```
MMM          MMM  TTTTTTTTTTTTTTT   HHH          HHH  RRRRRRRRRRR     TTTTTTTTTTTTTTT   LLL
MMM          MMM  TTTTTTTTTTTTTTT   HHH          HHH  RRRRRRRRRRRR    TTTTTTTTTTTTTTT   LLL
MMM          MMM  TTTTTTTTTTTTTTT   HHH          HHH  RRRRRRRRRRRR    TTTTTTTTTTTTTTT   LLL
MMMMMM    MMMMMM        TTT         HHH          HHH  RRR         RRR       TTT         LLL
MMMMMM    MMMMMM        TTT         HHH          HHH  RRR         RRR       TTT         LLL
MMMMMM    MMMMMM        TTT         HHH          HHH  RRR         RRR       TTT         LLL
MMM   MMM   MMM         TTT         HHH          HHH  RRR         RRR       TTT         LLL
MMM   MMM   MMM         TTT         HHH          HHH  RRR         RRR       TTT         LLL
MMM   MMM   MMM         TTT         HHH          HHH  RRR         RRR       TTT         LLL
MMM         MMM         TTT         HHHHHHHHHHHHHHHH  RRRRRRRRRRR           TTT         LLL
MMM         MMM         TTT         HHHHHHHHHHHHHHHH  RRRRRRRRRRRR          TTT         LLL
MMM         MMM         TTT         HHHHHHHHHHHHHHHH  RRRRRRRRRRRR          TTT         LLL
MMM         MMM         TTT         HHH          HHH  RRR   RRR             TTT         LLL
MMM         MMM         TTT         HHH          HHH  RRR   RRR             TTT         LLL
MMM         MMM         TTT         HHH          HHH  RRR   RRR             TTT         LLL
MMM         MMM         TTT         HHH          HHH  RRR      RRR          TTT         LLL
MMM         MMM         TTT         HHH          HHH  RRR      RRR          TTT         LLL
MMM         MMM         TTT         HHH          HHH  RRR      RRR          TTT         LLL
MMM         MMM         TTT         HHH          HHH  RRR         RRR       TTT         LLLLLLLLLLLLLLLL
MMM         MMM         TTT         HHH          HHH  RRR         RRR       TTT         LLLLLLLLLLLLLLLL
MMM         MMM         TTT         HHH          HHH  RRR         RRR       TTT         LLLLLLLLLLLLLLLL
```

```
MM      MM  TTTTTTTTTT  HH      HH  RRRRRRRR     AAAAAA    NN      NN  DDDDDDDD      OOOOOO    MM      MM
MM      MM  TTTTTTTTTT  HH      HH  RRRRRRRR     AAAAAA    NN      NN  DDDDDDDD      OOOOOO    MM      MM
MMMM  MMMM      TT      HH      HH  RR      RR   AA    AA  NN      NN  DD      DD  OO      OO  MMMM  MMMM
MMMM  MMMM      TT      HH      HH  RR      RR   AA    AA  NN      NN  DD      DD  OO      OO  MMMM  MMMM
MM  MM  MM      TT      HH      HH  RR      RR   AA    AA  NNNN    NN  DD      DD  OO      OO  MM  MM  MM
MM  MM  MM      TT      HH      HH  RR      RR   AA    AA  NNNN    NN  DD      DD  OO      OO  MM  MM  MM
MM      MM      TT      HHHHHHHHHH  RRRRRRRR     AA    AA  NN  NN  NN  DD      DD  OO      OO  MM      MM
MM      MM      TT      HHHHHHHHHH  RRRRRRRR     AA    AA  NN  NN  NN  DD      DD  OO      OO  MM      MM
MM      MM      TT      HH      HH  RR  RR       AAAAAAAAAA  NN    NNNN  DD      DD  OO      OO  MM      MM
MM      MM      TT      HH      HH  RR  RR       AAAAAAAAAA  NN    NNNN  DD      DD  OO      OO  MM      MM
MM      MM      TT      HH      HH  RR    RR     AA    AA  NN      NN  DD      DD  OO      OO  MM      MM
MM      MM      TT      HH      HH  RR    RR     AA    AA  NN      NN  DD      DD  OO      OO  MM      MM
MM      MM      TT      HH      HH  RR      RR   AA    AA  NN      NN  DDDDDDDD      OOOOOO    MM      MM
MM      MM      TT      HH      HH  RR      RR   AA    AA  NN      NN  DDDDDDDD      OOOOOO    MM      MM

LL              IIIIII      SSSSSSSS
LL              IIIIII      SSSSSSSS
LL                II      SS
LL                II      SS
LL                II      SS
LL                II      SS
LL                II        SSSSSS
LL                II        SSSSSS
LL                II              SS
LL                II              SS
LL                II              SS
LL                II              SS
LLLLLLLLLL      IIIIII    SSSSSSSS
LLLLLLLLLL      IIIIII    SSSSSSSS
```

