

Level 1 BLAS

	dim	scalar	vector	vector	scalars	5-element array		prefixes
SUBROUTINE xROTG (					A, B, C, S)		Generate plane rotation	S, D
SUBROUTINE xROTMG(					D1, D2, A, B,	PARAM)	Generate modified plane rotation	S, D
SUBROUTINE xROT (N,			X, INCX, Y, INCY,		C, S)		Apply plane rotation	S, D
SUBROUTINE xROTM (N,			X, INCX, Y, INCY,			PARAM)	Apply modified plane rotation	S, D
SUBROUTINE xSWAP (N,			X, INCX, Y, INCY)				$x \leftrightarrow y$	S, D, C, Z
SUBROUTINE xSCAL (N,	ALPHA,		X, INCX)				$x \leftarrow \alpha x$	S, D, C, Z, CS, ZD
SUBROUTINE xCOPY (N,			X, INCX, Y, INCY)				$y \leftarrow x$	S, D, C, Z
SUBROUTINE xAXPY (N,	ALPHA,		X, INCX, Y, INCY)				$y \leftarrow \alpha x + y$	S, D, C, Z
FUNCTION xDOT (N,			X, INCX, Y, INCY)				$dot \leftarrow x^T y$	S, D, DS
FUNCTION xDOTU (N,			X, INCX, Y, INCY)				$dot \leftarrow x^T y$	C, Z
FUNCTION xDOTC (N,			X, INCX, Y, INCY)				$dot \leftarrow x^H y$	C, Z
FUNCTION xxDOT (N,			X, INCX, Y, INCY)				$dot \leftarrow \alpha + x^T y$	SDS
FUNCTION xNRM2 (N,			X, INCX)				$nrm2 \leftarrow ||x||_2$	S, D, SC, DZ
FUNCTION xASUM (N,			X, INCX)				$asum \leftarrow ||re(x)||_1 + ||im(x)||_1$	S, D, SC, DZ
FUNCTION IxAMAX(N,			X, INCX)				$amax \leftarrow 1^{st} k \ni |re(x_k)| + |im(x_k)|$ $= \max(|re(x_i)| + |im(x_i)|)$	S, D, C, Z

