

NAG Fortran Library Routine Document

F08WWF (CGGBAK/ZGGBAK)

Note: before using this routine, please read the Users' Note for your implementation to check the interpretation of *bold italicised* terms and other implementation-dependent details.

1 Purpose

F08WWF (CGGBAK/ZGGBAK) forms the right or left eigenvectors of the real generalized eigenvalue problem $Ax = \lambda Bx$, by backward transformation on the computed eigenvectors given by F08YXF (CTGEVC/ZTGEVC). It is necessary to call this routine only if the optional balancing routine F08WVF (CGGBAL/ZGGBAL) was previously called to balance the matrix pair (A, B) .

2 Specification

```

SUBROUTINE F08WWF (JOB, SIDE, N, ILO, IHI, LSCALE, RSCALE, M, V, LDV,
1                INFO)
ENTRY          cggbak (JOB, SIDE, N, ILO, IHI, LSCALE, RSCALE, M, V, LDV,
1                INFO)
INTEGER       N, ILO, IHI, M, LDV, INFO
real         LSCALE(*), RSCALE(*)
complex     V(LDV,*)
CHARACTER*1   JOB, SIDE

```

The ENTRY statement enables the routine to be called by its LAPACK name.

3 Description

If the matrix pair has been previously balanced using the routine F08WVF (CGGBAL/ZGGBAL) then F08WWF (CGGBAK/ZGGBAK) backtransforms the eigenvector solution given by F08YXF (CTGEVC/ZTGEVC). This is usually the sixth and last step in the solution of the generalized eigenvalue problem.

For a description of balancing, see the document for F08WVF (CGGBAL/ZGGBAL).

4 References

Ward R C (1981) Balancing the generalized eigenvalue problem *SIAM J. Sci. Stat. Comp.* **2** 141–152

5 Parameters

1: JOB – CHARACTER*1 *Input*

On entry: specifies the backtransformation step required:

if JOB = 'N', no transformations are done;

if JOB = 'P', only do backward transformations based on permutations;

if JOB = 'S', only do backward transformations based on scaling;

if JOB = 'B', do backward transformations for both permutations and scaling.

Note: this must be identical to the parameter JOB as supplied to F08WVF (CGGBAL/ZGGBAL).

Constraint: JOB = 'N', 'P', 'S' or 'B'.

- 2: SIDE – CHARACTER*1 *Input*
On entry: indicates whether left or right eigenvectors are to be transformed, as follows:
 if SIDE = 'L', left eigenvectors are transformed;
 if SIDE = 'R', right eigenvectors are transformed.
Constraint: SIDE = 'L' or 'R'.
- 3: N – INTEGER *Input*
On entry: n , the order of the matrices A and B of the generalized eigenvalue problem.
Constraint: $N \geq 0$.
- 4: ILO – INTEGER *Input*
 5: IHI – INTEGER *Input*
On entry: i_{lo} and i_{hi} as determined by a previous call to F08WWF (CGGBAL/ZGGBAL).
Constraints:
 $1 \leq ILO \leq IHI \leq N$ if $N > 0$;
 $ILO = 1$ and $IHI = 0$ if $N = 0$.
- 6: LSCALE(*) – *real* array *Input*
Note: the dimension of the array LSCALE must be at least $\max(1, N)$.
On entry: details of the permutations and scaling factors applied to the left side of the matrices A and B , as returned by a previous call to F08WWF (CGGBAL/ZGGBAL).
- 7: RSCALE(*) – *real* array *Input*
Note: the dimension of the array RSCALE must be at least $\max(1, N)$.
On entry: details of the permutations and scaling factors applied to the right side of the matrices A and B , as returned by a previous call to F08WWF (CGGBAL/ZGGBAL).
- 8: M – INTEGER *Input*
On entry: m , the required number of left or right eigenvectors.
Constraint: $0 \leq M \leq N$.
- 9: V(LDV,*) – *complex* array *Input/Output*
Note: the second dimension of the array V must be at least $\max(1, M)$.
On entry: the matrix of right or left eigenvectors, as returned by F08WWF (CGGBAL/ZGGBAL).
On exit: the transformed right or left eigenvectors.
- 10: LDV – INTEGER *Input*
On entry: the first dimension of the array V as declared in the (sub)program from which F08WWF (CGGBAK/ZGGBAK) is called.
Constraint: $LDV \geq \max(1, N)$.
- 11: INFO – INTEGER *Output*
On exit: INFO = 0 unless the routine detects an error (see Section 6).

6 Error Indicators and Warnings

Errors or warnings detected by the routine:

INFO < 0

If INFO = $-i$, the i th parameter had an illegal value. An explanatory message is output, and execution of the program is terminated.

7 Accuracy

The errors are negligible, compared with the previous computations.

8 Further Comments

The number of operations is proportional to n^2 .

The real analogue of this routine is F08WJF (SGGBAK/DGGBAK).

9 Example

See Section 9 of the documents for F08XSF (CHGEQZ/ZHGEQZ) and F08YXF (CTGEVC/ZTGEVC).
