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TITLE	FP8 - FLOATING POINT ARITHMETIC SOFTWARE FOR DEC PDP-8 SERIES COMPUTERS
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ABSTRACT

FP8 is a floating point arithmetic interpretive program for use in any DEC PDP-8 series computer. It is somewhat smaller and much more versatile than the standard arithmetic package supplied by DEC. The full program requires 1249 locations in one memory field (plus from five to 34 locations in remote fields, for linkage) compared to the 1408 locations required by the DEC software. FP8 implements access across memory field boundaries for both instruction sequences and operand reference. A four-bit operation code is used to obtain an expanded set of floating-mode instructions including: add, subtract, multiply, divide, inverse divide, load, store, three-way compare, and jump and jump-to-subroutine. Operate-class instructions include: immediate load, absolute value, clear, change sign, set data field, and set output format. FP8 includes single- and double-precision fix and float operations, and square, square root, exponential, logarithm, sine, cosine, and arctangent functions, and free-format input and variable format output routines. The program size may be reduced to 663 locations by deletion of the function and input/output routines.

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I. INTRODUCTION

FP8 is a system of arithmetic and logical functions which interprets special PDP-8 code to perform a variety of floating-point arithmetic operations. The program will operate in any of the PDP-8 (and PDP-12) series of computers with 2k words (or more) of memory. FP8 has been designed for small size while implementing a versatile instruction set and utilization of extended memory for both operands and instruction sequences. The complete program requires 1249_{10} words of memory to provide 32_{10} interpretive-mode instructions including: inverse divide, three-way branch, six functions, free-format input and variable-format output, and single- and double-precision fix and float, as well as the usual arithmetic operations.

1. FP8 MEMORY REQUIREMENTS

The floating point interpretive package should be assembled to span locations 151_8 through 2511 of any PDP-8 memory field, although it is essentially page-relocatable beginning at location 200 provided that the proper linkage is made between the entry point at 176 and the new origin. All discussions and descriptions in this report assume that the normal assembly is made. If the functional operations (exp, log, sqrt, sin, cos, and atn) are not required, the first free location is 2041_8; if the input/output is also deleted, 1400_8 is the first free location.

FP8 FUNCTIONS	SIZE	
Arithmetic	1227_8	663_{10}
Arithmetic and I/O	1670	952
Arithmetic, I/O and Functions	2341	1249

In order to access FP8 from other memory fields, from five to 34 locations are required for linkage, depending on what facilities are to be used (illustrated in Appendix C, listing page 2). Basic access to the interpreter requires the sequence shown in the appendix, or the sequence:

```
.LOC   176              / AT 176 TO CONFORM TO
HLT                     / DEFINITION OF EFM.
CIF+10
JMS I  .+2
JMP I  176              / FP8 ASSUMED IN FIELD "1"
EME
```

An additional seven instructions are required for linkage to the single-precision float routine, and another 20 to link to the double-precision float routine and provide for loading and reading the high order floating accumulator.

The user must also supply character-handling routines appropriate to his IO devices for use by the FP8 input and output controllers.

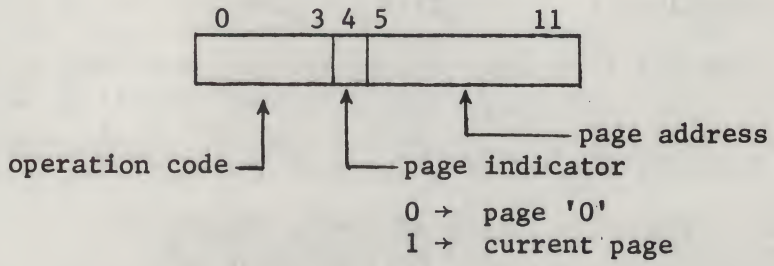
2. INITIATING AND TERMINATING INTERPRETIVE MODE

FP8 is a subroutine that operates on a variable length argument list; the arguments are the interpretive mode instructions. Interpretive mode is initiated by entering the subroutine (by a JMS) and is terminated by a special entry (0000) in the argument list. There are three entries to FP8, directly by executing JMS 176, or through the "single-signed float and enter" instruction JMS I 165, or the "double-precision float and enter" instruction JMS I 164. Provided that the linkage conventions displayed in Appendix C (listing, page 2) are followed, these operations are valid in any PDP-8 memory field.

Interpretive mode is terminated by executing one of the interpretive mode instructions LFM, SFIX, or DFIX. These instructions implement returns to normal mode with the AC clear, or containing the "FIX" (rounded) of the number in the floating accumulator.

3. INTERPRETIVE MODE ADDRESSING

In order to provide an expanded instruction set for floating point operations, bit three of the instruction word, used to indicate indirect addressing in normal PDP-8 coding, is utilized for part of the operation code by FP8. As a consequence, all FP8 memory references are implicitly indirect, and address pointers are required even when both operand and instruction are in the same PDP-8 page; there is no penalty, compared to normal mode coding, when two different pages are involved. The page indicator, bit four, is implemented exactly as in normal mode coding:



FP8 includes an (interpretive mode) instruction to specify the memory field for all data reference instructions (all memory reference instructions except JP, JS). Operands are determined by a pointer, in the current instruction memory field, containing the address of an operand in any other (or the same) memory field. Thus the interpreter, the interpreted coding, and the floating point data may be in the same, or in three different memory fields.

4. FLOATING POINT NUMBER FORMAT

FP8 represents floating point numbers in a three-word format; operands are addressed by the first of the three words. The first word is the binary exponent in two's-complement form, the second and third words contain a positive, normalized binary fraction in bits 1-11 of word two, continued in bits 0-11 of word three. The high-order bit of the second word contains the sign of the number; 0 for positive numbers, 1 for negative numbers:

TAG	Exponent	two's exponent
	S | High Mantissa	sign and high mantissa
	Low Mantissa	low order mantissa

The format for the Floating Accumulator (FAC) and the floating operand register is similar; the only difference is that the sign is separated from the mantissa and held in a separate register:

S |	ACS or BCS
Exponent	ACX or BCX
0 | High Mantissa	ACH or BCH
Low Mantissa	ACL or BCL

Although FP8 normalizes the FAC after each arithmetic operation, so that any data returned to memory by the store instruction (ST) are normalized, numbers loaded to the FAC by the load instruction (LD) are not tested for normalization; all assembled constants should be normalized.

This number format supports a precision greater than six (closer to seven) decimal digits and a magnitude range of 1200 decades. The arithmetic operations are accurate to 23 bits; results are truncated rather than rounded. Results of the "FIX" operations (SFIX, DFIX) are rounded to the nearest integer. The functional operations are generally accurate to 22 or 23 bits with occasional degradation to 21 bits. FP8 will thus reliably support six-decimal-digit computation in any normal application.

II. INTERPRETIVE MODE INSTRUCTIONS

There are 32 standard instructions available to the user in interpretive (floating) mode. The mnemonics used in the description are defined (by direct definition) as part of the FP8 coding. Many of the mnemonics are specifically dependent on the assembly of FP8 beginning at memory address 151.

1. CONTROL INSTRUCTIONS

EFM 4176 Enter Floating (Interpretive) Mode
JMS 176
Enter the interpreter subroutine to invoke floating point operating mode. Interpretive (floating) mode will remain in effect until one of the instructions LFM, SFIX, or DFIX is encountered. The floating accumulator is not affected.

SFLO 4565 Single (Signed) Float and Enter
JMS I 165
Convert the contents of the AC (a twelve-bit two's-complement integer) to a floating-format number in the FAC and enter interpretive mode.

DFLO 4564 Double-Precision Float and Enter
JMS I 164
Convert the 24-bit positive number in ACH (high order part) and the AC (low-order 12 bits) to a floating point number in the FAC and enter interpretive mode.

FCDF N 606N Change Floating Mode Data Field
For all interpretive-mode operand-reference instructions, until another FCDF instruction is encountered, all operands will be in PDP-8 memory field N. Operand address pointers are in the instruction field.

LFM 0000 Leave Floating (Interpretive) Mode
Terminate Interpretive Mode coding, leave zero in the AC. The Floating Accumulator (FAC) is not affected.

SFIX 6040 Single (Signed) Fix and Leave
Convert the number in the FAC to a twelve-bit two's-complement signed integer, leave the result in the AC, and leave interpretive mode. The result is rounded to the nearest integer. If the result is greater than or equal 2^{24} or less than 1/2, zero is returned. If the result is in the range $2^{12} \leq N < 2^{24}$, the low order 12 bits of the "double fix" are returned, two's-complemented if the FAC was negative. The content of the FAC is lost.

DFIX 6030 Double-Precision Fix and Leave Interpreter
Convert the number in the FAC to a 24-bit (magnitude, rounded) integer in ACH (high-order portion) and the AC (low twelve bits). The original content of the FAC is lost, except that the sign remains in ACS. If the result is greater than or equal 2^{24}, or less than 1/2, zero is returned. Program execution resumes in normal mode.

2. REGISTER MODIFICATION

ILA N ONNN Load N to Floating Accumulator
Immediately load the FAC with the positive number contained in the low-order eight bits of the ILA instruction. Numbers in the range $1 \leq N \leq 377_8$ may be generated directly in the FAC. Note that ILA 0 is the LFM instruction, and not legitimate.

ZAC 6000 Zero the Floating Accumulator
Load zero to the FAC.

ABS 6010 Absolute Value to the Floating Accumulator
Set the sign of the FAC positive, leave the magnitude unchanged.

CHS 6020 Change the Floating Accumulator Sign
Change the sign of the FAC from positive to negative, or from negative to positive, leave the magnitude unchanged.

3. JUMP INSTRUCTIONS

JP L 5400 Jump to Location
JMP I L
Load the address indicated by L to the interpreter instruction location register. Neither the FAC nor the interpretive data field is modified. Jumps are restricted to the current interpretive instruction memory field.

JS L 4400 Jump to Subroutine
JMS I L
Store the current instruction location register, incremented by one, in the location indicated by L, then jump to the following location. The FAC is not modified; the interpretive mode data field is not modified.

4. OPERAND REFERENCE

LD X 1000 Load Operand to the Floating Accumulator
The three-word floating-point number starting in the location indicated by X is loaded to the floating

accumulator (FAC). The operand is assumed properly normalized; the FP8 interpreter does not check for operand normalization in any "fetch" sequence.

ST X 1400 Store the Floating Accumulator
The number in the FAC is stored in the three words beginning with the address indicated by X.

