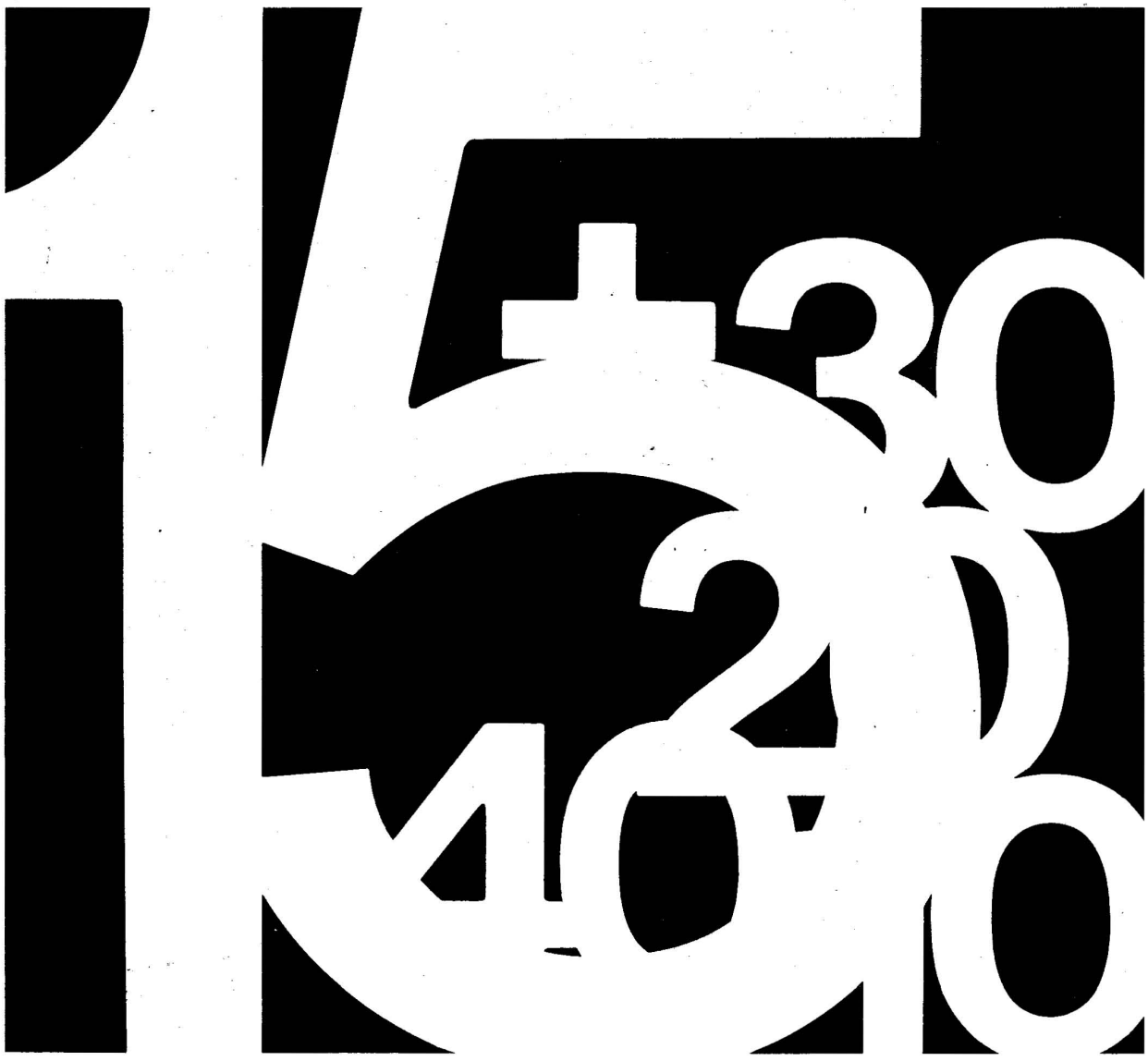
Digital Equipment Corporation
Maynard, Massachusetts

digital

Programmer's Reference Manual

8TRAN
PDP-8 to PDP-15 Translator



8TRAN
PDP-8 TO PDP-15 TRANSLATOR

For additional copies order DEC-15-ENZA-D from Digital Equipment Corporation, Program Library,
Maynard, Massachusetts 01754 Price: $1.60

DIGITAL EQUIPMENT CORPORATION • MAYNARD, MASSACHUSETTS

1st Printing January 1970

CONTENTS

CONTENTS (Cont)

CONTENTS (Cont)

