



# DECUS

JUNE 1968

**PROGRAM LIBRARY CATALOG**



**DECUS PROGRAM  
LIBRARY CATALOG**

**JUNE 1968**

DIGITAL EQUIPMENT COMPUTER USERS SOCIETY

MAYNARD, MASSACHUSETTS 01754

**PART I      CATEGORY INDEX**

**PART II     PROGRAMS AVAILABLE  
FROM AUTHORS**

**PART III    PROGRAMS  
FOR SALE OR LEASE**

**PART IV    ABSTRACTS OF PROGRAMS  
and NUMERICAL INDEXES**

# DECUS PROGRAM LIBRARY

The DECUS Program Library contains programs for the PDP-1, PDP-4, PDP-5, PDP-6, PDP-7, PDP-8, -8/S, -8/1, PDP-9, PDP-10, LINC, and LINC-8. This catalog is divided into four sections: Category Index, Programs Available From Authors, Programs for Sale or Lease, and Abstracts with Numerical Index. The programs in the Category Index are listed according to the following categories.

- I. Executive Routines, Assemblers, and Compilers
- II. Editors
- III. Debuggers
- IV. Punch and Loaders
- V. Duplicators, Verifiers
- VI. Arithmetic Routines - Elementary Functions, Numerical Input/Output
- VII. Special Functions
- VIII. Displays
- IX. Text Manipulation, Symbol Manipulation and Sorts
- X. Probability and Statistics - Curve Fittings
- XI. Scientific and Engineering Applications
- XII. Hardware Control
- XIII. Games and Demonstrators
- XIV. Linear Programming, Operations Research, Business Applications
- XV. Desk Calculators
- XVI. Maintenance
- XVII. Miscellaneous

In the Category Index, programs are listed in each category grouped by computer line. In the Abstracts, however, each computer line is given a separate section, grouped numerically. New programs added to the Library will be published in DECUSCOPE as revisions to the catalog.

A DECUS program submittal form and instructions follow. All programs should be submitted to: DECUS Executive Secretary, Digital Equipment Computer Users Society, Maynard, Massachusetts 01754. Additional forms may be obtained from the DECUS Office, or the form may be reproduced.

## DECUS LIBRARY PROGRAM SUBMITTAL INFORMATION

Programs may be contributed to or requested by any DECUS member from the

DECUS Program Library  
Digital Equipment Computer Users Society  
Maynard, Massachusetts 01754

### PROGRAM SUBMISSION

Each Program should include the following:

- 1) Program Submittal Form (attached)
- 2) Writeup - (existing documentation permissible):
  - Contents: Full operating instructions; Program Description; References for mathematical techniques employed; Additional information pertinent to users.
  - Format: Preferably typewritten or printed (black and white), for reproduction purposes. In general, writeups will be reproduced without alteration.
- 3) Paper Tapes or DECTape\* : Object (Binary) and Source (Symbolic).  
Cards (Source Deck)
  - Label paper tapes with following information:
    - a) Program Title
    - b) Subtitles (indicate various program subroutines)
    - c) Tape Format, i.e., Binary or ASCII
    - d) Starting Address
    - e) Version Date
- \* User-supplied DECTapes will be replaced by DECUS.
- 4) Listings and Flowcharts, whenever possible.

### PROGRAM REVISIONS and CORRECTIONS

Please include: New tapes; Writeup addendum indicating change; New Listings reflecting change.

### PROGRAM CLASSIFICATIONS (reference Submittal Form)

- |   |  |
|---|--|
| I. Executive Routines, Assemblers & Compilers                             | X. Probability & Statistics - Curve Fittings                           |
| II. Editors   | XI. Scientific & Engineering Applications                              |
| III. Debuggers  | XII. Hardware Control  |
| IV. Punch and Loaders   | XIII. Games and Demonstrators  |
| V. Duplicators, Verifiers   | XIV. Linear Programming, Operations Research,<br>Business Applications |
| VI. Arithmetic Routines - Elementary Functions,<br>Numerical Input/Output | XV. Desk Calculators   |
| VII. Special Functions  | XVI. Maintenance   |
| VIII. Displays  | XVII. Miscellaneous  |
| IX. Text Manipulation, Symbol Manipulation<br>and Sorts                   |  |

The Program announcement in DECUSCOPE will be abstracted from the information submitted on the attached form. This form may be reproduced, or additional forms may be obtained from the DECUS Program Library.

DECUS welcomes your comments, criticisms and suggestions.

# DECUS PROGRAM SUBMITTAL FORM

Submitted to the PDP-\_\_\_\_ LINC-\_\_\_\_ Library  
(Indicate computer(s) on which program may be run)

Title: \_\_\_\_\_

Author: \_\_\_\_\_ Date: \_\_\_\_\_

Submitted by: \_\_\_\_\_  
(other than author)

Company: \_\_\_\_\_

Address: \_\_\_\_\_

Classification(s): \_\_\_\_\_  
(reference "Program Classifications")

Minimum Hardware Required: \_\_\_\_\_

Other Programs or Subroutines Needed: \_\_\_\_\_

Programming Language: \_\_\_\_\_

Storage Requirement: \_\_\_\_\_

Restrictions: \_\_\_\_\_

Execution Time: \_\_\_\_\_

Miscellaneous: \_\_\_\_\_

Abstract (purpose of program and short description): \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Material (indicate number of copies of each item submitted):

<u>Paper Tape</u>	Object: Binary <input type="checkbox"/>	RIM <input type="checkbox"/>	Source: ASCII <input type="checkbox"/>
	_____ <input type="checkbox"/>	_____ <input type="checkbox"/>	_____ <input type="checkbox"/>
<u>DECtape</u>	Object: Binary <input type="checkbox"/>	Source: ASCII <input type="checkbox"/>	
	_____ <input type="checkbox"/>	_____ <input type="checkbox"/>	
<u>LINCtape</u>	Object: Binary <input type="checkbox"/>	Manuscript: LAP-4 <input type="checkbox"/>	
	_____ <input type="checkbox"/>	LAP-6 <input type="checkbox"/>	
Cards (Source Deck)	<input type="checkbox"/>	Listing <input type="checkbox"/>	Writeup <input type="checkbox"/>
Flowcharts	<input type="checkbox"/>	Other Documentation	<input type="checkbox"/>

I, the undersigned, give full permission to DECUS to publish information regarding this program in DECUSCOPE and to reproduce and distribute this program in full or part, free of charge, to all interested parties.

Signed: \_\_\_\_\_

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**PART I**  
**CATEGORY INDEX**

# CATEGORY INDEX

## I. Executive Routines, Assemblers, and Compilers

PDP-1-4	MAC - A Master Subroutine Control
PDP-1-5	MACRO
PDP-1-30	DX-1 Library Tapemaker
PDP-1-39	DECAL-BBN
PDP-1-40	Linking Loader for DECAL-BBN
PDP-1-41	Libtapemaker for DECAL-BBN
PDP-1-53	DX-1 Monitoring System
PDP-1-71	FRAP
PDP-1-80	DEXTER, A Magnetic Tape Executive Routine
PDP-1-82.3	FORTRAN for the PDP-1
PDP-1-85	LISP for the PDP-1
PDP-4-14	CCS Operator Systems
PDP-5-13	PDP-5 Assembler (for use on IBM 7044/7094)
PDP-5/8-18A,B,C	Binary Tape Disassembly Programs
PDP-5/8-20	Remote Operator FORTRAN System
PDP-5/8-28a	PAL III Modifications - Phoenix Assembler
PDP-5/8-45	PDP-5/8 Remote and Time-Shared System
PDP-5/8-46a	Utility Programs for the PDP-5 and PDP-8
PDP-8-59	PALDT - PAL Modified for DECTape (552 Control)
PDP-5/8-64	DECTape Programming System
PDP-8-67	PAL Modified for DECTape Input
PDP-8/8S-77	PDP-8 Dual Process System
PDP-8-82	Library System for 580 Magnetic Tape (Preliminary Version)
PDP-8-84	One-Pass PAL III
PDP-8-91	MICRO-8: An On-Line Assembler
PDP-8-102	A LISP Interpreter for the PDP-8
PDP-8-110	Directory Print (DIREC)
PDP-8-115	Double Precision Integer Interpretive Package
PDP-8-116	PDP-8/Automatic Tape Control (Type 57A) Library System
PDP-8-122	SNAP (Simplified Numerical Analysis Program)
PDP-8-123	UNIDEC Assembler
PDP-8-124	PDP-8 Assembler for IBM 360/67
PDP-8-125	PDP-8 Relocatable Assembler for IBM 360/67
PDP-6/8-12	PDP-8 Assembler for PDP-6
PDP-6-13	FORTRAN II Compiler
PDP-6/10-29	PDP-6/10 LISP 1.5
PDP-6/10-30	COBOL
PDP-6/10-38	LISP 1.6 for PDP-6/10
PDP-6/10-38.1	ALVINE
PDP-7/9-2a	FAST (Fast Acquisition of System Tapes)
PDP-7-15	FORTRAN Patch for EAE Arithmetic
PDP-7-29	A Non-FORTRAN DECTape System
PDP-7-41	Two-Pass Assembler
PDP-7-42	The ML/I Macro Processor
L-7	Modifications to PROGOFOP, Version 2
L-15	LEAP-1
L-20	A Monitor for Automatic Sequential Operation of Programs on the LINC-8
L-21	"LINC-TRAN": FORTRAN Macros for LINC-8
L-30	LAP-6-1C (Modification of LAP-6)
L-31	LINC-8 SNAP

## ii. Editors

PDP-1-7a	Expensive Typewriter (Modified Version)
PDP-1-29	TED: A Tape Editor
PDP-1-55	Tape Editor
PDP-1-69	SATED: Scope Aided Tape Editor
PDP-1-70	Frap Corrector
PDP-4-15	CCS Scope Editor
PDP-5-24	Vector Input/Edit
PDP-8-52	Tiny Tape Editor
PDP-8-66	Editor Modified for DECTape
PDP-8-97	GOOF
PDP-8-101	Symbolic Editor With View
PDP-6-15	DREDIT
PDP-6/10-38.1	ALVINE
PDP-7-9a	Scope Text Editor for the PDP-7/340

## iii. Debuggers

PDP-1-6	DDT
PDP-1-28	Scopetrace
PDP-1-43	Itek Compare Program
PDP-1-70	AID: Adams Associates Intercom and Debug Program
PDP-1-71	Typewriter Control
PDP-1-71	Colossal Typewriter
PDP-1-71	Trace
PDP-1-71	Debug
PDP-1-90	Color Debugger
PDP-4-1	Automonitor Program
PDP-4-5	KUS - Kie Utility System
PDP-4-6	DDT-4 With Floating Point Input/Output and Drum Read-Write
PDP-5/8-1.1	BPAK - A Binary Input/Output Package
PDP-5-2.1	OPAK - An On-Line Debugging Program
PDP-5-11	PDP-5 Debug System
PDP-8-19a	DDT-UP - Octal-Symbolic Debugging Program
PDP-5/8-33	Tape to Memory Comparator
PDP-5-36	Octal Memory Dump Revised
PDP-5-41	Breakpoint
PDP-5/8-55	PALEX - An On-Line Debugging Program for the PDP-5/8
PDP-5-63	SBUG - 4
PDP-8-56	Fixed Point Trace No. 1
PDP-8-57	Fixed Point Trace No. 2
PDP-8-78	Diagnose: A Versatile Trace Routine for the PDP-8 Computer with EAE
PDP-8/8S-83A&B	Octal Debugging Package (With and Without Floating Point)
PDP-8-89	XOD - Extended Octal Debugging Program
PDP-8-95	TRACE for EAE
PDP-8-105	D-BUG
PDP-8-111	DISKLOOK
PDP-6-20	DTADDT
PDP-7-44	An Interrupt Compatible DDT

## iv. Punch and Loaders

PDP-1-70	Prim. Punchout RIM Tapes
PDP-1-72	Binary Punchoff
PDP-1-72	Binary Punch and Load Package
PDP-1-79	Extended Memory Punch and Loader Routines
PDP-4-8	Short Loader for the PDP-4
PDP-5-3	A Binary Relocatable Loader with Transfer Vector Options for the PDP-5

#### IV. Punch and Loaders (Continued)

PDP-5-12	Pack-Punch Processor and Reader for the PDP-5
PDP-8-26A	Compressed Binary Loader (CBL)
PDP-8-26B	CBC (BIN to CBL) and CONV (CBL to BIN)
PDP-8-26C	XCBL - Extended Memory CBL Loader
PDP-8-26D	XCBL Punch Program
PDP-5/8-27 & 27a	Bootstrap Loader and Absolute Memory Clear
PDP-8-47	ALBIN - A PDP-8 Loader for Relocatable Binary Programs
PDP-5/8-48	Modified Binary Loader MKIV
PDP-8-106	Readable Punch
PDP-8-120	Disk/DECtape FAILSAFE
PDP-6-3	PUNCH

#### V. Duplicators, Verifiers

PDP-1-44	Itek Tape Duplicating and Verifying Program
PDP-1-71	Master Duplicator
PDP-1-74	Tapelibrary Program
PDP-1-91	DECtape Duplicate/Verify
PDP-5-16	Tape Duplicator for the PDP-5
PDP-5-22	DECtape Duplicate
PDP-5/8-33	Tape to Memory Comparator
PDP-5/8-53	COPCAT (DECtape Copy 552)
PDP-8-113	Conversion of Friden (EIA) to ASCII
PDP-7-18	Paper Tape Verifier (Uses EAE)
PDP-7-20	DECtape Copy Routine
PDP-7-27	Paper Tape Verifier (Without EAE)
PDP-9-1	DECtape Copy Routine

#### VI. Arithmetic Routines - Elementary Functions, Numerical Input/Output

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PDP-1-9	Divide
PDP-1-10	Single Precision Floating Point
PDP-1-14	Decimal Input-Output Package
PDP-1-15a	FLINT-36
PDP-1-19	Floating Reciprocal
PDP-1-26	Floating Nth Integer Power
PDP-1-37	DBN, DBI, DBF
PDP-1-38	BDN, BDI, BDF
PDP-1-47	Modifications to 18-18 Floating Point Arithmetic Package
PDP-1-49	Double Precision Fixed Point Routine
PDP-1-51	DSL Matrix Routines
PDP-1-52	Matrix Operations Program for the Experimental Dynamic Processor
PDP-1-57	Input-Output Routine
PDP-1-63	Floating Point Interpreter
PDP-1-67	"SIN-COS": Floating-Point Sine-Cosine Routines
PDP-1-68	"SQRT": Floating-Point Square Root Routine
PDP-1-71	Binary to Decimal Printout and Punchout
PDP-1-71	Decimal to Binary Printout and Punchout
PDP-1-71	Compare
PDP-1-73	MADCAP and MADCAP Checkup
PDP-1-76	A 28-Bit Floating Point Package for the PDP-1
PDP-1-86	Precision Hypotenuse/Square Root Subroutine
PDP-1-92	EMP (Extended Math Package)
PDP-4-2	Teletype Input and Output Package
PDP-4-4	Read a Decimal Number from Keyboard
PDP-4-9	SQRT - Single Precision Square Root Subroutine
PDP-4-12	BOOLEPAC Subroutines

VI. Arithmetic Routines - Elementary Functions, Numerical Input/Output (Continued)

PDP-5-4	Octal Typeout of Memory Area with Format Option
PDP-5-6	BCD to Binary Conversion of 3-Digit Numbers
PDP-5/8-7	Decimal to Binary Conversion by Radix Deflation on PDP-8
PDP-5-8	PDP-5 Floating Point Routines
PDP-5/8-21	Triple Precision Arithmetic Package
PDP-5/8-29	BCD to Binary Conversion Subroutine (73.6 $\mu$ sec)
PDP-5/8-35	Binary Coded Decimal to Binary Conversion Subroutine and Binary to Binary Coded Decimal Subroutine (Double Precision)
PDP-5/8-38	FTYPE - Fractional Signed Decimal Type-In
PDP-5/8-39	DSDPRINT, DDTYPE - Double-Precision Signed Decimal Input-Output Package
PDP-5-42	Alphanumeric Input
PDP-5/8-43	Unsigned Octal-Decimal Fraction Conversion
PDP-8-44	Modification to the Fixed Point Output in the PDP-8 Floating Point Package
PDP-8-60	Square Root Function by Subtraction Reduction
PDP-8-61	Improvement to Digital 8-9-F Square Root
PDP-5/8-69	LESQ29 and LESQ11
PDP-8-72	Matrix Inversion - Real Numbers
PDP-8-73	Matrix Inversion - Complex Numbers
PDP-8-74	Solution of System of Linear Equations: $AX=B$ , by Matrix Inversion and Vector Multiplication
PDP-8-75	Matrix Multiplication - Including Conforming Rectangular Matrices
PDP-8-80	Determination of Real Eigenvalues of a Real Matrix
PDP-8-93	CHEW - Convert Any BCD to Binary-Double Precision
PDP-8-96	J Bessel Function (FORTRAN)
PDP-8-100	Double Precision Binary Coded Decimal Arithmetic Package
PDP-8-103 A	Four Word Floating Point Function Package
PDP-8-103 B	Four Word Floating Point Rudimentary Calculator
PDP-8-103 C	Four Word Floating Point Output Controller with Rounding
PDP-8-103 D	Additional Instructions for Use with Four Word Floating Point Package
PDP-8-114	Rounded Decimal Output Modification for PDP-8 FORTRAN
PDP-8-115	Double Precision Integer Interpretive Package
PDP-8-118	General Linear Regression
PDP-6-9	LININV
PDP-6-11	MATINV
PDP-6-17	FIT
PDP-6-19	MXNOUT
PDP-6-23	TSUM, DERIV and CONPOL
PDP-6-24	CHISQ
PDP-6/10-28	CMPSRC
PDP-6-35	CUBIC, CUBTTY and CHRTTY
PDP-7-1	Accelerated Radix Deflation and Superdecimal Data Bytes on the PDP-7
PDP-7-10	DECPUN - Decimal Integer Punch Routine
PDP-7-11	POSPNT - Positive Decimal Integer Print Routine
PDP-7-12	Punch Output Package
PDP-9-3	Double Precision Integer Package
PDP-9-4	Integer - EAE
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L-29	DEC-BI

VII. Special Functions

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PDP-6-6	DTADIR
PDP-6-7	DTALST ALIAS PIP 3
PDP-6-26	WIRE

## VIII. Displays

PDP-1-1	Character-Display
PDP-1-2	Type, Punch, Display Decimal
PDP-1-3	Display Line
PDP-1-50	BANNER
PDP-1-65	Digital Function Generate and Display
PDP-1-71	Grid Plotting
PDP-1-75	SEETAPE - A Magnetic Tape Dump Program
PDP-1-89	Cube Display
PDP-1-89a	Matchbox Display
PDP-4-15	CCS Scope Editor
PDP-5/8-23A	PDP-5/8 Oscilloscope Symbol Generator (4 x 6 Matrix)
PDP-5/8-23B	PDP-5/8 Oscilloscope Symbol Generator (5 x 7 Matrix)
PDP-8-99A	Kaleidoscope
PDP-8-99B	Kaleidoscope - 338
PDP-8-107	CHESSBOARD for the PDP-8/338
PDP-8-108	Increment Mode Compiler - INCMOD (338)
PDP-8-109	SEETXT Subroutine (338)
PDP-6-1	ALPHAS
PDP-6-2	LPFOL
PDP-6-18	DISUBS
PDP-6-32	DISDAT
PDP-7/9-4c	PTSCOP, PTPEN, PTPLOT, CALIBR, LISTEN
PDP-7/9-8a	FPTSCOP, FPTPEN, FPTPLOT, CALIBR, LISTEN
PDP-7-9a	Scope Text Editor MKIV
PDP-7-13	Programming Manual for the 340 Display
PDP-7-15	FORTTRAN Patch for EAE Arithmetic
PDP-7-31	Display N Letter Word
PDP-7-39	Store Display Program
L-4	Interval Histogram
L-12	READIT
L-22	A New PDP-8 Display Instruction for LINC-8
L-27	Q & A Subroutine (Modification for LAP-6 Characters)

## IX. Text Manipulation, Symbol Manipulation and Sorts

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PDP-1-24	Move a Program
PDP-1-61	TLU - Table Look-up
PDP-1-62	DSL Block Manipulation Routines
PDP-1-71	Tem-Stor Push Down
PDP-1-77	DSL Sort Routines - Sort 2, Sort 3
PDP-8-121	DECTape Handler (552 DECTape)
PDP-6/10-16	FILER
PDP-6-33	PLIST
PDP-6-34	IBYTE
PDP-6-37	PACK, UNPACK, REPACK
PDP-7-33	Simple List Processing Package (SLP1)
L-11	DATUM8

## X. Probability and Statistics - Curve Fittings

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PDP-1-18	Random Walk Number
PDP-1-25	Get Number of Combinations
PDP-1-32	Gaussian Random Number Generator
PDP-1-34	Fast Bivariate Generator
PDP-1-42	PDP-1 Two Memory Checkerboard Program
PDP-1-64	Random Number Generators: Random, Ranmodn, Coin
PDP-4-3	Random Number Subroutine
PDP-4-7	Bivariate Curve Fit

## Probability and Statistics - Curve Fittings (Continued)

PDP-5/8-9	Analysis of Variance PDP-5/8
PDP-5-25	A Pseudo Random Number Generator
PDP-6-36	RANDOM
PDP-7-22	LEGFIT
PDP-7-23	OUTFLT

## XI. Scientific and Engineering Applications

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PDP-8-65	A Programmed Associative Multichannel Analyser
PDP-5/8-69	LESQ29 and LESQ11
PDP-5/8-90	Histogram on Teletype
PDP-8-92	Analysis of Pulse-Height Analyser Test Data With a Small Computer
PDP-8-117	A PDP-8 Interface for a Charged-Particle Nuclear Physics Experiment
PDP-8-118	General Linear Regression
PDP-7-5	Kinematics - FORTRAN Subroutines
PDP-7-6	CGC Function FORTRAN Subroutines
PDP-7-7	Input ND180, Inflt ND180, Input Victoreen, and Inflt Victoreen
PDP-7-16	Single Level Breit Wigner Fit
PDP-7-19	DUMP ND 180 and FDUMP ND 180
PDP-7-21	Reaction Kinematics
PDP-7-24	ENLOSS
PDP-7/9-30	GRASP: Gaussian Reduction and Analysis of Spectrum Peaks
PDP-7/9-34	BESSEL
PDP-7/9-35	Coulomb Excitation
PDP-7/9-36	Finite Geometry Attenuation Coefficients
PDP-7/9-37	DIRECS and LUBITZ
PDP-7/9-38	Gamma Ray Peeling Program
L-3	Off-Line LABCOM System
L-10	LINC-8 Multianalyser
L-13	AVPROG
L-25	LINC Spectrum Program

## XII. Hardware Control

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PDP-1-66	Short, Read Magnetic Tape Routines
PDP-1-78	Tape 52 Magnetic Tape Control Subroutines
PDP-1-87	Buffered DECTape Read and Write Routines
PDP-5/8-17	Drum Transfer Routine for Use on the PDP-5/8
PDP-5-30	GENPLOT - General Plotting Subroutines
PDP-5-31	FORPLOT - FORTRAN Plotting Program for PDP-5
PDP-5-37	Transfer II
PDP-5-40	ICS DECTape Routines (One-Page)
PDP-8-58	One-Page DECTape Routines (552 Control)
PDP-8-70	EAE Routines for FORTRAN Operating System
PDP-8-82	Library System for 580 Magnetic Tape (Preliminary Version)
PDP-8-104	Card Reader Subroutine for the PDP-8 FORTRAN Compiler
PDP-8-120	DISK/DECTape FAILSAFE
PDP-8-121	DECTape Handler (552 DECTape)
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PDP-6-22	MEM2 and MEM4
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PDP-7-14	ISENSE
PDP-7-17	CREASE
PDP-7-28	.IODEC Revision
PDP-7-15	FORTRAN Platter Library

## XII. Hardware Control (Continued)

L-5	Tape Subroutine
L-6	TRIGGR
L-8	DECtape Interface for LINC-8
L-9	LINC-Calcomp Plot Subroutine Package (LAP-5)
L-12	READIT
L-16	RWTAPE
L-17	LOAD
L-18	BUFFER
L-23	Control to Designate Left or Right LINC-8 Tape to Transport as Unit Zero
L-24	PLTKBD - Plot Keyboard
L-32	XMARK

## XIII. Games and Demonstrators

PDP-1-50	Banner
PDP-1-56	The Kalah Game Program
PDP-1-71	Pen Tracker
PDP-1-71	Grid Plotting
PDP-5/8-14	Dice Game for the PDP-5 or PDP-8
PDP-5/8-15	ATEPO (Auto Test in Elementary Programming and Operation of a PDP-5/8 Computer)
PDP-5/8-54	Tic-Tac-Toe Learning Program
PDP-8-71	Perpetual Calendar
PDP-8-79	TIC-TAC-TOE (Trinity College Version)
PDP-8-94A & B	BLACKJACK
PDP-8-98	3D DRAW for 338
PDP-8-99 A	Kaleidoscope
PDP-8-99 B	Kaleidoscope - 338
PDP-8-107	CHESSBOARD for the PDP-8/338
PDP-8-108	Increment Mode Compiler, INCMOD (338)
PDP-8-112	Sentence Generator
PDP-8-119	Off-Line TIC-TAC-TOE (PAL)
PDP-6-4	NUMBER
PDP-6-14	The Dots Playing Program
PDP-6-25	1KCLOK
PDP-7-25	PDP-7 DICE GAME
PDP-7-40	DUEL
PDP-7-43	A PDP-7 Music System
PDP-9-2	3D Draw for 339
L-2	Clock 1 for LINC and Clock 8 for LINC 8

## XIV. Linear Programming, Operations Research, Business Applications

PDP-1-13	CPA-21 - Critical Path Analysis
PDP-1-71	Tem-Stor Push Down
PDP-4-11	Engineering Project Scheduling System
PDP-6-21	Critical Path Scheduling

## XV. Desk Calculators

PDP-1-31	Expensive Desk Calculator
PDP-5-5	Expanded Adding Machine



## XVI. Maintenance

PDP-1-45	BKS Start-Stop Reader Test
PDP-1-71	Rotate Test
PDP-1-88	Typewriter Time Test
PDP-5-10	Paper Tape Reader Test
PDP-7-26	Normalized Instruction Test PDP-4/7
PDP-7-32	Extended Memory and Interrupt Test
L-26	RELTS8-1C (LINC-8 Only)

## XVII. Miscellaneous

PDP-1-11	Tone Generation Routine
PDP-1-12	Bit Manipulation Package
PDP-1-16	Check Parity
PDP-1-20	Millisecond Clock
PDP-1-22	Second Delay
PDP-1-23	Millisecond Delay
PDP-1-35	RATBIN
PDP-1-36	CHKSYM
PDP-1-58	UNARY Manipulation Routines
PDP-1-59	Title
PDP-1-60	SFLAG, RFLAG
PDP-4-10	Multi-Clock Simulation Subroutine
PDP-4-13	FISP: Foxboro Interpretive Simulation Program
PDP-5/8-18A, B, C	Binary Tape Disassembly Program
PDP-5/8-32a	Program to Relocate and Pack Programs in Binary Format
PDP-5-34	Memory Halt - A PDP-5 Program to Store Halt in Most Memory
PDP-5/8-50	Additions to Symbolic Tape Format Generator
PDP-5/8-51	Character Packing and Unpacking Routines
PDP-8-68a	LABEL for PDP-8
PDP-8-81	A BIN or RIM Format Data or Program Tape Generator
PDP-5/8-85	Set Memory Equal to Anything
PDP-8-87	XMAP
PDP-8-88	DECTape Symbolic Format Generator
PDP-8-112	Sentence Generator
PDP-6-5	TIMEF4
PDP-6-8	BELL STAR
PDP-6-10	DATE
PDP-6/10-28	CMPSRC
L-1	Manuscript Compressed Print
L-16	RWTAPE
L-19	LABELS for LINC-8
L-27	Q & A Subroutine (Modification for LAP-6 Characters)
L-28	TEXT TTY Subroutines

**PART II**  
**PROGRAMS AVAILABLE**  
**FROM AUTHORS**

# PROGRAMS AVAILABLE FROM AUTHORS

Many users have programs which for various reasons are not fully debugged or documented for submission into the DECUS Library but are working to a certain extent. Authors who would like to make these programs available to other users have submitted them to DECUS as "Programs Available from Authors." New additions are announced in DECUSCOPE and programs presently available are listed below. Persons interested in using these programs should request them directly from authors. Authors interested in submitting programs under this category should send a short summary of the program, length, I/O equipment needed, etc. and information regarding material available for tapes and documentation to the DECUS Executive Secretary, Maynard, Massachusetts 01754.

## COMPUTER - PDP-5 or PDP-8

Title: Morse Code Sender for PDP-5/8

Author: Jack Harvey, Communication Systems, Inc.,  
Paramus, New Jersey

This subroutine is entered with an ASCII character (trimmed or untrimmed) in the AC.

A square wave tone of the international Morse Code for the character is sent to any appropriate output device such as digital to analog converter, binary channel, or scope display. The program is easily altered to suit the particular output channel available. An ordinary audio amplifier and speaker on the channel make the tone audible. Three registers on page zero control tone pitch, code speed, and character spacing.

Documentation available from author:

1. Binary tape (routine uses 400-577)
2. Symbolic tape with relative addresses (no comments)
3. Photocopies of the author's notes on the listing of (2).

## COMPUTER - PDP-5, PDP-8, or PDP-8/S

Title: Wire List Package

Author: C. W. Peck, Synchrotron Laboratory, California  
Institute of Technology, Pasadena, California

This is a group of four routines used to prepare wire lists for Flip Chip modules to be installed in, at most, two DEC Type 1943 Mounting Panels (128 modules). With the wire lists and associated redundancy checks provided by the program, the author has had mounting panels hand wired with no errors. The four programs are:

1. WIRE LIST ORGANIZE (50-1777, 6400-6777, Connection List 2000-6377)

This program accepts paper tape input of a wire list taken from the engineering drawings and generates a connection list in core. It outputs an ordered wire list in which each connection terminal used is referred to only once. The connection sequence generated does not necessarily result in minimum wire length, but usually does. The three subsequent programs assume that a connection list such as generated by this program is in core.