AD X 2000 Add to the Floating Accumulator
The operand indicated by X is added to the number in the FAC. The result replaces the content of the FAC. The FAC is normalized after every arithmetic operation.

SB X 2400 Subtract from the Floating Accumulator
The operand indicated by X is subtracted from the FAC; the difference is normalized and retained in the FAC.

MP X 3000 Multiply the Floating Accumulator
The product of the number in the FAC and the operand indicated by X replaces the content of the FAC.

DV X 3400 Divide the Floating Accumulator
The number in the FAC is divided by the operand indicated by X; the quotient replaces the content of the FAC. If either the operand or the number in the FAC is zero, the result is set to zero.

RDV X 4000 Divide by the Floating Accumulator
The operand indicated by X is divided by the number in the FAC, the quotient replaces the content of the FAC. If either of the operands is zero, the result is zero.

CMP X 5000 Compare to the Floating Accumulator
The operand is algebraically compared to the number in the FAC and a conditional branch to one of the following three locations is made depending on whether the operand is less than, equal to, or greater than the number in the FAC:

```
go to L+1;  FAC < X
      L+2;  FAC = X
      L+3;  FAC > X
```

Neither the operand nor the FAC is modified.

5. FUNCTIONAL INSTRUCTIONS

The function algorithms used by FP8 have been collected from many sources, selected for brevity and relative accuracy rather than for speed in execution. The square is a simple multiplication, the square root is computed by a four-fold Newton iteration with an initial estimate equal to unity. The exponent, sine, and cosine are computed

by direct series expansion.* The logarithm and arctangent algorithms have been adapted from those used in the PDP-4/7/9 Basic Arithmetic Package "DISC" (DEC-9B-SFPA-PA).

FSQR 6070 Square the Floating Accumulator
The square of the number in the FAC is computed and left in the FAC.

FSQRT 6100 Square Root of the Floating Accumulator
The square root of the absolute value of the number in the floating accumulator replaces the number in the floating accumulator.

FEXP 6110 Natural Exponent
The natural exponent of the number in the FAC replaces the content of the FAC.

FLOG 6120 Natural Logarithm
The natural logarithm of the absolute value of the number in the FAC replaces the content of the FAC. Zero is returned for a zero argument.

FSIN 6130 Sine of the Floating Accumulator (Radians)
The sine of the number in the FAC, assumed to be in radians, replaces the content of the FAC. Accuracy deteriorates as the argument increases beyond 2π.

FCOS 6140 Cosine of the Floating Accumulator (Radians)
The cosine of the number in the FAC, assumed to be in radians, replaces the content of the FAC. Accuracy deteriorates as the argument increases beyond 2π.

FATN 6150 Arctangent of the Floating Accumulator
The principal value arctangent (in radians) of the number in the FAC replaces the content of the FAC.

6. INPUT/OUTPUT INSTRUCTIONS

The input/output instructions are described in detail in the section devoted to use of the FP8 I/O capabilities, and are listed here for the sake of completeness only.

FREAD	6050	Read to the Floating Accumulator
WRITE	6051	Write from the Floating Accumulator
FORMAT	6400	Set Output Format for "WRITE"
FCRLF	6052	Write CR/LF to Output Device

* The algorithms are described in USAEC Report ANCR-1039, "FP9, Floating Point Arithmetic for DEC PDP-9 and PDP-15 Computers", W. R. Myers, March 1972.

7. USER-DEFINED OP-CODE

FP8 has one unimplemented operation code (7000) that may be utilized for special purpose interpretive mode operations. The user may write a code sequence that contains both normal mode and certain interpretive mode (detailed below) operations, insert the starting address of the sequence in the FP8 branch table, and then execute that code as though it were part of the basic FP8 package. Memory locations of interest to the user who would implement the free operation code are:

LOCATION	NAME	
451	--	Location in the FP8 branch table in which the starting address of the special coding must be inserted. The special code must be in the same memory field as the interpreter.
160	FMQ	Contains the interpretive mode instruction word (in this case, 111 0XX XXX XXX) when control branches to the special code sequence.
401	FDF2	Contains the interpretive mode data field set by "FCDF+N" in the form CDF+10*N = 62N1.
206	XIF	Contains the interpretive mode instruction field (from which the instruction in FMQ was fetched) in the form CIF+10*M = 62M2.
220	XDF	Same as XIF, but in the form CDF+10*M = 62M1.
247 250 251	ADR	Contains the address of the operand as specified in the low eight bits of the operation code; this data may be meaningless, depending on the intent of the address field. Pointers to all three words of the operand are developed in 247-251.
172 173 174 175	BCS BCX BCH BCL	Contains the floating point operand when the branch is made to the user special coding; this data may be meaningless depending on the intent of the instruction address field.
153	ACZ	A page-zero link to a subroutine (ACZA) that tests the FAC for zero: JMS I ACZ returns to call+1 if the FAC is zero, to call+2 if the FAC is not zero.
1240	FXQ	The entry point to a subroutine that FIXes the contents of the FAC, by truncation, to ACH, ACL. The high-order fraction bit is returned in the LINK.

The user function must be in the interpreter memory field; it must not use any interpretive instructions in the function or input/output

class, or the FCDF instruction. Any normal-mode operations on the FAC or operand registers are allowed, as well as any of the basic FP8 operations (LD, ST, AD, etc., jumps and compare) provided that the operands are in the interpreter memory field. If interpretive operations are not used, the special function is terminated by JMP 177. If interpretive coding is used, interpretive mode is entered by JMS I SVPC which saves the current interpretive instruction location register and data field and then enters interpretive mode with the data field set to the interpreter field. After one execution of SVPC, the EFM and LFM instructions are used to switch modes. The sequence must now be terminated by JMP I RSPC (in either mode) to restore the instruction location and data field values and return to the normal interpretive procedures. The "SQUARE" and "SQUARE ROOT" routines (Appendix C, listing pages 22 and 25) and the "FORMAT" coding FM1 (listing page 22) should provide adequate examples for most purposes.

III. INPUT AND OUTPUT

FP8 includes a free-format input interpreter which converts ASCII character strings to floating point numbers in the floating accumulator and a variable-format output processor to convert a number in the floating accumulator to an ASCII character sequence specified by a format control word. The FP8 input and output routines are linked to devices by user-written character-handling subroutines to provide capability for device-independent or multiple-device IO.

The operation codes associated with input/output are:

FREAD 6050 Read to the Floating Accumulator
An ASCII character string consisting of numeric characters obtained by calling (JMS) a user-written routine is processed, until a non-numeric character is encountered. The input string is converted to a floating-point number and left in the FAC.

WRITE 6051 Write from the Floating Accumulator
The number in the FAC is converted to an ASCII character string, controlled by the contents of memory location FMT; each time a character is ready, a user-written subroutine is called (JMS) with the character in the AC. At the completion of WRITE, the FAC is restored to the absolute value of the initial content.

FORMAT 6400 Set Output Format for Write
The low eight bits of this instruction are moved to memory location FMT to control output format. Bits 4-8 and bits 9-11 are moved to bits 1-5 and bits 9-11 of FMT (with zeroes to the remaining bits) to control the "integer" field width and the "fraction" field width, respectively. The FAC is not modified.

FCRLF 6052 Write CR/LF to Output Device
This operation moves the codes 215_8 and 212_8 to the user character output routine to facilitate line formatting while in interpretive mode. The FAC is not modified.

1. THE INPUT INTERPRETER

When the interpretive-mode instruction "FREAD" is encountered, FP8 calls a user-written routine which must return a seven- or eight-level ASCII character in the accumulator; the character is masked to seven bits, stored in memory location ICHR, then tested for numeric or non-numeric. If the character is a numeric character (see table below), it is processed into the number currently being developed and the user routine is again called. Any non-numeric character acts as a terminator, causing the current number to be fully developed and left in the floating accumulator; program execution proceeds at the instruction following

the "FREAD" instruction. The terminator character will be in memory location ICHR, and the number of digits (a sub-set of the numeric characters) encountered will be in memory location CHRX. The user may leave interpretive mode at this point and examine ICHR if the terminator code has significance, and CHRX to establish that legitimate (non-trivial) input was processed.

The input character string has the form "SXXX.YYESZZT", where "S" is a sign (+ or -), "." is the decimal point or period, "E" is the character, and "T" is a non-numeric terminator character; "X", "Y", and "Z" are decimal digits. Any of the above fields may be deleted so that input may have any of the forms:

1., 1, 2.5, .3, -2.3, -1E10, -1E-10, 3.67E6

The only limitation is that the mantissa (XXXYY) should not contain more than seven significant digits; it must be smaller in magnitude than 2^{24}; the exponent (ZZ) must be smaller in magnitude than 2048.

All characters except those listed here as numeric characters act as terminators; numeric characters are:

0-9	60-71	decimal digits
E	105	exponent indicator (10)
-	55	negation (mantissa or exponent)
.	56	decimal point
+	53	(ignored) plus sign
(LF)	12	(ignored) line feed
null	0	(ignored) leader, null
(blank)	40	leading ignored, trailing terminates
(RO)	177	rub-out, erase

The two special numeric characters are the "blank" and "rub-out". Leading blanks, encountered before any digits have been read, are ignored, but a blank encountered subsequent to a digit acts as a terminator. If a rub-out (177) is read, the input interpreter is re-initialized, essentially erasing all characters processed up to that point. FP8 echoes the character "@" (100) to the user output routine on encountering the rub-out; if this echo is not desired, the user may insert 7610_8 in memory location RBO (1452_8).

2. USER CHARACTER INPUT ROUTINE

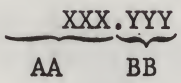
The input interpreter executes JMS I 163 each time it is ready for a character. The user of FP8 must write a subroutine appropriate to his input device and provide the proper linkage from memory location INR (163). An example of the required linkage is shown in Appendix C (listing pages 4 and 29). The input routine may contain no interpretive mode instructions, but otherwise may be as complex or as simple as required to return a seven- or eight-level ASCII character code in the accumulator.

3. THE OUTPUT CONTROLLER

The output controller, initiated by the interpretive instruction "WRITE", converts the number in the floating accumulator to a series of ASCII characters, controlled by the format word FMT, calling a user-written character-handling routine each time a character has been developed. Program execution continues at the instruction following the "WRITE" instruction when the format has been satisfied. Output characters are passed as eight-level (200+Code) ASCII codes in the accumulator (except for the rub-out echo, see above, which is 7700_8).

