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DECUS PROGRAM LIBRARY

ADDENDUM NO. 1

ABSTRACTS OF PROGRAMS

**DIGITAL EQUIPMENT COMPUTER USERS SOCIETY
MAYNARD, MASSACHUSETTS**

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PDP-1 PROGRAM LIBRARY

ADDENDUM NO. 1

DECUS No. 82.3

FORTTRAN for the PDP-1 (Version 3)

This version, performed with the MUL/MUS switch set to MUL and the DIV/DIS switch to DIV, replaces Version 2 for machines with MUL DIV hardware. Errors found in Versions 1 and 2 have been corrected and several changes made. One important addition is a check for mixed mode arithmetic, or "if", statements. Mixed mode combines fixed-point and floating point variables in one statement.

This version includes the FORTRAN "Print" Statement for use with a DEC Type 64 Line Printer. For systems without line printers, the following alteration can be made: change the clear print buffer instruction (730445) in location 4527 of the tape labeled "subroutine package" to a NOP instruction (760000).

DECUS No. 86

Precision Hypotenuse/Square Root Subroutine

Precision Hypotenuse forms the 34-bit sum of the squares of two 17-bit 1's-complement deltas and takes the square root. Precision Square Root, indicated by coding within the comments, will calculate the 17-bit square root of a 34-bit number.

The symbolic version of the subroutine is in Drum Frap but will assemble with ordinary Frap. The subroutine occupies 34₁₀ registers, using automatic multiply and divide hardware, and requires a constant of 200000₈.

DECUS No. 87

Buffered DEctape Read and Write Routines

These routines simulate paper tape on DEctape; instead of PPA and RPA the user writes JSP WRITEDT READDT.

DECUS No. 87 (continued)

Buffered DECTape Read and Write Routines

The routines take 1521_g locations plus constants including two 400_g word buffers for DECTape. The routines assume the computer is in extend and sequence break modes and return it to this state.

The characters are punched onto DECTape two per word, permitting 776_g characters on one DECTape block. The first location in the DECTape block contains the number of characters within the block. If this number is less than 776, the file ends after the last character in the buffer. A special return is available when the READDT routine reaches the end of the file.

PDP-4/PDP-7 PROGRAM LIBRARY

ADDENDUM NO. 1

PDP-4

DECUS No. 4-13

FISP: Foxboro Interpretive Simulation Program

The PDP-8 simulator, designed for Foxboro's Service Center PDP-4, uses some Foxboro peripheral equipment. The only generally useful feature that requires Foxboro devices in the present simulator is tracing, which uses their Selectric typewriter module. It appears that with some modification the simulator could use the teleprinter for tracing.

Machine requirements for the simulator are:

1. PDP-4 with EAE and 8,192-word core memory to simulate PDP-8 with EAE Type 182, Teletype Model 33-ASR keyboard and printer, Reader Type 750, and Punch Type 75 with all utility functions except tracing.
2. PDP-4 with EAE and 8,192-word core memory, and Type 24 Drum to simulate a PDP-8 with the same options as above plus Memory Extension Control Type 183, one additional memory field, and Drum Type 250 with all utility functions except tracing.

Symbolic tapes and documentation are available.

PDP-7

DECUS No. 7-10

DECPUN - Decimal Integer Punch Routine

DECPUN is a decimal integer punch routine. This permits raw data, as acquired by a PDP-7 in an on-line installation, to be punched out. Modification of the standard decimal integer print package (DEC 7-15-0) does not permit the operator to punch out numbers greater than 2^{17} . Since many times data is considered to be all positive numbers (e.g., counts), DECPUN treats all numbers as positive, allowing for the full 2^{18} machine capacity. This routine calls PDICIT to punch one digit. The user must supply the correct routine for the paper tape code being used. (See note under POSPNT.)

DECUS No. 7-11

POSPNT - Positive Decimal Integer Print Routine

This is a positive decimal integer print package. It is similar to DECPNT, except all numbers are treated as positive. It is available in two versions. POSPNT I in which initial 0's are printed, and POSPNT II which suppresses initial 0's. Both versions call TDIGIT from the Teletype Output Package (DEC 7-10-0); POSPNT II also calls TSP.

NOTE: DECPUN and both versions of POSPNT are written so that less than the full six decimal digits may be punched or printed if so desired. (Of course, the binary number must be within this reduced range).