2. TERMINAL USE PRINT (50-1777, Connection List 2000-6377)

This program generates a table indicating which cards are used and the number of connections on each terminal (0, 1, or 2).

3. EDITOR (50-1777, Connection List 2000-6377)

This program allows the user to edit a connection list. It checks for elementary wiring errors in the editing.

4. BUS INCLUDE (50-1777, 6400-6777, Connection List 2000-6377)

This program includes all bussing into the connection list. It allows the designer to make a complete check of signal loading.

Material available from author:

1. IBM compatible magnetic tape (200) density. Upon request, binary paper tapes could be created.
2. Operating instructions.

## COMPUTER - LINC

Title: Datamec Diagnostic

Author: D. W. Hazelton, Biomedical Computing Center,  
University of Wisconsin, Madison, Wisconsin

This program checks Datamec tapes for accuracy and also contains several "hardware" service routines.

The general user will find this program useful for checking CDC compatible tapes. Specifically, the check section tests in even or odd parity for the following:

1. Lateral Parity Errors
2. Missing Record Characters
3. Missing Longitudinal Redundancy Check Character (LRCC's)
4. Longitudinal Parity Errors

Also, if desired, one can count the total number (octal) of Datamec words in each record. The results of these tests are displayed on the scope.

To assist the user in tape manipulation, a backspace routine

capable of backing over any number of records less than 7777g is included:

Four routines are included to check various aspects of Datamec operation.

1. Parity Test
2. Test-Record Generation
3. General Purpose Tape Checking
4. Test Record Verification

#### COMPUTER - LINC

Title: General Sampling Program (GENSAM)

Author: D. W. Hazelton, Biomedical Computing Center,  
University of Wisconsin, Madison, Wisconsin

This general-purpose program takes digitized samples from the LINC analog-to-digital converter and writes them on Datamec tape in a CDC compatible format. From one to four channels can be sampled with the time interval between sample variables at any multiple of one millisecond from 1 to 4095<sub>10</sub>. The individual channels are sampled almost simultaneously; with reference to the preceding channel, each succeeding channel is sampled 112  $\mu$ sec later. Any of the LINC lines or potentiometers can be sampled. Starting and stopping can be effected by either a sense switch or a pulse on an external line. To assist the user in succeeding data manipulations, a sample counter is included which displays the total number of samples collected per channel.

#### COMPUTER - LINC

Title: LINC Computer User-Interactive Programs and  
MACRO Instructions

Authors: Walter E. Reynolds, Robert B. Tucker, Timothy  
B. Coburn, James C. Bridges, Stanford University  
School of Medicine, Stanford Medical Center,  
Palo Alto, California

This report describes four program packages for use on the LINC computer.

1. A program package which enables the LINC and a Teletype to be used as a very sophisticated desk calculator including graphical output with a Calcomp Plotter.
2. A general-purpose double-precision floating point subroutine package for the LINC.
3. A set of input-output routines providing for the communication of octal, decimal and alphanumeric information via a Teletype.
4. Also included is additional information on the LOSS system (see "An Operating System for the LINC Computer," R. K. Moore, NASA Technical Report No. IRL-1038) under which the above packages may be used.

The first program described, CALCULATOR III, is a complete program that enables the LINC and a Teletype to perform in a manner quite comparable to the most sophisticated electronic

calculators on the market today. In addition, vector or single dimension array operations are included, direct communication with data blocks on LINC tape is permitted, and if a Calcomp Plotter is available, output may be graphically displayed.

The second package is a set of floating-point routines. They also exist in CALCULATOR III, but here in a form more suitable for inclusion in any LINC program where double-precision floating point arithmetic is desired. They occupy two quarters of LINC memory and when so included, become a comprehensive set of floating point macro instructions.

The third package contains numerous general-purpose routines in source code form invaluable to any LINC program where conversational input-output is desired. These may be inserted into LINC programs as desired to allow octal, decimal or alphanumeric communication with the LINC using a Model 33 Teletype in half-duplex mode.

These packages are presently utilized under the LOSS system, a general description of which is contained in this report.

Documentation for the above is available from:

Mr. Timothy Coburn  
Stanford University School of Medicine  
Stanford Medical Center  
Palo Alto, California 94304

**PART III**  
**PROGRAMS**  
**FOR SALE OR LEASE**

# PROGRAMS FOR SALE OR LEASE

The programs listed below may be purchased or leased. Pricing information should be obtained directly from the supplier. DECUS makes no charge for announcing these programs and reserves the right to discontinue this service at any time. DECUS cannot guarantee the accuracy of these announcements. A complaint file will be maintained at the DECUS office for each offering and this file may be inspected by any DECUS member.

Programs will be announced for sale or lease only if they are submitted on behalf of corporations; no individual person may offer a program for sale or lease through DECUS.

## SUBMITTED BY INFORMATION CONTROL SYSTEMS, INC.

Information Control Systems is leasing its 4K version of extended FORTRAN II and ALICS II programming systems. These systems bring to the 4K PDP-8 family a capability that is not available with existing software.

USA FORTRAN II programs compile into ALICS II assembly code in a single pass. ALICS II assembles this FORTRAN output or directly coded ALICS in a single pass. It produces relocatable binary object programs.

A linking loader automatically loads and links the main program and all subroutines. These programs and subroutines may be coded in ALICS or FORTRAN. Standard subroutines may be added from the user or ICS Library.

The system has been especially useful for real-time applications due to the building block structure and the compatibility between the machine level ALICS language and the high level FORTRAN language. The system is equally effective for scientific programming and small scale data processing. Important system features include:

### Extended FORTRAN II

1. Large Capacity - A true compiler concept eliminates interpretive execution time systems. Programs up to 200 FORTRAN statements. May be fitted into a 4K memory.
2. Subroutines - Full provisions are made for either FORTRAN or ALICS II assembly language subroutines and external functions.
3. Precision - Floating point numbers are accurate to 8 significant digits, making the system suitable for accounting applications.
4. Speed - Object programs execute up to 4 times as fast as those processed with other compilers available for the PDP-8 family.
5. Relocation - Object programs are relocatable. They are automatically linked by the loader.

### ALICS II Assembler

1. Relocatable - Binary object programs are produced which can be relocated without reassembling. A linking loader automatically establishes linkages between your program and subroutines and fits them into the available core.
2. Automatic Paging - Allows the programmer to directly reference all of core without considering page boundaries.
3. Single Pass Assembly
4. Powerful Diagnostics - To help you find errors quickly.
5. Easily Learned - People with no previous language experience will find ALICS easy to master.

### ICS Library

1. Floating Point - Features 27 bit mantissa, 8 bit exponent, and sign. All operations fit on 3 pages.
2. Format Interpreter - Features full A, E, F, H, I, and X format term specifications for formatted I/O with conversion. I/O is device independent.
3. Integer MUL/DIV two's complement single precision.
4. Subscripts - One and two dimensional for FORTRAN arrays.
5. Mathematical functions - Includes ABS, IABS, SQRT, SIN, COS, TAN, EXP, ELOG, ATAN, and IRDSW for reading the console switches.

For more information contact:

Mr. John Wyman, Sales Manager  
Information Control Systems, Inc.  
327 South Fourth Avenue  
Ann Arbor, Michigan 48104

## SUBMITTED BY AGRIPPA-ORD CORPORATION

AGRIPPA-ORD Corporation is offering for sale the following LINC-8 programs.

### PLAP Assembler

1. Completely compatible with the Lap-6 utility system.
2. Assembles LINC code or PDP-8 code or both.
3. Six letter tags = 2047 user defined symbols.
4. Error diagnostics with listing.

5. Produces up to 16 blocks of binary.
6. Will load PDP-8 code into Bank 0 (new LO command).

#### CALCOMP Plotter Routines

1. Three subroutines: Plot alphanumeric, Plot graph, Plot line drawings.
2. Size - two quarters each subroutine (easily overlaid).
3. Self-relocating into any two consecutive quarters of Field 0 (lower 4K or PDP-8 memory).
4. 100% PDP-8 code - runs with the interrupt enabled - the LINC program can assign a task and go about its business.
5. Array driven, will plot text buffers, graph buffers, histogram buffers, or line drawings.
6. Data may be half or full-word packed, interleaved or sequential, and reside in any size machine.
7. Conversational subroutine driver supplied free of charge with purchase of three subroutines.

#### Isometric Scope Display

1. Displays isometric surface, 3D histogram or slices along X or Z axis.
2. Size - three quarters (1, 2, 3).
3. Data may be half or full-word packed, interleaved or sequential, up to 30K.
4. Display may be scaled, complemented and inverted.
5. Subroutine is called with four operands.

#### Graph and Text Display

1. Displays half-word packed LINC text strings and/or graph data.
2. Size - two quarters (binary for any two consecutive quarters).
3. Performs an operation (nop, add, subtract, multiply, divide) between two half or full-word packed data sets and displays result on the scope. If the operation is "nop", data set 1 is displayed.
4. Cursor, histogram, and scaling options.
5. Subroutine is called with nine operands.

#### t Test Subroutine

1. Computes and stores t Test values for related points of two data sets.

2. Size - three quarters (1, 2, 3).

3. Data sets may be half or full-word packed, sequential or interleaved, up to 2047 points each. An entry in a data set consists of a 12 bit mean value (6 bit optional) and a 12 bit standard deviation (6 bit optional).

4. Biased or unbiased option.
5. Subroutine called with 11 operands.

#### Correlation Subroutine

1. Generates the correlation function and correlation coefficient between two data sets at a specified lag value.

2. Size - three quarters (1, 2, 3).

3. Data sets may be half or full-word packed, sequential or interleaved, up to 1023 points each.

4. "Tail wrapping" option.
5. Subroutine called with nine operands.

#### Curve Fitting System

1. Keyboard or tape entry of 128 7-digit number.
2. Conversational operation.
3. Data and "best fit curve" can be displayed.
4. Analysis routines are completely modular - new versions may be added easily.
5. Present version includes: polynomial least-square approximations, simple linear regression, log-log and semi-log displays and multiple partition approximations, error analysis, and correlation coefficient.

For further information on these and other, more specialized, programs contact:

N. David Culver, President  
 AGRIPPA-ORD Corporation  
 Monument Square  
 Carlisle, Massachusetts 01741  
 Phone: (617) 369-2912

SUBMITTED BY  
APPLIED DATA RESEARCH, INC.

MACRO ASSEMBLER

MACRO8X is an improved and expanded version of the MACRO8 Assembler (DEC-08-CMA1). It is now a two-pass assembler which operates on PDP-5, 8, 8/S, 8/I, or LINC-8 with 8,192 words of memory and a high-speed paper tape reader and punch. MACRO8X is fully compatible with both PAL III and MACRO8.

General Enhancements

Larger Symbol Table - There is now room for over 750 user-defined symbols, minus that part of the user symbol area that is used to store macro definitions--more than five times the capacity provided by MACRO8.

Improved Literal and Link Processing - The processing of literals and the generation of links have been improved in two significant ways. Literals will not be dumped in the middle of a page and there is no duplication of literals. Second, MACRO8X will, when assigning any literal defined by parentheses or link, determine whether that literal has earlier in the source program been assigned to page 0. If the value has already been assigned a location on page 0, the page 0 literal will be used and no literal will be assigned on the current page.

Paginated and Formatted Output - Output listings produced during pass 2 of the assembler are divided into 8-1/2 X 11 inch pages. The MACRO8X listing routines also perform tabulation, converting tab characters into that number of spaces needed to produce a neat tabular listing.

Memory Allocation Table - At the end of each assembly, a table is printed showing what parts of memory were not used by the program. This table is intended for use as a guide in making patches and corrections to an assembled program.

Improved Functioning of FIELD Pseudo-op - When a FIELD command is encountered in the course of a MACRO8X assembly, all page zero literals are dumped and assignment of page zero literals begins for the new field.

Added Pseudo-Ops

UNLIST, LIST - The UNLIST pseudo-op suspends listing of the source and object programs on the teleprinter during pass 2. The printing of error messages, allocation, or the symbol table is not suppressed, however. The LIST pseudo-op resumes listing subsequent to the use of UNLIST.

LGM, NOLGM - The NOLGM pseudo-op suspends printing of the diagnostic message "LG" during pass 2. The LGM pseudo-op resumes printing of the diagnostic message "LG" subsequent to the use of NOLGM.

LIT - The LIT pseudo-op causes the current-page-literal-buffer to be printed and punched on paper tape during pass 2. This command is intended for use at the end of a page to improve readability of listings.

LITBAS - The LITBAS pseudo-op permits the user to specify an origin for the generation of literals which is other than location 177 of the page for which they are generated. The format of the LITBAS command is LITBAS n, where n is any number or symbolic expression.

VFD - The VFD pseudo-op permits the assembly of a word consisting of the concatenation of bit-patterns representing several numbers of symbolic expressions. Its format is:

VFD A:B,C:D,E:F...

It is terminated by the occurrence of any punctuation or expression which does not fit the VFD syntax. The meaning of the expression above is "Assemble a word consisting of A bits of B followed by C bits of D followed by E bits of F, etc." A, B, C, D, etc. may be numbers or symbolic expressions. VFD may also be used in any context in which a symbolic expression is legal.

Availability

MACRO8X is available on a lease basis at nominal cost from:

The Research Computation Center  
APPLIED DATA RESEARCH, INC.  
Route 206  
Princeton, New Jersey 08540  
(609) 921-8550

A MACRO8X assembly service is also available from the center--card or paper tape input, line printer output.



**PART IV**

**PROGRAM ABSTRACTS**  
**and**  
**NUMERICAL INDEX**

# **PDP-1 PROGRAMS**

# PDP-1 INDEX

<u>DECUS NO.</u>	<u>TITLE</u>	<u>TAPES AVAILABLE</u>	<u>LISTING</u>
1	Character-Display	S	
2	Type, Punch and Display Decimal	S	
3	Display Line	S	
4	MAC - A Master Subroutine Control System	H	
5	MACRO	B, S	
6	DDT	B	
7 A	Modified Expensive Typewriter	B, S	
8	Multiply Subroutine	S	X
9	Divide	S	X
10	Single Precision Floating Point Routines	S, LL	
11	Tone Generation Routine	R	
12	Bit Manipulation Package	B, R	
13	Critical Path Analysis	H, S	
14	Decimal Input-Output Package	S	
15 A	FLINT-36 A3D	S	X
16	Check Parity	S	
17	Get Number of Permutations	S	
18	Random Walk Number	S	
19	Floating Reciprocal	S	
20	Millisecond Clock	S	
21	Clear Block	S	
22	Second Delay	S	
23	Millisecond Delay	S	
24	Move A Program	S	
25	Get Number of Combinations	S	
26	Floating Nth Integer Power	S	
27	Obsolete - Replaced by DECUS No. 39		
28	SCOPETRACE	H	
29	TED: A Tape Editor	H	
30	DX-1 Library Tapemaker	S	

Code

A - ASCII Source  
 B - Binary Object  
 D - DECTape

H - High Binary Loader  
 L - LINCtape  
 LL - Linking Loader

R - RIM  
 S - Symbolic (Source)  
 X - Listing Available

Writeups are available for all programs.

<u>DECUS NO.</u>	<u>TITLE</u>	<u>TAPES AVAILABLE</u>	<u>LISTING</u>
31	Expensive Desk Calculator	R, S	
32	Gaussian Random Number Generator	S	
33	Scatter-Gather Mag Tape Routine	S	
34	Fast Bivariate Generator	S	
35	RATBIN (read and type a binary paper tape)	R, S	
36	CHKSYM (check a symbolic tape)	R, S	
37	dbn (decimal to binary mixed number), dbi (decimal to binary integer) and dbf (decimal to binary fraction)	R, S	
38	bdn (binary to decimal mixed number), bdi (binary to decimal integer) and bdf (binary to decimal fraction)	R, S	
39	DECAL-BBN	B, S	
40	Linking Loader for DECAL-BBN		
41	Libtapemaker for DECAL-BBN		
42	PDP-1 Two Memory Checkerboard Program	R	
43	Compare Program	B, S	
44	Tape Duplicating and Verifying Program	B	
45	Start-Stop Reader Test	B	
46	Obsolete - Replaced by DECUS No. 39		
47	Modifications to 18-18 Floating Point Arithmetic Package (To be distributed with DECUS No. 10)	S	
48	No longer available		
49	Double Precision Fixed Point Routines	S	Flow Charts
50	Banner	R	X
51	DSL Matrix Routines	S, LL	
52	Matrix Operations Program for the Experimental Dynamic Processor	H, S	Flow Charts
53	No longer available		
54	No longer available		
55	Tape Editor	B	
56	The KALAH Game Program	B	
57	Input-Output Routines	S, LL	
58	Unary Manipulation Routines	S, LL	
59	TITLE	S, LL	
60	SFLAG, RFLAG	S, LL	
61	TLU - Table Look-up	S, LL	
62	DSL Block Manipulation Routines	S, LL	
63	Floating Point Interpreter (For use with DECUS No. 10)	S, LL	
64	Random Number Generators: Random, Ranmodn, Coin	S	
65	Digital Function Generate and Display	B, S	
66	Short, Read Magnetic Tape Routines	S	
67	"SIN-COS": Floating-Point Sine-Cosine Routines	S	X

<u>DECUS NO.</u>	<u>TITLE</u>	<u>TAPES AVAILABLE</u>	<u>LISTING</u>
68	"SQRT": Floating-Point Square Root Routine	S	X
69	SATED: Scope Aided Tape Editor (ESD)	B	
70	OLD DECUS LIBRARY I		
	ADA-1 Analyzer	B, R	
	ADA-2 Frapcorrector	B	
	ADA-3 PRIM: Punch Read-In-Mode Tape	R	
	ADA-5 AID: Adams Associates Intercom & Debug Program	R	
71	OLD DECUS LIBRARY II		
	BBN- 1 FRAP	S	
	BBN- 2 Typewriter Control (TYC)	S, LL	
	BBN- 6 Colossal Typewriter Program (CT)	B, H	
	BBN-12 Decimal to Binary Conversion	S, LL	
	BBN-13 Binary to Decimal Conversion	S, LL	
	BBN-21 TRACE	S, LL	
	BBN-25 Rotate Test	S	
	BBN-27 Master Duplicator	B, S	
	BBN-32 Tem-Stor Push Down	S	
	BBN-33 Pen Tracker Routines	S	
	BBN-45 Grid Plotting Program (Plotgrid)	B, H	
	BBN-54 Compare	S, LL	
	BBN-67 Debug (DB)	B, H	
72	OLD DECUS LIBRARY III		
	BBN- 3 Binary Punch and Load Package	R	
	BBN-46 Binary Punchoff	R	
73	MADCAP: MAmmoth DeCimal Arithmetic Program for the PDP-1 Computer	B, S	
74	Tapelibrary Program	S, LL	
75	SEETAPE - A Magnetic Tape Dump Program	B, S	
76	A 28-Bit Floating Point Package for the PDP-1	B, S	
77	DSL Sort Routines - Sort 2, Sort 3	S	
78	TAPE 52 Magnetic Tape Control Subroutines	S	
79	Extended Memory Punch and Loader Routines (EXPCH1 and EXPCH0)	B, S	
80	DEXTER: A Magnetic Tape Executive Routine	R, S	
81	Calcomp Plotter Software	B, S	X
82.3	FORTTRAN for the PDP-1 (Version 3)	B, S	
83	340 Assembly Language and 340 DDT	B, S	
84	M.I.T. Floating Point Arithmetic Package	S	
85	LISP for the PDP-1	B, S	X
86	Precision Hypotenuse/Square Root Subroutine	R, S	X
87	Buffered DECTape Read and Write Routines	S, LL	
88	Typewriter Time Test	B, S	
89	Cube Display	B, S	X
89a	Matchbox Display	B	
90	Color Debugger	S	X
91	DECTape Duplicate/Verify	B, S, LL	X
92	EMP: Extended Math Package	S	X

# PDP-1 PROGRAM ABSTRACTS

## DECUS No. 1

Character Display

Ben Gurley and Weldon Clark

This subroutine effects the display of alphabetic, numeric, and special characters on the scope. The program is devised to make the scope react like a typewriter. Storage used: 466<sub>8</sub> registers. (FRAP Subroutine)

## DECUS No. 2

Type, Punch and Display Decimal

Mimi Wasser

This subroutine is used to convert octal numbers to decimal and to type, punch, and display the results. Occupies 131<sub>8</sub> registers. However, when one calls display-decimal, the character display subroutine is required using 465<sub>8</sub> registers. (FRAP Subroutine)

## DECUS No. 3

Display Line

William Fletcher, Bolt, Beranek & Newman, Incorporated

The purpose of this routine is to display a line of dots on the CRT between two specified points  $X_0, Y_0$  and  $X_1, Y_1$ . Storage-used: 165<sub>8</sub>. (FRAP Subroutine)

## DECUS No. 4

MAC-A Master Subroutine Control System

Richard Bennett

The program is a subroutine control system for the PDP-1. MAC simplifies writing of subroutines, reduces the number of registers required to write closed subroutines, and allows subroutines using this system to call themselves or other subroutines. MAC requires 174<sub>8</sub> registers, and 24<sub>8</sub> registers of storage. In addition, storage is required for subroutine returns and subroutines used repeatedly.

## DECUS No. 5

MACRO

Digital Equipment Corporation, Maynard, Massachusetts

MACRO is an assembly program for the PDP-1. MACRO uses two passes to assemble a source program, and allows the use of the user's own definition as well as its own. It automatically stores constants and variables in adequate blocks

of storage, allows the use of address tags and prints out errors in the source program during assembly.

## DECUS No. 6

DDT

Alan Kotok, Digital Equipment Corporation, Maynard, Massachusetts

DDT is a symbolic debugging program for the PDP-1. It occupies upper memory, starting at 600, and builds down into lower memory. Control is by the typewriter. DDT, by means of its "breakpoint" allows the user to program via the typewriter, edit, and examine any program location. Instructions can also be inserted by DDT. (MACRO)

## DECUS No. 7A

Modified Expensive Typewriter

Steve Piner and Peter Samson (Modified by S.B. Michaels and J.L. Ramsey)

Facilitates the editing of symbolic tapes both off-line and on-line.

## DECUS No. 8

Multiply Subroutine

Alan Tritter

This subroutine is used on machines which have no high-speed multiply option. It will form the signed product of two signed 17-bit numbers. It requires 70<sub>8</sub> registers. The subroutine returns to main program when completed. (DECAL)

## DECUS No. 9

Divide

Alan Tritter

A subroutine for PDP-1's lacking automatic multiply & divide. It may be called for a fractional divider of a signed 34-bit number by a signed 17-bit number or for an integer divide (i-dvd) of a signed 17-bit number by a 17-bit number. In either case a signed quotient returns in the AC and a remainder with the same as the dividend returns in the I/O. Occupies 75<sub>8</sub> registers. (DECAL)

## DECUS No. 10

### Single-DEC-Single Precision Floating Point Routine

R. J. McQuillin (Roland Silver)

These routines allow the use of the floating point mode, and include input, output, interpreter, arithmetic, exponential, square root, sine-cosine, natural log and arc tangent. Modified by DECUS No. 47. (DECAL)

## DECUS No. 11

### Tone Generation Routine

William Fletcher, Bolt, Beranek & Newman, Incorporated

This routine, which is controlled by the typewriter, can produce tones for which amplitude, frequency, and length can be controlled. Frequencies from 168 down to and including 100 are possible.

## DECUS No. 12

### Bit Manipulation Package

C. Fletcher

The program provides a convenient means for processing variable length contiguous groups of bits (referred to as items) without regard to word boundaries. Items of 1 to 16 bits can either be read from memory or stored in memory at an address relative to a pointer. Items from one to n bits may be moved forward or backward any amount and compared using routines in package. The read and store routine is a general packing and unpacking program, and is intended to provide a standard, simple means of expressing and using an item's bit address and length to obtain the item.

The pointer referred to is a word containing the address of some particular bit in memory, that is, it holds both a word address and the address of a bit in that word. Storage used: 1-466g.

## DECUS No. 13

### Critical Path Analysis

T. Shapin

Critical Path Analysis is a method of coordinating the efforts of many diverse activities toward a common goal. This program will handle 400 activities and 266 events (nodes). Careful preparation is needed to insure accurate output. The first input should be as "educated" estimates as possible. The order of events must be carefully organized by flow charts described in the "write-up". Upon completion, the program types out (after error print-outs have been corrected) a solution to the problem. Storage Used: 5113g. (DECAL)

## DECUS No. 14

### Decimal Input-Output Package

William Fletcher, Bolt, Beranek & Newman, Incorporated

This package is a set of subroutines to allow decimal-to-binary and binary-to-decimal conversion of integers, fractions, and mixed numbers. The output format can be precisely controlled by a subroutine included in the package. The routines use the typewriter as input and output, and subroutines are provided to allow use of paper tape reader and punch, or CRT for this purpose also. In addition, the package can be set to use any arbitrary input and output.

## DECUS No. 15A

### FLINT-36 A3D

J. M. Baker and D. J. Isenberg, Charles W. Adams Associates, Incorporated

FLINT is an interpretive routine that permits the PDP-1 to perform double-precision floating-point arithmetic, input, output, and elementary function evaluation. Originally written in FRAP for use in lens design work (though nonetheless a general-purpose program), FLINT has now been translated into DECAL to be compatible with other programs in this language. Arithmetic and function evaluation are performed interpretively, input and output are handled by closed subroutines addressed directly by the user's programs, and overall format control is left to the user's routines. FRAP symbolic tape is also available.

## DECUS No. 16

### Check Parity

R. S. Nickerson

The purpose of this routine is to check and/or add parity. Storage used: 33g (DECAL)

## DECUS No. 17

### Get Number of Permutations

R. S. Nickerson

This program is used to compute  $n(n-1) \dots n(n-4 1)$ . (i.e., the number of permutations of n things taken r at a time.) This program requires DECUS No. 25. Storage used: 70g (DECAL)

### DECUS No. 18

Random Walk Number

R. S. Nickerson

This program is used to do one of three things with equal probability:

1. add increment to number
2. subtract increment from number
3. leave number as is

Storage used: 20g (DECAL)

### DECUS No. 19

Floating Reciprocal

R. S. Nickerson

This program is used to get the reciprocal of a floating point number. Storage used: 16g (DECAL)

### DECUS No. 20

Millisecond Clock

R. S. Nickerson

Purpose is to count the milliseconds from time msc is called until a typewriter key is struck. Storage used: 24g (DECAL)

### DECUS No. 21

Clearblock

J. R. Hayes

Purpose is to clear a block of registers. Storage used: 11g (DECAL)

### DECUS No. 22

Second Delay

R. S. Nickerson

The purpose of this program is to delay a running program for a specified number of seconds. Storage used: 13g (DECAL) Uses DECUS No. 23.

### DECUS No. 23

Millisecond Delay

R. S. Nickerson

Purpose is to delay a running program for a specified number of milliseconds. Storage used: 21g. (DECAL)

### DECUS No. 24

Move a Program

D. M. Forsyth

To move a program from one memory location to another, changing effective addresses when appropriate. Storage used: 106g (DECAL)

### DECUS No. 25

Get Number of Combinations

R. S. Nickerson

Purpose is to compute  $\binom{n}{r} = n! / (r! (n - r)!)$  i.e., the number of combinations of n things taken r at a time. Storage used: 22g (DECAL)

### DECUS No. 26

Floating Nth Integer Power

R. S. Nickerson

Purpose is to raise a floating point number, x, to nth integer power. Storage used: 56g (DECAL) Uses DECUS No. 19.

### DECUS No. 27

Obsolete - Replaced by DECUS No. 39.

### DECUS No. 28

SCOPETRACE

John R. Hayes, Decision Sciences Laboratory, Hanscom Air Force Base, Bedford, Massachusetts

The program is designed to facilitate the debugging of object programs by providing a geometrical representation of the operation of the object program. There is a Hiscopetrace (5700g to 5777g registers) and Loscopetrace (1g to 1000g registers).

### DECUS No. 29

TED: A Tape Editor

C. R. Brown and D. W. Connolly, Operational Applications Laboratory, Hanscom Air Force Base, Bedford, Massachusetts

The program is an aid in the editing or modification of alpha-numerical text in that the operator may communicate with the computer in the very alphanumeric of the text itself. All typing involved in preparing and editing tapes may be done at an off-line typewriter punch.



