IMC-2001
VER 2.01

FOURTH EDITION
MAR. 1985 BY MARIA

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C O N T E N T S

F O R W A RRD

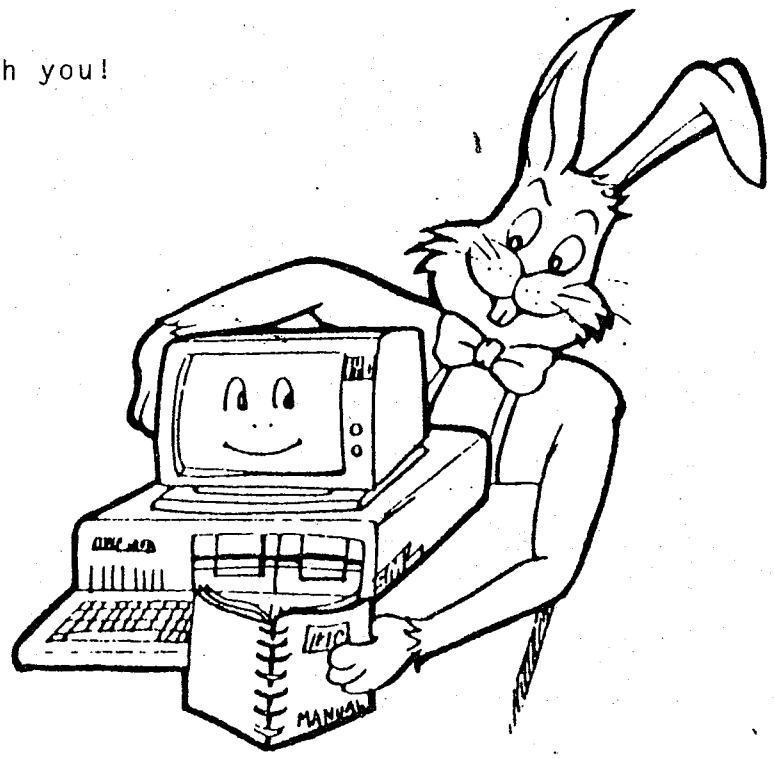
Congratulation for your choice of a IMC-2001 Personal Computer.

Your IMC-2001 (also known as IMC) is a compact but powerful computer, designed to satisfy the demanding requirements today.

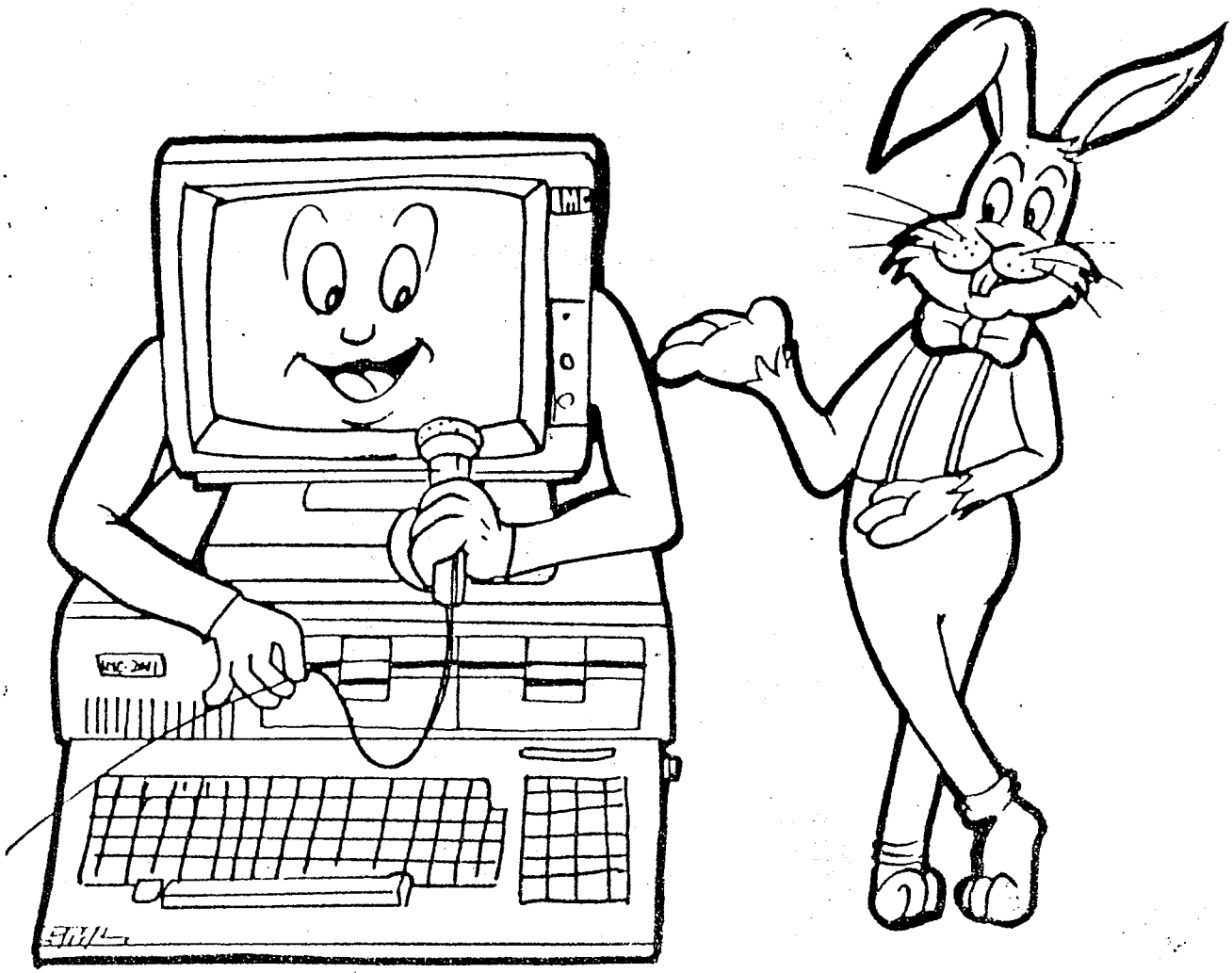
The "IMC" incorporate numerous high-level features to meet the exacting demands of the business and professional user. IMC comes with 8 bit Z-80 CPU giving the capability to access a large varieties of CP/M type software. With 6502 co-process and 7 expansion slots. IMC can upgrade to many different operating system as well as software and peripherals on todays market. Whether you are novice or experienced computer user, this manual will show you how to use or enhance your IMC computer both on hardware and software.

This manual is written from a non-technical aspect, if user need to know the technical or other information, please donnot hesitiate to contact your IMC local dealer.

May IMC be with you!



INTRODUCTION



CHAPTER 1 INTRODUCTION

THE IMC-2001

The IMC-2001 Personal Computer, here in after we call IMC, is a complete computer system. All IMC are made up a few basic part and typically of a few optional part, that tailor the IMC for a particular application.

In this chapter, you will learn what the basic parts of the IMC are, and what they will do. You will also learn about the more common optional parts that can be added to a system to customize it and the applications in which those parts might be used. When we refer to parts, we mean both physical units- that is, the HARDWARE, and the instructions or programs that incoperate with the hardware- that is, the SOFTWARE.

THE IMC SYSTEM HARDWARE

The basic hardware of a IMC system consists of:

* The System Unit with two Disk Drive
* The Keyboard
* The Parallel Interface Card
* The 80 Column Card
* The Firmware Card
* The Disk interface card

The system unit, show in Figure 1-1, is the heart of the IMC. Inside the system unit, is a printed circuit board called the SYSTEM BOARD, which contains the basic circuitry of the IMC. The system board also has seven(7) connectors called the SYSTEM EXPANSION SLOTS, shown in Figure 1-2. Several manufacturers, including INTER-ORIENT & WORLD CORP, offer cards or boards that can be plugged into the system expansion slots which will expand the functions of the IMC. As we will see, these optional expansion card may allow you to tailor the IMC to your own specific requirements.

THE MEMORY

Programs and data are stored in the memory of the IMC, as shown in Figure 1-3. There are two kinds of memory: ROM and RAM. ROM (Read-Only Memory) is used to store programs and data that permanently resided in the IMC. An example of a program stored in ROM is the "MONITOR ROM" that comes with the IMC. The contents of ROM will not violented when you turn the IMC off. RAM (Random-Access Memory) is used to store most of the programs and data that you will run. The contents of RAM are violented when the IMC is turned off.

Memory is organized in units call BYTES. A single byte represents a value which can be interpreted in a number of ways, depending on the application. For example, a byte in memory can be used to represent a single character or a number. The system board typically will contain 4 kilobytes (1 kilobyte = 1024 bytes) of ROM and up to 12 kilobytes (by optional card), 64 kilobytes of RAM. As we will see, the RAM of the IMC can be expanded through the installation of memory cards in the system expansion slots.

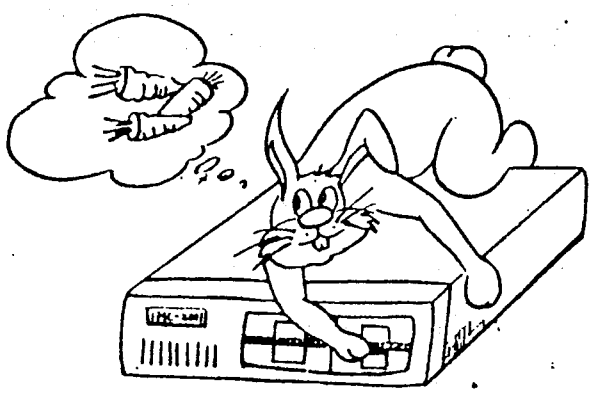


Figure 1-1

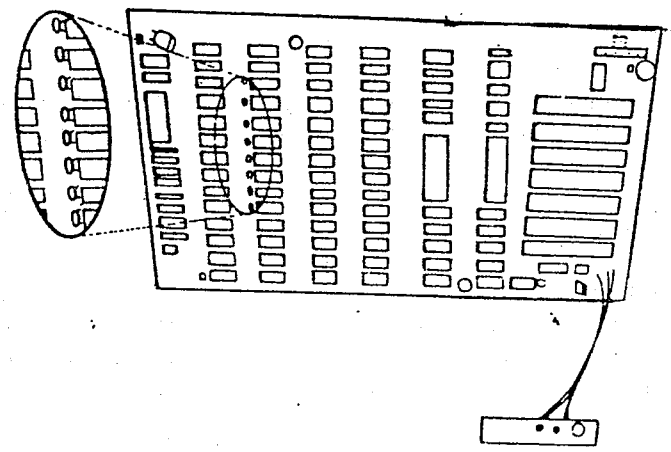


Figure 1-3

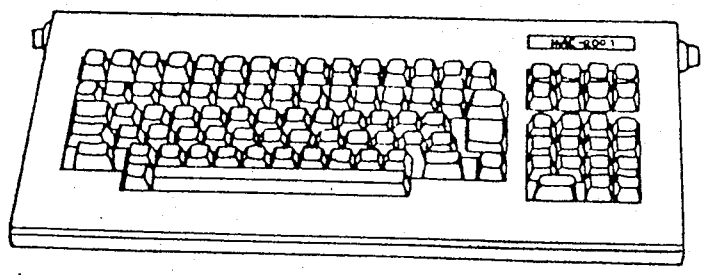


Figure 1-4

IMC KEYBOARD

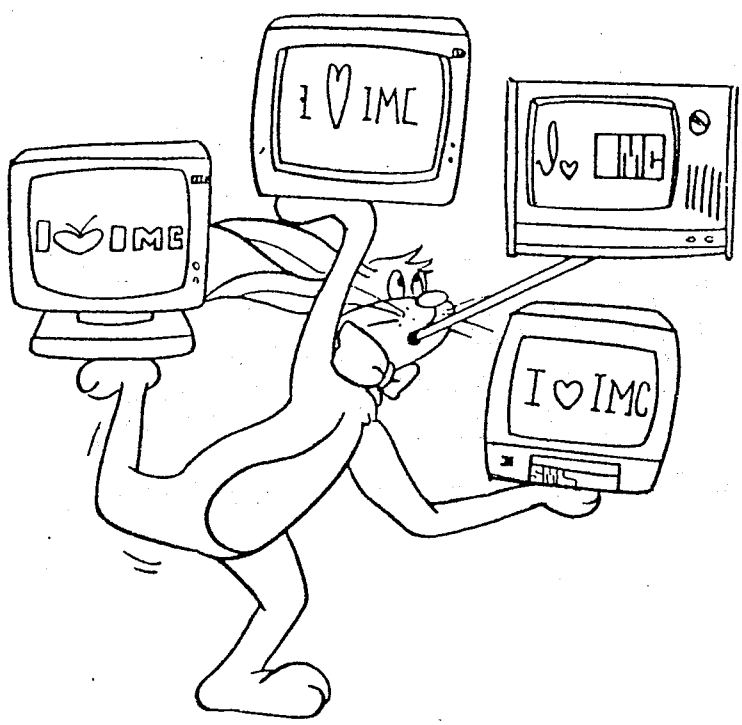
There are many special keys on the IMC keyboard which are very useful and can be used frequently when operating the IMC. The IMC keyboard is shown in Figure 1-4.

ADDITIONAL OPTIONS

Several other type of options enable your system to perform specific tasks, these options are available from manufacturers of IMC.

THE DISPLAY MONITOR

There are four kinds of monitors that can be used with the IMC. The monochrome display monitor, black and white video monitor, color monitor or regular television. Figure 1-5 show some examples of displays that can be used with IMC.



MASS STORAGE DEVICES

Mass storage devices allow you to store both program and data. The speed and ease that you can access this stored information depends upon the type of device that you are using.

* Floppy Disk Drive

Floppy disks are much better for Data Storage and Retrieval than cassette tapes, since floppy disks can store more information and access the information faster. Figure 1-6 shows two floppy disk drives.

Your IMC already has two 5-1/4" single sided, single density disk drives built in to the system. The disk drives are single sided and hold about 143K per disk while double-sided disks hold about 286K per disk.

* Hard Disk Drive

The faster and larger mass storage device for the IMC is the hard disk. Hard disks are typically capable of storing from 2 to 10 million bytes of data. They can be mounted in a separate enclosure.

STANDARD PERIPHERALS

The IMC can communicate with many kinds of devices outside the systems unit. For this, your dealer will supply more information about all peripherals that can be installed in the system expansion slots.

PRINTER AND PRINTER INTERFACE CARD

Dot Matrix printers can provide a hard copy for your programs. The printer, shown in Figure 1-7, can print a total of 66,80, or 132 characters per line depending upon the printing systems that is used.

There are many kinds of interface cards that can be used to connect the different brands of printers, e.g., Centronic Parallel or Serial type etc. You can check with your printer dealer when you buy your printer.

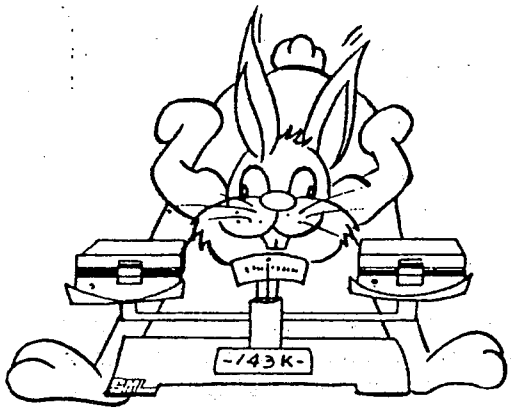


Figure 1-6

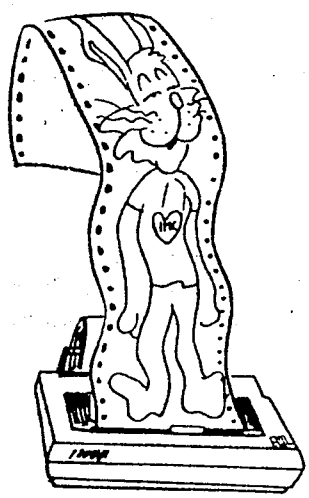


Figure 1-7

THE IMC SOFTWARE

IMCs are built with Z-80A and 6502 CPUs. With Z-80A basic, IMC allows you to run not only software programs of IMC, but is also compatible with the CP/M operating system. With the CP/M system, IMC can use many of the program languages and run thousand of software packages.

IMC OPERATING SYSTEM

An operating system is a program that controls the IMC hardware. IMC as many other computers have their own individual operating system but also are computible with the worlds most popular system -CP/M under IMC CPU Z-80A.

IMC requires an externally supplied operating system that is loaded from the disk drive into the machine when it is first tunred on.

There are several operating systems available with the IMC. Typically the programs that you want run on the IMC will determine which operating system you choose. To run a particular program often requires a specific operating system.

The major operating system available with the IMC is the CP/M 2.2. Most business software languages and application will run under the CP/M operating system. For access to other operating systems such as APPLE DOS and MS DOS, optional plug in interface cards are available.

CP/M (which stands for control program/microprocessor) is a standard operating system developed and trademarked by DIGITAL RESEARCH. A very large group of high-level languages and application software has been written to operate under the CP/M environment.

Standard CP/M programs will be compatible with 6502 mode CP/M. There is a minor difficulty in loading CP/M programs on the IMC type disk drive. IMC uses a physically different format than CP/M disks. Before a CP/M program written for another type of computer can be run on the IMC, it must be downloaded from standard CP/M to the IMC. This process is described in detail in the Software Utilities Manual.

CHAPTER 2 SETTING UP YOUR IMC-INSTALLATION

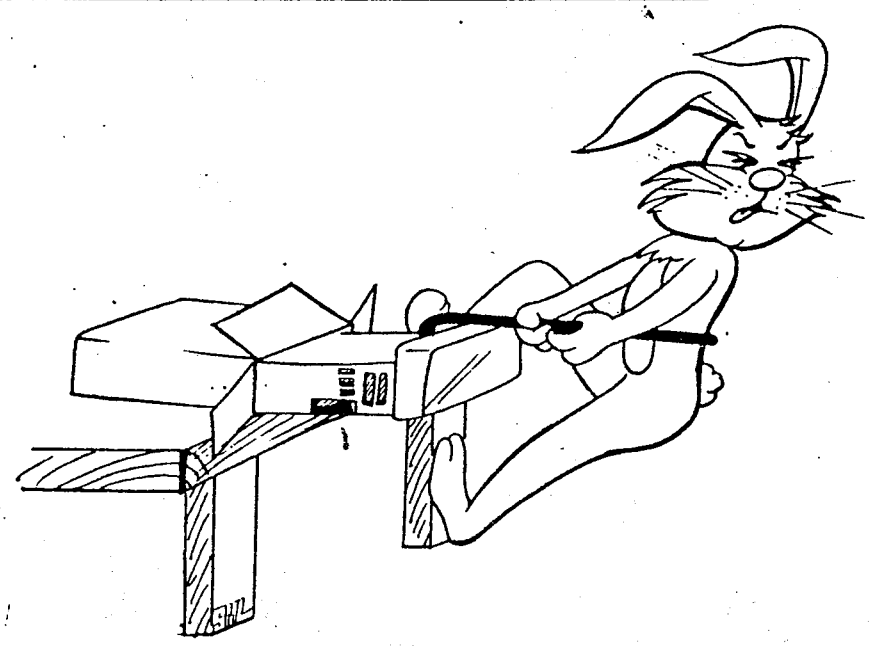
2- 0. Unpack your IMC from its packing cartons
2- 1. How to connect key-board
2- 2. How to plug-in firmware card
2- 3. Your expansion 80 column card
2- 4. Your expansion printer card
2- 5. How to plug-in home T.V.
2- 6. How to plug-in PAL system T.V.
2- 7. How to plug-in monitor
2- 8. How to use joystick
2- 9. How to plug-in cassette tape
2-10. How to connect other expansion peripherals

CHAPTER 2

SET-UP SYSTEM AND INSTALL EXPANSION PERIPHERALS

This chapter starts with unpacking your IMC, setting up the system, and installing different expansion cards ..... It is a guide to get your IMC computer running.

2-0. Unpack your IMC from its packing cartons



2-1. How to connect the keyboard

1. Make sure the power is turned off.
2. Find the coiled cable with a 15-pin D-type connector attached to the main system.
3. Plug this connector to the male connector on the rear right panel of key-board as shown in Figure 2-1.

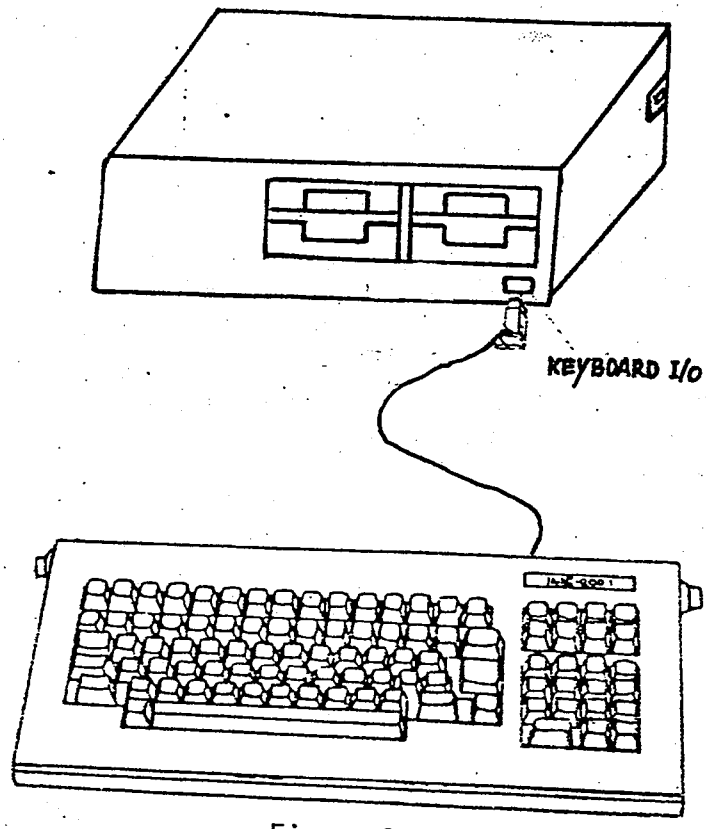


Figure 2-1

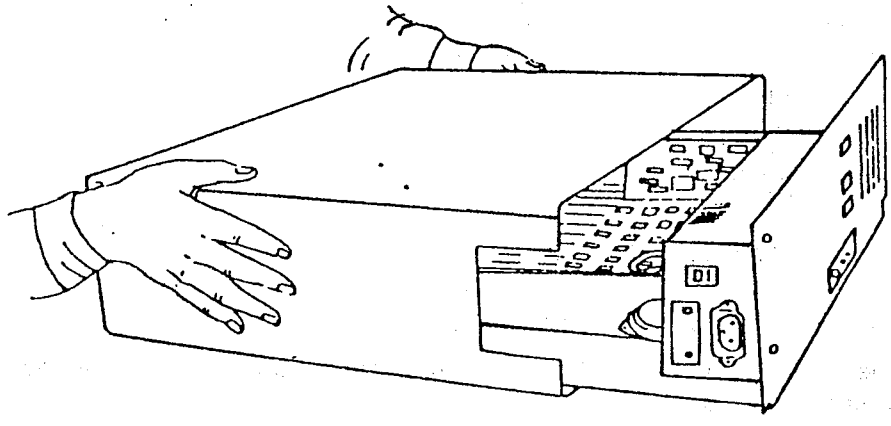
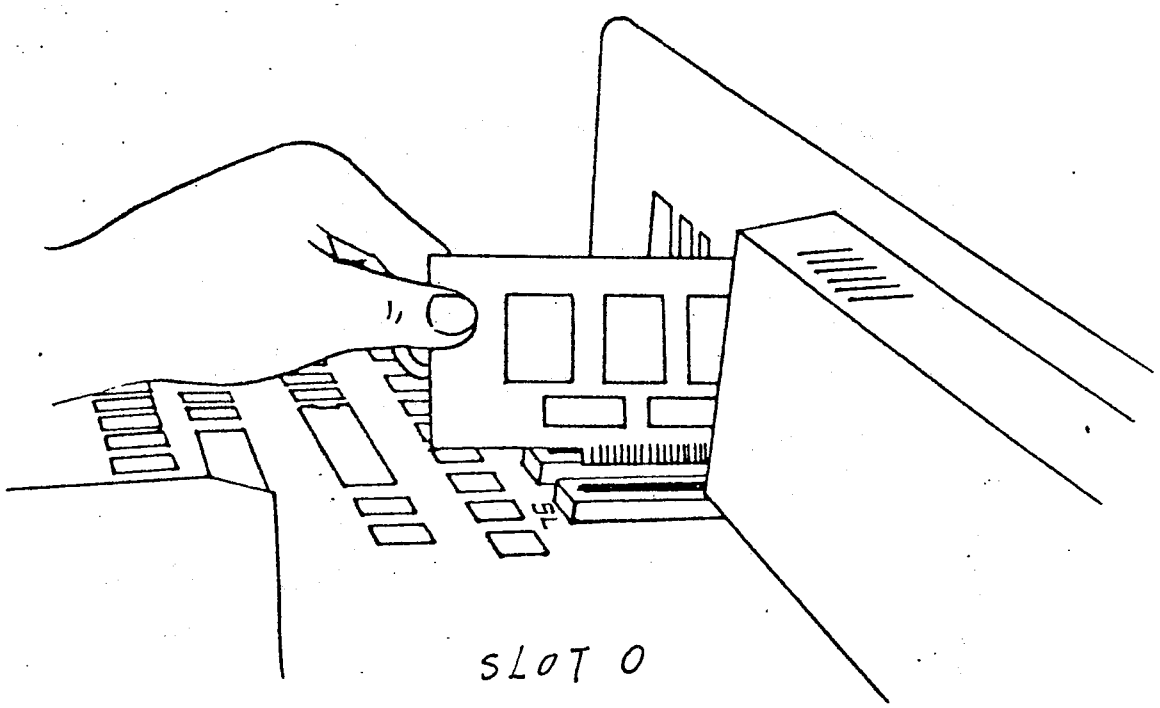


Figure 2-2 A

2-2. How to plug-in firmware card

1. Make sure the power is turned off.
2. Move the top cover from cabinet of IMC. (Figure 2-2A)
3. The card has three microchips on the side (the) TOP side) and solder spots on the other (the BOTTOM side), and one edge of the card has gold coloured strips along it. This is the edge that fits into the ROM slot. Hold the edge of the card with the TOP side facing Right and insert firmly into the ROM slot.
4. Don't press too hard when inserting any card. The main computer board is made of fibreglass resin and will crack under too much presure.
5. On setting up, if unsure of any procedure, always contact your dearler before proceeding.



2-3 How to plug-in your 80 column card

1. Turn the power of imc off.
2. Remove the Top cover of cabinet.
3. Insert 80 column card at slot #3 of the CPU board (As figure 2-3.1)
4. Connect monitor cable and 80 column cable.
5. If screen show nothing, adjust your 80 column at slot or cable connector.