DECUS No. 7-12

Punch Output Package

This is an output package for punching IBM compatible 7-line paper tape code, as used with the IBM 1620, or the IBM Model 26 tape-card converter and punch. Routines included are: PDIGIT to punch one BCD digit on tape (called with digit in AC, adds correct parity, etc.), PUNSP to punch a space (842) character, PUNEOL to punch an end-of-line (column 8) punch, PUNLDR to punch

DECUS No. 7-12 (continued)

Punch Output Package

a leader on the tape (128 lines of all 7 columns). A routine OPUN must be supplied to punch each character as generated by the package.

DECUS No. 7-13

Preliminary Programming Manual for the 340 Display

The Manual provides a single reference containing the information required to program the 340 Display. It summarizes information contained in seven DEC publications. Technical specifications which are not of general interest to the programmer have been omitted, but can be found in the appropriate DEC publications listed in the Manual. It is assumed that the reader is familiar with the PDP-7 Computer.

PDP-5/PDP-8 PROGRAM LIBRARY

ADDENDUM NO. 1

CHANGES:

DECUS No. 5/8-9 - last paragraph, sentence 2, change to (Digital 8-5-S).

DECUS No. 5-14 change to DECUS 5/8-14 and add: Uses Program interrupt facility.

DECUS No. 5/8-16 - No longer available thru DECUS, part of PDP-8 Digital Software Package.

ADDITIONS:

DECUS No. 5-1.1

BPAK-A Binary Input-Output Package for the PDP-5

This is a revision of the binary package originally written by A.D. Hause of Bell Telephone Laboratories (DECUS No. 5-1). With BPAK the user can read in binary tapes via the photoreader and punch them out via the Teletype punch. It may be used with any in-out device, but is presently written for the photoreader and Teletype punch. A simple modification, described in the write-up, converts BPAK so that it reads from the Teletype reader if the photoreader is disabled. In its present form it occupies locations 7600-7777 and incorporates these features:

1. Readin of BIN or RIM tapes with checksum verification, Teletype-character-ignore-provision (so that PAL error codes will be ignored), and ejection of the end-of-tape from photoreader. Entry is load address 7777; START.
2. "Verify" made, which is identical to readin except that the program is not stored in memory. This is very useful in checking on correct punchout of tapes (via the checksum) without spoiling the stored program.
3. Punchout in either RIM or BIN format. Checksum may be punched when desired. Use of readin mode will not affect punchout checksum.

DECUS No. 5-2.1

OPAK - An On-Line Debugging Program for the PDP-5

OPAK (octal package) is a utility program which enables the user to load, examine, and modify computer programs by means of the Teletype. This program is a revision of the program written by A.D. Hause, Bell Telephone Laboratories (DECUS No. 5-2). Extensive use of the program has suggested many refinements and revisions of the original program, the most significant additions being the work search and the break point. The standard version of OPAK is stored in 6200 to 7577 and also 0006. An abbreviated version is available (7000 to 7577, 0006) which is identical to the other except that it has no provision for symbolic dump. Both programs are easily relocated. Control is via Teletype, with mnemonic codes, (e.g., "B" for inserting breakpoint, "P" for proceed, etc.). This program includes:

1. Single or multiple register examination in symbolic or octal.
2. Single or multiple register loading in octal.
3. Breakpoint with accessible accumulator and link.
4. Block shifting of words in memory, which also allows filling up blocks with a single word.
5. Word search with mask, output in symbolic format.
6. Symbolic dump which includes:
 - a. variable format controlled by switch register
 - b. type out of effective addresses on all instructions
 - c. ability to recognize seven in-out device groups
 - d. trim-code interpretation of word (SR option).
7. All dumps are interrupted by striking any Teletype key, allowing rapid termination of any dump without using computer console.

DECUS No. 5-2.1 (continued)

OPAK - An On-Line Debugging Program for the PDP-5

ADDITIONAL FEATURES IN OPAK

Two new features have been added to OPAK (both OPAK regular and abbreviated) which should make its operation slightly easier. The manner of using OPAK is virtually unchanged. The new features are:

1. There is no longer a need to type initial zeros. If you wish to examine register 0207, simply type 207E $\$$. The symbol $\$$ denotes space. If you wish to store 0000 into some register when loading data, type one zero. Numbers are still right-adjusted. If only a space or comma is typed, the register is left alone.