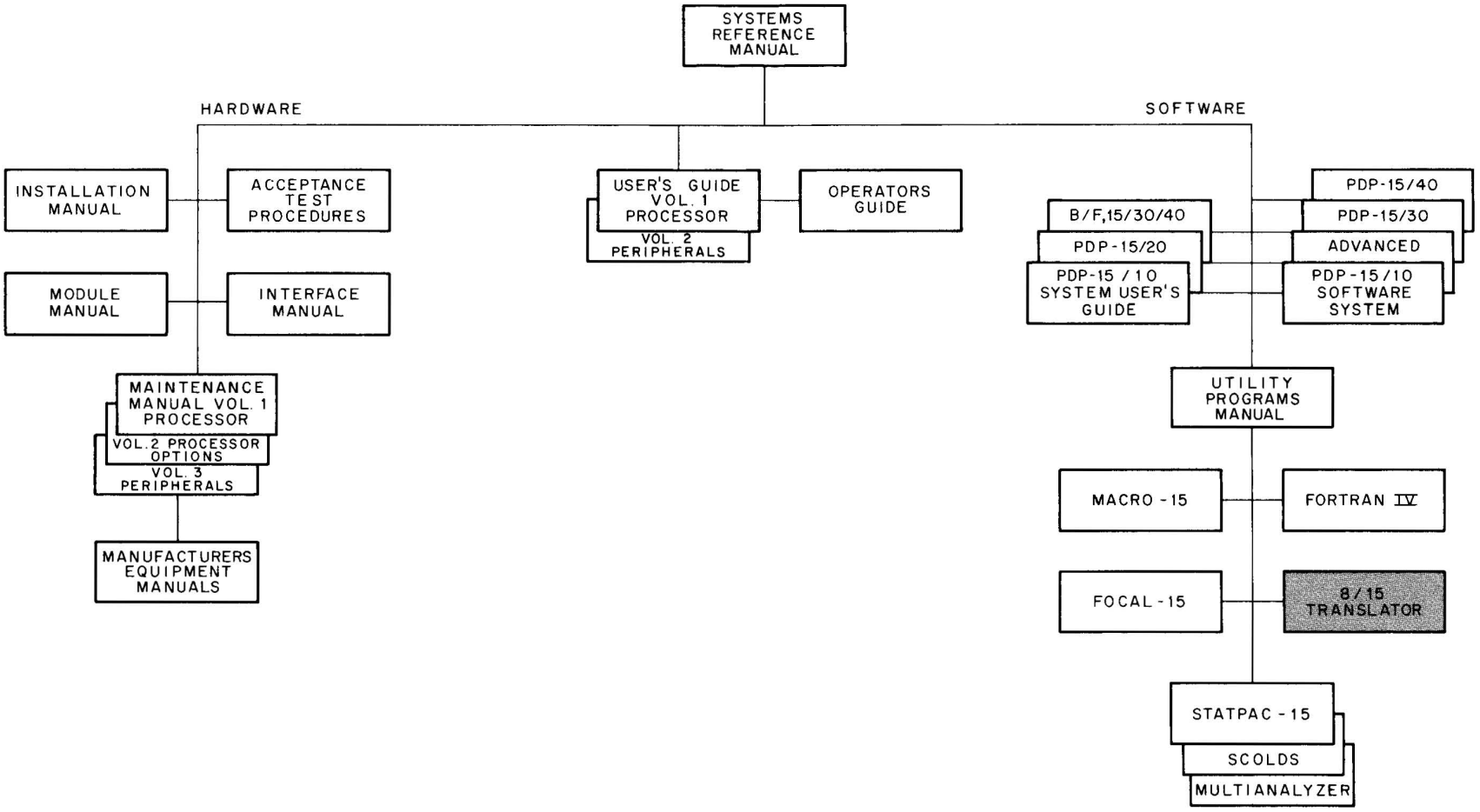
TABLES

PREFACE

8TRAN is a special purpose program designed to assist PDP-8 users in converting software for operation on the PDP-15. It is assumed that the programmer who wishes to use 8TRAN is completely familiar with the PDP-8 and PDP-15 documentation listed below.

PDP-8 User Handbook	F-85
PDP-8 PAL III Assembler	DEC-08-ASAB-D
PDP-8 MACRO-8 Assembler	DEC-08-CMAA-D
PDP-8 PAL-D Assembler	DEC-08-ASAB-D
PDP-15 User's Guide	DEC-15-H2DA-D
PDP-15 MACRO-15 Assembler	DEC-15-AMZA-D
PDP-15/10 User's Guide	DEC-15-GG1A-D
PDP-15/10 Software System	DEC-15-GR1A-D
PDP-15/20 User's Guide	DEC-15-MG2A-D
PDP-15/20 Advanced Software System	DEC-15-MR2A-D

PDP-15 FAMILY OF MANUALS



15-0040

SYSTEM REFERENCE MANUAL – Overview of PDP-15 hardware and software systems and options; instruction repertoire, expansion features and descriptions of system peripherals. (DEC-15-GRAZ-D)

USER'S GUIDE VOLUME 1, PROCESSOR – Principal guide to system hardware includes system and subsystem features, functional descriptions, machine-language programming considerations, instruction repertoire and system expansion data. (DEC-15-H2DA-D)

VOLUME 2, PERIPHERALS – Features functional descriptions and programming considerations for peripheral devices. (DEC-15-H2DA-D)

OPERATOR'S GUIDE – Procedural data, including operator maintenance, for using the operator's console and the peripheral devices associated with PDP-15 Systems. (DEC-15-H2CA-D)

PDP-15/10 SYSTEM USER'S GUIDE – COMPACT and BASIC I/O Monitor operating procedures. (DEC-15-GG1A-D)

PDP-15/20 SYSTEM USER'S GUIDE – Advanced monitor system operating procedures. (DEC-15-MG2A-D)

BACKGROUND/FOREGROUND MONITOR SYSTEM USER'S GUIDE – Operating procedures for the DECtape and disk-oriented Background/Foreground monitors. (DEC-15-MG3A-D)

PDP-15/10 SOFTWARE SYSTEM – COMPACT software system and BASIC I/O Monitor system descriptions. (DEC-15-GR1A-D)

PDP-15/20/30/40 ADVANCED Monitor Software System – ADVANCED Monitor System descriptions; programs include system monitor and language, utility and application types; operation, core organization and input/output operations within the monitor environment are discussed. (DEC-15-MR2A-D)

PDP-15/30 BACKGROUND/FOREGROUND Monitor Software System – Background/Foreground Monitor description, including the associated language, utility, and application programs. (DEC-15-MR3A-D)

PDP-15/40 Disk-Oriented BACKGROUND/FOREGROUND Monitor Software System – Background/Foreground Monitor in a disk-oriented environment is described; programs include language, utility and application types. (DEC-15-MR4A-D)

MAINTENANCE MANUAL VOLUME 1, PROCESSOR – Block diagram and functional theory of operation of the processor logic. Preventive and corrective maintenance data. (DEC-15-HB2A-D)

VOLUME 2, PROCESSOR OPTIONS – Block diagram and functional theory of operation of the processor options. Preventive and corrective maintenance data. (DEC-15-HB2A-D)

VOLUME 3, PERIPHERALS (Set of Manuals) – Block diagram and functional theory of operation of the peripheral devices. Preventive and corrective maintenance data. (DEC-15-HB2A-D)

INSTALLATION MANUAL – Power specifications, environmental considerations, cabling, and other information pertinent to installing PDP-15 Systems. (DEC-15-H2AA-D)

ACCEPTANCE TEST PROCEDURES – Step-by-step procedures designed to ensure optimum PDP-15 Systems operation.

MODULE MANUAL – Characteristics, specifications, timing, and functional descriptions of modules used in PDP-15 Systems.

INTERFACE MANUAL – Information for interfacing devices to a PDP-15 System. (DEC-15-H0AA-D)

UTILITY PROGRAMS MANUAL – Utility programs common to PDP-15 Monitor Systems. (DEC-15-YWZA-D)

MACRO-15 – MACRO assembly language for the PDP-15. (DEC-15-AMZA-D)

FORTRAN IV – PDP-15 version of the FORTRAN IV compiler language. (DEC-15-KFZA-D)

FOCAL-15 – An algebraic interactive compiler-level language developed by Digital Equipment Corporation. (DEC-15-KJZA-D)

PDP-8/15 TRANSLATOR (8TRAN) – A program which assists users in converting PDP-8 software for operation on the PDP-15. (DEC-15-ENZA-D)

CHAPTER 1
INTRODUCTION

PDP-15 8TRAN is a relocatable program which assists in the translation of PDP-8 programs to PDP-15 programs. 8TRAN accepts source coding in PAL-III, PAL-D, or MACRO-8 assembly languages and produces source code in MACRO-15 or CAP-15 assembly languages. Its main functions are:

Re-formatting of statements

Translation of mnemonics

Insertion of flags to indicate either that instructions have been translated or that translation is impossible.

NOTE

EAE coding and any input/output instructions other than those for the reader/punch and Teletype must be modified. Floating point instructions are translated to conform to the PDP-15/10 COMPACT Software System.

CHAPTER 2
INSTRUCTION SETS

2.1 MEMORY REFERENCE INSTRUCTIONS

Table 2-1 shows the correspondence between the two sets.

Table 2-1
Correspondence Between Memory Reference Instructions

PDP-8		PDP-15	
Mnemonic	Octal	Mnemonic	Octal
AND	0000	AND	500000
TAD	1000	TAD	340000
ISZ	2000	ISZ	440000
JMS	4000	JMS	100000
JMP	5000	JMP	600000
DCA	3000	DAC CLA	040000
		CAL	000000
		DZM	140000
		LAC	200000
		XOR	240000
		ADD	300000
		XCT	400000
		SAD	540000

2.2 INDIRECT REFERENCES AND AUTO-INDEX REGISTERS

Single level indirect addressing is identical on both machines.

	PDP-8	PDP-15	
I	0400	*	020000

The Auto-Index Registers (10-17) also operate identically. However, the PDP-8 has one set of Auto Index Registers for each 8K memory field, while the PDP-15 has only one set of Auto Index Registers in Page 0 of Bank 0.