4. FORMAT CONTROL

Output format is controlled by the contents of memory location FMT (162) which may be loaded in normal mode or using the interpretive instruction "FORMAT". Both "F" and "I" (Fortran notation) formats may be indicated. The format control word has the form "AABB", where "AA" indicates the number of characters to be written to the left of the decimal point, i.e., the "integer" part of the number, and "BB" indicates the number of characters, including the decimal point, to be written to the right of the "integer" part:

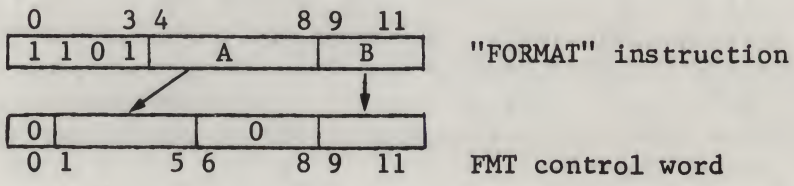


AA+BB is the total field width. AA must be large enough for all digits in the "integer" part of the number, for the sign (blank if positive, "-" if negative), and for any desired inter-number spacing. If BB = 0, only the "integer" part of the number is written, effecting an "I" format; if BB = 1, the decimal point is written, but none of the "fraction" digits are transmitted.

"FORTRAN" FORMATS	FP8
1F10.2	0703
1F15.6	1007
1I3	0300
1I10	1200

If the number to be written is too large for the specified field, the field is filled with "periods" (256) to indicate the error while assuring format continuity in multiple-number lines.

The interpretive instruction "FORMAT" facilitates format control without returning to normal mode to set FMT. The low eight bits of the instruction word are moved to the format control word:



The interpretive instruction "FCRLF" is also provided for interpretive formatting convenience. This instruction sends the ASCII chracter sequence "215, 212" to the user output routine to facilitate multiple line output.

5. USER CHARACTER OUTPUT ROUTINE

Each time the output controller has developed a character, it executes JMS I 161 to transmit the character, in the accumulator, to a user-written subroutine appropriate to the output device. The user must provide the linkage from memory location OTR (161) to his output routine; an example of the required linkage is shown in Appendix C (listing pages 4 and 29). The output routine may contain no interpretive instructions and it must return with a clear accumulator; it may otherwise be as simple or as complex as required.

APPENDIX A

GLOSSARY OF SPECIAL MEMORY LOCATIONS

Symbolic Tag	Location	Usage
CHRX	156	Contains a count of the number of input digits immediately* after each read (FREAD) operation.
ICHR	157	Contains the last character processed in an input (FREAD) operation, immediately after that operation.
FMQ	160	Contains the high-order product for integer multiply. The high-order dividend and the remainder for integer divide (see MPY, DIV).
OTR	161	Contains the address of the user-written character output subroutine.
FMT	162	Contains the output format control word.
INR	163	Contains the address of the user-written character input subroutines.
ACS	166	Floating Accumulator Sign.
ACS	167	FAC exponent.
ACH	170	FAC high-order mantissa, also contains the high-order portion of the result of the double-precision fix (DFIX) operation, and the high-order portion of the double-precision quantity for (DFLO) double float.
ACL	171	FAC low-order mantissa.

* Some of these locations are used for scratch variables by FP8 and will not always contain meaningful data.

Symbolic Tag	Location	Usage
BCS BCX BCH BCL	172 173 174 175	Floating Operand Register, format same as ACS ... ACL.
E	176	Interpreter entry point for access from local memory field (field occupied by FP8).
EME	226	Interpreter entry point for access from remote memory fields.
---	451	May contain an address for a user-written floating point operation utilizing operation code '7000'.
DIV	677	Entry point for integer divide sub-routine.
MPY	731	Entry point for integer multiply sub-routine.
---	2512	First free core location above FP8 interpreter package (exclusive of user written input and output linkage).

APPENDIX B

INTEGER MULTIPLY AND DIVIDE ROUTINES

FP8 is written to operate in any PDP-8 series computer and contains subroutines for integer multiply and divide that may be accessed by the user from the interpreter memory field. The calling sequences for these subroutines are:

```
JMS I     (MPY)        JMS I     (DIV)
ADRS                   ADRS
```

where "ADRS" is the address of the multiplier or the divisor. The multiply routine computes the unsigned 24-bit product of the number in the AC and the indicated multiplier. The high-order twelve bits of the product are left in memory location FMQ, the low-order twelve bits in the AC. The divide subroutine divides the 24-bit number contained in FMQ (high 12 bits) and the AC (low 12 bits) by the indicated divisor; the quotient is returned in the AC, and the remainder in FMQ. The divide routine does no error checking; the user must insure that he will not have divide overflow.

FP8 includes coding (Appendix C, listing page 30) to utilize EAE multiply and divide if available. If EAE is not available, this coding must be removed since it overlays the standard multiply and divide subroutines.

APPENDIX C

FP8 PROGRAM LISTING*

Instruction Summary and Definition
Cross-Bank Access Coding Example
FP8 Source Language Listing
Linkage Coding for Input/Output
Basic Coding for Special Function
Multiply and Divide Overlays for EAE

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* The user may find it necessary to edit the source language text for compatibility with his assembly environment.

** The user must define the instruction "UDF" (default is CDF+10) to correspond to the interpreter memory field to be used.

```
                        *** PDP-8 ASSEMBLY LISTING ***
                       / FP 8 EM  ANCR 1040
                       /     INSTRUCTION SUMMARY AND DEFINITION
                       /
                       / MNEMONIC   CODE  CLASS       DESCRIPTION
                       /
                       /     EFM    4176  CONTROL     ENTER INTERPRETIVE MODE.
                       /     SFLO   4565  CONTROL     SINGLE, SIGNED FLOAT AND EFM.
                       /     DFLO   4564  CONTROL     DOUBLE PRECISION FLOAT AND EFM.
                       /     FCDF   6060  CONTROL     CHANGE INTERPRETIVE DATA FIELD.
                       /     LFM    0000  CONTROL     LEAVE INTERPRETIVE MODE.
                       /     SFIX   6040  CONTROL     SINGLE FIX AND LFM.
                       /     DFIX   6030  CONTROL     DOUBLE FIX AND LFM.
                       /     LD     1000  MEM. REF.   LOAD FAC FROM MEMORY.
                       /     ST     1400  MEM. REF.   STORE FAC TO MEMORY.
                       /     AD     2000  MEM. REF.   ADD OPERAND TO FAC.
                       /     SB     2400  MEM. REF.   SUBTRACT OPERAND FROM FAC.
                       /     MP     3000  MEM. REF.   MULTIPLY FAC BY OPERAND.
                       /     DV     3400  MEM. REF.   DIVIDE FAC BY OPERAND.
                       /     RDV    4000  MEM. REF.   DIVIDE OPERAND BY FAC TO FAC.
                       /     JS     4400  MEM. REF.   JUMP TO SUBROUTINE
                       /     CMP    5000  MEM. REF.   COMPARE FAC, CONDITIONAL BRANCH.
                       /     JP     5400  MEM. REF.   JUMP TO NEW LOCATION.
                       /     ILA    0000  OPERATE     IMMEDIATE LOAD TO FAC.
                       /     ZAC    6000  OPERATE     SET FAC TO ZERO.
                       /     ABS    6010  OPERATE     ABSOLUTE VALUE TO FAC.
                       /     CHS    6020  OPERATE     CHANGE SIGN OF FAC.
                       /     FREAD  6050  OPERATE     FREE-FORMAT READ TO FAC.
                       /     WRITE  6051  OPERATE     FORMATTED OUTPUT FROM FAC.
                       /     FCRLF  6052  OPERATE     NEW LINE TO OUTPUT DEVICE.
                       /     FORMAT 6400  OPERATE     SET OUTPUT FORMAT.
                       /     FSQR   6070  FUNCTION    SQUARE OF FAC TO FAC.
                       /     FSQRT  6100  FUNCTION    SQUARE ROOT OF FAC.
                       /     FEXP   6110  FUNCTION    NATURAL EXPONENTIAL.
                       /     FLOG   6120  FUNCTION    NATURAL LOGARITHM.
                       /     FSIN   6130  FUNCTION    SINE OF FAC (RADIANS).
                       /     FCOS   6140  FUNCTION    COSINE OF FAC.
                       /     FATN   6150  FUNCTION    ARCTANGENT.
                       /
                             FIELD    0          / EXAMPLE ACCESS FROM '0'
**********************        .LOC      164      **********************************
 000164    007404                XDFLO            / DOUBLE FLOAT LINKAGE.
 000165    007412                XSFLO            / SINGLE FLOAT LINKAGE.
 000166    007420                XRHO             / READ HIGH FAC LINKAGE.
 000167    007426                XLHO             / LOAD HIGH FAC LINKAGE.
**********************        .LOC      175      **********************************
 000175    007400                XEE              / ENTER INTERPRETIVE
 000176    007402                HLT              / MODE LINKAGE.
 000177    005575                JMP I     .-2
 000200    007402   READA        HLT              / EXAMPLE INPUT ROUTINE
 000201    007300                CLA CLL
 000202    006214                RDF
 000203    001212                TAD       .+7
 000204    003210                DCA       .+4
 000205    006031                KSF
 000206    005205                JMP       .-1
 000207    006036                KRB
 000210    007402                HLT
 000211    005600                JMP I     READA
 000212    006202                CIF
```