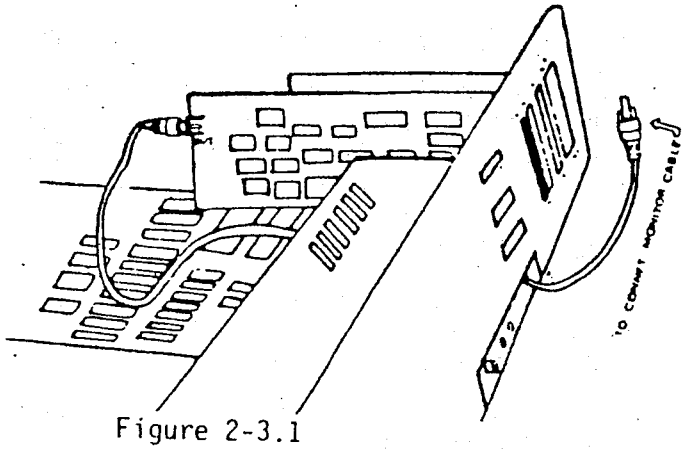


Figure 2-3.1

6. If you use 80 column card and switch box together The installation as figure 2-3.2

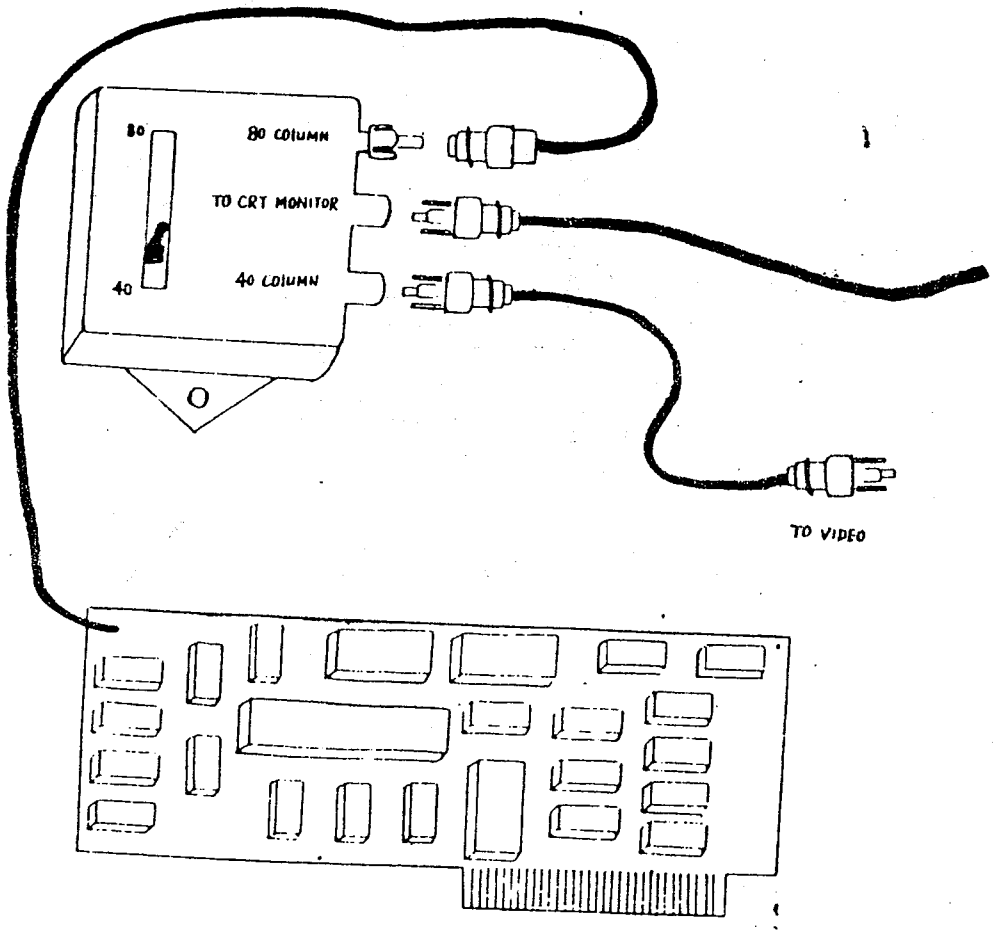
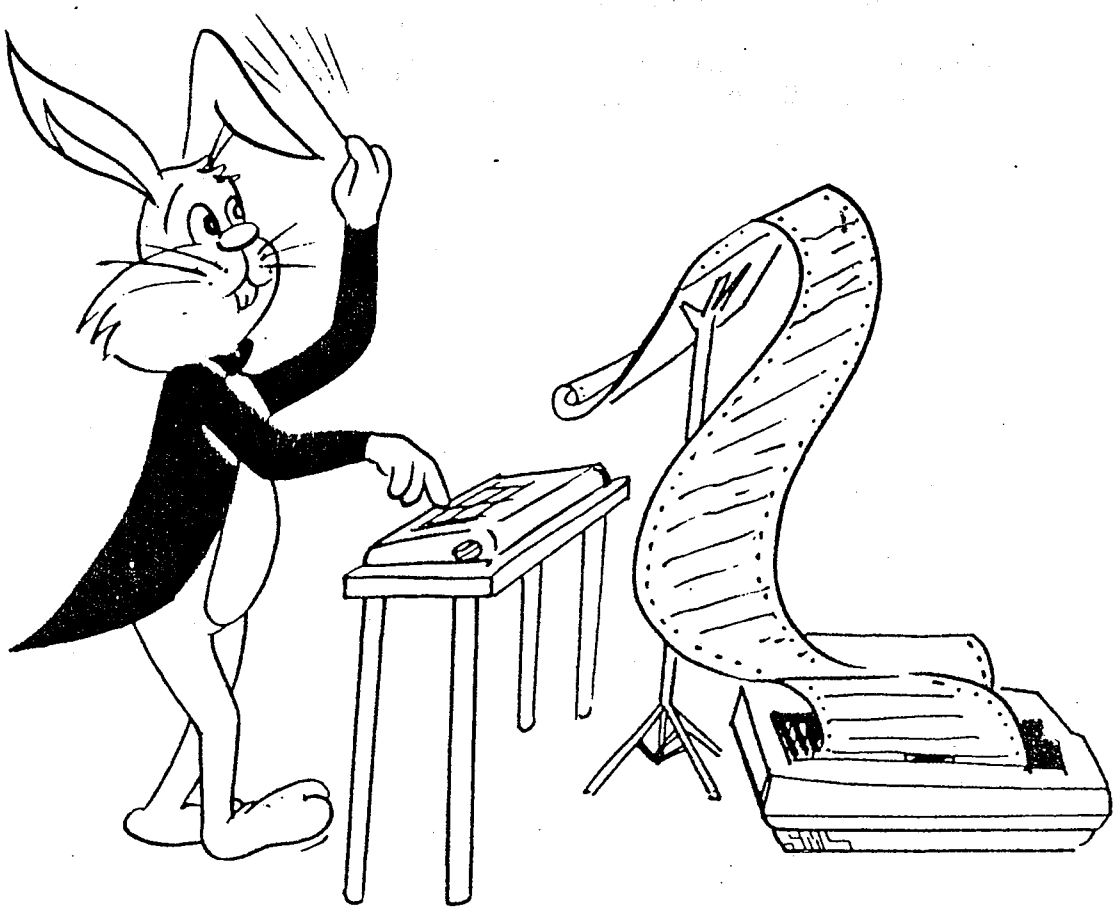


Figure 2-3.2

YOUR EXPANSION PRINTER CARD



2-4. Your expansion printer card

2-4.1 Introduction

One of the most important output devices of the computer is the printer. Your IMC system also comes with printer interface card (Figure 2-4.1) which is an improved version of the parallel interface card - Centronic compatible. In addition to advanced text features, if offers high resolution dot graphics (HIRES) dump routines located in the firmware, these features are easily invoked by using simple control commands.

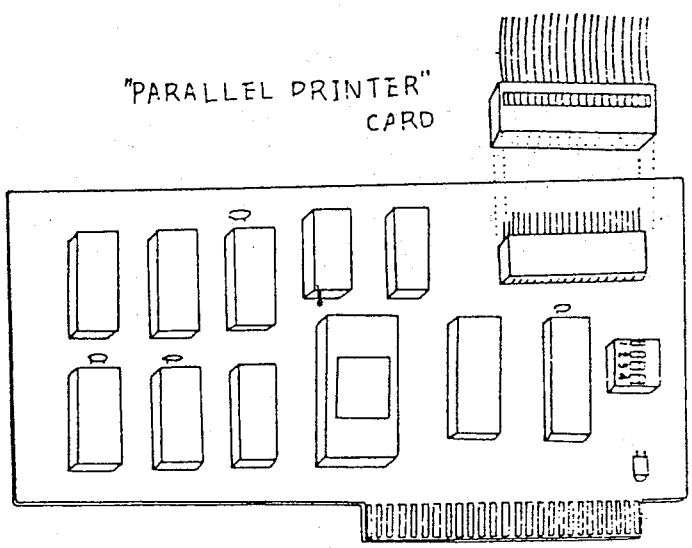


Figure 2-4.1

2-4.2 Installation instructions

To install the IMC printer card in your computer, simply plug it into any available peripheral alot except slot #0. Normally, the printer card is installed in slot #1.

1. Turn off the power to your computer, to prevent damage to both the computer and the IMC printer card.

2. Connect the printer cable to the set of pins located on the rear panel (as Figure 2-4.2). Make sure that all the pins on the card go into the plug's matching hole. The cable only fits one way. In the case of the IMC computer, connect the cable which is attached to the rear panel inside connector on the outside of the rear case.

3. Adjust the DIP switch on the printer card as required for your specific printer, Different printer manufacturers require different signals for printing. There is no standard among printer manfacturers.

   The DIP switch is composed of 4 small slinding switches #1 controls the MSB (Most Significant Bit or 8th data bit).
   When the switch is in the ON position, the MSB is NOT transmitted to the printer. When the switch is in the OFF or (-) position, the MSB is transmitted to the printer and is under software control.(see CTRL-I H & CTRL-I X under TEXT COMMANDS).

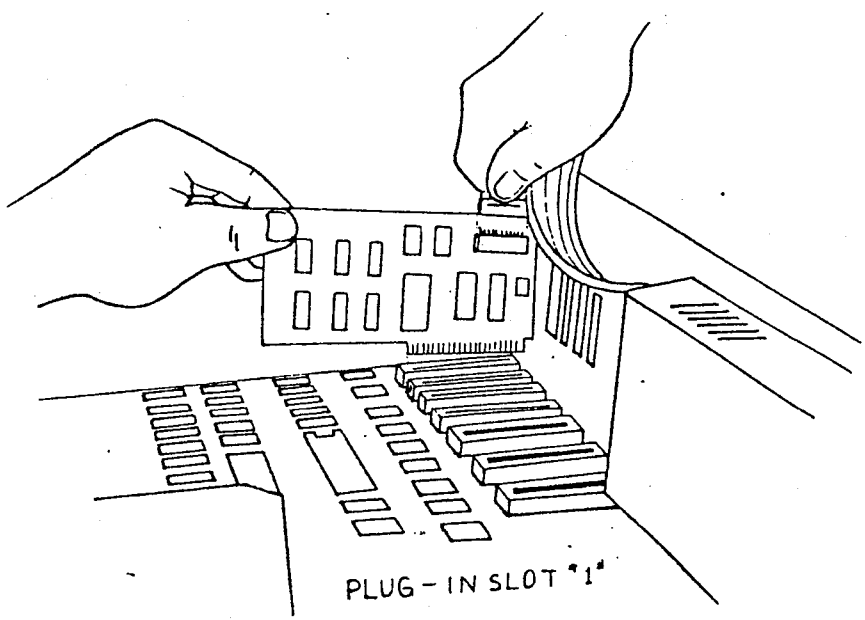


Figure 2-4.2

DIP SWITCH POSITIONS	# 1	# 2	# 3	# 4
EPSON printers	..	ON	ON	ON
NEC 8023/C, Itoh 8510	..	ON	ON	OFF
CENTRONICS 739-1	..	ON	OFF	ON
ANADEX printers/Data south'80	..	ON	OFF	OFF
OKIDATA 82 or 83	..	OFF	ON	ON
ADM	..	ON	ON	ON

***** W A R N I N G ****

Turn the power off before plugging or unplugging the printer card into your computer.

4. Insert the printer card into slot #1 with a gentle rocking motion until fully and firmly seated in the slot.

5. Pass the printer cable through one of the openings at the rear of the computer. In the case of the IMC computer, the cable terminates on the outside of the computer with a Centronics compatible connector.

6. Connect the other end of the cable to the printer. IMC owners will need printer cables with two " male" Centronics connectors to attach the printer to the computer.

7. Now turn both your computer and printer ON. Press CTRL-RESET, type "PR#n" (n = slot number) and hit "RETURN" 5 or 6 times. Your printer will print a prompt character for each time you hit the RETURN key. If not, double-check the installation procedures and check steps 1 thru 8 below.

2-4.3 Status check

The printer card will check your printer and paper status before attempting to send any information to your printer. If the printer is not "on-line" or is out of paper, warning will be printed on the screen and the computer will sound a beep. If this occurs, check the following.

1. Is the cable firmly and properly attached to the printer?
2. Is the cable properly attached to the printer card?
3. Is the printer turned ON?
4. Is the printer on-line?
5. Is there paper in the printer? (The printer card will not check the paper status on the Epson printer)
6. Is the printer set up for parallel interface operation?
7. Is the DIP switch on the printer card set properly?
8. Is the DIP switch on the printer set properly?

2-4.4 Control commands

The printer card has many text & graphic features, including adjustable margins, line length, page length and others. All features can be addressed. Each command is preceded by a control character (CTRL-I) from BASIC or CTRL-Y from PASCAL or CP/M unless specifically altered by the user's program.

The CONTROL key on the IMC and most computer is marked CTRL. If does not generate a character by itself, but alters the codes produced by other keys. Before entering a command to the IMC printer card, the card must be "turned on" by entering "PR#n" (n = slot number) and then "RETURN".

To access a particular function, press the CTRL key and the I key. Release the I key first. Then type the key or keys corresponding to the IMC function you desire. Do not enter spaces or punctuation.

For example: To set printer line length for 80-columns
COMMAND: CTRL-I 80N

1. Access printer: Enter "PR#1" and hit "RETURN"
2. Hold down the "CTRL"(CONTROL) key
3. Press the "I" key
4. Release the "I" key first and then the "CTRL" key
5. Key in "8", "0", & "N" key without entering any spaces or punctuations.
6. Hit the "RETURN" key to enter the command.

The printer will advance a line, type "80N", the computer will produce a beep sound and then the "SYNTAX ERROR" message will be displayed on both the printer and the screen.

This is normal. The computer does not recognize CTRL command input directly from the keyboard (not from a program) as valid syntax. The IMC printer card will however accept and excute the command.

If you find it bothersome, you can eliminate the "SYNTAX ERROR" by entering the command from within a program statement by using it equivalent character atring value. The above command, "CTRL-I 80N", becomes:

```
10  PR#1: PRINT CHR$(9):"80N"      (FP BASIC)
10  PR#1: PRINT "CTRL-I": "80N"
```

NOTE: Control characters are not visible on the video screen.

The IMC printer card does not contain special characters to control printer features such as emphasized, or bold characters or printing characters in the condensed mode. For these printer commands refer to the printer's manual.

2-4.5 Text commands and features

COMMAND	FP BASIC	FEATURES
PR#n	PR#n	ACCESS PRINTER CARD AT SLOT #n. All subsequent characters on the video will be also printed. (This command must be used before any of the following commands will be accepted by the printer card.
PR#0	PR#0	TURNS OFF PRINTER CARD. All subsequent data will be displayed on the video screen only.
CTRL-I A	PRINT CHR$(9):"A"	APPEND LINE ONTO CARRIAGE RETURN. The printer card will automatically issue an linefeed after every carriage return. BASIC wi-l not send a linefeed code after a carriage return-the printer will not advance the paper when the printhead returns to the left margin.
CTRL-I K	PRINT CHR$(9):"K"	DON'T APPEND LINEFEED ONTO CARRIAGE RETURN. Overrides the CTRL-I A command.
CTRL-I B	PRINT CHR$(9):"B"	TURN ON BELL. Allows CTRL-G to ring the printer bell. This feature is disabled as a default by the printer card.
CTRL-I C	PRINT CHR$(9):"C"	TURNS OFF BELL.
CTRL-I H	PRINT CHR$(9):"H"	ALLOW HIGH ORDER(8th) BIT TO BE OUTPUT TO THE PRINTER. On EPSON printers, this allows block graphics, line drawing graphics or special characters. Standard character set will not be accessable. (The DIP switch on the printer card must be OFF)
CTRL-I X	PRINT CHR$(9):"X"	DON'T OUTPUT HIGH ORDER BIT TO PRINTER. Puts printer to standard text mode & overrides CTRL-H command.

COMMAND	FP BASIC	FEATURES
CTRL-I nN	PRINT CHR$(9):"nN"	SET LINE LENGTH TO n CHARACTERS FROM LEFT SIDE OF PAGE. (NOT LEFT MARGIN) A carriage return will automatically be generated after n characters have been printed. If the line length is set to zero, no carriage will be issued until it receives one from the computer. (For dot graphics printing) Characters will be printed only to the printer, not the video screen. When listing BASIC programs, the printing will be formatted for 40 columns unless this command is used (i.e. CTRL-I 80N)
CTRL-I I	PRINT CHR$(9):"I"	TRANSMIT CHARACTER TO BOTH PRINTER & VIDEO SCREEN WHEN LINE LENGTH IS SET BY CTRL-I nN. This command will not work when listing a program.
CTRL-I nL	PRINT CHR$(9):"nL"	SET LEFT MARGIN TO "n"th COLUMN FROM LEFT EDGE OF PAGE.
CTRL-I nR	PRINT CHR$(9):"nR"	SET RIGHT MARGIN TO "n"th COLUMN FROM LEFT EDGE OF PAGE (NOT LEFT MARGIN) This prevents wrods from being split at the right margin. The IMC will end the line at the first space that occurs after the
CTRL-I S	PRINT CHR$(9):"S"	DUPLICATES THE PRESENT 40 COLUMN TEXT SCREEN ON THE PRINTER. The screen will be printed 20 spaces from the left edge of the paper.
CTRL-I 2S	PRINT CHR$(9):"2S"	PRINTS TEXT SCREEN PAGES 1/2 SIDE BY SIDE FOR AN 80 COLUMN OUTPUT. 80 column boards are not supported.
CTRL-I nP	PRINT CHR$(9):"nP"	SET PAGE LENGTH TO "n" LINES. The printer will print 6 linefeeds after "n" number of printed lines. Continuous form paper usually have 66 lines per page and your printer will skip over the perforations with 6 linefeeds.

COMMAND	FP BASIC	FEATURES
CTRL-I CTRL-Y	PRINT CHR$(9); CHR$(25)	CHANGE COMMAND CONTROL CHARACTER FROM CTRL-I TO CTRL-Y . Any control character may be used instead of "CTRL-Y". Avoid characters used by the printer or normal text control characters (CTRL-M: carriage return)

The values and conditions listed below are automatically set when the IMC printer card is "turned on" with "PR#n" (n = slot #) command or initialized from CP/M or PASCAL.

MARGIN: Left = 0 Right = 0
LINE LENGTH = 0
PAGE LENGTH = 0
VIDEO = "ON" with BASIC : "OFF" with PASCAL & CP/M
LINEFEED after CARRIAGE RETURN = "YES" with BASIC
"ON" with PASCEL & CP/M
EIGHTH BIT = "OFF" when printer DIP switch #1 is "ON" (not sent)
When the DIP switch #1 is "ON", the 8th bit is under software control.

2-4.6 Graphics features and commands

The IMC printer interface can output High Resolution (HIRES) screen to the printer by using simple commands similar to that of the TEXT commands. To access a particular graphics feature of the card type "CTRL-I" followed by "G" and any options listed below. If no other options are used(i.e. CTRL-I G with carriage return) then the HIRES page #1 will be printed.

COMMAND	FP BASIC	FEATURES
CTRL-IG	PRINT CHR$(9):"G"	PRINTS HIRES PAGE #1 HORIZONTALLY. Every white dot on the screen is printed as a black dot on the paper.
CTRL-IG2	PRINT CHR$(9):"G2"	PRINTS HIRES PAGE #2 HORIZONTALLY.

COMMAND	FP BASIC	FEATURES
CTRL-IGS	PRINT CHR$(9):"GS"	PRINTS HIRES PAGES #1 & #2 SIDE BY SIDE. * This option cannot be used in conjunction with rotated or double sized options. Some printers do not have enough character positions to allow this. Print two successive rotated pictures. (see CHART RECORDER MODE)
CTRL-IGM	PRINT CHR$(9):"GM"	PRINT THE GRAPHIC PICTURE & 4 LINES OF TEXT 20 SPACES FROM LEFT EDGE OF PAPER. The TEXT window may not align perfectly with the picture. This is due to the differences in the computer's graphics and the printer text mode. Rotate, double size and left margin features do not work with this command.
CTRL-IGD	PRINT CHR#(9):"GD"	PRINT GRAPHICS DOUBLE SIZE. May not work on some printers. Use the "CTRL-IGR" option. Otherwise the printer will get confused and crash (do nothing). If this happens, reset the ocmputer by pressing CTRL-RESET and turn the printer "OFF" and the "ON" again.
CTRL-IGE	PRINT CHR$(9):"GE"	PRINTS AN EMPHASIZED IMAGE . Two closely spaces dots will be printed in place of one.
CTRL-IGI	PRINT CHR$(9):"GI"	PRINTS AN INVERTED IMAGE. The printed image will look like a negative photograph. The white dots of the screen will remain white on paper.
CTRL-IGL	PRINT CHR$(9):"GL"	PRINT IMAGE AT THE LEFT MARGIN SET BY THE LEFT MARGIN TEXT COMMAND.
CTRL-IGR	PRINT CHR$(9):"GR"	ROTATE THE PICTURE CLOCKWISE 90. Some printers require this option when the picture is printed double size.

Any desired effect can be created by stringing several graphics commands together such as "CTRL-IGDIR2". This will print a double-sized inverse image of HIRES page #2, rotated 90 degrees.

*NOTE: To use the DUAL HIRES screen dump command, "CTRL-IGS", you must first load a binary file into the HIRES pages. To load a binary file directly from the keyboard use the following command:

```
BLOAD "filename", A$2000      (HIRES page #1)
BLOAD "filename", A$4000      (HIRES page #2)
```

To load a file from within a program (deferred mode), use the DOS commands:

```
PRINT CHR$(4):"BLOAD 'filename', A$2000"   (HIRES page #1)
PRINT CHR$(4):"BLOAD 'filename', A$4000"   (HIRES page #2)
```

2-4.7 Chart recorder mode

A chart recorder prints a continuous graph on a roll of paper. The IMC printer card can simulate a chart recorder by printing successive screens, single or dual HIRES, without any intervening spaces. This features works for both normal and rotated printing modes. (Centronics 739 will insert 1/2 linefeed when in rotated mode). The procedure is:

```
10 PRINT CHR$(4):"BLOAD 'graph1', A$2000"
20 PRINT CHR$(4):"BLOAD 'graph2', A$4000"
30 PR#1 (REM printer in slot #1)
40 PRINT CHR$(9):"GR"
50 PRINT CHR$(9):"G2R"
60 PR#0 :  END (REM SCREEN OUTPUT)
```

2-4.8 Pascal & CP/M compatibility

The IMC printer card is compatible with both PASCAL & CP/M operating systems. Both systems recognize the printer card as a serial interface. Entry points have been provided to mimic a serial interface so that the card will function properly with these systems. The card will function normally with a few exceptions as detailsed below.

Since both PASCAL & CP/M use CTRL-I to represent horizontal tab, the default control character command is changed to CTRL-Y. Consult your printer manual for setting printer tabs.

Both PASCAL 1.0 & CP/M use one of the I/O RAM locations to pass the output character. Since the printer interface is already using all available locations for its variables, the right margin function, CTRL-I nR, had been deleted to make it compatilbe. This feature is still available for BASIC & PASCAL 1.1.

2-4.9 Memory locations used by IMC

The IMC uses those RAM locations set aside for its particular slot and the slot scratchpad area common to all slots. The RAM is turned on using standard ROM expansion protocol and resides in the locations $C800 to $CFFF. The entry points and the various RAM variables are listed below. (N = Slot #)

COLD ENTRY	= $CN00
WARM ENTRY	= $CN02
LEFT MARGIN	= $478 + $0N
RIGHT MARGIN	= $678 + $0N
LINE LENGTH	= $578 + $0N
PAGE LENGTH	= $5F8 + $0N
CHARACTER COUNTER	= $4F8 + $0N
LINE COUNTER	= $6F8 + $0N
CURRENT CMD. CHAR.	= $778 + $0N
TEXT PAGE	= $7F8 + $0N

TEXT FLAG BIT REPRESENTATIONS:

Bit 7 - Output high order bit
Bit 6 - Video turned on
Bit 5 - Linefeed after carriage return
Bit 4 - Bell on
Bit 0/3 - Reserved

CUSTOM DRIVERS

ADDRESS	READ	WRITE
$C080,N0	STATUS	Output
$C081,N0	STATUS	Select bank 2 of ROM
$C082,N0	STATUS	Reset Interrupt Request & IRQ data bit
$C084,N0	STATUS	Output/Interrupt on ACK

NOTE: A READ in the range of $CN00 - $CNFF (N = slot #) will select bank #1 of ROM. When an Interrupt (IRQ) has been generated by the printer interface, bit 7 (MSB) of the status byte will be set to 1 (high).

2-4.10 Printer dip switch setting

All printers must configure to a Centronics type parallel interface. The following are DIP switch setting for some printers.

ANADES 9000/9500 Series:	All switches on S-3 must be OFF. Set switches on S-1 & S-2 appropriately
9620	: Set switches on S-14 & 15 appropriately
CENTRONICS 739-1	: All 4 switches must be OFF.
EPSON MX-80/80FT	: All switches on S-2 OFF. On DIP switch S-1 switch #8 ON & switch #3 OFF.
MX-100	: S-2 switch #3 must be OFF. S-1 switch #6 OFF, & #8 ON
MEC 8023	: SW-1: #6 & #7 closed, #8 open SW-2: 2 & #5 open, #6 & #7 closed
C. ITOH 8510A	: SW-1: #6 & #7 closed, #8 open SW-2: #2 & #5 open, #6 & #7 closed SW-3: no changes required SW-4: #4 open for parallel interface
MICROLINE 82A/83A	: SW-1: #1,2,3,4 & 8 OFF, #5,6, & 7 ON. SW-2: No changes required

2-5. How to plug-in home T.V.

REQUIRED ITEMS

Black and white television
Monitor cable
Power cord and outlet

PLUS

Radio ferquency (RF) modulator
and instructions
Voltage power adapter and outlet

1. Turn off the power of IMC

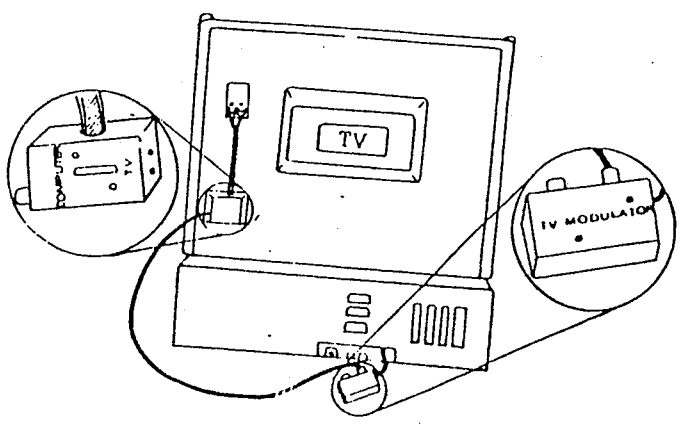
2. If using an RF modulator, follow instruction sheet supplied with it. Contact your computer dealer for held if needed.

3. Most common modulators require their own 9 volt power supply, and are preadjusted to operate on a particular television channel,usually Channel 1. (if not, try another channel)

4. You should find one power input wire, one video input wire,and one RF output socket. Video (or modulator) input comes from the video output socket on the rear of the IMC, and the RF output socket is usually connected to the television via an RCA cable. Usually the modulator casing must be earthed. Remamber to check intructions supplied with modulator.

* If your IMC system is provided with an autodisplay 80 column card, please refer to Chapter 2, section 3, on page 14 for plug-in your TV set.

* If your TV set is PAL system, please refer to following section.



2-6 How to plug-in PAL system TV

REQUIRED ITEMS

PAL color television
PAL color card and instructions
Interface cable
Power cable and outlet

1. After unpacking the PAL card, read the instruction sheet that comes with the card. Follow the manufacturer's recommendations with regards to adjustments on the card and television. Please contact your computer dealer if you have problems with the installation.

2. Turn off the power switch and remove the top cover.

3. Place the television set in convenient place. Note that the maximum recommended weight of a television resting on top of the IMC is 12 kgs. Do not place the television on top of the disk drive.

4. Turn on the IMC and the television, adjust the color, brightness until you can look comfortably. You will have to have a particular channel selected, depending on the card. Common channels for cards are:

IMC PAL CARD	CHANNEL 11

* If your television uses the NTSC system, you will not need use the PAL card.

2-7. How to plug-in monitor

REQUIRED ITENS

Monochrome monitor
Monitor cable
Power cord and outlet

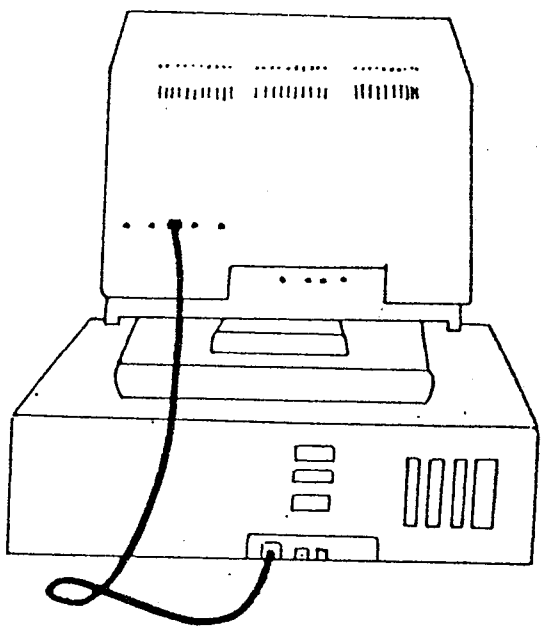
1. Plus one end of the monitor cable supplied into connector located on the rear right hand side of the IMC. The socket to be used is marked with "VIDEO".

2. Connect the other side of the monitor cable into your monitor.

3. You are now ready to POWER UP your IMC for the first time. Locate the ON/OFF switch on the outside left of the case, and make sure it is in the OFF position. Plug-in your monitor and IMC to AC outlet. Turn on the monitor and let it warm up. Turn on the IMC. Adjust brightness and contrast on the monitor until you can read clearly.

4. You may have to adjust screen controls of monitor to center picture etc.

* If your IMC system is provided with an autodisplay 80 column, please refer to Chapter 2 section 3 on page 14 for plug-in monitor.

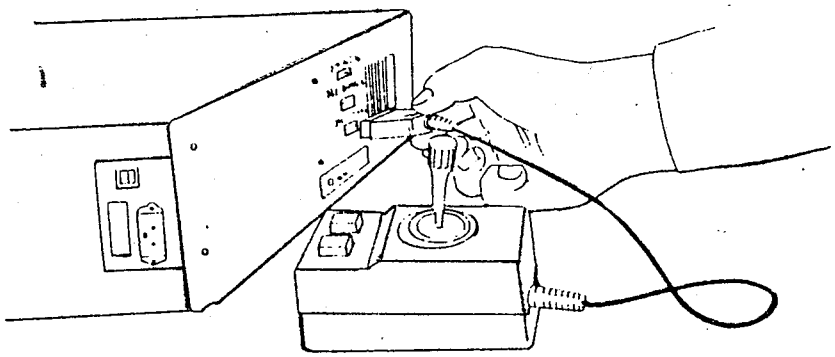


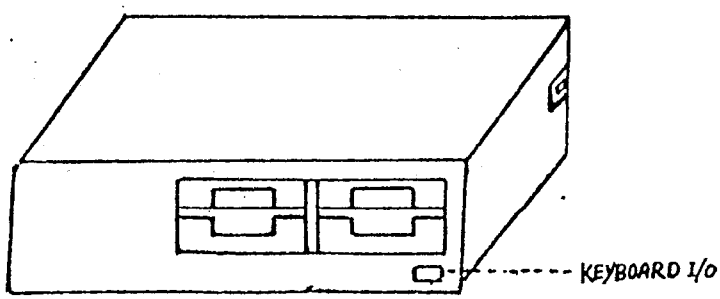
2-8. How to use joystick

REQUIRED ITEMS

Joystick (Game Paddles)

1. Turn off power of IMC.
2. At the rear panel, you can find a Game I/O Port.
3. Look at your joystick, you will find a 9-pin connector.
4. Plug connector into socket with care.
5. Gently push software diskette into drive and turn on the machine.
6. Operate computer as per instruction.





2-9 How to plug-in your cassette player

REQUIRED ITEMS

Firmware Card(plug in any slot)
Cassette Recorder in good condition
Computer Grade cassette tape
Cassette interface cable
Power Cable and outlet

1. Turn off the power switch on the IMC.

2. Locate the cassette interface sockets and connect the two cables as follows:

IMC		CASSETTE RECORDER
Cassette Out	to	EAR Jack
Cassette In	to	MIC Jack

3. Plug in and turn on the IMC and the cassette recorder. Insert the cassette tape into the recorder.

4. You can test your installation with the following program. Type in exactly what you see below:

```
10 HOME
20 PRINT "YOUR CASSETTE RECORDER HAS READ IN THIS
   PROGRAM CORRECTLY"
30 END
```

5. Make sure the tape is well past the leader part and press the RECORD and PLAY buttons on your recorder to start the tape.