Table of contents

```
0000     1          .TITLE  MTH$RANDOM - General Purpose Random Number Generator
0000     2          .IDENT  /1-006/         ; File: MTHRANDOM.MAR
0000     3
0000     4 ;
0000     5 ;*****************************************************************************
0000     6 ;*                                                                           *
0000     7 ;*  COPYRIGHT (c) 1978, 1980, 1982, 1984 BY                                 *
0000     8 ;*  DIGITAL EQUIPMENT CORPORATION, MAYNARD, MASSACHUSETTS.                   *
0000     9 ;*  ALL RIGHTS RESERVED.                                                     *
0000    10 ;*                                                                           *
0000    11 ;*  THIS SOFTWARE IS FURNISHED UNDER A LICENSE AND MAY BE USED AND COPIED    *
0000    12 ;*  ONLY IN  ACCORDANCE WITH  THE  TERMS  OF  SUCH  LICENSE  AND WITH THE   *
0000    13 ;*  INCLUSION OF THE ABOVE COPYRIGHT NOTICE. THIS SOFTWARE OR  ANY  OTHER    *
0000    14 ;*  COPIES THEREOF MAY NOT BE PROVIDED OR OTHERWISE MADE AVAILABLE TO ANY   *
0000    15 ;*  OTHER PERSON.  NO TITLE TO AND OWNERSHIP OF  THE  SOFTWARE IS  HEREBY   *
0000    16 ;*  TRANSFERRED.                                                             *
0000    17 ;*                                                                           *
0000    18 ;*  THE INFORMATION IN THIS SOFTWARE IS  SUBJECT TO CHANGE WITHOUT NOTICE    *
0000    19 ;*  AND  SHOULD  NOT  BE  CONSTRUED AS  A COMMITMENT BY DIGITAL EQUIPMENT   *
0000    20 ;*  CORPORATION.                                                             *
0000    21 ;*                                                                           *
0000    22 ;*  DIGITAL ASSUMES NO RESPONSIBILITY FOR THE USE  OR  RELIABILITY OF ITS    *
0000    23 ;*  SOFTWARE ON EQUIPMENT WHICH IS NOT SUPPLIED BY DIGITAL.                  *
0000    24 ;*                                                                           *
0000    25 ;*                                                                           *
0000    26 ;*****************************************************************************
0000    27 ;
0000    28
0000    29 ;++
0000    30 ; FACILITY: Mathematics Library
0000    31 ;
0000    32 ; ABSTRACT:
0000    33 ;
0000    34 ;       This is a general random number generator. It is
0000    35 ;       of the multiplicative congruential type, and hence
0000    36 ;       is fast, although prone to certain classes of
0000    37 ;       non-random sequences.
0000    38 ;
0000    39 ; ENVIRONMENT:  any access mode, normally user mode
0000    40 ;                modular, AST reentrant procedure
0000    41 ;--
0000    42 ;+
0000    43 ; AUTHOR: Peter F. Conklin, CREATION DATE: 28-Dec-77
0000    44 ;
0000    45 ; MODIFIED BY:
0000    46 ;
0000    47 ;       Peter F. Conklin, 1-Feb-78: VERSION 01
0000    48 ; 01    - Original creation.
0000    49 ; 02    - Change to LIB$ rather than MTH$.
0000    50 ; 03    - Change back to MTH$.  Some more comments.  JMT 4-Jan-78
0000    51 ; 04    - Correct documentation on usage.
0000    52 ; 1-005 - Put version number in standard format (three digits in
0000    53 ;         edit number field).  JBS 16-NOV-78
0000    54 ; 1-006 - Add "_" to the PSECT directive.  JBS 22-DEC-78
0000    55 ;-
```

```
                     0000     57          .SBTTL  DECLARATIONS
                     0000     58
                     0000     59 ;
                     0000     60 ; INCLUDE FILES:
                     0000     61 ;
                     0000     62 ;       NONE
                     0000     63 ;
                     0000     64 ; MACROS:
                     0000     65 ;
                     0000     66 ;       NONE
                     0000     67 ;
                     0000     68 ; EQUATED SYMBOLS:
                     0000     69 ;
                     0000     70
           00000004  0000     71          SEED=4                                  ; Only argument is the seed
                     0000     72
                     0000     73 ;
                     0000     74 ; OWN STORAGE:
                     0000     75 ;
                     0000     76 ;       NONE
                     0000     77 ;
                     0000     78
                     0000     79 ;
                     0000     80 ; PSECT DECLARATIONS:
                     0000     81 ;
                  00000000    82          .PSECT  _MTH$CODE,PIC,SHR,NOWRT,LONG,EXE
```

```
0000     84          .SBTTL  MTH$RANDOM - CALLable function
0000     85 ;++
0000     86 ; FUNCTIONAL DESCRIPTION:
0000     87 ;
0000     88 ; RANDOM - General Purpose Pseudo Random Number Generator
0000     89 ;
0000     90 ;       Call the function MTH$RANDOM (seed) to obtain the
0000     91 ;       next pseudo-random number. The seed is updated by
0000     92 ;       the function automatically as a side effect. The
0000     93 ;       result is a floating point number that is uniformly
0000     94 ;       distributed in the range 0.0 inclusive to 1.0 exclusive.
0000     95 ;       There are no restrictions on the seed, although
0000     96 ;       it should be initialized to different values on
0000     97 ;       separate runs.
0000     98 ;
0000     99 ;       The algorithm used is to update the seed as:
0000    100 ;
0000    101 ;               seed = 69069. * seed + 1    (mod 2**32)
0000    102 ;
0000    103 ;       and then to convert the seed to floating point.
