PANUA PARDISO Version 8.2

```
   CALL PARDISO(PT, MAXFCT, MNUM, MTYPE, PHASE, N, A, IA, JA,
 1              PERM, NRHS, IPARM, MSGLVL, B,  X, ERROR, DPARM)
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Name	Type	Description	Input/Output
PT (64)	INT	Internal memory address pointer.	I/O
MAXFCT	INT	Number of numerical factorizations in memory.	I
MNUM	INT	Actual matrix to factorize.	I
MTYPE	INT	Matrix type.	I
	1	real and structurally symmetric, supernode pivoting	
	2	real and symmetric positive definite	
	-2	real and symmetric indefinite, diagonal or Bunch-Kaufman pivoting	
	11	real and nonsymmetric, complete supernode pivoting	
	3	complex and structurally symmetric, supernode pivoting	
	4	complex and hermitian positive definite	
	-4	complex and hermitian indefinite, diagonal or Bunch-Kaufman pivoting	
	6	complex and symmetric	
	13	complex and nonsymmetric, supernode pivoting	
PHASE	INT	Solver Execution Phase.	I
	11	Analysis	
	12	Analysis, Numerical Factorization	
	13	Analysis, Numerical Factorization, Solve, Iterative Refinement	
	22	Numerical Factorization	
	-22	Selected Inversion	
	23	Numerical Factorization, Solve, Iterative Refinement	
	33	Solve, Iterative Refinement	
	-1	Release all internal memory for all matrices	
	0	Release memory for matrix number MNUM	
N	INT	Number of equations.	I
A (∗)	R/C	Matrix values.	I
IA (N+1)	INT	Beginning of each row.	I
JA (∗)	INT	Column indices.	I
PERM (N)	INT	User permutation.	I
NRHS	INT	Number of right-hand sides.	I
IPARM (64)	INT	Control parameters.	I/O
MSGLVL	INT	Message level.	I
	0	No output.	
	1	Output statistical information	
B (N, NRHS)	R/C	Right-hand sides.	I/O
X (N, NRHS)	R/C	Solution vectors (see IPARM(6)).	O
ERROR	INT	Error indicator.	O
DPARM (64)	REAL	Control parameters for iterative solver	I/O

Table 1: Overview of subroutine arguments.

Name	Description	
IPARM(1)	Use default options.	
	0	Set all entries to their default values *except* IPARM(3).
IPARM(2)	Use METIS reordering.	
	0	Do not use METIS.
	2*	Use METIS nested dissection reordering.
	3	Use METIS51 nested dissection reordering.
	4	Use AMD ordering.
IPARM(3)	Number of processors.	
	p	Number of OPENMP threads. This *must* be identical or slightly larger to the environment variable `OMP_NUM_THREADS`.
IPARM(4)	Do preconditioned CGS iterations (see description). Default is 0.	
IPARM(5)	Use user permutation.	
	0*	Do not use user perm.
	1	Use the permutation provided in argument PERM.
IPARM(6)	Solution on X / B	
	0*	Write solution to X
	1	Write solution to B
IPARM(8)	Max. numbers of iterative refinement steps.	
	k=0*	The solver automatically performs two steps of iterative refinement when perturbed pivots are obtained during the numerical factorization. The number of executed iterations is reported in IPARM(7).
	$k > 0$	Maximum number of iterative refinement steps that the solver performs. The solver performs not more than the absolute value of IPARM (8) steps of iterative refinement. The solver might stop the process before the maximum number of steps if (1) a satisfactory level of accuracy of the solution in terms of backward error is achieved, or (2) or if it determines that the required accuracy cannot be reached. In this case the solver returns -4 in the error parameter. The number of executed iterations is reported in IPARM(7).
	$k < 0$	Maximum number of iterative refinement steps with a negative sign. Unlike the case above the accumulation of the residuum uses extended precision real and complex data types. The number of iterative refinement steps is reported in IPARM(7).
	k=-99	no iterative refinement for all matrices.
