INTERSIL

IM6100 CMOS MICROPROCESSOR BASIC 4K SOFTWARE

INTERSIL CMOS/LSI

APPLICATION BULLETIN
M003

INTRODUCTION

The economies offered by low cost high performance microprocessors have opened new fields of dedicated computer applications. However, because of the lack of adequate software and applications support for microprocessors, microcomputer based systems have required substantial engineering investment on the part of the user. The lack of adequate software, general utility programs, mathematical routines and executive system software, increases the cost and lengthens the development time of a system by at least an order of magnitude when compared with minicomputer based systems. Since the investment in cost and time associated with the extensive engineering development must be off-set, microprocessors have been most cost effective only in large production volume systems.

The architecture, design and technology features of the single chip 12-bit CMOS Microprocessor introduced by Intersil Inc. and designated the IM6100, overcomes many of the problems associated with the current microprocessor designs. The IM6100 recognizes the instruction set of the DEC™ PDP-8/E™ minicomputer. The PDP-8 instruction set was chosen for a variety of reasons; the software support, efficient memory utilization, straightforward, yet, powerful instruction set and flexible input-output instructions. The DEC PDP-8 has the most well known machine organization and instruction set with more software support than any existing minicomputer system. System designers, familiar with conventional minicomputer hardware can now develop new microcomputer systems using the IM6100 with a minimum of time and effort.

The Digital Equipment Corporation Distribution Centers[1] maintain a library of more than one thousand fully developed and documented programs for the PDP-8 family of minicomputers. A list of available software for the PDP-8 can be obtained from the Software Distribution Centers. Additional programs and applications packages are available from DECUS, the DEC User's Society. DECUS is a nonprofit user's group—the second largest such group, worldwide—that sponsors technical symposia, publishes a periodic newsletter and maintains a library of more than 1200 programs for the various DEC computers. A complete catalog of available programs may be obtained from the society[2].

The IM6100 and the PDP-8/E are software compatible. The basic 4K PDP-8/E Paper Tape Software supplied by DEC will operate properly with the IM6100. The Extended Arithmetic Element, EAE, and the User Flag, UF, options of the PDP-8/E cannot be used with the IM6100. The EAE is used for hardware multiply/divide and the UF for timesharing. Like the PDP-8, an Extended Memory Control element can be used with the IM6100 to extend its addressing capacity from 4K to 32K. Since the bus structure of the IM6100 can be adapted to provide a subset of the PDP-8/E OMNIBUS® signals, all programmed I/O interface for the PDP-8/E, for example, Teletype, Paper Tape Reader/Punch, etc., will operate with the IM6100 without any hardware or software modification.

The remainder of this paper contains brief descriptions of a selection of PDP-8/E programs and software packages. This is not, by any means, an extensive summary of all available software. It gives emphasis only to the standard PDP-8 programs which can run with 4K words of memory, a Teletype and a Control Panel—the basic modules provided in the 6900 Prototyping System.

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[1]DEC Software Distribution Center, 146 Main St., Maynard, MA 01754
DEC Software Distribution Center, 1400 Terrabella Road, Mt. View, CA 94040

[2]Digital Equipment Corporation, DECUS, Parker Street, Mail Stop PK3/E55, Maynard, MA 01754

PDP-8/E EXTENDED SOFTWARE KIT (QF081-AB)

The basic PDP-8/E Paper Tape Software Kit assists the user to create and edit programs and to debug and correct programs after assembly or compilation. Two handbooks, "PDP-8/E Small Computer Handbook" and "Introduction to Programming", are available with this software package. The Small Computer Handbook provides extensive technical information concerning hardware options, interfacing and system operation of the PDP-8 family of computers. Introduction to Programming deals specifically with the fundamentals of machine and assembly language programming on a small machine. Following are summaries of the programs that make up the software package.