2.3 OPERATE INSTRUCTIONS

A single group of Operate instructions in PDP-15 corresponds to the two groups in PDP-8, as shown in Table 2-2.

Table 2-2
Correspondence Between Operate Instructions

PDP-8			PDP-15	
Group 1	NOP or OPR	7000	NOP or OPR	740000
	CLA	7200	CLA	750000
	CLL	7100	CLL	744000
	CMA	7040	CMA	740001
	CML	7020	CML	740002
	RAR	7010	RAR	740020
	RAL	7004	RAL	740010
	RTR	7012	RTR	472020
	RTL	7006	RTL	742010
	IAC	7001	IAC	740030
Group 2	CLA	7600	CLA	750000
	SMA	7500	SMA	740100
	SZA	7440	SZA	740200
	SNL	7420	SNL	740400
	SPA	7510	SPA	741100
	SNA	7450	SNA	741200
	SZL	7430	SZL	741400
	SKP	7410	SKP	741000
	OSR	7404	OAS	740004
	HLT	7402	HLT	740040

2.4 LAW INSTRUCTION

The LAW instruction in PDP-15 has no equivalent in PDP-8. The mnemonic LAW N has an octal value of 760000 + N.

2.5 PAGING

The address portion of Memory Reference Instructions consists of 8 bits on the PDP-8 and 12 bits on the PDP-15, permitting direct addressing of 4K on the PDP-15.

Using indirect address references, the address size is 12 bits in PDP-8 and up to 15 bits in PDP-15, so that data and instruction fields are not required in PDP-15.

CHAPTER 3
ASSEMBLERS

The symbolic programs acceptable to PAL III/MACRO-8 and to MACRO-15 are similar in most respects. The important differences which do exist are discussed in this chapter.

3.1 FORMAT

The MACRO-15 Assembler is field-oriented, which means that the interpretation of a statement depends on the field in which each element of the statement lies. There are four fields:

LABEL	(Field delimiter)
OPERATION	(Field delimiter)
ADDRESS	(Field delimiter)
COMMENT	(Statement delimiter)

A field delimiter is either a space or a tab. A statement delimiter is either a carriage return or a semicolon. In this document, tabs are indicated with the symbol →|, and carriage returns are indicated with).

In MACRO-15, there is no field for an indirect reference because indirect addressing is indicated by an asterisk (*) immediately following the mnemonic operator in the operation field.

Examples:

	PDP-8	PDP-15
TAG,	TAD A	TAG →| TAD →| A
	ISZ I B	→| ISZ* →| B
	JMP C	→| JMP →| C

Tabs are normally preferred to spaces as field delimiters. MACRO-15 does not require commas to terminate labels. Labels appearing on successive lines without any code are given consecutive addresses by MACRO-15, not the same address; an important difference from the PDP-8 assembler.

3.2 SYMBOLS

Symbols in MACRO-15 may use period (.) and percent sign (%) in addition to letters and numbers. The initial character must be a letter, period (.), or percent sign (%).

3.3 EXPRESSION OPERATORS

MACRO-15 has a more extensive set of operators. Addition (+), Subtraction (-), AND (&), and Inclusive OR (!) are supplemented by Exclusive OR (\), Multiplication (*), and Division (/).

3.4 NUMBERS

Octal and decimal numbers in the range $\pm 2^{18}-1$ for unsigned integers and $\pm 2^{17}-1$ for signed integers are available in MACRO-15. Double precision and floating-point constants (DUBL and FLTG pseudo-ops of MACRO-8) are not permitted in MACRO-15.

3.5 LOCATION COUNTER

The Location Counter may be referenced by period (.) in both systems. It is set as follows:

PDP-8	PDP-15
* n	.LOC n
PAGE n	Ignored
	Paging is redundant in PDP-15

The Location Counter is advanced as follows:

PDP-8	PDP-15
* . + n	.BLOCK n

The .BLOCK pseudo-op makes the operation more explicit in PDP-15.

3.6 TEXT HANDLING

Pseudo-ops to perform packing of 6-bit trimmed ASCII characters are available in both systems.

PDP-8	PDP-15
TEXT	.SIXBT

The 18-bit word in PDP-15 permits 3 characters per word, as compared with 2 characters per word in PDP-8.

An additional pseudo-op which performs the packing of five 7-bit ASCII characters in two words (.ASCII) is available in PDP-15.

3.7 TERMINATING PSEUDO-OPS

The correspondence between the two systems is:

PDP-8	PDP-15
PAUSE	.EOT
$	.END

3.8 LITERALS

Page zero literals have no meaning in PDP-15. The correspondence is:

PDP-8	PDP-15
[	(
(	(
]	)
)	)

It should be noted that neither nested literals, e.g., TAD (TAD (20)), nor 8-bit ASCII characters, e.g., TAD ("A), are allowed in MACRO-15.

3.9 SYMBOL TABLE

The Symbol Table of MACRO-15 cannot be deleted, hence EXPUNGE is not a valid pseudo-op.

Since the permanent Symbol Table of MACRO-15 is searched for octal matching and not symbol matching the pseudo-ops FIXMRI and FIXTAB are redundant. A memory reference instruction is defined by a parameter assignment, e.g., IDX=ISZ, or IDX=440000.

3.10 USER MACROS

User Macros can be more elaborate in MACRO-15. The correspondence between the sets is:

PDP-8	PDP-15
DEFINE	.DEFIN
<	Not used
>	.ENDM

Example:

PDP-8	PDP-15	
DEFINE SUB A B	.DEFIN	SUB A,B
< CLA	LAC	B
TAD B	CMA	
CIA	TAD	(1
TAD A>	TAD	A
	.ENDM	

CHAPTER 4
INPUT/OUTPUT

The most important difference between the PDP-8 and the PDP-15 in I/O lies in the fact that an extra 3 bits (12-14) are available in the PDP-15 instruction word.

Bits 12 and 13 are used for subdevice selection, and Bit 14, when set, clears the AC at event time 1; i.e., prior to transfers to/from the AC.

4.1 FLAGS

The PDP-15 has two instructions, not available on PDP-8, which read and clear flags.

IORS	Input/Output Read Status
CAF	Clear All Flags

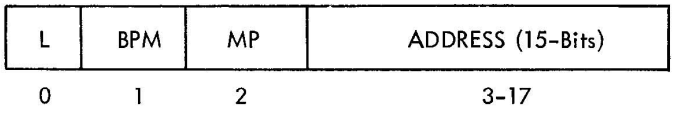
4.2 INTERRUPT

The interrupt structure is identical on both machines. When the interrupt function is enabled (ION), the setting of a flag will cause an interrupt; i.e., an effective JMS to location 0 of field 0.

The PDP-15 has an 18-bit word so that the full 15-bit address of the interrupt location is stored, eliminating the need for the 6-bit Interrupt Buffer in the PDP-8.

The remaining 3 bits of the PDP-15 word are used to store the state of the Link, Bank/Page Mode, and Memory Protect.

PDP-15



4.3 TELETYPE ®

There are two differences in the IOT instructions between PDP-8 and PDP-15.

KCC does not exist on the PDP-15. The Keyboard Flag is cleared by issuing a KRB, which also reads the buffer.

KRS (only recognized in the PDP-15/10 COMPACT System) performs the function of Keyboard Reader Select, a facility not available in PDP-8.

