



THE UNIVERSITY OF NEWCASTLE

NEW SOUTH WALES

AUSTRALIA

A PAL III ASSEMBLER  
FOR THE  
PDP-11 COMPUTER

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**ELECTRICAL ENGINEERING**

A PAL III ASSEMBLER  
FOR THE  
PDP-11 COMPUTER

by

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## ABSTRACT

This project is concerned with writing a computer program (PAL3H) for the PDP-11 computer that will assemble PDP-8 programs written in PAL III assembly language. The output from the program is PDP-8 machine code in a format acceptable to the PDP-8 Absolute Binary Loader.

The first section of the project describes the PAL III language with particular emphasis on those sections that affect the design of the assembler.

The second section describes the algorithms and techniques used in the general design of the PAL3H assembler, as well as in the detailed design of the individual routines.

A listing of the assembler is contained under a separate cover.

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## 1. PAL III ASSEMBLY LANGUAGE

### 1.1 Introduction to the PDP-8 Computer

The PDP-8 computer (PDP stands for Programmed Data Processor) is a single address, fixed word length, parallel transfer computer using 12-bit, 2's complement arithmetic. The cycle time of the 4096-word random access magnetic core memory is 1.2 microseconds for fetch and defer cycles without autoindex, and 1.4 microseconds for all other cycles. Standard features include indirect addressing, and facilities for instruction skips and program interrupt as a function of the input/output device condition.

The 4096 words of core memory are divided into 32 (40 octal) pages, with 128 (200 octal) words per page. At any time, 256 locations can be referenced directly, those on the current page, and those on page zero. Any of the 4096 locations can be referenced indirectly.

The PAL III Symbolic Assembler (PAL stands for Program Assembly Language) is a system program used to translate symbolic programs, which are written in the PAL III language, into binary coded object programs.

PAL III is a two-pass assembler with an optional third pass, that is, the symbolic program tape must be passed through the assembler two times to produce

the binary object tape, and the optional third pass produces a complete octal/symbolic program listing.

## 1.2 Character Set

The following characters are acceptable to PAL III.

1. The alphabetic characters - A through Z
2. The numeric characters - 0 through 9
3. The following special characters -

### (a) Printing characters

+	plus
-	minus
,	comma
=	equal sign
*	asterisk
;	semicolon
\$	dollar sign
.	period
/	slash