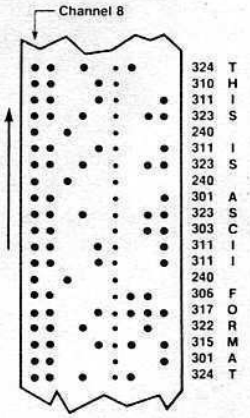
UTILITY ROUTINES

BINARY LOADER

The Binary Loader (BIN) is a short utility program which instructs the computer to read binary coded data punched on paper tape and store it in memory. BIN is used primarily to load DEC supplied binary programs and binary tapes produced by the PDP-8/E assemblers.

There are three basic paper tape formats commonly used by PDP-8 series computers.

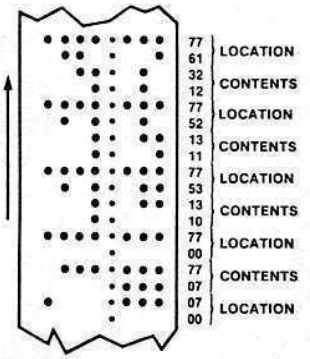
ASCII Format



The USA Standard Code for Information Interchange (ASCII) format uses all eight channels[1] of the paper tape to represent a single character (letter, number or symbol) as shown in the diagram at left.

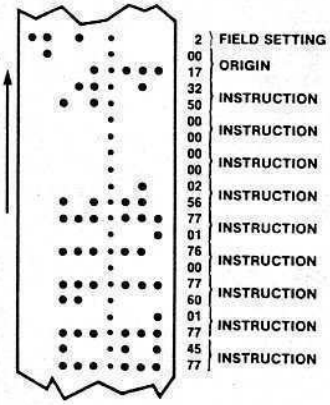
[1]Channel 8 is normally designated for parity check. The Teletype units used with PDP-8 series computers do not generate parity, and channel 8 is always punched.

RIM (Read In Mode) Format



RIM format tape uses pairs of adjacent columns to represent 12-bit binary words directly. Channels 1 through 6 are used to represent either addresses or information to be stored. A channel 7 punch indicates that the current column and the following column are to be interpreted as an address specifying the location at which the information contained in the following two columns is to be stored. The tape leader and trailer for RIM format tape must be punched in channel 8 only (octal 200).

BIN (Binary) Format



Binary format is similar to RIM format except that only the first address in a series of consecutive addresses is specified. A channel 7 punch indicates that the current column and the following column are to be interpreted as an address. Successive pairs of columns are stored in sequential locations following this address until another channel 7 punch is encountered. A channel 7 and a channel 8 punch designate the current column as a memory field specification. Leader/trailer tape must be punched in channel 8 only.

BIN is furnished to the programmer on punched paper tape in RIM coded format. Therefore, RIM loader must be in memory before BIN can be loaded. The RIM is loaded into the computer manually with the control panel switches. The RIM resides in locations 7756-7776 and the BIN in locations 7625-7752 and 7777.

RIM Loader

Abs. Addr.	Octal Contents		Instruction	Comments
7756,	6032	BEG,	KCC	/clear AC and flag
7757,	6031		KSF	/skip if flag = 1
7760,	5357		JMP.−1	/looking for char
7761,	6036		KRB	/read buffer
7762,	7106		CLL RTL	/ch8 in ACO
7763,	7006		RTL	/checking for leader
7764,	7510		SPA	/found leader
7765,	5357		JMP BEG+1	/OK, ch7 in link
7766,	7006		RTL	
7767,	6031		KSF	
7770,	5367		JMP.−1	
7771,	6034		KRS	/read, do not clear
7772,	7420		SNL	/checking for address
7773,	3776		DCA I TEMP	/store contents
7774,	3376		DCA TEMP	/store address
7775,	5356		JMP BEG	/next word
7776,	0000	TEMP,	0	/temp storage

However, the control panel of the 6900 Prototyping System has the BIN bootstrap loader programmed into the console memory itself. Since the 6903-CONTRL console memory is transparent to the main memory, the user program may use the entire 4K words of main memory.

RIM AND BIN PUNCH

The RIM and BIN Punch Programs provide the means of punching information contained in selected memory locations in RIM and BIN format via the ASR-33 Teletype Perforated Tape Punch.