DECUS No. 30

DX-1 Library Tapemaker

Ted Strollo, Air Force Cambridge Research Laboratories,  
Bedford, Massachusetts

DX-1 Library Tapemaker will load in any given number of LL tapes of subroutines, and punch these out as a single library tape. It may also be used to add new subroutines to an existing library tape. (DECAL)

DECUS No. 31

Expensive Desk Calculator

Robert A. Wagner, Massachusetts Institute of Technology,  
Cambridge, Massachusetts

EDC provides for performing arithmetic operations on numbers typed either on- or off-line, and printing results. Decimal numbers (integers, decimal fractions or integer fraction combinations) are acceptable; all indicated by ordinary decimal point conventions. EDC allows the internal storage of "variable" registers. The names of such registers, when used in the same contexts as typed numbers, automatically cause their current contents to be used in the calculation, as if contents had just been typed in. EDC stores arbitrary character strings for later use as input to EDC and for testing the sign of partial results. (MACRO)

DECUS No. 32

Gaussian Random Number Generator

Roland Silver

Ran-gauss, as it is called, is a subroutine which computes a random number of approximately gaussian distribution, of zero mean and specifiable variance. It requires the dvd, mpy and random subroutines and, in itself, occupies 35<sub>8</sub> registers and is executed in 157 cycles (average). (FRAP)

DECUS No. 33

Scatter-Gather Magnetic Tape Routine

William Fletcher, Bolt, Beranek and Newman, Incorporated

This routine is used to control up to three Type 50 Magnetic Tape Units connected to the PDP-1 computer through a Type 51 Tape Control Unit. Blocks of information on magnetic tape in standard IBM low density (200 bit) format may be written or read. A scatter feature allows information in one contiguous block in the computer memory. The converse operation allows several smaller blocks in memory to be gathered together and written as just one block on the magnetic tape. Information read from magnetic tape may be compared with the contents of memory rather than stored. When read, sections of the blocks on the magnetic tape may be by-passed altogether. The IBM end-of-file may be written and it is automatically sensed by the read routine. All read operations function either forward or reverse. Write

operations operate forward only. Storage Required: 732g. (DECAL)

DECUS No. 34

Fast Bivariate Generator

G. A. Paquette, United Aircraft Corporation

The program computes z as a function of x and y by cross-linear interpolation within a table of Z's. Fixed-point scaling used is under control of data provided at assembly or by user's program. Storage Used. 47g. (FRAP)

DECUS No. 35

RATBIN (read and type a binary paper tape)

Gerald Clawson, The Geotechnical Corporation, Dallas,  
Texas

The purpose is to read a machine language or data tape and list it on the typewriter. Storage used: Program, 300-3104, Data 3105-3363. (FRAP)

DECUS No. 36

CHKSYM (check a symbolic tape)

Gerald Clawson, The Geotechnical Corporation, Dallas,  
Texas

The purpose is to check a symbolic paper tape against a copy of it. Storage used: Program, 0010-0530, Data 0531-7777. (FRAP)

DECUS No. 37

dbn (decimal to binary mixed number),  
dbi (decimal to binary integer) and  
dbf (decimal to binary fraction)

Gerald Clawson, The Geotechnical Corporation, Dallas,  
Texas

The purpose is to make decimal to binary conversions. Storage used: 3620-3770 (FRAP)

DECUS No. 38

bdn (binary to decimal mixed number),  
bdi (binary to decimal integer) and  
bdf (binary to decimal fraction)

Gerald Clawson, The Geotechnical Corporation, Dallas,  
Texas

The purpose is to make binary to decimal conversions. Storage used: 4000-4167. (FRAP)

DECUS No. 39, 40 and 41

DECAL-BBN

Richard J. McQuillin, Bolt, Beranek, and Newman, Incorporated

DECAL-BBN is an assembler-compiler designed to process two broad classes of statements: Instruction Word Statements and Algebraic Statements. DECAL is available for both 1-core and 2-core machines. Programming and Technical Manuals available.

DECUS No. 42

Two Memory Checkerboard Program

J. C. Murphy, Jet Propulsion Laboratory

The program operates exactly as the MAINDEC 2 checkerboard program with the following exception: Upon completion of a selected pattern cycle in memory "0" the program will enter the extend mode, then jump to memory "1" and perform the same pattern cycle. Upon completion of this cycle the program will reenter memory "0" and select the next pattern. The program continues to alternate between memories until an error, or normal halt is incurred. An error in memory "1" is examined in the same manner as an error in memory "0" (barring extend mode or defer cycle logic failures). (DECAL)

DECUS No. 43

Compare Program

J. F. Fitzgerald, Itek Corporation

Enables one to punch a tape which will typeout on the off-line Flexowriter the registers that have been changed in the operation of a given program and their contents.

DECUS No. 44

Tape Duplicating and Verifying Program

C. E. Hurlburt

The purpose is to reproduce any paper tape and to verify the reproduction via the checksum method and by comparing line counts.

DECUS No. 45

Start-Stop Reader Test

T. Shapin, Beckman Instruments, Incorporated

This program is used to test the braking action of the PDP-1 paper tape reader.

DECUS No. 46

Obsolete-Replaced by DECUS No. 39.

DECUS No. 47

Modifications to 18-18 Floating Point Arithmetic Package (To be used with DECUS No. 10)

John B. Goodenough

These modifications to DECUS No. 10 round the results of floating point additions, subtractions, multiplications, divisions and shifts (R. & L.) for single and multicore use. Storage used: 532g.

DECUS No. 48

No longer available.

DECUS No. 49

Double Precision Fixed Point Routine

Terry Kleffman, Minneapolis-Honeywell Company

The double precision add, subtract, multiply, and divide subroutines and the 12 double precision MACRO instructions in this package provide the programmer with all the basic tools necessary for fixed point double precision programming. These subroutines were written specifically for maximum speed of execution and, therefore, little or no consideration was given to the amount of memory space it would occupy. This approach was taken in an effort to provide double precision accuracy for real-time, analog-to-digital simulations. However, the amount of memory space required to store the double precision subroutines is not restrictive for most applications. These routines require  $1362_8 = 754_{10}$  memory locations which in a  $10,000_8 = 4096_{10}$  word memory still leave  $6416_8 = 3342_{10}$  locations for additional programs. (MACRO)

DECUS No. 50

BANNER

Robert F. Stover, Minneapolis-Honeywell Company

Banner is a demonstration program for the PDP-1, and uses the Character Display Program - DECUS No. 1. It accepts a message typed in from the console typewriter and displays the message on the 16" display as letters moving from right to left. The message will be repeated indefinitely. The appearance is the same as the Times Square News Sign.

DECUS No. 51

DSL Matrix Routines

J. B. Goodenough, Decision Sciences Laboratory, Hanscom Air Force Base, Bedford, Massachusetts

This Matrix Package consists of programs to perform the following functions in either fixed or single precision floating point:

- Add columns to store matrix.
- Add or subtract two matrices.
- Multiply a matrix by a constant.
- Multiply two matrices.
- Multiply a row by a constant.
- Punch an intermediate matrix on paper tape.
- Read intermediate matrix tape.
- Calculate a row sum.

DECUS No. 52

Matrix Operations Program for the Experimental Dynamic Processor

C. Caso, J. Seltzer and J. Sexton, Wolf Research and Development Corporation, West Concord, Massachusetts

This Matrix Package is a system of computer programs to perform general matrix operations. The matrix operations that can be performed are solved eigenvalues and eigenvectors, add, inversion, multiplication, subtraction, and transposition. A set of input/output routines and an executive routine are included in this package. The executive routine is designed to allow effective usage of the package by people with minimal programming experience. This package has been coded for the experimental Dynamic Processor, DX-1. The system uses single-precision floating-point arithmetic.

DECUS No. 53

No Longer Available

DECUS No. 54

No Longer Available

DECUS No. 55

Tape Editor (BBN)

Harry Rudloe

This program edits symbolic paper tapes making use of the scope and on-line typewriter. Occupies registers 2450-7500. This version requires a full 16-channel sequence break machine. However, it can be modified to run on machine with a different configuration.

DECUS No. 56

The KALAH Game Program

Roland Silver

The computer plays kalah with you communicating through the typewriter as input and the scope as output media. (FRAP)

DECUS No. 57

Input-Output Routines

R. S. Nickerson and J. B. Goodenough, D.S.L., Hanscom Air Force Base, Bedford, Massachusetts

These routines are designed to supplement the DEC In-Out Package. They consist of the following DSL programs: Get Octal Number; Type Octal Numbers; Get and Read Alphanumeric String; Add Character, Delete Character, and Initialize String; String Decimal Numbers; and Space Decimal Output. (DECAL)

DECUS No. 58

Unary Manipulation Routines

R. S. Nickerson, D.S.L., Hanscom Air Force Base, Bedford, Massachusetts

Routines to: Count the number of ones in a block.  
Count the number of ones in a word. (DECAL)

DECUS No. 59

TITLE

C. V. Gaylord, D.S.L., Hanscom Air Force Base, Bedford, Massachusetts

Routine to punch out in readable form a typed title for binary tapes. (DECAL)

DECUS No. 60

SFLAG RFLAG

J. B. Goodenough, D.S.L., Hanscom Air Force Base, Bedford, Massachusetts

This routine is used to save and restore condition of flags. (DECAL)

DECUS No. 61

TLU - Table Look-up

J. B. Goodenough, D.S.L., Hanscom Air Force Base, Bedford, Massachusetts

This routine looks up an argument in a tape and returns with

### DECUS No. 61 (Continued)

address of first table entry greater than or equal to argument. (DECAL)

### DECUS No. 62

DSL Block Manipulation Routines

J.B. Goodenough and R. S. Nickerson, D.S.L., Hanscom Air Force Base, Bedford, Massachusetts

Consists of the following routines: Exchange Blocks; Move a Block; Compare Blocks, Get Standard Deviation; Push Block up N Registers; Larger, Equal, Smaller Algebraic or Absolute Magnitude; Order Block of Fixed Point Numbers Algebraically or According to Absolute Magnitude; DZM Block, Search, Compare Strings; Get Median; Select with/without Replacement; Rotate Block Right, Left; Inclusive or Blocks; Sort a Block of Items; Sort a Block of Alphabetic Items Using Sort 1. (DECAL)

### DECUS No. 63

Floating Point Interpreter (Modified for DECAL-BBN)

R. J. McQuillin, Bolt, Beranek and Newman, Incorporated

Routines to interpret fixed point coding as floating point when running a program. (DECAL) To be used in place of corresponding routine in DECUS No. 10.

### DECUS No. 64

Random Number Generators: Random, Ranmodn, Coin

William Fletcher

Random, when called, will return with a pseudo random number in the accumulator. The routine is initialized by depositing a known number in two preassigned registers. The routine occupies 12g registers.

Ranmodn, if called with a mod number in the accumulator, will return with a random number in the accumulator in in-out register which is between zero and the mod number minus one. It uses random and idvd.

Coin, when called, has a number in the accumulator which will be considered by the routine as a binary fraction with the radix at zero. If, at call time, Coin is at L then the routine will return to L + 1 with a probability of N and L + 2 with a probability of 1 - N. It occupies 12g registers and uses Random.

### DECUS No. 65

Digital Function Generate and Display

S. Jackson and G. Paquette, United Aircraft Corporation

Scope display for univariant or bivariant functions stored in "DECUS No. 34-Fast Bivariate Generator" format.

### DECUS No. 66

Short, Read Magnetic Tape Routines

William A. Fahle, Systems Research Laboratory, Incorporated, Dayton, Ohio

The purpose of the program is to read a record of a standard low density IBM format tape into a block of core. The entire record on tape must be transferred into core, thus allowing records of a non-predetermined length to be transferred. An entry is available for skipping records. The routine has an end-of-file return and a missed character indication. Storage used: 86<sub>10</sub> or 126<sub>8</sub>.

### DECUS No. 67

"SIN-COS": Floating-Point Sine-Cosine Routines

Richard Zacher, Princeton University, Princeton, New Jersey

These routines compute the sine or the cosine of the number in the floating accumulator and leaves the result in the floating accumulator. The routines use 73<sub>8</sub> registers.

### DECUS No. 68

"SQRT": Floating-Point Square Root Routine

Richard Zacher, Princeton University, Princeton, New Jersey

This routine computes the square root of the floating point number in the floating accumulator and leaves the result in the floating accumulator. The routine uses 56<sub>8</sub> registers.

### DECUS No. 69

SATED: Scope-Aided Tape Editor

Paul Weene, D.S.L., Hanscom Air Force Base, Bedford, Massachusetts

SATED is DSL program for preparing and editing symbolic tapes. The program requires a two core PDP-1, Type 30 CRT with character generator and light pen, Type 20 Sequence Break System and Automatic Multiply. (DECAL)

### DECUS No. 70

OLD DECUS LIBRARY I

Charles W. Adams Associates, Incorporated

1. Analyzer

Provides a program listing as a debugging aid. (FRAP)

2. Frapcorrector

## DECUS No. 70 (Continued)

Provides a convenient means of making changes to a FRAP Language source tape. (FRAP)

### 3. Punch Rim Tape

Provides a means of punching out information from sections of core memory. The console typewriter is used to provide the control information. (FRAP)

### 4. Adams Associates Intercom and Debug Program

#### Purpose:

To examine and modify individual memory locations via the console typewriter.

To obtain printouts of memory area via the on-line console typewriter or on paper tape for off-line printing on a Flexowriter.

To obtain up-dated binary read-in-mode format paper tape copies of programs which have been corrected from the console.

To obtain a "what has changed" print-out (on-line or off-line) of a program which has operated incorrectly.

To trap a program being debugged and obtain intermediate results by using the four functions above. Function 2 may be under program control as well as under manual control and thereby allows the program to continue automatically. A printout trace of JMP transfers is also available.

To make the AID printout routines available to other programs as subroutines.

Number of storage locations:  $776_8, 510_{10}$ .

## DECUS No. 71

### OLD DECUS LIBRARY II

Bolt, Beranek and Newman, Incorporated

#### 1. FRAP Assembly Program

Edward Fredkin

FRAP is designed to operate on a PDP-1 computer with at least 1024 words of memory and the minimum set of in-out equipment. The assembly language will accept, as input, a paper tape produced by a flexowriter. The tape is an isomorphic representation of the information contained in a typewritten program.

#### 2. Typewriter Control

John McCarthy

Helps in debugging other programs and allows the control of other programs from the on-line typewriter. It can be commanded from the typewriter to do the following: type-out

the contents of selected registers, change the contents of selected registers, execute instructions (including JMP instructions which give control to other routines), list those registers having given contents in a given field and define new typewriter control commands. (FRAP and DECAL)

#### 3. Colossal Typewriter Program

J. McCarthy and R. Silver (W. Fletcher)

May be used for tape preparation and tape editing. It uses the reader, punch and typewriter under typewriter control.

#### 4. Decimal to Binary Conversion

William Fletcher

This routine will convert a concise-coded decimal number between  $+000000_8$  and  $+377777_8$  to a binary number. (FRAP and DECAL)

#### 5. Binary to Decimal Printout and Punchout

William Fletcher

This routine is used to print or punch out a binary number between  $-377777_8$  and  $377777_8$ .

#### 6. TRACE

R. Silver and W. Fletcher

The TRACE Program is used to simulate the execution of a subject program one instruction at a time. After each instruction has been performed, the user's test routine is called to permit examination of the status of the machine, the pseudo-accumulator and the pseudo-program counter. (FRAP and DECAL)

#### 7. Rotate Test

William Fletcher

Rotate Test verifies that all the rotate instructions are operating correctly. (FRAP)

#### 8. Master Duplicator

William Fletcher

Master Duplicator routine allows the user to copy a tape from the reader to either or both punches and/or either or both typewriters. (FRAP)

#### 9. Tem-Stor Push Down

J. C. R. Licklider

The purpose of this package is to provide, in convenient form, a system for saving and restoring a system that can be incorporated into any FRAP program. (FRAP)

## DECUS No. 71.10 (Continued)

### 10. Tracker Routines

Roland Silver

The purpose of these routines is to track the light-pen over the face of the scope. (FRAP)

### 11. Grid Plotting Program (plotgrid)

J. C. R. Licklider

The plotgrid subroutine is used to plot, on the computer CRT display, a rectangular grid of the type used in graphs. The grid plotted by the program has eight parameters. These parameters are defined within the subroutine for external reference. It is assumed that they will be set (that their values will be filled in) by the subroutine that calls plotgrid. One calling of plotgrid plots the grid once.

### 12. Compare

Edward Fredkin

This routine will do a true 18-bit comparison for algebraic (signed) numbers (gela?) or for 18-bit magnitudes (glem?). This result is communicated by a return to one of three locations in the calling sequence. The numbers that are compared are masked prior to comparison. (DECAL and FRAP)

### 13. Debug

R. Silver and H. Rudloe

Debug is intended to help the programmer debug a program at the console.

## DECUS No. 72

### OLD DECUS LIBRARY III

William Fletcher, Bolt, Beranek and Newman, Incorporated

#### Binary Punch and Load Package

This routine allows the user to punch out any area of memory in the binary format, specifying the desired area with typed commands. (FRAP)

#### Binary Punchoff

This routine punches a tape which, when reloaded will reproduce the memory at time of punch-off. (FRAP)

## DECUS No. 73

### MADCAP; MAMmoth DeCimal Arithmetic Program

E. Myrvagnes, Parke Mathematical Laboratories, Incorporated

A multiple-precision floating-point arithmetic program. The number of significant digits maintained during calculations

can be varied easily to suit user's requirements of speed vs. accuracy. Programming in MADCAP's own source language is extremely simple.

## DECUS No. 74

### Tapelibrary Program

Daniel Forsyth, informational International Incorporated, Cambridge, Massachusetts

Tapelibrary Program stores the image of punched paper tapes on magnetic tape and reproduces them on command. Read checking is performed for paper-mag and mag-paper conversion. Records may be added to mag tape at any time, but not rewritten. Initial typed instructions are shortened when an operation is repeated. The program occupies 0-3117 registers.

## DECUS No. 75

### SEETAPE - A Magnetic Tape Dump Program

John B. Goodenough, D.S.L., Hanscom Air Force Base, Bedford, Massachusetts

SEETAPE is a program for dumping magnetic tape information on the scope. The user may specify the structure of the tape block to be dumped, space forward and backward any number of blocks, and rewind the tape. Binary versions are available for Type 51 Control and Type 52 Control.

#### Equipment Required:

1. At least two cores
2. Type 30 Scope with Type 33 Character Generator
3. Standard Typewriter
4. Type 51 or Type 52 Tape Control

## DECUS No. 76

### A 28-Bit Floating Point Package

Lt. Richard D. Smallwood, Air Force Cambridge Research Laboratories, Bedford, Massachusetts

The purpose is to provide a 28-bit mantissa and 8-bit exponent floating point numbers for more accuracy than the standard 18-18 package. Performs floating point arithmetic, conversion, input, and output. Storage used varies.

Special Hardware Required: Automatic multiply and divide.

## DECUS No. 77

### Sort Routines - Sort 2, Sort 3

John B. Goodenough, D.S.L., Hanscom Air Force Base, Bedford, Massachusetts

Order (ascending) a two-dimensional array. These routines will work in either single core or multi-core machines. In

DECUS No. 77 (Continued)

multi-core machines, the program must be called in extend mode with the operands referencing the proper core.

DECUS No. 78

TAPE 52 Magnetic Tape Control Subroutines

John B. Goodenough, D.S.L., Hanscom Air Force Base, Bedford, Massachusetts

A set of subroutines which exist on a library tape for using the tape transports connected to the Type 52 Control Unit. The routines allow the user to read or write, in even or odd parity, a block of consecutive words in core as one tape block; write and detect on IBM end-of-file mark; space forward and backward; rewind; maintain a block count, and automatically take corrective action when errors are detected during read or write operations. All routines may be used in extend mode and called from any core.

DECUS No. 79

Extended Memory Punch and Loader Routines

William E. Fletcher, Bolt, Beranek & Newman, Incorporated

Facilitates punching and loading binary information from any memory bank in the PDP-1. (DECAL)

DECUS No. 80

DEXTER, A Magnetic Tape Executive Routine

R. D. Keim, Wolf Research & Development Corporation

DEXTER is an executive routine designed to facilitate the operation of a PDP-1 data processing system during experimental runs. It provides an efficient method of loading programs from magnetic tape under on-line operator control. DEXTER requires an 8K PDP-1 with a Type 52 Magnetic Tape Control. The software consists of an executive routine and a maintenance routine. Other programs are written in a DEXTER COMPATIBLE FORMAT and stored on the executive magnetic tape. (AMP Language but can be converted to DECAL or MACRO easily.)

DECUS No. 81

Calcomp Plotter Software

Charles W. Adams Associates, Incorporated

Routines:

PLOTS 1	GRAPH
PICTUR	SYMBL5
PLOT 1	NUMBR 1
DXDY 1	MINMAX
SCALE 1	WHERE
AXIS 1	FACTOR
SCLGPH	Expensive Tape-Calcomp Plotter

DECUS No. 82.3

FORTRAN for the PDP-1 - Version 3

The FORTRAN Compiler for the PDP-1 is not intended to be a replacement language for the other compiler and assembly languages already in use on the PDP-1; however, it is useful for short programs which may easily be coded in FORTRAN. Version 3 is for machines with multi-div hardware.

DECUS No. 83

340 Assembly Language and 340 DDT

John B. Goodenough, D.S.L., Hanscom Air Force Base, Bedford, Massachusetts

This program resembles ordinary DDT in that it allows the bit patterns of the 340 Scope instructions to be inspected and changed, on-line, in a symbolic language. The symbols used are identical to the symbols used when compiling programs for the scope.

In addition registers may be inspected and changed using ordinary machine language.

The action operator tape, which defines the 340 Assembly Language, can be compiled only with the 2-core DECAL of November 1964 (or with versions of DECAL derived from the Skeletal DECAL of November 1964). After compilation, DECAL can be punched off to obtain a permanent copy of DECAL with the 340 definitions.

Following the action operators is a test program which can be compiled and loaded to check that the compiler is using the definitions correctly. The pattern produced by the test program is described in the 340 DDT write-up.

DECUS No. 84

M.I.T. Floating Point Arithmetic Package

Bill Gasper and Tom Eggers, M.I.T., Cambridge, Massachusetts

The Floating Package is a group of arithmetic subroutines in which numbers are represented in the form  $f \times 2^e$ .  $f$  is a 1's complement 18-bit fraction with the binary point between bits 0 and 1.  $e$  is a 1's complement 18-bit integer exponent of 2. The largest magnitude numbers that can be represented are  $\approx 10,39,000$ .

A number is normalized when  $1/2 < |f| < 1$ . All the floating point routines, except the two floating unnormalized adds, return a normalized answer. The fraction appears in the AC, the exponent in the I/O. Routines include:

Floating Add	- jda fad
Floating Multiply	- jda fmp
Floating Divide	- jda fdv
Floating Square Root	- jda fsq
Floating Log, base 2	- jda log
Floating Reciprocal	- jda rcp
Floating Input	- jda fip

### DECUS No. 84 (Continued)

Floating Output - jda fop  
Floating Unnormalized add - jda fua  
Floating Unnormalized add and Round - jda fur  
Floating Exponentiation - jda f2x

### DECUS No. 85

LISP for the PDP-1

L. Peter Deutsch and Edmund C. Berkeley

LISP (for LIST Processing) is a language designed primarily for processing data consisting of lists of symbols. It has been used for symbolic calculations in differential and integral calculus, electrical circuit theory, mathematical logic, game playing, and other fields of intelligent handling of symbols.

LISP for the PDP-1 uses, from the basic function, about 1500 registers, and for working storage from about 500 to 14000 registers (the latter in a four-core PDP-1) as may be chosen. It is flexible, permits much investigation, and the correction of preliminary expressions.

### DECUS No. 86

Precision Hypotenuse/Square Root Subroutine

Nick Chase, Charles W. Adams Associates, Incorporated

Precision Hypotenuse is used to form the 34-bit sum of the squares of two 17-bit one'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 34<sub>10</sub> registers, using automatic multiply and divide hardware, and requires a constant of 200000<sub>8</sub>.

### DECUS No. 87

Buffered DECtape Read and Write Routines

R. J. McQuillin, Inforonics, Incorporated, Cambridge, Massachusetts

These routines simulate paper tape on DECtape. When characters are written (punched) onto DECtape, they are packed two per word. Therefore, it is possible to put 776<sub>8</sub> characters on one DECtape block.

### DECUS No. 88

Typewriter Time Test

Lloyd J. Ostiguy, Inforonics, Inc., Maynard, Massachusetts

Indicates time ratios between key strokes on a typewriter.

### DECUS No. 89 and 89a

Cube Display and Matchbox Display

T. Hart

Demonstration programs displaying a cube or matchbox for use with the PDP-1 and Type 30 Display.

### DECUS No. 90

Color Debugger

Nick Chase, Charles W. Adams Associates, Incorporated, Cambridge, Massachusetts

Provides on-line debugging in octal using PDP-1 with color display and pushbuttons. It has two basic modes: examine/modify and program trace. Requires PDP-1 with memory extension control and a color display console, or black and white display Type 30 (preferably with pushbuttons connected to computer testword).

### DECUS No. 91

DECtape Duplicate/Verify

R. J. McQuillin, Inforonics, Incorporated, Cambridge, Massachusetts

This program copies DECtape on the PDP-1. When a DECtape is copied, it is automatically verified. An operation that will only verify one tape against another is also included. The user has control over how much of the tape is duplicated and verified. He may also adjust the internal buffer size to any core configuration.

Minimum Hardware: 4K, DECtape Dual Transport

Source Language: DECAL

Storage: 100-577 plus rest of memory for buffer

### DECUS No. 92

EMP (Extended Math Package)

Adams Associates, Cambridge, Massachusetts

EMP is an interpretive routine to perform double precision floating point arithmetic and elementary function evaluations. It is a condensation and revision of FLINT (DECUS #15A) for the FLINT 3-word floating point format. Changes include the addition of a floating jump instruction, operation only in extend mode, improved accuracy and elimination of the input-output routines. The program has been coded in MIDAS and may be fully relocated if desired.

Minimum Hardware: Standard PDP-1, memory extension control. CAL in extend mode should go to module 0.

Storage Requirement: 597<sub>10</sub>, plus constants

Execution Time: Typical floating add <300  $\mu$ sec; normalize <80  $\mu$ sec.



# **PDP-4 PROGRAMS**

# PDP-4 INDEX

<u>DECUS NO.</u>	<u>TITLE</u>	<u>TAPES AVAILABLE</u>	<u>LISTING</u>
4 - 1	PDP-4 Automonitor Program	S	X
4 - 2	Teletype Input and Output Package	S	X
4 - 3	Random Number Subroutine	S	X
4 - 4	Read a Decimal Number from Keyboard	S	X
4 - 5	KUS - Kie Utility System	B, S	X
4 - 6	DDT-4 With Floating Point Input/Output and Drum Read-Write	B	
4 - 7	Bivariate Curve Fit	S	X
4 - 8	Short-Loader for the PDP-4 - Flynn Loader	B	
4 - 9	SQRT - Single Precision Square Root Subroutine	S	
4 - 10	Multi-Clock Simulation Subroutine	S	X
4 - 11	Engineering Project Scheduling System	B, S	X
4 - 12	Boolepac Subroutine	S	X
4 - 13	FISP: Foxboro Interpretive Simulation Program	S	
4 - 14	CCS Operator System	B, S	X
4 - 15	CCS Scope Editor	B, S	X

Code

A - ASCII Source  
 B - Binary Object  
 D - DECtape

H - High Binary Loader  
 L - LINCtape  
 LL - Linking Loader

R - RIM  
 S - Symbolic (Source)  
 X - Listing Available

Writeups are available for all programs.

# PDP-4 PROGRAM ABSTRACTS

## DECUS No. 4-1

PDP-4 Automonitor Program

M. Kawahara, Mesa Scientific Corporation

This program is used to trace the execution of a program and provide a printout of the result of each command executed.

## DECUS No. 4-2

Teletype Input and Output Package

M. Stein, Center for Cognitive Studies, Harvard University, Cambridge, Massachusetts

This is a revision of the DEC Teletype Output Package. Several input routines are added and the typewriter can be initialized for either figures or letters.

## DECUS No. 4-3

Random Number Subroutines

D. A. Norman, Center for Cognitive Studies, Harvard University, Cambridge, Massachusetts

This program generates a random number and leaves it in the AC.

## DECUS No. 4-4

Read a Decimal Number From Keyboard

D. A. Norman, Center for Cognitive Studies, Harvard University, Cambridge, Massachusetts

This program reads the Teletype keyboard and converts typed decimal number to a binary number, leaving the results in the AC, and DNMB1.

## DECUS No. 4-5

KUS - Kie Utility System

Allen Rousseau, C. W. Adams Associates

KUS is an octal debugging and utility system. It consists of five basic routines:

1. Octal Correcting Routine
2. Word Search Routine
3. Octal Dump
4. Compare Tape Equal Routine
5. Jump Options

## DECUS No. 4-6

DDT-4 With Floating Point Input/Output and Drum Read-Write

James E. Curry and Jerome L. Abel, Adams Associates

Enables on-line DDT debugging of programs using floating point data, and convenient reading and writing of drum tracks. It occupies upper memory from 10000-12676 and 15101-17777.

## DECUS No. 4-7

Bivariate Curve Fit

Judith Green, Foxboro Company, Foxboro, Massachusetts

This program generates an approximating polynomial by the least squares technique to a set of points  $(x, y, z)$  where  $z = f(x, y)$ . The data which need not be equally spaced, may be weighted or not at the option of the user. The program allows for any number of points. The number of powers of  $x$  and  $y$  may be increased by altering the dimension statement

Storage: 4511<sub>g</sub>

## DECUS No. 4-8

Short-Loader for the PDP-4 Flynn Loader

James Baldrige and Jon D. Stedman, Lawrence Radiation Laboratory, Berkeley, California

As the PDP-4 has no LOAD button, it is necessary to have a small resident loading program in core storage. This Read-In Loader will load binary tapes in "funny format".

## DECUS No. 4-9

SQRT - Single Precision Square Root Subroutine

Jon D. Stedman, Lawrence Radiation Laboratory, Berkeley, California

This square root subroutine performs the fixed point square root of the contents of the AC (0, 17). The result is left in the AC.

## DECUS No. 4-10

Multi-Clock Simulation Subroutine

Jon D. Stedman, Lawrence Radiation Laboratory, Berkeley, California

A subroutine that simulates any required number of clocks.

#### DECUS No. 4-11

##### Engineering Project Scheduling System

R. Vernon

The Project Scheduling System is an engineering planning guide with an automated updating feature. The purpose of the system is to coordinate the engineering effort, both internally and with various service departments.

#### DECUS No. 4-12

##### Boolepac Subroutine

Donald Sordillo, Harvard University, Cambridge, Massachusetts

Allows the implementation of several Boolean functions.

#### DECUS No. 4-13

##### FISP: Foxboro's Interpretive Simulation Program

Adams Associates (submitted by Foxboro Company)

The PDP-8 Simulator was originally designed for Foxboro's Service Center PDP-4. 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. 8K PDP-4 with EAE, to simulate PDP-8 with EAE Type 182, Reader Type 750, and Punch Type 75 with all utility functions except tracing.
2. PDP-4 with EAE, 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 all utility functions except tracing.