6. To save your program on the cassette tape. type in

```
SAVE TEST
```

7. Once this has been entered press the RETURN key on the keyboard,the square block character will disappear from the screen.

8. Once the square block character reappears, hit the STOP button on your recorder and REWIND the tape to the beginning.

9. Type in NEW and hit the RETURN key. This will delete the program you have just typed in from the computer's memory.

10. You are now ready to reload your program from the tape. Type in LOAD TEST and hit PLAY on the recorder. Quickly hit RETURN on the keyboard.

11. The square block character will disappear again. You must adjust your Volume and Tone controls to mid range so the program will load correctly. If the square block character does not re-appear on the screen, adjust your recorder's tone and volume controls.

12. By the time you get this right, your tape may have passed the spot where your program is stored. If this is the case, REWIND the tape and let it PLAY again, until your Volume/ Tone combination is correct.

13. When the square block character re-appears, type in: LIST and hit RETURN, to see whether your program has loaded correctly. You should see what you had previously typed in appear on the screen.

14. To execute your program type in RUN and hit RETURN.

2-10. How to connect other expansion peripherals

IMC computer allows you compatibility with more than hundred interface cards peripherals, such as: Modem hard disk drive; 64K,128K,192K expansion card; 8088,16 bit MS-DOS card,etc...

1. Before you purchase any other expansion card or peripheral you must make sure first if it is compatible to IMC.
2. Always turn off power before you plug-in card or connect any peripherals.
3. Read instructions carefully before using.

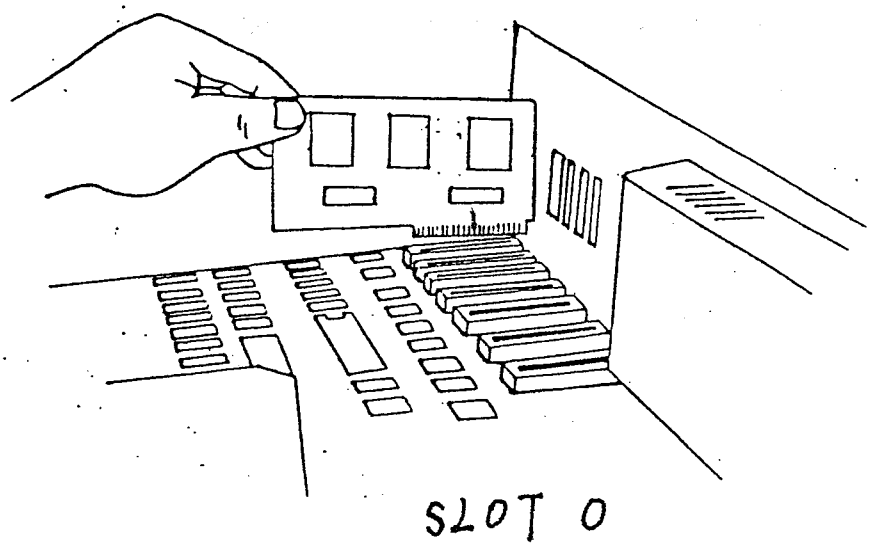
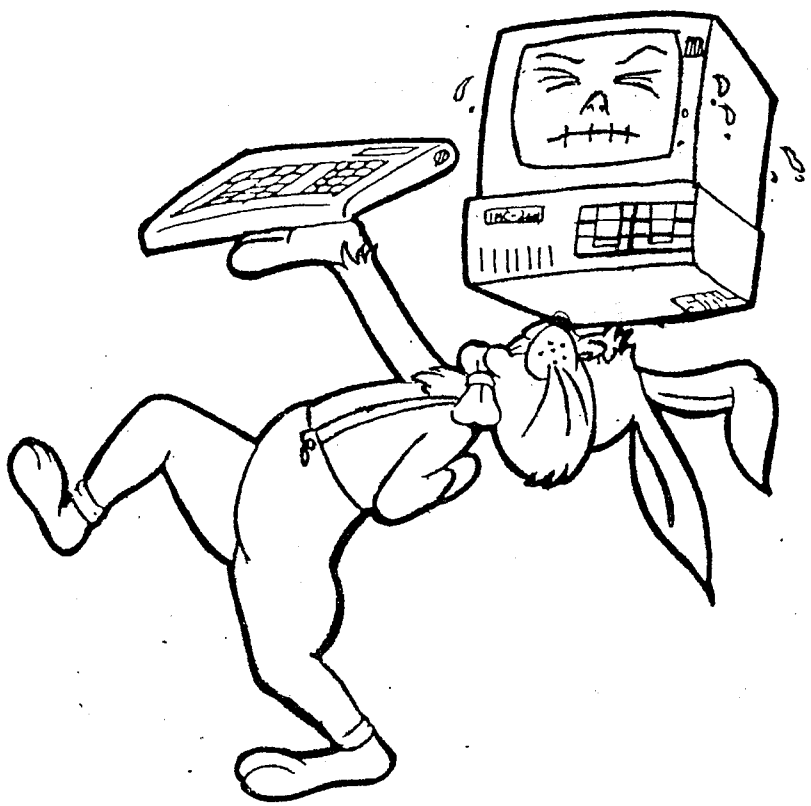


Figure 2-10

CHAPTER 3

GETTING STARTED

GETTING STARTED



CHAPTER 3 GETTING THE IMC UP AND RUNNING

3-1 GETTING STARED

In this chapter, we will get the IMC up and running. But as you may not buy all the peripherals in one time, so therefore, following we will introduce all major condition which might happen with different peripherals.

3-2 TURNING ON THE IMC with disk drive

REQUIRED ITEMS

IMC computer with keyboard
Monitor display
One or two disk drive

When you set-up above parts and turn on the power, you still can hear "beep" sound from speaker, and the screen shown as follow:

```
        ********************************
        *                              *
        *     IMC  JR   VER 1.1        *
        *                              *
        ********************************

(C)       BOOT ROM PROGRAM
          COPYRIGHT 1983 BY STI
          TX-NO 1-311-759 U.S.A.

              1) 6502  MODE
              2) Z-80  MODE

SELECT A NUMBER?
```

3-3 How to run 6502 mode for Apple type software

If you wish to run Apple type software, first please put "SOFT APPLE" (or Apple DOS 3.3 and FILER) diskette into your disk drive, then type 1 for select 6502 mode, now you will see your drive is moving, and the red light on drive 1 also glow. Few seconds later, your "SOFT APPLE" been booting on your system, see Figure 3-3.1. Press any key to programs select page (Figure 3-3.2)

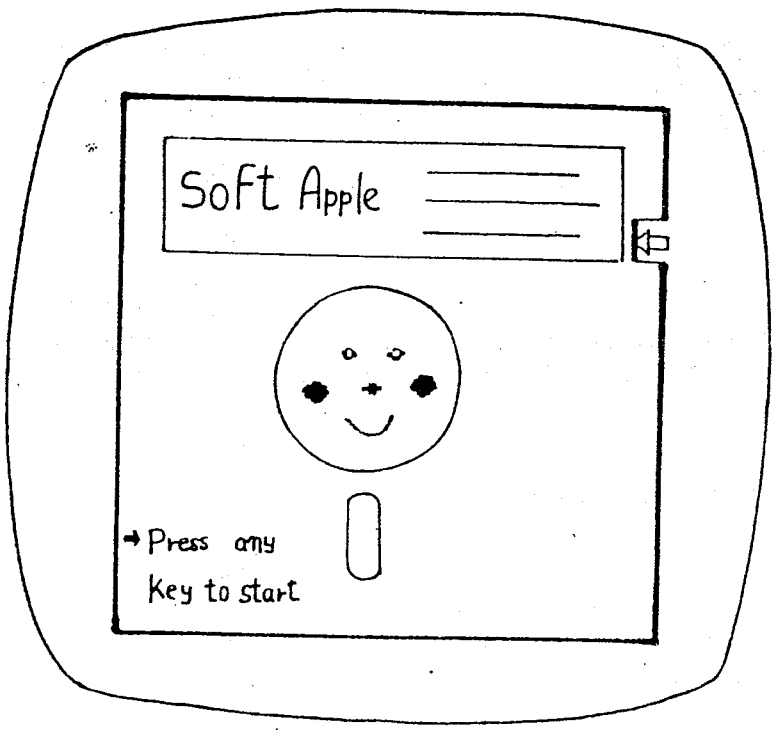


Figure 3-3.1

* DOS 3.3, FILER are optional

They means your IMC has already enter the FP BASIC. Under this FP BASIC, now you can programs Apple BASIC but also allow your IMC to run almost all the Apple type software, For example, if you wish to run another type of Applesoft, just put the diskette you wish to run intopdrive A (but be sure, the SYSTEM DISKETTE has taken away from drive A), and type:

PR#6

Press RETURN key to start booting your diskette.

If sometimes you change your mind and wish to run other type of Apple software, then you can use CTRL-RESET key to interrupt your program, and you can get back as Figure 3-3.3again.

Just like before, you can type PR#6 to start booting your new diskette.

But some of programs will not allow you reset, hence you must turn off the power to start your new program. Always put Apple DOS 3.3 SYSTEM MASTER or SOFT APPLE or FILER before you booting a new program. The proceeding is same as we meantioned before.

3-4 How to run CP/M™ software

When you have put CP/M software into Drive A, after turn on power, you will find the screen shown as Figure 3-4.1 Type 2 to select Z-80 modeand press RETURN, the following message will appear on the display monitor:

```
xxxxx
60K CP/M VER 2.2

A > □
```

Now you can following the application soft instruction or command to run your CP/M software.

3-5. Running with 80 column card

Most CP/M programdo request 80 column for bring more message of text at one screen page. If you want to run CP/M program, you should really need a additional 80 column card. (See your 80 column install manual carefully to know how to plug-in slot #3 correctly)

When turn on the power, you still will hear "beep" sound from speaker, but there are nothing shown in the monitor this time. Type "2" key, you will see your drive is moving, few seconds later, your screen will show text as below:

```
xxxx CP/M
56K VER 2.2
(C) 1980 MICROSOFT


A)
```

With 80 column card, you will glad to find it is much easier to you to run CP/M program than without.

3-6. Running with firmware card

IMC slso can compatible with many firware card, such as: IMC FM card, APPLE FP card. With this card, you can run all kind of Apple type and CP/M type software well, and don't need to load System Master (DOS 3.3, etc...) as well as Autostart every booting.

Note! When you buy FP card, you have to check is it original by Apple computer Inc. (Part No.AZB0009X). Or any other firm manufacturer the firmware card can compatible Apple software, you also need to make sure it is authorized by Apple computer Inc.

CHAPTER 4 GETTING FAMILIAR WITH THE KEYBOARD

As you have realized by now, you communicate with your IMC by typing on the keyboard, you can enter commands and information, respond to prompts and select different options or functions. All your word-processing and spread-sheet reports will be entered from the keyboard, as well as any information you want to use with other application program.

Your IMC keyboard is arranged very similsrly to a typewriter keyboard. Most of the keys are narked just as they are on a typewrite with a few notable exception. Following we will see the difference between your IMC keyboard and a typewriter.

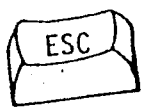
The IMC keyboard is laid out in 4 groups:

1. Typewriter keyboard section
2. 16-key numeric keypad
3. Cursor control keys
4. Function keys

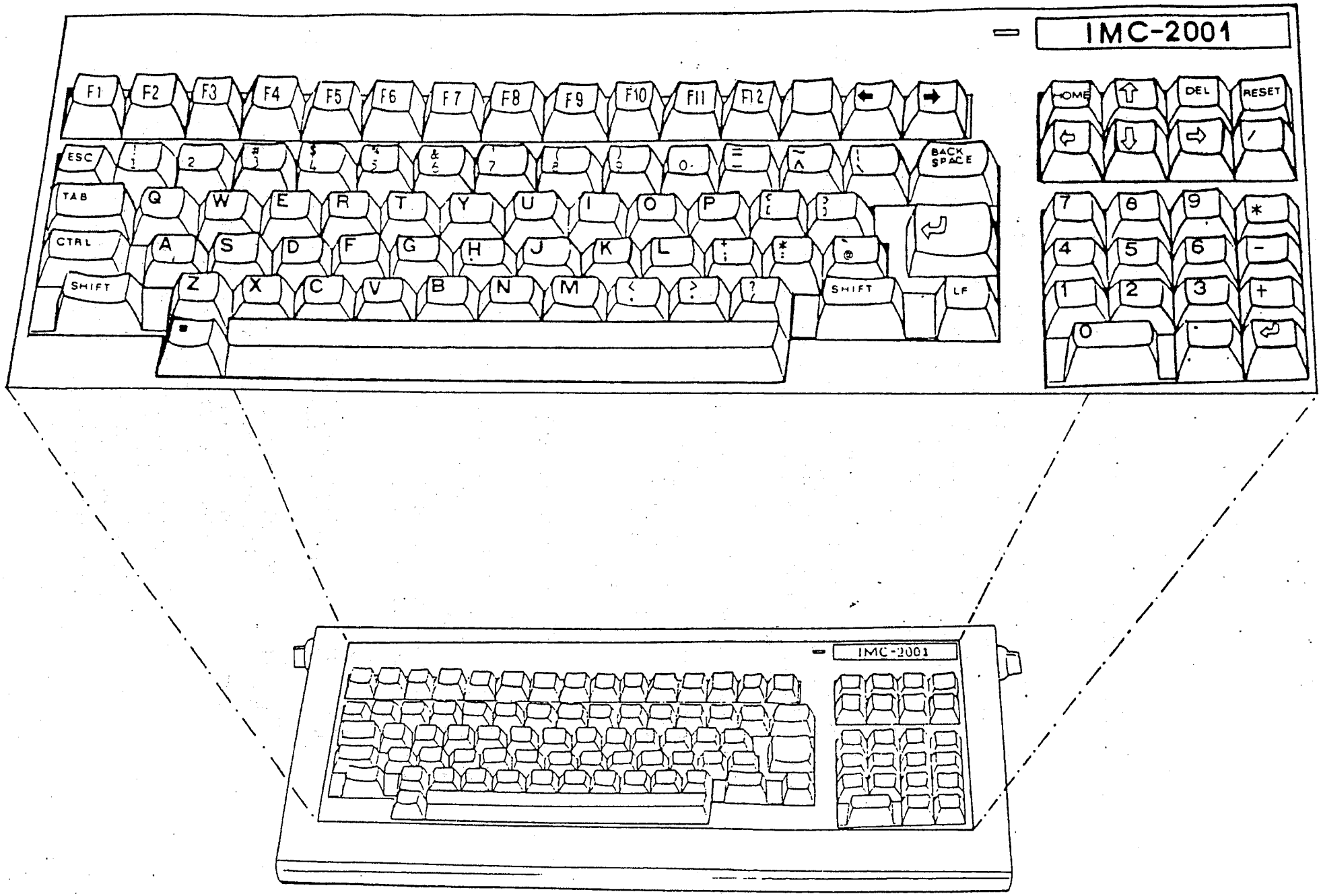
1. Typewriter keyboard section

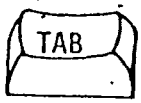
While most of the keys on this section look like those on a typewriter, many do not. They are important to know about. The following keys are peculiar to computers. You will soon get used to them even though they will be a bit mysterious at first.

: Backspace key, moves cursor to the left and deletes one character for each key stroke.

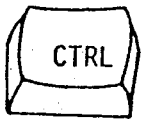


: The ESC (Escape) key is the most important of the control keys as it is used to put the computer in the ESCAPE MODE or to begin an ESCAPE SEQUENCE. Pressing the ESC key when the computer is in floating point BASIC language will put the IMC into edit mode. ESC-@ is the same as the HOME command, ESC -I,J,K,M or ESC-A,B,C,D, keys to move the cursor for editing, but they do not re-copy characters they pass over.


IMC-2001
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
F11
F12
ESC
TAB
CTRL
SHIFT
BACK SPACE
SHIFT
LF
HOME
DEL
RESET
IMC-2001



: Moves cursor to the NEXT tab setting



: Is always used with another key to perform a command or function. In IMC, a control character is a non-printing character that causes something to happen depending on a given program. Some control characters are:

1. CTRL-B Switches the IMC into BASIC (Beginner's All-purpose Symbolic Instruction Code) computer language. This command will erase any program statements or variable currently in memory.

2. CTRL-C Stops the running of any user-written program

3. CTRL-E Inspects the registers in the microprocessor of a program in MONITOR mode.

4. CTRL-G Rings a buzzer or bell.

5. CTRL-K Boots a program from MONITOR mode.

6. CTRL-M Moves the cursor to the beginning of the next line.

7. CTRL-P Boots a program from the MONITOR mode.

8. CTRL-S Temporarily freezes the listing of a program or the running of some programs. Pressing any key will re-start the program. (like a pause button)

9. CTRL-X Tells the IMC to disregard everything you have typed on the current line. You want to start over again.

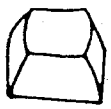
10. CTRL-Y Invokes a user-definable command in response to a MONITOR prompt.

11. CTRL-RESET Stops a current program or re-starts the system when the computer's power supply is already on.

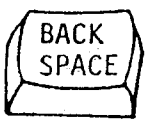
: Changes lower case letters to capital, and also you can use them to type symbols such as %, and some function marks.

: SPACE BAR

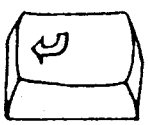
: The CAPSLOCK key locks the keyboard so it generates the capital letters without using the SHIFT key. In fact, when the keyboard is locked in the capital mode, using the SHIFT key makes any letter create a lower-case letter. The CAPLOCK key differs from the Shift lock key on a typewriter, because it effects only the 26 letters of the alphabet. For example, you must always press both SHIFT and /keys to get a ?. Press CAPLOCK once to set capital mode; press it again to return normal.



: The MULE key, the only key with no identification symbols, used by itself has no functions. When both MULE and CTRL(Control)keys are pressed at the same time, it toggles the key-acceptance beep tone ON/ OFF. When used with the SHIFT key, it toggles the single keystroke function keys between BASIC and CP/M.



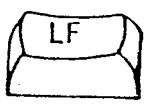
: The key wroks much like the BACKSPACE key on a typewriter. However, it not only moves the cursor back on space, but also erases the character that was there.



: The RETURN key is an important key as it serves two purpose:

1. It indicates the end of one line and moves the cursor to the begin of the next line, like a carriage return on a typewriter.

2. Pressing the RETURN key at the end of a command indicates the end of the command and passes the control to computer, just as the appearance of the cursor on the monitor screen passes the control to you.



: LINE FEED, moves cursor one line DOWN.

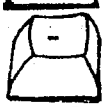
Special Note:

On a normal typewriter, some keys are used as substitutes for others such as the lower case letter "L" for the number "1" or the upper case letter "O" for the number "Ø". The computer does not accept substitutes, unless the programmer specifically instructs the computer to do so.

2. 16-key numeric keypad

The IMC's 16-key numeric keypad is arranged for efficient input of figures and commands. Often used commands such as +, -, *, / and the "REUTRN" keys are grouped along the right-hand row, like on a professional calculator.

: Multiply (different from conventional)



: Subtract

: Add

: As other RETURN key.

3. Cursor control keys

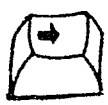
: Moves the cursor to the first character of the top line of the screen.

: The IMC has a DELETE key to enable the user to delete letters off the screen. Most programs written for the Apple II and II+ do not know this key. Some programs print a checkerboard character when you press this key, and some ignore it or indicate error.

: UP-ARROW moves cursor UP one line without erasing what you have typed. (same as ESC-I)

: DOWN-ARROW moves cursor DOWN one line without erasing any information. (same as ESC-M)

: LEFT-ARROW moves cursor LEFT one space without erasing any information. (same as ESC-J)



: RIGHT-ARROW moves cursor RIGHT one space without erasing any information. (same as ESC-K)

Note: keep in mind that many programs impose limitations on the cursor control keys. Some programs even consider some or all the arrow keystrokes invalid. Check at program manual for the proper cursor control keys to use.

: DIVIDE (different from conventional)

: The RESET key is often a "panic button". When things freeze up on your computer, often the only way to unjam them is to hit RESET, or CTRL-RESET. Again, depending on the program in memory, hitting the RESET key will do different things. If you accidentally hit RESET instead of the "-" or RETURN key, for example, usually by typing in RUN you will get your program back. With centain programs in memory, though, strange things can happen if you hit RESET. Don't be afraid of it, but for now only use it when instructed or when a program freezes up on you. (As a rule of thumb, NEVER press RESET when your disk drive light is on and the door is closed!)

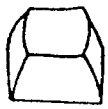
4. Function keys

The IMC keyboard has 32 special function keys. Some keys have already been described in earlier sections. This section concentrates on the row of keys labeled F1 to F12, located above the "typewriter" section.

These programmable function keys are pre-programmed with Disk Operating System(DOS), commands of CP/M and FP BASIC. FP BASIC commands are obtained directly, while CP/M commands are obtained by first press the SHIFT key.

KEY	FUNCTION BASIC/ CP/M
F1	CATALOG/DIR (immediate execution)
F2	RUN/DIR (followed by drive location such as A; or B;)
F3	CALL-151/FORMAT
F4	LIST/COPY
F5	PRINT/TYPE
F6	PR#/STAT
F7	LOAD/DUMP
F8	SAVE/LOAD
F9	POKE/SAVE

KEY	FUNCTION BASIC / CP/M
F10	PEEK/PIP
F11	GOTO/MBASIC
F12	TEXT/GBASIC

 : (CTRL-MULE) ON/OFF key-click

(SHIFT-MULE) FP BASIC or CP/M function modes

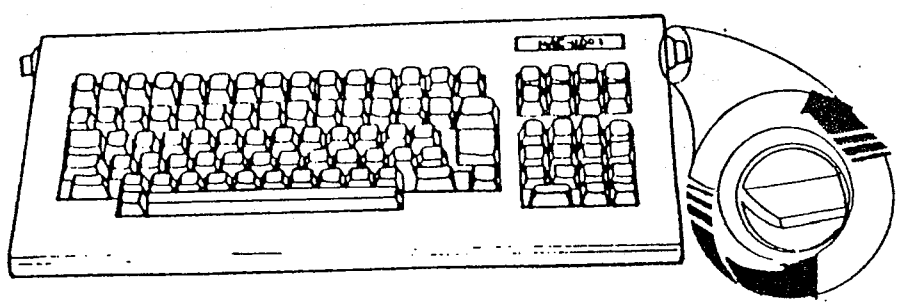
 : Solid LEFT-ARROW
Moves cursor LEFT one space. However, when you press RETURN, the IMC receives only the information preceding the cursor's current position. This key can be used to remove information.

 : Solid RIGHT-ARROW
Moves cursor RIGHT one space. Some programs let you use this key to copy text that is already on the screen.

Other features

AUTO-REPEAT: When you hold any key down for more than a second, the generated character is repeated.

Selectable Input: Acceptance key-click
Depressing CTRL and MULE keys at the same time toggles the beep tone OFF/ON.



CHAPTER 5 GETTING TO KNOW YOUR IMC HARDWARE

Your IMC computer is constructed by four major parts and two minor parts.

The major parts are:
1. The system board
2. The keyboard with housing
3. The disk drive
4. The power supply
5. The main cabinet.

The minor parts are:
1. The speaker
2. The power cable
3. The cooling fan

Let's examine the different parts of the IMC computer hardware.

5-1. The system board

Looking at the parts on the system board, you will see a lot of IC's over it, there are about 97 IC's on the system board, and many other small components.

IMC has made it simple for you to remove and replace the IC's by putting them into sockets. It is very convenient when you need to replacement about the system board at this point is slots. Total IMC built-in 7 expansion slots from 0 through 7 (except 4 & 6) located left of the system board. Never, Never, even sometimes, install or remove a card or cable to this computer while the indicator is "ON". Irrepairable damage can occur both to the peripheral card and the computer if a transient power surge should occur due to a sudden removal or insertion while the computer has power applied to it.

Just to the right of system slot, close to the edge of system board you will find another (4) white pins connector can be used as an input to an optional RF-Modulator. Used to send the video signals to a standard TV set instead of monitor.

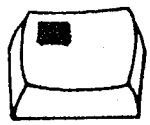
5-2. The IMC keyboard

The IMC detach keyboard connected with 6-ft telephone cable, is special designed for IMC computer.

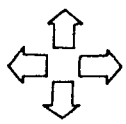
The keyboard is built-in a microprocessor with EPROM and electrically connected to the system board by a 9-pin D-connector cable with a convertible board.

5-2.1 Main specifications

* Number of keys : 95
* Coding : upper and lower case ASCII
* Number of codes : 128
* Rollover : 3 keys
* Power Requirement : +5V at 250MA
* Output : 8 bits ASCII with clock
* Special Keys : [CTRL] , [ESC] , [RESET] , [←] , [→], [HOME] , [F1] ..... [F12]

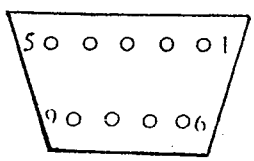


: (Cap. lock with led display when you pressed this key, led light and getting-in lower case mode)



: Screen Edit Keys, sam as [ESC] [I] or [J] or [K] or [M]

5-2.2 Keyboard connector



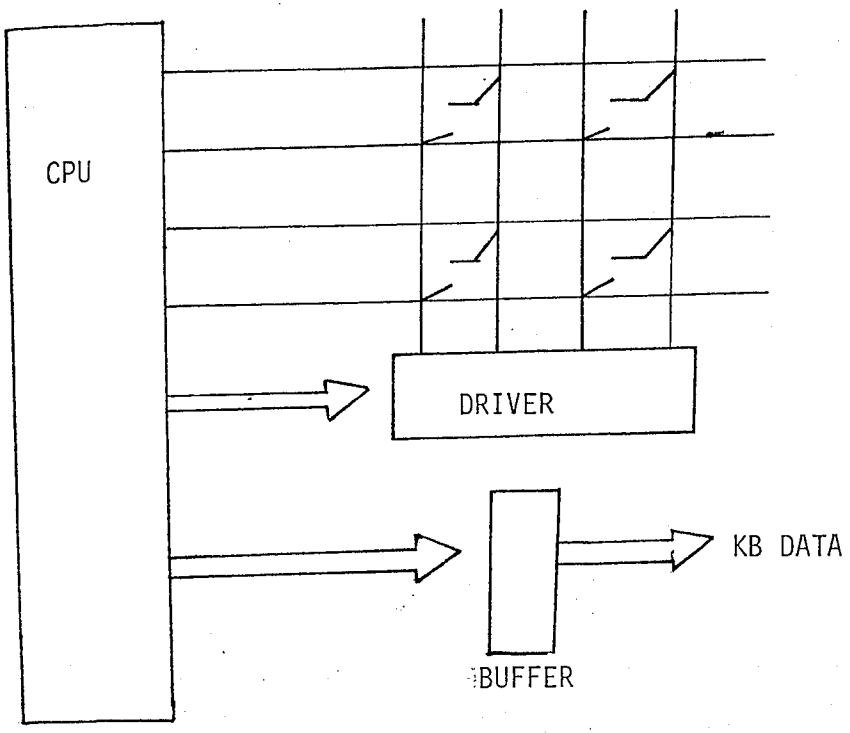
(Front View)

1. CLOCK
2. RESET
3. DATA
4. GND
6. VCC (+5V)

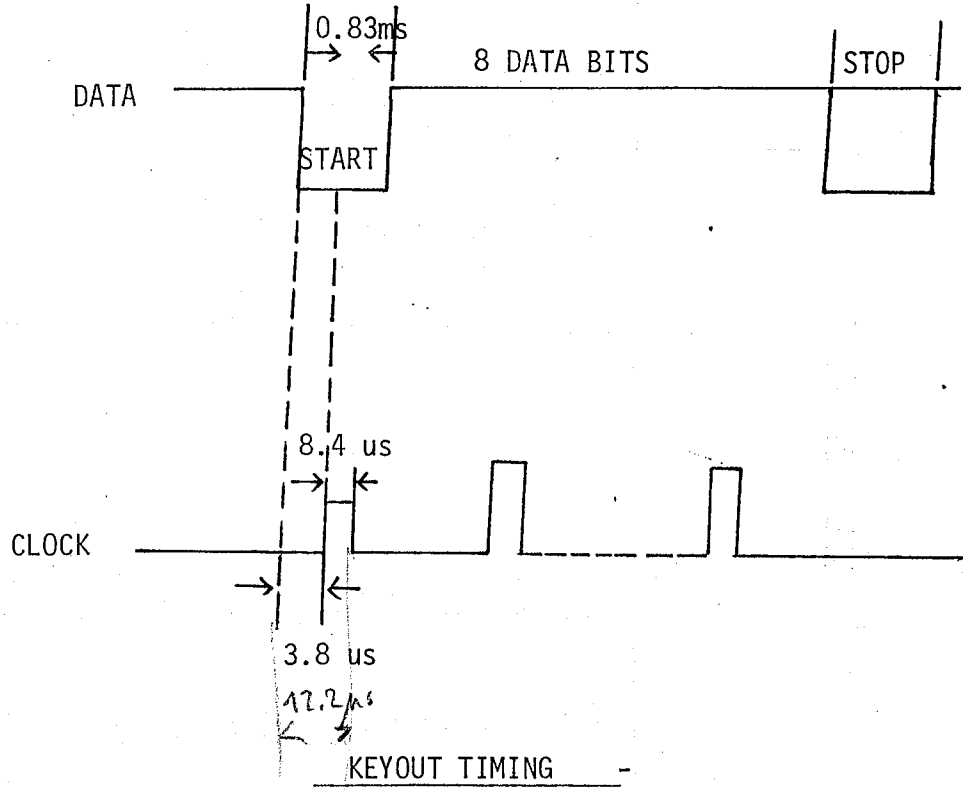
5. NPC

5-2.3 KB BLOCK DIAGRAM & OUTPUT TIMING

1 start
0 stop
8 data (clocked)



