

G01ECF – NAG Fortran Library Routine Document

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

G01ECF returns the lower or upper tail probability for the χ^2 distribution with real degrees of freedom, via the routine name.

2 Specification

```

real FUNCTION G01ECF(TAIL, X, DF, IFAIL)
  INTEGER          IFAIL
  real           X, DF
  CHARACTER*1     TAIL
CHARACTER*1

```

3 Description

The lower tail probability for the χ^2 distribution with ν degrees of freedom, $P(X \leq x : \nu)$ is defined by:

$$P(X \leq x : \nu) = \frac{1}{2^{\nu/2}\Gamma(\nu/2)} \int_{0.0}^x X^{\nu/2-1} e^{-X/2} dX, \quad x \geq 0, \nu > 0.$$

To calculate $P(X \leq x : \nu)$ a transformation of a gamma distribution is employed, i.e., a χ^2 distribution with ν degrees of freedom is equal to a gamma distribution with scale parameter 2 and shape parameter $\nu/2$.

4 References

- [1] Abramowitz M and Stegun I A (1972) *Handbook of Mathematical Functions* Dover Publications (3rd Edition)
- [2] Hastings N A J and Peacock J B (1975) *Statistical Distributions* Butterworths

5 Parameters

- 1: TAIL — CHARACTER*1 *Input*
On entry: indicates whether the upper or lower tail probability is required.
 If TAIL = 'L', the lower tail probability is returned, i.e., $P(X \leq x : \nu)$.
 If TAIL = 'U', the upper tail probability is returned, i.e., $P(X \geq x : \nu)$.
Constraint: TAIL = 'L' or 'U'.
- 2: X — **real** *Input*
On entry: the value of the χ^2 variate, x , with ν degrees of freedom.
Constraint: $X \geq 0.0$.
- 3: DF — **real** *Input*
On entry: the degrees of freedom, ν , of the χ^2 distribution.
Constraint: $DF > 0$.

4: IFAIL — INTEGER*Input/Output*

On entry: IFAIL must be set to 0, -1 or 1. Users who are unfamiliar with this parameter should refer to Chapter P01 for details.

On exit: IFAIL = 0 unless the routine detects an error or gives a warning (see Section 6).

For this routine, because the values of output parameters may be useful even if IFAIL \neq 0 on exit, users are recommended to set IFAIL to -1 before entry. **It is then essential to test the value of IFAIL on exit.**

6 Error Indicators and Warnings

If on entry IFAIL = 0 or -1 , explanatory error messages are output on the current error message unit (as defined by X04AAF).

Errors or warnings specified by the routine:

If IFAIL = 1, 2 or 3 on exit, then G01ECF returns 0.0.

IFAIL = 1

On entry, TAIL \neq 'L' or 'U'.

IFAIL = 2

On entry, X < 0.0.

IFAIL = 3

On entry, DF \leq 0.0.

IFAIL = 4

The solution has failed to converge while calculating the Gamma variate. The result returned should represent an approximation to the solution.

7 Accuracy

A relative accuracy of 5 significant figures is obtained in most cases.

8 Further Comments

For higher accuracy the transformation described in Section 3 may be used with a direct call to S14BAF.

9 Example

Values from various χ^2 distributions are read, the lower-tail probabilities calculated, and all these values printed out, until the end of data is reached.

9.1 Program Text

Note. The listing of the example program presented below uses bold italicised terms to denote precision-dependent details. Please read the Users' Note for your implementation to check the interpretation of these terms. As explained in the Essential Introduction to this manual, the results produced may not be identical for all implementations.

```
*      G01ECF Example Program Text
*      Mark 14 Release.  NAG Copyright 1989.
*      .. Parameters ..
      INTEGER          NIN, NOUT
      PARAMETER        (NIN=5,NOUT=6)
*      .. Local Scalars ..
```

```

      real          DF, PROB, X
      INTEGER      IFAIL
*    .. External Functions ..
      real          G01ECF
      EXTERNAL     G01ECF
*    .. Executable Statements ..
      WRITE (NOUT,*) 'G01ECF Example Program Results'
*    Skip heading in data file
      READ (NIN,*)
      WRITE (NOUT,*)
      WRITE (NOUT,*) '   X           DF     PROB'
      WRITE (NOUT,*)
20    READ (NIN,*,END=40) X, DF
      IFAIL = -1
*
      PROB = G01ECF('Lower',X,DF,IFAIL)
*
      IF (IFAIL.EQ.0) THEN
          WRITE (NOUT,99999) X, DF, PROB
      ELSE
          WRITE (NOUT,99999) X, DF, PROB, ' NOTE: IFAIL = ', IFAIL
      END IF
      GO TO 20
40    STOP
*
99999 FORMAT (1X,F6.3,F8.3,F8.4,A,I1)
      END

```

9.2 Program Data

G01ECF Example Program Data

8.26	20.0
6.2	7.5
55.76	45.0

9.3 Program Results

G01ECF Example Program Results

X	DF	PROB
8.260	20.000	0.0100
6.200	7.500	0.4279
55.760	45.000	0.8694