Previously, if a nonoctal character was typed in load mode, it was ignored. Now nonoctal characters are illegal (except for space and comma), and if typed will cause an immediate reentry of the "E" mode. In the following example X represents any nonoctal character.

4000L3523X4000=3523

Also,

4320E 4320=7021 4334E4320=4334

2. Whenever OPAK is in keyboard listen mode, the accumulator will contain the following information:
 - a. No breakpoint in effect, AC=0.
 - b. Breakpoint in effect, AC=breakpoint location.

It is possible at a glance to determine OPAK's breakpoint status.

The insertion of the above features required extensive revision of memory locations 7000-7377. A new symbolic dump has been prepared. The remainder of OPAK is unchanged, except for 7576 and 7577.

DECUS No. 5/8-27

ERC Boot

The ERC Boot is a bootstrap routine somewhat simpler than the one presently available for the PDP-8. This routine restores the entire last page, consisting of:

1. a Clear Memory Routine,
2. RIM Loader and,
3. Modified Binary Loader.

The Clear Memory routine is entered at 7600 (octal). It clears (to 0000) the lower 31 pages of memory, then branches to the Binary Loader.

The modified Binary Loader halts after reading tape with the checksum in the accumulator. If the binary tape is properly terminated, pressing CONTINUE takes a branch to the beginning location of the program. PAL compiled programs may be properly terminated by ending the PAL symbolic tape in the following manner:

```
P
A
L
S
Y
M
P
R
O
G
R
A
M
*START (any named starting address)
$
```

The Binary Loader stores the octal value for START in the location labeled ORIGIN in BIN. The instruction following HLT in BIN is replaced by JMP 1 ORIGIN (5616), causing a branch to START.

DECUS No. 5/8-27 (continued)

ERC Boot

Instructions for the bootstrap operation are as follows: Toggle in the instructions beginning at 0030.

```
0030 Load Address
7404 Deposit
6036 Deposit
7012 Deposit
7010 Deposit
3025 Deposit
2034 Deposit
5030 Deposit
0030 LOAD ADDRESS
      START
```

Place the tape in the ASR33 reader with pins under the first character.

Turn reader to ready.
Press CONTINUE four times.

When reader stops, entry may be made at 7600 (to clear memory), or in normal fashion to RIM or BIN.

DECUS No. 5/8-28

PAL III Modifications for PDP-8 and ASR-33

This modification of the PAL III Assembler speeds up assembly on the ASR-33/35 and operates only with this I/O device. The symbolic tape is read only once, on pass 0, and stored in the machine. This pass initiates as does pass 1, except that both switches 0 and 1 must be down. Other passes of the assembly initiate normally, but do not end the symbolic tape.

If the program is too large for the buffer, the Teletype punches 50, 200 codes before halting. If the program size is doubtful, it is advisable to leave the punch on during pass 0 and not continue to pass 1.

DECUS No. 5/8-28 (continued)

PAL III Modifications for PDP-8 and ASR-33

The user and symbol table starts at 2736 and the buffer begins at 3103, allowing room for 25 user symbols only. The highest location of the buffer is 7440. This leaves a buffer size of 4336_8 or 2270_{10} , which is sufficient for a large program or a small program with many comments, allowing one tape character per location. To increase symbol table size, constants at 1413 and 1414 may be adjusted. For instance, if 50 symbols are desired:

```
1413 BUF, 3246
1414 BUFCNT, -4172
```

A few other modifications have been made to aid in circumventing the slow speed of the Teletype. The length of the leader-trailer tape has been shortened; there is no pass III leader punched; and the symbol table has no leader or trailer on either pass, making the symbol tape incompatible with DDT (an appropriate leader can be punched manually). To restore any of these characteristics, the appropriate statements in the modifications tape may be deleted.

Symbolic tape may be modified as above and a new binary tape produced. The binary tape must then read in after loading the assembler for modification. This process can be done each time the assembler is loaded, or the modified assembler can be punched as a complete separate tape.

DECUS No. 5/8-29

BCD to Binary Conversion Subroutines

These two subroutines improve upon the DEC supplies conversion routine. Comparison cannot be made to the DECUS-supplied fixed-time conversion, DECUS No. 5-6, because it is specified only for the PDP-5. One routine is designed for minimal storage, the other for minimal time. Both are fixed-time conversions; time specified is for a 1.5- μ sec machine.