BLOCK DIAGRAM



KEYOUT TIMING

5-2.4 ASCII CODE TABLE

KEY	UNSHIFT	CTRL	SHIFT	CTRL AND SHIFT
SPACE	$20	$20	$20	$20
0	$30	$30	$30	$30
1 !	$31	$31	$21	$21
2 "	$32	$32	$22	$22
3 #	$33	$33	$23	$23
4 $	$34	$34	$24	$24
5 %	$35	$35	$25	$25
6 &	$36	$36	$26	$26
7 '	$37	$37	$27	$27
8 (	$38	$38	$28	$28
9)	$39	$39	$29	$29
: *	$3A	$3A	$2A	$2A
; +	$3B	$3B	$2B	$2B
[	$5B	$1B	$7B	$7B
=	$2D	$2D	$3D	$3D
] }	$5D	$1D	$7D	$7D
/ ?	$2F	$2F	$3F	$3F
A	$41	$01	$41	$01
B	$42	$02	$42	$02
C	$43	$03	$43	$03
D	$44	$04	$44	$04
E	$45	$05	$45	$05
F	$46	$06	$46	$06
G	$47	$07	$47	$07
H	$48	$08	$48	$08
I	$49	$09	$49	$09
J	$4A	$0A	$4A	$0A
K	$4B	$0B	$4B	$0B
L	$4C	$0C	$4C	$0C
M	$4D	$0D	$4D	$0D
N	$4E	$0E	$4E	$0E
O	$4F	$0F	$4F	$0F
P	$50	$50	$50	$50
Q	$51	$11	$51	$51
R	$52	$12	$52	$12
S	$53	$13	$53	$13
T	$54	$14	$54	$14
U	$55	$15	$55	$15
V	$56	$16	$56	$16
W	$57	$17	$57	$17
X	$58	$18	$58	$18

KEY	UNSHIFT	CTRL	SHIFT	CTRL AND SHIFT
Y	$59	$19	$59	$19
Z	$5A	$1A	$5A	$1A
→	$15	$15	$15	$15
←	$08	$08	$08	$08
ESC	$1B	$1B	$1B	$1B
@ `	$40	$00	$60	$60
, <	$2C	$2C	$3C	$3C
. >	$2E	$2E	$3E	$3E
\ |	$5C	$1C	$7C	$7C
^ ~	$5E	$1E	$7E	$7E
CR	$0D	$0D	$0D	$0D
TAB	$09	$09	$09	$09
BS	$08	$08	$08	$08
DEL	$7F	$7F	$7F	$7F
LF	$0A	$0A	$0A	$0A
a	$61	$01	$41	$01
b	$62	$02	$42	$02
c	$63	$03	$43	$03
e	$65	$05	$45	$05
f	$66	$06	$46	$06
g	$67	$07	$47	$07
h	$68	$08	$48	$08
i	$69	$09	$69	$09
j	$6A	$0A	$4A	$0A
k	$6B	$0B	$4B	$0B
l	$6C	$0C	$4C	$0C
m	$6D	$0D	$4D	$0D
n	$6E	$0E	$4E	$0E
o	$6F	$0F	$4F	$0F
p	$70	$50	$50	$50
q	$71	$11	$51	$51
r	$72	$12	$52	$12
s	$73	$13	$53	$13
t	$74	$14	$54	$14
u	$75	$15	$55	$15
v	$76	$16	$56	$16
w	$77	$17	$57	$17
x	$78	$18	$58	$18
y	$79	$19	$59	$19
z	$7A	$1A	$5A	$1A

5-2.5 FUNCTION CODE TABLE

FUNCTION	FP BASIC	CP/M	(CODE) FP BASIC	(CODE) CP/M
F 1	CATALOG ↵	DIR	43 41 54 43 4C 4F 47 20	44 49 52 ØD
F 2	RUN ↵	DIR ↵	52 55 4E 20	44 49 52 20
F 3	CALL-151	FORMAT ↵	43 41 4C 2D 31 35 31 ØD	46 4F 52 4D 41 54 20
F 4	LIST ↵	COPY ↵	4C 49 53 54 20	43 4F 50 59 20
F 5	PRINT ↵	TYPE ↵	50 52 49 4E 54 20	54 59 50 45 20
F 6	PR #	STAT ↵	50 52 23	53 54 41 54 20
F 7	LOAD ↵	DUMP ↵	4C 4F 41 44 20	44 55 4D 50 20
F 8	SAVE ↵	LOAD ↵	53 41 56 45 20	4C 4F 41 44 20
F 9	PAKE ↵	SAVE ↵	50 41 4B 45 20	53 41 56 45 20
F10	PEEK ↵	PIP	50 45 45 4B 20	50 49 50 ØD
F11	GOTO ↵	MBASIC	47 4F 54 4F 20	4D 42 41 53 49 43 ØD
F12	TEXT ↵	GBASIC	54 45 58 54 20	47 42 41 53 49 43 ØD
HOME	ESC @	ESC @	1B 40	1B 40
→	ESC A	ESC A	1B 41	1B 41
←	ESC B	ESC B	1B 42	1B 42
↓	ESC C	ESC C	1B 43	1B 43
↑	ESC D	ESC D	1B 44	1B 44

5-3. Floppy disk drive

Your IMC system built-in with two 5¼ inch minifloppy disk drives, which are standard size for personal computer today.

5-3.1 Specification

a. Capacity (Unformatted)

Media	125K BYTES
Track	3125 BYTES

b.	Sector Method	Soft
c.	Spindle Actuator	Belt
d.	Rotational Speed	300 rpm
e.	Track Density	48 Tpe
f.	Transfer Rate	125K bits/sec
g.	Recording Method	FM
h.	Access Time	
	Track to Track	12 msec
	Settling	15 msec
i.	Motor Start Time	MAX 1 sec

5-3.2 Reliability

a. Error Rate

Soft Read Errors	1×10^{-9}/bits
Seek Errors	1×10^{-6}/bits

b. MTBF	8×10^{3} hours
c. Media Life	3×10^{6} passes per track

5-3.3 POWER

a. +12 ± 0.6 VOC	1.2 AMAX 0.9A Typical
b. +5 ± 0.25 VOC	0.5A Typical
c. -12 ± 0.6 VOC	0.02A Typical

5-4. The Power Supply

Looking inside your computer to the left side. You will see a rectangular metal box, some are silver and some are black colored. This box will also have a sticker by IMC , with "CAUTION" of power supply.

Power Supply Specification:

Output Characteristics

Output current capacity:

Output Voltage	+5VDC	+12VDC	-12VDC	-5VDC
Load min Load max	0.35A 3.5 A	0.15A 1.5 A	0 A 0.25A	0 A 0.25A
Tolerance	± 5%	± 5%	+25%/-8.3%	+25%/-8.3%
Output Ripple	50mV p-p	150mV p-p	150mV p-p	150mV p-p

NOTES:

The output tolerance refers to the nominal voltage and includes line regulation, load regulation, temperature drift and set-up tolerance.

The specified ripple is at the rated line voltage and load range.

Individual maximum ratings:

+ 5VDC: 5 amps if no load on +12V output, or 2.5 amps if load draws 2.5 amps on +12V output
+12VDC: 2.5 amps if +5V output olad draws 1.5 amps or less
-12VDC: 0.5 amps.
- 5VDC: 0.5 amps.

Note: The maximum continuous output power shall not exceed 40 Watts (2.5A). Specified voltage tolerances do not apply to the above individual maximum currents.

General Characteristics

Operation temperature:		$0 \sim 50^0$C.
Efficiency	:	70%
Input line regulation:		±0.2% max.
Over-voltage protection:		5.8V min. to 6.8V max. (+5V line only)
Hold-up time	:	15msec.
Line regulation	:	±0.5% high line at full load.
Over-current protection:		All output protected to short circuit conditions.
Line transient response:		Meets IEEE standards.
Power line disturbances:		Output supply unaffected through half cycle absence of input power during full load and 90 VAC input
Inrush current	:	<79 amps @110VAC or 220VAC.

Mechanical Characteristics

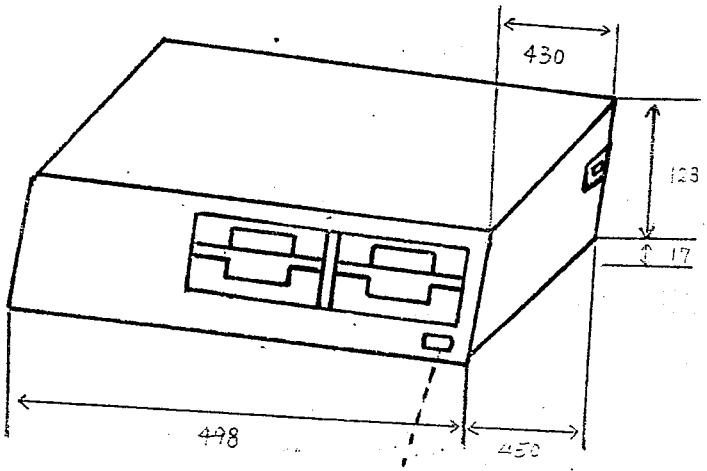
Side (overall):	length:	160mm. (6.3in)
	width :	100mm. (3.9in)
	height:	47.5mm. (1.87in)
Weight :		0.388Kg. (13.69oz)

5-5. The Main Cabinet of IMC

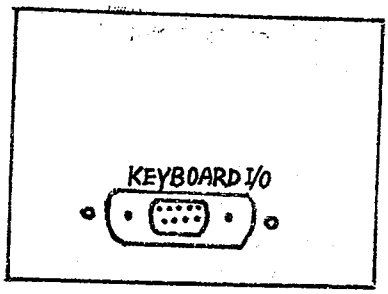
The main cabinet of IMC is actually made up by four parts:

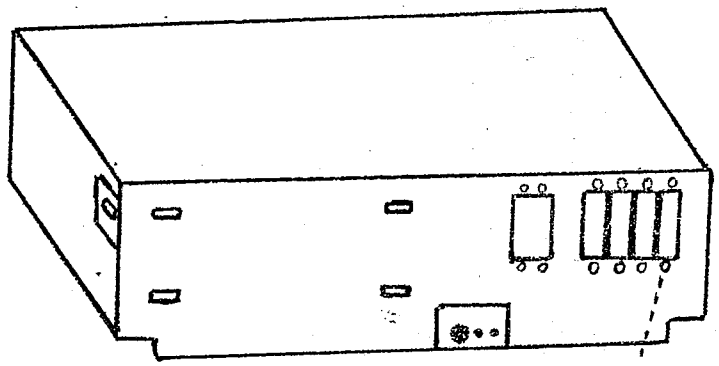
1. The housing which is made by metal on the lid ataches to.
2. Housing for built-in disk drive
3. The metal botem plate with keyboard cable
4. Plastic front panel

IMC CABINET

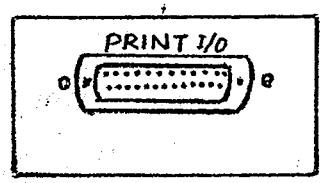


CARTON: SIZE 18 x 48.5 x 55 (cm)
WEIGHT 1.10 KG





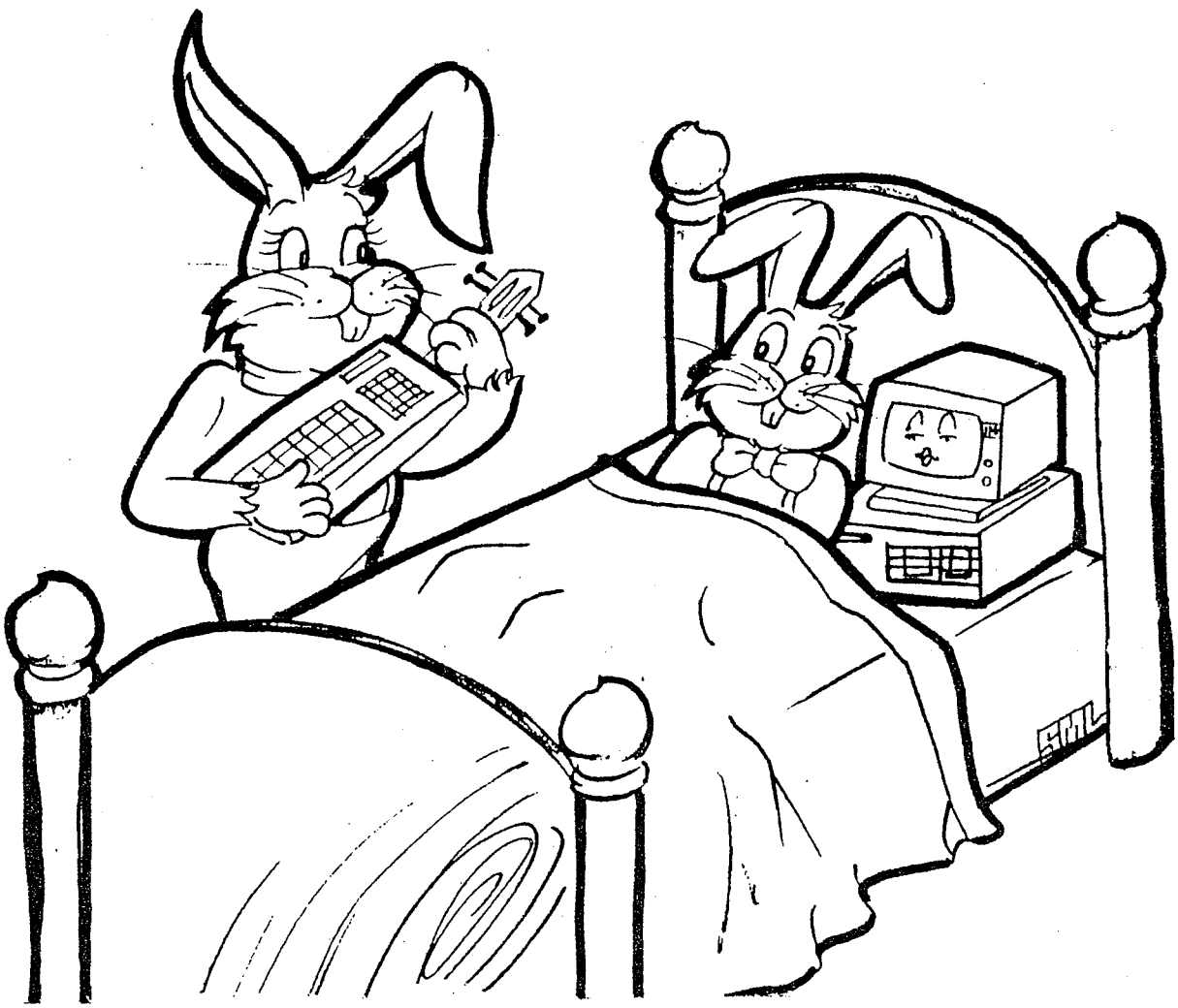
MIART CASE : WEIGHT 6.35KG
MATERIAL.
A. ABS PANEL
B. 1 mm UPPER COVER
C. 1.3 mm BASE



IMC TECHNICAL

Microprocessor	:	Z-80 (4.00 MHz) 6502 (1.02 MHz)
Word Size	:	8 bits
Address Size	:	16 bits
Keyboard Controller:		8048
Memory	:	64 Kilobytes of RAM 4 Kilobytes of ROM
Text	:	40 characters per line x 20 lines (80 character optional) Normal, Inverse and Flasing characters Upper/Lower case
Keyboard	:	Detachable typewriter style layout with 95 keys 23 keys Numeric keyboard 24 keys Function keyboard 4 keys Cursor keyboard
I/O	:	Disk drive interface Cassette interface Joystick/Paddle connector 7 peripheral board slots RF-Modulator interface Video interface monochrome and NTSC colour Speaker connector Power indicator connector Power supply connector
Graphics	:	40 Horiz x 48 Vert. Resolution 40 Horiz x 40 Vert. Resolution With 4 lines of text
High Resolution Graphics:		280 Horiz x 192 Vert. Resolution 280 Horiz x 160 Vert. Resolution with 4 lines of text
Dimensions:	System cabinet	44(H) x 39(W) x 11(D) cm
	Keyboard	41(H) x 19(W) x 5.5(D) cm

MAINTENANCE AND TROUBLE SHOOTING



TAKE CARE OF YOUR COMPUTER

CHAPTER 6 MAINTENANCE AND TROUBLE SHOOTING

6-1. Take Care of Your Computer

When was the last time you cleaned your computer? I don't mean a fast wipe with a cloth or a quick pass with a vacuum cleaner, but a complete job on inlets, fan filters, card connectors,and under the keytops. Be honest. If it has been more than a month, you have committed a cardinal sin of computer usage.

Many recreational and professional computer users overlook or ignore conditions that contribute to unnecessary failures and malfunctions. You can minimize these conditions to extend the operating life, improve overall performance, and reduce repair costs. Specifically, the areas of concern are dirt and contamination, excess heat,.stray magnetic fields, electrostatic charges, power disturbances, and mechanical wear.

Dirt and Contamination

Anything existing outside a sealed environment gets dirty, if only form airborne dust and contaminants. This includes computer systems; dirt is the mortal enemy of any ststem.

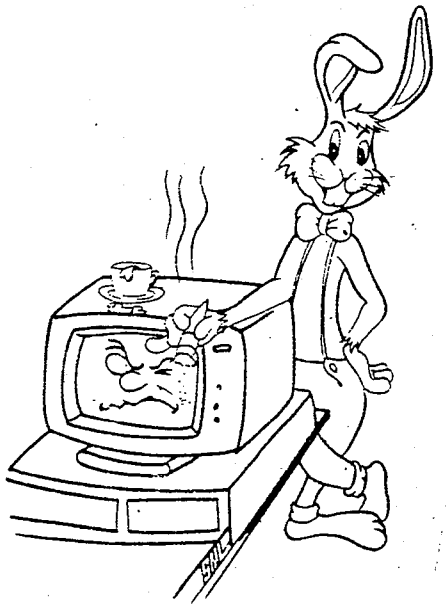
A few years ago, most computers were housed in special rooms where temperature and humidity were regulated, air was filtered, and activities such as smoking, drinking and eating were prohibited. In large corporations using mainframes, you still find glass rooms, walled off from the rest of the world.

With the advent of the personal computer, however, machines have been moved into open, uncontrolled environments. The new breed for homes, professional offices, stores, and similar installations had to be accessible to people, with a corresponding increase in problems resulting from dirt and contamination.

Modern microcomputers are exposed to dust, smoke, soot, chemical pollutants, fine particulates known as "aerosols," and corrosive gases, with little or no thought about the effects. There are no totally clean offices or homes. The average office is full of cigarette smoke, urban pollution, and dust. The average home has airborne cooking grease, pet hairs, and carpet fibers, among other unsavory things in the air.

Add particles of human hair, dandruff, upholstery fibers, and bits of food, and you begin to understand what the computer must endure. More problems are particles of printer paper, oxide form tapes or disks, and fibers broken loose from printer ribbons.

Computer equipment cannot be airtight. Components generate heat and require a continuous flow of cooling air provided by either natural convection or fans. Because more air flows through fan-cooled machines, they collect more internal dirt than convection-cooled ones and generally require more cleaning and care.



Effects

Dirt can cause anything from a gradual decline in performance to outright failure, and problems often build slowly until a malfunction occurs.

Dirt on outer surfaces usually isn't serious. Dirty screens are hard to read. Dirty keys feel strange; dirty covers are unsightly. External surfaces are cleaned easily, however, and cause few operational difficulties.

Dirt inside the system is a serious problem. Though contaminated drives and disks aren't readily spotted, they show up as data misreads (I/O errors), head "crashes," damaged disk surfaces, or random intermittent errors.

Dirt blocking the cooling air allows heat to build up, leading to damaged components and costly repairs. Contaminated connectors (cable and circuit board) and switches can fail to make good contact or can make and break contact intermittently. Even the telephone plugs of modems and other communications devices can be contaminated, leading to data transmission errors and the loss of expensive network time.

Furthermore, some contaminants are conductors, creating unwanted electrical paths and short circuits. Graphite particles from pencils, soot, metallic chips, and magnetic oxides are particular problems.

Preventive and Remedial Steps

The best cure for dirt-related problems is prevention, primarily through regular inspections and cleanin

On the installation level, replace filters on forced-air heating and cooling systems every two or three weeks. In dry climates, install a room or furnace humidifier to reduce both airborne contaminants and static-electricity problems. Portable room-air filtration devices also help, but the filters must be changed frequently. Furthermore, such units must be kept several feet from the computer and magnetic media to avoid potential proglems from electromagnetic fields.

Beware of auxiliary heating devices, especially kerosene heaters and wood stoves. Even the most efficient kerosene heaters emit a kerosene mist. When the mist condenses on surfaces, circuit boards, chips, disks, tapes, and screens, it leaves a greasy, conductive film that can do immeasurable damage. As a rule, if you own a computer; don't use a kerosene heater anywhere in the same building. Similarly, wood stoves are "dirty" devices that lead to the unavoidable spread of ash, smoke, and dust. Though not as damaging as a kerosene film, these contaminants must be removed from both the outside and inside of the computer, perhaps as often as three or four times a week.

Clean your installation, system components, and surrounding area every week. Vacuum the floors, baseboards, window sills, and furniture. Wipe down desk or table tops, component casings, and other exposed surfaces with a soft, damp cloth or a commercial cleaning product intended for computer use. Be certain the cleaning cloth is damp, not wet. Avoid detergents-they leave residues that later cause more contamination. Avoid chemical solvents, particularly degreasing chemicals-they can damage components.

Make use of the many cleaning products available for computer and electronic equipment. Screen-cleaning solutions, pressurized clean-air canisters, and lint-free cloths are essential for proper care of your equipment. Make a special point of obtaining and using a disk-drive cleaning kit, perferably one that contains a special disk and solutions so that drive heads can be cleaned simply by inserting the disk and activating a drive for 30-seconds or so. It voids your warranty or service contract to open drives and clean them with swabs.

Inspect all air vents and intakes, giving special attention to filters and fan housings where screens or filters may block the air flow. Replace or clean filters and screens in accordance with the manufacturer's recommendations.

Check the cables to printers, terminals, disk drives, and modems. A common cause of system failures and communication problems is a loose connector, and many connectors work loose simply from the normal operating vibration of fans, disk drives, and printers.

At least once a month, inspect the inside of your equipment chassis, assuming of course you can open it without endangering a warranty or service contract. Be sure power is off and the power cord

disconnected before opening anything, then remove the covers and look for accumulations of dirt and dust. Remove any such accumulations, especially around boards and connectors. Tweezers and a canister of pressurized clean air are useful tools for removing dirt. Do not reverse the hose of a vacuum cleaner and use it to blow into a device - if you have tried reversing a hose, you probably have seen puffs of dirt and dust emitted, and the last thing you want is to introduce that dust into your equipment.

Check mechanical components for evidence of wear. Look for worn spots on moving surfaces inside printers, especially on the rails and bearing surfaces of the printhead and print hammer. Be sure to clean paper chips and accumulated paper fibers from inside the printer. If the disk drives can be opened, check the rails on which the heads ride, and look for "burn marks" and abrasions on the magnetic heads. Also look for excessive deposits of oxide worn from disks, indicating a possible problem with eigher the heads or the disks themselves. Check all guide rails in printers and disk drives for dust and dirt that many interface with smooth tracking. Follow the instruction in your manuals concerning lubrication of mechanical parts. If your manuals don't cover care and maintenance, contact the manufacturer and request or purchase a service manual.

Once or twice a year, be prepared to strip, clean, and reassemble your equipment - or pay a technician to do it for you. Remove circuit boards and clean the edge connectors and sockets. Check the seating of all integrated circuits. Check the seating of all cable connectors. Remove the keytops from the keyboard and clean out accumulated dirt. Basically, perform a minor overhaul.

Heat Buildup

Heat buildup is a sneaky hazard that catches unwary users by surprise. All equipment has manufacturer-specified operating and nonoperating temperature ranges that must be observed. In general, personal and small-business computers and peripherals can operate successfully under ambient temperatures from 50° F to 80° F (10° C to 26.6° C). That range covers the limits of normal operator comfort, typically 65° F to 78° F (18° C to 25.5° C). It is important to maintain the operating environment within the specified range. If the remperature is too low, mechanical actions such as disk accesses and printing may become sluggish. If too warm, overheating may cause improper operating and anything from a total shutdown to intermittent errors.

Remember that electronic and mechanical devices generate heat, which, if not vented or cooled, can cause internal temperatures to exceed the ambient temperature. It is the internal temperature that causes difficulties, and it must be controlled so that the equipment can function normally. Often it is necessary to install special cooling devices on the equipment. Slotted covers and auxiliary fans may be necessary to maintain satisfactory operating temperatures.

Particular heat problems occur when plug-ins are added to computers, with each unit adding its own heat to the total and possibly exceeding the cooling level for which the unit was designed. With smaller machines, the situation is compounded by vertical component stacking, where disk drives are placed on top of the computer and a monitor is on top of the drives. That creates a vertical heat column, in which upper units block the cooling of lower ones, while lower units add to the heat built up in higher ones.

The usual cause of excess heat is blockage of air intakes. Such blockages result from installing a unit having left insufficient air space around it, placing something over the vents, or allowing dirt deposits to collect on filters or screens. Internal dirt also blocks the flow of air around critical components.

Never install computer equipment above or near heat sources. Stay at least three feet from heating vents or radiators. Keep at least six feet from auxiliary space heaters, including electrically powered radiant heat panels and stoves. Becuase of the double threat from heat and contamination, don't put the computer in the same room with a kerosene heater or wood stove- preferably not in the same building.

Less obvious is the danger from direct sunlight. sunlight stricking the machine generates heat keyond the levels with which the cooling air flow can cope. Heat radiated by window glass, drapes, carpets, and furniture exposed to sunlight adds more problems. Furthermore, sunlight can warp disks and magnetic tapes, leading to loss of valuable data.

Devastating Effects

Often, the first sign of a heat problem is erratic operation, including numerous errors during data processing. Extended exposure to excess heat shortens the life of circuit chips and other components, eventually leading to more failures under various operating conditions. The cumulative effects can be devastating and expensive.

According to one report, "Studies have shown that the life of electronics equipment is cut in half for every 10°C rise in temperature. So if you keep your ..... computer 10 degrees cooler, you double its life and also increase its reliability during normal operation."

Preventive and Remedial Steps

No system should ever be damaged by heat since heat problem can be prevented. By keeping the equipment away from sources of direct heat and out of direct sunlight,you have most of the problem licked. If you like to look out the window while you work, consider putting a commercial reflective window film on the glass in the computer area. Bronza - or silver-tone reflective film is inexpensive compared to computer failures; it's easily installed, and it substantially reduces the heat generated by direct sunlight. However, don't rely totally on reflective films- some heat gets through; so draw the drapes as often as you can.

Keep the equipment clean, both inside and outside. Take care not to obstruct air intakes, vents, fan inlets, and other openings, either by placing something in the way or allowing dirt and dust to accumulate.

Third, allow sufficient space for free air flow. Never jam a unit up against a wall or set it on a soft surface like wall or set it on a soft surface like carpeting. Even foam vibration pads are dangerous to components having air intakes on the bottom (the "feet" sink in and the clearance to the bottom is reduced.)

Don't stack components vertically; instead spread them out horizontally. That avoids concertrating the rising heat and creating an additive thermal column that easily overheats the uppermost units. I don't care for most commercial workstations used to house system in a minimum area, because many of them concentrate the heat sources while they block the free flow of cooling air.

Install additional cooling whenever possible. Be especially alert to auxiliary fans marketed for units normally cooled by convection. Often potential heat problems aren't evident until the system has been on the market a while and manufacturers begin providing plug-ins. Then someone sees a heat-related failure and realizes that convection cooling isn't adequate for a fully-equipped unit or that the cooling fans have been undersized. The appearance of auxiliary fans on the market for a specific brand of equipment indicates that extra cooling is required.

Electromagnetic Fields

Magnetic or electromagnetic fields are hazardous because they can disrupt computer operations, alter data being processed, and erase magnetic storage media.

Every electrical current and, thus, every electrical or electronic device generates an electromagnetic field- some weak, others strong. Motors, bells, buzzers, and transformers contain electromagnets, and some also have permanent magnets. All have electromagnetic fields. Even computer components generate fields, including ribbon-lifters of printers, disk drive motors, and transformers in monitors and terminals. Furthermore, loose ferrous (iron-based) metal objects may be magnetized, including screwdrivers, pliers, wrenches, tweezers, scissors, paper clips and staples.

Effects

Like other hazards, the effects of stray magnetic fields are unpredictable, showing up as drive failures, memory losses or alterations, garbled data, garbaged printouts, pulsating displays, unexpected breaks or transmission erros in network communications. The most damaging is erasure of magnetically stored data. Interference with electronic operation is transient and generally causes little or no permanent damage to hardware, but lost data can be expensive.

Preventive and Remedial Steps

Most problems with electromagnetic fields are avoidable. Remove the source of the field and the problem is gone. It is difficult to know which item causes the problem, and people tend to overlook the obvious.

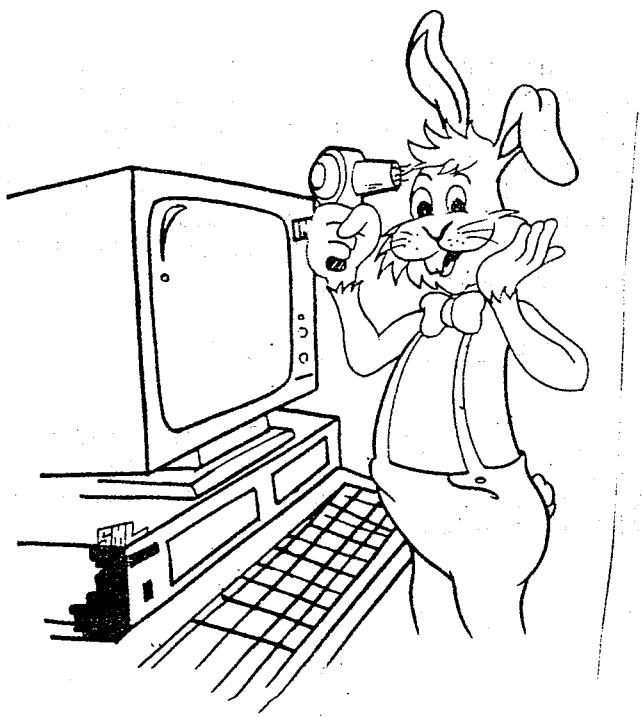
One offender is the phone. Because its bell operates with a powerful electromagnet, putting the phone next to a box of disks could damage the contents of the box when the phone rings. Similarly, placing the phone near disk drives or memory circuits may interface with storage and processing operations.

