



## 1 SUMMARY

Generates **uniformly distributed pseudo-random numbers**. Random numbers are generated in the ranges  $0 < \xi < 1$ ,  $-1 < \eta < 1$  and random integers in  $1 \leq k \leq N$  where  $N$  is specified by the user.

A multiplicative congruent method is used where a 32 bit generator word  $g$  is maintained. On each call to the subroutine  $g_{n+1}$  is updated to  $9228907 \times g_n \bmod(2^{32})$ ; the initial 32 bit value of  $g$  is '01010101...01'. Depending on the type of random number required the following are computed,  $\xi = 2^{-32} g_{n+1}$ ;  $\eta = 2^{-31} g_{n+1} - 1$  or  $k = \text{int.part}\{\xi N\} + 1$ .

The subroutine also provides a facility for saving the current value of the generator word and for re-starting with any specified value.

**ATTRIBUTES** — **Version:** 1.0.0. **Types:** FA01A; FA01AD. **Original date:** August 1967. **Origin:** R.C.F.McLatchie, Harwell. **Remark:** FA01A was formerly called FA01AS.

## 2 HOW TO USE THE PACKAGE

### 2.1 Argument lists and calling sequences

There are four entries.

(i) *to obtain random floating point numbers*

*The single precision version*

R=FA01A(I)

*The double precision version*

R=FA01AD(I)

I is an INTEGER variable which must be set by the user to chose one of two ranges for the random number. Only its sign is significant. If  $I \geq 0$  the result is a real value in the range  $0 < \xi < 1$  and if  $I < 0$  the result is a real value in the range  $-1 < \eta < 1$ .

FA01A is a REAL valued function subprogram returned set to the random number.

FA01AD is a DOUBLE PRECISION valued function subprogram returned set to the random number.

(ii) *to obtain random integers*

*The single precision version*

CALL FA01B(N,K)

*The double precision version*

CALL FA01BD(N,K)

N is an INTEGER variable which must be set by the user to specify the upper limit  $N$  of the range of integers from which the random number is to be taken, i.e. the random number  $k$  is chosen from  $1 \leq k \leq N$ . **Restriction:**  $N$  must be positive.

K is an INTEGER variable which will be set by the subroutine to the random integer  $k$ .

(iii) *to save the current generator word*

*The single precision version*

```
CALL FA01C(IL,IR)
```

*The double precision version*

```
CALL FA01CD(IL,IR)
```

IL and IR are INTEGER variables which will be set by the subroutine to the current value of the generator word  $g = IL \times 16^4 + IR$ .

(iv) *to reset the current value of the generator word*

*The single precision version*

```
CALL FA01D(IL,IR)
```

*The double precision version*

```
CALL FA01DD(IL,IR)
```

IL and IR are INTEGER variables which must be set by the user to the new generator word and should only be set to values previously obtained from FA01C/CD.

## 2.2 Common

One common block is used. The common block is

*The single precision version*

```
COMMON / FA01E/GL,GR
```

*The double precision version*

```
COMMON / FA01ED/GL,GR
```

where the parameters are given default values by a block data subprogram FA01F/FD.

GL,GR are DOUBLE PRECISION variables which contain current value of the generator word.

## 3 GENERAL INFORMATION

**Use of common:** The common block FA01E/ED is used, see § 2.2.

**Workspace:** none.

**Other subprograms:** none.

**Input/Output:** none.

## 4 METHOD

The generator integer  $g$  is held as a double precision variable  $G$  and revised on every call of FA01A/AD or FA01B/BD. It is initialized as if FA01D/DD is called with

$$IL = IR = 21845 = (16^4 - 1)/3$$

and on each call is revised as if the statement

```
G=DMOD(G*9228907.,16.**8)
```

were executed. The output from FA01A/B uses the revised  $G$  as follows

```
FA01A(1)=G/16.**8
```

```
FA01A(-1)=2*G/16**8-1.  
K=INT(FA01A(1)*FLOAT(N))+1
```

## 5 EXAMPLE OF USE

We illustrate the use of the package by saving and printing the generator word, printing a random positive real number, printing a random integer in the range 1 to 9, and resetting the generator word.

Suitable code is as follows:-

```
C SIMPLE EXAMPLE OF USE OF FA01 PACKAGE  
C  
C SAVE AND PRINT THE GENERATOR WORD  
  CALL FA01C(IL,IR)  
  WRITE(6,10)IL,IR  
10  FORMAT(' GENERATOR = ',2I6)  
C  
C PRINT A RANDOM POSITIVE REAL NUMBER  
  WRITE(6,20)FA01A(1)  
20  FORMAT(' RANDOM POSITIVE NUMBER = ', F8.6)  
C  
C PRINT A RANDOM INTEGER IN THE RANGE 1 TO 9  
  CALL FA01B(9,I)  
  WRITE(6,30)I  
30  FORMAT(' RANDOM INTEGER IN RANGE 1 TO 9 = ', I1)  
  
C RESET THE GENERATOR WORD  
  CALL FA01D(IL,IR)  
C  
  STOP  
  END
```

This produces the following output

```
GENERATOR = 21845 21845  
RANDOM POSITIVE NUMBER = 0.332617  
RANDOM INTEGER IN RANGE 1 TO 9 = 1
```