### (b) Non-printing keyboard characters

SPACE

TAB

RETURN

4. Ignored characters -  
FORM FEED

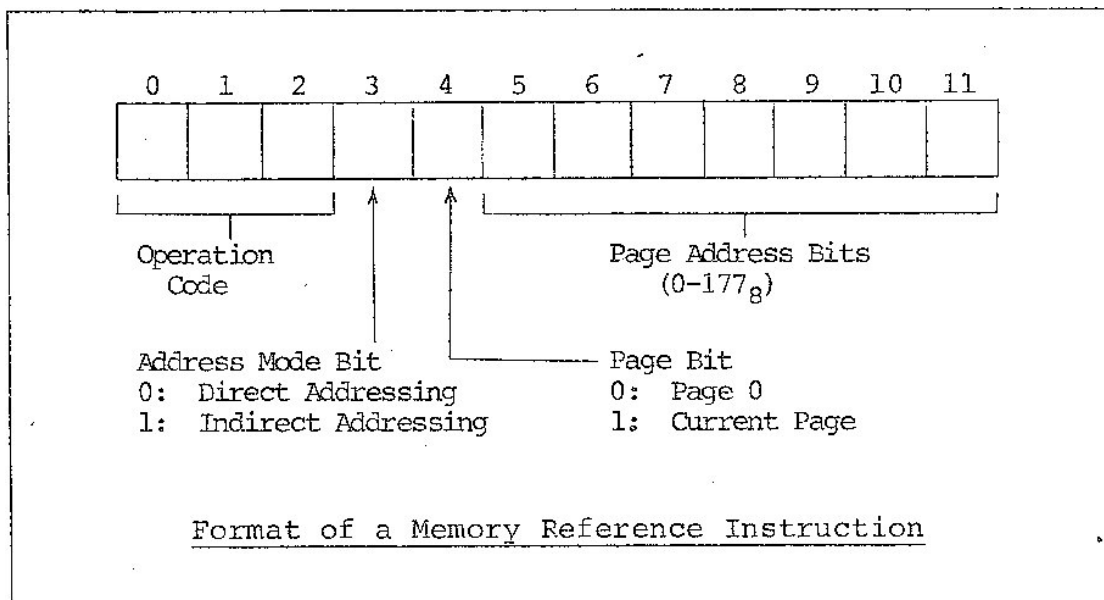
## Comments

The assembler ignores everything from a slash to the next character return.

### 1.4 Instructions

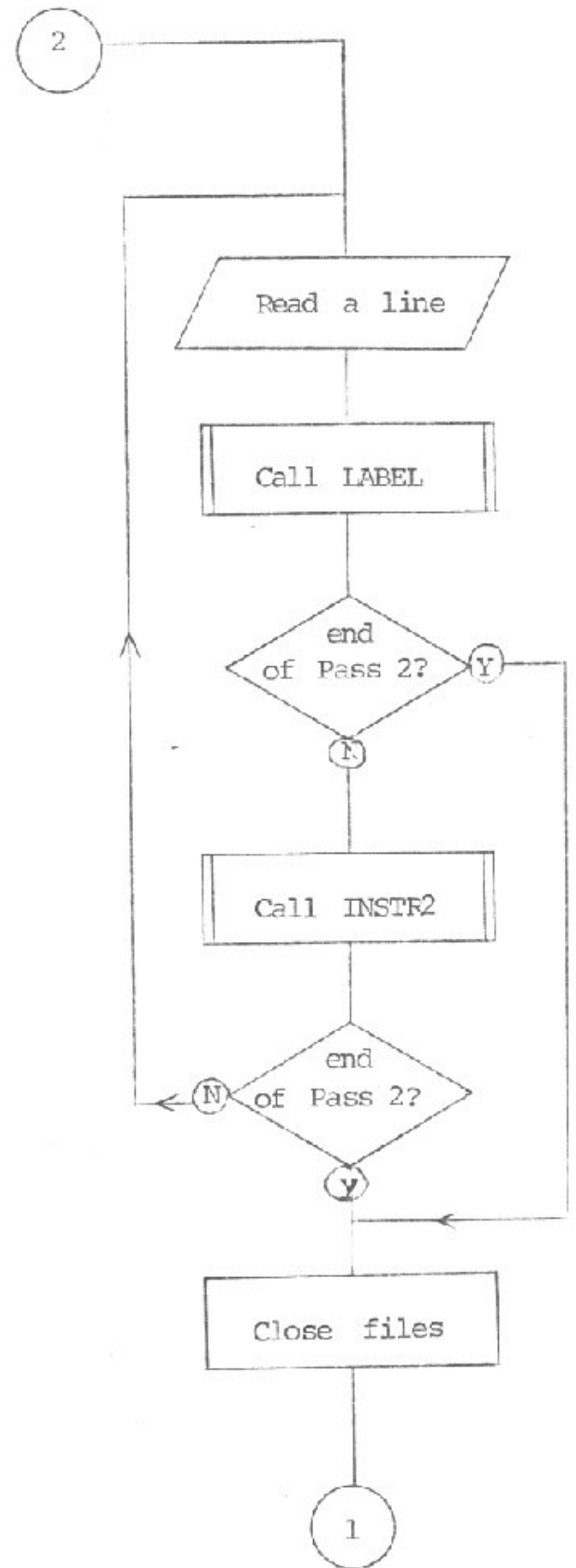
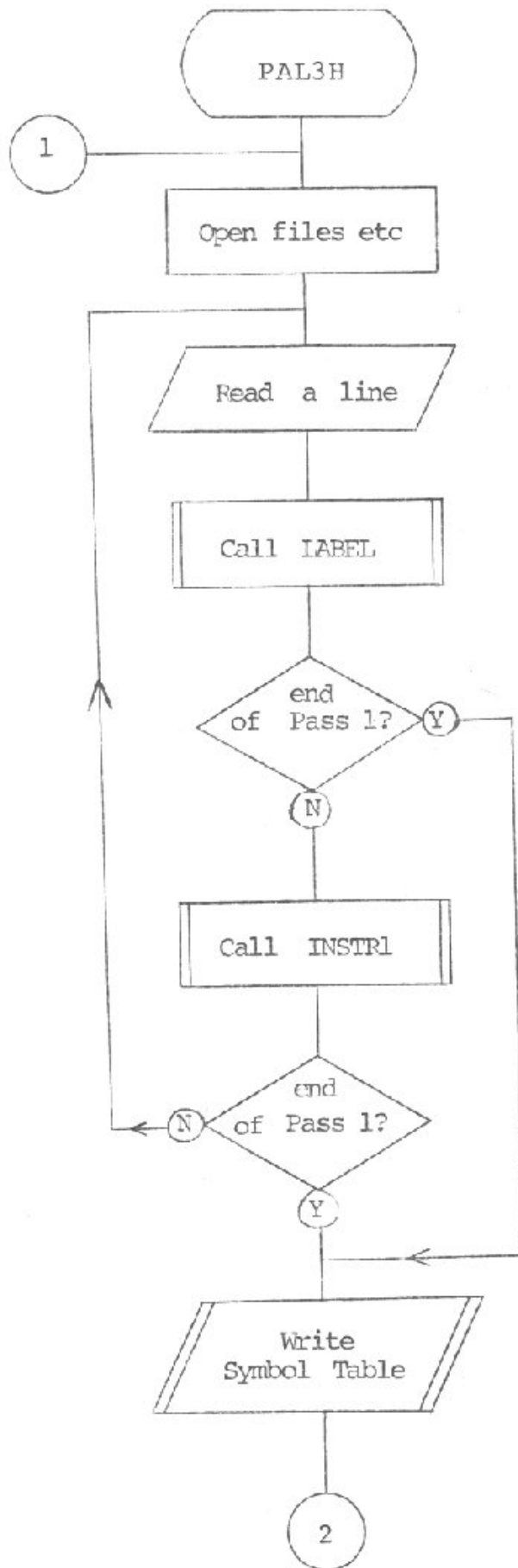
There are two basic groups of instructions - Memory reference instructions and microinstructions. Memory reference instructions require an operand; microinstructions do not require an operand. In all instructions, the first three bits specify the operation code.

