

## 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		prefixes
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
xGEMV (	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 ( UPLO,		N,		ALPHA,	A, LDA,	X, INCX,	BETA,	Y, INCY )	$y \leftarrow \alpha Ax + \beta y$	C, Z
xHEMV ( UPLO,		N, K,		ALPHA,	A, LDA,	X, INCX,	BETA,	Y, INCY )	$y \leftarrow \alpha Ax + \beta y$	C, Z
xHPMV ( UPLO,		N,		ALPHA,	AP,	X, INCX,	BETA,	Y, INCY )	$y \leftarrow \alpha Ax + \beta y$	C, Z
xSYMV ( UPLO,		N,		ALPHA,	A, LDA,	X, INCX,	BETA,	Y, INCY )	$y \leftarrow \alpha Ax + \beta y$	S, D
xSBMV ( UPLO,		N, K,		ALPHA,	A, LDA,	X, INCX,	BETA,	Y, INCY )	$y \leftarrow \alpha Ax + \beta y$	S, D
xSPMV ( UPLO,		N,		ALPHA,	AP,	X, INCX,	BETA,	Y, INCY )	$y \leftarrow \alpha Ax + \beta y$	S, D
xTRMV ( UPLO, 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 ( UPLO, 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 ( UPLO, TRANS, DIAG,		N,		AP,	X, INCX )				$x \leftarrow Ax, x \leftarrow A^T x, x \leftarrow A^H x$	S, D, C, Z
xTRSV ( UPLO, 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 ( UPLO, 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 ( UPLO, 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 ( UPLO,		N,		ALPHA,	X, INCX,		A, LDA )		$A \leftarrow \alpha xx^H + A$	C, Z
xHPR ( UPLO,		N,		ALPHA,	X, INCX,		AP )		$A \leftarrow \alpha xx^H + A$	C, Z
xHER2 ( UPLO,		N,		ALPHA,	X, INCX,	Y, INCY,	A, LDA )		$A \leftarrow \alpha xy^H + y(\alpha x)^H + A$	C, Z
xHPR2 ( UPLO,		N,		ALPHA,	X, INCX,	Y, INCY,	AP )		$A \leftarrow \alpha xy^H + y(\alpha x)^H + A$	C, Z
xSYR ( UPLO,		N,		ALPHA,	X, INCX,		A, LDA )		$A \leftarrow \alpha xx^T + A$	S, D
xSPR ( UPLO,		N,		ALPHA,	X, INCX,		AP )		$A \leftarrow \alpha xx^T + A$	S, D
xSYR2 ( UPLO,		N,		ALPHA,	X, INCX,	Y, INCY,	A, LDA )		$A \leftarrow \alpha xy^T + \alpha yx^T + A$	S, D
xSPR2 ( UPLO,		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		prefixes	
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,		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,		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  
D - DOUBLE PRECISION  
C - COMPLEX  
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](mailto:netlib@ornl.gov)

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

```
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:

```
send cblas from blas
send cblas2 from blas
send cblas3 from blas
```

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

```
send zblas from blas
send zblas2 from blas
send zblas3 from blas
```

Send comments and questions to [lapack@cs.utk.edu](mailto: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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