

NAG Library Routine Document

F07TWF (ZTRTRI)

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

F07TWF (ZTRTRI) computes the inverse of a complex triangular matrix.

2 Specification

```
SUBROUTINE F07TWF (UPLO, DIAG, N, A, LDA, INFO)
```

```
INTEGER                N, LDA, INFO
COMPLEX (KIND=nag_wp) A(LDA,*)
CHARACTER(1)          UPLO, DIAG
```

The routine may be called by its LAPACK name *ztrtri*.

3 Description

F07TWF (ZTRTRI) forms the inverse of a complex triangular matrix A . Note that the inverse of an upper (lower) triangular matrix is also upper (lower) triangular.

4 References

Du Croz J J and Higham N J (1992) Stability of methods for matrix inversion *IMA J. Numer. Anal.* **12** 1–19

5 Parameters

- 1: UPLO – CHARACTER(1) *Input*
On entry: specifies whether A is upper or lower triangular.
 UPLO = 'U'
 A is upper triangular.
 UPLO = 'L'
 A is lower triangular.
Constraint: UPLO = 'U' or 'L'.
- 2: DIAG – CHARACTER(1) *Input*
On entry: indicates whether A is a nonunit or unit triangular matrix.
 DIAG = 'N'
 A is a nonunit triangular matrix.
 DIAG = 'U'
 A is a unit triangular matrix; the diagonal elements are not referenced and are assumed to be 1.
Constraint: DIAG = 'N' or 'U'.

- 3: N – INTEGER *Input*
On entry: n , the order of the matrix A .
Constraint: $N \geq 0$.
- 4: A(LDA,*) – COMPLEX (KIND=nag_wp) array *Input/Output*
Note: the second dimension of the array A must be at least $\max(1, N)$.
On entry: the n by n triangular matrix A .
 If UPLO = 'U', A is upper triangular and the elements of the array below the diagonal are not referenced.
 If UPLO = 'L', A is lower triangular and the elements of the array above the diagonal are not referenced.
 If DIAG = 'U', the diagonal elements of A are assumed to be 1, and are not referenced.
On exit: A is overwritten by A^{-1} , using the same storage format as described above.
- 5: LDA – INTEGER *Input*
On entry: the first dimension of the array A as declared in the (sub)program from which F07TWF (ZTRTRI) is called.
Constraint: $LDA \geq \max(1, N)$.
- 6: 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.

INFO > 0

If INFO = i , $a(i, i)$ is exactly zero; A is singular and its inverse cannot be computed.

7 Accuracy

The computed inverse X satisfies

$$|XA - I| \leq c(n)\epsilon|X||A|,$$

where $c(n)$ is a modest linear function of n , and ϵ is the *machine precision*.

Note that a similar bound for $|AX - I|$ cannot be guaranteed, although it is almost always satisfied.

The computed inverse satisfies the forward error bound

$$|X - A^{-1}| \leq c(n)\epsilon|A^{-1}||A||X|.$$

See Du Croz and Higham (1992).

8 Further Comments

The total number of real floating point operations is approximately $\frac{4}{3}n^3$.

The real analogue of this routine is F07TJF (DTRTRI).

9 Example

This example computes the inverse of the matrix A , where

$$A = \begin{pmatrix} 4.78 + 4.56i & 0.00 + 0.00i & 0.00 + 0.00i & 0.00 + 0.00i \\ 2.00 - 0.30i & -4.11 + 1.25i & 0.00 + 0.00i & 0.00 + 0.00i \\ 2.89 - 1.34i & 2.36 - 4.25i & 4.15 + 0.80i & 0.00 + 0.00i \\ -1.89 + 1.15i & 0.04 - 3.69i & -0.02 + 0.46i & 0.33 - 0.26i \end{pmatrix}.$$

9.1 Program Text

```

Program f07twfe

!      F07TWF Example Program Text

!      Mark 24 Release. NAG Copyright 2012.

!      .. Use Statements ..
!      Use nag_library, Only: nag_wp, x04dbf, ztrtri
!      .. Implicit None Statement ..
!      Implicit None
!      .. Parameters ..
!      Integer, Parameter          :: nin = 5, nout = 6
!      Character (1), Parameter   :: diag = 'N'
!      .. Local Scalars ..
!      Integer                    :: i, ifail, info, lda, n
!      Character (1)              :: uplo
!      .. Local Arrays ..
!      Complex (Kind=nag_wp), Allocatable :: a(:, :)
!      Character (1)              :: clabs(1), rlabs(1)
!      .. Executable Statements ..
!      Write (nout,*) 'F07TWF Example Program Results'
!      Skip heading in data file
!      Read (nin,*)
!      Read (nin,*) n
!      lda = n
!      Allocate (a(lda,n))

!      Read A from data file

!      Read (nin,*) uplo
!      If (uplo=='U') Then
!         Read (nin,*)(a(i,i:n),i=1,n)
!      Else If (uplo=='L') Then
!         Read (nin,*)(a(i,1:i),i=1,n)
!      End If

!      Compute inverse of A
!      The NAG name equivalent of ztrtri is f07twf
!      Call ztrtri(uplo,diag,n,a,lda,info)

!      Print inverse

!      Write (nout,*)
!      Flush (nout)

!      ifail: behaviour on error exit
!      =0 for hard exit, =1 for quiet-soft, =-1 for noisy-soft
!      ifail = 0
!      Call x04dbf(uplo,diag,n,n,a,lda,'Bracketed','F7.4','Inverse','Integer', &
!                rlabs,'Integer',clabs,80,0,ifail)

End Program f07twfe

```

9.2 Program Data

F07TWF Example Program Data

```

4                                     :Value of N
'L'                                   :Value of UPLO
( 4.78, 4.56)
( 2.00,-0.30) (-4.11, 1.25)
( 2.89,-1.34) ( 2.36,-4.25) ( 4.15, 0.80)
(-1.89, 1.15) ( 0.04,-3.69) (-0.02, 0.46) ( 0.33,-0.26) :End of matrix A

```

9.3 Program Results

F07TWF Example Program Results

```

Inverse
          1          2          3          4
1 ( 0.1095,-0.1045)
2 ( 0.0582,-0.0411) (-0.2227,-0.0677)
3 ( 0.0032, 0.1905) ( 0.1538,-0.2192) ( 0.2323,-0.0448)
4 ( 0.7602, 0.2814) ( 1.6184,-1.4346) ( 0.1289,-0.2250) ( 1.8697, 1.4731)

```
