

NAG Library Routine Document

F07UWF (ZTPTRI)

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

F07UWF (ZTPTRI) computes the inverse of a complex triangular matrix, using packed storage.

2 Specification

```
SUBROUTINE F07UWF(UPLO, DIAG, N, AP, INFO)
  INTEGER          N, INFO
  complex*16      AP(*)
  CHARACTER*1      UPLO, DIAG
```

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

3 Description

F07UWF (ZTPTRI) forms the inverse of a complex triangular matrix A , using packed storage. 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: indicates 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: AP(*) – **complex*16** array

Input/Output

Note: the dimension of the array AP must be at least $\max(1, N \times (N + 1)/2)$.

On entry: the n by n triangular matrix A , packed by columns.

More precisely,

if UPLO = 'U', the upper triangle of A must be stored with element A_{ij} in $AP(i + j(j - 1)/2)$ for $i \leq j$;

if UPLO = 'L', the lower triangle of A must be stored with element A_{ij} in $AP(i + (2n - j)(j - 1)/2)$ for $i \geq j$.

If DIAG = 'U', the diagonal elements of A are assumed to be 1, and are not referenced; the same storage scheme is used whether DIAG = 'N' or 'U'.

On exit: A is overwritten by A^{-1} , using the same storage format as described above.

5: 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 can not 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 F07UJF (DTPTRI).

9 Example

This example computes the inverse of the matrix A , where

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

using packed storage.

9.1 Program Text

```
*      F07UWF Example Program Text
*      Mark 15 Release. NAG Copyright 1991.
*      .. Parameters ..
      INTEGER          NIN, NOUT
      PARAMETER        (NIN=5,NOUT=6)
      INTEGER          NMAX
      PARAMETER        (NMAX=8)
      CHARACTER        DIAG
      PARAMETER        (DIAG='N')
*      .. Local Scalars ..
      INTEGER          I, IFAIL, INFO, J, N
      CHARACTER        UPLO
*      .. Local Arrays ..
      COMPLEX *16      AP(NMAX*(NMAX+1)/2)
      CHARACTER        CLABS(1), RLABS(1)
*      .. External Subroutines ..
      EXTERNAL         X04DDF, ZTPTRI
*      .. Executable Statements ..
      WRITE (NOUT,*) 'F07UWF Example Program Results'
*      Skip heading in data file
      READ (NIN,*)
      READ (NIN,*) N
      IF (N.LE.NMAX) THEN
*
*         Read A from data file
*
*
      READ (NIN,*) UPLO
      IF (UPLO.EQ.'U') THEN
         READ (NIN,*) ((AP(I+J*(J-1)/2),J=I,N),I=1,N)
      ELSE IF (UPLO.EQ.'L') THEN
         READ (NIN,*) ((AP(I+(2*N-J)*(J-1)/2),J=1,I),I=1,N)
      END IF
*
*         Compute inverse of A
*
*
      CALL ZTPTRI(UPLO,DIAG,N,AP,INFO)
*
*         Print inverse
*
      WRITE (NOUT,*)
      IFAIL = 0
      CALL X04DDF(UPLO,DIAG,N,AP,'Bracketed','F7.4','Inverse',
+              'Integer',RLABS,'Integer',CLABS,80,0,IFAIL)
      END IF
*
      END
```

9.2 Program Data

F07UWF 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

F07UWF 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)
```