Level 2 BLAS

	options	dim	b-width	scalar	matrix	vector	scalar	vector		
xGEMV (	TRANS,	M, N,		ALPHA, A, LDA,	X, INCX,	BETA, Y, INCY)	$y \leftarrow \alpha Ax + \beta y, y \leftarrow \alpha A^T x + \beta y, y \leftarrow \alpha A^H x + \beta y, A - m \times n$		S, D, C, Z
xGBMV (	TRANS,	M, N, KL, KU,		ALPHA, A, LDA,	X, INCX,	BETA, Y, INCY)	$y \leftarrow \alpha Ax + \beta y, y \leftarrow \alpha A^T x + \beta y, y \leftarrow \alpha A^H x + \beta y, A - m \times n$		S, D, C, Z
xHEMV (	UPL0,	N,		ALPHA, A, LDA,	X, INCX,	BETA, Y, INCY)	$y \leftarrow \alpha Ax + \beta y$		C, Z
xHBMV (	UPL0,	N, K,		ALPHA, A, LDA,	X, INCX,	BETA, Y, INCY)	$y \leftarrow \alpha Ax + \beta y$		C, Z
xHPMV (	UPL0,	N,		ALPHA, AP,	X, INCX,	BETA, Y, INCY)	$y \leftarrow \alpha Ax + \beta y$		C, Z
xSYMV (	UPL0,	N,		ALPHA, A, LDA,	X, INCX,	BETA, Y, INCY)	$y \leftarrow \alpha Ax + \beta y$		S, D
xSBMV (	UPL0,	N, K,		ALPHA, A, LDA,	X, INCX,	BETA, Y, INCY)	$y \leftarrow \alpha Ax + \beta y$		S, D
xSPMV (	UPL0,	N,		ALPHA, AP,	X, INCX,	BETA, Y, INCY)	$y \leftarrow \alpha Ax + \beta y$		S, D
xTRMV (	UPL0, TRANS, DIAG,	N,		A, LDA,	X, INCX)		$x \leftarrow Ax, x \leftarrow A^T x, x \leftarrow A^H x$		S, D, C, Z
xTBMV (	UPL0, TRANS, DIAG,	N, K,		A, LDA,	X, INCX)		$x \leftarrow Ax, x \leftarrow A^T x, x \leftarrow A^H x$		S, D, C, Z
xTPMV (	UPL0, TRANS, DIAG,	N,		AP,	X, INCX)		$x \leftarrow Ax, x \leftarrow A^T x, x \leftarrow A^H x$		S, D, C, Z
xTRSV (	UPL0, TRANS, DIAG,	N,		A, LDA,	X, INCX)		$x \leftarrow A^{-1} x, x \leftarrow A^{-T} x, x \leftarrow A^{-H} x$		S, D, C, Z
xTBSV (	UPL0, TRANS, DIAG,	N, K,		A, LDA,	X, INCX)		$x \leftarrow A^{-1} x, x \leftarrow A^{-T} x, x \leftarrow A^{-H} x$		S, D, C, Z
xTPSV (	UPL0, TRANS, DIAG,	N,		AP,	X, INCX)		$x \leftarrow A^{-1} x, x \leftarrow A^{-T} x, x \leftarrow A^{-H} x$		S, D, C, Z
	options	dim		scalar	vector	vector	matrix			
xGER (		M, N,		ALPHA, X, INCX, Y, INCY, A, LDA)			$A \leftarrow \alpha xy^T + A, A - m \times n$		S, D
xGERU (		M, N,		ALPHA, X, INCX, Y, INCY, A, LDA)			$A \leftarrow \alpha xy^T + A, A - m \times n$		C, Z
xGERC (		M, N,		ALPHA, X, INCX, Y, INCY, A, LDA)			$A \leftarrow \alpha xy^H + A, A - m \times n$		C, Z
xHER (	UPL0,	N,		ALPHA, X, INCX,		A, LDA)	$A \leftarrow \alpha xx^H + A$		C, Z
xHPR (	UPL0,	N,		ALPHA, X, INCX,		AP)	$A \leftarrow \alpha xx^H + A$		C, Z
xHER2 (	UPL0,	N,		ALPHA, X, INCX, Y, INCY, A, LDA)			$A \leftarrow \alpha xy^H + y(\alpha x)^H + A$		C, Z
xHPR2 (	UPL0,	N,		ALPHA, X, INCX, Y, INCY, AP)			$A \leftarrow \alpha xy^H + y(\alpha x)^H + A$		C, Z
xSYR (	UPL0,	N,		ALPHA, X, INCX,		A, LDA)	$A \leftarrow \alpha xx^T + A$		S, D
xSPR (	UPL0,	N,		ALPHA, X, INCX,		AP)	$A \leftarrow \alpha xx^T + A$		S, D
xSYR2 (	UPL0,	N,		ALPHA, X, INCX, Y, INCY, A, LDA)			$A \leftarrow \alpha xy^T + \alpha yx^T + A$		S, D
xSPR2 (	UPL0,	N,		ALPHA, X, INCX, Y, INCY, AP)			$A \leftarrow \alpha xy^T + \alpha yx^T + A$		S, D