IPARM(9)	Tolerance level for the relative residual.	
	0*	If set to zero, default checks are used to determine when to stop the iterations (see IPARM (8) description)
	k	Tolerance level for the relative residual in the iterative refinement process. If set to a non-zero value, an additional criterion is used for stopping the iterative refinement: $\|\|r\|\|_2/\|\|b\|\|_2 < 10^{-IPARM(9)}$).
IPARM(10)	eps pivot (perturbation 10^{-k}).	
	13*	Default for nonsymmetric matrices
	8*	Default for symmetric indefinite matrices

Table 2: Overview of input IPARM control parameters. An asterisk (*) indicates the default value.

Name	Description	
IPARM(11)	Use (non-) symmetric scaling vectors.	
	0	Do not use .
	1*	Use (nonsymmetric matrices).
	0*	Do not use (symmetric matrices).
IPARM(12)	Solve transposed matrix.	
	0*	Do normal solve.
	1	Do solve with transposed matrix.
IPARM(13)	Improved accuracy using (non-)symmetric matchings	
	0	Do not use.
	1*	Use (nonsymmetric matrices).
	2	Use a very robust method for symmetric indefinite matrices.
	0*	Do not use (symmetric matrices).
IPARM(18)	Number of nonzeros in LU.	
	0	Do not determine.
	-1*	Will only be determined if -1 on entry.
IPARM(19)	Gflops for LU factorization.	
	0*	Do not determine.
	-1	Will only be determined if -1 on entry. Increases ordering time.
IPARM(21)	Pivoting for symmetric indefinite matrices. Default is 1.	
	0	1×1 Diagonal Pivoting
	1*	1×1 and 2×2 Bunch-Kaufman pivoting.
IPARM(24)	Parallel Numerical Factorization	
	0	Do one-level parallel scheduling.
	1*	Do two-level parallel scheduling.
IPARM(25)	Parallel Forward/Backward Solve	
	0	Do sequential solve.
	1*	Do parallel solve.
IPARM(26)	Partial Forward/Backward Solve	
	0*	Do forward/backward solve with L and U.
	1	Do forward solve with L or U^T.
	2	Do backward solve with U or L^T.
IPARM(28)	Parallel METIS reordering	
	0*	Do sequential METIS reordering.
	1	Do parallel METIS reordering.
IPARM(29)	32-bit/64-bit IEEE accuracy	
	0*	Use 64-bit IEEE accuracy.
	1	Use 32-bit IEEE accuracy.
IPARM(30)	Control size of supernodes	
	0*	Use default configuration.
	1	Use use configuration.

Table 3: Overview of input IPARM control parameters. An asterisk (*) indicates the default value.

Name	Description	
IPARM(31)	Partial solve for sparse right-hand sides and sparse solutions	
	0*	Compute all components in the solution vector.
	1	Compute only a few selected in the solution vector.
IPARM(32)	Use the multi-recursive iterative linear solver	
	0*	Use sparse direct solver.
	1	Use multi-recursive iterative solver.
IPARM(33)	Determinant for a matrices	
	0*	Do not compute determinant.
	1	Compute determinant.
IPARM(34)	Identical solution independent on the number of processors	
	0*	No identical parallel results.
	1	Identical parallel results
IPARM(36)	Selected inversion for A_{ij}^{-1}	
	0*	Overwrite internal factor with inverse elements.
	1	Do not overwrite internal factor with inverse elements.
IPARM(37)	Selected inversion for A_{ij}^{-1} for symmetric matrices	
	0*	Return inverse elements in upper triangular symmetric compressed CSR format (1-index based).
	1	Return inverse elements in full symmetric compressed CSR format (1-index based).
IPARM(38)	Schur-complement computation	
	0*	Indicates the numbers of rows/columns in S.
	k	Schur-complement matrix S is a $k\times$ matrix.