Audio speakers are a source of trouble for people who like music while they work. Speakers have powerful magnets to move the cones. In turn, the magnetic fields damage disks, tapes, memory contents, and read/write operations if not located a sufficient distance away.

Just moving offending devices three to six feet from the computer is usually sufficient. But be careful not to put them where you could walk through a field with a disk or tape in your hands. In general, keep anything not required for computer operation away from the machinery, including tools, flashlight, intercoms, and any other device of metallic nature or which operates from an electrical outlet.

Be careful of viceo terminals and monitors, reserve power supplies, and similar devices. They often contain powerful transformers with fields that can devastate memory storage and mass media quickly. Some tape and disk devices are particularly sensitive and can not be run within two ro three feet of a CRT or monitor. That's another reason for not stacking a monitor on top of disk deives - the transformer can prevent proper read/write operation and can even erase disks while they spin in the drives.

If a device cannot be relocated, try shielding it from the other components with a thin sheet of soft iron or carbon steel. Often such an insert is sufficient to block the magnetic field and protect the sensitive components. Protect your magnetic media at all costs. Store tapes and disks in dust-protective jackets and boxes at least three to four feet from any electrical or electronic device. Never leave magnetic media on top or beside the computer, drives, monitor or CRT, or printer. Never allow them near the telephone, speaker, calculators, or similar gadgets.



Electrostatic Charges

Static electricity, a constant problem around computers, is always a potential source of malfunction. A good description of the phenomenon is provided by The Static Control System division of the 3M Company:

"In scientific terms, it is an imbalance of electrons on the surface of a material. Whenever two materials that are in contact are separated, an imbalance of electrons occurs each surface, resulting in a positive charge (deficiency of electrons)on one surface and a negative charge (over-abundance of electrons) on the other surface. Because this charged state is 'unnatural', each surface makes an effort to discharge, or return to its neutral state. A typical example .... is a person walking across a floor (generating a static charge) and then getting a shock (discharging) as a door knob is touched. Quantitatively, when a person feels this shock, a charge of at least 2500 volts is involved, a charge level high enough to cause malfunctions of electronic equipment..... charges well below 2500 volts can cause equipment malfunctions, so static protection may be needed even though 'shocking' is not present."

All floor surfaces are potential problems - carpeting, vinyl tile, wood, and concrete. Furthermore, moving objects such as the flywheels and diskettes in continuously spinning disk drives are internal sources. Even paper moving through a printer can build and carry a charge.

Eliminating carpeting doesn't cure the problem. The 3M Company report cites experimental work done at Western Electric Co., determining that the most common buildup for a person walking across a carpet was 12,000 volts; waling accross a vinyl tile floor under the same environmental conditions accumulated 4000 volts. The highest readings reported were 39,000 volts for carpeting generates higher voltages, but solid floors still generate enough to be dangerous to delicate equipment.

Contrary to popular belief, high humidity does not eliminate static. Although high humidity reduces charges and danger, it does not get rid of static.

Static Damage

The most obvious static effect is a spark from one object to another. But even when arcing isn't evident, static can damage the inside of electronic devices or data stored on magnetic media.

Static can alter or wipe out the contents of memory, generate faulty data, blank a video display, cause unwanted printer carriage returns, and create a host of similar problems. Worse, static discharges can burn out circuit chips or entire circuit boards. A discharge to magnetic media can permanently destroy data or even damage the magnetic surface.

Interface cables are particularly vulnerable. sometimes cables have to be routed where it is possible to step on them. Simply walking across the floor can discharge static into the cables, thereby "clobbering" the devices at either end. This can lead to lost data, blown circuit chips on interface boards, fuse failures and system shutdowns, or damaged circuit boards. In network communications, the cords that connect the computer and the modem are entry points for static that disrupts the communications, garbles the transmissions, and generally incurs increased time and charges for the network use. At worst, static penetrating a telephone cord could damage the modem itself or the computer to which it is connected.

Expect static to cause erratic computer behavior at all levels from disk operations through network communications. Be alert to the possiblity even if you don't see any sparking; if you get a spark when touching the equipment, you have a problem that has to be eliminated.

Curing Static

The best cure for static is prevention. Ensuring that every component is grounded serves as a good first step, but it isn't foolproof. Be certain the third prong (the round one) of every line plug is properly grounded. Don't attempt to defeat the grounding by cutting or bending the prong and don't attempt to use two-prong adapters without connecting their pigtail wires. If you have any doubts about the electrical grounds in your building, it pays to have an electrician check or install them before you hoop up your computer system.

Other steps that redeuce but don't entirely eliminate static problems are removing carpets and rugs from the working area, installing a humidifier, avoiding crepe or rubber soled shoes, and avoiding excessive movement such as shuffling your feet while working.

Connecting cables should be routed to that they can't be stepped on or touched. Putting them under a carpet may help avoid tripping, but static discharges can penetrate the carpet to reach the cable and connected electronics.

Sometimes commercial anti-static sprays are helpful in cutting down shortterm problems, but they must not be sprayed directly onto the keyboard,screen, or magnetic media. The residue left behind could cause problems later. Some sprays irritate the eyes, so be careful where and how you use them. Remember, you will have to repeat the treatment periodically; vacuuming the carpet or wiping the desk surface removes or degrades the antistatic protection.

You can achieve effective, long-term solutions to static problems with antistatic floor mats placed under chairs, behind counters, and in other locations where people walk and come in contact with delicate electronic devices. They are also useful on top of connecting cables (between devices and to communications modems) as a means of preventing discharges into the cables. Conductive anti-static mats must be connected to a good gournd to be effective, usually to the center screw of a grounded wall receptacle. Sitting or standing on such a mat then grounds static built up while you

walk to the installation and prevents buildups while you move around at the equipment.

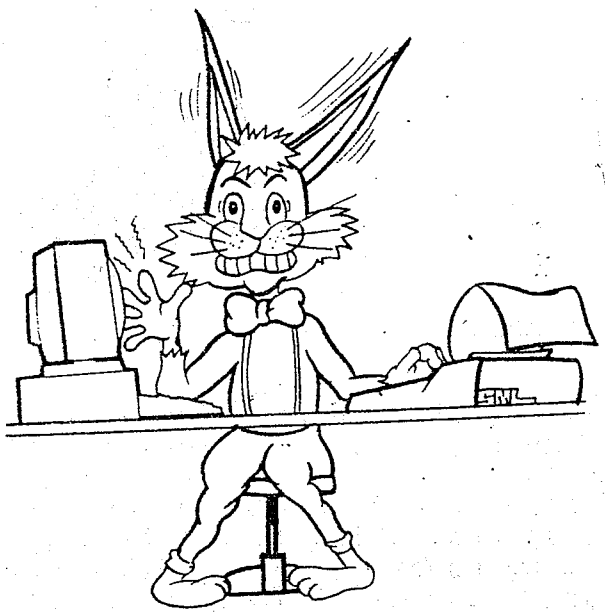
Power Disturbances

Power disturbances are the biggest pain of all, both to stand-alone computer operations and network communications. If the lights don't go off completely, low voltages (brownouts), surges, spikes, line noise, and other problems wreak havoc with computer operations and data transmissions. Basically, there are three major types of disturbances: power outages, voltage fluctuations and line noise. All are disruptive and all can be destructive.

Did you know that you are the one responsible for providing appropriate power and installing protective devices? Did you know that failure to condition your power lines can be considered negligence and cause for voiding warranties or canceling service contracts? Did you know that neither the manufacturer nor the retailer is responsible for problems resulting from your failure to meet power specifications?

It is common to receive line power above or below the maximums and minimums specified for a piece of equipment. If the specification calls for 115 VAC nominal with a maximum of 130 VAC, utility lines carrying 131 VAC are "out of spec," and it is your responsibility to detect the condition and o something about it.

Most power disturbances originate on the utility lines, resulting from causes as diverse as power switching, damage to underground cables, lightning strikes on lines and transformers, and auto accidents knocking out distribution boxes. Of course, you can overload a circuit and blow a breaker or fuse, create interference or noise with appliances, or generate other problems of your own, but the most series and the most difficult to control begin outside your installation.



Sudden Shutdown

One effect of a power outage or blackout is a sudden shutdown of the computer system, losing programs and data in memory and whatever results have been computed to that point. That is typical of interruptions lasting more than a few power cycles. Shorter interruptions cause glitches which in turn cause erroneous results or data transmissions, alter programs, trash displays or printouts, disconnect network links, and so on.

Those are just operating errors; much worse can happen. A high-voltage surge can figuratively "fry" equipment, burning out circuits or entire boards. Internal power supplies can burn out. Mechanical parts can jam, with the possibility of severe damage. Disks can crash, possibly damaging heads or magnetic media. If the magnetic medium isn't physically damaged, stored data may be erased or altered. Files may be irretrievable.

Not only are power disturbances damaging to the system, you can't predict, prevent, or control them. You can, however, spend the time and money to protect the most vital components and operations against them.

Providing Protection

You are the only one who can dtermine how much protection you can afford, how much your applications justify, and which of several alternatives is suitable. For instance, recreational users might be able to afford and to justify protection only against voltage spikes, which is relatively cheap with "surge protectors" costing upward of $25. Other user may want to guard against both surges and electrical noise, usually requiring a combination of surge protection and line "isolation" in devices costing from $60 to $200.

On the other hand, protecting against short-duration power interruptions and brownouts using standby power supplies can cost from $250 to $1200 for small personal computers and many thousands for large-scale professional systems. Business users with critical applications may have to spend considerable sums to achieve multi-purpose protection against numerous disturbances. Yet, those expenditures may be justified by eliminating equipment damage and losses of vital data.

The number of available power conditioning devices is staggering. At the low end of the price scale are inexpensive in-line surge suppressors and noise filters that guard against sudden increases in line voltage and against electrical noise that might be imposed on lines by appliance motors and other devices. Effective for mild disturbances on residential and commercial power lines, they do not safeguard equipment or data from outages, and most give limited protection against severe surges or the extreme noise typical of industrial facilities.

Heavy duty devices areavailable at added cost, providing improved protection against severe spikes and surges while eliminating potential electrical interactions between devices plugged into the individual sockets. Actually, if you can afford one, such heavy duty suppressors and isolators are preferable to the inexpensive home units. If you use your computer strictly for entertainment, an "industrial strength" isolator and suppressor will give you a definite edge.

For those with the money to spend, standby power supplies and uninterruptible power supplies are by far the best. Standby supplies are available in sizes from about 200 watts to megawatts and at prices from about $300 to many thousands of dollars. However, the average home or small-business user probably can get by with a 200-watt unit for a personal computer or something between 500 and 1250 watts fo a professional or business system. The advantage to these power supplies is that they provide automatic switch-over to temporary battery backup power during an outage or severe low-voltage condition. Furthermore, they typically include surge suppression and noise filtration with the standby power.

True uninterruptible power supplies, known as UPS units, differ in that they power the computer equipment continuously from batteries and charge the batteries while the incoming line is active. When line power is interrupted, batteries continue to output without any switchover. Like the standby units, these are available at many prices and in many sizes. However, a UPS unit of a given power rating typically costs more than a switching reserve supply of the same rating.

Wear and Tear

Physical wear affects the moving parts in printers, disk drives, tape transports, keyboard, and switches. Since the component used most often wears the fastest, input-oriented systems probably will have more wear on the keyboards while output-oriented systems will have more wear on the printer.

The effects are twofold, leading to gradual decline in performance or an abrupt failure. In the first, the system starts showing a few minor problems, but they quickly multiply. One key might not register every time, then another and another. Disk I/O errors you saw once a month become weekly, then daily,then hourly. Printouts get fuzzy and indistinct, especially when compared to ones done months earlier.

Or there can be a sudden failure without warning. A printer abruptly stops feeding ribbon or paper; a disk drive spins the disk but can't seem to access any data; a power switch may not work to turn the equipment on or off.

Lubrication

The best protection, in fact, the only protection against wear is keeping the equipment clean, properly lubricated and operating at design temperatures. There is no way to eliminate wear and stress on moving components, but you can minimize their effects.

Suitable lubrication is particularly important and must be provided in strict accordance with any schedules or procedures in equipment manuals. Failure to lubricate moving parts quickly runs up high repair bills; mechanical parts are much more expensive to fix than electronic ones. Excess lubrication isn't acceptable either, because it leaves residues that attact dirt, increase friction, and cause more wear. Watch out for parts that should not be lubricated, with special attention to the rails and ... components of the disk drives. Most maintenance manuals warn against lubricating the rails that support the read/write heads.

Be sure to use only those lubricants approved for the units or parts. There is no such thing as a universal oil, and one component like a letter-quality printer may need a dozen or more different lubricants. Of course, many high-grade lubricants are expensive, and stocking multiple types gets costly. Even service shops and technicians usually don't stock them all - a reason they don't volunteer often to clean and lubricate a machine.

If there is a wear - or stress - related failure, there is little to do except to replace the part or parts or to pay to have them replaced. However, you should be aware that it is hard to find

a good source of repairs for mechanical components. Almost any hack can fix computer electronics by hit or miss replacements until the problem goes away. But mechanical units like letter-quality printers take some training and skill to repair, often requiring total machine realignment and adjustment for replacing a single small part. In fact, it is often necessary to send something like a printer back to the factory or to a regional service depot to get the job done right.

Retrospect

In this article, I have tried to give you some insight into what is really involved in caring for a small computer. Regrettably, a magazine article doesn't afford space to cover a subject like this in the detail it deserves.

It is important to look for the obvious. Take care of dirt, excess heat, magnetic fields, static charges, power disturbances, and lubrication, and you have solved most of the problems. By doing some routine tasks, you improve the odds in favor of a long, happy relationship with your computer system.

6-2. Diskette Care & Handing

To get best performance from your diskettes, and to provide the best protection to the information you put on them, we recommend that you note these few Diskette Do's and Don'ts:

1. Whenever handling your diskettes, DON'T ever tough the diskette recording surface. Handle your diskettes only on the jacket area.

2. After you have finished using a diskette, DO put it back in its protective envelope immediately. If you leave a diskette exposed: dust, debris, cigarette smoke and other environmental hazards will quickly cause damage to your data.

3. When writing on your diskette ID label, DON'T use a ball-point pen, fountain pen, pencil or other hard marker. Use only a felt tip pen. Hard markers can make an impression on your diskette, causing data loss.

4. Diskettes work at best temperatures between 50F and 122F. Temperatures above 122F can occur easily in an automobile, or in front of a window pane. DON'T store your diskettes in areas of extreme temperature. To keep them working best, keep them where the temperature is comfortable.

5. DON't let a magnet or magnetized object get near your diskettes. That little magnet that keeps all your phone messages in place could cause your diskette to lose all its information.

6. DON'T ever fold, bend or crease your diskette. Handle your diskette carefully, so it will always be in good shape to make contact with the read/write head in the disk drive properly.

7. DON't use erasers on the diskette ID label. You could get debris in the diskette, and that's a lot worse than having a messy ID lable.

8. Do gently load your diskette in your disk drive. If you don't it may bend or cneter improperly. That causes the diskette to rotate in an elliptic orbit, missing data.

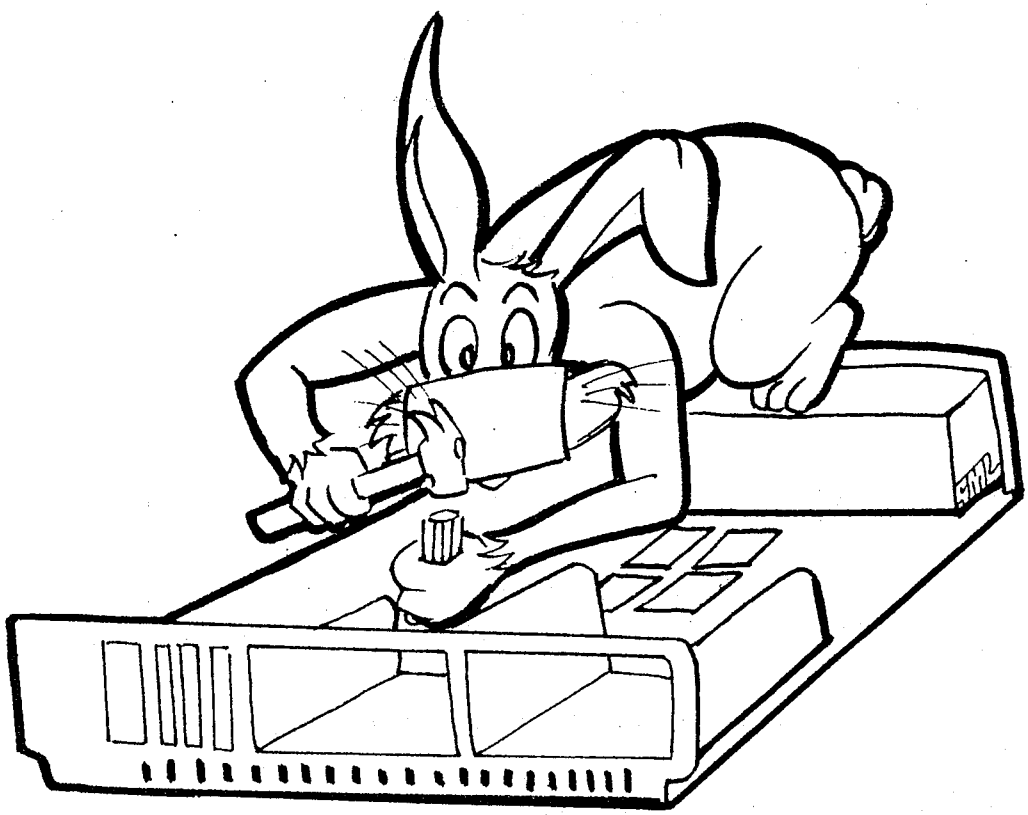
Back up your import information

Anytime you find yourself with information on a diskette that you simply can't lose, you're open for trouble. Why? Because you could accidentally lost it. Think of all the time you put into creating a specific program, or worse yet, the money you spend buying one. In a case like this value of a back-up diskette can't be overemphasised. In some instances, it may be advisable to have two back-ups. Make sure you store your back-up data in a well-protected, safe place and use the silver write protect labels to stop accidental erasure.

Protect your data with write protect labels

Most blank disks that you purchase for use with yout IMC, have a small square notch cut into the upper right hand side of the diskette. To "Write Protect" data on your disks, the write protect notch must be covered-up with one of the foil labels supplied. With one of these silver lables in place you cannot accidentally write over or destory the information contained on the diskette. To write on a disk, uncover the notch. REMEMBER to put the write protect label on the disk AFTER you have stored all the information you want on it. Your IMC can still READ & WRITE protected disk, but it cannot WRITE on to it.

TROUBLE-SHOOTING THE SYSTEMBOARD



6-3 Trouble-shooting the motherboard

Now you know the basics of your computer. this section explains the problems you might have with the motherboard, and explains how you might repair your computer by yourself.

Once you know which parts need to be replaced, you can go to your local electronics store and plurchase the necessary replacement parts.

You will be amazed at how little some of the IC's cost. (Which may also make you wonder why repair bills are so high).

You will also see that most of the IC's in your computer are stock parts available from almost any well stocked electronic store.

Let's get a little more familiar with the IC's on the motherboard. If you look at a diagram of the parts on your motherboard, refer to page 89, you can see the IC's general layout.

A1 is a number of small parts that make up what is called the crystal circuitry. It is where everything gets started in your motherboard.

If this area fails generally you will see no video at all and hear no beep. But when the computer is turned on, you will see a mementary flicker on the monitor.

After using the chip swapping chart and you still have no video and no beep, you may suspect this area. Especially, if the little can (which is the crystal itself) is silver colored and coated in purple.

A5 is a character generator chip. It generates the proper characters you see on the monitor.

If this chip fails, you will still get a beep, but the screen will be improper. Wrong characters may be displayed or not definable characters at all.

This chip can also cause a flicker in parts of characters on the monitor.

C3 through C10 are your RAM chips. RAM stands for Randon Access Memory. Quite simply it means memory IC's that the computer can write information into,and later retrieve the same information.

If any of these chips fail, it can cause a variety of symptoms sss too numerous to list. However the most popular problem will be.

1. Some diskettes will load but others won't.
2. No power on reset (no beep and no curser on the monitor)
3. Programs load but bomb out after awhile.
4. The computer goes into the wrong graphic mode. ee

Should you suspect a RAM problem, try swapping the RAM chips around. This is really the only area that this is feasible to do.

All the RAM chips are the same. IMC uses the 4164 chip, most computers have 4116 chips or equivalent. Replacement sets are generally purchased in sets of eight.

J1 is your ROM chip. ROM stands for Read Only Memory. Aside from the character generator mentioned above, these are the only chips not available from the average electronics store and must purchased from an IMC repair store.

This ROM determines whether you have a standard computer or a computer plus.

If this ROM fails it can cause just about as many problems as a RAM failure. However, if you can get a power on reset, you will generatlly notice that assembly language programs will run, but basic programs fail.

If diagnostics programs are not available, and you can't use the peripheral system, the only thing left is replacing the ROM - firmware. If you have an IMC OS card, you can use the IMC OS card to operate it, it being the same.

F7 is a microprocessor, it is the heart of IMC system board, it can run CP/M type software and all the instructions of Z-80 assembly and 8088 assembly.

H7 isthe microprocessor chip itself, and also the heart of your motherboard. It is a 6502 CPU.

Very seldom will this chip ever go bad and you should suspect it last.

while it is almost impossible to list every problem, and every solution, we think the following charts in this chapter will hitover 90% of the failures on the motherboard.

The chart is of course written from the standpoint that a bad IC chip is causing the problem. There are a few other parts on the motherboard, but the IC's are most likely to fail first.

When you suspect what failures on the motherboard, and before you replace your IC's, you must be sure the other part or the peripheral system are O.K.

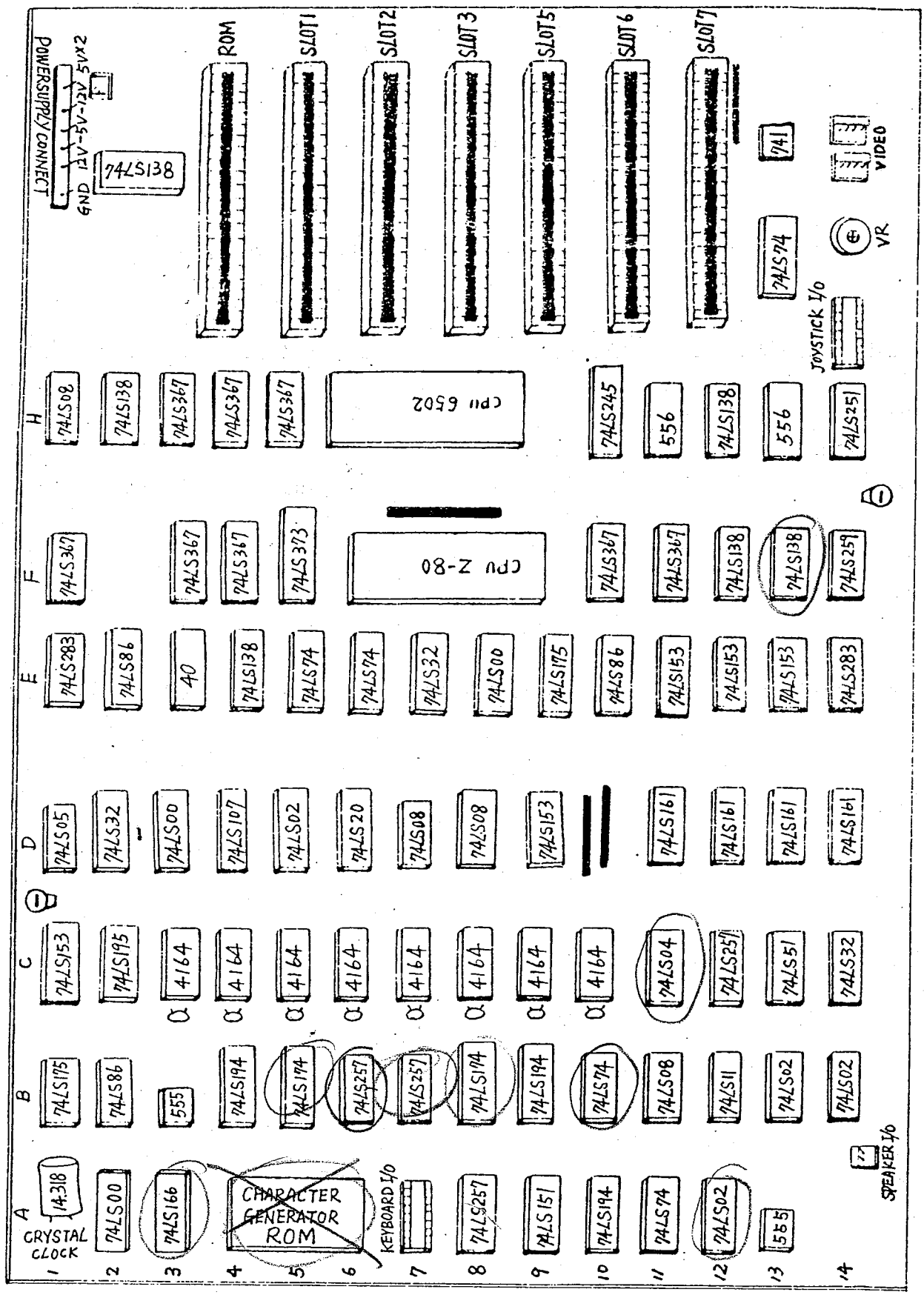
Should you come to the section in the chart that says replace a part in an area, and you don't have a part in that area, just disregard replacing that part.

Trouble-shooting Chart:

TROUBLE	REPLACE IC's at
Dead computer No speaker beep no video indications at all, or just a flicker on the screen when the power switch is turned on. Power light on Keyboard is on.	A_2 B_2, B_{10}, B_{13} C_1, C_2 (C_1= 153)
No video indications at all, or just a flicker of the screen when the power switch is turned on. Speaker does beep. Power light on keyboard is on.	A_2, A_8, A_9, A_{10} B_2, B_{10}, B_{13} C_2, C_{11} D_2, D_{11} thru D_{14} (D_{11} =161)
CRT comes to like but no curser prompt. CRT may be filled with different characters which may or may not change when computer is turned off then back on. Speaker does not beep or may have a respy sound when power switch is turned on. Power light on keyboard is on. (Note: this problem is the most common in the computer.)	A_2, A_{13} B_5, B_6 thru B_8, B_{11} C_1, C_2, C_3 thru C_{10}, C_{14} E_5, E_6, E_7, E_{11} thru E_{13} F_4, F_{10} thru F_{14} H_1 thru H_6, H_{10}, H_{14} (B_{11} =08, E_5=74)
CRT comes on with wield looking graphic characters, but no words. Speaker beeps.	$A_3, A_5, A_8, A_9, A_{10}$ B_2
CRT rolls vertically with or without stopping.	A_2 C_{13}, C_{14} D_{13}, D_{14}

CRT characters look like they are crunched, and everything is alanted grossly on the screen. (This is horizontal failure)	B_{11} C_{13}, C_{14} D_{13}, D_{14}
Z-80 SECTION PROBLEMS: all works normally, plug-in 80 column card, screen has no characters.	B_1 D_1, D_4 E_1 thru E_4, E_9 F_1, F_3 thru F_{11}
Z-80 section problems; all elseis normal plug-in 80 column card, screen shows 40 column or deformed words.	E_6, E_7
Run CP/M screen shows "can't find Z-80 card" or no prompt	D_6 E_7, E_8
Run CP/M, wrong or deformed characters on screen	D_1 $E_1, E_2, E_4, E_6, E_7, E_8$ F_3, F_5, F_6 H_3
Computer has memory retention problem General memory problems may also be caused from:	A_2 B_5, B_8 C_1 thru C_{12} D_5, D_6 E_{11} thru E_{14} H_1
Graphic problems. Text mode wroks fine. All else is normal	A_8 thru A_{11} $B_4, B_5, B_8, B_9, B_{12}, B_{13}$ C_1, C_3 thru C_{10}, C_{12}, C_{14} E_{11} thru E_{14} F_{14} H_1
Wrong or deformed characters on CRT	$A_3, A_4,$ B_5 thru B_8

Abnormal curser. All else normal	A_3 B_2, B_3, B_{11}, B_{13}
Speaker doesn't work. All else normal	F_{13} K_{13}
Keyboard not working properly, swapping keyboard does not fix problem	A_{12} B_6, B_{10} C_{11} F_{13}
Add on board won't work in one slot. Or works in one slot, but won't work in a different slot	H_2 thru H_6, H_{10}, H_{12}
Joystick	F_{13} H_{11}, H_{13}, H_{14}
Cassette	F_{13} H_{14} K_{12}



IMC-640E COMPONENTS LOCATION

CHAPTER 7

The Z-80 Instruction Set (Numeric)

HEXADECIMAL			COMMAND CODE		HEXADECIMAL			COMMAND CODE	
00		*	NOP		1C		*	INC	E
01	nnnn	*	LD	BC,nnnn	1D		*	DEC	E
02		*	LD	(BC),A	1E	nn	*	LD	E,nn
03		*	INC	BC	1F		*	RRR	
04		*	INC	B	20	dd		JR	NZ,dd
05		*	DEC	B	21	nnnn	*	LD	HL,nnnn
06	nn	*	LD	B,nn	22	nnnn	*	LD	(nnnn),HL
07		*	RLCA		23		*	INC	HL
08			EX	AF,AF'	24		*	INC	H
09		*	ADD	HL,BC	25		*	DEC	H
0A		*	LD	A,(BC)	26	nn	*	LD	H,nn
0B		*	DEC	BC	27		*	DAA	
0C		*	INC	C	28	dd		JR	Z,dd
0D		*	DEC	C	29		*	ADD	HL,HL
0E	nn	*	LD	C,nn	2A	nnnn	*	LD	HL,(nnnn)
0F		*	RRCA		2B		*	DEC	HL
10	dd		DJNZ	dd	2C		*	INC	L
11	nnnn	*	LD	DE,nnnn	2D		*	DEC	L
12		*	LD	(DE),A	2E	nn	*	LD	L,nn
13		*	INC	DE	2F		*	CPL	
14		*	INC	D	30	dd		JR	NC,dd
15		*	DEC	D	31	nnnn	*	LD	SP,nnnn
16	nn	*	LD	D,nn	32	nnnn	*	LD	(nnnn),A
17		*	RLA		33		*	INC	SP
18	dd		JR	dd	34		*	INC	(HL)
19		*	ADD	HL,DE	35		*	DEC	(HL)
1A		*	LD	A,(DE)	36	nn	*	LD	(HL),nn
1B		*	DEC	DE	37		*	SCF	