PDP-8	PDP-15
KCC	None (use KRB)
KRS	None (use KRB)
---	KRS (Keyboard Reader Select)

All other Teletype IOTs are identical.

4.4 READER/PUNCH

All reader/punch functions available on the PDP-8 are also available on the PDP-15. The PDP-8 operates in Alphanumeric mode only, while the PDP-15 operates in Binary mode as well as Alphanumeric mode. (Binary permits the reading of an 18-bit word from 3 lines of tape and the punching of a single line in the format of the binary read.)

PDP-8	PDP-15
RSF	RSF
RRB	RRB
RFC	RSA
--	RSB
PLS	PSA
--	PSB
PCF	PCF
PSF	PSF

4.5 DECTAPE

The DECtape controllers, TC01 on PDP-8 and TC02 on PDP-15, work in an identical manner.

The standard format of data on the tape differs significantly (see Table 4-1). There is, however, no incompatibility of control word format; therefore, a standard block of 129 words written by the PDP-8 can be read as a block of 86 words by the PDP-15.

®Teletype is the registered trademark of Teletype Corporation.

Table 4-1
Tape Standard Data Format

	PDP-8	PDP-15
Words per Block	129_{10} (12 bits)	256_{10} (18 bits)
Blocks	$0\text{-}2701_8$	$0\text{-}1101_8$
Address of Word Count	7754	30
Address of Current Address	7755	31

The instructions to the two controllers differ in only one respect. The single IOT DTSF (skip if error flag or DECtape control flag=1) in the TC01 is replaced by the two IOTs, DTDF (skip if DECtape control flag=1) and DTEF (skip if DECtape error flag=1), on the TC02.

The two Status Registers, A and B, are 12 bits on both machines ($AC_{0\text{-}11}$ on the PDP-15).

4.6 IOTs IN PERMANENT SYMBOL TABLE

MACRO-15 assumes that input/output will be handled by I/O System Macros using device handlers. Device-dependent IOTs are therefore not included in the Symbol Table. The P (parameter) option in MACRO-15 provides the facility for adding to the Symbol Table prior to an assembly; IOTs may always be assigned in this manner if required.

Any EAE coding for the PDP-8 should be rewritten for the PDP-15, since:

a. The word length on the two machines is different.
b. The PDP-15 EAE is considerably more powerful than its PDP-8 counterpart.

Table 5-1 indicates the correspondence between the two instruction sets.

Table 5-1
Correspondence Between Instruction Sets

PDP-8	PDP-15
DVI	DVI
NMI	NORM
SHL N	LLS+N+1
ASR N	LRSS+N+1
LSR N	LRS+N+1
MQL	LMQ
MUY	MUL
MQA	OMQ
CAM	CLQ
SCA	OSC

5.1 MULTIPLICATION AND DIVISION

Signed operations (MULS and DIVS) are available on PDP-15. The full number of shifts is always performed in multiplication and division on PDP-8. The number of shifts in PDP-15 is programmable (contained in bits 12-17 of the instruction word) to reduce execution time where numbers are less than 18 bits in magnitude.

In division, the high order part only or the lower order part only of the dividend may be used in the operation as alternatives to the usual double word operation.

(IDIV, IDIVS, FRDIV, FRDIVS)

5.2 SHIFTING

Three additional shifting operations are available on PDP-15. They are:

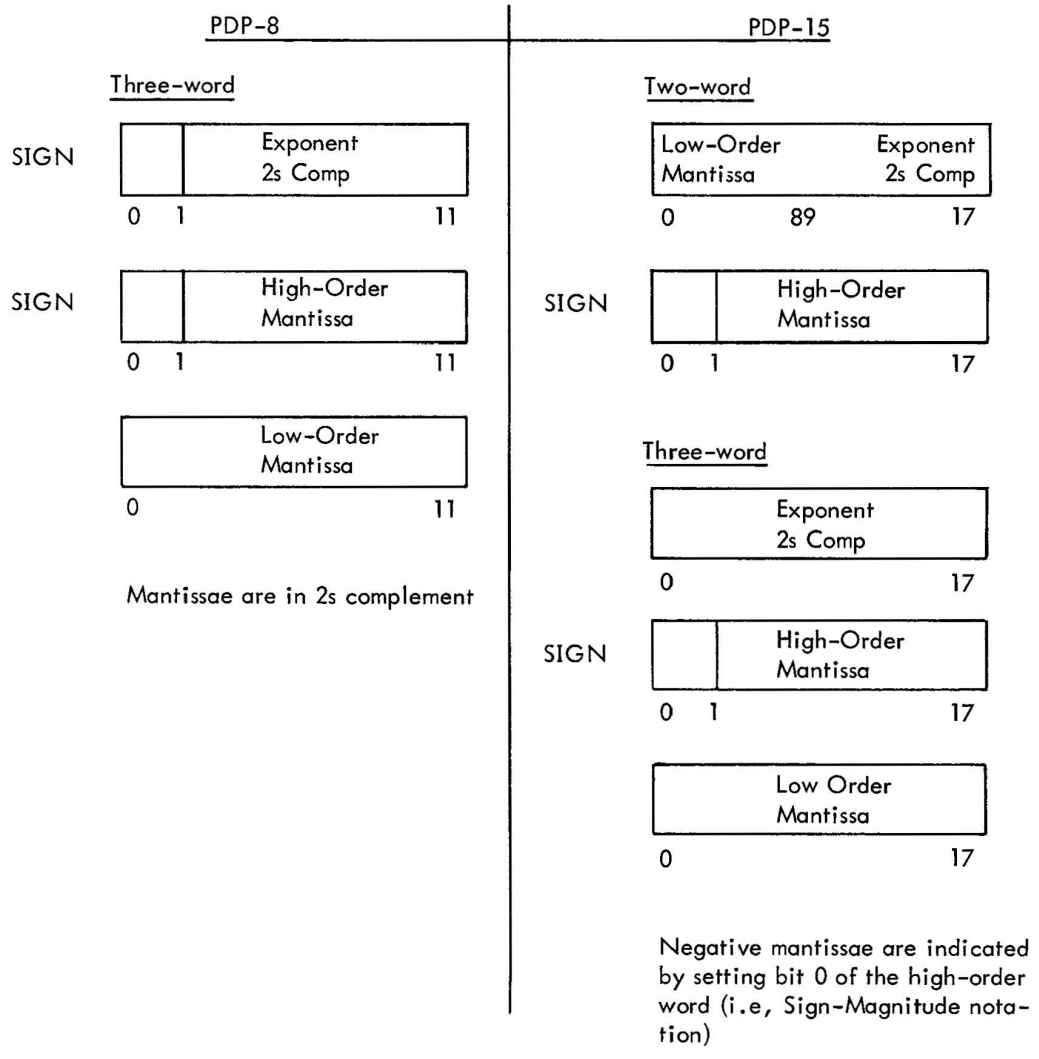
a. Signed left shift (LLSS)
b. Accumulator left shift (ALS)
c. Signed accumulator left shift (ALSS).

CHAPTER 6

FLOATING-POINT ARITHMETIC

Both the format and the treatment of floating-point numbers are different on the two machines.

6.1 FORMAT



6.2 ARITHMETIC PACKAGE

The PDP-8 performs floating-point arithmetic by use of an interpreter. The PDP-15 uses subroutine calls to perform its arithmetic, the address of the argument being in the location following the JMS. Indirect addresses are indicated by setting bit 0 of the word (i.e., XCT).

