

# NAG Library Routine Document

## F06HRF

**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

F06HRF generates a complex elementary reflection.

### 2 Specification

```
SUBROUTINE F06HRF (N, ALPHA, X, INCX, TOL, THETA)
INTEGER           N, INCX
REAL (KIND=nag_wp) TOL
COMPLEX (KIND=nag_wp) ALPHA, X(*), THETA
```

### 3 Description

F06HRF generates details of a complex elementary reflection (Householder matrix),  $P$ , such that

$$P \begin{pmatrix} \alpha \\ x \end{pmatrix} = \begin{pmatrix} \beta \\ 0 \end{pmatrix}$$

where  $P$  is unitary,  $\alpha$  is a complex scalar,  $\beta$  is a real scalar, and  $x$  is an  $n$ -element complex vector.

$P$  is given in the form

$$P = I - \gamma \begin{pmatrix} \zeta \\ z \end{pmatrix} (\zeta \quad z^H),$$

where  $z$  is an  $n$ -element complex vector,  $\gamma$  is a complex scalar such that  $\text{Re}(\gamma) = 1$ , and  $\zeta$  is a real scalar.  $\gamma$  and  $\zeta$  are returned in a single complex value  $\theta = (\zeta, \text{Im}(\gamma))$ . Thus  $\zeta = \text{Re}(\theta)$  and  $\gamma = (1, \text{Im}(\theta))$ .

If  $x$  is such that

$$\max(|\text{Re}(x_i)|, |\text{Im}(x_i)|) \leq \max(\text{tol}, \epsilon \max(|\text{Re}(\alpha)|, |\text{Im}(\alpha)|)),$$

where  $\epsilon$  is the *machine precision* and  $\text{tol}$  is a user-supplied tolerance, then:

either  $\theta$  is set to 0, in which case  $P$  can be taken to be the unit matrix;

or  $\theta$  is set so that  $\text{Re}(\theta) \leq 0$  and  $\theta \neq 0$ , in which case

$$P = \begin{pmatrix} \theta & 0 \\ 0 & I \end{pmatrix}.$$

Otherwise  $1 \leq \text{Re}(\theta) \leq \sqrt{2}$ .

### 4 References

None.

### 5 Arguments

1: N – INTEGER

*Input*

*On entry:*  $n$ , the number of elements in  $x$  and  $z$ .

- 2: ALPHA – COMPLEX (KIND=nag\_wp) *Input/Output*  
*On entry:* the scalar  $\alpha$ .  
*On exit:* the scalar  $\beta$ .
- 3: X(\*) – COMPLEX (KIND=nag\_wp) array *Input/Output*  
**Note:** the dimension of the array X must be at least  $\max(1, 1 + (N - 1) \times \text{INCX})$ .  
*On entry:* the  $n$ -element vector  $x$ .  $x_i$  must be stored in  $X(1 + (i - 1) \times \text{INCX})$ , for  $i = 1, 2, \dots, N$ .  
Intermediate elements of X are not referenced.  
*On exit:* the referenced elements are overwritten by details of the complex elementary reflection.
- 4: INCX – INTEGER *Input*  
*On entry:* the increment in the subscripts of X between successive elements of  $x$ .  
*Constraint:*  $\text{INCX} > 0$ .
- 5: TOL – REAL (KIND=nag\_wp) *Input*  
*On entry:* the value  $tol$ .
- 6: THETA – COMPLEX (KIND=nag\_wp) *Output*  
*On exit:* the scalar  $\theta$ .

## 6 Error Indicators and Warnings

None.

## 7 Accuracy

Not applicable.

## 8 Parallelism and Performance

F06HRF makes calls to BLAS and/or LAPACK routines, which may be threaded within the vendor library used by this implementation. Consult the documentation for the vendor library for further information.

Please consult the X06 Chapter Introduction for information on how to control and interrogate the OpenMP environment used within this routine. Please also consult the Users' Note for your implementation for any additional implementation-specific information.

## 9 Further Comments

None.

## 10 Example

None.

---