0000    104 ;
0000    105 ;       Note, because the result is never 1.0, a simple
0000    106 ;       way to get a uniform random integer selector is
0000    107 ;       to multiply by the number of cases. For example
0000    108 ;       if a uniform choice among 5 situations is to be
0000    109 ;       made, then the following FORTRAN statement will
0000    110 ;       work:
0000    111 ;               GO TO (1,2,3,4,5) 1+IFIX(5.*MTH$RANDOM(seed))
0000    112 ;
0000    113 ;       Note that the explicit IFIX is necessary before
0000    114 ;       adding 1 in order to avoid a possible rounding
0000    115 ;       during the normalization after the floating add.
0000    116 ;
0000    117 ;       This is a general random number generator. It is
0000    118 ;       of the multiplicative congruential type, and hence
0000    119 ;       is fast, although prone to certain classes of
0000    120 ;       non-random sequences. This non-random behavior
0000    121 ;       typically arises when considering triples of
0000    122 ;       numbers generated by this method.
0000    123 ;
0000    124 ;       For more information on congruential generators,
0000    125 ;       see:
0000    126 ;               Random Number Generation (pp. 1192-1197)
0000    127 ;                 by G. Marsaglia
0000    128 ;
0000    129 ;       in:     Encyclopedia of Computer Science
0000    130 ;                 edited by Anthony Ralston
0000    131 ;                 Petrocelli (New York, 1976)
0000    132 ;
0000    133 ; CALLING SEQUENCE:
0000    134 ;
0000    135 ;       result.wf.v = MTH$RANDOM (seed.mlu.r)
```

```
0000   137 ;
0000   138 ; INPUT PARAMETERS:
0000   139 ;
0000   140 ;       SEED.mlu.r              Longword seed is modified each call
0000   141 ;
0000   142 ; IMPLICIT INPUTS:
0000   143 ;
0000   144 ;       NONE
0000   145 ;
0000   146 ; OUTPUT PARAMETERS:
0000   147 ;
0000   148 ;       NONE
0000   149 ;
0000   150 ; IMPLICIT OUTPUTS:
0000   151 ;
0000   152 ;       NONE
0000   153 ;
0000   154 ; FUNCTION VALUE
0000   155 ;
0000   156 ;       Returns in R0 a single-precision floating point value between
0000   157 ;       0.0 inclusive and 1.0 exclusive.
0000   158 ;
0000   159 ; SIDE EFFECTS:
0000   160 ;
0000   161 ;       NONE
0000   162 ;
0000   163 ;--
```

```
                        0000  0000   165          .ENTRY  MTH$RANDOM,0            ;no registers save, clear IV
                              0002   166
                              0002   167 ;-
                              0002   168 ; If this were to be placed as an inline expansion, then
                              0002   169 ; EMUL SEED,#69069,#1,R0 should replace the next two
                              0002   170 ; instructions because this would prevent the possibility
                              0002   171 ; of integer overflow trapping.
                              0002   172 ;-
                              0002   173
      04 BC    00010DCD 8F    C4   0002   174          MULL2   #69069,@SEED(AP)        ;update seed with multiplier
               04 BC          D6   000A   175          INCL    @SEED(AP)               ;increment seed to protect
                              000D   176                                              ; against strange seeds
                              000D   177
                              000D   178 ;
                              000D   179 ; The next instructions convert the seed from unsigned integer
                              000D   180 ; to floating point in the range 0.0 to 1.0 exclusive.
                              000D   181 ;
                              000D   182
   50 04 BC    18    08    EF   000D   183          EXTZV   #8,#24,@SEED(AP),R0     ;Get the most significant bits
                              0013   184                                              ; of the seed in the range
                              0013   185                                              ; 0 .. (2**24)-1
               50    50    4E   0013   186          CVTLF   R0,R0                   ;Convert to floating without
                              0016   187                                              ; rounding. The result is
                              0016   188                                              ; positive and in the range
                              0016   189                                              ; 0.0 .. (2.0**24)-1.0
                              0016   190
                              0016   191 ;
                              0016   192 ; If this were to be placed as an inline expansion, then
                              0016   193 ; MULF #^X00003480,R0 could replace the next two instructions.
                              0016   194 ;
                              0016   195
                  05    13  0016   196          BEQL    10$                     ;If zero, already correct
   50    0C00 8F    A2   0018   197          SUBW    #24@7,R0                ;DIVF #^F2.0**24
                              001D   198                                              ; the result is now in the
                              001D   199                                              ; range 0.0 .. 1.0 exclusive
                              001D   200
                        04    001D   201 10$:     RET
                              001E   202
                              001E   203          .END
```

```
MTH$RANDOM      00000000 RG    01
SEED          = 00000004
```