HEXADECIMAL			COMMAND CODE	
38	dd		JR	C,dd
39		*	ADD	HL,SP
3A	nnnn	*	LD	A,(nnnn)
3B		*	DEC	SP
3C		*	INC	A
3D		*	DEC	A
3E	nn	*	LD	A,nn
3F		*	CCF	
40		*	LD	B,B
41		*	LD	B,C
42		*	LD	B,D
43		*	LD	B,E
44		*	LD	B,H
45		*	LD	B,L
46		*	LD	B,(HL)
47		*	LD	B,A
48		*	LD	C,B
49		*	LD	C,C
4A		*	LD	C,D
4B		*	LD	C,E
4C		*	LD	C,H
4D		*	LD	C,L
4E		*	LD	C,(HL)
4F		*	LD	C,A
50		*	LD	D,B
51		*	LD	D,C
52		*	LD	D,D
53		*	LD	D,E
54		*	LD	D,H
55		*	LD	D,L
56		*	LD	D,(HL)
57		*	LD	D,A
58		*	LD	E,B
59		*	LD	E,C
5A		*	LD	E,D
5B		*	LD	E,E
5C		*	LD	E,H
5D		*	LD	E,L

HEXADECIMAL		COMMAND CODE	
5E	*	LD	E,(HL)
5F	*	LD	E,A
60	*	LD	H,B
61	*	LD	H,C
62	*	LD	H,D
63	*	LD	H,E
64	*	LD	H,H
65	*	LD	H,L
66	*	LD	H,(HL)
67	*	LD	H,A
68	*	LD	L,B
69	*	LD	L,C
6A	*	LD	L,D
6B	*	LD	L,E
6C	*	LD	L,H
6D	*	LD	L,L
6E	*	LD	L,(HL)
6F	*	LD	L,A
70	*	LD	(HL),B
71	*	LD	(HL),C
72	*	LD	(HL),D
73	*	LD	(HL),E
74	*	LD	(HL),H
75	*	LD	(HL),L
76	*	HALT	
77	*	LD	(HL),A
78	*	LD	A,B
79	*	LD	A,C
7A	*	LD	A,D
7B	*	LD	A,E
7C	*	LD	A,H
7D	*	LD	A,L
7E	*	LD	A,(HL)
7F	*	LD	A,A
80	*	ADD	A,B
81	*	ADD	A,C
82	*	ADD	A,D
83	*	ADD	A,E

HEXADECIMAL		COMMAND CODE	
84	*	ADD	A,H
85	*	ADD	A,L
86	*	ADD	A,(HL)
87	*	ADD	A,A
88	*	ADC	A,B
89	*	ADC	A,C
8A	*	ADC	A,D
8B	*	ADC	A,E
8C	*	ADC	A,H
8D	*	ADC	A,L
8E	*	ADC	A,(HL)
8F	*	ADC	A,A
90	*	SUB	B
91	*	SUB	C
92	*	SUB	D
93	*	SUB	E
94	*	SUB	H
95	*	SUB	L
96	*	SUB	(HL)
97	*	SUB	A
98	*	SBC	A,B
99	*	SBC	A,C
9A	*	SBC	A,D
9B	*	SBC	A,E
9C	*	SBC	A,H
9D	*	SBC	A,L
9E	*	SBC	A,(HL)
9F	*	SBC	A,A
A0	*	AND	B
A1	*	AND	C
A2	*	AND	D
A3	*	AND	E
A4	*	AND	H
A5	*	AND	L

HEXADECIMAL		COMMAND CODE		
A6		*	AND	(HL)
A7		*	AND	A
A8		*	XOR	B
A9		*	XOR	C
AA		*	XOR	D
AB		*	XOR	E
AC		*	XOR	H
AD		*	XOR	L
AE		*	XOR	(HL)
B0		*	OR	B
B1		*	OR	C
B2		*	OR	D
B3		*	OR	E
B4		*	OR	H
B5		*	OR	L
B6		*	OR	(HL)
B7		*	OR	A
B8		*	CP	B
B9		*	CP	C
BA		*	CP	D
BB		*	CP	E
BC		*	CP	H
BD		*	CP	L
BE		*	CP	(HL)
BF		*	CP	A
C0		*	RET	NZ
C1		*	POP	BC
C2	nnnn	*	JP	NZ,nnnn
C3	nnnn	*	JP	nnnn
C4	nnnn	*	CALL	NZ,nnnn
C5		*	PUSH	BC
C6	nn	*	ADD	A,nn
C7		*	RST	0
C8		*	RET	Z

HEXADECIMAL			COMMAND CODE	
C9		*	RET	
CA	nnnn	*	JP	Z,nnnn
CB	00		RLC	B
CB	01		RLC	C
CB	02		RLC	D
CB	03		RLC	E
CB	04		RLC	H
CB	05		RLC	L
CB	06		RLC	(HL)
CB	07		RLC	A
CB	08		RRC	B
CB	09		RRC	C
CB	0A		RRC	D
CB	0B		RRC	E
CB	0C		RRC	H
CB	0D		RRC	L
CB	0E		RRC	(HL)
CB	0F		RRC	A
CB	10		RL	B
CB	11		RL	C
CB	12		RL	D
CB	13		RL	E
CB	14		RL	H
CB	15		RL	L
CB	16		RL	(HL)
CB	17		RL	A
CB	18		RR	B
CB	19		RR	C
CB	1A		RR	D
CB	1B		RR	E
CB	1C		RR	H
CB	1D		RR	L
CB	1E		RR	(HL)
CB	1F		RR	A
CB	20		SLA	B
CB	21		SLA	C
CB	22		SLA	D
CB	23		SLA	E
CB	24		SLA	

HEXADECIMAL		COMMAND CODE	
CB	25	SLA	L
CB	26	SLA	(HL)
CB	27	SLA	A
CB	28	SRA	B
CB	29	SRA	C
CB	2A	SRA	D
CB	2B	SRA	E
CB	2C	SRA	H
CB	2D	SRA	L
CB	2E	SRA	(HL)
CB	2F	SRA	A
CB	38	SRL	B
CB	39	SRL	C
CB	3A	SRL	D
CB	3B	SRL	E
CB	3C	SRL	H
CB	3D	SRL	L
CB	3E	SRL	(HL)
CB	3F	SRL	A
CB	40	BIT	0,B
CB	41	BIT	0,C
CB	42	BIT	0,D
CB	43	BIT	0,E
CB	44	BIT	0,H
CB	45	BIT	0L
CB	46	BIT	0,(HL)
CB	47	BIT	0,A
CB	48	BIT	1,B
CB	49	BIT	1,C
CB	4A	BIT	1,D
CB	4B	BIT	1,E
CB	4C	BIT	1,H
CB	4D	BIT	1,L
CB	4E	BIT	1,(HL)
CB	4F	BIT	1,A
CB	50	BIT	2,B
CB	51	BIT	2,C
CB	52	BIT	2,D
CB	53	BIT	2,E

HEXADECIMAL	COMMAND CODE		HEXADECIMAL	COMMAND CODE	
CB 54	BIT	2,H	CB 78	BIT	7,B
CB 55	BIT	2,L	CB 79	BIT	7,C
CB 56	BIT	2,(HL)	CB 7A	BIT	7,D
CB 57	BIT	2,A	CB 7B	BIT	7,E
CB 58	BIT	3,B	CB 7C	BIT	7,H
CB 59	BIT	3,C	CB 7D	BIT	7,L
CB 5A	BIT	3,D	CB 7E	BIT	7,(HL)
CB 5B	BIT	3,E	CB 7F	BIT	7,A
CB 5C	BIT	3,H	CB 80	RES	0,B
CB 5D	BIT	3,L	CB 81	RES	0,C
CB 5E	BIT	3,(HL)	CB 82	RES	0,D
CB 5F	BIT	3,A	CB 83	RES	0,E
CB 60	BIT	4,B	CB 84	RES	0,H
CB 61	BIT	4,C	CB 85	RES	0,L
CB 62	BIT	4,D	CB 86	RES	0,(HL)
CB 63	BIT	4,E	CB 87	RES	0,A
CB 64	BIT	4,H	CB 88	RES	1,B
CB 65	BIT	4,L	CB 89	RES	1,C
CB 66	BIT	4,(HL)	CB 8A	RES	1,D
CB 67	BIT	4,A	CB 8B	RES	1,E
CB 68	BIT	5,B	CB 8C	RES	1,H
CB 69	BIT	5,C	CB 8D	RES	1,L
CB 6A	BIT	5,D	CB 8E	RES	1,(HL)
CB 6B	BIT	5,E	CB 8F	RES	1,A
CB 6C	BIT	5,H	CB 90	RES	2,B
CB 6D	BIT	5,L	CB 91	RES	2,C
CB 6E	BIT	5,(HL)	CB 92	RES	2,D
CB 6F	BIT	5,A	CB 93	RES	2,E
CB 70	BIT	6,B	CB 94	RES	2,H
CB 71	BIT	6,C	CB 95	RES	2,L
CB 72	BIT	6,D	CB 96	RES	2,(HL)
CB 73	BIT	6,E	CB 97	RES	2,A
CB 74	BIT	6,H	CB 98	RES	3,B
CB 75	BIT	6,L	CB 99	RES	3,C
CB 76	BIT	6,(HL)	CB 9A	RES	3,D
CB 77	BIT	6,A	CB 9B	RES	3,E

HEXADECIMAL	COMMAND CODE
CB 9C	RES 3,H
CB 9D	RES 3,L
CB 9E	RES 3,(HL)
CB 9F	RES 3,A
CB A0	RES 4,B
CB A1	RES 4,C
CB A2	RES 4,D
CB A3	RES 4,E
CB A4	RES 4,H
CB A5	RES 4,L
CB A6	RES 4,(HL)
CB A7	RES 4,A
CB A8	RES 5,B
CB A9	RES 5,C
CB AA	RES 5,D
CB AB	RES 5,E
CB AC	RES 5,H
CB AD	RES 5,L
CB AE	RES 5,(HL)
CB AF	RES 5,A
CB B0	RES 6,B
CB B1	RES 6,C
CB B2	RES 6,D
CB B3	RES 6,E
CB B4	RES 6,H
CB B5	RES 6,L
CB B6	RES 6,(HL)
CB B7	RES 6,A
CB B8	RES 7,B
CB B9	RES 7,C
CB BA	RES 7,D
CB BB	RES 7,E
CB BC	RES 7,H
CB BD	RES 7,L
CB BE	RES 7,(HL)
CB BF	RES 7,A
CB C0	SET 0,B
CB C1	SET 0,C

HEXADECIMAL	COMMAND CODE
CB C2	SET 0,D
CB C3	SET 0,E
CB C4	SET 0,H
CB C5	SET 0,L
CB C6	SET 0,(HL)
CB C7	SET 0,A
CB C8	SET 1,B
CB C9	SET 1,C
CB CA	SET 1,D
CB CB	SET 1,E
CB CC	SET 1,H
CB CD	SET 1,L
CB CE	SET 1,(HL)
CB CF	SET 1,A
CB D0	SET 2,B
CB D1	SET 2,C
CB D2	SET 2,D
CB D3	SET 2,E
CB D4	SET 2,H
CB D5	SET 2,L
CB D6	SET 2,(HL)
CB D7	SET 2,A
CB D8	SET 3,B
CB D9	SET 3,C
CB DA	SET 3,D
CB DB	SET 3,E
CB DC	SET 3,H
CB DD	SET 3,L
CB DE	SET 3,(HL)
CB DF	SET 3,A
CB E0	SET 4,B
CB E1	SET 4,C
CB E2	SET 4,D
CB E3	SET 4,E
CB E4	SET 4,H
CB E5	SET 4,L
CB E6	SET 4,(HL)
CB E7	SET 4,A

HEXADECIMAL			COMMAND CODE	
CB	E8		SET	5,B
CB	E9		SET	5,C
CB	EA		SET	5,D
CB	EB		SET	5,E
CB	EC		SET	5,H
CB	ED		SET	5,L
CB	EE		SET	5,(HL)
CB	EF		SET	5,A
CB	F0		SET	6,B
CB	F1		SET	6,C
CB	F2		SET	6,D
CB	F3		SET	6,E
CB	F4		SET	6,H
CB	F5		SET	6,L
CB	F6		SET	6,(HL)
CB	F7		SET	6,A
CB	F8		SET	7,B
CB	F9		SET	7,C
CB	FA		SET	7,D
CB	FB		SET	7,E
CB	FC		SET	7,H
CB	FD		SET	7,L
CB	FE		SET	7,(HL)
CB	FF		SET	7,A
CC	nnnn	*	CALL	Z,nnnn
CD	nnnn	*	CALL	nnnn
CE	nn	*	ADC	A,nn
CF		*	RST	8
D0		*	RET	NC
D1		*	POP	DE
D2	nnnn	*	JP	NC,nnnn
D3	nn	*	OUT	(nn),A
D4	nnnn	*	CALL	NC,nnnn
D5		*	PUSH	DE

HEXADECIMAL			COMMAND CODE	
D6	nn	*	SUB	nn
D7		*	RST	10H
D8		*	RET	C
D9			EXX	
DA	nnnn	*	JP	C,nnnn
DB	nn	*	IN	A,(nn)
DC	nnnn	*	CALL	C,nnnn
DD	09		ADD	IX,BC
DD	19		ADD	IX,DE
DD	21nnnn		LD	IX,nnnn
DD	22nnnn		LD	(nnnn),IX
DD	23		INC	IX
DD	29		ADD	IX,IX
DD	2Annnn		LD	IX,(nnnn)
DD	2B		DEC	IX
DD	34dd		INC	(IX+dd)
DD	35dd		DEC	(IX+dd)
DD	36ddnn		LD	(IX+dd),nn
DD	39		ADD	IX,SP
DD	46dd		LD	B,(IX+dd)
DD	4Edd		LD	C,(IX+dd)
DD	56dd		LD	D,(IX+dd)
DD	5Edd		LD	E,(IX+dd)
DD	66dd		LD	H,(IX+dd)
DD	6Edd		LD	L,(IX+dd)
DD	70dd		LD	(IX+dd),B
DD	71dd		LD	(IX+dd),C
DD	72dd		LD	(IX+dd),D
DD	73dd		LD	(IX+dd),E
DD	74dd		LD	(IX+dd),H
DD	75dd		LD	(IX+dd),L
DD	77dd		LD	(IX+dd),A
DD	7Edd		LD	A,(IX+dd)
DD	86dd		ADD	A,(IX+dd)

HEXADECIMAL		COMMAND CODE	
DD	8Edd	ADC	A,(IX+dd)
DD	96dd	SUB	(IX+dd)
DD	9Edd	SBC	A,(IX+dd)
DD	A6dd	AND	(IX+dd)
DD	AEdd	XOR	(IX+dd)
DD	B6dd	OR	(IX+dd)
DD	BEdd	CP	(IX+dd)
DD	CBdd06	RLC	(IX+dd)
DD	CBdd0E	RRC	(IX+dd)
DD	CBdd16	RL	(IX+dd)
DD	CBdd1E	RR	(IX+dd)
DD	CBdd26	SLA	(IX+dd)
DD	CBdd2E	SRA	(IX+dd)
DD	CBdd3E	SRL	(IX+dd)
DD	CBdd46	BIT	0,(IX+dd)
DD	CBdd4E	BIT	1,(IX+dd)
DD	CBdd56	BIT	2,(IX+dd)
DD	CBdd5E	BIT	3,(IX+dd)
DD	CBdd66	BIT	4,(IX+dd)
DD	CBdd6E	BIT	5,(IX+dd)
DD	CBdd76	BIT	6,(IX+dd)
DD	CBdd7E	BIT	7,(IX+dd)
DD	CBdd86	RES	0,(IX+dd)
DD	CBdd8E	RES	1,(IX+dd)
DD	CBdd96	RES	2,(IX+dd)
DD	CBdd9E	RES	3,(IX+dd)
DD	CBddA6	RES	4,(IX+dd)
DD	CBddAE	RES	5,(IX+dd)
DD	CBddB6	RES	6,(IX+dd)
DD	CBddBE	RES	7,(IX+dd)
DD	CBddC6	SET	0,(IX+dd)
DD	CBddCE	SET	1,(IX+dd)
DD	CBddD6	SET	2,(IX+dd)
DD	CBddDE	SET	3,(IX+dd)
DD	CBddE6	SET	4,(IX+dd)
DD	CBddEE	SET	5,(IX+dd)
DD	CBddF6	SET	6,(IX+dd)
DD	CBddFE	SET	7,(IX+dd)

HEXADECIMAL			COMMAND CODE	
DD	E1		POP	IX
DD	E3		EX	(SP),IX
DD	E5		PUSH	IX
DD	E9		JP	(IX)
DD	F9		LD	SP,IX
DE	nn	*	SBC	A,nn
DF		*	RST	18H
E0		*	RET	PO
E1		*	POP	HL
E2	nnnn	*	JP	PO,nnnn
E3		*	EX	(SP),HL
E4	nnnn	*	CALL	PO,nnnn
E5		*	PUSH	HL
E6	nn	*	AND	nn
E7		*	RST	20H
E8		*	RET	PE
E9		*	JP	(HL)
EA	nnnn	*	JP	PE,nnnn
EB		*	EX	DE,HL
EC	nnnn	*	CALL	PE,nnnn
ED	40		IN	B,(C)
ED	41		OUT	(C),B
ED	42		SBC	HL,BC
ED	43nnnn		LD	(nnnn),BC
ED	44		NEG	
ED	45		RETN	
ED	46		IM	0
ED	47		LD	I,A
ED	48		IN	C,(C)
ED	49		OUT	(C),C
ED	4A		ADC	HL,BC
ED	4Bnnnn		LD	BC,(nnnn)
ED	4D		RETI	
ED	4F		LD	R,A
ED	50		IN	D,(C)
ED	51		OUT	(C),D
ED	52		SBC	HL,DE
ED	53nnnn		LD	(nnnn),DE

HEXADECIMAL			COMMAND CODE	
ED	56		IM	1
ED	57		LD	A,I
ED	58		IN	E,(C)
ED	59		OUT	(C),E
ED	5A		ADC	HL,DE
ED	5Bnnnn		LD	DE,(nnnn)
ED	5E		IM	2
ED	5F		LD	A,R
ED	60		IN	H,(C)
ED	61		OUT	(C),H
ED	62		SBC	HL,HL
ED	67		RRD	
ED	68		IN	L,(C)
ED	69		OUT	(C),L
ED	6A		ADC	HL,HL
ED	6F		RLD	
ED	72		SBC	HL,SP
ED	73nnnn		LD	(nnnn),SP
ED	78		IN	A,(C)
ED	79		OUT	(C),A
ED	7A		ADC	HL,SP
ED	7Bnnnn		LD	SP,(nnnn)
ED	A0		LDI	
ED	A1		CPI	
ED	A2		INI	
ED	A3		OUTI	
ED	A8		LDD	
ED	A9		CPD	
ED	AA		IND	
ED	AB		OUTD	
ED	B0		LDIR	
ED	B1		CPIR	
ED	B2		INIR	
ED	B3		OTIR	
ED	B8		LDDR	
ED	B9		CPDR	
ED	BA		INDR	
ED	BB		OTDR	
EE	nn	*	OR	N
EF		*	ST	28H

HEXADECIMAL			COMMAND CODE	
F0		*	RET	P
F1		*	POP	AF
F2	nnnn	*	JP	P,nnnn
F3		*	DI	
F4	nnnn	*	CALL	P,nnnn
F5		*	PUSH	AF
F6	nn	*	OR	nn
F7		*	RST	30H
F8		*	RET	M
F9		*	LD	SP,HL
FA	nnnn	*	JP	M,nnnn
FB		*	EI	
FC	nnnn	*	CALL	M,nnnn
FD	09		ADD	IY,BC
FD	19		ADD	IY,DE
FD	21nnnn		LD	IY,nnnn
FD	22nnnn		LD	(nnnn),IY
FD	23		INC	IY
FD	29		ADD	IY,IY
FD	2Annnn		LD	IY,(nnnn)
FD	2B		DEC	IY
FD	34dd		INC	(IY+dd)
FD	35dd		DEC	(IY+dd)
FD	36ddnn		LD	(IY+dd),nn
FD	39		ADD	IY,SP
FD	46dd		LD	B,(IY+dd)
FD	4Edd		LD	C,(IY+dd)
FD	56dd		LD	D,(IY+dd)
FD	5Edd		LD	E,(IY+dd)
FD	66dd		LD	H,(IY+dd)
FD	6Edd		LD	L,(IY+dd)
FD	70dd		LD	(IY+dd),B
FD	71dd		LD	(IY+dd),C
FD	72dd		LD	(IY+dd),D
FD	73dd		LD	(IY+dd),E
FD	74dd		LD	(IY+dd),H
FD	75dd		LD	(IY+dd),L
FD	77dd		LD	(IY+dd),A
FD	7Edd		LD	A,(IY+dd)
FD	86dd		ADD	A,(IY+dd)

HEXADECIMAL		COMMAND CODE	
FD	8Edd	ADC	A,(IY+dd)
FD	96dd	SUB	(IY+dd)
FD	9Edd	SBC	A,(IY+dd)
FD	A6dd	AND	(IY+dd)
FD	AEdd	XOR	(IY+dd)
FD	B6dd	OR	(IY+dd)
FD	BEdd	CP	(IY+dd)
FD	CBdd06	RLC	(IY+dd)
FD	CBdd0E	RRC	(IY+dd)
FD	CBdd16	RL	(IY+dd)
FD	CBdd1E	RR	(IY+dd)
FD	CBdd26	SLA	(IY+dd)
FD	CBdd2E	SRA	(IY+dd)
FD	CBdd3E	SRL	(IY+dd)
FD	CBdd46	BIT	0,(IY+dd)
FD	CBdd4E	BIT	1,(IY+dd)
FD	CBdd56	BIT	2,(IY+dd)
FD	CBdd5E	BIT	3,(IY+dd)
FD	CBdd66	BIT	4,(IY+dd)
FD	CBdd6E	BIT	5,(IY+dd)
FD	CBdd76	BIT	6,(IY+dd)
FD	CBdd7E	BIT	7,(IY+dd)
FD	CBdd86	RES	0,(IY+dd)

HEXADECIMAL			COMMAND CODE	
FD	CBdd8E		RES	1,(IY+dd)
FD	CBdd96		RES	2,(IY+dd)
FD	CBdd9E		RES	3,(IY+dd)
FD	CBddA6		RES	4,(IY+dd)
FD	CBddAE		RES	5,(IY+dd)
FD	CBddB6		RES	6,(IY+dd)
FD	CBddBE		RES	7,(IY+dd)
FD	CBddC6		SET	0,(IY+dd)
FD	CBddCE		SET	1,(IY+dd)
FD	CBddD6		SET	2,(IY+dd)
FD	CBddDE		SET	3,(IY+dd)
FD	CBddE6		SET	4,(IY+dd)
FD	CBddEE		SET	5,(IY+dd)
FD	CBddF6		SET	6,(IY+dd)
FD	CBddFE		SET	7,(IY+dd)
FD	E1		POP	IY
FD	E3		EX	(SP),IY
FD	E5		PUSH	IY
FD	E9		JP	(IY)
FD	F9		LD	SP,IY
FE	nn	*	CP	nn
FF		*	RST	38H

CHAPTER 8

6502 MICROPROCESSOR INSTRUCTIONS

ADC	Add Memory Accumulator With Carry
AND	"AND" Memory With Accumulator
ASL	Shift Left One Bit (Memory or Accumulator)
BCC	Branch on Carry Clear
BCS	Branch on Carry Set
BEQ	Branch on Result Zero
BIT	Test Bits in Memory With Accumulator
BMI	Branch on Result Minus
BNE	Branch on Result not Zero
BPL	Branch on Result Plus
BRK	Force Break
BVC	Branch on Overllow Clear
BVS	Branch on Overllow Set
CLC	Clear Carry Flag
CLD	Clear Decimal Mode
CLI	Clear Interrupt Disable Bit
CLV	Clear Overllow Flag
CMP	Compare Memory and Accumulator
CPX	Compare Memory and Index X
CPY	Compare Memory and Index Y
DEC	Decrement Memory by One
DEX	Decrement Index X by One
DEY	Decrement Index Y by One
EOR	"Exclusive-Or" Memory with Accumulator
INC	Increment Memory by One
INX	Increment Index X by One
INY	Increment Index Y by One
JMP	Jump to New Location
JSR	Jump to New Location Saving Return Address
LDA	Load Accumulator with Memory
LDX	Load Index X with Memory
LDY	Load Index Y with Memory

LSR	Shitt Right one Bit (Memory or Accumulator)
NOP	No Operation
ORA	"OR" Memroy with Accumulator
PHA	Push Accumulator On Stack
PHP	Push Processor Status On Stack
PLA	Push Accumulator from Stack
PLP	Pull Processor Status from Stack
ROL	Rotate One Bit Left (Memory or Accumulator)
ROR	Rotate One Bit Right (Memory or Accumulator)
RTI	Return trom Interrupt
RTS	Return trom Subroutine
SBC	Subtract Memory from Accumulator with Borrow
SEC	Set Carry Flag
SED	Set Decimal Mode
SEI	Set Interrupt Disable Status
STA	Store Accumulator in Memory
STX	Store Index X in Memory
STY	Store Index Y in Memory
TAX	Transter Accumulator to Index X
TAY	Transter Accumulator to Index Y
TSX	Transter Stack Pointer to Index X
TXA	Transter Index X to Accumulator
TXS	Transter Index X to Stack Pointer
TYA	Transter Index Y to Accumulator

THE FOLLOWING NOTATION
APPLIES TO THIS SUMMARY:

A	Accumulator
XY	Index Registers
M	Memory
C	Borrow
P	Processor Status Register
S	Stack Pointer
✓	Change
—	No Change
+	Add
∧	Logical AND
-	Subtract
∀	Logical Exclusive Or
↑	Transfer From Stack
↓	Transfer To Stack
→	Transfer To
←	Transfer To
V	Logical OR
PC	Program Counter
PCM	Program Counter High
PCL	Program Counter Low
OPER	Operand
,	Immediate Addressing Mode

FIGURE 1. ASL-SHIFT LEFT ONE BIT OPERATION

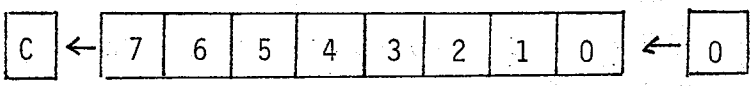


FIGURE 2. ROTATE ONE BIT LEFT (MEMORY OR ACCUMULATOR)

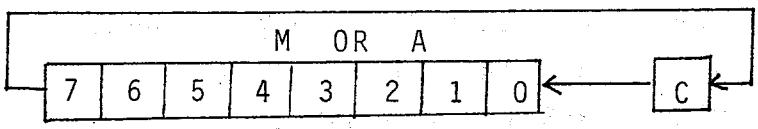
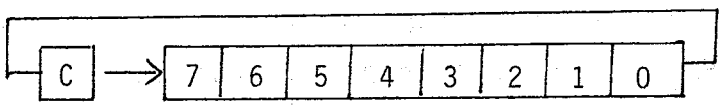


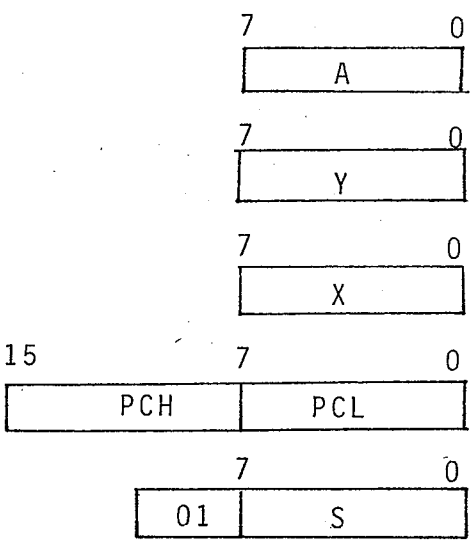
FIGURE 3.