The correspondence between the two systems is shown in Table 6-1.

Table 6-1
Correspondence Between Arithmetic Packages

PDP-8	PDP-15
JMS 17 (Enter Interpreter)	None (not interpretive)
FADD A	JMS →|FAD A
FSUB I B	JMS →|FSUB XCT →|B
FMPY	JMS →|FMPY
FDIV	JMS →|FDVD
FGET	JMS →|FLAC
FPUT	JMS →|FDAC
FNOR	JMS →|%FNOR
FEXT	None (not interpreted)

6.3 INPUT/OUTPUT

The PDP-15/10 COMPACT system has an I/O package similar to that of the PDP-8. Numbers are input to and output from the floating accumulator.

The subroutine call for the PDP-15/10 is followed by an argument. On input, bit 0 of the argument indicates the input device (other bits are ignored). On output, bit 0 indicates the output device, the other bits indicate the number of digits in the mantissa output.

PDP-8	PDP-15
JMS I 5	{ JMS →|FLIP 0
JMS I 6	(JMS →|FLOP 6

Floating-point constants must be changed, and where FLTG is used in MACRO-8 the appropriate octal numbers must be inserted.

Examples:

Decimal	PDP-8	PDP-15
0.1	7775 3146 3146	460775 314631
-7.0	0003 4400 0000	000003 740000
π	0002 3110 3755	550002 311037
5.0	FLTG 5.0	000003 240000

CHAPTER 7
TRANSLATOR FUNCTIONS

The Translator program accepts a symbolic source tape (or file) written in either PAL III, PAL D, or MACRO-8, and translates it to MACRO-15 or CAP-15 assembly language, within the limits described below.

7.1 FORMATS

Each statement is re-formatted in MACRO-15 format. The Translator inserts a tab after a label field and after the operation field, so that the MACRO-15 listing appears in columns as shown in the examples below.

PDP-8	PDP-15		
TAG, CLA CMA	TAG	CLA!CMA	
TAD I Z AUTO		TAD*	AUTO

[The optional page zero indicator (Z) is ignored.]

7.2 TRANSLATION

The following translations are performed. (Mnemonics processed by the Translator, and their translation where appropriate, are listed in Appendix A.)

7.2.1 Memory Reference Instructions

PDP-8	PDP-15
DCA LOC	DAC → LOC CLA

Where DCA is followed by TAD, the CLA in the above translation may sometimes be eliminated. The Translator treats the situation in one of three ways:

PDP-8	PDP-15		
DCA LOC TAD LOC		DAC	LOC
DCA LOC1 TAD LOC2		DAC LAC	LOC1 LOC2
DCA LOC TAG,TAD LOC		DAC CLA	LOC
	TAG	TAD	LOC

In the last example above, the CLA is not eliminated because the TAD is labelled.

Where successive DCAs are translated, DZM replaces each DCA after the first, terminating the last DZM with a CLA. If a DCA is tagged, however, DZM is not generated.

PDP-8	PDP-15		
DCA LOC1		DAC	LOC1
DCA LOC2		DZM	LOC2
DCA LOC3		DZM	LOC3
TAG,DCA LOC4		CLA	
JMP LOC5	TAG	DAC	LOC4
		CLA	
		JMP	LOC5

All other MRIs are transferred without change.

7.2.2 Input/Output Instructions

PDP-8	PDP-15
RFC	RSA
PLS	PSA

All other Teletype and reader/punch instructions are transferred without change. IOT instructions for other devices are declared undefined symbols (see Paragraph 7.3.1.4).

7.2.3 Operate Instructions

PDP-8	PDP-15
IAC	IAC
CLA IAC	CLA!IAC
CIA	CMA!IAC
CLL RTL	CLL RTL
OSR	OAS
CLA OSR	LAS

In addition to separating double-rotate instructions from other instructions because of conflicting event times, single-rotate instructions are also separated when they conflict.

7.2.4 Pseudo-Operations

7.2.4.1 Miscellaneous

PDP-8	PDP-15
DECIMAL	.DEC
OCTAL	.OCT
PAUSE	.EOT
$	.END

The PDP-8 pseudo-ops PAGE and * for setting the location counter are not translated.

7.2.4.2 Text Handling

PDP-8	PDP-15
TEXT	.SIXBT

Both .SIXBT in MACRO-15 and TEXT in PDP-8 assemblers treat text strings as trimmed ASCII. MACRO-15 stores three characters per 18-bit word.

7.2.4.3 Macro Defining - The left angle bracket (<), used in MACRO-8, is ignored. However, instructions within a macro are translated. Since there is no macro facility in the CAP-15 Assembler, the 4K COMPACT version of 8TRAN ignores macro definitions. (Macro names, DEFINE or < > will be flagged as undefined symbols when encountered.)

PDP-8	PDP-15
DEFINE	.DEFIN
<	ignored
>	.ENDM

7.2.5 Literals

PDP-8	PDP-15
[	(
]	)
("N	(nnn

Page 0 literals are translated as ordinary literals. Instructions within literals are translated. ASCII characters are translated into their 7-bit octal equivalent.

7.2.6 Floating Point

PDP-8	PDP-15
FEXT	Ignored
FADD	JMS →| FAD
FSUB	JMS →| FSUB
FMPY	JMS →| FMPY
FDIV	JMS →| FDVD
FGET	JMS →| FLAC
FPUT	JMS →| FDAC
FNOR	JMS →| %FNOR
I	XCT
JMS I 5	JMS →| FLIP 0
JMS I 6	JMS →| FLOP 6
JMS I 7	Ignored

The calls to the Input/Output routines (JMS I 5 and JMS I 6) and the entry to the interpreter (JMS I 7) are frequently given other names by parameter assignment. Where these instructions occur in a parameter assignment, the following translations occur.

PDP-8	PDP-15
JMS I 5	JMS →| FLIP
JMS I 6	JMS →| FLOP
JMS I 7	NOP

The arguments of JMS FLIP and JMS FLOP are dropped and any entry to the interpreter is effectively ignored. However, the input and output calls must be followed by arguments, so insertion would have to be made at appropriate points in the program.

Floating-point variable storage can be reduced by one location for each variable, but no program error will occur if this is not done.

7.3 FLAGS

Flags are inserted to signal translations (or the absence of a translation) which may result in incorrect operation when assembling on the PDP-15. A flag occurs as a comment after the relevant instruction, starting on a new line, and is always preceded by

/**-

followed by a brief message, as defined below and summarized in Appendix B. There are two types of flags, optional and mandatory.

7.3.1 Optional Flags

Optional flags may be suppressed by the user because the appearance of these flags does not necessarily mean that changes have to be made to the program. (The method of suppressing optional flags is explained in Chapter 8.) The Translator may insert optional flags for the conditions described below.

7.3.1.1 Additional Code - When the Translator generates extra lines of code, a flag may be raised. The two situations are:

DCA	A DCA instruction was translated into DAC followed by CLA.
SMI	(Segmented Micro-instruction) - A segmented micro-instruction was encountered which could be translated only by splitting it into two instructions.

7.3.1.2 Relative Addresses - Since extra lines of code are generated, any relative address which occurs in the program may be in error.

REL An address followed by ±n (where n is a number) was encountered.

7.3.1.3 Rotate Instructions - Since the word length of the two machines is different, the use of rotate instructions may result in incorrect operation.