Psect synopsis

PSECT name	Allocation	PSECT No.	Attributes
. ABS .	00000000 (0.)	00 (0.)	NOPIC USR CON ABS LCL NOSHR NOEXE NORD NOWRT NOVEC BYTE
_MTH$CODE	0000001E (30.)	01 (1.)	PIC USR CON REL LCL SHR EXE RD NOWRT NOVEC LONG

Performance indicators

Phase	Page faults	CPU Time	Elapsed Time
Initialization	32	00:00:00.08	00:00:00.55
Command processing	134	00:00:00.53	00:00:04.12
Pass 1	71	00:00:00.46	00:00:01.67
Symbol table sort	0	00:00:00.00	00:00:00.00
Pass 2	48	00:00:00.42	00:00:01.53
Symbol table output	2	00:00:00.00	00:00:00.19
Psect synopsis output	2	00:00:00.04	00:00:00.08
Cross-reference output	0	00:00:00.00	00:00:00.00
Assembler run totals	291	00:00:01.55	00:00:08.22

```
The working set limit was 900 pages.
1893 bytes (4 pages) of virtual memory were used to buffer the intermediate code.
There were 10 pages of symbol table space allocated to hold 2 non-local and 1 local symbols.
203 source lines were read in Pass 1, producing 10 object records in Pass 2.
0 pages of virtual memory were used to define 0 macros.
```

Macro library statistics

Macro library name	Macros defined
_255DUA28:[SYSLIB]STARLET.MLB;2	0

```
0 GETS were required to define 0 macros.

There were no errors, warnings or information messages.

MACRO/ENABLE=SUPPRESSION/DISABLE=(GLOBAL,TRACEBACK)/LIS=LIS$:MTHRANDOM/OBJ=OBJ$:MTHRANDOM MSRC$:MTHRANDOM/UPDATE=(ENH$:MTHRANDOM)
```

MTHJMIN0
LIS

MTHMSG
LIS

MTHIMIN0
LIS

MTHMAX1
LIS

MTHJIDNNT
LIS

MTHMSGDEF
LIS

MTHJIHNNT
LIS

MTHSGN
LIS

MTHJMAX0
LIS

MTHMOD
LIS

MTHSIGNAL
LIS

MTHSQRTR2
LIS

MTHJNINT
LIS

MTHSINCOS
LIS

MTHSQRT
LIS

MTHININT
LIS

MTHRANDOM
LIS

MTHJIGNNT
LIS

MTHMIN1
LIS

MTHJISIGN
LIS

MTHSIGN
LIS

MTHSINH
LIS