NOTE: BIT - TEST BITS

Bit 6 and 7 are transferred to the status register if the result of A M is zero, then Z = 1 otherwise Z = 0

PROGRAMMING MODEL



Name Descriptions	Operations	Addressing Name	Assembly Language Form	MEX or Code	Ms. Sytes	"P" Status Reg. M Z C I O V
ADC Add memory to accumulator with carry	A-M-C → AC	Immediate Zero Page Zero Page X Absolute Absolute X Absolute Y (Indirect.X) (Indirect),Y	ADC Oper ADC Oper ADC Oper.X ADC Oper ADC Oper.X ADC Oper.Y ADC (Oper.X) ADC (Oper.)Y	69 65 75 69 79 79 51 71	2 2 2 3 3 3 2 2	✓✓✓--✓
AND "AND" memory with accumulator	A A M → A	Immediate Zero Page Zero Page.X Absolute Absolute,X Absolute,Y (Indirect.X) (Indirect).Y	AND Oper AND Oper AND Oper.X AND Oper AND Oper.X AND Oper.Y AND (Oper.X) AND (Oper.)Y	29 25 35 20 30 39 21 31	2 2 2 3 3 3 2 2	✓✓---
ASL Shift left one bit (memroy or accumulator)	(See Figure 1)	Accumulator Zero Page Zero Page.X Absolute Absolute.X	ASL A ASL Oper ASL Oper.X ASL Oper ASL Oper.X	0A 06 16 0E 1E	1 2 2 3 3	✓✓✓---
BCC Branch on carry clear	Branch on C-0	Relative	BCC Oper	90	2	--------
BCS Branch on carry set	Branch on C-1	Relative	BCS Oper	50	2	---------
BEQ Branch on result zero	Branch on Z-1	Relative	BEQ Oper	F0	2	--------
BIT Test bits in memroy with accumulator	A A M M_7 → M M_5 → V	Zero Page Absolute	"BIT" Oper "BIT" Oper	24 2C	2 3	M_7✓---M6
BMI Branch on result minus	Branch on N = 1	Relative	BMI Oper	30	2	--------
BNE Branch on result not zero	Branch on Z - 0	Relative	BNE Oper	D0	2	-------
BPL Branch on result plus	Branch on N=0	Relative	BPL Oper	10	2	-------
BRK Farce Break	Forced interrupt PC-2 ↓ P↓	Impleied	BRK+	00	1	----1 ----
BVC Branch on overflow clear	Branch on V = 0	Relative	BVC Oper	50	2	-------

Name Descriptions	Operations	Addressing Name	Assembly Language Form	MEX or CODE	Ms. Sytes	"P" Status Reg. M Z C I O V
BVS Branch on overflow set	Branch on V=1	Relative	BVS Oper	70	2	--------
CLC Clear carry flag	0 → C	Implied	CLC	18	1	----0---
CLD Clear overlow mode	0 → D	Implied	CLD	D6	1	--- 0 ---
CLI	0 → I	Implied	CLI	58	1	--- 0 ---
CLV Clear Overflow flag	0 → V	Implied	CLV	B8	1	0 -------
CMP Compare memory and accumulator	A → M	Immediate Zero Page Zero Page.X Absolute Absolute.X Absolute.Y (Indirect.X) (Indirect.Y)	CMP Oper CMP Oper CMP Oper.X CMP Oper CMP Oper.X CMP Oper.Y CMP (Oper.X) CMP (Oper.Y)	C9 C5 D5 CD DO D9 C1 D1	2 2 2 3 3 3 2 2	✓✓✓ ----
CPX Compare memory and Index X	X → M	Immediate Zero Page Absolute	CPX Oper CPX Oper CPX Oper	E0 E4 E6	2 2 3	✓✓✓ ---
CPY Compare memory and Index Y	Y → M	Immediate Zero Page Absolute	CPY Oper CPY Oper CPY Oper	C0 C4 CC	2 2 3	✓✓✓ ---
DEC Decrement memory by one	M - 1→M	Zero Page Zero Page.X Absolute Absolute.X	DEC Oper DEC Oper.X DEC Oper DEC Oper.X	C6 D6 CE DE	2 2 3 3	✓✓ ----
DEX Decrement index X by one	X - 1→X	Implied	DEX	CA	1	✓✓ ---
DEY Decrement Index Y by one	Y - 1→Y	Implied	DEY	D6	1	✓✓ ----

Name Descriptions	Operations	Addressing Name	Assembly Language Form	MEX or CODE	Ms Sytes	"P" Status Re M Z C I O V
EOR "Exclusive" or memroy with accumulator	A V M → A	Immediate	EOR Oper	49	2	vv----
		Zero Page	EOR Oper	45	2	
		Zero Page.X	EOR Oper.X	55	2	
		Absolute	EOR Oper	40	3	
		Absolute.X	EOR Oper.X	50	3	
		Absolute.Y	EOR Oper.Y	58	3	
		(Indirect.X)	EOR (Oper.X)	41	2	
		(Indirect).Y	EOR (Oper),Y	51	2	
INC Increment memory by one	M.1 → M	Zero Page	INC Oper	E6	2	vv----
		Zero Page.X	INC Oper.X	F6	2	
		Absolute	INC Oper	EE	3	
		Absolute.X	INC Oper.X	FE	3	
INX Increment Index X by One	X.1 → X	Implied	INX	E6	1	vv---
INY Increment Index Y by one	Y.1 → Y	Implied	INY	C6	1	vv---
JMP Jump to new location	(PC.1) → PCL (PC.2) → PCH	Absolute	JMP Oper	4C	3	-------
		Indirect	JMP (Oper)	6C	3	
JSR Jump to new location saving return address	PC.2 (PC.1) → PCL (PC.2) → PCH	Absolute	JSR Oper	20	3	--------
LDA Load accumulator with memory	M → A	Immediate	LDA Oper	A9	2	vv----
		Zero Page	LDA Oper	A5	2	
		Zero Page.X	LDA Oper.X	B5	2	
		Absolute	LDA Oper	AD	3	
		Absolute.X	LDA Oper.X	BD	3	
		Absolute.Y	LDA Oper.Y	B9	3	
		(Indirect.X)	LDA (Oper.x)	A1	2	
		(Indirect).Y	LDA (Oper).Y	Ba	2	
LDX Load Index.X with memroy	M → X	Immediate	LDX Oper	A2	2	vv----
		Zero Page	LDX Oper	A6	2	
		Zero Page.Y	LDX Oper.Y	B6	2	
		Absolute	LDX Oper	AE	3	
		Absolute.Y	LDX Oper.Y	BE	3	
LDY Load index Y with memory	M → Y	Immediate	LDY Oper	AD	2	vv----
		Zero Page	LDY Oper	A4	2	
		Zero Page.X	LDY Oper.X	B4	2	
		Absolute	LDY Oper	AC	3	
		Absolute.X	LDY Oper.X	BC	3	

Name Descriptions	Operations	Addressing Name	Assembly Language Form	MEX or Code	Ms. Sytes	"P" Status Reg. M Z C I O V
LSR Shift right one bit (memory or accumulator)	(See Figure 1)	Accumulator Zero Page Zerp Page.X Absolute Absolute.X	LSR A LSR Oper LSR Oper.X LSR Oper LSR Oper.X	4A 46 56 4E 5E	1 2 2 3 3	0 vv ----
NOP No Operation	No Operation	Implied	NOP	EA	1	--------
ORA "OR" memory with accumulator	A V M → A	Immediate Zero Page Zero Page.X Absolute Absolute.X Absolute.Y (Indirect.X) (Indirect).Y	ORA Oper ORA Oper ORA Oper.X ORA Oper ORA Oper.X ORA Oper.Y ORA (Oper.X) ORA (Oper).Y	09 05 15 00 10 19 01 11	2 2 2 3 3 3 2 2	vv ----
PHA Push Accumulator on stack	A ↑	Implied	PHA	46	1	--------
PHP Push processor status on stack	P ↓	Implied	PHP	06	1	----------
PLA Pull accumulator from stack	A ↑	Implied	PLA	69	1	vv---------
PLP Pull processor status from stack	P ↓	Implied	PLP	29	a	From Stack
ROL Rotate one bit left (memory of accumulator)	(See Figure 2)	Accumulator Zero Page Zero Page.X Absolute Absolute.X	ROL A ROL Oper ROL Oper.X ROL Oper ROL Oper.X	2A 26 36 2E 3E	1 2 2 3 3	vvv---
ROR Rotate one bit right (memory of accumulator)	(See Figure 3)	Accumulator Zero Page Zero Page.X Absolute Absolute.X	ROR A ROR Oper ROR Oper.X ROR Oper ROR Oper.X	6A 66 76 6E 7E	1 2 2 3 3	vvv----

Name Descriptions	Operations	Addressing Name	Assembly Language Form	MEX or Code	Ms Sytes	"P" Status Reg. M Z C I O V
RTI Return from interrupt	P↑PC↑	Implied	RTI	40	1	From Stack
RTS Return from subroutline	PC↑ PC-1 → PC	Implied	RTS	60	1	-------
SBC Subtract memory from accumulator with borrow	A.M.C̄→A	Immediate Zero Page Zero Page.X Absolute Absolute.X Absolute.Y (Indirect.X) (Indirect).Y	SBC Oper SBC Oper SBC Oper.X SBC Oper SBC Oper.X SBC Oper.Y SBC (Oper.X) SBC (Oper.)Y	E9 E5 F5 ED FD F9 E1 F1	2 2 2 3 3 3 2 2	vvv----
SEC Set carry flag	1 → C	Implied	SEC	38	1	-- 1 --
SED Set decimal mode	1 → D	Implied	SED	F8	1	---1---
SEI Set interrupt disable statue	1 → 1	Implied	SEI	78	1	--- 1 --
STA Store accumulator in memory	A → M	Zero Page Zerp Page,X Absolute Absolute.X Absolute.Y (Indirect.X) (Indirect).Y	STA Oper STA Oper.X STA Oper STA Oper.X STA Oper.Y STA (Oper.X) STA (Oper.)Y	85 96 80 90 99 81 91	2 2 3 3 3 2 2	--------
STX Store index X in memory	X → M	Zero Page Zero Page.Y Absolute	STX Oper STX Oper.Y STX Oper	86 96 BE	2 2 3	--------
STY Store Index Y in memroy	Y → M	Zero Page Zero Page.X Absolute	STY Oper STY Oper.X STY Oper	84 94 BC	2 2 3	------
TAX Transfer accumulator to index X	A → X	Implied	TAX	AA	1	vv---
TAY Transfer accumulator to index X	A → Y	Implied	TAY	A8	1	vv---
TSX Transfer stack pointer to index X	S → X	Implied	TSX	BA	1	vv---
TXA Transfer index X to accumulator	X → A	Implied	TXA	BA	1	vv---
TXS Transfer index X in stack pointer	X → S	Implied	TXS	BA	1	-----
TYA Transfer index Y to accumulator	Y → A	Implied	TYA	96	1	vv---

HEX OPERATION CODES

00	BRK		24	BIT	Zero Page
01	ORA	(Indirect.X)	25	AND	Zero Page
02	NOP		26	ROL	Zero Page
03	NOP		27	NOP	
04	NOP		28	PLP	
05	ORA	Zero Page	29	AND	Immediate
06	ASL	Aero Page	2A	ROL	Accumulator
07	NOP		2B	NOP	
08	PHP		2C	BIT	Absolute
09	ORA	Immediate	2D	AND	Absolute
0A	ASL	Accumulator	2E	ROL	Absolute
0B	NOP		2F	NOP	
0C	NOP		30	BMI	
0D	ORA	Absolute	31	AND	(Indirect),Y
0E	ASL	Absolute	32	NOP	
0F	NOP		33	NOP	
10	BPL		34	NOP	
11	ORA	(Indirect).Y	35	AND	Zero Page,X
12	NOP		36	ROL	Zero Page,X
13	NOP		37	NOP	
14	NOP		38	SEC	
15	ORA	Zero Page,X	39	AND	Absolute,Y
16	ASL	Zero Page,X	3A	NOP	
17	NOP		3B	NOP	
18	CLC		3C	NOP	
19	ORA	Absolute,Y	3D	AND	Absolute,X
1A	NOP		3E	ROL	Absolute,X
1B	NOP		3F	NOP	
1C	NOP		40	RTI	
1D	ORA	Absolute,X	41	EOR	(Indirect,X)
1E	ASL	Absolute,X	42	NOP	
1F	NOP		43	NOP	
20	JSR		44	NOP	
21	AND	(Indirect,X)	45	EOR	Zero Page
22	NOP		46	LSR	Zero Page
23	NOP		47	NOP	

48	PHA		71	ADC	(Indirect),Y
49	EOR	Immediate	72	NOP	
4A	LSR	Accumulator	73	NOP	
4B	NOP		74	NOP	
4C	JMP	Absolute	75	ADC	Zero Page,X
4D	EOR	Absolute	76	ROR	Zero Page,X
4E	LSR	Absolute	77	NOP	
4F	NOP		78	SEI	
50	BVC		79	ADC	Absolute,Y
51	EOR	(Indirect),Y	7A	NOP	
52	NOP		7B	NOP	
53	NOP		7C	NOP	
54	NOP		7D	ADC	Absolute,X NOP
55	EOR	Zero Page,X	7E	ROR	Absolute,X NOP
56	LSR	Zero Page,X	7F	NOP	
57	NOP		80	NOP	
58	CLI		81	STA	(Indirect,X)
59	EOR	Absolute,Y	82	NOP	
5A	NOP		83	NOP	
5B	NOP		84	STY	Zero Page
5C	NOP		85	STA	Zero Page
5D	EOR	Absolute,X	86	STX	Zero Page
5E	LSR	Absolute,X	87	NOP	
5F	NOP		88	DEY	
60	RTS		89	NOP	
61	ADC	(Indirect,X)	8A	TXA	
62	NOP		8B	NOP	
63	NOP		8C	STY	Absolute
64	NOP		8D	STA	Absolute
65	ADC	Zero Page	8E	STX	Absolute
66	ROR	Zero Page	8F	NOP	
67	NOP		90	BCC	
68	PLA		91	STA	(Indirect),Y
69	ADC	Immediate	92	NOP	
6A	ROR	Accumulator	93	NOP	
6B	NOP		94	STY	Zero Page,X
6C	JMP	Indirect	95	STA	Zero Page,X
6D	ADC	Absolute	96	STX	Zero Page,Y
6E	ROR	Absolute	97	NOP	
6F	NOP		98	TYA	
70	BVS		99	STA	Absolute,Y

9A	TXS	
9B	NOP	
9C	NOP	
9D	STA	Absolute,X
9E	NOP	
9F	NOP	
A0	LDY	Immediate
A1	LDA	(Indirect,X)
A2	LDX	Immediate
A3	NOP	
A4	LDY	Zero Page
A5	LDA	Zero Page
A6	LDX	Zero Page
A7	NOP	
A8	TAY	
A9	LDA	Immediate
AA	TAX	
AB	NOP	
AC	LDY	Absolute
AD	Absolute	
AE	LDX	Absolute
AF	NOP	
B0	BCS	
B1	LDA	(Indirect),Y
B2	NOP	
B3	NOP	
B4	LDY	Zero Page,X
B5	LDA	Zero Page,X
B6	LDX	Zero Page,Y
B7	NOP	
B8	CLV	
B9	LDA	Absolute,Y
BA	TSX	
BB	NOP	
BC	LDY	Absolute,X
BD	LDA	Absolute,X
BE	LDX	Absolute,Y
BF	NOP	
C0	CPY	Immediate
C1	CMP	(Indirect,X)
C2	NOP	
C3	NOP	
C4	CPY	Zero Page
C5	CMP	Zero Page
C6	DEC	Zero Page
C7	NOP	
C8	INY	
C9	CMP	Immediate
CA	DEX	
CB	NOP	
CC	CPY	Absolute
CD	CMP	Absolute
CE	DEC	Absolute
CF	NOP	
D0	BNE	
D1	CMP	(Indirect),Y
D2	NOP	
D3	NOP	
D4	NOP	
D5	CMP	Zero Page,X
D6	DEC	Zero Page,X
D7	NOP	
D8	CLD	
D9	CMP	Absolute,Y
DA	NOP	
DB	NOP	
DC	NOP	
DD	CMP	Absolute,X
DE	DEC	Absolute,X
DF	NOP	
E0	CPX	Immediate
E1	SBC	(Indirect,X)
E2	NOP	
E3	NOP	
E4	CPX	Zero Page
E5	SBC	Zero Page
E6	INC	Zero Page
E7	NOP	

CHAPTER 9 GLOSSARY

PERSONAL COMPUTER DICTIONARY

ASCII American Standard Code Information Interchange

ACOUSTIC COUPLER
A Device into which you place the handset of a telephone so that your computer can communicate with another computer.

APPLICATION PROGRAM
A program such as a word processor or accounting program that allows you to apply your computer's power to a particular task.

BACKUP
A copy of a diskette.

BASIC
An acronym that stands for Beginner's All-Purpose Symbolic Instruction Code. It is a language used to program computers.

BINARY FILE
Generally, a file that holds only certain types of programs.

BOOT
The process of inserting a diskette in a disk drive and turning the computer on so that the disk operating system loads into the computer from the diskette.

CHARACTER
Generally, any number, letter, symbol, or space on the keyboard.

COMPUTER CALISTHENICS
Doing things like locking a file that's already locked.

COMMAND
A computer user's order or direction to a program running in the machine.

COMPATIBILITY
The ability of different components,e.g. programs peripherals, computers, etc., to replace one another with little or no change in capability.

CP/M

An operating system for small computers by Digital Research Corporation.

CPU

Central Processing Unit

CURSOR

The blinking square that shows you where the next character you type on your computer screen will appear.

DATA

Programs and information in their simplest useable form: electronic signals.

DOS

Disk Operating System

DEFAULT OR DEFAULT VALUE

The alternative option you choose by chossing none of the others that are open to you. In other words, you let the computer supply the answer to a question being asked on the screen, this is usually done by hitting the RETURN key.

DESTINATION

The disk drive to which you're sending data, usually during the copying of a diskette or files.

DISK DRIVE

A device to which you're sending data, usually during the copying of a diskette of files.

DISPLAY MONITOR

A television-like device that enables you to see what you're doing as you use your computer.

80 COLUMNS

Twice as many columns of data as your TPC, normally lets you display on your video screen.

RETURN

To type data into the computer. Sometimes means to press the RETURN key.

ERROR MESSAGE

A report from a computer program that something has failed to go as planned.

FILE

A medium of categorixing and storing data on a diskette.

FILE NAMES

Name given to computer files according to certain conventions so that they are easily stored and retrieved.

FILE TYPE

A classification system whereby data is categorized according to the programming language for which it is written.

FLOPPY DISKETTE

A flat square device used for storing data.

FLOPPY DISK SYSTEM

The components (usually disk drives) necessary in a computer system in order to use floppy diskettes as a storage medium for computer data.

O.S.

Operating System functions.

FORMAT

To add an organizational scheme to a diskette.

INTERFACE CARDS

(Modem, Video, Disk Drive Controller, etc.) printed circuit boards that enable you to connect your computer to disk drives, telecommunications devices, and a number of other peripheral devices.

I/O

The place on your IMC's main electronics board where you plug in your joysticks or paddles.

JOYSTICKS

Devices useful for playing computer games.

LOAD

To bring a program or data from a diskette into your computer.

MACHINE

A word commonly used synonymously with computer.

MAIN ELECTRONICS BOARD

The large piece of plastic-like material that houses the majority of the electronics components in your computer.

MEMORY

Generally, the place in the computer where data stays before, during, and for a short time after processing.

MENU

A list of options, usually operations, provided by a program so that you can choose what you want to do from what you see on your display screen.

MICROPROCESSOR

The principal component in your computer, central to all of the computer processes that take place.

MODEM

A device that allows you to connect your computer to the telephone lines in order to communicate with another computer.

NIBBLE COPIERS

Programs that make copies of other programs that would otherwise be impossible to copy.

PADDLES

Gadgets useful for playing games.

PERIPHERALS

Devices such as disk drives and display monitor whose main place of residence is o9utside the computer but without which you'd have no good means of communication with the computer.

PROGRAM

A set of instructions that directs the operation of a computer; to write such a set of instructions.

PROMPT

A character, word, phrase, or statement which indicates either that something is missing or that the program is ready to accept some further information, usually a command.

RAM

Random Access Memory

READ

To introduce data into the computer from a diskette in a disk drive.

RESEATING

The process of opening the disk drive door, removing and reinserting the diskette, and reclosing the disk drive door. The sometimes facilitates the functioning of a diskette in a disk drive.

RESET

The button you might consider using if your program has gone crazy but which you must avoid at all costs if your computer is reading or writing data on a diskette.

RF MOCULATOR

A gadget that let you use your television set as a display monitor for your computer.

ROM

Read Only Memory.

RUN

To execute or operate a program in the computer.

SAVE

To send whatever data is in the computer out to a diskette for storage.

SLOTS

Elonated sockets at the back of the main electronics board. Slots hold peripherals cards such as the disk drive controller card.

SOURCE

The disk drive holding the diskette that's providing the data to the computer.

UTILITY PROGRAM

A program you use to sort through files, reorganize the contents of a diskette, and perform a number of other housekeeping functions.

WINCHESTER

A device that uses a hard disk rather than a floppy disk for storing data.

WRITER

To transcibe data onto a diskette in a disk drive from the computer itself.

WRITE-PROTECT TAB

A piece of adhesive plastic or paper (approximately 3/8" x 1") used to cover the rectangular noth on the side of a diskette so that it's impossible to write on the diskette.

APPENDIX A. INTRODUCTION TO CP/M™

Since its inception in 1970 the microprocessor has quietly reshaped our world as we know it. It has enabled "intelligence" to be incorporated into products which we use on an everyday basis, from automobile engines to microwave ovens. In addition to their use in enhancing the capabilities of consumer and industrial products, microprocessors have been used over the past five years as the heart of small, but remarkably powerful, computers. These computers are usually referred to as microcomputer. These microcomputer are being used today in many business applications such as accounting and word processing, in education and research to interpret and compile data, and even in the home as very sophisticated educational and entertainment devices.

How can the microcomputer be used in so many unique end products? The answer is that the microcomputer responds to a unique set of machine instructions, and the way these instructions are grouped or arranged determines how the microprocessor's of words, a traffic light controller, or a computer game. It is the flexibility and power of these instructions which give the microprocessor its power and versatility.

As with most things in life, no two microcomputer applications ever seem quite the same. Therefore, one would expect that each microcomputer must have its own unique program to allow it to perform its particular function. To a large extent, this is true. However, each of these individual programs have certain elements that are common. Each program must have sections to input data from some form of console device, print output to a printer, store and retrieve data on a disk, and so on. The common elements of these programs are usually grouped together into what is referred to as an operating system. Thus. a programmer can save a tremendous amount of time and energy. By integrating these common elements into the main program via the operating system, the programmer is then free to concentrate on the parts of the program that are unique to the specific application at hand.

In the last 20 years many computer manufactuer have developed operating systems for their particular hardware system. CP/M is one of the most popular and widely used operating systems for microcomputer. Since its introduction in 1975, CP/M has been used by dozens of manufacturers of microcomputers and has become as close as anything to being the "industry standard." This popularity is no doubt directly related to its ease of operation and flexibility.

A.1 WHAT IS AN OPERATING SYSTEM?

For those who have suddenly found themselves' caught up in computers and computing, terms such as "operating system," "RAM","list device", and the like tend to be confusing when they are first encountered. We will make a small digression at this point to explain exactly what an operating system is, why it is necessary, and what it does. Those of you who are already familiar with operating systems may want to read the rest of this section to refresh your memory, or you may want to skip ahead to the next section.

A computer, whether it is a $5000 microcomputer or a multimillion dollar IBM maingrame, is a machine which continuously executes a series of instructions called a program. Although a computer has tremendous capabilities and often appears to have a very fast and efficient human mind, it does not have any of the human characteristics called intuition or deductive reasoning. Thus a computer must be told what to do all times. The nature of computer design is such that in addition to the requirement that the computer have a program to execute at all times, the steps or sequence of instructions of that program is critical.

In order to illustrate this point a little more clearly, let us assume that you are out for a Sunday drive and you notice that your gas gauge registers a bit on the low side. You pull into the brand new "gas station of the future" which MONOCO (Monolithic Oil Company) has just installed up the street, and you notice that there is a computer miniding the station instead of the high school kid who used to pump the gas. You roll down your window and say into the computer's grill-like ears "full'er up", expecting that without further ado your gas tank will be filled with unleaded gas, your oil, radiator, windshield washer, and battery levels will be checked, and your front and back windshields will be cleaned for you just like the old days. Right? Wrong.

To start with the computer, who speaks nothing but the King's English, does not recognize the word "fill'er" as "fill her" However, even if it had it would not have been able to guess what kind of gas to put in the car, although the high school kid would have looked at the car and figured out that since it is a 1978 car it must use unleaded. The computer would not have checked under the hood for you since you didn't ask, and would not have even attempted to clean your wind-shield since "clean" is such a subjective term.

By this time of course, you have figured out that the only intelligent plan of action at this point is to immediately drive away and find a good ol' fashioned gas station that understands the expression "fill'er up". Of course you could have painstakingly explained in infinite detail to the computer back there at the MONOCO station exactly how to perform all of those tasks, but after all, you wanted to go for a drive on this particular Sunday.

Which brings us to the whole point of this discussion. If you don't tell the computer how to do these things, someone else has to. The whole reason for installing the computer there at MONOCO was to allow you to have your car filled with gas promptly and efficiently. So someone must tell the computer how to perform these basic functions, and that set of instructions is what would be referred to as an operating system. An operating system would know what to do when you said "fill'er up."

Generally, any operating system can be defined as the interface between the computer and the computer user. Its purpose is to provide the user with a flexible and manageable means of control over the resources of the computer. The three primary functions fulfilled by all operating systems are:

1. Provide an orderly and consistent input/out-put (i/o) environment for the various elements of the computer (i.e., terminal, printer, hard or floppy disk, magnetic tape, etc.) to operate in. Input/output is a generalized expression that means responding to a key being depressed on the keyboard, sending a character to the screen or printer, etc.
2. Provide file management and status reporting for the data being stored in the computer system. A file management system will allow a user to find out what files are on a disk, how big the files are, how much unused space is left on the disk, as well as managing the reading and writing of information to and from the disk.
3. Provide for the loading and execution of user programs. Many operating systems have far more elaborate features such as the ability to execute more than one user task at one time, the ability to keep track of the amount of time each user spends on the system, a system of passwords to protect data and programs, etc. However, they all perform the three basic functions mentioned above in one form or another.

A.2 THE HISTORY OF CP/M

The microcomputer traces its roots to the first microprocessor, the Intel 4004. The 4004 was first introduced in 1970 and was extremely primitive by standards of today. However, elementary as it was, it was a major advancement in integrated circuit technology. Intel followed the 4004 with the 4040, both of which were 4-bit machines and then the 8008, the first 8-bit microprocessor. Finally, in early 1973 Intel announced the 8080, the first microprocessor which was powerful enough to be used in a microcomputer.

The first real microcomputer, and the one that started the current expansion of small computers was the MITS Altair. The Altair appeared on the cover of Popular Electronics in December of 1974. Its popularity was phenomenal and it caught everyone by surprise. Apparently a huge unperceived market existed for computers in the under $1000 range (the MITS Altair kit went for $375 back then in its most stripped-down version). Soon there were other companies springing up to offer additional computer products that were compatible with the Altair as well as some companies that started making computers to compete with the Altair. Some of the early companies were Imsai, Processor Technology, Cromenco, and North Star. As the hardware offerings of these companies began to round out, initial software offerings in the form of assembiers, disassemblers, and rudimentary BASIC interpreters appeared.

The initial mass storage medium for the early microcomputers was the familiar cassette card which allowed the user to attach an ordinary cassette tape recorder to the computer and thereby store and retrieve programs, data, and text. Each company had its own programs which controlled the tape cassette, recording method, and other features. However, there was little or no compatibility between the various recording schemes and formats. Although several attempts were made to create a standard tape storage format(most motably the Kansas City standard), no clear-cut standard ever appeared Consequently there was very little software transportability between different manufacturers' devices, and programs could not be easily traded or swapped among computer owners.

Soon after the cassette recorder appeared on the market, a few the more innovative companies introduced a floppy disk based mass storage device. The floppy disk offered a price/ performance increase over the cassette of several times. With a floppy disk, a program could be loaded in seconds, instead of minutes and a much larger number of programs could be stored on one diskette than could ever be stored on a cassette.

With the advent of the floppy disk drive, applications for the microcomputer opened up which had not existed previously. With cassette tape as the only mass storage medium, the microcomputer was limited to educational, hobby, and other applications where the limitations imposed by the use of cassette tapes as a mass storage medium could be accepted. However, with the floppy disk,business, scientific, and other higher performance applications became possible.

While all of this was going on, Gary Kildall (the author of CP/M) was working for Intel as a consultant writing a language called PL/M for Intel's development systems. As can best be determined from microcomputer folklore (passed down from generation to generation by the great sages) the development of CP/M went something like this.

At that time, paper tape was the only from of mass storage that had been adapted for microcomputers (consisting mainly at that time of the Intel Intellec development systems). The most commonly used paper tape punch and reader is the Teletype Model 33 telex machine. For those of you who have never used one of these beasts, their particular brand of noisy, slow, mechanical dependability can only be appreciated by those who understand the sublime beauty of a Sherman tank. Fortunately, there are very few people in the microcomputer field who possess this state of mind, and so it is no surprise that Gary found the then recently developed floppy disk drive intriguing.

After securing a floppy disk for himself, Gary realized that a floppy alone does not a mass storage device make. A cabinet, controller, power supply, cables, and programming are also necessary. Thus Gary enlisted the help of this friend John Torode to complete the project. While Gary developed the file manager (the forerunner of CP/M's BDOS), John completed the disk controller, Finally, all was ready and the first CP/M disk system was a reality.

During the next year or so relatively little interest was shown by the microcomputer industry for CP/M, Intel expressed no interest, and although a few commercial licenses were granted, none of the then dominant microcomputer manufacturers expressed any interest. It was not until Glenn Ewing of Imsai approached Gary for a license that CP/M really began to take off. Out of the dialog with Glenn came the concept of consolidating all of the hardware dependent portions of CP/M in one section, so that anyone could buy a copy of CP/M and do his or her own modification. With this change, the rapid proliferation of CP/M throught the industry began.

In order to provide the support manufacturers and users would require, Gary started Digital Research in 1976. Since that time, Digital Research has groqn and matured with the microcomputer market, and now offers more advanced versions of CP/M, as well as relared software products such as a macroassembler (MAC), a symbolic debugger (SID) for debugging assembly language programs, a text formatter (TEX) which can be used with text editors such as ED to produce professional word processor quality text output. More recently, products which support more than one user at a time in the CP/M environment have been announced. No doubt, more products will be announced in the near future from Digital Research.

Gary and Digital Research added an assember, debugger, text editor, and a number of system utilities to CP/M with time which allowed the user to write programs, store and retrieve data, and in general utilize the full capacity of a microcomputer. However, its most important contribution was that CP/M was not designed around any one manufacturer's hardware but rather, was written so that it could be used, with the proper modifications, on almost any microcomputer. This was a large step forward, since it meant that programmers could develop software such as more sophisticated BASIC interpreters, text editors, and other software in the CP/M environment and be assured that it would run and be available on the hardware of many manufacturers.

A.3 WHY CP/M IS SO POPULAR

The CP/M operating system has been around for over five years and during that time a huge number of programs have been written to run under it. There are business programs, educational programs, games, programming aids, high level languages, and other special purpose programs such as data communications programs adailable for the CP/M environment.

There are over 100 companies offering software products that run under CP/M. Appendix B lists a sampling of these programs as well as the names of companies to write to for more information. Table 7.3-1 summarizes some of the types of programs currently available which are CP/M compatible. In addition to the programs listed in Table 7.3-1 and Appendix B, there is a vast number of games and other entertainment-oriented programs which can be found in computer magazines, computer club newsletters, books, and other commonly available sources. Table 7.3-1 Summary of Types of Programs Currently Available That Are CP/M Compatible.

A.4 WHAT IS THE FUTURE FOR CP/M?

During their first five years, CP/M and Digital Research have made a significant contribution to the field of microcomputers, whether for personal or business use. Without the CP/M operating system, and its easy adaptability to many different computers, the large body of software which is currently available for microcomputers would not be nearly as large or as sophisticated as it currently is.