Minimal time routine: 73.6 μ sec/32 locations

Minimal storage routine: 85 μ sec/29 locations

DEC routine: 64-237 μ sec/37 locations

Time for number D_1 , D_2 , and D_3 , is $64 + (D_1 + D_2) 9.6\mu\text{sec}$.

DECUS No. 5-30

GENPLOT - General Plotting Subroutine

This self-contained subroutine is for the PDP-5 with a 4K memory and a CALCOMP incremental plotter. The subroutine can move (with the pen in the up position) to location (x,y) , make an "X" at this location, draw a line from this present position to location (x,y) , and initialize the program location counters. A binary, relocatable tape is available.

If the subroutine is to be relocatable, the titles are: MOVE, PLOT, DRAW, and INIT. The readin procedure is the same as for other relocatable subroutines.

If it to be used as a normal binary tape, the subroutine will occupy registers 3600 to 4151 inclusive. The table below shows the function of each section and where it is entered.

DECUS No. 5-30 (continued)

GENPLOT - General Plotting Subroutine

<u>Title of Section</u>	<u>Octal Entry Address</u>	<u>Operation Performed</u>
MOve	3600	The plotter pen is picked up and moved from present position to location (x,y). The x-component is given in the AC and the y-component is given after the JMS instructions.
PLot	3602	The pen is moved as in the MOve section to location (x,y) and an "X" is made.
DRaw	3604	An approximating straight line is drawn from the present position to location (x,y). The x-component is given in the AC and the y-component is given after the JMS instruction.
INit	3606	The x and y plotter location counters are set to 0.

FORPLOT - FORTRAN Plotting Program for PDP-5

FORPLOT is a general-purpose plotting program for the PDP-5 computer in conjunction with the CALCOMP 560 Plotter. It is self-contained and occupies memory locations 0000₈ to 4177₈. FORPLOT accepts decimal data inputted on paper tape in either fixed or floating point formats. Formats can be mixed at will. PDP-5 FORTRAN output tapes are acceptable directly and any comments on these are filtered out.

FORPLOT scales input data. The operator informs the computer, in advance, of the data values to be assigned to the top, bottom, right, and left plot boundaries. There are no restrictions on these data values. It is not necessary that any of them be zero, nor is it necessary that the top and right boundaries correspond to more positive data values than the bottom and left boundaries, respectively.

All plotted graphs are 10 inches in the ordinate direction. The operator controls the length of the abscissa which may reach a maximum of 39.99 inches.

A number of plot format options are available to the user. The program is capable of drawing an abscissa and ordinate axis, each ticked at intervals of 1 inch, at the right and bottom boundaries of the plot, respectively. If the user chooses to omit these axes, a circled point is placed at the starting point to indicate the bottom-right plot boundary. Points are left unconnected unless connected through user control. Finally, at the option of the user, FORPLOT can locate either a small "x" or a small octagon (approximately 1/16 inch across), or a superposition of both at each plotted point to make the point more plainly visible.

A column selection feature is provided enabling the operator to select data columns from tapes containing several of them. In this bulletin "column" refers to a column in the arrangement of the data when it is printed on the ASR-33. If desired, the operator can supply only the ordinates and the program will space the plotted points uniformly in the abscissa direction according to a present constant.

Program to Relocate and Pack Programs in Binary Format

This relocation program has a facility to accept or reject programs from the switch register.

For programs which exist in modular form, the user decides which functions are necessary to perform a certain operation. Each function exists as a subroutine and all that is necessary is to read each subroutine into the computer and write an executive to join these modules together. The main difficulty of using fixed subroutines is immediately apparent. Fixed subroutines may overlap requiring many of them to be reassembled. Fixed programs also leave gaps that cannot readily be used by other programs.

The relocation program will allow programs on binary formatted paper tape to be relocated in memory. Two modes of operation are provided.

1. Relocate to a starting address specified by the operator from the keyboard.
2. Relocate to registers determined by the relocation program. The relocation program will search the the memory starting from register 200 for sufficient consecutive registers to hold the new program. Unoccupied registers are assumed to contain zero.

The following is an illustration of the manner in which this program can be used:

A library tape is provided to each PDP-5/8 user on the project. Every subroutine module is contained on this tape. A user, using the relocation program, can choose only those subroutines for the operations he wishes to perform. Subroutines can be accepted or rejected from the switch register. Using a fast reader, subroutines for a set of requirements can be assembled in just a few minutes.