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000213  007402  PRINTA  HLT                     / EXAMPLE OUTPUT ROUTINE
000214  006046          TLS
000215  006041          TSF
000216  005215          JMP     .-1
000217  006042          TCF
000220  007300          CLA CLL
000221  006214          RDF
000222  001212          TAD     .-10
000223  003224          DCA     .+1
000224  007402          HLT
000225  005613          JMP I   PRINTA
**********          .LOC    7400    **********
007400  006212  XEE     CIF+10                  / ASSUME INTERPRETER
007401  004603          JMS I   .+2             / IN MEMORY FIELD #1.
007402  005576          JMP I   176
007403  000226          EME
007404  007402  XDFLO   HLT                     / DOUBLE FLOAT AND ENTER
007405  006212          CIF+10                  / FOR CROSS-BANK ACCESS.
007406  004611          JMS I   .+3
007407  004176          EFM
007410  005604          JP      XDFLO
007411  001210          AFLO
007412  007402  XSFLO   HLT                     / CROSS-BANK SINGLE, SIGNED
007413  006212          CIF+10                  / FLOAT AND ENTER INTERPRETER.
007414  004617          JMS I   .+3
007415  004176          EFM
007416  005612          JP      XSFLO
007417  001216          BFLO
                EXRHA=4566                      / DEFINE READ HIGH FAC.
007420  007402  XRHO    HLT                     / READ HIGH FAC IN FIELD '1'
007421  006211          CDF+10                  / FROM NORMAL MODE CODE
007422  001625          TAD I   .+3             / IN FIELD '0'.
007423  006201          CDF
007424  005620          JMP I   XRHO
007425  000170          ACH
                EXLHA=4567                      / DEFINE LOAD HIGH FAC.
007426  007402  XLHO    HLT                     / LOAD HIGH FAC,
007427  006211          CDF+10                  / CROSS-BANKS '1' AND '0'.
007430  003625          DCA I   .-3
007431  006201          CDF
007432  005626          JMP I   XLHO
                /       FP 8 EM
                /       PDP-8 FLOATING POINT
                /       EXTENDED MEMORY VERSION
                /       ANCR 1040
                /       W R MYERS
                /       FEBRUARY 1972
                / FLOATING MODE INSTRUCTIONS:
                UDF=6211                        / FP IN FIELD #1
                EFM=4176                        / ENTER INTERPRETER
                LFM=0                           / LEAVE FLOATING MODE
                ILA=0                           / IMMEDIATE LOAD FAC
                LD=1000                         / LOAD FAC
                ST=1400                         / STORE FAC
                AD=2000                         / ADD
                SB=2400                         / SUBTRACT
                MP=3000                         / MULTIPLY
                DV=3400                         / DIVIDE
                RDV=4000                        / DIVIDE INVERTED
                JS=4400                         / JUMP TO SUBROUTINE
```

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                    CMP=5000                        / THREE-WAY COMPARE
                    JP=5400                         / JUMP TO LOCATION
                    SFLO=4565                       / SINGLE FLOAT AND EFM
                    DFLO=4564                       / DOUBLE FLOAT AND EFM
                    ZAC=6000            / ZERO TO FAC
                    ABS=6010            / ABSOLUTE VALUE
                    CHS=6020            / CHANGE SIGN
                    DFIX=6030           / DOUBLE FIX AND LFM
                    SFIX=6040           / SIGNED FIX AND LFM
                    FREAD=6050          / INPUT TO FAC
                    WRITE=6051          / OUTPUT FROM FAC
                    FCRLF=6052          / NEW OUTPUT LINE
                    FORMAT=6400         / SET OUTPUT FORMAT
                    FCDF=6060           / SET FLOATING DATA FIELD
                    FSQR=6070           / SQUARE FAC
                    FSQRT=6100          / SQUARE ROOT
                    FEXP=6110           / EXPONENT
                    FLOG=6120           / LOGARITHM
                    FSIN=6130           / SINE
                    FCOS=6140           / COSINE
                    FATN=6150           / ARCTANGENT
                    /         START OF ASSEMBLED CODE
                          FIELD     1           / EXAMPLE FP 8 IN FIELD '1'
**********                .LOC      151         **********************************
 000151   000424      SVPC      SPC1
 000152   000411      RSPC      RPC1
 000153   000511      ACZ       ACZA
 000154   000524      BCZ       BCZA
 000155   000556      NOR       NORA
 000156   000000      CHRX      0                       / INPUT CHARACTER COUNTER.
 000157   000000      ICHR      0                       / LAST INPUT CHARACTER.
 000160   000000      FMQ       0                       / 'MQ' REGISTER.
 000161   002512      OTR       UOR                     / OUTPUT ROUTINE.
 000162   001305      FMT       1305                    / FORMAT INDICATOR.
 000163   002520      INR       UIR                     / INPUT ROUTINE.
 000164   001204                FLOR                    / DOUBLE FLOAT AND ENTER.
 000165   001200                FLOS                    / SINGLE SIGNED FLOAT.
 000166   000000      ACS       0                       / FLOATING ACCUMULATOR.
 000167   000000      ACX       0
 000170   000000      ACH       0
 000171   000000      ACL       0
 000172   000000      BCS       0                       / FLOATING OPERAND.
 000173   000000      BCX       0
 000174   000000      BCH       0
 000175   000000      BCL       0
 000176   000000      E         0                       / INTERPRETER LOCAL ENTRY.
 000177   007300      R         CLA CLL                 / INTERPRETIVE RETURN.
 000200   004211                JMS       TENT
 000201   007000                NOP
 000202   001624                TAD I     EX
 000203   007440                SZA                     / TEST FOR LFM.
 000204   005260                JMP       EGO
 000205   004211                JMS       TENT        / RESTORE INSTRUCTION
 000206   006202      XIF       CIF                   / AND DATA FIELDS
 000207   003176                DCA       E           / AND RETURN.
 000210   005624                JMP I     EX
 000211   007402      TENT      HLT                   / TEST ENTRY AND
 000212   001176                TAD       E           / FIX DATA FIELD FOR
 000213   007450                SNA                   / INTERPRETER
 000214   005220                JMP       .+4         / INSTRUCTION FIELD.
```

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000215  002211          ISZ     TENT
000216  006211          UDF
000217  005222          JMP     .+3
000220  006211  XDF     UDF
000221  001226          TAD     EME
000222  003224          DCA     EX
000223  005611          JMP I   TENT
000224  000000  EX      0
000225  006201          CDF
000226  000000  EME     0               / CROSS-BANK ENTRY.
000227  007300          CLA CLL
000230  006214          RDF             / CALCULATE DATA FIELD
000231  001225          TAD     EX+1    / AND RETURN LINKAGE.
000232  003220          DCA     XDF
000233  001220          TAD     XDF
000234  007001          IAC
000235  003206          DCA     XIF
000236  005177          JMP     R
000237  007402  IFPC    HLT             / INCREMENT LOCAL OR
000240  004211          JMS     TENT    / EXTENDED INSTRUCTION
000241  005244          JMP     .+3     / POINTER.
000242  002176          ISZ     E
000243  007410          SKP
000244  002226          ISZ     EME
000245  006211          UDF
000246  005637          JMP I   IFPC
000247  000000  ADR     0               / OPERAND ADDRESS
000250  000000          0               / POINTERS.
000251  000000          0
000252  000177  P1      177             / PAGE #1 CONSTANTS.
000253  000200          200
000254  007600          7600
000255  004000          4000
000256  003777          3777
000257  000007          7
000260  003160  EGO     DCA     FMQ     / SAVE INSTRUCTION.
000261  001160          TAD     FMQ
000262  000252          AND     P1      / CALCULATE OPERAND ADDRESS.
000263  003247          DCA     ADR
000264  001160          TAD     FMQ
000265  000253          AND     P1+1
000266  007650          SNA CLA         / TEST PAGE INDICATOR.
000267  005274          JMP     .+5
000270  001224          TAD     EX
000271  000254          AND     P1+2
000272  001247          TAD     ADR
000273  003247          DCA     ADR
000274  001647          TAD I   ADR     / INDIRECT ADDRESSING
000275  003247          DCA     ADR     / IS IMPLICIT.
000276  001247          TAD     ADR
000277  007001          IAC             / SET ADDRESS POINTERS.
000300  003250          DCA     ADR+1
000301  001250          TAD     ADR+1
000302  007001          IAC
000303  003251          DCA     ADR+2
000304  004774          JMS I   F8DF    / SET OPERAND DATA FIELD.
000305  001647          TAD I   ADR
000306  003173          DCA     BCX     / MOVE OPERAND TO
000307  001650          TAD I   ADR+1   / FLOATING OPERAND
000310  000255          AND     P1+3    / REGISTER.
```

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000311  003172          DCA     BCS
000312  001650          TAD I   ADR+1
000313  000256          AND     P1+4
000314  003174          DCA     BCH
000315  001651          TAD I   ADR+2
000316  003175          DCA     BCL
000317  004237          JMS     IFPC
000320  001160          TAD     FMQ       / GET OPERATION CODE.
000321  007006          RTL
000322  007006          RTL
000323  000257          AND     P1+5
000324  007004          RAL
000325  007440          SZA
000326  005333          JMP     .+5
000327  001160          TAD     FMQ       / IMMEDIATE LOAD FAC,
000330  004732          JMS.I   .+2       / USE SINGLE FLOAT
000331  005177          JMP     R         / ROUTINE.
000332  001216          BFLO
000333  001340          TAD     T1        / CALCULATE BRANCH
000334  003157  FN2     DCA     ICHR      / TO OTHER FUNCTIONS.
000335  001557          TAD I   ICHR
000336  003157          DCA     ICHR
000337  005557          JMP I   ICHR
000340  000433  T1      OPT-2
000341  004774  ST1     JMS I   F8DF      / STORE FAC TO MEMORY.
000342  001167          TAD     ACX
000343  003647          DCA I   ADR
000344  001170          TAD     ACH
000345  001166          TAD     ACS
000346  003650          DCA I   ADR+1
000347  001171          TAD     ACL
000350  003651          DCA I   ADR+2
000351  005177          JMP     R
000352  004211  JS1     JMS     TENT
000353  005361          JMP     .+6
000354  001176          TAD     E
000355  003647          DCA I   ADR
000356  001250          TAD     ADR+1
000357  003176  JP2     DCA     E
000360  005177          JMP     R
000361  001226          TAD     EME
000362  003647          DCA I   ADR
000363  001250          TAD     ADR+1
000364  003226  JP3     DCA     EME
000365  005177          JMP     R
000366  004211  JP1     JMS     TENT
000367  005372          JMP     .+3
000370  001247          TAD     ADR
000371  005357          JMP     JP2
000372  001247          TAD     ADR
000373  005364          JMP     JP3
000374  000400  F8DF    FDF1
000375  004777  LD1     JMS I   XAB2
000376  005177          JMP     R
000377  000645  XAB2    XAB1
000400  007402  FDF1    HLT
000401  006211  FDF2    UDF
000402  005600          JMP I   FDF1
000403  001160  CDX1    TAD     FMQ       / FLOATING OPERAND
000404  000217          AND     SPC1-5    / DATA FIELD SET.
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000405  007104          CLL RAL
000406  007006          RTL
000407  001221          TAD     SPC1-3
000410  005215          JMP     .+5
000411  000000  RPC1    LFM                     / RESTORE INSTRUCTION
000412  001222          TAD     SPC1-2          / POINTER AND OPERAND
000413  003176          DCA     E               / FIELD AND RETURN
000414  001223          TAD     SPC1-1          / FROM FUNCTION.
000415  003201          DCA     FDF2
000416  005177          JMP     R
000417  000007          7
000420  006211          UDF
000421  006201          CDF
000422  007402          HLT
000423  007402          HLT
000424  007402  SPC1    HLT                     / SAVE LOCAL INSTRUCTION
000425  001176          TAD     E               / POINTER AND DATA FIELD
000426  003222          DCA     SPC1-2          / FOR FP8 USE OF FP8.
000427  001201          TAD     FDF2
000430  003223          DCA     SPC1-1
000431  001220          TAD     SPC1-4
000432  003201          DCA     FDF2
000433  004176          EFM
000434  005624          JP      SPC1
000435  000375  OPT     LD1                     / OPERATION BRANCH TABLE.
000436  000341          ST1
000437  001060          AD1
000440  001055          SB1
000441  000772          MP1
000442  001120          DV1
000443  001117          RD1
000444  000352          JS1
000445  001354          CM1
000446  000366          JP1
000447  000454          FN1
000450  002020          FM1
000451  002525          USER    / USER-DEFINED FUNCTIONS; OP=7000.
000452  000017          17
000453  000463          OPF
000454  001160  FN1     TAD     FMQ
000455  007010          RAR
000456  007012          RTR
000457  000252          AND     FN1-2
000460  001253          TAD     FN1-1
000461  005662          JMP I   .+1
000462  000334          FN2
000463  000570  OPF     ZA1                     / FUNCTION BRANCH TABLE.
000464  000576          AB1
000465  000574          CH1
000466  001301          AFIX
000467  001271          BFIX
000470  000501          IO1
000471  000403          CDX1
000472  001771          SQAR
000473  002243          SQRT
000474  002073          EXP
000475  002142          LOG
000476  002423          SIN
000477  002377          COS
000500  002277          ATN
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000501  001160      IO1     TAD         FMQ
000502  000217              AND         SPC1-5
000503  001305              TAD         .+2
000504  005662              JMP I       OPF-1
000505  000506              .+1
000506  001530              IN1                     / IO BRANCH TABLE.
000507  001600              OT1
000510  001764              CR1
000511  007402      ACZA    HLT                     / TEST FAC FOR ZERO.
000512  001170              TAD         ACH
000513  007640              SZA CLA
000514  005322              JMP         .+6
000515  001171              TAD         ACL
000516  007640              SZA CLA
000517  005322              JMP         .+3
000520  003167              DCA         ACX
000521  005711              JMP I       ACZA
000522  002311              ISZ         ACZA
000523  005711              JMP I       ACZA
000524  007402      BCZA    HLT                     / TEST OPERAND FOR ZERO.
000525  001174              TAD         BCH
000526  007640              SZA CLA
000527  002324              ISZ         BCZA
000530  005724              JMP I       BCZA
000531  007402      RACL    HLT                     / ROTATE FAC LEFT
000532  001171              TAD         ACL         / AND DECREMENT
000533  007104              CLL RAL                 / EXPONENT.
000534  003171              DCA         ACL
000535  001170              TAD         ACH
000536  007004              RAL
000537  003170              DCA         ACH
000540  007040              CMA
000541  001167              TAD         ACX
000542  003167              DCA         ACX
000543  005731              JMP I       RACL
000544  007402      RACR    HLT                     / ROTATE FAC RIGHT
000545  001170              TAD         ACH         / AND INCREMENT
000546  007110              CLL RAR                 / EXPONENT.
000547  003170              DCA         ACH
000550  001171              TAD         ACL
000551  007010              RAR
000552  003171              DCA         ACL
000553  002167              ISZ         ACX
000554  005744              JMP I       RACR
000555  005744              JMP I       RACR
000556  007402      NORA    HLT                     / NORMALIZE FAC.
000557  004311              JMS         ACZA
000560  005756              JMP I       NORA
000561  001170              TAD         ACH
000562  007700              SMA CLA
000563  005366              JMP         .+3
000564  004344              JMS         RACR
000565  005756              JMP I       NORA
000566  004331              JMS         RACL
000567  005361              JMP         .-6
000570  003171      ZA1     DCA         ACL         / CLEAR FAC.
000571  003170              DCA         ACH
000572  003167              DCA         ACX
000573  005376              JMP         AB1
000574  007130      CH1     STL RAR                 / CHANGE SIGN.
```