Two recent products announced by Digital Research can give us some idea of what is in store for microcomputers and CP/M during the next five years. MP/M and CP/Net are the two products and both represent the current focus in the industry to ward distributed processing and microcomputer networks. Exciting as microcomputers have been in the past five years, they have been limited to single-user applications. The possibilities of applications involcing microcomputers accessing large common data bases or microcomputers strung together into large networks are truly mind-bogging. The next five years show incredible promise for CP/M, MP/M, and CP/Net as microcomputer programmers begin to explore the capabilities of microcomouters joined together into ever larger and more sophisticared networks.

CP/M REFERENCE

DESIDENT COMMANDS

DIR	Type a directory of the current disk.
DIR ufn	Check for a file on the current disk.
DIR afn	Check for one or more files on the current disk.
ERA ufn	Erase a file from the current disk.
DRA afn	Erase one or more files from the current disk.
REN ufn=ufn,...,ufn=ufn	Rename one or more files. New filename is left of equal sign and old filename is to the right.
SAVE n ufn	Save n 256 byte blocks of memory in a file on the current disk.
TYPE ufn,ufn,...,ufn	Type one or more files to the console.

Note: An optional disk drive reference can be inserted before any ufn (d:ufn) or afn (d:afn) if the file or files desired are not on the current disk. In the above examples, ufn means unambiguous filename and afn means ambiguous filename. The "?" is the single character wildcard, and "*" is the "fill right with "?s" wildcard. Filenames many have up to eight characters in them, and file types may have up to three.

STAT Check Status

STAT	Returns the amount of unused space on the currently logged disk.
STAT x:	Returns the amount of unused space on drive x:.
STAT ufn	Returns the size in bytes, records, and extents of file ufn.
STAT afn	Returns the size in bytes, records, and extents of the files that match afn.
STAT x:=R/O	Sets drive x: as read only.
STAT val:	Returns the possible logical-physical assignments for the four i/o devices.
STAT dev:	Returns the current logical-physical assignments for the four i/o devices.
STAT ld:=pd:	Assigns logical device ld:as physical device pd:
STAT dsk:	Returns the current disks logged on to the system.

PIP TRANSFER FILES

PIP y=x:ufn	Transfer a file, ufn from one deive x: to another drive y:.
PIP y:=x:afn	Transfer one or more files that match the afn from drive x: to drive y:.
PIP y:ufn1=x:ufn2	Transfer a file, ufn2 from drive x:to drive y: and rename it ufn1.

MOVCPM RELOCATE SYSTEM LMAGE

MOVCPM*	Relocates the system image size to utilize all available menory.
MOVCPMn*	Relocates the system image to utilize nK bytes of memory. Note: The "*" instructs MOVCPM to leave the new system image in menory (for subsequent use by SYSMOV). If the "*" is left out, the system image is moved to the disk that was last booted off of.

SYSGEN GENERATE A CP/M SYSTEM

SYSGEN	Initiates the SYSGEN dialog.

Assembler Directives:

ORG	Define starting address of the program or data section.
END	End program assembly.
EQU	Define a numeric constant.
SET	Set a numeric value.
IF	Begin conditional assembly.
ENDIF	End conditional assembly.
DB	Define data byte.
DW	Define data word.
DS	Define data storage area.

DDT DEBUG A FILE

DDT ufn Load DDT into memory. Optional filename is loaded into the default FCB (File Control Block) for future - R (Read) commands.

Commands:

Aa	Assenble code starting at address a.
Ds,f	Display menory from optional starting address s to optional ending address f.
Fs,f,d	Fill menory from starting address s through ending address f with hexadecimal value d.
G,a	Begin program execution, independent of DDT, with optional breakpoint at address a.
Iafn	Insert filename into the default FCB for future -R commands
Ls,f	List a program from optional starting address s to optional ending address f.
Ms,f,d	Move a block of data starting with address s and ending with address f to a new memory block beginning with address d.
R	Read the file whose filename is in the default FCB into memory.
Sa	Set the byte contained in menory location a to a new value.
Tn	Trace n program steps.
Un	Untrace n program steps.
Xr	Examine and modify CPU register r.

LOAD CONVERT HEX TO COM FILE

LOAD ufn Load reads a. HEX file created with ASM and creates a. COM file.

A.5 CP/M COMPATIBLE SOFTWARE

This appendix presents an extensive, but still partial list of CP/M compatible programs and the companies that sell them. The list represents a condensed version of a survey put out by Small Systems Group (Box 5429, Santa Monica, CA, 90405). The complete survey can be purchased from Small Systems Group for $1.00 plus a stamped self-addressed envelope.

The list here is divided into five program categories: accounting programs, general applications, industrial programs, utilities, and system programs. Within each of these five categories are further divisions to help keep the list clear. You can add to it as you desire.

Under each heading is a name of the program product followed by the address of the program's vendor. Multiple addresses are included if one vendor has more than one product in the list to simplify your understanding of the companies and what they market. You can write to the company to gather information (specs, price, terms, etc.) A simple postcard will do. Note that you read about them in the CP/M Primer. A careful combing of the magazines: Byte, Kilobaud, Creative Computing, On Computing, and Infoworld will provide advertisements of the latest developments in CP/M software.

ACCOUNTING APPLICATIONS.

Integrated Accounting

Program Name	Vendor and Address
Accounting Package	Aaron Associates Inc., Box 170A, Garden Grove, CA 92640
Complete Accounting	Micro Byte Computer Store, 2626 Union Avenue San Jose, CA 95124
Moneybelt	Micro Source, 1425 W. 12th Place, Tempe, AZ 85281
Accounts Payable/Receivable	Osborne Associates, Inc., Box 2036, Berkeley, CA 94702
Integrated Business System	Serendipity Systems, 225 Elmira Rd., Ithaca, NY 14850

General Ledger

Genera; :edger	Aaron Associates Inc., Box 170A, Garden Grove, CA 92640
General Ledger	BAS; 16755 Littlefield Lane, Los Gatos,CA 95030
General Ledger	California Microcomputer, Box 3199, Chico,CA 95927
Micro Ledger	CompuMax Associates, 505 Hamilton Avenue, Palo Alto, CA 94301
General Ledger	Data Train Inc., 840 N.W. 6th Street, Grants Pass, OR 97526
General Ledger	International Micro Systems, 3077 Merriman Lane, Kansas City, KS 66106
General Ledger	Micro Computer Consultants, Box 255625, Sacramento, CA 95825
Ledger Plus	Micro Source, 1425 W. 12th Place, Tempe,AZ 85281
General Ledger	Personal Software, 592 Weddell Drive, Sunnyvale, CA 94086
General Ledger	Serendipity Systems, 225 Elmira Rd., Ithaca, NY 14850

Program Name	Vendor and Address
Payroll	
Payroll	Aaron Associates Inc., Box 170A, Garden Grove, CA 92640
Payroll	California Microcomputer, Box 3199, Chico, CA 95927
Micro Pers	CompuMax Associates, 505 Hamilton Avenue, Palo Alto, CA 94301
Payroll	Graham Dorian Software Systems, 211 North Broadway, Wichita, KS 67202
Payroll	International Micro Systems, 3077 Merriam Lane, Kansas City, KS 66106
Payroll	Micro Data, 5622 Pacific Avenue, Olympia, WA 98503
Payroll	Personal Software, 592 Weddell Drive, Sunnyvale, CA 94086
Payroll (Personnel)	Serendipity Systems, 225 Elmira Rd., Ithaca, NY 14850
Accounts Payable	
Accounts Payable	BAS, 16755 Littlefield Lane,Los Gatos,CA 95030
Accounts Payable	Commercial Computer Inc., 9742 Humboldt Avenue, Minneapolis, MN 55431
Accounts Payable	Data Train Inc., 840 N.W. 6th Street, Grants Pass, OR 97526
Accounts Payable	Micro Byte Computer Store, 2626 Union Avenue, San Jose, CA 95124
Accounts Payable	Micro Data, 5622 Pacific Avenue, Olympia, WA 98503
Accounts Payable	Rothenberg Information Systems, 260 Sheridan Ave., Palo Alto, CA 94306
Accounts Payable	Serendipity Systems, 225 Elmira Rd., Ithaca, NY 14850
ACCOUNTS RECEIVABLE	
Accounts Receivable	Aaron Associates Inc., Box 170A, Garden Grove, CA 92640
Accounts Receivable	BAS, 16755 Littlefield Lane,Los Gatos,CA 95030
Balance Forward A/R	California Microcomputer, Box 3199, Chico, CA 95927
Microrec	CompuMax Associates, 505 Hamilton Avenue, Palo Alto, CA 94301
Accounts Receivable	H.H.Associates, Inc., Box 19504, Denver, CO 80219
Balance Forward A/R	International Micro Systems, 3077 Merriam Lane, Kansas City, KS 66106
Account Receivable	Micro Data, 5622 Pacific Avenue, Olympia, WA 98503
Accounts Receivable	Personal Software, 592 Weddell Drive, Sunnyvale, CA 94086
Accounts Receivable	Structured Systems Group, 5208 Claremont Ave., Oakland, CA 94618
Billing	The Software Store, 706 Chippewa Square, Marquette, MI 49855

Program Name	Vendor and Address
Accounts Receivable	Univair International, 10327 Lambert Intl., Airport, Saint Louis, MO 63145
INVENTORY	
Inventory	Aaron Associates Inc., Box 170A, Garden Grove, CA 92640
Microinv	CompuMac Associates, 505 Hamilton Avenue, Palo Alto, CA 94301
Inventory System	H.H.Associates, Inc., Box 19504, Denver, CO 80219
Inventory Control	International Micro Systems, 3077 Merriam Lane, Kansas City, KS 66106
Backorder Management	International Micro Systems, 3077 Merriam Lane, Kansas City, KS 66106
Mfr/Whlsale Inventory	Micro Computer Consiltants, Box 255625, Sacramento, CA 95825
Inventory Management	Personal Software, 592 Weddell Drive, Sunnyvale, CA 94086
Retail Inventory	Serendipity Systems, 225 Elmira Rd., Ithaca, NY 14850
ORDER ENTRY	
Order Entry System	H.H.Associates,Inc., Box 19504, Denver,CO 80219
CASH DISBURSEMENTS	
Cash Disbursements	Aaron Associates Inc., Box 170A, Garden Grove, Ca 92640
Cash Disbursements Posting	International Micro Systems, 3077 Merriam Lane, Kansas City, KS 66106
CASH RECEIPTS	
Cash Register	Graham Dorian Software Systems, 211 North Broadway, Wichita, KS 67202
JOB COSTING	
Job Costing	Graham Dorian Software Systems, 211 North Broadway, Wichita, KS 67202
FIXED ASSETS ACCOUNTING	
Fixed Assets Accounting	Data Train Inc., 840 N.W. 6th Street, Grants Pass, OR 97526
GENERAL APPLICATIONS	
DATA BASE SYSTEM	
Data Management System	Creative Computer Applications, 2218 Glenn Canyon Road, Altadena, CA 91001
Pearl	Computer Pathways Unlimited, 2151 Davcor Street, S.E. Salem, OR 97302
Global	Global Parameters, 1505 Ocean Avenue, Brooklyn, NY 11230

Program Name	Vendor and Address
Categorical Information	H.H.Associates, Inc., Box 19504, Denver, CO 80219
Selector	Micro-Ap, 9807 Davona Drive, San Ramon, CA 94583
Midas	Rothenberg Information Systems, 260 Sheridan Ave., Palo Alto, CA 94306
Data Base	TSA Software, 39 Williams Dr., Monroe, CT 06468
Data Management	Univair International, 10327 Lambert Intl., Airport, Saint Louis, MO 63145
TEXT EDITOR	
Zedit	Computer Design Labs, 342 Columbus Avenue, Trenton, NJ 08629
Weed	Digital Marketing, 2670 Cherry Lane, Walnut Creek, CA 94596
Wordmaster	MicroPro International, 5810 Commerce Blvd., Rohnert Park, CA 94928
Text Editor	Software Ingenuity, Box 1964, Eugene, OR 97401
Text Editing System	Technical Systems Consultants, Box 2574, West Lafayette, IN 47906
TEXT OUTPUT FORMATTER	
Top	Computer Design Labs, 342 Columbus Avenue, Trenton, NJ 08629
Script 80 Professional	J. Vilkaitis, Box 26, High Street Extension, Thomaston, CT 06787
Textwriter	Organic Software, 1492 Windsor Way, Livermore, CA 94550
Text Processing System	Technical Systems Consultants, Box 2574, West Lafayette, IN 47906
WORD PROCESSOR	
Idsword	CW Applications, 1776 E. Jefferson street, Rockville, MD 20852
Pro-Type	Interactive Microwave Inc., Box 771, State College, PA 16801
Word Star	MicroPro International, 5810 Commerce Blvd., Rohnert Park, CA 94928
Electric Pencil	Michael Shrayer Software, 1253 Viste Superba Dr., Glendale, CA 91205
Power Text	Personal Software, 592 Weddell Drive, Sunnyvale, CA 94086
The Magic Wand	Small Business Applications, 3220 Louisiana St., Houston, TX 77006
Letteright	Structured Systems Group, 5208 Charemont Ave., Oakland, CA 94618
MWP/SEL	The Software Store, 706 Chippewa Square, Marquette, MI 49855
MAILING LIST SYSTEM	
Mail List	Aaron Associates Inc., Box 170A, Garden Grove, CA 92640
Mail Listing	Commercial Computer Inc., 9742 Humboldr Avenue, Minneapolis, MN 55431

Program Name	Vendor and Address
Mailing List Management	International Micro Systems, 3077 Merriam Lane, Kansas City, KS 66106
Postmaster	Lifeboat Associates, 164 W. 83rd Street, New York, NY 10024
NAD	Structured Systems Group, 5208 Claremont Ave., Oakland, CA 94618
INDUSTRY APPLICATIONS	
MEDICAL	
Automated Patient History	Cybermetics Inc., 8041 Newman Avenue, Huntington Beach, CA 92647
Medical Office Building	H.H.Associates, Inc., Box 19504, Denver, CO 80219
Medical Management	Univair International, 10327 Lambert Intl. Airport, Saint Louis, MO 63145
LEGAL	
Law Office Billing	H.H.Associates, Inc., Box 19504, Denver, CO 80219
DENTAL	
Dental Receivables	MBA Inc., Box 2528, Pasco, WA 99302
CONSTRUCTION	
House Cost Estimation Package	Business Information Systems, 7905 L Street, Omaha, NE 68129
Contractor Payroll	Micro Data, 5622 Pacific Avenue, Olympia, WA 98503
PROPERTY MANAGEMENT	
Property Management	A-T Enterprises, 221 North Lois, La Habra, CA 90631
Apartment Management	H.H.Associates, Inc., Box 19504, Denver, CO 80219
Cash Flow	Realty Software Inc., 2126 Lombard Street, San Francisco, CA 94123
MEMBERSHIP BILLING	
Country Club Receivables	MBA Inc., Box 2528, Pasco, WA 99302
UTILITY BILLING	
Utility Billing	Micro Data, 5622 Pacific Avenue, Olympia, WA 98503
GOFT CLUB	
Golf Handicap	Micro Data, 5622 Pacific Avenue, Olympia, WA 98503
ACCOUNTING	
Master Tax	CP Aids, 1640 Franklin Avenue, Kent, OH 44240
CPA G/L and Client Statement	MBA Inc., Box 2528, Pasco, WA 99302

Program Name	Vendor and Address
PROFESSIONAL	
Integrated Professional Office	Serendipity Systems, 225 Elmira Rd., Ithaca, NY 14850
Professional Client Billing	Serendipity Systems, 225 Elmira Rd., Ithaca, NY 14850
MEDICAL OR DENTAL	
Integrated Med/Dental Office	Serendipity Systems, 225 Elmira Rd., Ithaca, NY 14850
Medical/Dental Patient Billing	Serendipity Systems, 225 Elmira Rd., Ithaca, NY 14850
SCHOOL ADMINLSTRATION	
Student Records and Scjeduling	International Micro Systems, 3077 Merriam Lane, Kansas City, KS 66106
ENGINEERING	
Control Systems Analysis	Compco, 8705 North Port Washington Rd., Milwaukee, WI 53217
BOWLING ALLEY	
Bowling Bookeeper	Compco, 8705 North Port Washington Rd., Milwaukee, WI 53217
UTILITY APPLICATIONS	
MATHEMATICAL ROUTINE	
Development Utilities	Allen Ashley, 395 Sierra Madre Villa, Pasadena, CA 91107
Floating Point Package	Southern Systems of Birmingham, Box 3373-A, Birmingham, AL 35205
STATISTICAL PACKAGE	
Statistics	Basic Business Software, Box 2032, Salt Lake City, UT 84110
Statpak	Northwest Analytical, Box 14430, Portland, OR 97214
ISAM PACKAGE	
Kiss	EIDOS Systems Corp., 315 Wilhagan Rd., Nashville, TN 37217
GRAPHICS	
Graphic Subroutine Package	Compco, 8705 North Port Washington Rd., Milwaukee, WI 53217
PLOTTING	
Plotting	Basic Business Software, Box 2032, Salt Lake City, UT 84110
FINANCE	
Finance Calculator	Basic Business Software, Box 2032, Salt Lake City, UT 84110

Program Name	Vendor and Address
COMMUNICATION	
Download	Cybernetics Inc., 8041 Newman Avenue, Huntington Beach, CA 92647
Mcall	Micro Call Services, 9655-M Homestead Court, Laurel, MD 20810
Intellingent Terminal	TSA Software, 39 Williams Dr., Monroe, CT 06468
SCREEN EDITOR	
Forms-2	Micro Focus Ltd., 1601 Civic Center Drive, Santa Clara, CA 95050
FORM PRODUCTION	
Automated Forms Control	H.H.Associates, Inc., Box 19504, Denver, CO 80219
PRINT SPOOLER	
Despool	Digital Research, Box 579, Padific Grove, CA 93950
Sort	
Super Sort	MicroPro International, 5810 Commerce Blvd., Rohnert Park, CA 94928
Multi Key Sort	Rothenberg Information Systems, 260 Sheridan Ave., Palo Alto, CA 94306
Sort	The Software Store, 706 Chippewa Square, Marwuette, MI 49855

SYSTEMS PROGRAMS

DEVELOPMENT SYSTEMS	
PDS-Program Development System	Allen Ashley, 395 Sierra Madre Villa, Pasadena, CA 91107
Z-80 Development Package	Lifeboat Associates, 164 W. 83rd Street, New York, NY 10024
Low Precision Basic	Computer Design Labs, 342 Columbus Avenue, Trenton, NJ 08629
Business Basic	Computer Design Labs, 342 Columbus Avenus, Trenton, NJ 08629
UCSD Pascal	Digimedics, 501 Cedar Street, Santa Cruz,CA 95060
Basic Compiler	Interactive Microwave Inc., Box 771, State College, PA 16801
ALGOL 60 Compiler(Z-80)	Lifeboat Associates, 164 W. 83rd Street, New York, NY 10024
CIS COBOL Compact	Micro Focus Ltd., 1601 Civic Center Drive, Santa Clara, CA 95050
Basic Compiler	Microsoft, 10800 NE Eighth, Bellevue, WA 98004
COBOL-80	Microsoft, 10800 NE Eighth, Bellevue, WA 98004
CBASIC	Software Systems, Box 145, Sierra Madre, CA 91024
Tarbell Basic	Tarbell Electronics, 950 Dovlen Place, Carson, CA 90746
APL Interpreter	Vanguard Systems Corp., 6712 Pedro Avenue, San Antonio, TX 78216

Program Name	Vendor and Address
ASSEMBLER	
XMAC 6800	Allen Ashley, 395 Sierra Madre Villa, Pasadena, CA 91107
MAC	Digital Research, Box 579, Pacific Grove., CA 93950
8048 Cross Assembler	Software Ingenuity, Box 1964, Eugene, OR 97401
RLSAM	TSA Software, 39 Williams Dr., Monroe, CT 06468
A-Natural Assembler	Whitesmiths Ltd., 127 E. 59th Street, New York, NY 10022
DEBUGGING MONITOR	
DEBUG	Computer Design Labs, 342 Columbus Avenue, Trenton, NJ 08629
SID	Digital Research, Box 579, Pacific Grove, CA 93950
UTILITY PROGRAM	
Z80/8080 Disassembler	Affordable Computers, 16508 Hawthorne Blvd., Lawndale, CA 90260
Transfer	Computer Services, 30 Hwy, 321, NW, Hickory, NC 28601
DISLOG	Lifeboat Associates, 164 W. 83rd Street, New York, NY 10024
Expander	MICAH, P.O.Box 22212, San Francisco, CA 94122
IBM-CP/M File Conversion	Smith Computer Systems, 530 Pierce Avenue, Dyer, IN 46311
TTY Model 40 Printer Interface	Smith Computer Systems, 530 Pierce Avenue, Dyer, IN 46311
DISK Utility	The Software Store, 706 Chippewa Square, Marquette, MI 49855
PRGM/MAP	The Software Store, 706 Chippewa Square, Marquette, MI 49855
Librarian	Whitesmiths Ltd., 127 E. 59th Street, New York, NY 10022
REL	Whitesmiths Ltd., 127 E. 59th Street, New York, NY 10022
LOADER	
Linker	Computer Design Labs, 342 Columbus Avenue, Trenton, NJ 08629

Courtesy Small Systems Group

APPENDIX B

B.1. HISTORY OF COMPUTERS

THE FIRST COMPUTER

Using Binary Logic 10 fingers can express any number between 0 and 1023.

Example here expresses 935.

512	256	128	64	32	16	8	4	2	1	
1	1	1	0	1	0	0	1	1	1	= 935

THE DIGIT

The word DIGIT derives from the Latin for finger. The decimal number system was originally designed as a program to allow the ten fingers to be used as a form of calculating machine. Extremely elaborate methods of finger reckoning were widely employed until a few centuries ago. Thus, you may say that man's fingers were the first computer, and certainly the most portable.

THE ABACUS

The AGACUS is the first known semi-mechanical computer. The name is derived from a Hebrew word meaning dust or sand. The earliest and most primitive form of ABACUS consisted of a tray containing sand, in which lines could be traced, on which small stones could be placed to indicate the numbers forming the calculations.

The word CALCULATION itself derives from the Latin 'calculus', meaning 'small stone or pebble'.

The ABACUS was used by the Greeks, Romans and Chinese in pre-Christian times. The Chinese version is the one most familiar today, the kind we buy children as an early aid to counting. It consists of a wooden frame, containing beads strung on wires and is still extensively used in the Far East by shopkeepers for commercial arithmetic.

The early English form of ABACUS had to be more flexible because of the difficulty of calculation using the Roman number system. It took the form of a board with lines cut into the sureface, on which counters could be placed, allowing counters to be moved from a line below to a line above, which was not possible with the wire and bead type. It was, in fact, used by the professional man in purely a mechanical way, without any real understanding of the mathematical logic behind its use.

The Arabic numbers we use today are of Hindu origin,brought into Europe by the MOors in the Eight Century. This simplified calculation to a point where the ABACUS was no longer necessary or desirable up the process of arithmetic to pencil.and paper methods, as we use today.

B.2 HISTORY OF COMPUTERS (HARDWARE)

Until the mid 1940's the basic principle in the design of calaulating machines had advanced little. Blaise Pascal's concept of geared cog-wheels performing addition and subtraction was improved upon by Charles Babbage in the early 19th Century. His Difference and Analytical engines were significant innovations and were indeed the machines upon which today's concept of computing has been built

History for our purpose is however better confined to the concept of the computer, as we understand it today, a machine that provides for the automatic electronic processing and storing of data.

1943 ENIAC

The ELECTRONIC NUMERICAL INTEGRATOR AND COMPUTER built at the University of Pennsylvania was heraled as the first Automatic Electronic Computer. It weighed thirty tons. contained some 20.000 thermionic valves and if had

a very limited storge capacity. Programs were loaded into the machine by a system of changing wired plugboard and using a series of manual switches.

1949 EDSAC

Taking the lead from ENIAC a Cambridge University team built the EDSAC (Electronic Delay Storge Automatic Computer) EDSAC was of some signeable program of instruction within its own memory.

of programming aids but ALGOL and PASCAL, by virtue of their compatible design seem more adjusted to this methodology than most.

On investigation of computer faults, the Pentagon committee found that is programmers were using hundred of conflicting computer languages. Recognising that such a system when aligned to military needs could be horrific, the American Defence Department in consultation with the EEC decided that enough was enough. This led to a final attempt to develop a super language that could be used world-wide on every type of computer. The Pentagon were particularly concerned about failures in early warning systems and decided that after the construction of the proposed new language, tight control over its use would be essential.

ADA

To provide a basic specification as a first step in the search for a super language, a special Higher Order Language Committee (HOLC) was established. They in turn set up a series of specification teams to expand upon recommendations. Starting from scratch, these teams provided a completely new set of rules. Between 1975 and 1979 five separate versions of a proposed language emerged. The final one, code-named "Steelman" recommended that the new language should be based on one of three existing ones: ALGOL, PASCAL or PL/1. All met the specification required by "Steelman" but PASCAL was finally chosen as the base upon which the new language would be constructed. A decision that is now leading to wider scrutiny of PASCAL as a teaching language.

From sixteen tendering companies, four were financed for a periof of six months, Intermetrics, CII/Honeywell/Bull, SRI International and Softex. These companies were given colour code names to make them anonymous. They were then charged with the task of creating by their own initiative the foundation of a new language based on PASCAL. Drawn from the Pentagon, industry, commerce and universities a total of 80 different independent review committees were formed to evaluate results. The conclusion from 50 of these teams gave the honours to code name "Green" which turned out to be CII/Honeywell/Bull of Paris, thereby providing a European connection.

By 1980 final specifications were complete but not until more than one hundred separate programming teams had been involved in the task of testing the validity of the language. The name ADA given to the language was in honour of a pioneer of programming, Ada Augusta, Countess of Lovelace, the daughter of Lord Byron and friend of Babbage the inventor of the 19th Century analytical engine.

1951 UNIVAC 1

UNICAL 1 built by Eckert and Manchley provided a further advance in the history of computers. Installed in the Bureau of Census in the U.S.A. it became the first computer to be put to commercial use. The corporation which founded marketed and developed UNIVAC 1 is supplying computer equipment today.

1953 LEO

To eliminate durdgery from their office work and improve business efficiency in general, J. Lyons & Co. of Tea and Coffic House fame developed in 1953 from a modified copy of EDSAC, the first electronic computer to carry out the task of processing clerical information. Lyons Electronic Office or LEO for short was the immediate forerunner of modem data processing eqipment. This machine operated from 1954 until 1965.

POST LEO

The mid-Fifties witnessed the development of a range of computers with new forms of fast access store - magnetic drum and magnetic core storage. Names like IBM, Univax, Hoenywell and ICT became synonymous with the groth of commercially developed and marketed computers.

Each corporation was, at this time, designing their own systems and programs in inslation in the same way as early supplier of razors made their own style of blares. A most significant step in the rationalisation of sofeware was taken in 1963 with the emergence of COBOL (Common Business Orientated Language). This was the first attempt to develop a universally acceptable programming language that could be used on all computers.

The method of handling vast quantities of information via the computer was confined to dealing with the requirements of each department,within the confines of a remote computer complex. This was done in the same way as a washeteria deals with peoples washing. This method often created delay and frustration,isolating departmental management from the computer staff.

B.3 HISTORY OF COMPUTERS (SOFTWARE)

BASIC

At the time PL/1 and ALGOL were being launched, a team of porgrammers at Dartmough College, Now Hampshire, USA were putting

the final touches to another combination language of a much simpler type using FORTRAN and small amount of ALGOL as its base. This language, called BASIC (Beginners Allpurpose Symbolic Instruction Code), was successful right from the start. Taking advantage of the newly acquired interactive ability of the computer made available through extra machine power, it appealed greatly to mathematics teachers and soon became a common language for use in schools, colleges and many universities. The route from an idea to a running program was simple. The maths element and the reactive quality had great appeal as a teaching aid and also as a means of training unskilled personnel. Due to its wide popularity, BASIC has gone the same way as most other languages. There are now so many dialects that complete programs cannot be easily moved from one machine to another. consequently, although the language has made useful converts from the FORTRAN and COBOL community, conversely there are a growing number of manufacturers offering both PASCAL and COBOL programs for use on mini and micro computers.

With a weather eye on PL/1 in 1965 the IFIP ALGOL Committee of Standards made an attempt to turn ALGOL into a more flexible language and set about its redesign with major surgery.

ALGOL 65

The result is an overwhelmingly difficult-to-learn language that is almost impossible to handle on anything except a large computer. Being a European language, its use has been scorned in the USA by both manufacturers and users alike.

PASCAL

One member of the IFIP team Mr. Nikluswirth, decided that too many cooks were spoiling the broth and so produced his own version called PASCAL. This language was aimed specifically at teaching and was simpler and more machine compatible. Teachers very much appreciated PASCAL in the USA, where it is now available on almost every type of computer.

AIDS

By 1970 programmers were bogged down with program garbage, spending for too much of their valuable time debugging impervious codes. To counter such built-in complexities, control systems called top-down design and structured programming techniques were developed. By these methods a skilled user can greatly reduce programming time. All languages constructed can benefit from the application

ADA, a product of both Europe and the USA, is now a reality-albeit an untried one. The question is,will ADA be refined and controlled by rigid copyright from one powerful international source, or will it, like most predecessors, lose identity in the couse of usage?

Certainly the Pentegon has hte experience and, along with the EEC, have totally committed themselves to its invigilation. Any changes will require their authorty. A harsh set of rules to govern the construction of compilers has already been laid down. Manufacturers must show that their compiler has passed a laid down validation test in order to offer ADA, otherwise they will not be able to tender for American defence contracts. At present there seems to be only one source in the United Kingdom investigating the possibility of using ADA and constructing a compiler. This is York University, working under the auspices of the Science and Engineering Research Council.

Although ADA has many critics, a great deal of in-depedent thought,expertise, energy and capital has gone into its construction. ADA under the control of a highly determined body could well emerge as the world's first all-purpose international computer language. Should ADA turn out to be the super slade that fits all razors, we may be able to say with confidence, "This really is - that Last One."

Remarks:

The contents of this manual are subgect to change without notice. IMC assumes no responsibilities for errors in the manual or their consequences.