OCTAL MEMORY DUMP

This program enables the user to dump, in octal, the contents of selected memory locations to the Teletype.

A detailed description of the various PDP-8 loaders, verifiers, duplicators, conversion and printing routines is given in the PDP-8 Family Commonly Used Utility Routines Document (DEC-81-RZPA-A).

SYMBOLIC EDITOR

The Symbolic Editor is used to create and modify symbolic (source) program tapes from the Teletype keyboard eliminating the tedious task of preparing source program tapes off-line. The Editor is fully interactive. The editing changes may be verified and recorrected, if necessary. The Editor includes a search feature to scan the text for occurences of a specified character. Other commands permit blocks of text to be inserted, deleted, appended, listed or changed. The Editor is documented in Chapter 5 of the Introduction to Programming.

PAL III ASSEMBLER

PAL III is a three pass Assembler designed for the PDP-8 family of computers with 4K words of memory. During the first pass of the assembly, all user symbols are defined and placed in the Assembler Symbol Table. During the second pass, the binary equivalent of the input source language, is generated and punched. The Assembler's third pass, which is optional, produces a printed assembly listing of the program instructions with the location, generated binary and source code side by side on each line. The binary tape output of the second pass can be loaded into the computer for execution.

The DEC manual, entitled "4K Assemblers", contains descriptions of two PDP-8 4K Assemblers, the most basic of which is PAL III. In addition to PAL III, the document also discusses the MACRO-8 Assembler, which is similar to the PAL III with some additional features such as user defined macros, double precision integers, floating point constants, arithmetic and Boolean operators, literals, text facilities, etc. However, the MACRO-8 does not have as large a symbol table capacity as the PAL III.

DEBUGGING PROGRAMS

Dynamic Debugging Technique (DDT) and Octal Debugging Technique (ODT) are two debugging programs for the PDP-8. These two service programs allow the user to run the user program on the computer and to use the Teletype keyboard to control program execution, examine registers, change their contents and make alterations to the program. With the DDT, the user can debug the programs, using the symbolic language of the source program, with the DDT performing all translations to and from the binary representation. ODT has the same capabilities as the DDT, except that the programmer must use octal representation instead of the mnemonic symbols. Chapter 5 of Introduction to Programming discusses the features of both of these service routines.

MATHEMATICAL ROUTINES

The 23-bit Floating Point Package (FPP) provides an easy means of performing basic arithmetic operations such as addition, subtraction, multiplication and division using floating point numbers. It also provides extended function capabilities for the computation of natural logarithms, exponential functions, basic trigonometric functions and the like. The 23-bit FPP maintains a high degree of precision and greatly facilitates I/O operations in floating point notation. Chapter 8 of the Introduction to Programing describes the functional features of the 23-bit FPP.

FOCAL-8 (DEC-8E-LFOCA-A-PB, DEC-08-LFL8A-A-D)

FOCAL-8 is an interactive algebraic language developed specifically for the PDP-8/E. FOCAL's desk calculator mode of operation makes the full computational power of the computer available to the user in response to simple sentence structured keyboard commands. FOCAL® is similar to BASIC and FORTRAN in many respects, however, it is more easily learned. The dynamic combination of computational capability and simplicity makes FOCAL-8 an ideal language for on-line problem solving without having to master a complex programming language. FOCAL requires only 4K words of memory, yet, it offers a full range of mathematical functions, extendable I/O and versatile self-editing capabilities.

PDP-8/E DIAGNOSTIC SOFTWARE KIT (ZF002-RB)

This software package consists of programs to perform extensive tests on the processor, memory and the Teletype. The 6900 Prototyping System will execute the complete set of processor, memory and Teletype diagnostics for the PDP-8/E.

These software programs are available from DEC in binary and source language tapes and listings with instruction manuals. The Software Performance Summary, also available from DEC, is a cumulative report which provides each new software user with up-to-date information about software problems and solutions, general system information and programming techniques.