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000575  001166                  TAD     ACS
000576  003166  AB1     DCA     ACS     / ABSOLUTE VALUE.
000577  005177          JMP     R
000600  007402  DTAD    HLT             / DOUBLE PRECISION ADD
000601  007300          CLA CLL         / AC AND BC MANTISSAS.
000602  001171          TAD     ACL
000603  001175          TAD     BCL
000604  003171          DCA     ACL
000605  007204          CLA RAL
000606  001170          TAD     ACH
000607  001174          TAD     BCH
000610  003170          DCA     ACH
000611  005600          JMP I   DTAD
000612  007402  MPTN    HLT             / MULTIPLY FAC BY TEN.
000613  001170          TAD     ACH
000614  003174          DCA     BCH
000615  001171          TAD     ACL
000616  003175          DCA     BCL
000617  004764          JMS I   RR3
000620  004764          JMS I   RR3
000621  004200          JMS     DTAD
000622  002167          ISZ     ACX
000623  007100          CLL
000624  004555          JMS I   NOR
000625  005612          JMP I   MPTN
000626  007402  DVTN    HLT             / DIVIDE FAC BY TEN.
000627  001170          TAD     ACH
000630  003160          DCA     FMQ
000631  001171          TAD     ACL
000632  004277          JMS     DIV
000633  000766          RR3+2
000634  003170          DCA     ACH
000635  004277          JMS     DIV
000636  000766          RR3+2
000637  003171          DCA     ACL
000640  001365          TAD     RR3+1
000641  001167          TAD     ACX
000642  003167          DCA     ACX
000643  004555          JMS I   NOR
000644  005626          JMP I   DVTN
000645  007402  XAB1    HLT             / EXCHANGE FAC
000646  001171          TAD     ACL     / AND OPERAND.
000647  003200          DCA     DTAD
000650  001170          TAD     ACH
000651  003212          DCA     MPTN
000652  001167          TAD     ACX
000653  003226          DCA     DVTN
000654  001166          TAD     ACS
000655  007104          CLL RAL
000656  001172          TAD     BCS
000657  003166          DCA     ACS
000660  007010          RAR
000661  003172          DCA     BCS
000662  001173          TAD     BCX
000663  003167          DCA     ACX
000664  001174          TAD     BCH
000665  003170          DCA     ACH
000666  001175          TAD     BCL
000667  003171          DCA     ACL
000670  001200          TAD     DTAD
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000671  003175          DCA     BCL
000672  001212          TAD     MPTN
000673  003174          DCA     BCH
000674  001226          TAD     DVTN
000675  003173          DCA     BCX
000676  005645          JMP I   XAB1
000677  007402  DIV     HLT             / DIVIDE FMQ,AC BY
000700  003200          DCA     DTAD    / ADDRESSED NUMBER.
000701  001677          TAD I   DIV
000702  003212          DCA     MPTN    / QUOTIENT IN AC AND
000703  001612          TAD I   MPTN    / REMAINDER IN FMQ.
000704  007141          CIA CLL
000705  003212          DCA     MPTN
000706  001367          TAD     RR3+3
000707  003245          DCA     XAB1
000710  002277          ISZ     DIV
000711  005322          JMP     .+11
000712  001160          TAD     FMQ
000713  007004          RAL
000714  003160          DCA     FMQ
000715  001160          TAD     FMQ
000716  001212          TAD     MPTN
000717  007430          SZL
000720  003160          DCA     FMQ
000721  007200          CLA
000722  001200          TAD     DTAD
000723  007004          RAL
000724  003200          DCA     DTAD
000725  002245          ISZ     XAB1
000726  005312          JMP     .-14
000727  001200          TAD     DTAD
000730  005677          JMP I   DIV
000731  007402  MPY     HLT             / MULTIPLY AC BY
000732  003200          DCA     DTAD    / ADDRESSED NUMBER.
000733  003160          DCA     FMQ
000734  001370          TAD     RR3+4   / HIGH PRODUCT IN FMQ,
000735  003212          DCA     MPTN    / LOW PRODUCT IN AC.
000736  001731          TAD I   MPY
000737  003277          DCA     DIV
000740  001677          TAD I   DIV
000741  003277          DCA     DIV
000742  002331          ISZ     MPY
000743  007100          CLL
000744  001200          TAD     DTAD
000745  007010          RAR
000746  003200          DCA     DTAD
000747  001160          TAD     FMQ
000750  007420          SNL
000751  005354          JMP     .+3
000752  007100          CLL
000753  001277          TAD     DIV
000754  007010          RAR
000755  003160          DCA     FMQ
000756  002212          ISZ     MPTN
000757  005344          JMP     .-13
000760  001200          TAD     DTAD
000761  007010          RAR
000762  007100          CLL
000763  005731          JMP I   MPY
000764  000544  RR3     RACR
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000765  007774          7774
000766  005000          5000
000767  007763          7763
000770  007764          7764
000771  000531          RACL
000772  004771  MP1     JMS I   RR3+5    / MULTIPLY FAC
000773  001167          TAD     ACX      / BY OPERAND.
000774  001173          TAD     BCX
000775  007001          IAC
000776  003167          DCA     ACX
000777  001166          TAD     ACS
001000  001172          TAD     BCS
001001  003166          DCA     ACS
001002  001171          TAD     ACL
001003  004765          JMS I   MP4
001004  000175          BCL
001005  007300          CLA CLL
001006  001160          TAD     FMQ
001007  003172          DCA     BCS
001010  001171          TAD     ACL
001011  004765          JMS I   MP4
001012  000174          BCH
001013  001172          TAD     BCS
001014  003172          DCA     BCS
001015  007204          GLK
001016  001160          TAD     FMQ
001017  003171          DCA     ACL
001020  007204          GLK
001021  003173          DCA     BCX
001022  001170          TAD     ACH
001023  004765          JMS I   MP4
001024  000175          BCL
001025  001172          TAD     BCS
001026  007204          GLK
001027  001171          TAD     ACL
001030  003171          DCA     ACL
001031  007204          GLK
001032  001173          TAD     BCX
001033  003173          DCA     BCX
001034  001160          TAD     FMQ
001035  001171          TAD     ACL
001036  003171          DCA     ACL
001037  007204          GLK
001040  001173          TAD     BCX
001041  003173          DCA     BCX
001042  001170          TAD     ACH
001043  004765          JMS I   MP4
001044  000174          BCH
001045  001171          TAD     ACL
001046  003171          DCA     ACL
001047  007204          GLK
001050  001173          TAD     BCX
001051  001160          TAD     FMQ
001052  003170          DCA     ACH
001053  004555          JMS I   NOR
001054  005177          JMP     R
001055  007130  SB1     STL RAR          / SUBTRACT.
001056  001172          TAD     BCS
001057  003172          DCA     BCS
001060  004554  AD1     JMS I   BCZ      / ADD OPERAND TO FAC.
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001061  005177          JMP     R
001062  004553          JMS I   ACZ
001063  005766          JMP I   MP4+1
001064  004767          JMS I   MP4+2
001065  007740          CLA SMA SZA
001066  004770          JMS I   MP4+3
001067  001173          TAD     BCX
001070  007041          CIA
001071  001167          TAD     ACX
001072  007700          SMA CLA
001073  005276          JMP     .+3
001074  004771          JMS I   MP4+4
001075  005267          JMP     .-6
001076  001166          TAD     ACS
001077  001172          TAD     BCS
001100  007650          SNA CLA
001101  005312          JMP     .+11
001102  001171          TAD     ACL
001103  007141          CLL CIA
001104  003171          DCA     ACL
001105  001170          TAD     ACH
001106  007040          CMA
001107  007430          SZL
001110  007001          IAC
001111  003170          DCA     ACH
001112  001172          TAD     BCS
001113  003166          DCA     ACS
001114  004772          JMS I   MP4+5
001115  004555  AR3     JMS I   NOR
001116  005177          JMP     R
001117  004770  RD1     JMS I   MP4+3       / INVERSE DIVIDE.
001120  004553  DV1     JMS I   ACZ         / NORMAL DIVIDE.
001121  005177          JMP     R
001122  004554          JMS I   BCZ
001123  005773          JMP I   MP4+6
001124  001166          TAD     ACS
001125  001172          TAD     BCS
001126  003166          DCA     ACS
001127  001173          TAD     BCX
001130  007041          CIA
001131  001167          TAD     ACX
001132  003167          DCA     ACX
001133  001175          TAD     BCL
001134  007104          CLL RAL
001135  003175          DCA     BCL
001136  001174          TAD     BCH
001137  007004          RAL
001140  003174          DCA     BCH
001141  001170          TAD     ACH
001142  004765          JMS I   MP4
001143  000175          BCL
001144  004774          JMS I   MP4+7
001145  000174          BCH
001146  007141          CLL CIA
001147  001171          TAD     ACL
001150  003171          DCA     ACL
001151  007420          SNL
001152  007040          CMA
001153  001170          TAD     ACH
001154  003160          DCA     FMQ
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001155  001171          TAD     ACL
001156  004774          JMS I   MP4+7
001157  000174          BCH
001160  003170          DCA     ACH
001161  004774          JMS I   MP4+7
001162  000174          BCH
001163  003171          DCA     ACL
001164  005315          JMP     AR3
001165  000731  MP4     MPY
001166  000375          LDI
001167  001324          CPQ
001170  000645          XABI
001171  000544          RACR
001172  000600          DTAD
001173  000570          ZAI
001174  000677          DIV
001175  007402  SCRI    HLT
001176  007402          HLT
001177  007402          HLT
001200  007402  FLOS    HLT             / SINGLE, SIGNED
001201  004216          JMS     BFLO    / FLOAT AND ENTER.
001202  004176          EFM
001203  005600          JP      FLOS
001204  007402  FLOR    HLT             / DOUBLE PRECISION
001205  004210          JMS     AFLO    / FLOAT AND ENTER.
001206  004176          EFM
001207  005604          JP      FLOR
001210  007402  AFLO    HLT
001211  003171          DCA     ACL
001212  003166          DCA     ACS
001213  001210          TAD     AFLO
001214  003216          DCA     BFLO
001215  005230          JMP     CFLO
001216  007402  BFLO    HLT
001217  007500          SMA
001220  005225          JMP     .+5
001221  007041          CIA
001222  003171          DCA     ACL
001223  007130          STL RAR
001224  007410          SKP
001225  003171          DCA     ACL
001226  003166          DCA     ACS
001227  003170          DCA     ACH
001230  001314  CFLO    TAD     T5
001231  003167          DCA     ACX
001232  004555          JMS I   NOR
001233  006214          RDF
001234  001315          TAD     T5+1
001235  003236          DCA     .+1
001236  007402          HLT
001237  005616          JMP I   BFLO
001240  007402  FXQ     HLT
001241  001167          TAD     ACX
001242  007500          SMA
001243  005250          JMP     .+5
001244  007300          CLA CLL
001245  003170          DCA     ACH
001246  003171          DCA     ACL
001247  005640          JMP I   FXQ
001250  001316          TAD     T5+2
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001251  007500          SMA
001252  005244          JMP       .-6
001253  003210          DCA       AFLO
001254  004717          JMS I     T5+3
001255  002210          ISZ       AFLO
001256  005254          JMP       .-2
001257  001171          TAD       ACL
001260  005640          JMP I     FXQ
001261  007402  CFIX    HLT
001262  004240          JMS       FXQ
001263  007620          SNL CLA
001264  005661          JMP I     CFIX
001265  002171          ISZ       ACL
001266  005661          JMP I     CFIX
001267  002170          ISZ       ACH
001270  005661          JMP I     CFIX
001271  004261  BFIX    JMS       CFIX
001272  001166          TAD       ACS       / SINGLE, SIGNED FIX
001273  007104          CLL RAL             / AND LEAVE.
001274  001171          TAD       ACL
001275  007430          SZL
001276  007041          CIA
001277  003171          DCA       ACL
001300  007410          SKP
001301  004261  AFIX    JMS       CFIX      / DOUBLE PRECISION
001302  001720          TAD I     T5+4      / FIX AND LEAVE.
001303  007101          IAC CLL
001304  003261          DCA       CFIX
001305  001721          TAD I     T5+5
001306  003310          DCA       .+2
001307  004722          JMS I     T5+6
001310  007402          HLT
001311  003176          DCA       E
001312  001171          TAD       ACL
001313  005661          JMP I     CFIX
001314  000027  T5      27
001315  006202          CIF
001316  007751          7751
001317  000544          RACR
001320  000224          EX
001321  000206          XIF
001322  000211          TENT
001323  000237          IFPC
001324  007402  CPQ     HLT               / COMPARE OPERAND
001325  001173          TAD       BCX       / MAGNITUDES.
001326  007041          CIA
001327  001167          TAD       ACX
001330  007440          SZA
001331  005724          JMP I     CPQ
001332  001174          TAD       BCH
001333  007041          CIA
001334  001170          TAD       ACH
001335  007440          SZA
001336  005724          JMP I     CPQ
001337  001175          TAD       BCL
001340  007141          CIA CLL
001341  001171          TAD       ACL
001342  007020          CML
001343  007440          SZA
001344  007010          RAR
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001345  005724          JMP I   CPQ
001346  001166  CZ      TAD     ACS
001347  007640          SZA CLA
001350  005177          JMP     R
001351  004723          JMS I   T5+7
001352  004723          JMS I   T5+7
001353  005177          JMP     R
001354  004553  CM1     JMS I   ACZ     / THREE-WAY BRANCH.
001355  005375          JMP     RAZ
001356  004554          JMS I   BCZ
001357  005346          JMP     CZ
001360  001166          TAD     ACS
001361  001172          TAD     BCS
001362  007640          SZA CLA
001363  005346          JMP     CZ
001364  004324          JMS     CPQ
001365  007450          SNA
001366  005352          JMP     CZ+4
001367  007700          SMA CLA
001370  005346          JMP     CZ
001371  001172          TAD     BCS
001372  007640          SZA CLA
001373  005351          JMP     CZ+3
001374  005177          JMP     R
001375  004554  RAZ     JMS I   BCZ
001376  005352          JMP     CZ+4
001377  005371          JMP     .-6
001400  007402  CHAR    HLT             / INPUT CHARACTER PROCESSOR.
001401  004563          JMS I   INR
001402  000314          AND     K5      / MASK TO SEVEN BITS.
001403  007450          SNA             / IGNORE NULL.
001404  005201          JMP     CHAR+1
001405  003157          DCA     ICHR    / SAVE CHARACTER.
001406  001157          TAD     ICHR
001407  001315          TAD     K5+1    / TEST FOR RUB-OUT.
001410  007450          SNA
001411  005252          JMP     RBO
001412  001316          TAD     K5+2    / TEST FOR 'E'.
001413  007450          SNA
001414  005365          JMP     EXPN
001415  001317          TAD     K5+3    / TEST FOR DECIMAL POINT.
001416  007450          SNA
001417  005250          JMP     DC5
001420  007001          IAC             / TEST FOR MINUS.
001421  007450          SNA
001422  005245          JMP     MN5
001423  001320          TAD     K5+4    / IGNORE PLUS.
001424  007450          SNA
001425  005201          JMP     CHAR+1
001426  001321          TAD     K5+5    / BLANK MAY TERMINATE.
001427  007450          SNA
001430  005255          JMP     BK5
001431  001322          TAD     K5+6    / IGNORE LINE-FEED.
001432  007450          SNA
001433  005201          JMP     CHAR+1
001434  001323          TAD     K5+7    / TERMINATE IF NOT
001435  007540          SMA SZA         / DECIMAL DIGIT.
001436  005260          JMP     INAN
001437  001324          TAD     K5+10
001440  007510          SPA
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001441  005260          JMP       INAN      / INCREMENT COUNTER,
001442  003167          DCA       ACX       / RETURN FOUR-BIT
001443  002156          ISZ       CHRX      / DIGIT IN ACX.
001444  005600          JMP I     CHAR
001445  007330  MN5     STL CLA RAR
001446  002200          ISZ       CHAR
001447  005600          JMP I     CHAR
001450  007240  DC5     CLA CMA
001451  005337          JMP       IN2-1
001452  001302  RBO     TAD       ROC
001453  004561          JMS I     OTR
001454  005330          JMP       IN1
001455  001156  BK5     TAD       CHRX
001456  007650          SNA CLA
001457  005201          JMP       CHAR+1
001460  007300  INAN    CLA CLL               / INTERPRET AND NORMALIZE
001461  001317          TAD       K5+3        / INPUT NUMBER.
001462  003167          DCA       ACX
001463  004555          JMS I     NOR
001464  001175          TAD       BCL
001465  007104          CLL RAL
001466  001174          TAD       BCH
001467  007430          SZL
001470  007141          CIA CLL
001471  001172          TAD       BCS
001472  007450          SNA
001473  005177          JMP       R
001474  003172          DCA       BCS
001475  001172          TAD       BCS
001476  007500          SMA
001477  007041          CIA
001500  003173          DCA       BCX
001501  001172          TAD       BCS
001502  007700  ROC     SMA CLA
001503  005306          JMP       .+3
001504  001326          TAD       K5+12
001505  007410          SKP
001506  001325          TAD       K5+11
001507  003200          DCA       CHAR
001510  004600          JMS I     CHAR
001511  002173          ISZ       BCX
001512  005310          JMP       .-2
001513  005177          JMP       R
001514  000177  K5      177
001515  007601          7601
001516  000072          72
001517  000027          27
001520  000002          2
001521  000013          13
001522  000026          26
001523  007720          7720
001524  000012          12
001525  000612          MPTN
001526  000626          DVTN
001527  000731          MPY
001530  003156  IN1     DCA       CHRX
001531  003171          DCA       ACL
001532  003170          DCA       ACH
001533  003166          DCA       ACS
001534  003175          DCA       BCL
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001535  003174          DCA     BCH
001536  003172          DCA     BCS
001537  003173          DCA     BCX
001540  004200  IN2     JMS     CHAR
001541  005344          JMP     .+3
001542  003166          DCA     ACS
001543  005340          JMP     IN2
001544  001172          TAD     BCS
001545  001173          TAD     BCX
001546  003172          DCA     BCS
001547  001170          TAD     ACH
001550  004727          JMS I   K5+13
001551  001524          K5+10
001552  003170          DCA     ACH
001553  001171          TAD     ACL
001554  004727          JMS I   K5+13
001555  001524          K5+10
001556  001167          TAD     ACX
001557  003171          DCA     ACL
001560  007204          CLA RAL
001561  001170          TAD     ACH
001562  001160          TAD     FMQ
001563  003170          DCA     ACH
001564  005340          JMP     IN2
001565  004200  EXPN    JMS     CHAR
001566  005371          JMP     .+3
001567  003175          DCA     BCL
001570  005365          JMP     EXPN
001571  001174          TAD     BCH
001572  004727          JMS I   K5+13
001573  001524          K5+10
001574  001167          TAD     ACX
001575  003174          DCA     BCH
001576  005365          JMP     EXPN
001577  007402          HLT
001600  001162  OT1     TAD     FMT     / FIXED-POINT OUTPUT.
001601  000344          AND     T6A
001602  007041          CIA
001603  003342          DCA     FRWD
001604  001162          TAD     FMT
001605  007012          RTR
001606  007012          RTR
001607  007012          RTR
001610  000344          AND     T6A
001611  007041          CIA
001612  003343          DCA     INWD
001613  001166          TAD     ACS
001614  007700          SMA CLA
001615  005220          JMP     .+3
001616  001350          TAD     T6A+4
001617  007410          SKP
001620  001347          TAD     T6A+3
001621  003353          DCA     T6A+7
001622  003166          DCA     ACS
001623  004551          JMS I   SVPC
001624  001737          ST      T6B
001625  000000          LFM
001626  004553          JMS I   ACZ
001627  005251          JMP     ZOT
001630  001342          TAD     FRWD
```

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001631  007500          SMA
001632  007240          CLA CMA
001633  003355          DCA     SPAC
001634  004176          EFM
001635  000005          ILA     5
001636  000000          LFM
001637  004740          JMS I   T6B+1
001640  002355          ISZ     SPAC
001641  005237          JMP     .-2
001642  004176          EFM
001643  002337          AD      T6B
001644  000000          LFM
001645  001167          TAD     ACX
001646  007740          SMA SZA CLA
001647  005273          JMP     IGOT
001650  005253          JMP     .+3
001651  001352  ZOT     TAD     T6A+6
001652  003353          DCA     T6A+7
001653  007001          IAC
001654  001343          TAD     INWD
001655  007510          SPA
001656  004355          JMS     SPAC
001657  001353          TAD     T6A+7
001660  004561          JMS I   OTR
001661  001342  FRO     TAD     FRWD
001662  007700          SMA CLA
001663  005317          JMP     ODN
001664  001351          TAD     T6A+5
001665  004561          JMS I   OTR
001666  002342          ISZ     FRWD
001667  007610          SKP CLA
001670  005317          JMP     ODN
001671  004741          JMS I   T6B+2
001672  005266          JMP     .-4
001673  003156  IGOT    DCA     CHRX
001674  004740          JMS I   T6B+1
001675  002156          ISZ     CHRX
001676  001167          TAD     ACX
001677  007740          SMA SZA CLA
001700  005274          JMP     .-4
001701  001343          TAD     INWD
001702  001156          TAD     CHRX
001703  007510          SPA
001704  005322          JMP     OCN
001705  007200          CLA
001706  001342          TAD     FRWD
001707  001343          TAD     INWD
001710  003156          DCA     CHRX
001711  001347          TAD     T6A+3
001712  007410          SKP
001713  001351          TAD     T6A+5
001714  004561          JMS I   OTR
001715  002156          ISZ     CHRX
001716  005313          JMP     .-3
001717  004176  ODN     EFM
001720  001337          LD      T6B
001721  005552          JP      RSPC
001722  007001  OCN     IAC
001723  007510          SPA
001724  004355          JMS     SPAC
```