#### DECUS No. 4-14

##### CCS Operator System

Harry Rudloe, Center for Cognitive Studies, Harvard University, Cambridge, Massachusetts

Allows one to perform a variety of DECtape operations under control of the Teletype. The principal functions are:

1. writing records
2. reading records
3. searching for records
4. logging a tape to have the names of all records listed on the Teletype
5. erasing tape

The Operator System also contains a complete package of Teletype and DECtape routines which are rendered available for use by the programmer. In addition, a package called the Operator Extension is provided which contains sub-routines for the reader, punch and input-output of FIO-DEC text from the Teletype.

#### DECUS No. 4-15

##### CCS Scope Editor

H. Rudloe, Center for Cognitive Studies, Harvard University, Cambridge, Massachusetts

A program for rapid editing of textual materials, particularly symbolic programs. Selected portions of a text are displayed on the 340 Scope and edited under control of the Teletype and light pen. Its in-out operations involve only the paper tape reader and punch and the Teletype. It will process FIO-DEC symbolic tapes only.

Storage used: Requires all of memory (8K), but is easily modified for 4K machines.

Special Hardware: Type 340 Scope with Type 342 Symbol Generator, Type 28 Teletype, Reader and Punch and Single Channel Interrupt.

Requires DECUS No. 4-14.

**PDP-5 / PDP-8, 8/S, 8/I**  
**PROGRAMS**

# PDP-5/PDP-8, 8/S, 8/I INDEX

<u>DECUS NO.</u>	<u>TITLE</u>	<u>TAPES AVAILABLE</u>	<u>LISTING</u>
6/8-12	PDP-8 Assembler for Use on PDP-6	D	
5/8-1.1	BPAK - A Binary Input-Output Package for the PDP-5	B	X
5-2.1	OPAK - An On-Line Debugging Program for the PDP-5	B	
5-3	BRL - A Binary Relocatable Loader with Transfer Vector Options for the PDP-5 Computer	B	
5-4	Octal Typeout of Memory Area with Format Option	No Tapes	X
5-5	Expanded Adding Machine	No Tapes	X
5-6	BCD to Binary Conversion of 3-Digit Numbers	No Tapes	X
5/8-7	Decimal to Binary Conversion by Radix Deflation on PDP-8	No Tapes	X
5-8	PDP-5 Floating Point Routines	B	X
5/8-9	Analysis of Variance PDP-5/8	B, S	X
5-10	Paper Tape Reader Test	B	
5-11	PDP-5 Debug System	B	
5-12	Pack-Punch Processor and Reader for the PDP-5	S	X
5-13	PDP-5 Assembler for IBM 7094/7044	Source Deck	
5/8-14	Dice Game for the PDP-5/8	B	
5/8-15	ATEPO - Auto Test in Elementary Programming and Operation of a PDP-5/8 Computer	B	
5-16	Paper Tape Duplicator for the PDP-5	B	X
5/8-17	Type 250 Drum Transfer Routine for Use on PDP-5/8	B, S	X
5/8-18 A, B, C	Bin Tape Disassembler for the PDP-5/8	B	X
8-19a	DDT-UP: Octal Symbolic Debugging Program	B	
5/8-20	Remote Operator FORTRAN System	B	X
5/8-21	Triple Precision Arithmetic Package for the PDP-5/8	B, S	X
5-22	DECTape Duplicate	B, S	X
5/8-23A	PDP-5/8 Oscilloscope Symbol Generator (4 x 6 Matrix)	B	X
5/8-23B	PDP-5/8 Oscilloscope Symbol Generator (5 x 7 Matrix)	B, S	X
5-24	Vector Input/Edit	B, S	Flow Charts
5-25	A Pseudo Random Number Generator for the PDP-5 Computer	B, S	X
8-26A	Compressed Binary Loader (CBL)	B	X
8-26B	CBC (BIN to CBL) and CONV (CBL to BIN)	B	

## Code

A - ASCII Source  
 B - Binary Object  
 D - DECTape

H - High Binary Loader  
 L - LINCTape  
 LL - Linking Loader

R - RIM  
 S - Symbolic (Source)  
 X - Listing Available

Writeups are available for all programs.

<u>DECUS NO.</u>	<u>TITLE</u>	<u>TAPES AVAILABLE</u>	<u>LISTING</u>
8-26C	XCBL - Extended Memory CBL Loader	B	
8-26D	XCBL Punch Program	B	
5/8-27 & 27a	Bootstrap Loader and Absolute Memory Clear	B	X
5/8-28a	PAL III Modifications - Phoenix Assembler	B	
5/8-29	BCD to Binary Conversion Subroutines	B, S	X
5-30	GENPLOT - General Plotting Subroutines	B	
5-31	FORPLOT - FORTRAN Plotting Program for PDP-5	B	
5/8-32a	Program to Relocate and Pack Programs in Binary Format	B	X
5/8-33	Tape to Memory Comparator	S	X
5-34	Memory Halt - A PDP-5 Program to Store HALT in Most of Memory	B	X
5/8-35	BCD to Binary Conversion Subroutine and Binary to BCD Subroutine (Double Precision)	S	X
5-36	Octal Memory Dump Revised	B, S	
5-37	Transfer II	B, S	
5/8-38	FTYPE - Fractional Signed Decimal Type-in	B	X
5/8-39	DSDPRINT, DDTYPE - Double-Precision Signed Decimal Input-Output Package	B	X
5-40	ICS DECTape Routines (One-Page) (552)	B, S	
5-41	Breakpoint	B, S	
5-42	Alphanumeric Input	B, S	
5/8-43	Unsigned Octal-Decimal Fraction	B, A	X
8-44	Modifications to the Fixed Point Output in the PDP-8 Floating Point Package (Digital 8-5-5)	B, S	X
5/8-45	PDP-5/8 Remote and Time-Shared System	B	
5/8-46a	Utility Programs for the PDP-5 and PDP-8	B	
8-47	ALBIN - A PDP-8 Loader for Relocatable Binary Programs	B, S	
5/8-48	Modified Binary Loader MKIV	R	X
8-49	Relativistic Dynamics	B	X
5/8-50	Additions to Symbolic Tape Format Generator (DEC-8-21-4)	B, S	X
5/8-51	Character Packing and Unpacking Routines	B, S	X
8-52	Tiny Tape Editor	B, S	X
5/8-53	COPCAT (DECTape Copy) (552)	B, A	X
5/8-54	Tic-Tac-Toe Learning Program	B, S	X
5/8-55	PALEX - On-Line Debugging Program for PDP-5/8	B, S	X
8-56	Fixed Point Trace No. 1	B, A	X
8-57	Fixed Point Trace No. 2	B, A	X
8-58	One-Page DECTape Routines (552 Control)	S	X
8-59	PALDT - PAL Modified for DECTape (552 Control)	B, S	X
8-60	Square Root Function by Subtraction Reduction	S	X
8-61	Improvement to Digital 8-9-F Square Root	S	X

<u>DECUS NO.</u>	<u>TITLE</u>	<u>TAPES AVAILABLE</u>	<u>LISTING</u>
8-62a	Obsolete		
5-63	SBUG-4	R	X
5/8-64	DECTape Programming System (552 & TC01 Controls)	D	X
8-65	A Programmed Associative Multichannel Analyzer	B	
8-66	Editor Modified for DECTape (552)	B, S	X
8-67	PAL Modified for DECTape Input (552)	B, S	X
8-68a	LABEL for PDP-8		
5/8-69	LESQ29 and LESQ11	D, S	X
8-70	EAE Routines for FORTRAN Operating System (DEC-08-CFA3)	B, A	X
8-71	Perpetual Calendar	B, S	X
8-72	Matrix Inversion, Real Numbers	B, S	X
8-73	Matrix Inversion, Complex Numbers	B, S	X
8-74	Solution of System of Linear Equations: $AX=B$ , by Matrix Inversion and Vector Multiplication	B, S	X
8-75	Matrix Multiplication - Including Conforming Rectangular Matrices	B, S	X
8/8S-76	PDP NAVIG 2/2	B, S	
8/8S-77	PDP-8 Dual Process System	B, S	X
8-78	Diagnose: A Versatile Trace Routine for PDP-8 with EAE	B, A	X
8-79	Tic-Tac-Toe (Trinity College Version)	B, S	X
8-80	Determination of Real Eigenvalues of a Real Matrix	B, S	X
8-81	A BIN or RIM Format Data or Program Tape Generator	B, S	X
8-82	Library System for 580 Magnetic Tape - Preliminary Version	B	X
8/8S-83 A & B	Octal Debugging Package (With and Without Floating Point)	B, A	X
8-84	One-Pass PAL III (8K PDP-8)	B, A	X
5/8-85	Set Memory Equal to Anything		X
8-86	Obsolete		
8-87	XMAP	D (B,S)	X
8-88	DECTape Symbolic Format Generator	D (B,S)	
8-89	XOD - Extended Octal Debugging Program	B	
5/8-90	Histogram on Teletype	S	X
8-91	Micro-8: An On-Line Assembler	B	
8-92	Analysis of Pulse-Height Analyzer Test Data With a Small Computer	B	X
8-93	CHEW - Convert Any BCD to Binary - Double Precision	S	X
8-94 A, B	BLACKJACK	B, S	X
8-95	TRACE for EAE	B, S	X
8-96	J Bessel Function (FORTRAN)	FORTRAN (Object & Source)	X
8-97	GOOF	S	X
8-98	3D DRAW for the 338	B, S	
8-99 A	Kaleidoscope	B, S	X
8-99 B	Kaleidoscope - 338		



<u>DECUS NO.</u>	<u>TITLE</u>	<u>TAPES AVAILABLE</u>	<u>LISTING</u>
8-100	Double Precision Binary Coded Decimal Arithmetic Package	S	X
8-101	Symbolic Editor With View	B, S	
8-102	A LISP Interpreter for the PDP-8	B	X
8-103A	Four Word Floating Point Function Package	B, S	X
8-103B	Four Word Floating Point Rudimentary Calculator	B, S	X
8-103C	Four Word Floating Point Output Controller with Rounding	B, S	X
8-103D	Additional Instructions for Use with Four Word Floating Point Package	B, S	X
8-104	Card Reader Subroutine for PDP-8 FORTRAN Compiler	B, A	X
8-105	D-BUG	B, A	
8-106	Readable Punch	B, S	X
8-107	CHESSBOARD (Demonstration) for the PDP-8/338	B	X
8-108	INCMOD - Increment Mode Compiler (338)	B	X
8-109	SEETXT Subroutine (338)	B	X
8-110	DIREC - Directory Print	B	X
8-111	DISKLOOK	B	X
8-112	Sentence Generator	B, A	X
8-113	Conversion of Friden (EIA) to ASCII	B, A	X
8-114	Rounded Decimal Output Modification for PDP-8 FORTRAN	B	X
8-115	Double Precision Integer Interpretive Package	B, A	X
8-116	PDP-8 Automatic Magnetic Tape Control (Type 57A) Library System	B	
8-117	A PDP-8 Interface for a Charged-Particle Nuclear Physics Experiment	No Tapes	X
8-118	General Linear Regression	A	X
8-119	Off-Line TIC-TAC-TOE	B, A	X
8-120	Disk/DECtape FAILSAFE	B, A	X
8-121	DECtape Handler (552 DECtape)	B, A	X
8-122	SNAP	B	
8-123	UNIDEC Assembler	Source Deck	X
8-124	PDP-8 Assembler for IBM 360/67	Source Deck	X
8-125	PDP-8 Program Relocatable Assembler/IBM 360/67	Source Deck	X

# PDP-5\* and PDP-8\*, 8/S, 8/I PROGRAM ABSTRACTS

## DECUS No. 6/8-12

### PDP-8 Assembler for PDP-6

Henry Burkhardt, Digital Equipment Corporation, Maynard, Massachusetts

Assembles PDP-8 programs written in PAL on a PDP-6 using any I/O devices.

## DECUS No. 5/8-1.1

### BPAK - A Binary Input-Output Package

P.T. Brady, New York University, New York, New York

A revision of the binary package originally written by A. D. Hause of Bell Telephone Laboratories. 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 converts BPAK so that it reads from the Teletype reader if the photoreader is disabled. In its present form it occupies locations 7600 - 7777.

## DECUS No. 5-2.1

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

P.T. Brady, New York University, New York, New York

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. Extensive use of the program has suggested many refinements and revisions of the original program, the most significant additions being the word search and the breakpoint. 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.).

## DECUS No. 5-3

### BRL - A Binary Relocatable Loader with Transfer Vector Options for the PDP-5 Computer

P. T. Brady, Bell Telephone Laboratories, Inc., Murry Hill, New Jersey

A binary loader program occupying 4640<sub>8</sub> to 6177<sub>8</sub> registers,

also 160 to 177. It has two main functions:

- 1) It allows a PDP-5 operator to read a suitably prepared binary program into any page location in memory except the registers occupied by BRL.
- 2) It greatly simplifies the calling of programmed subroutines by allowing the programmer to use an arbitrary subroutine calling sequence when writing his program, instead of having to remember the location of the subroutines.

## DECUS No. 5-4

### Octal Typeout of Memory Area with Format Option

Donald V. Weaver, New York, New York

(Writeup and Listing Only)

## DECUS No. 5-5

### Expanded Adding Machine

Donald V. Weaver, New York, New York

Expanded Adding Machine is a minimum-space version of Expensive Adding Machine (DEC-5-43-D) using a table lookup method including an error space facility.

This is a basic version to which additional control functions can easily be added. Optional vertical or horizontal format, optional storage of intermediate result without reentry fixed-point output of results within reason, and other features that can be had in little additional space under switch register control. (Writeup and Listing Only)

## DECUS No. 5-6

### BCD to Binary Conversion of 3-Digit Numbers

Donald V. Weaver, New York, New York

This program is based on DEC-5-4 and is intended to illustrate the use of alternative models in program construction.

While not the fastest possible, this program has one or two interesting features. It converts any 3-digit BCD-coded decimal number, D<sub>1</sub>D<sub>2</sub>D<sub>3</sub> into binary in the invariant time of 372 microseconds. Efficient use is made of BCD positional logic to work the conversion formula  $(10D_1 + D_2) 10 + D_3$  by right shifts in the accumulator. In special situations, it could be profitable to insert and initial test/exit on zero, adding 12 microseconds to the time for non-zero numbers. (Writeup and Listing Only)

\* Note: Programs listed as DECUS No. 5-(number) indicate that they work on the PDP-5, and compatibility to the PDP-8 is uncertain. Programs marked DECUS No. 5/8-(number) indicate they can be used on both 5 and 8 computers. Those marked DECUS No. 8-(number) work on PDP-8, and compatibility to PDP-5 is uncertain.

DECUS No. 5/8-7

Decimal to Binary Conversion by Radix Deflation on PDP-8

Donald V. Weaver, New York City, New York

(Writeup and Listing Only)

DECUS No. 5-8

PDP-5 Floating Point Routines

Jerry Crawford, Culver City High School, Culver City, California

Consists of the following routine:

- 1) Square Root-Binary Tape and Symbolic Listing
- 2) Sine-Cosine - Binary Tape only
- 3) Exponential - Binary Tape only

DECUS No. 5/8-9

Analysis of Variance PDP-5/8

Henry Burkhardt, Digital Equipment Corporation, Maynard, Massachusetts

An analysis of variance program for the standard PDP-5/8 configuration. The output consists of:

- A. For each sample:
  - 1) sample number
  - 2) sample size
  - 3) sample mean
  - 4) sample variance
  - 5) sample standard deviation
- B. The grand mean
- C. Analysis of Variance Table:
  - 1) the grand mean
  - 2) the weighted sum of squares of class means about the grand mean
  - 3) the degrees of freedom between samples
  - 4) the variance between samples
  - 5) the pooled sum of squares of individual values about the means of their respective classes
  - 6) the degrees of freedom within samples
  - 7) the variance within samples
  - 8) the total sum of squares of deviations from the grand mean
  - 9) the degrees of freedom
  - 10) the total variance
  - 11) the ratio of the variance between samples to the variance with samples.

This is the standard analysis of variance table that can be used with the F test to determine the significance, if any, of the differences between sample means. The output is also useful as a first description of the data.

All arithmetic calculations are carried out by the Floating Point Interpretive Package (Digital-8-5-S).

DECUS No. 5-10

Paper Tape Reader Test

Tony Schaeffer, Lawrence Radiation Laboratory, Berkeley, California

A test tape can be produced and will be continuously read as an endless tape. Five kinds of errors will be detected and printed out. The Read routine is in 6033-6040. Specifications: Binary with Parity Format - Length: registers in locations (octal): 10,11, 4 through 67 (save 63, 64), and 6000-7777.

DECUS No. 5-11

PDP-5 Debug System

Tony Schaeffer and Don Zurlinden, Lawrence Radiation Laboratory, Berkeley, California

Purpose of this program is to provide a system capable of:

- 1) Octal dump 1 word per line.
- 2) Octal dump 10g words per line.
- 3) Modifying memory using the typewriter keyboard.
- 4) Clearing to zero parts of memory.
- 5) Setting to HALT codes part of memory.
- 6) Entering breakpoints into a program.
- 7) Initiating jumps to any part of memory.
- 8) Punching leader on tape.
- 9) Punching memory on tape in RIM format.
- 10) Punching memory on tape in PARITY format.
- 11) Load memory from tape in PARITY format.

DECUS No. 5-12

Pack-Punch Processor and Reader for the PDP-5

R. L. Becker, Boston College, Boston, Massachusetts

The processor converts a standard binary-format tape into a more compressed format, with two 12-bit words contained on every three lines of tape. Checksums are punched at frequent intervals, with each origin setting, or at least every 200 words.

The reader, which occupies locations 7421 to 7577 in the memory will load a program which is punched in the compressed format. A test for checksum error is made for each group of 200 or less and the program will halt on error detection. Only the most recent group of words need be re-loaded. Read-in time is about 10% less than for conventional binary format, but the principal advantage is that little time is lost when a checksum error is detected, no matter how long the tape.

DECUS No. 5-13

PDP-5 Assembler for use on IBM 7094/7044

Tony Schaeffer, Lawrence Radiation Laboratory, Berkeley, California

This program accepts IBM 7094/7044 symbolic programs punched on cards and assembles them for the PDP-5. An assembly listing is produced, and a magnetic tape is generated containing the program. This magnetic tape can be converted to paper tape and then read into the PDP-5 or it can be read directly into a PDP-5 with an IBM compatible tape unit. Cards are available.

DECUS No. 5/8-14

DICE Game for the PDP-5/8

Edward Steinberger, Digital Equipment Corporation, Maynard, Massachusetts

Enables a user to play the game DICE on either the PDP-5 or PDP-8.

DECUS No. 5/8-15

ATEPO (Auto Test in Elementary Programming and Operation of a PDP-5/8 Computer)

Rutgers University, Electrical Engineering Department, New Brunswick, New Jersey

The program will type questions or instructions to be performed by the operator of a 4K PDP-5/8. The program will check to see if the operator has answered the questions correctly. If this is the case, it will type the next question or instruction.

DECUS No. 5-16

Paper Tape Duplicator for PDP-5

Henry Burkhardt, Digital Equipment Corporation, Maynard, Massachusetts

The tape duplicator for the PDP-5 is a single buffered read and punch program utilizing the program interrupt. It computes a character count and checksum for each tape and compares with checks at the end of the tape. Checks are also computed and compared during punching.

DECUS No. 5/8-17

Type 250 Drum Transfer Routine For Use on PDP-5/8

S. Arthur MacIlroy, Foxboro Company, Natick, Massachusetts

Transfers data from drum to core (Read) or core to drum (Write) via ASR-33 Keyboard Control.

DECUS No. 5/8-18A

Binary Tape Disassembly Program

G. A. Sabin, NRL-USRD, Orlando, Florida

Disassembles a PDP-5 or 8 program, which is on tape in BIN format. It prints the margin setting, address, octal contents, mnemonic interpretation (PAL) of the octal contents. A normal program or a program which uses Floating Point may be disassembled.

DECUS No. 5/8-18B

Binary Tape Disassembler

Revision by Roger Due, N.A.D. Crane

An extension of the Disassembler which enables double spacing and paging of output.

DECUS No. 5/8-18C

Disassembler with Symbols

Eberhard Werner, University of California, Marine Physical Laboratory of the Scripps Institution of Oceanography, San Diego, California

This disassembler accepts a binary tape of standard format and produces a listing of the tape in PAL III mnemonics, and a cross-reference table of all addresses referenced by any memory-reference instruction. A symbol table may be entered to produce a listing similar to a PAL III Pass 3 listing. A patch to produce only a cross reference table is included.

Minimum Hardware: PDP-8 (4K), ASR-33, high-speed reader, EAE

Storage: 20-1773<sub>g</sub> for program, 1774-7577<sub>g</sub> for scratch

DECUS No. 8-19a

DDT-UP: Octal-Symbolic Debugging Program

Michael S. Wolfberg and Robb N. Russell, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pennsylvania

DDT-UP is an octal-symbolic debugging program for the PDP-8 which occupies locations 5600 through 7677. It is able to read a symbol table punched by PDPSYM and stores symbols, four locations per symbol, from 5577 down towards 0000. The mnemonics for the eight basic instructions and standard OPR and IOT group instructions are initially defined and highest available location for the user is initially 5363.

From the Teletype, the user can symbolically examine and modify the contents of any memory location. DDT-UP allows the user to punch a corrected program in CBL format.

DECUS No. 8-19a (Continued)

DDT-UP has a breakpoint facility to help the user run sections of his program. When this facility is used, the debugger also uses location 0005.

DECUS No. 5/8-20

Remote Operator FORTRAN System

Jim Miller, Dow Badische, Freeport, Texas

Program modification and instructions to make the FORTRAN OTS version dated 2/12/65 operate from remote stations.

DECUS No. 5/8-21

Triple Precision Arithmetic Package for the PDP-5 and the PDP-8

Joseph A. Rodnite, Information Control Systems, Ann Arbor, Michigan

An arithmetic package to operate on 36-bit signed integers. The operations are add, subtract, multiply, divide, input conversion, and output conversion. The largest integer which may be represented is  $2^{35} - 1$  or 10 decimal digits. The routines simulate a 36-bit (3 word) accumulator in core locations 40, 41, and 42 and a 36-bit multiplier quotient register in core locations 43, 44, and 45. Aside from the few locations in page 0, the routines use less core storage space than the equivalent double-precision routines.

DECUS No. 5-22

DECtape Duplicate

Jim Miller, Dow Badische, Freeport, Texas

A DECtape routine for the PDP-5 to transfer all of one reel (transport 1) to another (transport 2). Occupies one page of memory beginning at 7400. The last page of memory is not used during the operation of the program; however, the memory from 1 to 7436 is used to set the DECtape reels in the proper starting attitude and is then destroyed during duplication. Duplication will commence after which both reels will rewind. Parity error will cause the program to halt with 0040 in the accumulator.

DECUS No. 5/8-23A

PDP-5/8 Oscilloscope Symbol Generator (4 x 6 Matrix)

Gary H. Sanders, Columbia Radiation Laboratory, New York City, New York

The subroutine may be called to write a string of characters, a pair of characters, or a single character on an oscilloscope. Seventy (octal) symbols in ASCII Trimmed Code and four special "format" commands are acceptable to this

routine. The program is operated in a fashion similar to the DEC Teletype Output Package.

DECUS No. 5/8-23B

PDP-5/8 Oscilloscope Symbol Generator (5 x 7 Matrix)

Larry T. Gell, Center for Visual Science, University of Rochester, Rochester, New York

This subroutine may be called to write a string of characters, a pair of characters, or a single character on a 34D Oscilloscope. Twenty-six alphabetic characters and  $\emptyset - 9$  numeric characters are acceptable. However, there is space available to include any symbol the user desires. The program is operated in a fashion similar to the DEC Teletype Output Package.

Source Language: MACRO-8

Storage 200g-777g registers

DECUS No. 5-24

Vector Input/Edit

Elayne R. Rubinoff, Don Goelman, and Mark J. Flomenhoff, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pennsylvania

Accepts input to a PDP-5 and allows both time-of-entry and post time-of-entry corrections.

DECUS No. 5-25

A Pseudo Random Number Generator

Olr Jacobs, University of Edinburgh, Edinburgh, Scotland

The random number generator subroutine, when called repeatedly, will return a sequence of 12-bit numbers which, though deterministic, appears to be drawn from a random sequence uniform over the interval 0000g to 7777g. Successive numbers will be found to be statistically uncorrelated. The sequence will not repeat itself until it has been called over 4 billion times.

DECUS No. 8-26A

Compressed Binary Loader (CBL)

Michael S. Wolfberg, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pennsylvania

The CBL (Compressed Binary Loader) format in contrast to BIN format utilizes all eight information channels of the tape, thus achieving nearly 25% in time savings.

Whereas BIN tapes include only one checksum at the end of the tape, CBL tapes are divided into many independent blocks, each of which includes its own checksum. Each

DECUS No. 8-26A (Continued)

block has an initial loading address for the block and a word count of the number of words to be loaded.

The CBL loader occupies locations 7700 through 7777.

DECUS No. 8-26B

CBC (BIN to CBL) and CONV (CBL to BIN)

Charles Kapps and Mark J. Flomenhoft, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pennsylvania

Two conversion programs which use the PDP-8 on-line Teletype to read a binary tape in one format and punch a binary tape in the other format. The conversion programs both ignore memory field characters so that the output is a tape for memory field 0.

DECUS No. 8-26C

XCBL - Extended Memory CBL Loader

Michael S. Wolfberg, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pennsylvania

XCBL is used to load binary tapes punched in CBL format into a PDP-8 with more than standard 4K memory. This loader occupies locations 7670 through 7777 of any memory field.

DECUS No. 8-26D

XCBL Punch Program

Michael S. Wolfberg, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pennsylvania

This program permits a user to prepare an XCBL tape of portions of a PDP-8 extended memory through the control of the keyboard of the on-line Teletype.

The program is loaded by the BIN Loader.

There are two versions of the program so that any section of memory may be punched:

LOW XCBL occupies 00000 - 00377  
and its starting address is 00000.

HIGH XCBL occupies 17200 - 17577  
and its starting address is 17200.

The program may be restarted at the starting address at any time.

One option is provided according to the setting of bit 0 of the Switch Register. If bit 0 is a ONE, the operation of XCBL PUNCH is similar to that of DDT-UP (DECUS No. 8-19a).

DECUS No. 5/8-27 and 5/8-27a

Bootstrap Loader and Absolute Memory Clear

Willard Crittenden, Ann Arbor Computer Corporation, Ann Arbor, Michigan

Bootstrap Loader inserts a bootstrap loading program in page 0 from a minimum of toggled instructions.

Absolute Memory Clear leaves the machine in an absolutely clear state and, therefore, cycling around memory obeying an AND instruction with location zero. Should not be used unless one plans to re-insert the loader program.

DECUS No. 5/8-28a

PAL III Modifications - Phoenix Assembler

Terrel L. Miedaner, Space Astronomy Laboratory, Madison, Wisconsin

This modification of the PAL III Assembler speeds up assembly on the ASR-33/35 and operates only with this I/O device. Operation is essentially the same as PAL III, except that an additional pass has been added, Pass 0. This pass, started in the usual manner, but with the switches set to zero, reads the symbolic tape into a core buffer area. Subsequent passes then read the tape image from storage instead of from the Teletype.

DECUS No. 5/8-29

BCD to Binary Conversion Subroutines

Terrel L. Miedaner, Space Astronomy Laboratory, Madison, Wisconsin

These two subroutines improve upon the DEC-supplied conversion routine. Comparison cannot be made to the DECUS-supplied fixed-time conversions, 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 -  $\mu$ sec. machine.

Minimal time routine: 73.6  $\mu$ sec/32 locations

Minimal storage routine: 85  $\mu$ sec/29 locations

DEC Routine: 64-237  $\mu$ sec/37 locations

DECUS No. 5-30

GENPLOT - General Plotting Subroutines

M. Adamowicz, Department of Electrical Engineering, New York University, New York City, New York

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.

DECUS No. 5-31

FORPLOT - FORTRAN Plotting Program for the PDP-5

Jerome Feder, Department of Electrical Engineering,  
New York University, New York City, New York

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 0000g to 4177g. 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 comment on these are filtered out.

DECUS No. 5/8-32a

Program to Relocate and Pack Programs in Binary Format

J. W. Bowman, Atomic Energy of Canada Ltd., Chalk River, Ontario, Canada

Provides a means to shuffle machine language programs around in memory to make the most efficient use of computer store.

DECUS No. 5/8-33

Tape to Memory Comparator

Milton Collins, Teradyne, Boston, Massachusetts

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. Presently uses high-speed reader, but may be modified for TTY reader.

DECUS No. 5-34

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

P. T. Brady, Department of Electrical Engineering,  
New York University, New York City, New York

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 to 7403

DECUS No. 5/8-35

BCD to Binary Conversion Subroutine and Binary to BCD Subroutine (Double Precision)

Selene H. C. Weise, Bermuda Press Ltd., Hamilton, Bermuda

This program consists of a pair of relatively simple and straightforward double-precision conversions.

DECUS No. 5-36

Octal Memory Dump Revised

Paul Hammond, Woods Hole Oceanographic Institution,  
Woods Hole, Massachusetts

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 78<sub>10</sub> 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

Paul Hammond, Woods Hole Oceanographic Institution,  
Woods Hole, Massachusetts

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. 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. Transfer II enables more extensive use of memory banks.

DECUS No. 5/8-38

FTYPE - Fractional Signed Decimal Type-In

P. T. Brady, Department of Electrical Engineering,  
New York University, New York City, New York

Enables a user to type fractions of the form: 582, - 73,

DECUS No. 5/8-38 (Continued)

etc., which will be interpreted as sign plus 11 bits (e.g., 0.5=2000<sub>8</sub>). Subroutine reads into 300-3177 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

P. T. Brady, Department of Electrical Engineering, New York University, New York City, New York

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 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)

Information Control Systems, Inc., Ann Arbor, Michigan

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.

