## Meaning of prefixes

| | |
|---|---|
| S - `REAL` | C - `COMPLEX` |
| D - `DOUBLE PRECISION` | Z - `COMPLEX*16` (may not be supported by all machines) |

## Level 2 and Level 3 PBLAS Matrix Types

GE - GEneral
SY - SYmmetric
HE - HErmitian
TR - TRiangular

## Level 2 and Level 3 PBLAS Options

Dummy options arguments are declared as CHARACTER*1 and may be passed as character strings.
TRANS□ = 'No transpose', 'Transpose', 'Conjugate transpose', ($X$, $X^T$, $X^H$)
UPLO = 'Upper triangular', 'Lower Triangular'
DIAG = 'Non-unit triangular', 'Unit triangular'
SIDE = 'Left' or 'Right' (A or op(A) on the left, or A or op(A) on the right)

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

For Hermitian matrices, TRANS□='T' is not allowed.

For complex symmetric matrices, TRANS□='C' is not allowed.

## Obtaining the software via netlib

In order to get instructions for downloading the PBLAS, send email to `netlib@ornl.gov` and in the body of the message type `send index from scalapack`.

Send comments, questions to `scalapack@cs.utk.edu`.

## Array Descriptor, Increment

The array descriptor *DESCA* is an integer array of dimension 9. It describes the two-dimensional block-cyclic mapping of the matrix A.

The first two entries are the descriptor type and the BLACS context. The third and fourth entries are the dimensions of the matrix (row, column). The fifth and sixth entries are the row- and column block sizes used to distribute the matrix. The seventh and eighth are the coordinates of the process containing the first entry of the matrix. The last entry contains the leading dimension of the local array containing the matrix elements.

The increment specified for vectors is always global. So far only 1 and DESCA(M_) are supported.

## References


J. Dongarra and R. C. Whaley, LAPACK, Working Note 94, *A User's Guide to the BLACS v1.0*, Computer Science Dept. Technical Report CS-95-281, University of Tennessee, Knoxville, March, 1995. To receive a postscript copy, send email to netlib@ornl.gov and in the mail message type: `send lawn94.ps from lapack/lawns`.

J. Choi, J. Dongarra, and D. Walker, *PB-BLAS: A Set of Parallel Block Basic Linear Algebra Subroutines*, Proceedings of Scalable High Performance Computing Conference (Knoxville, TN), pp. 534-541, IEEE Computer Society Press, May 23-25, 1994.

J. Choi, J. Demmel, I. Dhillon, J. Dongarra, S. Ostrouchov, A. Petitet, K. Stanley, D. Walker and R. C. Whaley, LAPACK, Working Note 95, *ScaLAPACK: A Scalable Linear Algebra library for Distributed Memory Concurrent Computers - Design Issues and Performance*, Computer Science Dept. Technical Report CS-95-283, University of Tennessee, Knoxville, March 1995. To receive a postscript copy, send email to netlib@ornl.gov and in the mail message type: `send lawn95.ps from lapack/lawns`.

J. Choi, J. Dongarra, S. Ostrouchov, A. Petitet, D. Walker and R. C. Whaley, LAPACK, Working Note 100, *A Proposal for a Set of Parallel Basic Linear Algebra Subprograms*, Computer Science Dept. Technical Report CS-95-292, University of Tennessee, Knoxville, July 1995. To receive a postscript copy, send email to netlib@ornl.gov and in the mail message type: `send lawn100.ps from lapack/lawns`.