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001725  001156          TAD     CHRX
001726  007040          CMA
001727  003156          DCA     CHRX
001730  001353          TAD     T6A+7
001731  004561          JMS I   OTR
001732  002156          ISZ     CHRX
001733  007610          SKP CLA
001734  005261          JMP     FRO
001735  004741          JMS I   T6B+2
001736  005332          JMP     .-4
001737  001175  T6B     SCR1
001740  000626          DVTN
001741  002000          DGO
001742  007402  FRWD    HLT
001743  007402  INWD    HLT
001744  000077  T6A     77
001745  000212          212
001746  000215          215
001747  000240          240
001750  000255          255
001751  000256          256
001752  000260          260
001753  007402          HLT
001754  007402          HLT
001755  007402  SPAC    HLT
001756  003354          DCA     T6A+10
001757  001347          TAD     T6A+3
001760  004561          JMS I   OTR
001761  002354          ISZ     T6A+10
001762  005357          JMP     .-3
001763  005755          JMP I   SPAC
001764  001346  CR1     TAD     T6A+2
001765  004561          JMS I   OTR
001766  001345          TAD     T6A+1
001767  004561          JMS I   OTR
001770  005177          JMP     R
001771  004551  SQAR    JMS I   SVPC
001772  001737          ST      T6B
001773  003337          MP      T6B
001774  005552          JP      RSPC
001775  007402  SCR2    HLT
001776  007402          HLT
001777  007402          HLT
002000  007402  DGO     HLT             / PRINT FAC HIGH
002001  004632          JMS I   T7A     / DECIMAL DIGIT.
002002  004176          EFM
002003  001634          ST      T7A+2
002004  000000          LFM
002005  004633          JMS I   T7A+1
002006  003235          DCA     T7B
002007  001235          TAD     T7B
002010  001236          TAD     T7B+1
002011  004561          JMS I   OTR
002012  001235          TAD     T7B
002013  007041          CIA
002014  004565          SFLO
002015  002234          AD      T7A+2
002016  000000          LFM
002017  005600          JMP I   DGO
002020  001160  FM1     TAD     FMQ     / SET OUTPUT FORMAT.
```

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002021  000237          AND     T7B+2
002022  003235          DCA     T7B
002023  001160          TAD     FMQ
002024  000240          AND     T7B+3
002025  007104          CLL RAL
002026  007006          RTL
002027  001235          TAD     T7B
002030  003162          DCA     FMT
002031  005177          JMP     R
002032  000612  T7A     MPTN
002033  001240          FXQ
002034  001775          SCR2
002035  007402  T7B     HLT
002036  000260          260
002037  000007          7
002040  000370          370
002041  007402  SCR3    HLT
002042  007402          HLT
002043  007402          HLT
002044  000001  PIOT    1
002045  003110          3110
002046  003755          3755
002047  000001  ONE     1
002050  002000          2000
002051  000000  HALF    0
002052  002000          2000
002053  000000  ZERO    0
002054  000000          0
002055  000000          0
002056  000000  XK2     0
002057  002000          2000
002060  000000          0
002061  002047  XTA     ONE
002062  002225          XK1
002063  001175          SCR1
002064  002230          XK1+3
002065  002056          XK2
002066  001775          SCR2
002067  002041          SCR3
002070  002053          ZERO
002071  002127          EXPS
002072  002114          EXPT
002073  004551  EXP     JMS I   SVPC    / NATURAL EXPONENT.
002074  003262          MP      XTA+1
002075  001663          ST      XTA+2
002076  006040          SFIX
002077  003235          DCA     T7B
002100  001235          TAD     T7B
002101  007001          IAC
002102  003256          DCA     XK2
002103  001235          TAD     T7B
002104  007041          CIA
002105  004565          SFLO
002106  002263          AD      XTA+2
002107  003264          MP      XTA+3
002110  001663          ST      XTA+2
002111  001261          LD      XTA
002112  001666          ST      XTA+5
002113  000010          ILA     10
002114  001667  EXPT    ST      XTA+6
```