IPARM(50)	Use out-of-core solver	
	0*	Use in-core solver
	> 0	Use out-of-core solver
IPARM(51)	Use parallel distributed-memory solver	
	0*	Use OpenMP-threaded solver
	1	Use Mixed OpenMP-MPI solver
IPARM(52)	Number of nodes for distributed-memory solver	
	1*	For OpenMP-threaded solver
	p	Use p compute nodes
IPARM(53)	Block size of Compression	
	0*	Normal CSR matrix format is expected on input, block compression is not used
	p	Use p are the block size, block compression is used

Table 4: Overview of input IPARM control parameters. An asterisk (*) indicates the default value.

Name	Description	
IPARM(54)	This parameter sets the number of dense columns for compression	
	0*	Dense column compression is not used
	p	Use p dense columns at the end of the matrix, dense column compression is used
IPARM(55)	METIS 4.0.1 and METIS 5.1 ordering options	
	0*	Default values in METIS
	1	Other values can be used in METIS. Please see below.
IPARM(56)	Matching type in METIS	
	1	Random Matching (RM)
	2	Heavy-Edge Matching (HEM, only for METIS 4.0.1).
	3*	Sorted Heavy-Edge Matching (SHEM) (Default).
IPARM(57)	Algorithm used during METIS initial partitioning.	
	1*	Edge-based region growing (Default)
	2	Node-based region growing.
IPARM(58)	Algorithm used for METIS refinement.	
	1	Two-sided node FM refinement.
	2*	One-sided node FM refinement (Default).
IPARM(59)	Used for METIS debugging purposes.	
	0*	no output.
	> 0	output from METIS (statistics, etc, pleaser refer to the METIS manuals).
IPARM(60)	Compression of the graph in METIS.	
	0*	no compression.
	> 0	compression, pleaser refer to the METIS manuals).
IPARM(61)	Removal of vertices with high degree in METIS	
	0	Do not remove any vertices
	p*	Removal o vertices
IPARM(62)	Trial number of separators.	
	1*	only one trial
	k	Use k trials

Table 5: Overview of input IPARM control parameters. An asterisk (*) indicates the default value.

Name	Description	
IPARM(7)	Number of performed iterative refinement steps.	
IPARM(14)	Number of perturbed pivots.	
IPARM(15)	Peak Memory in KBytes during analysis.	
IPARM(16)	Permanent Memory in KBytes from analysis that is used in phases 2 and 3.	
IPARM(17)	Peak Double Precision Memory in KBytes including one LU Factor.	
IPARM(18)	Number of nonzeros in LU.	
	0	Do not determine.
	-1 *	Will only be determined if -1 on entry.
IPARM(19)	Gflops for LU factorization.	
	0 *	Do not determine.
	-1	Will only be determined if -1 on entry. Increases ordering time.
IPARM(20)	Numbers of CG Iterations.	
IPARM(22)	Number of positive eigenvalues for symmetric indefinite systems.	
IPARM(23)	Number of negative eigenvalues for symmetric indefinite systems.	
IPARM(39)	Number of nonzeros in Schur-complement matrix S	
DPARM(33)	Determinant for real symmetric indefinite matrices.	
DPARM(34)	Relative residual after Krylov-Subspace convergence.	
DPARM(35)	Number of Krylov-Subspace iterations.	

Table 6: Overview of output IPARM/DPARM control parameters. An asterisk (*) indicates the default value.

Error	Information
0	No error.
-1	Input inconsistent.
-2	Not enough memory.
-3	Reordering problem.
-4	Zero pivot, numerical fact. or iterative refinement problem.
-5	Unclassified (internal) error.
-6	Preordering failed (matrix types 11, 13 only).
-7	Diagonal matrix problem.
-8	32-bit integer overflow problem.
-10	No license file pardiso.lic found.
-11	License is expired.
-12	Wrong username or hostname.
-100	Reached maximum number of Krylov-subspace iteration in iterative solver.
-101	No sufficient convergence in Krylov-subspace iteration within 25 iterations.
-102	Error in Krylov-subspace iteration.
-103	Break-Down in Krylov-subspace iteration.

Table 7: PARDISO Error codes.