# Parallel Basic Linear Algebra Subprograms

**Release 1.0**


**University of Tennessee**



March 28, 1995


**A Quick Reference Guide**

## Level 1 PBLAS

| | dim scalar | vector | vector | | prefixes |
|---|---|---|---|---|---|
| P□SWAP | ( N, | X, IX, JX, DESCX, INCX, | Y, IY, JY, DESCY, INCY ) | $x \leftrightarrow y$ | S, D, C, Z |
| P□SCAL | ( N, ALPHA, | X, IX, JX, DESCX, INCX ) | | $x \leftarrow \alpha x$ | S, D, C, Z, CS, ZD |
| P□COPY | ( N, | X, IX, JX, DESCX, INCX, | Y, IY, JY, DESCY, INCY ) | $y \leftarrow x$ | S, D, C, Z |
| P□AXPY | ( N, ALPHA, | X, IX, JX, DESCX, INCX, | Y, IY, JY, DESCY, INCY ) | $y \leftarrow \alpha x + y$ | S, D, C, Z |
| P□DOT | ( N, DOT, | X, IX, JX, DESCX, INCX, | Y, IY, JY, DESCY, INCY ) | $dot \leftarrow x^T y$ | S, D |
| P□DOTU | ( N, DOTU, | X, IX, JX, DESCX, INCX, | Y, IY, JY, DESCY, INCY ) | $dotu \leftarrow x^T y$ | C, Z |
| P□DOTC | ( N, DOTC, | X, IX, JX, DESCX, INCX, | Y, IY, JY, DESCY, INCY ) | $dotc \leftarrow x^H y$ | C, Z |
| P□NRM2 | ( N, NORM2, | X, IX, JX, DESCX, INCX ) | | $norm2 \leftarrow \|x\|_2$ | S, D, SC, DZ |
| P□ASUM | ( N, ASUM, | X, IX, JX, DESCX, INCX ) | | $asum \leftarrow \|re(x)\|_1 + \|im(x)\|_1$ | S, D, SC, DZ |
| P□AMAX | ( N, AMAX, INDX, | X, IX, JX, DESCX, INCX ) | | $indx \leftarrow 1^{st}\ k \ni \lvert Re(x_k)\rvert + \lvert Im(x_k)\rvert = max(\lvert Re(x_i)\rvert + \lvert Im(x_i)\rvert) = amax$ | S, D, C, Z |

## Level 2 PBLAS

| | options | dim | scalar | matrix | vector | scalar | vector | | |
|---|---|---|---|---|---|---|---|---|---|
| P□GEMV | ( TRANS, | M, N, | ALPHA, | A, IA, JA, DESCA, | X, IX, JX, DESCX, INCX, | BETA, | Y, IY, JY, DESCY, INCY ) | $y \leftarrow \alpha op(A)x + \beta y, op(A) = A, A^T, A^H, A - m \times n$ | S, D, C, Z |
| P□HEMV | ( UPLO, | N, | ALPHA, | A, IA, JA, DESCA, | X, IX, JX, DESCX, INCX, | BETA, | Y, IY, JY, DESCY, INCY ) | $y \leftarrow \alpha Ax + \beta y$ | C, Z |
| P□SYMV | ( UPLO, | N, | ALPHA, | A, IA, JA, DESCA, | X, IX, JX, DESCX, INCX, | BETA, | Y, IY, JY, DESCY, INCY ) | $y \leftarrow \alpha Ax + \beta y$ | S, D |
| P□TRMV | ( UPLO, TRANS, DIAG, | N, | | A, IA, JA, DESCA, | X, IX, JX, DESCX, INCX ) | | | $x \leftarrow \alpha Ax, x \leftarrow \alpha A^T x, x \leftarrow \alpha A^H x,$ | S, D, C, Z |
| P□TRSV | ( UPLO, TRANS, DIAG, | N, | | A, IA, JA, DESCA, | X, IX, JX, DESCX, INCX ) | | | $x \leftarrow \alpha A^{-1} x, x \leftarrow \alpha A^{-T} x, x \leftarrow \alpha A^{-H} x,$ | S, D, C, Z |

| | options | dim | scalar | vector | vector | matrix | | |
|---|---|---|---|---|---|---|---|---|
| P□GER | ( | M, N, | ALPHA, | X, IX, JX, DESCX, INCX, | Y, IY, JY, DESCY, INCY, | A, IA, JA, DESCA ) | $A \leftarrow \alpha xy^T + A, A - m \times n$ | S, D |
| P□GERU | ( | M, N, | ALPHA, | X, IX, JX, DESCX, INCX, | Y, IY, JY, DESCY, INCY, | A, IA, JA, DESCA ) | $A \leftarrow \alpha xy^T + A, A - m \times n$ | C, Z |
| P□GERC | ( | M, N, | ALPHA, | X, IX, JX, DESCX, INCX, | Y, IY, JY, DESCY, INCY, | A, IA, JA, DESCA ) | $A \leftarrow \alpha xy^H + A, A - m \times n$ | C, Z |
| P□HER | ( UPLO, | N, | ALPHA, | X, IX, JX, DESCX, INCX, | | A, IA, JA, DESCA ) | $A \leftarrow \alpha xx^H + A$ | C, Z |
| P□HER2 | ( UPLO, | N, | ALPHA, | X, IX, JX, DESCX, INCX, | Y, IY, JY, DESCY, INCY, | A, IA, JA, DESCA ) | $A \leftarrow \alpha xy^H + y(\alpha x)^H + A$ | C, Z |
| P□SYR | ( UPLO, | N, | ALPHA, | X, IX, JX, DESCX, INCX, | | A, IA, JA, DESCA ) | $A \leftarrow \alpha xx^T + A$ | S, D |
| P□SYR2 | ( UPLO, | N, | ALPHA, | X, IX, JX, DESCX, INCX, | Y, IY, JY, DESCY, INCY, | A, IA, JA, DESCA ) | $A \leftarrow \alpha xy^T + \alpha yx^T + A$ | S, D |