DECUS No. 5-41

Breakpoint

Arthur R. Miller, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

This debugging routine has been reduced to a minimum operation. It is a mobile routine which can operate around any program that leaves an extra 30 cells of memory space.

Its function is to insert break points in any given location of the program being debugged, and to hold the contents of AC and Link. The programmer may examine any locations desired and then continue to the next breakpoint. It is presently located in 140<sub>8</sub> - 170<sub>8</sub>, but may be easily relocated.

DECUS No. 5-42

Alphanumeric Input

Paul D. Hammond, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

With the Alphanumeric Input Package, any character may

be read into the PDP-5 through either the Teletype or the high-speed reader. The characters are packed two/cell and stored in the address indicated in the switch register.

DECUS No. 5/8-43

Unsigned Octal - Decimal Fraction Conversion

Frank Ollie, Defence Research Telecommunications Establishment, Ottawa, Ontario, Canada

This routine accepts a four-digit octal fraction in the accumulator and prints it out as an N-digit decimal fraction where N=12 unless otherwise specified. After N digits, the fraction is truncated. Programs are included for use on the PDP-5 with Type 153 Automatic Multiply-Divide and the PDP-8 with Type 182 Extended Arithmetic Element.

Storage requirements: 55 Octal locations for the PDP-5. 47 Octal locations for the PDP-8.

DECUS No. 8-44

Modifications to the Fixed Point Output in the PDP-8 Floating Point Package (Digital 8-5-S)

A. R. McKenzie, Data Systems Division, Standard Telephone & Cables Ltd. England

The Floating Point Package ( Digital 8-5-S) includes an Output Controller which allows output in fixed point as well as floating point format. This Output Controller takes the form of a certain number of patches to the "Floating Output E Format" routine, plus an additional page of coding.

Using the Calculator program (Digital 8-10-S), which includes the Floating Point Package, certain deficiencies were noted in the fixed-point output format, particularly the lack of any automatic rounding off. For example, the number 9, if outputted as a single digit, appears as 8. Modification attempts to provide automatic rounding off resulted in the Output Controller being completely rewritten with minor changes in the format.

This new version of the Output Controller is also in the form of patches to the Floating Output with an additional page of coding, thereby not increasing the size of the Floating Point Package.

The following summarizes this new version:

1. The number output is automatically rounded off to the last digit printed, or the sixth significant digit, whichever is reached first. Floating point output is rounded off to six significant figures since the seventh is usually meaningless.
2. A number less than one is printed with a zero preceding the decimal point (e.g., "+0.5" instead of "+.5").
3. A zero result, after rounding off, is printed as "+0" instead of "+".
4. The basic Floating Point Package includes the facility to



DECUS No. 8-44 (Continued)

specify a carriage return/line feed after the number using location 55 as a flag for this purpose. The patches for the Output Controller caused this facility to be lost. This version restores this facility.

DECUS No. 5/8-45

PDP-5/8 Remote & Time-Shared System

James Miller, Dow Badische Chemical Company, Freeport, Texas

A time-shared programming system which allows remote stations immediate access to the computer and a wide selection of programs.

DECUS No. 5/8-46a

PDP-5/8 Utility Programs

Edward Della Torre, American-Standard, Princeton, New Jersey

Consists of seven programs (listed below) each of which may be selected via the teletypewriter. When the program is started, either by a self-starting binary loader or by manually starting the computer in address 200(g), it is in its executive mode. In this mode, it will respond only to eight keys and perform the following functions.

- B - go to BIN to QK Converter Program
- E - go to Editor Program
- F - FORTRAN tape formatter
- L - type a section of leader and stay in executive
- N - go to Editor program without typing leader
- P - go to Page Format Program
- T - Assembly language tape formatter
- Q - go to QK to BIN Converter Program

DECUS No. 8-47

ALBIN - A PDP-8 Loader for Relocatable Binary Programs

J. L. Visschers, P. U. ten Kate and M. A. A. Sonnemans, Instituut Voar Kernfysisch Onderzoek (IKO), Amsterdam, The Netherlands

ALBIN is a simple method for constructing relocatable binary formatted programs, using the PAL III Assembler. Allocation of these programs can be varied in units of one memory page (128<sub>10</sub> registers). When loading an ALBIN program, the actual absolute addresses of indicated program elements (e.g., the keypoint of subroutines) are noted down in fixed program-specified location on page zero. In order to make a DEC symbolic program suitable for translation into its relocatable binary equivalent, minor changes are required which, however, do not influence the length of the program. Due to its similarity to the standard DEC BIN loader, the ALBIN loader is also able to read-in normal DEC binary tapes. ALBIN requires 122<sub>10</sub> locations, RIM loader included. Piling-up in core memory of ALBIN programs stored on conventional or DECtape can be achieved using the same method with some modifications.

DECUS No. 5/8-48

Modified Binary Loader MKIV

R. Ward, American-Standard Research Division, New Brunswick, New Jersey

The Mark IV Loader was developed to accomplish four objectives:

1. Incorporate the self-starting format described in DECUS 5/8-27, ERC Boot.
2. Select the reader in use, automatically, without switch register settings.
3. Enable a newly-prepared binary tape to be checked prior to loading by calculating the checksum.
4. Reduce the storage requirements for the loader so that a special program would fit on the last page of memory with it.

DECUS No. 8-49

Relativistic Dynamics

G. Sharman, Southampton University, Southampton, England

Prints tables for relativistic particle collisions and decay in the same format as the Oxford Kinematic Tables. It can be used in two ways:

1. Two-particle Collisions - Given the masses of incident, target, and emitted particles, the incident energy and centre-of-mass angles, the program calculates angles and energies of the emitted particles in the Lab frame. If the process is forbidden energetically, program outputs "E" allowing the threshold energy to be found.
2. Single Particle Decays - By specifying  $M_2 \neq 0$  (target), the problem will be treated as a decay, and similar tables to the above will be printed.

DECUS No. 5/8-50

Additions to Symbolic Tape Format Generator (DEC-8-21-4)

Richard Merrill, Digital Equipment Corporation, Maynard, Massachusetts

Performs further useful functions by the addition of a few octal patches. By making the appropriate octal patches via the toggles, the Format Generator can also format FORTRAN tapes, shorten tape by converting space to tabs, and convert the type of tape.

A short binary tape may be made and added on to the end of 8-21-U to "edit" an original tape that was punched off-line

The rubout character will cause successive deletion of the

DECUS No. 5/8-50 (Continued)

previous characters until the last C. R. is reached but not removed. The use of "←" will cause the current line to be restarted. Thus an input tape maybe prepared off-line with-out attention to format spacing, mistakes corrected as they occur, and finally passed through the Format Generator to create a correctly formatted, edited, and line-fed tape on either rolled or fanfold paper tape.

DECUS No. 5/8-51

Character Packing and Unpacking Routines

Richard Merrill, Digital Equipment Corporation, Maynard, Massachusetts

ASCII characters may be packed two to a word and recovered. Control characters are also packable but are preceded by a 37 before being packed into the buffer. The two programs total  $63_{10}$  words.

DECUS No. 8-52

Tiny Tape Editor

Richard Merrill, Digital Equipment Corporation, Maynard Massachusetts

This Tiny Tape Character Editor fits in core at the same time as the PAL III or MACRO-8 assemblers. A tape may be duplicated at three speeds and stopped at any character for insertion or deletion. The toggle switches control the speed and the functions desired.

The program occupies  $72_{10}$  registers.

DECUS No. 5/8-53

COPCAT

Russell Winslow, Digital Equipment Corporation, Maynard, Massachusetts

COPCAT is a tape to tape copy routine for the PDP-5 and PDP-8 DEctape (552 Control).

DECUS No. 5/8-54

Tic-Tac-Toe Learning Program - T<sup>3</sup>

Michael Green, Stevens Institute of Technology, Hoboken, New Jersey

This program plays Tic-Tac-Toe basing its moves on stored descriptions of previously lost games. The main program is written in FORTRAN. There is a short subroutine written in PAL II used to print out the Tic-Tac-Toe board. The program comes already educated with about 32 lost games stored. Requires FORTRAN Object Time System.

DECUS No. 5/8-55

PALEX - An On-Line Debugging Program for the PDP-5/8

Robert Berger, Bell Telephone Laboratories, New York, New York

One problem with programs written in Program Assembly Language (PAL) for operation on a PDP-5/8 computer is the danger of an untested program being self-destructive, running wild, destroying other programs residing in memory such as loading programs. PALEX prevents any of the above unwanted operations from occurring while it gives the operator-programmer valuable debugging information and enables him to make changes in his program and try out the modified program. Once running, PALEX cannot be destroyed by any program or instruction in memory, the operator need not touch any manual console controls, and all required information is printed in easy-to-read format on the Teletype console.

DECUS No. 8-56

Fixed Point Trace No. 1

B. J. Biavati, Columbia University, New York, New York

A minimum size monitor program which executes the users program one instruction at a time and reports the contents of the program counter, the octal instruction, the contents of the accumulator and link and the contents of the effective address by means of the ASR-33 Teletype. Storage Requirements: two pages.

DECUS No. 8-57

Fixed Point Trace No.2

B. J. Biavati, Columbia University, New York, New York

Similar to Fixed Point Trace No. 1 except that the symbolic tape provided has a single origin setting instruction of (6000). Any four consecutive memory pages can be used, with the exception of page zero, by changing this one instruction.

DECUS No. 8-58

One-Page DEctape Routine (552 Control)

Submitted by : Massachusetts Institute of Technology, Boston, Massachusetts

A general-purpose program for reading, writing, and searching of magnetic tape. This program was written for the Type 552 Control. It has many advantages over both the standard DEC routines and also over the DECUS No. 5-46. The routines are one page long and can be operated with the interrupt on or off. The DEC program delays the calling program while waiting for the unit and movement delays to time-out. This routine returns control to the calling program. This saves 1/4 seconds every time the tape searches forward and half that time when it reverses. In addition, it will read and write block 0. This program is an advantage over the previous

DECUS No. 8-58 (Continued)

one-page routines in that it allows interrupt operations, doesn't overflow by one location, interrupts the end zone correctly and not as an error, and provides a calling sequence identical to the DEC program.

DECUS No. 8-59

PALDT - PAL Modified for DECTape (552 Control)

George Friedman, Massachusetts Institute of Technology, Cambridge, Massachusetts

When assembling programs, PALDT requires that the symbolic tape be read in only once. The program writes on the library tape itself after finding the next available block from the directory. During pass 0 the tape is read in using the entire user's symbol table. During passes 1,2,3, as much of the symbol table is used as possible. This means the fewest tape passes as possible. As an added advantage pass 0 ignores blank tape, leader-trailer, line feeds, for feeds, and rub outs; saving space. The whole program decreases the users symbol table by only three pages: one for the DECTape program above, one for pass 0, and one for the minimal length read in buffer.

DECUS No. 8-60

Square Root Function by Subtraction Reduction

George Friedman, Massachusetts Institute of Technology, Cambridge, Massachusetts

A single precision square root routine using EAE. This routine is usually faster than the DEC routine and can easily be modified for double precision calculation at only twice the computation time.

DECUS No. 8-61

Improvement to Digital 8-9-F Square Root

George Friedman, Massachusetts Institute of Technology, Cambridge, Massachusetts

An improved version of the DEC Single Precision Square Root Routine (without EAE). Saves a few words of storage and execution is speeded up 12 per cent.

DECUS No. 8-62

High-Speed Reader Option for FORTRAN Compiler

(Obsolete - See DECUSCOPE Volume 6 No. 5, Digital PDP-8 FORTRAN)

DECUS No. 5-63

SBUG-4

Robert LaFore, Lawrence Radiation Laboratory, Berkeley, California

SBUG-4 allows the PDP-5 to execute one instruction of any given program at a time, returning to SBUG-4 following each instruction and printing out the contents of various registers. This permits following the path of a program which has gone astray or examining some defective operation.

DECUS No. 5/8-64

DECTape Programming System

Submitted by: DEC Software Services Group, Digital Equipment Corporation, Maynard, Massachusetts

This program provides rapid access to DEC software and utilizes routines through the use of DECTape. Programs may be stored, edited, assembled, listed, or executed without reliance upon paper tape.

May be used with both TCØ1 and 552 DECTape Controls.

DECUS No. 8-65

A Programmed Associative Multichannel Analyser

G. C. Best, Atomic Energy Research Establishment, Harwell, England

The program describes the use of a small computer as an associative analyser with special reference to the PDP-8. The advantages and limitations of the method are discussed in the write-up, and general program algorithms are presented.

DECUS No. 8-66

Editor Modified for DECTape

Robin B. Wadleigh, Johns Hopkins University, Baltimore, Maryland

This program consists of modifications to the Digital 8-1-S Symbolic Editor to enable reading and writing on DECTape. This results in considerable time savings in assembling PAL programs since PAL has also been modified to accept the symbolic program directly from DECTape. The DECTape compatibility is also useful for storing text for later use and for regaining Editor memory space lost due to delete and change commands.

DECUS No. 8-66 (Continued)

In addition, the overflow detection routine is now foolproof and results in a HALT.

Storage: Editor <Ø, 1461>

Modifications: <1462, 1502> <6376, 7177>

DECtape Routines: <72ØØ, 7577>

Equipment: PDP-8 with EAE, ASR-33, DECtape

DECUS No. 8-67

PAL Modified for DECtape Input

Robin B. Wadleigh, Johns Hopkins University, Baltimore, Maryland

This program consists of modifications to the Digital 8-3L-5 PAL Assembly Program to enable it to obtain the symbolic program to be assembled from DECtape (in addition to paper tape), outputting the assembled program in the usual manner. (The symbolic program is written onto DECtape by use of the "Editor Modified for DECtape" Program.) The modification also makes it possible to assemble sections of programs in any order, and to intersperse sections or commands from the keyboard with those from DECtape. The resulting assembly is limited in speed mainly by the punching of the assembled program during Pass 2, and Pass 1 is speeded considerably. The modifications also include a tabulator interpreter, so that Pass 3 listings are produced in tabulated format.

Storage: PAL III <Ø, 3561> plus symbol table  
Modifications <6555, 7177>  
DECtape Routines <72ØØ, 7577>

Equipment: PDP-8 with EAE, ASR-33, DECtape

DECUS No. 8-68A

LABEL Program (Teletype Punch)

Michael S. Wolfberg, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pennsylvania

The LABEL Program punches labels for paper tapes on the Teletype punch. When a key on the Teletype keyboard is depressed, no echo is performed, but a few characters of tape are punched which form the outline of the character associated with the key. Outlines are punched for all characters whose code is between 240 and 337.

All characters have a width of 5 lines of tape and a height of 6 columns. Column 7 of the tape is never punched and column 8 is always punched, so that the labels are underlined. Three extra lines are normally punched between each character to provide separation. The user may alter the number of separation lines by depressing one of the control keys at any time.

The program occupies locations 200 through 677 of any memory field, (locations 400-677 of Readable Punch, DECUS No. 8-106).

DECUS No. 5/8-69

LESQ29 and LESQ11

Michael W. King, Phillips Petroleum Company, Idaho Falls, Idaho

The purpose of the program is to fit the best sequences of parabolas to a given 400 point data curve in order to remove extraneous noise; rather than rely on a single 400 point parabola least squares fit to approximate a given data curve. Approximately 400 individual parabolas are computed as follows.

LESQ29

Data values 1 through 29 are subjected to a second order Least Squares fit. The median point of the resulting parabola (point #15) is then substituted for the original data value #15.\*

A second parabola is then computed using data values 2 through 30. The median point of this parabola (point #16) is then substituted for point #16 of the original data curve.

This procedure is repeated until all data values have been replaced (except for the first and last 14 points which are excluded by the mechanics of the operation).

LESQ11

Process identical to LESQ29 except that an 11 rather than a 29 point smooth interval is used. First point replaced is point #6, and only the first and last 5 points are excluded from smoothing.

LESQ11 will preserve higher frequency data than LESQ29 for a given data curve with constant time between data points.

Minimum Hardware: 4K Memory PDP-5 or PDP-8, Teletypewriter (plotter, DECtape optional)

Other Programs Needed: Floating Point Package and appropriate data handling routines.

Storage Requirements: (LESQ11: 400-564; 700-716)  
(LESQ29: 400-564; 700-751)

Execution Time: (PDP-5) LESQ11: 1 minute.  
LESQ29: 2.5 minutes.

Restrictions: Positive integer data <3777g; time between data points constant.

\*See B. J. Power, R. N. Hagen, S. O. Johnson, "SPORT, A System for Processing Reactor Transient Data on the IBM-7040 Computer," pp. 4-8, AEC Research and Development

DECUS No. 5/8-69 (Continued)

Report (IDO-17078), Available from: The Clearinghouse for Federal Scientific and Technical Information, National Bureau of Standards, U. S. Department of Commerce, Springfield, Virginia.

DECUS No. 8-70

EAE Routines for FORTRAN Operating System (DEC-08-CFA3)

Russell B. Ham, U. S. Public Health Service, Winchester, Massachusetts

These are two binary patches to the FORTRAN Operating System which utilizes the Type 182 EAE hardware for single precision multiplication and normalization, replacing the software routines in FOSSIL (the operating system). The binary tape is loaded by the BIN Loader after FOSSIL has been loaded. Execution time of a Gauss-Jordan matrix inversion is reduced by approximately 30%.

Minimum Hardware: PDP-8 with Type 182 EAE

Other Programs Needed: FORTRAN Operating System (DEC-08-CFA3-PB) dated March 2, 1967

DECUS No. 8-71

Perpetual Calendar

E. Singer, McGill University, Montreal, Quebec, Canada

The program is designed as a computer demonstration. When a valid date is fed into the computer, the corresponding day of the week is typed out. If an invalid date is given, "YOU GOOFED, TRY AGAIN" is typed out. The program is based on the Gregorian Calendar and is, therefore, limited to years between 1500 and 4095. The upper limit being due to the computer's capacity. Storage: 20 - 1333

Minimum Hardware: 4K storage, ASR-33 Teletype

DECUS No. 8-72

Matrix Inversion - Real Numbers

A. E. Sapega, Trinity College, Hartford, Connecticut

The program inverts a matrix, up to size  $12 \times 12$ , of real numbers. The algorithm used is the Gauss-Jordan method. A unit vector of appropriate size is generated internally at each stage. Following the Gauss sweep-out, the matrix is shifted in storage, another unit vector is generated, and the calculation proceeds.

Other Programs Needed: FORTRAN Compiler and FORTRAN Operating System

Storage: This program uses essentially all core not used by the FORTRAN Operating System.

Execution Time: Actual computation takes less than 10 seconds. Data read-in and read-out may take up to five minutes.

DECUS No. 8-73

Matrix Inversion - Complex Numbers

A. E. Sapega, Trinity College, Hartford, Connecticut

The program inverts a matrix, up to size  $6 \times 6$ , of complex numbers. The algorithm used is the Gauss-Jordan method, programmed to carry out complex number calculations. A unit vector of appropriate size is generated internally. Following the Gauss sweep-out, the matrix is shifted, another unit vector is generated, and the calculation proceeds. The print-out of the matrices uses the symbol J to designate the imaginary part, e.g.  $A = a + jb$ .

Other Programs Needed, Storage, etc. - Reference DECUS No. 8-72

DECUS No. 8-74

Solution of System of Linear Equations:  $AX = B$ , by Matrix Inversion and Vector Multiplication

A. E. Sapega, Trinity College, Hartford, Connecticut

This program solves the set of linear algebraic equations  $AX = B$  by inverting matrix A using a Gauss-Jordan method. When the inverse matrix has been calculated, it is printed out. At that point, the program requests the B-vector entries. After read-in of the B-vector, the product is computed and printed out. The program then loops back to request another B-vector, allowing the system to solve many sets of B-vectors without the need to invert matrix A again. Maximum size is  $8 \times 8$ .

Other Programs Needed, Storage, etc. - Reference DECUS No. 8-72

DECUS No. 8-75

Matrix Multiplication - Including Conforming Rectangular Matrices

A. E. Sapega and Chester Sic, Trinity College, Hartford, Connecticut

This program multiplies two matrices, not necessarily square but which conform for multiplication.

Other Programs Needed, Storage, etc. - Reference DECUS No. 8-72

Author's comments regarding the four matrix routines: DECUS Nos. 8-72, -73, -74, -75.

"Each program has been written in FORTRAN for use on the basic PDP-8. The printed output of each program has been organized to efficiently and effectively use the Teletype, yet maintain a readable and meaningful output format. This

### DECUS No. 8-75 (Continued)

has been done at the expense of optimizing storage requirements. Thus, each program may be changed to handle slightly larger cases by cutting down on the printout information. Since the source programs are in FORTRAN, a user may readily change the program to suit his own requirements.

"Another common feature of each program is a printout of the input data from core. This has been found desirable for checking that data was read in properly, and for purposes of having an accurate record of a given calculation. Also, since each program requires a large amount of data input, it is suggested that a data tape be made prior to running the program.

"The matrix inversion scheme used is straightforward and gives good results on run-of-the-mill matrices. However, error build-up is quite rapid on an ill-conditioned matrix. This is partly due to errors in the fifth and sixth decimal place caused by the floating point conversion at read-in time, and also to the limited mantissa carried in the PDP-8 floating point word."

### DECUS No. 8/85-76

#### PDP NAVIG 2/2

M. Talwani and J. Dorman, Lamont Geological Observatory, Columbia University, Palisades, New York

This program utilizes the output of the U.S. Navy's AN/SRN-9 satellite navigation receiver to obtain fixes on a PDP-8 or PDP-8/S. This program, except for some details of input and output, follows very closely NAVIG2 written for the IBM 1620 which in turn is derived from the TRIDON program written at the Applied Physics Laboratory of Johns Hopkins University for the IBM 7090.

PDP NAVIG 2/2 is written in PAL III for a 4096 core machine using the ASR-33. Floating point numbers using two 12-bit words as mantissa and one 12-bit word as exponent are employed. The accuracy is slightly less than that using 7 decimal digits per word.

### DECUS No. 8/85-77

#### PDP-8 Dual Process System

Richard M. Merrill, Digital Equipment Corporation, Maynard, Massachusetts

The purpose of this system is to expedite the programming of multiprocessing problems on the PDP-8 and PDP-8/S. It maximizes both the input speed and the portion of real time actually used for calculations by allowing the program to run during the intervals between issuing I/O commands and the raising of the device flag to signal completion of the command. The technique also allows queuing of input data or commands so that the user need not wait while his last line is being processed, and so that each line of input may be processed as fast as possible regardless of its length. The system uses the interrupt facilities and has less than 3%

overhead on the PDP-8/S (about .1% on the PDP-8).

This method is especially useful for a slower machine where the problem may easily be calculation limited but would, without such a system, become I/O bound.

The program may also be easily extended to handle input from an A/D converter. Here, the input would be buffered by groups of readings terminated either arbitrarily in groups of N or by zero crossings.

The system requires 600g registers for two TTY's plus buffer space. Several device configurations are possible.

This program can increase the I/O to computation efficiency of some programs by 100%. It can do this even for single Teletype. Each user will probably want to tailor the program to his individual needs.

### DECUS No. 8-78

Diagnose: A Versatile Trace Routine for the PDP-8 Computer with EAE

Keith B. Oldham, North American Aviation Science Center, Thousand Oaks, California

This trace routine will track down logical errors in a program (the "sick" program). Starting at any convenient location in the "sick" program, instructions are executed, one at a time, and a record of all operations is printed out via the Teletype. To avoid tracing proven subroutines, an option is provided to omit subroutine tracing. The present routine is significantly more versatile than two other trace routines in the DECUS library (DECUS Nos. 8-56 and 8-57 - Biavati) for the PDP-8 in that it is able to trace "sick" programs containing floating-point, extended arithmetical, and a variety of input/output instructions. Diagnose is, however, at a disadvantage compared with Biavati's first routine (DECUS No. 8-56) in requiring more memory space (five pages as opposed to two); and compared with his second routine (DECUS No. 8-57) in not possessing the trace-suppression features of the latter. The mode of operation of Diagnose is quite different from that of the trace routines of Biavati.

Minimum Hardware: PDP-8 with EAE

Other Programs Needed: Floating Point Package needed for floating point tracing.

Miscellaneous: Program is Relocatable

### DECUS No. 8-79

TIC-TAC-TOE (Trinity College Version)

Gunnar Walmet, Trinity College, Hartford, Connecticut

This TIC-TAC-TOE game is programmed, using internal logic, so that the computer will either win or stalemate, but not lose a game. Either the player or the computer may choose to go first. At the termination of a game, the program restarts for the next game by typing anew the grid code to be followed.

## DECUS No. 8-80

### Determination of Real Eigenvalues of a Real Matrix

A. E. Sapega, Trinity College, Hartford, Connecticut

This is a two-part program for determining the real eigenvalues of a real-valued matrix. The matrix does not have to be symmetric. Part I uses the power method of iterating on an eigenvector to determine the largest eigenvalue of the matrix. Part II then deflates the matrix using the results of Part I so as to produce a matrix of order one less than that solved for in Part I. Part I can then be reloaded, and the next eigenvalue in line may be calculated. In this, all the real eigenvalues may be computed in order.

## DECUS No. 8-81

### A BIN or RIM Format Data or Program Tape Generator

R. F. Templeman, The Physical Laboratories, The University, Manchester, England

This program enables a PDP-8 operator to generate tapes under Teletype control in RIM or PAL BIN format without formal assembly, assuming the operator knows the octal codes corresponding to each instruction. This is particularly useful when one is dealing with small programs for testing interface equipment or when making small modifications to large programs when one does not wish to spend time reassembling the whole program. Often during program debugging, changes are repeatedly toggled into core manually, which leaves no permanent record of the changes made and is prone to error. Tapes generated using this program can be appended to existing BIN or RIM tapes and can then be loaded with the original tape into core with the appropriate loader. Another use of this program is in the preparation of data tapes in RIM or BIN format so that data can be loaded straight into PDP-8 core via the usual loaders. The program also generates leader/trailer code and a checksum under program control.

Storage: Program occupies locations 6000-6077.

## DECUS No. 8-82

### Library System for 580 Magnetic Tape (Preliminary Version)

G. Sharmon, University of Southampton, England

The system provides for storing program files (or other files) on the 580 Magnetic Tape with PDP-8, and recalling them at will without altering the state of the rest of the computer. In general principle, it is similar to the DECtape Library System, and the only effective storage requirement is the last page of memory.

At present, the system consists of three programs known as BOOTSTRAP 1, BOOTSTRAP 2, and the LIBRARY Routines.

Bootstrap 1 is a minimal loader program which resides in the last page of memory. Its function is to rewind the tape

and load Bootstrap 2 into the last page, automatically transferring control to it. Bootstrap saves the area of core to be used by the system as a record on the magnetic tape, loads the Library Routines into core, and transfers control to them.

The Library Routines comprise a Directory of the files on tape, an Input-Output package, enabling communication with the Teletype, and four system programs:

Llist	Types out the names of files in the Directory
CALL	Transfers a file into core and exits
DUMP	Writes a file on tape, rewrites the Directory, and exits
EXIT	Restores the computer to its original state, with Bootstrap 1 and BIN on the last page.

The magnetic tape subroutines and some control functions are included in Bootstrap 2. Each entry in the directory consists of three words: the name of the file, its first location in core, and the number of words it occupies. The capacity of the directory is 22<sub>10</sub> entries.

## DECUS No. 8/8S-83A and B

### Octal Debugging Package (With and Without Floating Point)

James Rothman, Digital Equipment Corporation, Maynard, Massachusetts

This program is an on-line debugger which will communicate with the operator through the ASR-33 Teletype. It allows register examination and modification, octal dumping, binary punching, multiple and simultaneous breakpoints, starting a program, and running at a particular location with preset AC and link. ODP is completely relocatable at the beginning of all pages except page zero, and is compatible with the PDP-5, the PDP-8, and the PDP-8/S.

Requirements: The high version of ODP requires locations 7000-7577. The low version requires locations 0200-0777. All versions will require three pages. Also, location 0002 is used for a breakpoint pointer to ODP.

Equipment: The standard PDP-8 with ASR-33 Teletype is required. A high-speed punch is optional.

## DECUS No. 8-84

### One-Pass PAL III

Krause and Riedl, Siemens, Erlangen, Germany

This is a modification to Digital 8-3L-5. It is for use on an 8K PDP-8 with ASR 33. The principle of the modification is to store the incoming characters during Pass 1 into the memory extension and to take them from there during Pass 2 and 3. Source programs must be limited to 4095 characters. This modification can save about 40% of assembly time.

DECUS No. 8-84 (Continued)

Operation of the program is the same as for PAL III except that the reading of the source program for Pass 2 and 3 need not be repeated. For these passes, one simply presses CONTINUE after setting the correct switches.

Restriction: The program does not work with high-speed reader and punch.

DECUS No. 5/8-85

Set Memory Equal to Anything

Roy S. Taylor, Department of Defense, Fort Meade, Maryland

This program will preset all locations to any desired settings. Thus, combining a memory clear, set memory equal to HALT, etc. into a single program. The program is loaded via the switch registers into core.

DECUS No. 8-86

Obsolete

DECUS No. 8-87

XMAP

Curtis Jansky and Robert B. Brown, Communications Systems, Inc., Paramus, New Jersey

This program types on TTY keyboard the contents of the DEC-tape directory. The list includes the name of the program, its initial block number, the amount of blocks used, the starting address and the location(s) of the program in core. The above restriction is only a format restriction due to the line length on the TTY unit. At present, this program is operational only with the TCØ1 control; however, the symbolic version may be modified for use with the 552 control.

Storage: 0000-1232, 6000-6577 (directory)

Restrictions: Each program on tape is assumed to occupy no more than three successive sequences of memory pages.

