CVADD)
- Complex vector multiply (CVMU)

Operation Involving Three Complex Vectors:
- Complex vector multiply and add (CVMA)

Signal Processing Vector Operation Examples
- Auto-correlation time-domain (ACORT)
- Cross-correlation frequency-domain (CCORF)
- Convolution and correlation (CONV)
- Hanning window multiply (HANN)
- Histogram (HIST)
- Transfer function (TRANS)
- Vector exponential averaging (VAVEXP)
- Vector linear averaging (VAVLIN)
- Vector conversion to db (VDBCON)
- In-place complex Fast Fourier Transform (CFFT)
- Not-in-place real-to-complex Fast Fourier Transform (RFFTB)

Image Processing Operation Examples
- 2-D convolution and correlation (CONV2D)
- 4-D coordinate transformation (CTRN4)
- Complex 2-D Fast Fourier Transform (CFFT2D)
- In-place real-to-complex 2-D Fast Fourier Transform (RFFT2D)

Real Matrix Operations Examples

Operations on Matrices Stored in the Full Unsymmetric Format:
- Real matrix multiply (RMMUL)
- Real matrix transpose (RMTRAN)
- Real matrix, full unsymmetric solve (RMFUSV)

Operations on Matrices Stored in the Envelope Symmetric Format:
- Real matrix envelope symmetric factor (RMESFC)
- Real matrix envelope symmetric solve (RMESSV)

Operations on matrices stored in the sparse symmetric format:
- Real matrix, sparse symmetric solve (RMSSSV)
- Real matrix, sparse symmetric factor and solve (RMSSFS)

Operations on matrices stored in the sparse unsymmetric format:
- Real matrix, sparse unsymmetric factor and solve (RMSUFS)
- Real matrix, sparse unsymmetric define fill-in (RMSUFL)

Complex Matrix Operations

Operations on matrices stored in the full unsymmetric format:
- Complex nested dot product (NNDOTP)
- Complex matrix, full unsymmetric factor (CMFUFC)
- Complex matrix, full unsymmetric solve (CMFUSV)

Operations on matrices stored in the envelope symmetric format:
- Complex matrix envelope symmetric factor (CMESFC)
- Complex matrix envelope symmetric factor and solve (CMESFS)

Operations on matrices stored in the sparse symmetric format:
- Complex matrix, sparse symmetric factor and solve (CMSSFS)
- Complex matrix, sparse symmetric define fill-in (CMSSFL)

Operations on matrices stored in the sparse unsymmetric format:
- Complex matrix, sparse unsymmetric factor (CMSUFC)
- Complex matrix, sparse unsymmetric solve (CMSUSV)

Basic Linear Algebra Subprograms Examples

The basic linear algebra subprograms (BLAS) are available only on 50 Series APs.

Operations involving a vector (BLAS Level 1):

- Real scalar times a complex vector (CSSCAL)
- Double precision real vector copy (DCOPY)
- Construct Givens plane rotation (SROTG)
- Real scalar times a real vector (SSCAL)
- Sum of magnitudes of real and imaginary parts function (SCASUM)

Operations involving a vector and a matrix (BLAS Level 2):

- Matrix-vector product for general matrix (CGEMV)
- Rank-one update for general matrix, conjugated vector (CGERC)
- Solve a system of linear equations for triangular banded matrix (CTBSV)

Operations involving matrices (BLAS Level 3):

- Matrix-matrix product with one symmetric matrix (CSYMM)
- Solution of a triangular system of equations (CTRSM)
- Rank-k update of a Hermitian matrix (CHERK)

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