ROT A single or double rotate instruction was encountered.

7.3.1.4 Undefined Symbols - Since the Translator contains tables of pseudo-operations, Memory Reference, Operate, and Teletype and reader/punch I/O instructions only (the latter two being limited to CAP-15), any other symbol encountered in the operation field is undefined. Provision is therefore included to read a User Symbol Table prior to translation, so that a symbol is not declared undefined until a search of all user symbols has been made.

US An undefined symbol was found in the operation field.

NOTE

1) If a User Symbol Table is to be retained for a number of tapes, each tape except the last must be terminated by a PAUSE pseudo-op.
2) If a User Symbol Table is not read prior to translation, it will be built during translation; hence only forward references in the operation field will be flagged.

7.3.2 Mandatory Flags

The flags in this group are always typed when applicable. They are generated for the following reasons.

7.3.2.1 Location Counter Settings - The setting of the location counter by PAGE and * is ignored, and the code is simply printed as a comment.

LOC A location counter setting was ignored.

NOTE

Each translation is preceded by .ABS and .LOC 100.

7.3.2.2 Illegal Characters - When an illegal character is encountered, its octal value in 7-bit ASCII is output. The character is ignored.

IC nnn Illegal character.

7.3.2.3 Literals - Instructions within literals are translated only if the translation comprises a single line of code. Nested literals are illegal in MACRO-15.

LIT A literal was nested, or, if translated, would have produced extra code.

7.3.2.4 Multiple Precision Constants - Double precision integers (DUBL) and floating-point constants (FLTG) have a different representation in PDP-15. They are not translated.

MPC A DUBL or FLTG pseudo-operation was encountered and ignored.

7.3.2.5 Skip Instructions - If the instruction following a Skip instruction is segmented, the Skip will cause an error at execution:

SKP A segmented micro-instruction followed a Skip instruction.

7.3.2.6 Symbol Table Overflow - The symbol table capacity is 1024 symbols in the CAP-15 version, and all of the unused core between .SCOM+2 and .SCOM+3 in the MACRO-15 version. If the symbol table is filled, no further symbols will be stored.

SE Symbol Table Exceeded.

CHAPTER 8
OPERATION

8TRAN exists in three versions to allow operation in the various PDP-15 software environments. The Advanced and Background/Foreground Monitor version uses standard device handlers for I/O functions. The Basic I/O Monitor version is similar, differing only in the assignment of device handlers. The COMPACT version operates using its own embedded I/O functions. Appendix C provides a typical example of 8TRAN operation in the Advanced Monitor Environment.

8.1 MONITOR VERSIONS

These versions of 8TRAN are relocatable binary paper tapes which must be loaded either by the Linking Loader or DDT.

8.1.1 .DAT Slot Assignments

The following .DAT slots are used:

-15 Input	(Default - DTA2)	- Advanced and Background/ Foreground version
-14 Output	(Default - DTA1)	- Advanced and Background/ Foreground version
-3 Messages	TTA	- Both versions
-2 Command String	TTA	- Both versions
3 Input	PRA	- Basic I/O Monitor version
5 Output	PPA	- Basic I/O Monitor version

NOTE

The Advanced and Background/Foreground version uses the system Macro .FSTAT. Any file oriented device handler used must recognize .FSTAT, otherwise an IOPS6 error will occur.

8.1.2 Loading Procedures

8.1.2.1 Advanced and Background/Foreground Environment - When the Monitor is in core, perform the following steps:

a. Assign .DAT slots (optional).

b. Type:

GLOAD)

c. When the Linking Loader is in core, it types:

LOADER Vnn
>

d. If using Advanced Monitor, type:

← 8TRAN (ALT MODE)

If using Background/Foreground Monitor, type:

← 8TRAN (ALT MODE)

e. When loaded, 8TRAN types:

8TRAN Vnn
>

and waits for a command string (see Paragraph 8.1.2.3).

8.1.2.2 Basic I/O Monitor Environment - Perform the following steps:

a. Put the 8TRAN tape in the tape reader.

b. Set the ADDRESS Switches to 17720 (8K).

c. Press I/O RESET and READIN.

d. When loaded, 8TRAN types

8TRAN Vnn
>

and waits for command string (see Paragraph 8.1.2.3).

8.1.2.3 Command String - 8TRAN expects a command string in the following format:

Options ← Filename) or (ALT MODE)

Options: See Paragraph 8.1.3

Filename): Restarts 8TRAN when current translation is completed.

(ALT MODE):

a. Causes a return to the Monitor after translation is completed (Advanced and Background/Foreground).

b. Halts 8TRAN when current translation is complete (press CONTINUE to restart).

8.1.3 Options

There are two options in 8TRAN, which may be exercised separately or together:

Ś	Read a symbol table prior to translation.
F	Suppress output of flags.

8.1.3.1 Symbol Table - If S is typed, it must be followed by the name of the symbol table file. The file will be a symbol table output by either PAL III or MACRO-8.

Example S ← SYMTAB)

The program reads the symbol table, stores it and types

SYMBOL TABLE READ
>

The program now requires the name of the file to be translated.

e.g., ← MAC8) or (ALT MODE)

8.1.3.2 Flag Suppression - If F is typed, 8TRAN responds by typing FLAGS, after which it waits for the user to type any or all of the following

DCA, REL, ROT, SMI, US,

to suppress output of the corresponding flags. The flag names may appear in any order, separated by space or tab, and terminated by a carriage return. Example:

FLAGS - DCA US REL)

8.1.4 Translation

The program then proceeds to translate the file named in the command string. The file name extension for input is assumed to be SRC unless it is given in the command string. The file name extension on output will always be SRC irrespective of the extension given in the command string. It is recommended that the extension PAL be given to PDP-8 programs so that there will be no confusion between original and translated programs.

8.1.5 Other Features

a. PAUSE - When a PAUSE is encountered, the symbol table is preserved for the translation of other tapes. The program types:

```
PAUSE
>
```

and waits for another command string.

b. $ - If a $ is encountered in a translation where the last command string was terminated by ALT MODE, either the user is returned to the Monitor (Advanced and Background/Foreground Environment) or 8TRAN restarts (Basic I/O Monitor Environment). If a $ is encountered when the last command string was terminated with), 8TRAN restarts and types

```
8TRAN Vnn
>
```

c. CTRL P - If another translation is required, type CTRL P at any time to cause 8TRAN to restart with

```
8TRAN Vnn
>
```

8.1.6 Error Conditions

a. If the command string is not understood,

```
??
>
```

is typed by the translator; a corrected command string should then be typed by the user.

b. If the name of the program to be translated is not on the input device,

```
INPUT FILE NOT ON DEVICE
>
```

is typed, and the command string must be retyped with the correct name.

c. If the name of the program (with SRC extension) is already on the output device,

```
OUTPUT FILE ALREADY ON DEVICE TYPE ↑P TO RESTART OR CR TO OVERWRITE
```

is typed and the user takes appropriate action.

d. If an IOPS4 error (I/O device not ready) occurs, type CTRL R when the condition has been corrected.

e. Refer to the applicable User's Guide or Software System manual for a description and listing of all IOPS errors.

8.2 COMPACT VERSION

This version of 8TRAN is an absolute binary paper tape which must be loaded using the COMPACT Loader.