#### 1.41 Memory Reference Instructions



### Operation Code

The operation is specified by bits 0 to 2.





PAL3H SUBROUTINE INDEX

No	Name	Subroutine Called	Subroutine Called By
0	PAL3H	6,7,8,9,14,15,22,24	-
1	BINOUT	15	7
2	CLASS	-	3,8
3	EXPR	2,4,5,16,19,20,23	5,7,8
4	GETSYM	-	3,7,8
5	ICERR	23	3,8
6	INSTR1	3,11,18	0
7	INSTR2	1,3,4,10,11,12,13,14,17,18,20,23	0
8	LABEL	2,4,5,11,15,16,18,20,23	0
9	LEADER	-	0
10	LINOUT	17	7
11	LINSKP	-	3,6,8
12	LMNEMS	-	7,13
13	LOOKUP	12	7
14	NOCODE	-	0,7
15	OBJOPCH	-	0,1,8
16	OCTIN	-	3
17	OCTOUT	-	7,10,22,23,24
18	PUTSYM	19,21,23	6,7,8
19	SEARCH	-	3,18
20	SSPACE	-	3,7,8
21	SYMERR	-	18
22	WREND	17	0
23	WRERR	17	3,5,7,8,21
24	WRSYM	17	0

References

- Introduction to Programming                      Chapters 2,3, page 4-17  
(Digital PDP-8 Handbook Series)
- Programming Languages                              Chapter 14  
(Digital PDP-8 Handbook Series)
- PDP-8/E and PDP-8/M Small                      Chapters 3,4  
Computer Handbook