Level 3 BLAS

options		dim	scalar	matrix	matrix	scalar	matrix		
xGEMM (	TRANSA, TRANSB,	M, N, K,	ALPHA, A, LDA, B, LDB, BETA, C, LDC)					$C \leftarrow \alpha op(A)op(B) + \beta C, op(X) = X, X^T, X^H, C - m \times n$	S, D, C, Z
xSYMM (	SIDE, UPLO,	M, N,	ALPHA, A, LDA, B, LDB, BETA, C, LDC)					$C \leftarrow \alpha AB + \beta C, C \leftarrow \alpha BA + \beta C, C - m \times n, A = A^T$	S, D, C, Z
xHEMM (	SIDE, UPLO,	M, N,	ALPHA, A, LDA, B, LDB, BETA, C, LDC)					$C \leftarrow \alpha AB + \beta C, C \leftarrow \alpha BA + \beta C, C - m \times n, A = A^H$	C, Z
xSYRK (	UPLO, TRANS,	N, K,	ALPHA, A, LDA, B, LDB, BETA, C, LDC)					$C \leftarrow \alpha AA^T + \beta C, C \leftarrow \alpha A^T A + \beta C, C - n \times n$	S, D, C, Z
xHERK (	UPLO, TRANS,	N, K,	ALPHA, A, LDA, B, LDB, BETA, C, LDC)					$C \leftarrow \alpha AA^H + \beta C, C \leftarrow \alpha A^H A + \beta C, C - n \times n$	C, Z
xSYR2K(	UPLO, TRANS,	N, K,	ALPHA, A, LDA, B, LDB, BETA, C, LDC)					$C \leftarrow \alpha AB^T + \bar{\alpha} BA^T + \beta C, C \leftarrow \alpha A^T B + \bar{\alpha} B^T A + \beta C, C - n \times n$	S, D, C, Z
xHER2K(	UPLO, TRANS,	N, K,	ALPHA, A, LDA, B, LDB, BETA, C, LDC)					$C \leftarrow \alpha AB^H + \bar{\alpha} BA^H + \beta C, C \leftarrow \alpha A^H B + \bar{\alpha} B^H A + \beta C, C - n \times n$	C, Z
xTRMM (	SIDE, UPLO, TRANSA,	DIAG, M, N,	ALPHA, A, LDA, B, LDB)					$B \leftarrow \alpha op(A)B, B \leftarrow \alpha Bop(A), op(A) = A, A^T, A^H, B - m \times n$	S, D, C, Z
xTRSM (	SIDE, UPLO, TRANSA,	DIAG, M, N,	ALPHA, A, LDA, B, LDB)					$B \leftarrow \alpha op(A^{-1})B, B \leftarrow \alpha Bop(A^{-1}), op(A) = A, A^T, A^H, B - m \times n$	S, D, C, Z

Meaning of prefixes

S - REAL	C - COMPLEX
D - DOUBLE PRECISION	Z - COMPLEX*16

(this may not be supported by all machines)

For the Level 2 BLAS a set of extended-precision routines with the prefixes ES, ED, EC, EZ may also be available.

Level 1 BLAS

In addition to the listed routines there are two further extended-precision dot product routines DQDOTI and DQDOTA.

Level 2 and Level 3 BLAS

Matrix types:

GE - GEneral	GB - General Band	
SY - SYmmetric	SB - Sym. Band	SP - Sum. Packed
HE - HERmitian	HB - Herm. Band	HP - Herm. Packed
TR - TRiangular	TB - Triang. Band	TP - Triang. Packed

Level 2 and Level 3 BLAS Options

Dummy options arguments are declared as CHARACTER*1 and may be passed as character strings.

TRANx	= 'No transpose', 'Transpose', 'Conjugate transpose' (X, X^T, X^H)
UPLO	= 'Upper triangular', 'Lower triangular'
DIAG	= 'Non-unit triangular', 'Unit triangular'
SIDE	= 'Left', 'Right' (A or op(A) on the left, or A or op(A) on the right)

For real matrices, TRANSx = 'T' and TRANSx = 'C' have the same meaning.

For Hermitian matrices, TRANSx = 'T' is not allowed.

For complex symmetric matrices, TRANSx = 'H' is not allowed.

References

C. Lawson, R. Hanson, D. Kincaid, and F. Krogh, "Basic Linear Algebra Subprograms for Fortran Usage," *ACM Trans. on Math. Soft.* 5 (1979) 308-325

J.J. Dongarra, J. DuCroz, S. Hammarling, and R. Hanson, "An Extended Set of Fortran Basic Linear Algebra Subprograms," *ACM Trans. on Math. Soft.* 14,1 (1988) 1-32

J.J. Dongarra, I. Duff, J. DuCroz, and S. Hammarling, "A Set of Level 3 Basic Linear Algebra Subprograms," *ACM Trans. on Math. Soft.* (1989)

Obtaining the Software via netlib@ornl.gov

To receive a copy of the single-precision software, type in a mail message:

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send sblas from blas
send sblas2 from blas
send sblas3 from blas
```

To receive a copy of the double-precision software, type in a mail message:

```
send dblas from blas
send dblas2 from blas
send dblas3 from blas
```

To receive a copy of the complex single-precision software, type in a mail message:

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send cblas2 from blas
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send zblas2 from blas
send zblas3 from blas
```

Send comments and questions to lapack@cs.utk.edu.

Basic

Linear

Algebra

Subprograms

A Quick Reference Guide

University of Tennessee
Oak Ridge National Laboratory
Numerical Algorithms Group Ltd.

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