DECUS No. 8-88

DECTape Symbolic Format Generator

Jack Harvey, Communications Systems, Inc., Paramus, New Jersey

These are DECTape versions of the Symbolic Tape Format Generator, Digital 8-21-U, that operate under the DECTape Programming System, DECUS 5/8-64. They provide neat formats for symbolic files generated with XEDIT, and a means to get symbolic programs out on paper. They compact a program containing extra spaces and give the number of

blocks actually used in the output file. The library tape is executable on TCØ1 equipment only, but the write-up gives instructions for altering it for 552 equipment.

Other programs needed: XRDCT, XWDCT, XBUFF  
(DECUS 5/8-64)

Storage: 0-4777(8)

DECUS No. 8-89

XOD - Extended Octal Debugging Program

Michael S. Wolfberg, The Moore School of Electrical Engineering, Philadelphia, Pennsylvania

XOD is an octal debugging program for a PDP-8 with extended memory which preserves the status of program interrupt system at breakpoints. The program occupies locations 6430 through 7577 of any memory field.

From the on-line Teletype, the user can examine and modify the contents of any memory location. Positive and negative block searches with a mask may be also be performed.

XOD includes an elaborate breakpoint facility to help the user run sections of his program. When this facility is used, the debugger also uses locations 0005, 0006, and 0007 of every memory field.

The ability to punch binary tapes is not included in XOD.

DECUS No. 5/8-90

Histogram on Teletype

J. B. Levin, University of Arizona, Tucson, Arizona

This routine provides a means of plotting histograms on the Teletype when there is no CRT display available or of making a permanent copy of a CRT display. Input to the routine consists of a vertical scaling factor, the size of the table to be plotted (limited only by the size of the Teletype print line), the starting address of two core areas: one containing the data to be plotted, and one for use as temporary storage by the machine.

Storage: 128<sub>10</sub> words plus tables

DECUS No. 8-91

MICRO-8: An On-Line Assembler

K. F. Kinsey, State University of New York, Geneseo, New York

M. E. Nordberg, Jr., Cornell University, Ithaca, New York

Micro-8 is a short assembler program for the PDP-8 that translates typed mnemonic instructions into the appropriate binary code and places them in specified memory locations



DECUS No. 8-91 (Continued)

immediately ready to function. It processes the typed instructions by a table-lookup procedure.

It is especially useful for programs of less than one page which are to be run immediately. Only octal (not symbolic) addresses may be specified, but the user has control of the zero page and indirect addressing bits. An octal typeout routine permits examination of any memory location.

Storage: 3200 - 4200

Restrictions: Micro-8 is quite capable of modifying itself.

DECUS No. 8-92

Analysis of Pulse-Height Analyzer Test Data With A Small Computer

E. McDaniel and J. W. Woody, Jr., Oak Ridge National Laboratory, Oak Ridge, Tennessee

This PDP-8 computer program is used in the evaluation of test data for multichannel pulse-height analyzers. The program determines integral and differential non-linearities and examines smooth spectra of radioactive decay.

DECUS No. 8-93

CHEW - Convert Any BCD to Binary - Double Precision

Louis O. Cropp, Sandia Corporation, Albuquerque, New Mexico

This subroutine converts a double precision (6 digit) unsigned-integral-binary coded decimal (BCD) number with bit values of 4, 2, 2, and 1 to its integral-positive-binary equivalent in two computer words. It is possible to change the bit values to any desired values and thereby convert any BCD number to binary.

Storage: 0109<sub>10</sub>

DECUS No. 8-94A

BLACKJACK

Dennis J. Frailey, Ford Motor Company, Dearborn, Michigan

This program enables a person to play Blackjack with the computer. The computer acts as dealer and keeps track of bets, cards played, etc.

Storage: 0 - 3777<sub>8</sub>

DECUS No. 8-94B

Patch for BLACKJACK

Steven L. Bard, U. S. Army Nuclear Defense Laboratory, Edgewood Arsenal, Maryland

This patch contains two overlays for the Blackjack Program (DECUS No. 8-94A). The first eliminates the need for the EAE hardware, the second allows one to "double down" on any two cards with the instruction "D" (Ø response to "HIT?" is made invalid).

With these overlays the Blackjack Program will run on any 4K PDP-5, PDP-8, 8/S, or 8/I.

DECUS No. 8-95

TRACE for EAE

Eberhard Werner, Scripps Institution of Oceanography, University of California, San Diego, California

Trace interpretively executes a PDP-8 program. At the same time a printout is provided of the contents of the program counter, the instruction, the link, accumulator, and multiplier-quotient registers, and where applicable the effective address, and the contents of the effective address. This printout may be for all or a selected type of instruction within selected memory bounds. The program is capable of handling any PDP-8 instruction including IOT, two-word EAE, and interrupt instructions. Trace cannot be destroyed by the program being traced while Trace is in control.

Minimum Hardware: PDP-8 with Type 182 EAE, ASR-33 Teletype

Storage: 400g or 500g Locations

DECUS No. 8-96

J Bessel Function (FORTRAN)

J. A. Crawford, Communications Systems, Inc., Paramus, New Jersey

This program computes the J Bessel Function for a given argument and order. It is complete PDP-8 FORTRAN program that operates in a conversational mode.

Other Programs Needed: FORTRAN Compiler/Operating System

DECUS No. 8-97

GOOF

Pete Andrews and Charles Wagner, Fairchild R & D, Palo Alto, California

A one-page program which allows insertion of instruction

DECUS No. 8-97 (Continued)

(xxxx) in location (nnnn) by means of the TTY keyboard. A feature of automatically incrementing the current address permits rapid insertion of blocks of data or instructions. Typing "RUB-OUT" reinitializes the program.

Storage: 175g locations (1 page)

DECUS No. 8-98

3D DRAW for 338

Barry Wessler

This program is a demonstration of the capabilities of the 338 system. The program allows the user to sketch three dimensional objects on the scope and rotate them in real time. The equipment required consists of a basic 338.

DECUS No. 8-99 A

Kaleidoscope

The program creates pictures on the PDP-8 or PDP-8/S with 34D Display. They are varied by manipulating the sense switches (within the range 0000 - 0007). The program was submitted without comments by an anonymous donor.

DECUS No. 8-99 B

Kaleidoscope - 338

Michael S. Wolfberg, Moore School of Electrical Engineering, Philadelphia, Pennsylvania

The program creates varied pictures by manipulating the buttons of the 338 Display pushbutton bank (within the range 0000 - 0007). Storage: 200g - 274g.

DECUS No. 8-100

Double Precision Binary Coded Decimal Arithmetic Package

Richard M. Merrill, Digital Equipment Corporation, Maynard, Massachusetts

Consists of the following routines:

BCDADD - The single precision BCD addition routine is the basic component of the BCD arithmetic package. This routine functions simply by masking out and adding together corresponding BCD digits (i.e., four bits) and checking for carry (i.e., when the sum of two four-bit numbers is greater than 9 (1001)).

MPYBCD - This routine multiplies a single precision (three digit) number times a double precision one to produce another double precision number. Overflow is indicated in the link; the arguments are not affected.

DECUS No. 8-100 (Continued)

SUBBCD - One double precision BCD number is subtracted from a second by this routine. It uses a 9's complement routine and the double precision add routine.

DOLOUT - Special formats: ("XXXXX·YY "); ("XXXXXX "); (3 non-printing data codes); ("XXX ").

DECUS No. 8-101

Symbolic Editor With View

Barry Wessler

This program is an extended version of the standard PDP-8 Symbolic Editor (high-speed I/O) program. One extra command has been added, "V", which takes the lines specified by the arguments and displays them on the CRT (338). The program, otherwise, operates in the same way as the Editor. The following pushbutton options are provided:

- Ø: Count Up Scale
- 1: Count Down Scale
- 2: Count Up Intensity
- 3: Count Down Intensity

Minimum Hardware: 8K PDP-8 and VC-38 character generator.

DECUS No. 8-102

A LISP Interpreter For The PDP-8

Dr. G. van der Mey and Dr. W. L. van der Poel, Technical University of Delft, The Netherlands

LISP is a programming language for list manipulation. The system is particularly suitable for conversational use and teaching. There are very few restrictions to the language apart from the total storage space. The system is designed to operate on a basic 4K PDP-8 and an ASR-33 Teletype. More than half of the storage is used as list space.

DECUS No. 8-103 A

Four Word Floating Point Function Package

D.A. Dalby, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada

This program package, written for use with Digital's Four Word Floating Point Package (DEC-08-FMHA-PB), includes subroutines to evaluate square, square root, sine, cosine, arctangent, natural logarithm, and exponential functions.

DECUS No. 8-103 B

Four Word Floating Point Rudimentary Calculator

D. E. Wells, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada

## DECUS No. 8-103 B (Continued)

This is a minimum space program to perform calculations with the 10.5 decimal place precision of Digital's Four Word Floating Point Package (DEC-08-FMHA-PB), and uses the Four Word Floating Point Function Package (DECUS 8-103A). Operations are performed in the sequence in which they are entered. One storage register is provided. Up to five user-defined operation routines may be called.

## DECUS No. 8-103 C

### Four Word Floating Point Output Controller With Rounding

C. K. Ross, Bedford Institute of Oceanography,  
Dartmouth, Nova Scotia, Canada

This subprogram is almost identical to the output controller for the Three Word Floating Point Package (Digital 8-5-S) with the rounding addition (DECUS 8-44) except that the Four Word Floating Point Package (DEC-08-FMHA-PB) is used.

## DECUS No. 8-103 D

### Additional Instructions for Use With Four Word Floating Point Package

C. K. Ross, Bedford Institute of Oceanography,  
Dartmouth, Nova Scotia, Canada

These subroutines allow the Four Word Floating Point Interpreter to perform the operations: read a floating point number, skip positive floating point accumulator, skip zero floating point accumulator, no operation, unconditional jump, negate floating point accumulator, and halt. The two skip instructions and the jump instruction allow forward or backward jumping up to 15 locations from location of instruction.

## DECUS No. 8-104

### Card Reader Subroutine for PDP-8 FORTRAN Compiler

Steve Sullivan, Oregon State University, Corvallis, Oregon

Modifications and additions which allow the PDP-8 FORTRAN Compiler to read source programs from cards. The standard FORTRAN card format is used with only minor modifications.

Minimum Hardware: 8K PDP-8 and a Type CRO1-C Card Reader

## DECUS No. 8-105

### D-BUG

F. K. Williamson, Solartron Electronic Group Ltd.,  
Farnborough, Hampshire, England

D-BUG is an aid used in debugging PDP-8 programs by

## DECUS No. 8-105 (Continued)

facilitating communication with the program being run. Communication between operator and program is via the ASR-33 Teletype. D-BUG is similar to DEC's program ODT II (DEC-08-COA1-PB); however, it uses the DEC Floating Point Interpreter (Digital 8-5-S).

Two modes of operation are possible, fixed and floating point. D-BUG features include register examination and modification, control transfer, octal dumping, and instruction trap-outs to D-BUG control. Registers containing floating point numbers may also be examined, and break-traps can be inserted in floating point programs.

## DECUS No. 8-106

### Readable Punch

A. M. Lane-Nott, Letchworth College of Technology,  
England

This program enables the user to type a character on the keyboard and produce the character in readable form on paper tape. The program uses the high-speed punch. The readable characters on tape are produced by means of a table which contains the format of a 6 x 5 matrix using three words of storage per character to be punched. In addition, channel 8 is punched throughout. The program is terminated by typing a carriage return which generates 6 inches of tape. (Reference DECUS No. 8-68A)

## DECUS No. 8-107

### CHESSBOARD for the PDP-8/338

Michael S. Wolfberg, Moore School of Electrical Engineering,  
University of Pennsylvania, Philadelphia, Pennsylvania

This program displays a chessboard on the screen of a DEC 338 Display with all thirty-two chessmen set up on their initial board positions. There is no provision to move them about the board; it is just a demonstration picture.

The program occupies 03000 through 04230.

## DECUS No. 8-108

### INCMOD - Increment Mode Compiler (338)

Michael S. Wolfberg, Moore School of Electrical Engineering,  
University of Pennsylvania, Philadelphia, Pennsylvania

The INCMOD program for the DEC 338 Display allows the user to build a display subroutine composed of increments only. The user inputs information by pointing with the light pen. The program displays the figure he is constructing in each of the four available scale settings. The program is of value as a demonstration and may be of help for maintenance purposes. It occupies locations 00000-01231 and builds the increment mode display file beginning at location 01232.

#### DECUS No. 8-109

##### SEETXT Subroutine

Michael S. Wolfberg, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pennsylvania

SEETXT is a subroutine for the DEC 338 Display which can be called instead of the normal typeout subroutine. In addition to typing, it displays all printed characters on the screen corresponding to the last twenty lines which have been typed out.

The program includes the option of suppressing the typing, so that output can occur at a much higher rate than ten characters per second. The user has the option of controlling the length of a delay loop in the subroutine, so the output rate may range from nearly immediate to Teletype rate.

The maximum number of lines displayed, the scale, and intensity may be altered at any time. There is also the option of clearing the screen or displaying a blinking marker at the current typing position.

SEETXT is a subroutine for a standard 338, and does not depend upon the VC38 Character Generator. It occupies locations 0016 through 1500 (approximately) of any memory field and its entry point (for a JMS) is location 0200.

#### DECUS No. 8-110

##### DIREC - Directory Print

Michael S. Wolfberg, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pennsylvania

DIREC is a system program to be used with the PDP-8 Disk Monitor System. The program lists, on the on-line Teletype, an index of the file directory for the disk. The user has the option of seeing the index to system files or user files, or both.

DIREC can also be used in conjunction with the SEETXT Subroutine for the 338 Display to obtain a listing of the directory on the display screen.

#### DECUS No. 8-111

##### DISKLOOK

Michael S. Wolfberg, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pennsylvania

DISKLOOK is a small utility program for a PDP-8 with a 32K DF32 Disk. Using the on-line Teletype, the user may examine and alter any location (in octal) on the disk. Masked searches are also available. DISKLOOK occupies locations 200 through 777 of any memory field.

#### DECUS No. 8-112

##### Sentence Generator

D. Dyment, Digital Equipment of Canada Ltd., Carleton Place, Ontario, Canada

This program generates random English language sentences, using a dictionary (provided by the user) of ten basic word groups (A - J). The dictionary is used in conjunction with a random number generator and a syntactical algorithm to provide an output of randomly constructed English language sentences.

The program is an excellent vehicle for computer demonstration purposes. It may also be used to advantage in English teaching programs to aid students in perceiving sentence structure and errors in the use of words.

#### DECUS No. 8-113

##### Conversion of Friden (EIA) to ASCII

John F. Puterbaugh, Continental Aviation and Engineering Corporation, Toledo, Ohio

This program will translate tapes prepared on a Friden Flexowriter (EIA) into ASCII for direct assembly, further editing, or feeding into the FORTRAN program. Alphabetic characters may be in either upper or lower case. The program uses a table lookup and comparison with the negative complement of the EIA character, then outputs the corresponding ASCII character.

Storage: 213g including 2 auto-index registers

#### DECUS No. 8-114

##### Rounded Decimal Output Modification for PDP-8 FORTRAN

G. R. Hervey, University of Leeds, England

The program loads over the PDP-8 FORTRAN Operating System (DEC-08-AFA3-PB) and provides output in conventional decimal form: rounded, aligned, and with plus sign, leading zeros (other than one, in the case of fractional numbers), and trailing decimal point replaced by spaces. The FORTRAN trigonometrical routines are over-written. The source program must begin with two statements assigning integer variables representing, respectively, the numbers of digits required to the right of the decimal point, and the total number of digits (these can be reassigned, by program or manually). Output is called in the normal way, i.e. by TYPE statements referring to FORMAT statements containing the symbol E. If output of a number is not possible in the format requested, the decimal point is shifted to the right in the field; if formatted output is still impossible, or if zero or negative total digits were requested, output reverts to "E" format.

Restrictions: FORTRAN source language programs must begin with two special statements defining format required.

## DECUS No. 8-115

### Double Precision Integer Interpretive Package

Roger E. Anderson, Lawrence Radiation Laboratory,  
Livermore, California

This program is a Double Precision Integer Interpretive Package similar in operation to the Floating Point Package (Digital 8-5-S). It consists of addition, subtraction, multiplication, division, load, store, jump and branch subroutines coupled to an interpreter. It allows direct and indirect addressing in the normal assembly language manner. The operation is faster and more compact than the collected individual double precision subroutines. The program requires fourteen words on page zero and an additional two pages of memory.

Minimum Hardware: Basic PDP-5, -8, -8/S or -8/I

## DECUS No. 8-116

### PDP-8 Automatic Magnetic Tape Control (Type 57A) Library System

Robert E. McCullough and Jeffrey B. Pearce, Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, Colorado

The PDP-8 Automatic Magnetic Tape Control (Type 57A) Library System is a series of bootstrap programs which load library programs into memory from an IBM-compatible magnetic tape read using a Type 57A Automatic Magnetic Tape Control. A program is selected by entering the appropriate code number into the switch register on the computer console.

A copy of the IBM-compatible library tape may be obtained by sending a 1/2" magnetic tape to the authors.

## DECUS No. 8-117

### A PDP-8 Interface for a Charged-Particle Nuclear Physics Experiment

W. R. Burrus, E. Madden, C. O. McNew, and  
R. W. Peelle

Documentation (only) describing an interface constructed to use a PDP-8 computer with a charged particle detector system employing three solid-state detectors and flight-time analysis. Up to 48 bits from each randomly-occurring event are transferred through the data (break) channel to a hardware-selected buffer region in the core of a PDP-8 computer. Designed for use as a magnetic tape analyzer for the most complex cases, the system assumes that the 48 bits originate in flag bits set by fast logic and in (presently four) amplitude digitizers, all of which are assumed to contain information for the same event. The system includes some limited capability for controlling the course of the experiment, and provides for readout through the computer of a series of external fast counters. The report summarizes the design concepts, shows schematic flow diagrams, defines the computer instructions associated with the interface system, and gives

## DECUS No. 8-117 (Continued)

simple model programs to illustrate methods of application.

## DECUS No. 8-118

### General Linear Regression

Ian E. Bush, Medical College of Virginia, Richmond,  
Virginia

The major section of this program is the "Main Arithmetic IX" which consists of four initializing statements; an input section; a weighting section; a section which cumulates means, sums of squares, etc.; a section which calculates the relevant regression coefficients, etc.; and a section which calculates confidence limits as variances.

The section which calculates the relevant regression coefficients allows for both cases of linear regression, and in the computation of standard error of the intercept, uses (N-2) degrees of freedom to provide a better estimate for small values of N while providing negligible differences from conventional calculation when N is large.

The section which calculates confidence limits as variances provides a calculation of the variance of the error of the estimate of the dependent variable again using (N-2) degrees of freedom for the general case. This calculation is fully corrected for both random variance within the tested population of data and for the difference between the independent variable and the mean of the independent variable for the population of data.

## DECUS No. 8-119

### Off-Line TIC-TAC-TOE

Dave Hawkins, Foxboro Company, Foxboro, Massachusetts

TIC-TAC-TOE is a self-learning program which will improve its game as it plays. Whenever its human opponent wins, the program changes its strategy such that it can never be beaten again in the same way. Thus, the program gains "experience" every time it loses. The program will punch its experience on paper tape in binary format on request. This experience tape can be reread by the program at any time and will reset the program to the level of experience it had when the tape was punched. The program will notify the operator if any error is made in reading the experience tape and gets very upset if the player tries to cheat. The program occupies locations 10-4000 (approximately) and will operate with low or high speed tape input/output equipment.

## DECUS No. 8-120

### Disk/DECtape FAILSAFE

Charles Conley, Digital Equipment Corporation, Maynard,  
Massachusetts

This program will punch the contents of the disk (or DECtape) onto paper tape which can be loaded back onto the disk

DECUS No. 8-120 (Continued)

using the same program. The paper tape is punched in 200g word blocks in binary format, with a checksum for each block. FAILSAFE simplifies and speeds the process of rebuilding the Disk System Monitor after running disk tests.

Minimum Hardware: PDP-8, -8/S, -8/I with 32K Disk or DECTape

DECUS No. 8-121

DECTape Handler

B. Eiben, III Physikalisches Institut der T.H. Aachen, Aachen, W. Germany

This program allows quick, controlled data-block transfers between the PDP-8 and DECTape. It reads, writes and searches in minimum time (interrupt mode), requires minimum place (overlay with last page BIN, RIM, DECSYS Loaders) and occupies only two blocks on tape (block 0 = System, block 1 = Return-System). It is protected against destruction and gives, after the transfer, the status levels for testing purposes. It is usable as a Switch Register controlled program or as a subroutine with or without interrupt, giving the possibility of quick data storage, program shuffling and overlay technique with PDP-8 and DECTape.

Minimum Hardware: PDP-8, DECTape 552 Control

DECUS No. 8-122

SNAP - Simplified Numerical Analysis Program

Developed at Harvard Medical School, Boston, Massachusetts, under and NIH grant

SNAP is a computer language for real-time interactive computation which can be learned in less than one hour. It is particularly useful in teaching programming to beginners.

A unique feature of SNAP is its ability to interact on-line with other laboratory instruments. SNAP can accept electrical inputs directly and can read inputs from a real-time clock. Both of these functions are incorporated in a single SNAP instruction.

Another feature particularly useful for biological problems is Table Instructions. A list of 100 numbers may be entered from the keyboard or from punched paper tape.

DECUS No. 8-123

UNIDEC Assembler

C. Stephen Carr, University of Utah, Salt Lake City, Utah

The UNIDEC Assembler runs on the Univac 1108 and passes assembled PDP-8 code over the electronic link between the 1108 and PDP-8. The source statements are punched on cards for input into the 1108 in a format nearly identical to

that of MACRO-8. A printed listing and the object code are produced as fast as the cards can be read.

Note: Source deck and documentation only available.

DECUS No. 8-124

PDP-8 Assembler for IBM 360/67

V. Michael Powers, University of Michigan, Ann Arbor, Michigan

The 360/PDP-8 Assembler is a collection of programs written mostly in FORTRAN IV (G) which operate on the IBM 360/67. It assembles programs for PDP-5 and PDP-8 computers. Once a program has been assembled, it may be punched on cards, saved in a file, or transmitted through the Data Concentrator over data lines. It is also possible to obtain binary paper tapes by use of the Data Concentrator.

The Assembler follows the PAL III operation code and addressing conventions. The input format and program listing conventions are slightly different from those of PAL III, because it is organized around a line format, while PAL III is organized around a paper tape format.

Note: Source deck and documentation only available.

DECUS No. 8-125

PDP-8 Relocatable Assembler for IBM 360/67

D. L. Mills and V. Michael Powers, University of Michigan, Ann Arbor, Michigan

The documentation available describes a method for segmenting PDP-8 programs for the purpose of facilitating program maintenance and residence in MTS (Michigan Terminal System) files. The method provides for program storage on a page-relocatable basis with relocation information contiguous to but not necessarily integral with text information. Linkages between separately assembled program segments are provided in a form very similar to those used in IBM System/360 systems.

Currently available utilities within MTS provide assembly and link-editing facilities, using programs stored either as punched card decks or in MTS files. Utilities are also included for the purpose of paper tape transcription either in PAL-compatible format or in a special format useful for dynamic loading via a data link to a remote machine. In addition to these MTS utilities, two relocating PDP-8 loaders are available which operate using the special dynamic-loading format. Each of these programs occupies one dedicated page of PDP-8 memory and operates in a multicore-bank environment. One of these programs is designed to operate as a stand-alone utility, while the other is designed to operate within the RAMP system.

# **PDP-6 PROGRAMS**

# PDP-6 INDEX

<u>DECUS NO.</u>	<u>TITLE</u>	<u>TAPES AVAILABLE</u>	<u>LISTING</u>
6-1	ALPHAS	D	X
6-2	LPFOL	D	X
6-3	PUNCH	D	X
6-4	NUMBER	D	X
6-5	TIMEF4	D	X
6-6	DTADIR	D	X
6-7	DTALST ALIAS PIP-3	D	X
6-8	BELL STAR	D	X
6-9	LININV	D	X
6-10	DATE	D	X
6-11	MATINV	D	X
6/8-12	PDP-8 Assembler for PDP-6	D	
6-13	FORTRAN II Compiler	D	
6-14	The Dots Playing Program	D	X
6-15	DREDIT	D	
6/10-16	FILER	D	
6-17	FIT	D	X
6-18	DISUBS	D	X
6-19	MXNOUT	D	X
6-20	DTADDT	D	X
6-21	Critical Path Scheduling	D	X
6-22	MEM2 and MEM4	D	X
6-23	TSUM, DERIV and CONPOL	D	X
6-24	CHISQ	D	X
6-25	1KCLOK	D	X
6-26	WIRE	D	
6/10-27	Not available at this time.		
6/10-28	CMPSRC	D	
6/10-29	LISP 1.5 for PDP-6/10	D	
6/10-30	COBOL	D	
6-31	CARD	D	X
6-32	DISDAT	D	X

Code

A - ASCII Source  
 B - Binary Object  
 D - DECtape

H - High Binary Loader  
 L - LINcTape  
 LL - Linking Loader

R - RIM  
 S - Symbolic (Source)  
 X - Listing Available

Writeups are available for all programs.



<u>DECUS NO.</u>	<u>TITLE</u>	<u>TAPES AVAILABLE</u>	<u>LISTING</u>
6-33	PLIST	D	X
6-34	IBYTE	D	X
6-35	CUBIC, CUBTTY and CHRTTY	D	X
6-36	RANDOM	D	X
6-37	PACK, UNPACK, REPACK	D	X
6/10-38	LISP 1.6 for PDP-6/10	D	
6/10-38.1	ALVINE		

# PDP-6 PROGRAM ABSTRACTS

## DECUS No. 6-1

### ALPHAS

Richard Gruen, Digital Equipment Corporation, Palo Alto, California

Contains a set of the most used ASCII characters (letters, numbers, and a few other characters) for use with the 340 Display. Also included is a small driver program illustrating use of the display in time sharing.

## DECUS No. 6-2

### LPFOL

Richard Gruen, Digital Equipment Corporation, Palo Alto, California

Displays a square at the last point seen by the light pen. Follows the light pen as the pen moves around the screen.

## DECUS No. 6-3

### PUNCH

Richard Gruen, Digital Equipment Corporation, Palo Alto, California

The program accepts characters from the Teletype and punches them (in hand-readable format onto paper tape). It can be easily modified for use as a titling subroutine.

## DECUS No. 6-4

### NUMBER

Richard Gruen, Digital Equipment Corporation, Palo Alto, California

NUMBER converts 7-digit telephone numbers into mnemonics. It prints all mnemonics for a given phone number of four pages of line printer paper.

## DECUS No. 6-5

### TIMEF4

Richard Gruen, Digital Equipment Corporation, Palo Alto, California

TIMEF4 calls each of the FORTRAN IV Library routines 20,000 times and publishes the average time per call. It uses randomly-generated numbers as input. This program was used to calculate the timings shown in the FORTRAN IV Library write-up.

## DECUS No. 6-6

### DTADIR

I. D. Pugsley, The University of Western Australia Computing Centre, Nedlands, Western Australia

A 1K program which may manipulate DECTape directories. Performs several functions:

- Zeroize a DECTape directory,
- List a DECTape directory,
- Save a DECTape directory file,
- Get a saved file and write-up as a DECTape directory.

## DECUS No. 6-7

### DTALST ALIAS PIP 3

I. D. Pugsley, The University of Western Australia Computing Centre, Nedlands, Western Australia

A program for listing DECTape data with minimal processing. Output format is controlled by switches included in the command string. Useful for:

- Debugging programs with DECTape output,
- reading data with parity errors on the tape,
- teaching, and general program listings.

## DECUS No. 6-8

### BELL STAR

C. B. Horan, The University of Western Australia Computing Centre, Nedlands, Western Australia

A program which contains two subroutines. These operate in the DDT submode on the user's TTY. Bell outputs two Teletype bells. Star outputs a carriage return and an asterisk, thus enabling FORTRAN programs to be written to accept input in the standard CUSP command manner.

## DECUS No. 6-9

### LININV

D.W.G. Moore, The University of Western Australia Computing Centre, Nedlands, Western Australia

A matrix inversion and/or linear equation solver. All I/O is from the user's Teletype.

DECUS No. 6-10

DATE

I. D. Pugsley, The University of Western Australia Computing Centre, Nedlands, Western Australia

Routine returns today's date in form suitable for output from a FORTRAN program.

DECUS No. 6-11

MATINV

Submitted by The University of Western Australia Computing Centre, Nedlands, Western Australia

Gauss-Jordan total pivotal elimination subroutine for matrix inversion, solution of linear equations with multiple right-hand sides, and determinant evaluation.

DECUS No. 6/8-12

PDP-8 Assembler for PDP-6

Henry Burkhardt, Digital Equipment Corporation, Maynard, Massachusetts

Assembles PDP-8 programs written in PAL on a PDP-6 using any I/O devices.

DECUS No. 6-13

FORTRAN II Compiler

Peter Sampson, Digital Equipment Corporation, Maynard, Massachusetts

Minimum Hardware: PDP-6 with DECTapes and TTY

Other Programs Needed: Package is complete except for PDP-6 Loader

Source Language: MACRO-6

Storage: 22K - Can be made into 10K version

DECUS No. 6-14

The Dots Playing Program

David Gross, Digital Equipment Corporation, Maynard, Massachusetts

The Dots Playing Program allows the PDP-6 computer to play the game of dots against a human opponent. This program illustrates the strengths and weaknesses of tree-searching methods and the methods of eliminating branches from the tree.

DECUS No. 6-15

DREDIT

William Meier, Applied Logic, Princeton, New Jersey

DREDIT is an editor for sequence-numbered files. Operation is similar to DEC's DECTape Editor. It permits copying of old files to new files so they can be used on devices other than DECTape.

DECUS No. 6/10-16

Filer

R. N. Freedman, Massachusetts Institute of Technology, Laboratory for Nuclear Science, Cambridge, Massachusetts

This program uses magtape as a large random access storage. Under Teletype control, it copies specified files from an input device onto magtape and later extracts desired files for further manipulation. The capacity of a magtape is much larger than DECTape, but the access time is still much shorter than card or paper tape files.