8.2.1 Loading Procedure

Perform one of the following two procedures, depending upon whether you are using the low speed reader (ASR33) or the high speed reader (PC-15) as the loading device for the loader.

a. Low-Speed Reader

1. Set the BANK/PAGE switch to PAGE.
2. Place the tape containing the Low Speed Hardware Readin Binary Loader in the ASR33 reader.
3. Set the reader switch to ON.
4. Set the ADDRESS switches to 7700 (17700 8K).
5. Press I/O RESET and READIN. When the Loader is loaded, the computer will halt with 777777 in the AC.
6. Set the reader switch to OFF and place the 8TRAN tape in the ASR33 reader.
7. Set the reader switch to ON.
8. Press START. 8TRAN will be loaded.

b. High-Speed Reader

1. Set the BANK/PAGE switch to PAGE.
2. Place the tape containing the High Speed Hardware Readin Binary Loader in the PC15 reader.
3. Set the ADDRESS switches to 7720 (17720 8K).
4. Press I/O RESET and READIN. When loading is complete, the computer will halt with 777777 in the AC.
5. Place the 8TRAN tape in the PC15 reader and press START. 8TRAN will be loaded.

8.2.2 Initialization Sequence

When 8TRAN is loaded, it types:

8TRAN Vnn

and proceeds to type a series of messages as follows:

Message	Option	User Types
*IN	PC15 or ASR33 reader input	H) To select PC15 L) To select ASR33
*OUT	PC15 or ASR33 punch output	H) L) As above
*SYM	Symbol Table	Y) Read symbol table.

NOTE

The symbol table tape must be in the reader prior to typing Y, and it must be terminated with an EOT (ASCII 04) symbol. When finished, 8TRAN types:

SYMTAB

N) No symbol table.

Message	Option	User Types
*FLG	Flag Suppression	

NOTE

Place the program to be translated in the reader before proceeding.

	N) No suppression, proceed with translation.
	Y) Select suppression option. List flags.†
*DCA	Y) Suppress.
	N) Allow.
*REL	Y) Suppress.
	N) Allow.
*ROT	Y) Suppress.
	N) Allow.
*SMI	Y) Suppress.
	N) Allow.
*US	Y) Suppress.
	N) Allow.

8.2.3 Translation

Translation proceeds automatically after the carriage return ( ) which terminates the response to the *US message or after the carriage return ( ) following an "N" response to the *FLG message. 8TRAN will restart when the current translation is completed.

†See Paragraph 7.3

8.2.4 Other Features

a. PAUSE - When a PAUSE is encountered by 8TRAN, the symbol table is preserved for the translation of other tapes. The program types:

```
PAUSE
↑P
```

Place the next tape in the reader and type CTRL P.

b. CTRL P typed at any other time will cause the program to restart with

```
8TRAN
*IN
```

c. $ - When a $ is encountered the program restarts, as above.

d. The program may be started at location 100.

8.2.5 Error Conditions

There are two conditions that will cause the program to halt in the COMPACT environment:

a. When the PC15 paper tape punch is out of paper tape, the program halts at location 70 with all ones in the AC. To continue, reload tape into the punch and press CONTINUE.

b. When an interrupt occurs, not caused by the PC15 or ASR33, the program halts at location 70 with the IORS in the AC. Press CONTINUE to execute a CAF instruction, in an attempt to clear the cause of the interrupt.

APPENDIX A

SYMBOL TRANSLATIONS

PDP-8	PDP-15
Memory Reference	
AND	AND
TAD	TAD
ISZ	ISZ
DCA	(DAC (CLA
JMS	JMS
JMP	JMP
I	*
Z	Ignored
Operate	
NOP	NOP
OPR	OPR
IAC	IAC
RAL	RAL
RTL	RTL
RAR	RAR
RTR	RTR
CML	CML
CMA	CMA
CLL	CLL
CLA	CLA
HLT	HLT
OSR	OAS
SKP	SKP
SNL	SNL

PDP-8	PDP-15
Operate (Cont)	
SZL	SZL
SZA	SZA
SNA	SNA
SMA	SMA
SPA	SPA
Combined Operate	
CIA	CMA!IAC
STL	STL
GLK	GLK
STA	CLC
LAS	LAS
Input/Output	
IOF	IOF
ION	ION
IOT	IOT
KSF	KSF
KRB	KRB
TCF	TCF
TSF	TSF
TLS	TLS
RFC	RSA
RSF	RSF
RRB	RRB
PLS	PSA

PDP-8	PDP-15
Input/Output (Cont)	
PCF	PCF
PSF	PSF
Floating Point	
FEXT	Ignored
FADD	JMS FAD
FSUB	JMS FSUB
FMPY	JMS FMPY
FDIV	JMS FDVD
FGET	JMS FLAC
FPUT	JMS FDAC
FNOR	JMS%FNOR
I	XCT
JMS I 5	JMS FLIP 0
JMS I 6	JMS FLOP 6
JMS I 7	Ignored

PDP-8	PDP-15
Pseudo Operators	
PAGE, FIELD, *	Ignored
DECIMAL	.DEC
OCTAL	.OCT
DUBL, FLTG	Ignored
TEXT	.SIXBT
PAUSE	.EOT
$	.END
DEFINE	.DEFIN
<	Ignored
>	.ENDM
EXPUNGE, FIXMRI, FIXTAB	Ignored

APPENDIX B

FLAGS

Group	Descriptor	Meaning
Optional	DCA	A DCA instruction was translated.
	REL	A relative address was encountered.
	ROT	A rotate microinstruction was encountered.
	SMI	Segmented microinstruction.
	US	An undefined symbol occurred in the operation field.
Mandatory	IC nnn	An illegal character was encountered and ignored.
	LIT	A literal was nested, or, if translated, would have produced extra code.
	LOC	A location counter setting was ignored.
	MPC	A DUBL or FLTG pseudo-operation was encountered and ignored.
	SE	Symbol Table Exceeded.
	SKP	An SMI followed a Skip instruction.

APPENDIX C

8TRAN DEMONSTRATION

The appendix consists of a demonstration of 8TRAN operation in the Advanced Monitor environment. The listing in the left column is the MACRO-8 source program to be translated. (For the convenience of the reader, additional spaces have been inserted in the body of the listing to align the code.) The column on the right on the page is an 8TRAN output listing showing the results of translation.

NOTE

Summaries of symbol translations and diagnostic flags are provided in Appendices A and B respectively.