## Level 3 PBLAS

| | options | dim | scalar | matrix | matrix | scalar | matrix | | |
|---|---|---|---|---|---|---|---|---|---|
| P□GEMM | ( TRANSA, TRANSB, | M, N, K, | ALPHA, | A, IA, JA, DESCA, | B, IB, JB, DESCB, | BETA, | C, IC, JC, DESCC ) | $C \leftarrow \alpha op(A)op(B) + \beta C, op(X) = X, X^T, X^H, C - m \times n$ | S, D, C, Z |
| P□SYMM | ( SIDE, UPLO, | M, N, | ALPHA, | A, IA, JA, DESCA, | B, IB, JB, DESCB, | BETA, | C, IC, JC, DESCC ) | $C \leftarrow \alpha AB + \beta C, C \leftarrow \alpha BA + \beta C, C - m \times n, A = A^T$ | S, D, C, Z |
| P□HEMM | ( SIDE, UPLO, | M, N, | ALPHA, | A, IA, JA, DESCA, | B, IB, JB, DESCB, | BETA, | C, IC, JC, DESCC ) | $C \leftarrow \alpha AB + \beta C, C \leftarrow \alpha BA + \beta C, C - m \times n, A = A^H$ | C, Z |
| P□SYRK | ( UPLO, TRANS, | N, K, | ALPHA, | A, IA, JA, DESCA, | | BETA, | C, IC, JC, DESCC ) | $C \leftarrow \alpha AA^T + \beta C, C \leftarrow \alpha A^T A + \beta C, C - n \times n$ | S, D, C, Z |
| P□HERK | ( UPLO, TRANS, | N, K, | ALPHA, | A, IA, JA, DESCA, | | BETA, | C, IC, JC, DESCC ) | $C \leftarrow \alpha AA^H + \beta C, C \leftarrow \alpha A^H A + \beta C, C - n \times n$ | C, Z |
| P□SYR2K | ( UPLO, TRANS, | N, K, | ALPHA, | A, IA, JA, DESCA, | B, IB, JB, DESCB, | BETA, | C, IC, JC, DESCC ) | $C \leftarrow \alpha AB^T + \alpha BA^T + \beta C, C \leftarrow \alpha A^T B + \alpha B^T A + \beta C, C - n \times n$ | S, D, C, Z |
| P□HER2K | ( UPLO, TRANS, | N, K, | ALPHA, | A, IA, JA, DESCA, | B, IB, JB, DESCB, | BETA, | C, IC, JC, DESCC ) | $C \leftarrow \alpha AB^H + \bar{\alpha} BA^H + \beta C, C \leftarrow \alpha A^H B + \bar{\alpha} B^H A + \beta C, C - n \times n$ | C, Z |
| P□TRAN | ( | M, N, | ALPHA, | A, IA, JA, DESCA, | | BETA, | C, IC, JC, DESCC ) | $C \leftarrow \beta C + \alpha A^T, A - n \times m, C - m \times n$ | S, D |
| P□TRANU | ( | M, N, | ALPHA, | A, IA, JA, DESCA, | | BETA, | C, IC, JC, DESCC ) | $C \leftarrow \beta C + \alpha A^T, A - n \times m, C - m \times n$ | C, Z |
| P□TRANC | ( | M, N, | ALPHA, | A, IA, JA, DESCA, | | BETA, | C, IC, JC, DESCC ) | $C \leftarrow \beta C + \alpha A^H, A - n \times m, C - m \times n$ | C, Z |
| P□TRMM | ( SIDE, UPLO, TRANSA, DIAG, | M, N, | ALPHA, | A, IA, JA, DESCA, | B, IB, JB, DESCB ) | | | $B \leftarrow \alpha op(A)B, B \leftarrow \alpha Bop(A), op(A) = A, A^T, A^H, B - m \times n$ | S, D, C, Z |
| P□TRSM | ( SIDE, UPLO, TRANSA, DIAG, | M, N, | ALPHA, | A, IA, JA, DESCA, | B, IB, JB, DESCB ) | | | $B \leftarrow \alpha op(A^{-1})B, B \leftarrow \alpha Bop(A^{-1}), op(A) = A, A^T, A^H, B - m \times n$ | S, D, C, Z |