Minimum Hardware: magtapes

Source Language: MACRO-6

Storage Requirement: 2K

Restrictions: The program has been run only on Type 50 Tape Units, but there is no known reason why it should not work on other units.

DECUS No. 6-17

FIT

C. L. Jarvis and D. G. Moore, The University of Western Australia Computing Centre, Nedlands, Western Australia

This subroutine has calling sequence: CALL FIT (XX,YY,K,A,SMR,L,M,DELTA). XX and YY are the observation arrays, K is the number of observations, A returns with chebyshev coefficients, SMR returns with mean square residuals, L = order required, DELTA returns with the sum of squares of the residuals. M is the switch which is initially set to 1. If the fit of order L + 1 is required, then if M is set to A value > 1 and L incremented, less computation is required when the subprogram is reentered.

Source Language: FORTRAN IV

DECUS No. 6-18

DISUBS

M. J. Erickson, The University of Western Australia Computing Centre, Nedlands, Western Australia

This group of subroutines allows easy access to the display

and light pen from a FORTRAN IV program. Basically, the programmer imagines the display to be a sheet of graph paper with the edges of the screen having coordinates specified under program control. The user then builds up pictures in arrays working in cartesian coordinates (using floating point arithmetic) specifying points, lines and characters which are interpreted relative to the current values of the coordinate limits, XMAX, XMIN, YMAX, YMIN which are held in common. The routines are automatically aware of several other variables in common. LP is the status of the light pen. To make any part of a picture light pen sensitive, the light pen bit must be set (LP=1) when entering that part of the picture in a display table. If light pen sensitivity is not required, LP is zero.

The intensity bit, ISHOW, is equal to one for all information to be displayed. It is sometimes necessary to plot hidden vectors and points, in which case ISHOW is zero.

ITENS specifies the intensity and may vary from 1 to 7, the display being brightest when INTENS is 7.

ISCALE controls the size of characters and the scale in line and vector modes. The X and Y coordinates are multiplied by 2\*\*N if ISCALE=N. This has the effect of double spacing the points. ISCALE may be  $\emptyset$  (usual case), 1, 2, or 3.

The following subroutines are available:

1. INTAB (A,L)

Initialize the array A as a display table of maximum length L. Before INTAB is called, the parameters LP, ISHOW, INTENS, and ISCALE should be defined, although they may be modified as the program runs.

2. POINT (A,X,Y)

Enter the coordinates to display a point at X, Y.

3. LINE (A,X1,Y1,X2,Y2)

Draw a line parallel and of equal length to that joining (X1,Y1), (X2,Y2) from the current display position.

4. VECONT (A,X1,Y1,X2,Y2)

As for LINE but continue the line to the edge of the screen.

5. CHAR (A,B)

Display the alphanumeric characters held in B. As 5 is the maximum number B can hold, CHAR may need to be called several times to display a line of text. There are several special characters interpreted by the display.

a. # - This must follow the last character to be displayed and must appear before breaking out of character mode.

b. † - Normally characters are displayed horizontally. However, any characters appearing after † are displayed vertically.

c. [ - Characters appearing after this are displayed

horizontally.

d. ] - Line feed.

e. \ - Carriage return.

6. SPOT (A,X,Y)

Display a point at X, Y and its four surrounding points on the display area. The light pen is unable to detect a single point but will detect these five points.

7. FLOTE (A,Z)

Display the floating point number in Z at the current display position.

8. GFLOTE (A,Z,K,L)

Display the floating point number in Z in G format where K is the field width and L is the number of decimal places.

9. OFIX (A,K)

Display the fixed point number in K at the current display position.

10. DISPLY (K,A,B,C...)

Display the K tables A, B, C... until another display command is given. If K is zero the display is released and nothing is displayed.

11. LITEPN (L,X,Y)

Call the light pen interrupt routine once. If an interrupt occurs, L is set to minus one and the coordinates at which the interrupt occurs, relative to the current coordinate limits, are placed in X and Y. L is zero if no interrupt has occurred.

To estimate the size required for an array in general, a point requires a full 36-bit word; a line whose length is equal to one tenth of the screen width requires 18 bits; and each character requires 6 bits. The subroutines themselves require less than 1K.

Source Language: MACRO-6

DECUS No. 6-19

MXNOUT

D.W.G. Moore, The University of Western Australia Computing Centre, Nedlands, Western Australia

This FORTRAN IV subroutine will output an MXN matrix suitably partitioned for a 120 column printer.

Source Language: FORTRAN IV

DECUS No. 6-20

DTADDT

I. D. Pugsley, The University of Western Australia Computing Centre, Nedlands, Western Australia

DECUS No. 6-20 (Continued)

DTADDT is a program, based on user-DDT, capable of examining or modifying any word or words on a DECTape. The primary use of DTADDT is for limited editing of dump files, but it may be used for modifying any part of a DECTape (files with any format), or transferring single blocks or small groups of blocks from one tape to another. Since all output to the user is on his Teletype, the program has a practical limitation on the number of words which may be examined or modified, which would be about 200 words. However, a DDT search may be extended over a very wide range.

Source Language: DDT  
Equipment Needed: One or two DECTapes, user's Teletype, 3K core.

DECUS No. 6-21

Critical Path Scheduling

D.W.G. Moore, The University of Western Australia Computing Centre, Nedlands, Western Australia

This program, written in FORTRAN IV for the PDP-6, computes the earliest starts, latest starts, earliest finishes, latest finishes, total float and free float of jobs constrained by arrow diagram network. Familiarity with arrow diagramming techniques is assumed.

Output from this program may be used as input to scheduling programs developed for limited resource problems.

Source Language: FORTRAN IV  
Subroutines: LSH, DATE

DECUS No. 6-22

MEM2 and MEM4

R. H. Smith, The University of Western Australia Computing Centre, Nedlands, Western Australia

This program allows DECTapes to be treated as a random access device. Storage on tape is in binary form. The FORTRAN calling program must have the statement - DIMENSION ARRAY (127).

Source Language: MACRO-6

DECUS No. 6-23

TSUM, DERIV and CONPOL

Mr. Boundy, C. L. Jarvis, and D.W.G. Moore, The University of Western Australia, Nedlands, Western Australia

Chebyshev polynomial subroutines:

TSUM

This function evaluates -

$$A(1)/2+A(2)*T(1)+. . . . .A(N+1)*T(N)$$

DERIV

This subroutine calculates the derivative of the polynomial chebyshev coefficients at a point, i.e. the first derivative of  $A(1)/2+A(2)*T(1)+. . . . .A(N+1)*T(N)=C(1)/2+C(2)*T(1)+. . . . .+C(N)*T(N-1)$ . The C(I)'s over write the A(I)'s.

CONPOL

This subroutine converts -

$$A(1)/2*A(2)*T(1)+. . . . .+A(N+1)*T(N) \text{ to } C(1)+C(2)*X+C(3)*X**2+. . . . .+C(N+1)*X**N$$

(i.e. the equivalent polynomial)

In all cases, maximum order of polynomial is 25.

DECUS No. 6-24

CHISQ

N. S. Stenhouse, The University of Western Australia Computing Centre, Nedlands, Western Australia

This program calculates chi-squared up to order 6 x 12 on users TTY. Yates corrections are applied for 2 x 2 matrix.

Source Language: FORTRAN IV  
Subroutines: STAR

DECUS No. 6-25

1KCLOK

R. L. Macmillan, The University of Western Australia, Nedlands, Western Australia

This is a demonstration program in which the date and time are converted from their number form into a clock face on the display. Display routines used are taken directly from DISUBS, (DECUS 6-18).

NOTE: Power line frequency must be 50 CPS.

Source Language: MACRO-6  
Equipment Needed: display, 1K core

DECUS No. 6-26

WIRE

Richard J. Plano, Rutgers - The State University, New Brunswick, New Jersey

DECUS No. 6-26 (Continued)

WIRE is a program designed to help with the tedious and detailed bookkeeping involved in wiring digital circuits. It assumes the circuit is known with all module and pin assignments made. Given this information, it will optimize the wiring connections in the sense of making the wire lengths short, bussing where advantageous, and keeping wiring between rows to a minimum. It assumes 32 modules in a row with 15 possible connections on each (as for Digital Equipment Corporation Flip Chip modules neglecting pins A, B, C, which generally carry power and ground).

It can then produce a variety of output including a list of loops of connected points, a list of busses and grounds, a wiring list which contains the number of connections already on each pin to which a connection is about to be made, and the length of wire needed for the connection. A detailed map can also be printed out showing both ends of each connection as well as busses, grounds, and module names.

An updating or editing facility is also provided so that the map and loops can be kept up-to-date as the circuit is modified or debugged.

The program is written for a PDP-6 computer using the Digital Equipment Corporation multiprogramming system. It requires approximately  $(6+N)*1000$  decimal words of core, where N is the number of rows of modules. The storage is automatically expanded at run time. I/O equipment required is a user Teletype, one DECTape, and a line printer. Running time for a 20-row circuit, including all print out and optimizing but no editing, is approximately 20 minutes.

DECUS No. 6-27

The program originally announced as 6/10-27 has been temporarily removed from the DECUS Library. Further information will be available at a later date.

DECUS No. 6/10-28

CMPSRC

Joan Lechnor, Applied Logic Corporation, Princeton, New Jersey

This program compares two (MACRO-6 or similar) source files and prints list of differences in readable form. Insertions and deletions are handled. Program is run using DDT.

Storage Requirements: 5K and variable size buffer.

DECUS No. 6/10-29

PDP-6/10 LISP 1.5

T. Eggers, Digital Equipment Corporation, Maynard, Massachusetts

LISP is a general-purpose programming language which utilizes a list-structure storage scheme for both program and data. It is primarily suited for manipulation of symbolic

quantities, although it offers complete fixed and floating point arithmetic as well. LISP functions may be recursive.

LISP is used effectively for arithmetic simplification and for symbolic differentiation and integration. It has been used extensively for studies in artificial intelligence, man-machine communication, and solution of game-playing problems.

On PDP-10 systems, the LISP interpreter runs under control of the system Monitor. It includes device-independent input/output capability and the ability to process character-by-character input. The system also includes a large set of LISP functions as subroutines. All storage made available to LISP will be used for the data structure.

The documentation available is supplementary to the M.I.T. Press LISP 1.5 Manual.

Minimum Hardware: 16K PDP-6/10 with DECTapes.

Source Language: MACRO-10

Storage Requirement: 9K or more

DECUS No. 6/10-30

COBOL

Submitted by Applied Logic Corporation, Princeton, New Jersey

COBOL (Common Business-Oriented Language) enables a PDP-6/10 user to write a computer program in a language which reads as easily as if it were ordinary English. For example, the calculation of the price of an item after adding a four percent sales tax could be written as:

Tax-calculation. Multiply net-price by 0.04 giving sales-tax. Add sales-tax to net-price giving total-price.

PDP-6/10 compact COBOL runs under the control of the PDP-6/10 Monitor Systems.

DECUS No. 6-31

CARD

C. B. Horan, The University of Western Australia Computing Centre, Nedlands, Western Australia

This FORTRAN IV function returns a false answer if either the device with the logical name LPT or the logical name CDR is a DECTape.

It is intended to be used so that a program may request a file name when one of these assignments is made.

Source Language: MACRO-6

DECUS No. 6-32

DISDAT

C. B. Horan, The University of Western Australia Computing Centre, Nedlands, Western Australia

This program calls DISUBS (DECUS No. 6-18) to display date at current display position. Display parameters must be set by calling program.

Source Language:       MACROX

Subroutines:           DISUBS

DECUS No. 6-33

PLIST

R. L. Macmillan, The University of Western Australia Computing Centre, Nedlands, Western Australia

PLIST is a series of subroutines enabling the user to manipulate up to five push-down lists from a FORTRAN IV program.

Arrays must be set up within the user's program in which the push-down lists reside. The size of these arrays can be approximated by using the following:

Each 'PUSH' onto the PDL uses 1 location,  
but for each 'PUSHJ' called, 17 locations  
are used.

Source Language:       MACRO-6

DECUS No. 6-34

IBYTE

D.W.G. Moore, The University of Western Australia Computing Centre, Nedlands, Western Australia

BYTE Manipulation Routines for FORTRAN IV are routines to allow a FORTRAN IV user to take successive bytes from an array. Up to 5 arrays may be manipulated simultaneously.

Source Language:       MACRO-6

DECUS No. 6-35

CUBIC\*, CUBTTY and CHRTTY

A. Peters, The University of Western Australia Computing Centre, Nedlands, Western Australia

\*Subroutine CUBIC from Monash University

The subroutine CUBIC evaluates the roots of a cubic equation by Cardans method.

CUBTTY is a Teletype routine which uses subroutine CUBIC to solve a cubic equation.

CHRTTY evaluates the characteristic equation of a 3 x 3 matrix and, using CUBIC, solves the equation and prints out the eigenvalues of the matrix.

Source Language:       FORTRAN IV

DECUS No. 6-36

RANDOM

R. L. Macmillan, The University of Western Australia Computing Centre, Nedlands, Western Australia

Subroutine for generating real random numbers.

Example:

To generate a sequence of 100 integer random numbers between 0 and 9, the FORTRAN program may read as follows -

```
DIMENSION M(100)
N=1568321
DO 1 I=1,100
CALL RANDOM(0.0, 10.0, N, RAND)
1 M(I)=RAND
```

Core Requirements:    28 words

Source Language:       MACRO-6

DECUS No. 6-37

PACK, UNPACK, REPACK

D. W. Goodall, The University of Western Australia Computing Centre, Nedlands, Western Australia

These three subroutines, written in MACRO-6 for use in FORTRAN IV programs, enable integer data from a one-dimensional array to be packed in bytes of any chosen size into the successive words in a specified section of a two-dimensional array and for individual entries to be retrieved or replaced.

DECUS No. 6/10-38

LISP 1.6

Stanford University Artificial Intelligence Laboratory, Stanford, California

LISP 1.6 is an advanced list processing language for use on the PDP-6/10. LISP 1.6 features completely recursive string manipulation and arithmetic, automatic storage allocation using a garbage collector, and the ability to interact conversationally with the LISP Interpreter. Several ancillary routines are included: the LISP Compiler, and ALVINE Text Editor, and a number of auxiliary LISP functions designed to aid the conversational user.

Minimum Hardware:    PDP-6/10 with DEC system

DECUS No. 6/10-38 (Continued)

Other Programs Needed: DEC MONITOR

Source Language:       MACRO Version 15

DECUS No. 6/10-38.1

ALVINE

Stanford University Artificial Intelligence Laboratory,  
Stanford, California

Alvine, Allen's very inchoate editor, is an interim string search editor for LISP and the PDP-6. A very simple command language is used for processing character strings. One can insert and delete arbitrary strings and store these strings on various I/O devices.



# **PDP-7 and 7/9 PROGRAMS**

# PDP-7 and 7/9 INDEX

<u>DECUS NO.</u>	<u>TITLE</u>	<u>TAPES AVAILABLE</u>	<u>LISTING</u>
7 - 1	Accelerated Radix Deflation and Superdecimal Data Bytes on the PDP-7	No Tapes	X
7/9 - 2a	FAST Start	R, B, A	X
7 - 3	CUS - Console Utility System	B, S	X
7/9 - 4c	PTSCOPE, PTPEN, PTPLOT, CALIBRATE, LISTEN	A	X
7 - 5	KINEMATICS	A	X
7 - 6	CGC Function	A	X
7 - 7	INPUT ND 180, INFLT ND 180, INPUT VICTOREEN, and INFLT VICTOREEN	A	X
7/9 - 8a	FPTSCOPE, FPTPEN, and FPTPLOT	A	X
7 - 9a	Scope Text Editor	B	X
7 - 10	DECPUN - Decimal Integer Punch Routine	A	X
7 - 11	POSPNT - Positive Decimal Integer Print Routine	A	X
7 - 12	Punch Output Package	A	X
7 - 13	340 Display Programming Manual	No Tapes	
7 - 14	ISENSE	R, A	X
7 - 15	FORTTRAN Patch for EAE Arithmetic	R, A	X
7 - 16	Single-Level Breit Wigner Fit	R, A	X
7 - 17	CREASE		X
7 - 18	Paper Tape Verifier (Uses EAE)	B, S	X
7 - 19	Dump ND 180 and FDump ND 180	R, A	X
7 - 20	PDP-4/7 DECTape Copy Routine	B, S	X
7 - 21	Reaction Kinematics	A	X
7 - 22	LEGFIT	A	X
7 - 23	OUTFLT	A	X
7 - 24	ENLOSS	A	X
7 - 25	PDP-7/9 Dice Game	B	
7 - 26	Normalize Instruction Test - PDP-4/7	B, S	X
7 - 27	Paper Tape Verifier	B, A	X
7 - 28	.IODEC Revision	B, A	X
7 - 29	Non-FORTTRAN DECTape System	B, A	X
7/9 - 30	GRASP: Gaussian Reduction & Analysis of Spectrum Peaks	B, A	X
7 - 31	Display N Letter Word	B	X
7 - 32	Extended Memory and Interrupt Test	B, S	X

Code

A - ASCII Source  
 B - Binary Object  
 D - DECTape

H - High Binary Loader  
 L - LINCTape  
 LL - Linking Loader

R - RIM  
 S - Symbolic (Source)  
 X - Listing Available

Writeups are available for all programs.

<u>DECUS NO.</u>	<u>TITLE</u>	<u>TAPES AVAILABLE</u>	<u>LISTING</u>
7 - 33	Simple List Processing Package - SLP1	A	X
7/9 - 34	BESSEL	A	X
7/9 - 35	Coulomb Excitation	A	X
7/9 - 36	Finite Geometry Attenuation Coefficients	A	X
7/9 - 37	DIRECS and LUBITZ	A	X
7/9 - 38	Gamma Ray Peeling Program	A	X
7 - 39	Store Display Program	B, A	
7 - 40	DUEL	Funny Format (Object)	
7 - 41	Two-Pass Assembler	R	X
7 - 42	The ML/I Macro Processor	B, S	X
7 - 43	A PDP-7 Music System	B, S	X
7 - 44	An Interrupt Compatible DDT	B	
7 - 45	FORTTRAN Plotter Library	B	X

# PDP-7 and 7/9 PROGRAM ABSTRACTS

## DECUS No. 7-1

Accelerated Radix Deflation and Superdecimal Data Bytes on the PDP-7.

M. Kawahara, Mesa Scientific Corporation

## DECUS No. 7/9-2a

FAST 7 START and FAST 9 START

Philip Bevington, Stanford University, Stanford, California

FAST 7 and FAST 9 (Fast Acquisition of System Tapes) are mutually compatible monitors written for the PDP-7 and PDP-9 to retrieve frequently used programs from DECtape. Each FAST monitor includes five programs.

1. The FAST Loader
2. The FAST Writer
3. The FAST Reader
4. The FAST Low Writer
5. The FAST Low Reader

## DECUS No. 7-3

CUS - Console Utility System

Allen Rousseau, C. W. Adams Associates

CUS is an octal debugging and utility system. It consists of the following routines:

1. Octal Correcting Routines
2. Word Search Routine
3. Octal Dump
4. Compare Tape Equal Routine
5. Jump Options
6. Transfer Routine
7. Fill Routine

## DECUS No. 7/9-4c

PTSCOPE, PTPEN, PTPLOT, CALIBRATE, and LISTEN

Philip Bevington, Stanford University, Stanford, California

Five FORTRAN Subroutines for the PDP-7 which provide oscilloscope displays and X-Y plots of single-parametric spectra using the Type 34 Display.

## DECUS No. 7-5

KINEMATICS

Philip Bevington, Stanford University, Stanford, California

A FORTRAN subroutine for use with nuclear reactions to transform energies, angles, and cross sections non-relativistically between the laboratory system and the center-of-mass system.

## DECUS No. 7-6

CGC Function

Philip Bevington, Stanford University, Stanford, California

The CGC (Clebsch Gordon Coefficient) subprogram is designed to be used with FORTRAN programs running under the Operating Time System on the PDP-7. It calculates angular momentum vector coupling coefficients with the phase conventions of Condon and Shortley.

## DECUS No. 7-7

INPUT ND I80, INPUT VICTOREEN, and INFLT VICTOREEN

Philip Bevington, Stanford University, Stanford, California

Four FORTRAN subroutines for the PDP-7 which read punched paper tapes of data from nuclear data multichannel pulse-height analyzers and stores them in fixed or floating point arrays. These subroutines are in mixed FORTRAN and PDP-4/7 symbolic languages and utilize EAE instructions.

## DECUS No. 7/9-8a

FPTSCOPE, FPTPEN, and FPTPLOT

Philip Bevington, Stanford University, Stanford, California

Three FORTRAN subroutines for the PDP-7 which provide oscilloscope display and X-Y plots of single parameter spectra using the Type 34 Display. These subroutines are similar to DECUS No. 7-4, but display spectra stored in floating point mode.

## DECUS No. 7-9a

Scope Text Editor MK III

R. E. Thomas and N. E. Wiseman, Cambridge University, England

A general-purpose, on-line text editing program for ASCII

DECUS No. 7-9a (Continued)

8-track paper tape documents. It is controlled by commands issued via the lightpen and keyboard. Monitoring of the text is provided by the CRT which serves as a "window" into a selected area of the text.

DECUS No. 7-10

DECPUN - Decimal Integer Punch Routine

Luther C. Abel, Rensselaer Polytechnic Institute, Troy, New York

Permits raw data, as acquired by a PDP-7 in an on-line installation, to be punched out. DECPUN treats all numbers as positive, allowing for the full  $2^{18}$  machine capacity.

DECUS No. 7-11

POSPNT - Positive Decimal Integer Print Routine

Luther C. Abel, Rensselaer Polytechnic Institute, Troy, New York

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 TDGIT from the Teletype Output Package (DEC 7-10-0); POSPNT II also calls TSP.

DECUS No. 7-12

Punch Output Package

Luther C. Abel, Rensselaer Polytechnic Institute, Troy, New York

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 tapecard 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 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

340 Display Programming Manual

Stanford C. Adler, Bronx, New York

The Manual provides a single reference containing the information required to program the 340 Display. It summarizes information contained in seven DEC publications. It assumes that the user is familiar with the PDP-7 Computer.

DECUS No. 7-14

ISENSE

Philip Bevington, Stanford University, Stanford, California

A FORTRAN function permitting the use of the AC switches on the PDP-4/7 or the SCANS Idiot box spectrum-stripping switches as sense switches. It also uses the Idiot box display scale switch with scope display, or plots programs as a PTSCOPE.

DECUS No. 7-15

FORTTRAN Patch for EAE Arithmetic

Philip Bevington, Stanford University, Stanford, California

This subroutine is a modification to the FSWMIO FORTRAN for the PDP-4/7, taking advantage of the EAE arithmetic to increase the speed of computation by a factor of 2.5 for two-word mode.

DECUS No. 7-16

Single-Level Breit Wigner Fit

P. Paul, Stanford University, Stanford, California

This FORTRAN program calculates the energy dependence and size of the total cross section of a single isolated resonance in the R-matrix formalism of nuclear theory. Included are subroutines for calculating Coulomb wave functions and phases shifts.

DECUS No. 7-17

CREASE

Philip R. Bevington, Stanford University, Stanford, California

A program for the PDP-4/7 to transfer source programs and data from punched cards to paper tape.

DECUS No. 7-18

Paper Tape Verifier (Uses EAE)

Phylis Niccolai, Carnegie Institute of Technology, Saxonburg, Pennsylvania

Paper Tape Verifier verifies each line of a master tape against its corresponding line on a duplicated paper tape. The master tape is read into the computer and stored two lines per word in memory. Two lines of the duplicated paper tape are then read and compared with their corresponding lines on the master tape in memory. In the event of an error, the contents of the two lines from the duplicated paper tape are typed in octal and, immediately below, the contents of the same two lines on the master tape are also typed in octal. Requires 8K PDP-7 with EAE.

DECUS No. 7-19

DUMP ND 180 and FDUMP ND 180

Philip Bevington, Stanford University, Stanford, California

Subroutine to transfer data from the memory of a Nuclear Data 180 (or 181) multichannel Pulse-Height Analyzer and deposit the spectrum in a special matrix in fixed point mode.

DECUS No. 7-20

DECtape Copy Routine

James D. Pitts, Digital Equipment Corporation, Maynard, Massachusetts

This program will reproduce the data information from one DECtape reel (master) to another (copy) and verify such information. A tape on which timing and mark tracks are written should be used. The program uses the PDP-4/7 DECtape subroutine (Digital 4/7-22-IO).

DECUS No. 7-21

Reaction Kinematics

Philip Bevington, Stanford University, Stanford, California

A FORTRAN program for use with nuclear reactions to tabulate the transformations of energies, angles, and cross sections non-relativistically between an operator at the console of a computer and the subroutine KINEMATICS (DECUS No. 7-5) to specify the input parameters and output format.

DECUS No. 7-22

LEGFIT

Dale Heikkinen, Stanford University, Stanford, California

A FORTRAN program which performs a least-squares fit to data with a Legendre polynomial expansion of the form:

$$Y(\theta_i) = \sum_{L=0}^N A_L P_L(\cos\theta_i).$$

The expansion can contain both even and odd terms or even terms alone, depending on the user's option. The program uses the subroutine MATINV for matrix inversion.

DECUS No. 7-23

OUTFLT

Philip Bevington, Stanford University, Stanford, California

A FORTRAN subroutine for the PDP-4/7 which punches arrays of floating point numerical data with an output format identical with that from Nuclear Data 180 Multi-channel Pulse-Height Analyzers (in ASCII code).

DECUS No. 7-24

ENLOSS

Dale Heikkinen, Stanford University, Stanford, California

A program which calculates the Kinematics of nuclear reactions with provision for a determination of the energy loss of the outgoing light particle due to passage through foils.

DECUS No. 7-25

PDP-7/9 DICE Playing Game

James D. Pitts, Digital Equipment Corporation, Maynard, Massachusetts

A program which enables a user to play the game DICE, using computer and ASR-33.

DECUS No. 7-26

Normalize Instruction Text - PDP-4/7

R. Law, Foxboro Company, Foxboro, Massachusetts

Program lacs a number, puts it in the MQ, normalizes the number, returns the number to original form, then checks it against original number. If OK, increments number and repeats process. If in error, original number and normalized-unnormalized numbers are printed out. Checks all numbers 1→37777.

DECUS No. 7-27

Paper Tape Verifier (Without EAE)

A. C. Kilgour, University of Edinburgh, Scotland

The program is an amended version of DECUS No. 7-18, in which all EAE instructions have been replaced by calls to subroutine. The specification is the same as for DECUS 7-18 except that storage for program has gone up to 411g, and EAE is not required.

## DECUS No. 7-28

### .IODEC REVISION

Phylis F. Niccolai, Carnegie Institute of Technology,  
Saxonburg, Pennsylvania

This revision of the PDP-7 library program .IODEC, reduces the memory requirement of the relocatable library program from 1007<sub>10</sub> words to 538<sub>10</sub> words. Only binary transfers of data are permitted and operation codes 4 - 8 are replaced with a fast search option.

Minimum Hardware: 8K PDP-7, EAE, KSR-33  
Teletype, 2 DECTapes

Other Programs Needed: FORTRAN Main Program  
FORTRAN OTS and Subroutines  
as called by main program

## DECUS No. 7-29

### A Non-FORTRAN DECTape System

K.W. Bixby, Philco-Ford Corporation, Newport Beach,  
California

The DECTape System was designed to provide a relatively easy means for running and storing of machine language programs on and off DECTape. The system is loaded from DECTape via a bootstrap that is on paper tape in HRI mode. Programs are called in through the system's keyboard monitor section. The system has the ability to insert new programs, change existing programs, copy the entire DECTape with another one, and generate just the system itself onto a new DECTape.

Minimum Hardware: 8K PDP-7, Dual DECTape Transport  
Type 555 and DECTape Control Type  
550

Storage: Occupies 15600<sub>8</sub> - 17770<sub>8</sub> and DECTape loader  
occupies 7603<sub>8</sub> → 7761<sub>8</sub>

## DECUS No. 7/9-30

### GRASP: Gaussian Reduction and Analysis of Spectrum Peaks

Albert Anderson, Stanford, University, Stanford, California

GRASP is a FORTRAN program to make least-squares fits to peaks in pulse-height spectra with a Gaussian shape plus a quadratic background.

Minimum Hardware: 8K PDP-7/9, EAE, Type 34 Display,  
Type 370 Light Pen

Other Programs Needed: DECUS Nos. 7-4(a), 7-7, and  
7-14

Storage: Entire Memory

## DECUS No. 7-31

### Display N Letter Word

Allen M. Cohen, New York University, New York City,  
New York

"Display N Letter Word" will display any word with the letters arranged in any desired sequence. Because of this capability, the program is useful for investigating perceptual processing in man.

It was specifically written for a PDP-7 equipped with the Type 340 Precision Display and Type 342 Symbol Generator, driving a Fairchild CRT equipped with a P-24 phosphor. The program, however, is adaptable to any fast phosphor, computer-controlled display.

Programs are available for 5-, 10-, and 20-letter random displays.

## DECUS No. 7-32

### Extended Memory and Interrupt Test

Richard E. Law, Foxboro Co., Foxboro, Massachusetts

The program tests for all possible types of breaks while operating in any desired memory bank. Activation signals are periodically sent to various devices which continue to run and generate asynchronous interrupts for several seconds. The program attempts to activate all devices, but otherwise ignores non-operational or unavailable units. Programmed devices include: Real-time clock (clock break); teleprinter, tape reader, tape punch (all program breaks); CDC or Model 24 Drum (Data Break); and EAE (special break). Provision has been made for the user to add one more special device to the program (such as A/D converter for example) by inserting indicated instructions.