MACRO-8 Program

```
/DIGIT OCTAL SQUARE CONVERSATIONAL
/PROGRAM
*200
START,      CLA CLL
            TLS
            JMS         CRLF
            JMS         LISN
            TAD         M260
            RAL CLL
            RTL
            DCA         NUMBER
            JMS         LISN
            TAD         M260
            TAD         NUMBER
            DCA         NUMBER
```

Translation

```
                .ABS
                .LOC        100
/DIGIT OCTAL SQUARE CONVERSATIONAL
/PROGRAM
/** -LOC      *200
START           CLA!CLL
                TLS
                JMS         CRLF
                JMS         LISN
                TAD         M260
                CLL!RAL
/** -ROT
                RTL
/** -ROT
                DAC         NUMBER
/** -DCA
                CLA
                JMS         LISN
                TAD         M260
                TAD         NUMBER
                DAC         NUMBER
/** -DCA
                CLA
```

MACRO-8 Program

```
MULT,   TAD     NUMBER
        CIA
        DCA     TALLY
        TAD     NUMBER
        ISZ     TALLY
        JMP     .-2
        DCA     NUMSQR

TYPSQU, TAD     MESAG1
        DCA     POINTR
        TAD     M10
        DCA     ENDCHK
        JMS     MESAGE

TYPANS, TAD     M4
        DCA     DIGCTR
        DCA     STORE
        TAD     NUMSQR
        CLL RAL

UNPACK, TAD     STORE
        RAL
        RTL
        DCA     STORE
        TAD     STORE
        AND     K7
        TAD     K260
        JMS     TYPE
        ISZ     DIGCTR
        JMP     UNPACK

TYPOCT, TAD     MESAG2
        DCA     POINTR
        TAD     M7
        DCA     ENDCHK
        JMS     MESAGE
        JMS     CRLF
        JMP     START+2
```

Translation

```
MULT    TAD     NUMBER
        CMA!IAC
        DAC     TALLY
/** -DCA
        LAC     NUMBER
        ISZ     TALLY
        JMP     .-2
/** -REL
        DAC     NUMSQR
/** -DCA
        CLA
TYPSQU  TAD     MESAG1
        DAC     POINTR
/** -DCA
        LAC     M10
        DAC     ENDCHK
/** -DCA
        CLA
        JMS     MESAGE
TYPANS  TAD     M4
        DAC     DIGCTR
/** -DCA
        DZM     STORE
        LAC     NUMSQR
        CLL!RAL
/** -ROT
UNPACK  TAD     STORE
        RAL
/** -ROT
        RTL
/** -ROT
        DAC     STORE
/** -DCA
        AND     K7
        TAD     K260
        JMS     TYPE
        ISZ     DIGCTR
        JMP     UNPACK
TYPOCT  TAD     MESAG2
        DAC     POINTR
/** -DCA
        LAC     M7
        DAC     ENDCHK
/** -DCA
        CLA
        JMS     MESAGE
        JMS     CRLF
        JMP     START+2
/** -REL
```

MACRO-8 Program

```
TYPE,   0
        TSF
        JMP     .-1
        TLS
        CLA
        JMS I   TYPE
CRLF,   0
        TAD     K215
        JMS     TYPE
        TAD     K212
        JMS     TYPE
        JMP I   CRLF
LISN,   0
        KSF
        JMP     .-1
        KRB
        TLS
        JMP I   LISN

MESAGE, 0
        TAD I   POINTR
        JMS     TYPE
        ISZ     POINTR
        ISZ     ENDCHK
        JMP     .-4
        JMP I   MESAGE
NUMBER, 0
M260,   -260
TALLY,  0
NUMSQR, 0
MESAG1, START1
POINTR, 0
M10,    -10
ENDCHK, 0
STORE,  0
M4,     -4
DIGCTR, 0
K7,     7
M7,     -7
K260,   260
K212,   212
K215,   215
MESAG2, START2
```

Translation

```
TYPE    0
        TSF
        JMP     .-1
/** -REL
        TLS
        CLA
        JMS*    TYPE
CRLF    0
        TAD     K215
        JMS     TYPE
        TAD     K212
        JMS     TYPE
        JMP*    CRLF
LISN    0
        KSF
        JMP     .-1
/** -REL
        KRB
        TLS
        JMP*    LISN
MESAGE  0
        TAD*    POINTR
        JMS     TYPE
        ISZ     POINTR
        ISZ     ENDCHK
        JMP     .-4
/** -REL
        JMP*    MESAGE
NUMBER  0
M260    -260
TALLY   0
NUMSQR  0
MESAG1  START1
/** -US
POINTR  0
M10     -10
ENDCHK  0
STORE   0
M4      -4
DIGCTR  0
K7      7
M7      -7
K260    260
K212    212
K215    215
MESAG2  START2
/** -US
```

MACRO-8 Program

```
START1,  323     /S
         321     /Q
         325     /U
         301     /A
         322     /R
         305     /E
         304     /D
         275     /=
START2,  240     /SPACE
         317     /O
         303     /C
         324     /T
         301     /A
         314     /L
         256     /PERIOD
$
```

Translation

```
START1   323     /S
         321     /Q
         325     /U
         301     /A
         322     /R
         305     /E
         304     /D
         275     /=
START2   240     /SPACE
         317     /O
         303     /C
         324     /T
         301     /A
         314     /L
         256     /PERIOD
         .END
```

INDEX

HOW TO OBTAIN SOFTWARE INFORMATION

Announcements for new and revised software, as well as programming notes, software problems, and documentation corrections are published by Software Information Service in the following newsletters.

Digital Software News for the PDP-8 Family
Digital Software News for the PDP-9/15 Family
PDP-6/PDP-10 Software Bulletin

These newsletters contain information applicable to software available from Digital's Program Library.

Please complete the card below to place your name on the newsletter mailing list.

Questions or problems concerning DEC Software should be reported to the Software Specialist at your nearest DEC regional or district sales office. In cases where no Software Specialist is available, please send a Software Trouble Report form with details of the problem to:

Software Information Service
Digital Equipment Corporation
146 Main Street, Bldg. 3-5
Maynard, Massachusetts 01754

These forms, which are available without charge from the Program Library, should be fully filled out and accompanied by teletype output as well as listings or tapes of the user program to facilitate a complete investigation. An answer will be sent to the individual and appropriate topics of general interest will be printed in the newsletter.

New and revised software and manuals, Software Trouble Report forms, and cumulative Software Manual Updates are available from the Program Library. When ordering, include the document number and a brief description of the program or manual requested. Revisions of programs and documents will be announced in the newsletters and a price list will be included twice yearly. Direct all inquiries and requests to:

Program Library
Digital Equipment Corporation
146 Main Street, Bldg. 3-5
Maynard, Massachusetts 01754

Digital Equipment Computer Users Society (DECUS) maintains a user Library and publishes a catalog of programs as well as the DECUSCOPE magazine for its members and non-members who request it. For further information please write to:

DECUS
Digital Equipment Corporation
146 Main Street
Maynard, Massachusetts 01754

Send Digital's software newsletters to:

Name_____
Company Name_____
Address_____
_____
(zip code)

My computer is a

PDP-8/I ☐		PDP-8/L ☐	
LINC-8 ☐		PDP-12 ☐	
PDP-9 ☐		PDP-15 ☐	Please specify
PDP-10 ☐		OTHER ☐	_____

My system serial number is_____ (if known)

8TRAN
PDP-8 to PDP-15 TRANSLATOR
DEC-15-ENZA-D

READER'S COMMENTS

Digital Equipment Corporation maintains a continuous effort to improve the quality and usefulness of its publications. To do this effectively we need user feedback – your critical evaluation of this manual.

Please comment on this manual's completeness, accuracy, organization, usability, and readability.

_____

_____

_____

_____

_____

Did you find errors in this manual? _____

_____

_____

_____

_____

How can this manual be improved? _____

_____

_____

_____

_____

_____

DEC also strives to keep its customers informed of current DEC software and publications. Thus, the following periodically distributed publications are available upon request. Please check the appropriate boxes for a current issue of the publication(s) desired.

☐ Software Manual Update, a quarterly collection of revisions to current software manuals.

☐ User's Bookshelf, a bibliography of current software manuals.

☐ Program Library Price List, a list of currently available software programs and manuals.

Please describe your position. _____

Name _____ Organization _____

Street _____ Department _____

City _____ State _____ Zip or Country _____