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002115  004263          RDV     XTA+2
002116  003266          MP      XTA+5
002117  002261          AD      XTA
002120  001666          ST      XTA+5
002121  001267          LD      XTA+6
002122  002661          SB      XTA
002123  005270          CMP     XTA+7
002124  005671          JP      XTA+10
002125  005671          JP      XTA+10
002126  005672          JP      XTA+11
002127  001266  EXPS    LD      XTA+5
002130  003265          MP      XTA+4
002131  005552          JP      RSPC
002132  002200  LGK     LGC
002133  002203          LGC+3
002134  002206          LGC+6
002135  002211          LGC+11
002136  002214          LGC+14
002137  002217          LGC+17
002140  002222          LGC+22
002141  002051          HALF
002142  001167  LOG     TAD     ACX     / NATURAL LOGARITHM.
002143  003256          DCA     XK2
002144  007001          IAC
002145  003167          DCA     ACX
002146  003166          DCA     ACS
002147  004553          JMS I   ACZ
002150  005177          JMP     R
002151  004551          JMS I   SVPC
002152  002333          AD      LGK+1
002153  001666          ST      XTA+5
002154  002732          SB      LGK
002155  003666          DV      XTA+5
002156  001666          ST      XTA+5
002157  003266          MP      XTA+5
002160  001663          ST      XTA+2
002161  003335          MP      LGK+3
002162  002336          AD      LGK+4
002163  003263          MP      XTA+2
002164  002337          AD      LGK+5
002165  003263          MP      XTA+2
002166  002340          AD      LGK+6
002167  003266          MP      XTA+5
002170  001666          ST      XTA+5
002171  000000          LFM
002172  001256          TAD     XK2
002173  004565          SFLO
002174  002741          SB      LGK+7
002175  002266          AD      XTA+5
002176  003334          MP      LGK+2
002177  005552          JP      RSPC
002200  000002  LGC     2
002201  002650          2650
002202  001172          1172
002203  000001          1
002204  002650          2650
002205  001172          1172
002206  000000          0
002207  002613          2613
002210  004414          4414
```