## DECUS No. 7-33

### Simple List Processing Package (SLP1)

Neil E. Wiseman, University Mathematical Laboratory,  
Cambridge, England

The package contains routines for the administration of uni-directional list structures. The facilities are: INITIALIZE PACKAGE, INITIALIZE A LIST, MOVE FORWARD, PUSH DOWN, POP UP, ENTER SUBROUTINE, EXIT SUBROUTINE. The list structures are stored in a slightly unorthodox manner intended to conserve core space. An automatic "garbage collector" is provided and certain space jams may be monitored to be cleared by user-supplied subroutines.

Storage: Approximately 290<sub>10</sub> registers

### DECUS No. 7/9-34

#### BESSEL

Albert Anderson, Stanford University, Stanford, California

BESSEL is a FORTRAN subprogram for the PDP-4/7/9 to calculate spherical BESSEL and spherical Neumann functions accurate to five significant figures.

Source Language: FORTRAN II (with symbolic coding)

Storage Requirements: 425g

Restrictions: Written in two-word mode

### DECUS No. 7/9-35

#### Coulomb Excitation

J. L. Black, Stanford University, Stanford, California

COULOMB EXCITATION is a FORTRAN program for calculating Coulomb excitation cross sections for heavy-ion beams. The Coulomb excitation angular correlation attenuation coefficients  $\overline{a_2}$  and  $\overline{a_4}$  are also calculated.

Minimum Configuration: 8K memory

Source Language: FORTRAN II

Storage Requirement: entire memory

### DECUS No. 7/9-36

#### Finite Geometry Attenuation Coefficients

J. L. Black, Stanford University, Stanford, California

This is a FORTRAN program for calculation of angular correlation attenuation coefficients and efficiencies for NaI(Tl) or Li(Ge) detectors.

Minimum Configuration: 8K memory

Source Language: FORTRAN II

Storage Requirement: entire memory

### DECUS No. 7/9-37

#### DIRECS and LUBITZ

Albert Anderson, Stanford University, Stanford, California

Direct REaction Cross Section: A FORTRAN program to calculate PWBA (Plane Wave Born Approximation) predictions of distributions for reaction products from direct nuclear reactions such as stripping and pick-up, utilizing a FORTRAN subroutine (LUBITZ) which calculates the parameters found in Lubitz's tables as described in MacFarlane and French, Rev. Mod. Phys. 32, 567 (1960).

LUBITZ is a FORTRAN subroutine to calculate the function  $\sigma_{LTAB}$  (tabulated by C. R. Lubitz) which determines the PWBA angular distribution of nuclear reaction products in stripping or pick-up reactions involving the transfer of one nucleon. The subroutine generates spherical Bessel functions by two different methods for speed and accuracy.

Minimum Configuration: 8K memory

Other Programs Needed: DIRECS requires FPTSCOPE, LISTEN, FPTPEN, FPTPLOT, CALIBRATE (DECUS No. 7/9-8A)

Source Language: FORTRAN II (with symbolic coding)

Storage Requirement: 1536g for LUBITZ

Execution Time: 150 msec/angle for LUBITZ

Restrictions: Some of the subroutines listed above assume the availability of EAE for proper operation.

### DECUS No. 7/9-38

#### Gamma Ray Peeling Program

Friedrich Riess, Stanford University, Stanford, California

This is a FORTRAN program to make a least square fit to a peak in a gamma-ray pulse-height spectrum with a line shape interpolated from three standard line shapes, combined with folding in a Gaussian, Lorentzian or rectangular function.

Minimum Configuration: 8K memory

Other Programs Needed: PTSCOPE, LISTEN, PTPLOT, CALIBRATE, (DECUS No. 7/9-4A) INPUT ND 180 (DECUS No. 7-7)

Source Language: FORTRAN II

Storage Requirement: entire memory

Restrictions: Some of the subroutines listed above assume the availability of EAE for proper operation.

### DECUS No. 7-39

#### Store Display Program

Nigel A. Rose, Computer-Aided Design Project, University of Edinburgh, Edinburgh, Scotland

The program allows one to examine the contents of specified addresses in the core store, using the Type 340 Display. The contents are displayed in both mnemonic and octal form.

Minimum Configuration: PDP-7 with Model 33/35 Teletype and 4K core store. Type 340 Display with Type 347 Subroutine Option.



## DECUS No. 7-40

### DUEL

M. S. Peterson and J. C. Viner, University Mathematical Laboratory, Cambridge University (England)

"DUEL" is a game, played by two people, using the PDP-7 and 340 Display. Each person can operate five switches controlling the movement and gun firing of his own "space ship" on the display screen, the object being to destroy the enemy ship by firing bullets at it.

Each ship is a 1/2" diameter circle plus a "gun turret" - a line radiating from the center of the circle. The two ships are distinguished by having the first part of the gun turret of only one of the ships visible.

The linear acceleration of the ship, (forwards and backwards) is controlled by two switches. The motion is along the instantaneous direction of the gun turret and is as if in a viscous medium. Thus, operating the forward switch with the ship at rest causes a slow acceleration to a terminal velocity. Resetting the switch causes the ship to decelerate to rest. Two other switches allow rotation of the gun turret at a constant rate - one for clockwise motion, the other for counter-clockwise.

A fifth switch fires a bullet from the gun. This moves at a constant velocity across the screen - this velocity being the vector sum of the ship's instantaneous velocity and the bullet's muzzle velocity. All the bullets die out after a fixed time from the moment of firing. Up to that time, if the bullet strikes the ship, this is deemed to have been destroyed, the screen goes blank and indicator lights on the operating console show who is the winner. The starting position can then be reset for the next game. One can lose by being shot down by one's own bullets.

NOTE: DUEL is a program very similar to SPACE-WAR for the PDP-1

## DECUS No. 7-41

### Two-Pass Assembler

P. Fleck, M.I.T., Lincoln Laboratory, Lexington, Massachusetts

#### I. General

The FLAP two-pass assembler uses a source program prepared in ASCII code on paper tape, or in Hollerith code on punched cards, or in packed Hollerith code on magnetic tape. This source program is read in two passes and produces an assembly listing and a binary object paper tape in absolute (Read In Mode), RIM, or relocatable format. If 16K memory is used, the binary program is assembled in core memory ready to run.

The minimum requirements for the assembler are: a PDP-7 with EAE and 8K of memory, tape reader and punch and a Teletype. The assembler was designed to operate on a

PDP-7 with a card reader, line printer, and one magnetic tape unit; and this extra equipment reduces the assembly time. If cards or paper tape are input, an option allows for writing the source program in packed Hollerith on magnetic tape (unit Ø) during the first pass. This collating tape will be used for the second pass (to reduce the assembly time) or it can be used as input to the assembly program (e.g. if the magnetic tape is prepared off-line by pre-storing cards onto tape).

The optional listing can be on the Teletype or line printer. The listing includes the complete octal code, the location of this word in memory and the symbolic source statement which was assembled into this octal code.

The binary output is optionally punched on paper tape. If 16K memory is available, the binary output will be stored in the upper bank where it can optionally be moved to lower bank at the end of the assembly for immediate execution.

The FLAP assembler can also be used as a card or paper tape (ASCII) or mag tape (FLAP format) lister. Since the assembler is not used, any format can be used on the input, with the qualification that for paper tape anything after the 80th character after each carriage return will be listed on a new line, and only the symbols for which characters exist in Hollerith will be listed (i.e., characters like !["":\← are illegal and will be incorrectly listed as ↗).

## DECUS No. 7-42

### The ML/I Macro Processor

P. J. Brown, University Mathematical Laboratory, Cambridge, England

ML/I is a general Macro processor. It is general in the sense that it can be used to process any kind of text. The text may be in any programming language or natural language, or it may be numerical data. The most important use of ML/I is to provide the user with a simple means of adding extra statements (or other syntactic forms) to an existing programming language in order to make the language more suitable for his own field of application. This process of extension may be carried to the level where the extended language could be regarded as a new language in its own right. Other uses of ML/I are program parameterization (e.g. a parameter might determine whether debugging statements are to be included in a program) and various applications in text editing or correction and data format conversion. ML/I is also suitable for use as the final pass of a compiler.

Minimum Hardware: Basic PDP-7

Storage Requirement: 8K

### DECUS No. 7-43

#### A PDP-7 Music System

Ronald F. Brender, Logic of Computers Group, The University of Michigan, Ann Arbor, Michigan

This is a pair of programs concerned with producing four-part music on the PDP-7. One program "performs" the music, while the other translates from symbolic musical text to the form required by the music player program. Four independent simultaneous parts in the frequency range 1 to 2000 Hz are produced.

Complete instructions and examples include a concert of seven pieces from Bach to The Loving Spoonfuls. These programs are easily adapted to PDP-4 or PDP-9.

Minimum Hardware: 4K and EAE

### DECUS No. 7-44

#### An Interrupt Compatible DDT

Ronald F. Brender, Logic of Computers Group, The University of Michigan, Ann Arbor, Michigan

A modified DDT is provided which facilitates the debugging of programs using the interrupt hardware of the PDP-7. Interrupt and teleprinter flag status are saved and optionally restored at breakpoints and can be specified when starting execution. Several additional commands are provided to control these features.

Minimum Hardware: 4K

Storage Requirement: Approximately 1500 words plus user symbol table - about the same as Basic DDT

### DECUS No. 7-45

#### FORTRAN Plotter Library

Taketora Yamagata and Kazuhiro Hoshi, Institute for Nuclear, University of Tokyo, Tokyo, Japan

This program is a library system for an Incremental Graphic Plotter and a PDP-7 and is used as part of the FORTRAN II I/O Library. The program calling formats are similar to those for the IBM Graphic Plotter Routines in order that those acquainted with the IBM Graphic Plotter System might use the present system with ease.

The library consists of ten subroutines produced in a PDP-7 FORTRAN II library format. Input data which represent coordinates or lengths should be given as floating point numbers in units of millimeters; and that which represent angles, as floating point numbers in units of degrees.

The subroutines are:

PLOT NUMBER	PLOTS LETTER	FACTOR SCALE	OFFSET AXIS	WHERE LINE
----------------	-----------------	-----------------	----------------	---------------

Minimum Hardware: 8K PDP-7 with Incremental Plotter and Control Type 350

Other Programs Needed: PDP-7 FORTRAN II System

Storage: 3532g (Including SINP, COSF Routine.)

Restrictions: Limited to three-word mode.

# **PDP-9 PROGRAMS**

# PDP-9 INDEX

<u>DECUS NO.</u>	<u>TITLE</u>	<u>TAPES AVAILABLE</u>	<u>LISTING</u>
9-1	DECTape Copy Routine	B	
9-2	3D Draw for 339	B, S	
9-3	Double Precision Integer Package	A	
9-4	Integer - EAE	B	X

## Code

A - ASCII Source  
B - Binary Object  
D - DECTape

H - High Binary Loader  
L - LINCtape  
LL - Linking Loader

R - RIM  
S - Symbolic (Source)  
X - Listing Available

Writeups are available for all programs.

# PDP-9 PROGRAM ABSTRACTS

## DECUS No. 9-1

### PDP-9 DECTape Copy Routine

James D. Pitts, Digital Equipment Corporation, Maynard, Massachusetts

This program will reproduce data information from one reel (master) to a second (copy) and verify information using verified DECTape on the PDP-9.

The complete tape of 576 blocks may be copied or any number of blocks can be reproduced as designated by the operator through the AC SWS. Data can be copied in multiples of one block only. The blocks indicated in the AC SWS will be copied from the master reel to the corresponding blocks of the copy reel.

## DECUS No. 9-2

### 3D Draw for 339

Barry Wessler (Written at: Digital Equipment Corporation, Maynard, Massachusetts)

This program is a demonstration of the capabilities of the 339 system. It allows the user to sketch three-dimensional objects on the scope and rotate them in real time. The equipment required consists of a basic 339.

## DECUS No. 9-3

### Double Precision Integer Package (PDP-9 Advanced Software)

Submitted by: J. Pitts, Digital Equipment Corporation, Maynard, Massachusetts

This set of subroutines provides the user with the ability to perform double precision signed integer addition, subtraction, multiplication, and division. A 36-bit input can be expanded to a result of 72 bits by every operation except division.

This package is the same Double Precision Integer Package found in the PDP-9 Basic Software System. It has been converted to MACRO-9 source for use in a relocatable, Advanced Software environment.

## DECUS No. 9-4

### INTEGE, Integer Arithmetic, EAE

A. B. Trevor, University of Arizona, Tucson, Arizona

This program is an improved version of DEC's INTEGE for the PDP-9/EAE.

**LINC and LINC-8  
PROGRAMS**



# LINC and LINC-8 INDEX

<u>DECUS NO.</u>	<u>TITLE</u>	<u>TAPES AVAILABLE</u>	<u>LISTING</u>
L-1	MSCPNT - Manuscript Compressed Print	L (B)	X
L-2	Clock 1 for LINC, Clock 8 for LINC-8	L (B)	
L-3	Off-Line LABCOM System	L (B and Manuscript)	
L-4	Interval Histogram	L, Sym paper tape	X
L-5	Tape Subroutine	L, Sym paper tape	X
L-6	TRIGGR	L	X
L-7	Modifications to PROGOFOP, Version 2	L, B & A paper tapes	X
L-8	DECTape Interface for LINC-8	L, B & A paper tapes	X
L-9	LINC-Calcomp Plot Subroutine Package	L	X
L-10	LINC-8 Multianalyzer	B, S paper tapes	X
L-11	DATUM8	L	X
L-12	READIT		X
L-13	AVPROG	L	
L-14	MEAN	L	
L-15	LEAP-1	L	X
L-16	RWTAPE	A	X
L-17	LOAD	L	X
L-18	BUFFER	L	X
L-19	LABELS	L	X
L-20	MONITOR - A Monitor for Automatic Sequential Operation of Programs on the LINC-8	L	X
L-21	LINC-TRAN - FORTRAN Macros for LINC-8	L	X
L-22	A New PDP-8 Display Instruction for LINC-8		X
L-23	Control to Designate Left or Right LINC-8 Tape Transport as Unit Zero		
L-24	PLTKBD - Plot Keyboard		X
L-25	LINC Spectrum Program	L	
L-26	RELTS8-1C (LINC-8 Only)	L	X
L-27	Q & A Subroutine (Modification for LAP-6 Characters)	L	X
L-28	TEXT TTY Subroutine	L	X
L-29	DEC-BI	L	X
L-30	LAP-6-1C (Modification to LAP-6)	L	
L-31	LINC-8 SNAP (With and without EAE)	B	
L-32	XMARK	L	X

## Code

A - ASCII Source  
 B - Binary Object  
 D - DECTape

H - High Binary Loader  
 L - LINCtape  
 LL - Linking Loader

R - RIM  
 S - Symbolic (Source)  
 X - Listing Available

Writeups are available for all programs.

subroutine. The program triggers only if the input signal crosses the trigger level in the positive sense.

Source Language: LAP4

Storage Requirements: 114g

#### DECUS No. L-7

Modifications to PROGOFOP, Version 2

Submitted by: Richard Clayton, Digital Equipment Corporation, Maynard, Massachusetts

This modification to PROGOFOP, Version 2, allows for:

1. The simulation of the Classic LINC interrupt system, in conjunction with a one-second Program Interrupt Clock with which the system is provided.
2. The addition of I/O commands to allow PROGOFOP to answer the Soraban Keyboard.
3. The modification of the PROGOFOP execute and mag-tape commands to utilize the EXC command to request mag-tape operations from tape units 2 and 3.

#### DECUS No. L-8

DECTape Interface for LINC-8

Submitted by Digital Equipment Corporation, Maynard, Massachusetts

Programming and documentation for a minimal hardware interface which allows the LINC-8 to read and write single blocks of PDP-8 format DECTape. It consists of eleven modules which are added to the LINC-8 memory section. Digital Equipment Corporation will make this interface available to LINC-8 customers, either as a factory installed option, a field installed option, or supply the drawings and programming for those who wish to implement this interface themselves.

Material available:

1. The block schematic diagram C-BS-7605206-0-1.
2. A description of the interface and its function.
3. A set of PDP-8 subroutines to use the modified LINC-8 Tape Control to read and write blocks of PDP-8 format DECTape.
4. A program which will copy a LINC format DECTape to a PDP-8 format DECTape or vice versa.
5. Binary and ASCII paper tapes, ASCII third-pass listings, and LINCtape containing the appropriate programming.

#### DECUS No. L-9

LINC-Calcomp Plot Subroutine Package (LAP-5)

Maynard Engerbrettson, St. Louis University, St. Louis, Missouri

Three subroutines for use on the LINC-Calcomp:

Character Plot Subroutine  
Pen Control Subroutine  
X-Y Motion Subroutines

#### DECUS No. L-10

LINC-8 Multianalyzer  
(Adapted to the LINC-8 from the Pulse Height Analysis Program - J-5260)

Richard M. Merrill, Digital Equipment Corporation, Maynard, Massachusetts

The analysis facilities for high-speed data input and display have been adapted to the LINC-8 computer and several extra features have been added.

The basic program allows display of a complete three-dimensional data matrix as a 2D projection or as a contour display. Vertical or horizontal cross-sections of the data may also be displayed. The third basic mode, the Twinkle Display, shows dynamically the X and Y coordinates of only the current data points.

Additional features: (All numbers indicated below are octal.)

##### I. Display

- A. Histograms (including three-dimensional histograms) may be plotted as an option via sense switch zero.
- B. The data matrix is 100 x 53; the Twinkle Display is 100 x 100.
- C. For one-dimensional analysis, the X or Y coordinate may be changed via a control knob for selection of the data region. (Max: 53 (Y) sets of 100 (X) values of Z.)

##### II. Z-Coordinate

- A. The Z-coordinate may also be an analog signal instead of a count.
- B. X, Y, or Z coordinates may be taken from any of 16 built-in A-D converters. The value of Z for a given X, Y will be the last one taken.
- C. If the signal to noise ratio is small, then Z may be taken as a running average over  $2^N$  samples; plus N is read from the left switches.



### III. Miscellaneous

- A. A built-in variable timer is used and may be calibrated.
- B. Qualitative audio indications of  $\pm X$  and  $\pm Z$  are available.
- C. The LINC-8 Library System and data storage via DECTape may be used.

#### DECUS No. L-11

##### DATUM8

Richard W. Young (Submitted by: Dr. Walter H. Moran, Jr., West Virginia University, Morgantown, West Virginia)

DATUM8 is a revision of and an addition to DATAM by James Hance contained in the general library supplied with the LINC-8 computer. This program has retained all the features of DATAM. Some of the original routines have been changed in order to eliminate undesired features. In addition, DATUM8 has the ability to multiply, subtract, and display the data with two cursors. The data not included between the cursors can be suppressed allowing, for instance, integration between definite limits. The program has been re-coded to facilitate future modifications.

Minimum Hardware: LINC (2K) or LINC-8

Source Language: LAP6

Storage: 0-3777g

#### DECUS No. L-12

##### READIT

Dr. T. D. Williams, University of Bristol, England

READIT is a program for measuring data stored on LINCtape. The program will read the data into store and then display it.

#### DECUS No. L-13

##### AVPROG

T. D. Williams, University of Bristol, England

AVPROG is a program for averaging analog signals.

#### DECUS No. L-14

##### MEAN

T. D. Williams, University of Bristol, England

MEAN is a program for calculating the mean and standard deviation of a set of numbers.

#### DECUS No. L-15

##### LEAP-1

Harold L. Pearson, West Virginia University, Morgantown, West Virginia

LEAP-1 is basically DECUS 5/8-64, PDP-8 DECTape Programming System by J. Fitzgerald, modified to run on a LINC-8. With LEAP-1, the LINC-8 user may edit, assemble, and load PDP-8 programs without using paper tape. (See also DECUS No. L-16 and DECUS No. L-32.)

#### DECUS No. L-16

##### RWTAPE

Harold L. Pearson, West Virginia University, Morgantown, West Virginia

RWTAPE is a general input-output subroutine for LINCtapes. The program was written to replace the DECTape routines in the PDP-8 DECTape Programming System (DECUS No. 5/8-64). It can read or write consecutive blocks on any LINC-8 tape unit. It requires only one page of memory.

#### DECUS No. L-17

LOAD - Extended Load Sequence for LINC-8

L. N. Law, Institute of Psychiatry, London, England

This program extends the load sequence so that the LINC Operating System, GUIDE, may be started without using any toggle switches other than the LOAD switch. (For LINC-8 only.)

#### DECUS No. L-18

BUFFER - Fully Buffered Teletype I/O

L. N. Law, Institute of Psychiatry, London, England

BUFFER extends PROGOFOP to provide fully buffered operation for the ASR-33 Teletype. The input and output buffers each have storage for up to 100g Teletype characters and communicate with the ASR-33 via the computer interrupt. LINC instructions KST, KBD, KBDi, and TYP are executed by the Buffer Routines. In addition, OPR 12 reads ASCII or Binary character values from the input buffer. (For LINC-8 only.)

#### DECUS No. L-19

##### LABELS

L. N. Law, Institute of Psychiatry, London, England

This program punches patterns on paper tape to reproduce the character typed on the keyboard. A 4 x 6 matrix is used,

based on the LINC display characters. All printing keys are valid, together with the space bar. All other control keys are ignored. The program uses L-18, BUFFER, for I/O and checks that it is operating on a LINC-8 with the BUFFER routines available on the Unit 0 tape. (For LINC-8 only.)

#### DECUS No. L-20

**MONTOR** - A Monitor for Automatic Sequential Operation of Programs on the LINC-8

R. W. Tuttle, K. Pavel, and C. F. Stroebel, Institute of Living Hospital, Hartford, Connecticut

MONTOR is a monitor operating system for the LINC-8 which permits sequential, automatic processing of GUIDE-filed programs. Any combination of data sampling, data reduction, process control, and data processing jobs can be intermixed on a daily or more frequent basis. Very minor alterations are required in GUIDE-filed programs to make them MONTOR compatible.

#### DECUS No. L-21

**LINC-TRAN** - FORTRAN Macros for the LINC-8

R. W. Tuttle, K. Pavel, and C. F. Stroebel, Institute of Living Hospital, Hartford, Connecticut

LINC-TRAN is a programming system which permits FORTRAN object programs and the FORTRAN Operating System to be called as part of a LINC-8 program. For example, data could be collected, primary processed, and stored in the LINC mode, floating point calculations performed in the PDP-8 FORTRAN mode, with a return to the LINC mode for further processing or display of results. As a result, full use can be made of the unique capabilities and full power of the joint configuration (LINC and PDP-8) of the LINC-8 computer.

#### DECUS No. L-22

**A New PDP-8 Display Instruction for LINC-8**

R. W. Tuttle, K. Pavel, and C. F. Stroebel, Institute of Living Hospital, Hartford, Connecticut

This documentation describes hardware changes for a new PDP-8 IOT instruction so that the LINC-8 display unit may be controlled directly by the PDP-8

#### DECUS No. L-23

**Control to Designate Left or Right LINC-8 Tape Transports as Unit Zero**

R. W. Tuttle, K. Pavel, and C. F. Stroebel, Institute of Living Hospital, Hartford, Connecticut

Since many programs for the LINC-8 are designed to run only on Tape Unit 0, it has been found convenient to add a "NORMAL-REVERSE CONFIGURATION" switch to the

LINCtape transports. This switch allows the operator to choose NORMAL (left-hand Unit 0, right-hand Unit 1) or REVERSE (right-hand Unit 0, left-hand Unit 1) designation for the tape transports. All tape control functions are shifted by this one switch. One could also place this switch under program control by either using the relay register or constructing a new one-bit register. Circuit diagram available.

#### DECUS No. L-24

**PLTKBD** - Plot Keyboard

R. Cooper, Burden Neurological Institute, Bristol, England

PLTKBD, Plot Keyboard, is a LINC-8 program which plots the characters of the Teletype keyboard on a CALCOMP 365 Plotter. The program occupies four blocks and starts at 1 or 20. It uses the OPR instructions embedded in PROGOFOP (DEC-L8-SFAO-D). The size of the characters is set by the LSW. They can be rotated through 90° by SNSO.

ALT MODE A draws a head stamp (useful in Electroencephalography)

ALT MODE B moves the drum down 1 inch so that the position of printing can be first set on the CALCOMP viewer crosswires.

ALT MODE C returns to GUIDE

The program is protected against illegal characters ALT MODE D, E, F, etc.

#### DECUS No. L-25

**LINC Spectrum Program**

James Bryan, National Institute of Mental Health, Bethesda, Maryland

This is a spectrum program using the new Cooley-Tukey Fast Fourier Transform Algorithm.

#### DECUS No. L-26

**RELTS8-1C** (LINC-8 only)

Submitted by: Dr. W. H. Calvin, University of Washington, Seattle, Washington

The original RELTS8 has been modified in three ways:

1. To make the numbers typed correspond to the (inverted) labeling on the data terminal panel.
2. To vary the duration of relay closure via the SAM 0 knob.
3. To automatically repeat the relay closure at a rate determined by SAM 2 knob (enabled by SNS 0 up).

DECUS No. L-27

Q & A Subroutine (Modification for LAP-6 Characters)

Submitted by: Dr. W. H. Calvin, University of Washington, Seattle, Washington

This Q & A Subroutine is the original Q & A Subroutine modified to use the LAP6 character table.

DECUS No. L-28

TEXT TTY Subroutine

Dr. W. H. Calvin, University of Washington, Seattle, Washington

This subroutine types out a list of LINC characters generated by LAP6 quotation mark method, analogous to the way in which Q & A Subroutine displays them. Control is restored at the location following the end of the list, marked by a 77 half-word.

DECUS No. L-29

DEC-BI

Dr. W. H. Calvin, University of Washington, Seattle, Washington

The subroutine retrieves the half-words typed into the question marks during the Q & A Subroutine and converts them from decimal to binary. It will do a decimal-to-binary conversion on one to four digits. There may be any number of question marks (1, 2, 3, or 4) and leading zeros need not be typed.

DECUS No. L-30

LAP-6-1C

This is a modification procedure for modifying LAP6 to adapt it to:

1. LINC-8 Teletype and mnemonics SKP, PDP, TYP, and EXC.
2. Fan-Fold paper in the Teletype.

The Teletype, mnemonic, and fan-fold mods are independent of one another.

DECUS No. L-31

SNAP

LINC-8 version of SNAP (with and without EAE). See abstract of DECUS No. 8-122.

DECUS No. L-32

XMARK

Harold L. Pearson, West Virginia University, Morgantown, West Virginia

XMARK is a program which marks LINCtapes in a format which allows more efficient usage of the LINC-8 Library System and the LEAP-1 System (DECUS No. L-15) tapes. It marks the tape in 128 word blocks with 1792 (3400 octal) blocks per tape. The standard tape marking program (MARKL8) marks 256 word blocks with 512 (1000 octal) blocks per tape. XMARK significantly increases tape capacity and speed of operation for PDP-8 programs on the LINC-8.

# LINC and LINC-8 PROGRAM ABSTRACTS

## DECUS No. L-1

MSCPNT - Manuscript Compressed Print

Alan C. Roohvarg, Biomedical Computing Division,  
University of Wisconsin, Madison, Wisconsin

MSCPNT is a program which prints LAP4 manuscripts (packed or unpacked) using the Teletype. The program is written to be used under GUIDE. Sense switch options and parameter input format are the same as those of MSPRNT. This routine is approximately 25 percent faster than MSPRNT.

The manuscript consists of three sections. The first is the main program, MSCPNT, which is 1622g lines long. The second part is the Q & A subroutine, Q ASUB, which is 471g lines long. The third is the Teletype driver, TTYSUB, which is 204g lines long. The binary program requires six blocks of tape for storage under GUIDE. The program uses eight quarters of memory at execution time.

## DECUS No. L-2

"Clock 1" for LINC; "Clock 8" for LINC-8

Jim Davis, Digital Equipment Corporation, Maynard,  
Massachusetts

"Clock 1" and "Clock 8" are demonstration programs for the LINC and LINC-8 respectively. The program also checks for the position of sense switch 0. If the switch is down, the clock runs normal (keeping time); switch up and the clock will run fast (not keeping time).

## DECUS No. L-3

Off-Line LABCOM\* System

Submitted by University of Wisconsin Hospitals, Madison,  
Wisconsin

The system was developed by the University of Wisconsin Hospitals, Clinical Laboratories, to assist the staff in hospital clinical laboratories perform routine calculations and to store laboratory data for administrative reports and quality control.

It also includes an experimental program for on-line monitoring by the computer of a single automatic laboratory analyzing device.

This system is written for the classic LINC. For use on the LINC-8, slight modifications to Teletype programs are necessary.

Source Language: LAP4

Storage Requirements: 2048 words - programming is overlapped.

Restrictions: Full capability requires four LINCtape drives

\*Laboratory Aided By COMPUTER

## DECUS No. L-4

Interval Histogram

Hans Reiter, Physiological Institute of the Free University of Berlin, Berlin, Germany

This is a program to calculate and display an interval histogram.

Choice of different resolution and delay after trigger is also provided.

Source Language: LAP-4

## DECUS No. L-5

Tape Subroutine

Juergen Klauske, Physiological Institute of the Free University of Berlin, Berlin, Germany

This program can be used as a subroutine for reading, writing and checking one variable block size on LINC-8 tapes.

The subroutine does not use program interrupt. If the main program does use the interrupt, then the interrupt service routine must assign highest priority to the LINCtape.

Source Language: PAL III

## DECUS No. L-6

TRIGGR

Hans Reiter, Physiological Institute of the Free University of Berlin, Berlin, Germany

This program is to be used as a trigger program. Input is via channel 10 and comparison with a trigger level is controlled by knob 0. It is also possible to arrange a delay by an octal number submitted from the main program to the subroutine. During the time of delay, no trigger is possible. The input and the trigger level is displayed.

The minimum delay is 450  $\mu$ sec with an input of 1776, 3776, 5776, or 7776 in register 1F+1.

The program uses the auto index registers 2, 3, and 6. The following tags are used: 1F, 2F, 4F, 1D, 4M, 5M. The execution time in each case is exactly 150  $\mu$ sec with the jump return to the main program, but without the jump to the

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