# NAG Toolbox for MATLAB

# f07mw

## 1 Purpose

f07mw computes the inverse of a complex Hermitian indefinite matrix $A$, where $A$ has been factorized by f07mr.

## 2 Syntax

```
[a, info] = f07mw(uplo, a, ipiv, 'n', n)
```

## 3 Description

f07mw is used to compute the inverse of a complex Hermitian indefinite matrix $A$, the function must be preceded by a call to f07mr, which computes the Bunch–Kaufman factorization of $A$.

If **uplo** $=$ 'U', $A = PUDU^{\mathrm{H}}P^{\mathrm{T}}$ and $A^{-1}$ is computed by solving $U^{\mathrm{H}}P^{\mathrm{T}}XPU = D^{-1}$ for $X$.

If **uplo** $=$ 'L', $A = PLDL^{\mathrm{H}}P^{\mathrm{T}}$ and $A^{-1}$ is computed by solving $L^{\mathrm{H}}P^{\mathrm{T}}XPL = D^{-1}$ for $X$.

## 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

### 5.1 Compulsory Input Parameters

1: **uplo – string**

Indicates how $A$ has been factorized.

**uplo** $=$ 'U'

$A = PUDU^{\mathrm{H}}P^{\mathrm{T}}$, where $U$ is upper triangular.

**uplo** $=$ 'L'

$A = PLDL^{\mathrm{H}}P^{\mathrm{T}}$, where $L$ is lower triangular.

*Constraint*: **uplo** $=$ 'U' or 'L'.

2: **a(lda,$*$) – complex array**

The first dimension of the array **a** must be at least $\max(1, \mathbf{n})$

The second dimension of the array must be at least $\max(1, \mathbf{n})$

Details of the factorization of $A$, as returned by f07mr.

3: **ipiv($*$) – int32 array**

**Note**: the dimension of the array **ipiv** must be at least $\max(1, \mathbf{n})$.

Details of the interchanges and the block structure of $D$, as returned by f07mr.

### 5.2 Optional Input Parameters

1: **n – int32 scalar**

*Default*: The second dimension of the array **a** The dimension of the array **ipiv**.

$n$, the order of the matrix $A$.

*Constraint*: $\mathbf{n} \geq 0$.

### 5.3 Input Parameters Omitted from the MATLAB Interface

lda, work

### 5.4 Output Parameters

1: **a(lda,$*$) – complex array**

The first dimension of the array **a** must be at least $\max(1, \mathbf{n})$

The second dimension of the array must be at least $\max(1, \mathbf{n})$

The factorization contains the $n$ by $n$ Hermitian matrix $A^{-1}$.

If **uplo** = 'U', the upper triangle of $A^{-1}$ is stored in the upper triangular part of the array.

If **uplo** = 'L', the lower triangle of $A^{-1}$ is stored in the lower triangular part of the array.

2: **info – int32 scalar**

**info** $= 0$ unless the function detects an error (see Section 6).

## 6 Error Indicators and Warnings

Errors or warnings detected by the function:

**info** $= -i$

If **info** $= -i$, parameter $i$ had an illegal value on entry. The parameters are numbered as follows:

1: **uplo**, 2: **n**, 3: **a**, 4: **lda**, 5: **ipiv**, 6: **work**, 7: **info**.

It is possible that **info** refers to a parameter that is omitted from the MATLAB interface. This usually indicates that an error in one of the other input parameters has caused an incorrect value to be inferred.

**info** $> 0$

If **info** $= i$, $d(i,i)$ is exactly zero; $D$ is singular and the inverse of $A$ cannot be computed.

## 7 Accuracy

The computed inverse $X$ satisfies a bound of the form

if **uplo** = 'U', $\left|DU^{\mathrm{H}}P^{\mathrm{T}}XPU - I\right| \leq c(n)\epsilon\left(|D|\left|U^{\mathrm{H}}\right|P^{\mathrm{T}}|X|P|U| + |D|\left|D^{-1}\right|\right)$;
if **uplo** = 'L', $\left|DL^{\mathrm{H}}P^{\mathrm{T}}XPL - I\right| \leq c(n)\epsilon\left(|D|\left|L^{\mathrm{H}}\right|P^{\mathrm{T}}|X|P|L| + |D|\left|D^{-1}\right|\right)$,

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

## 8 Further Comments

The total number of real floating-point operations is approximately $\frac{8}{3}n^3$.

The real analogue of this function is f07mj.

## 9 Example

```
uplo = 'L';
```

```
a = [complex(-1.36, +0), complex(0, +0), complex(0, 0), complex(0, 0);
      complex(1.58, -0.9), complex(-8.87, 0), complex(0, 0), complex(0, 0);
       complex(2.21, +0.21), complex(-1.84, +0.03), complex(-4.63, +0), complex(0, 0);
      complex(3.91, -1.5), complex(-1.78, -1.18), complex(0.11, -0.11), complex(-1.84, +0)];
[a, ipiv, info] = f07mr(uplo, a);
[aOut, info] = f07mw(uplo, a, ipiv)
```

```
aOut =
   0.0826                  0                  0                  0
  -0.0335 + 0.0440i  -0.1408                  0                  0
   0.0603 - 0.0105i   0.0422 - 0.0222i  -0.2007                  0
   0.2391 - 0.0926i   0.0304 + 0.0203i   0.0982 - 0.0635i   0.0073
info =
           0
```