```
002211  007777          -1
002212  003362          3362
002213  005646          5646
002214  000000          0
002215  002234          2234
002216  006604          6604
002217  000000          0
002220  003661          3661
002221  006112          6112
002222  000002          2
002223  002705          2705
002224  002436          2436
002225  000001  XK1     1
002226  002705          2705
002227  002436          2436
002230  000000          0
002231  002613          2613
002232  004414          4414
002233  001175  TSQ     SCR1
002234  001775          SCR2
002235  000000          0
002236  002051          HALF
002237  002047          ONE
002240  007774          7774
002241  002267          SQRTL
002242  000000          0
002243  003166  SQRT    DCA     ACS     / SQUARE ROOT.
002244  004553          JMS I   ACZ
002245  005177          JMP     R
002246  001167          TAD     ACX
002247  007510          SPA
002250  007020          CML
002251  007010          RAR
002252  003242          DCA     SQRT-1
002253  007204          GLK
002254  003167          DCA     ACX
002255  001240          TAD     TSQ+5
002256  003235          DCA     TSQ+2
002257  004551          JMS I   SVPC
002260  001633          ST      TSQ
002261  002237          AD      TSQ+4
002262  005641          JP      TSQ+6
002263  004176          EFM
002264  001634          ST      TSQ+1
002265  004233          RDV     TSQ
002266  002234          AD      TSQ+1
002267  003236  SQRTL   MP      TSQ+3
002270  000000          LFM
002271  002235          ISZ     TSQ+2
002272  005263          JMP     .-7
002273  001167          TAD     ACX
002274  001242          TAD     SQRT-1
002275  003167          DCA     ACX
002276  005552          JMP I   RSPC
002277  001166  ATN     TAD     ACS     / ARCTANGENT.
002300  003235          DCA     TSQ+2
002301  003166          DCA     ACS
002302  001167          TAD     ACX
002303  003242          DCA     TSQ+7
002304  004551          JMS I   SVPC
```

```
002305  005237          CMP     TSQ+4
002306  005745          JP      KAT+1
002307  005745          JP      KAT+1
002310  004237          RDV     TSQ+4
002311  001755  ATL     ST      KAT+11
002312  003355          MP      KAT+11
002313  001754          ST      KAT+10
002314  003753          DV      KAT+7
002315  002352          AD      KAT+6
002316  004354          RDV     KAT+10
002317  002351          AD      KAT+5
002320  004354          RDV     KAT+10
002321  002350          AD      KAT+4
002322  004354          RDV     KAT+10
002323  002347          AD      KAT+3
002324  004354          RDV     KAT+10
002325  002346          AD      KAT+2
002326  004354          RDV     KAT+10
002327  002237          AD      TSQ+4
002330  003355          MP      KAT+11
002331  000000          LFM
002332  001242          TAD     TSQ+7
002333  007750          SPA SNA CLA
002334  005341          JMP     .+5
002335  004176          EFM
002336  006020          CHS
002337  002344          AD      KAT
002340  000000          LFM
002341  001235          TAD     TSQ+2
002342  003166          DCA     ACS
002343  005552          JMP I   RSPC
002344  002044  KAT     PIOT
002345  002311          ATL
002346  002356          XAT
002347  002363          XAT+5
002350  002366          XAT+10
002351  002371          XAT+13
002352  002360          XAT+2
002353  002374          XAT+16
002354  001175          SCR1
002355  001775          SCR2
002356  000002  XAT     2
002357  007000          7000
002360  000006          6
002361  006622          6622
002362  002322          2322
002363  000000          0
002364  006161          6161
002365  006351          6351
002366  000004          4
002367  007743          7743
002370  000460          0460
002371  007776          7776
002372  006456          6456
002373  002636          2636
002374  007775          7775
002375  007353          7353
002376  001611          1611
002377  003166  COS     DCA     ACS     / COSINE.
002400  004551          JMS I   SVPC
```

```
002401  002207              AD      KR1
002402  005603              JP      .+1
002403  002424              SIN+1
002404  001175  KS1         SCR1
002405  001775              SCR2
002406  002041              SCR3
002407  002044  KR1         PIOT
002410  001240              FXQ
002411  002047              ONE
002412  000000              0
002413  002414  SCOS        .+1
002414  007402  SCOX        HLT
002415  004205              RDV     KS1+1
002416  003206              MP      KS1+2
002417  006020              CHS
002420  002211              AD      KR1+2
002421  001606              ST      KS1+2
002422  005614              JP      SCOX
002423  004551  SIN         JMS I   SVPC      / SINE.
002424  000000              LFM
002425  001166              TAD     ACS
002426  003212              DCA     KR1+3
002427  003166              DCA     ACS
002430  004176              EFM
002431  003607              DV      KR1
002432  001604              ST      KS1
002433  000000              LFM
002434  004610              JMS I   KR1+1
002435  007012              RTR
002436  003214              DCA     SCOX
002437  007210              CLA RAR
002440  001212              TAD     KR1+3
002441  003212              DCA     KR1+3
002442  003170              DCA     ACH
002443  001171              TAD     ACL
002444  004564              DFLO
002445  006020              CHS
002446  002204              AD      KS1
002447  001604              ST      KS1
002450  000000              LFM
002451  001214              TAD     SCOX
002452  007500              SMA
002453  005260              JMP     .+5
002454  004176              EFM
002455  001211              LD      KR1+2
002456  002604              SB      KS1
002457  000000              LFM
002460  004176              EFM
002461  003207              MP      KR1
002462  001604              ST      KS1
002463  003204              MP      KS1
002464  001605              ST      KS1+1
002465  001211              LD      KR1+2
002466  001606              ST      KS1+2
002467  000322              322
002470  004613              JS      SCOS
002471  000234              234
002472  004613              JS      SCOS
002473  000156              156
002474  004613              JS      SCOS
```

```
002475  000110                  110
002476  004613                  JS          SCOS
002477  000052                  52
002500  004613                  JS          SCOS
002501  000024                  24
002502  004613                  JS          SCOS
002503  000006                  6
002504  004613                  JS          SCOS
002505  003204                  MP          KS1
002506  000000                  LFM
002507  001212                  TAD         KR1+3
002510  003166                  DCA         ACS
002511  005552                  JMP I       RSPC
                        /       SAMPLE USER OUTPUT ROUTINE
                        /       USES 'PRINTA' ROUTINE IN FIELD '0'
002512  007402          UOR     HLT
002513  006202                  CIF+00
002514  004717                  JMS I       .+3
002515  007300                  CLA CLL
002516  005712                  JMP I       UOR
002517  000213                  PRINTA
                        /       SAMPLE USER INPUT ROUTINE
                        /       USES 'READA' ROUTINE IN FIELD '0'
002520  007402          UIR     HLT
002521  006202                  CIF+00
002522  004724                  JMS I       .+2
002523  005720                  JMP I       UIR
002524  000200                  READA
                        /       SAMPLE USER-DEFINED FUNCTION
002525  004551          USER    JMS I       SVPC        / SAVE FPC AND EFM.
                        /       ANY CODE (SEE TEXT)
002526  005552                  JMP I       RSPC        / RESTORE AND RETURN.
                        /
                        /   THE FOLLOWING CODE OVERLAYS THE SOFTWARE
                        /   MULTIPLY AND DIVIDE ROUTINES.
                        /   REMOVE IF EAE NOT AVAILABLE.
                        /
**********************      .LOC        DIV         ****************************
000677  007402                  HLT                     / FP8 EAE DIVIDE.
000700  007421                  7421
000701  001677                  TAD I       DIV
000702  002277                  ISZ         DIV
000703  003212                  DCA         MPTN
000704  001612                  TAD I       MPTN
000705  003310                  DCA         .+3
000706  001160                  TAD         FMQ
000707  007407                  7407
000710  007402                  HLT
000711  003160                  DCA         FMQ
000712  007501                  7501
000713  005677                  JMP I       DIV
**********************      .LOC        MPY         ****************************
000731  007402                  HLT
000732  003340                  DCA         .+6         / FP8 EAE MULTIPLY.
000733  001731                  TAD I       MPY
000734  002331                  ISZ         MPY
000735  003212                  DCA         MPTN
000736  001612                  TAD I       MPTN
000737  007425                  7425
000740  007402                  HLT
```

```
000741   003160          DCA       FMQ
000742   007501          7501
000743   005731          JMP I     MPY
```

ADDENDUM

Aerojet Nuclear Company

P. O. BOX 1845
IDAHO FALLS, IDAHO 83401

August 30, 1973

SEP 4 1973

DECUS Program Librarian (8)
Digital Equipment Corporation
Maynard, Massachusetts 01754

CORRECTION TO "DECUS 8-594" - My-20-73

To: Library and Distribution

A change of coding is required in "FP-8, Floating Point Arithmetic Software for DEC PDP-8 Series Computers", DECUS No. 8-594, to correct a malfunction in rare but realizable situations.

The last four words of the subroutine "CPQ" should be changed from:

```
X1342/    7020    CML
          7440    SZA
          7010    RAR
          5724    JMP I  CPQ
```

changed to:

```
X1342/    7440    SZA
          7270    CML RAR CLA CMA
          5724    JMP I  CPQ
          7402    HLT
```

I regret the deficiency, but am consoled by the fact that it took over two years to discover it.

cb

W R Myers

W. R. Myers

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