DECUS No. 5/8-32 (continued)

Program to Relocate and Pack Programs in Binary Format

If a permanent record of this configuration is necessary, a binary punch program associated with relocation program will produce a binary tape of only those areas of memory containing program.

This program can be adapted to a faster secondary storage medium such as magnetic tape. Subroutines could be called and relocated when required, allowing maximum storage space for data.

DECUS No. 5/8-33

Tape to Memory Comparator

Tape to Memory Comparator is a debugging program which allows comparison of the computer memory with a binary tape. It is particularly useful for detecting reader problems, or during stages of debugging a new program.

A typeout occurs whenever the memory disagrees with the contents of the binary program tape. The typeout consists of the memory location, contents of memory, and contents of the tape on one line. The checksum is typed out as an error at one location greater than the last address on the tape.

Presently, the program uses a high-speed reader; however it may be modified for the TTY reader. The program occupies 165 octal locations on a single page. It does not use page 0 or autoindex registers.

DECUS No. 5-34

Memory Halt - A PDP-5 Program to Store Halt in Most of Memory

With Memory Halt and OPAK, (DECUS No. 5-2.1), in memory, it is possible to store halt (7402) in the following memory locations:

0001 to 0005
0007 to 6177
7402 and 7403

Memory Halt occupies locations 0200 to 0237 with a starting address of 0200. When started, it stores 7402 in locations 0001 to 0005 and locations 7402 and 7403. It then sets up some memory location so that OPAK can store 7402 in location 0007 to 6177.

Halts in memory are useful when a program transfers control to an area of memory not occupied by the program itself. Upon executing the JMP or JMS instruction, the computer halts. With careful investigation, the programmer can determine why the transfer of control took place.

DECUS No. 5/8-35

Binary Coded Decimal to Binary Conversion Subroutine and Binary to Binary Coded Decimal Subroutine (Double Precision)

This program consists of a pair of relatively simple and straightforward double-precision conversions. They make no claim to speed or brevity. A double entry has been used which is:

TAD High
JMS BCD Bin
TAD Low
JMS BCD Bin+3

DECUS No. 5-36

Octal Memory Dump Revised

The Octal Memory Dump on Teletype is a DEC routine (DEC-5-8-U) which dumps memory by reading the switch register twice; once for a lower limit and again for an upper limit.

It then types an address, the contents of the program and the next three locations, issues a CR/LF, then repeats the process for the next four locations. This leaves the right two-thirds of the Teletype page unused. The 78₁₀ instructions occupy two pages.

This revised routine uses the complete width of the Teletype page and occupies only one memory page, using less paper and two less instructions. Now an address and the contents of 15 locations are typed out before a carriage return.

Octal Memory Dump Revised has proved its value as a subroutine and/or a self-contained dump program when it is necessary to dump large sections of DECTape, magnetic tape (IBM compatible), or a binary formatted paper tape.

DECUS No. 5-37

Transfer II

For users who have more than one memory bank attached the PDP-5/8, Transfer II may prove valuable in moving information from one field to another. Often areas designated for loaders are being used for other reasons, only to find the loaders necessary a few minutes later. When debugging, Transfer II enables a programmer to make a few changes in a new program and test it without reading in the original program again, especially if his corrections did not work. In short, Transfer II enables more extensive use of memory banks.

DECUS No. 5/8-38

FTYPE - Fractional Signed Decimal Type-In

Enables a user to type fractions of the form: .582, - .73, etc., which will be interpreted as sign plus 11 bits (e.g., $0.5 = 2000_8$). Subroutine reads into 3000-3177 and is easily relocated, as it will work on any page without modifications.

DECUS No. 5/8-39

DSDPRINT, DDTYPE - Double-Precision Signed Decimal Input-Output Package

DSDPRINT, when given a signed 24-bit integer, types a space or minus sign, and then a 7-digit decimal number in the range - 8388608 to +8388607. DDTYPE enables the user to type in a signed decimal number in either single or double precision. These routines are already separately available, but the present subroutine package occupies only one memory page and allows for more efficient memory allocation. Located in 3000-3177, but will work on any page.

DECUS No. 5-40

ICS DECTape Routines (One-Page)

The routines will read or write from the specified DECTape unit and delay the program until all I/O is completed. The last block read will overflow the specified region and destroy one core location. Only standard 129 word DECTape blocks will be read or written. The routines will halt if an error occurs with the status bits in the AC.

