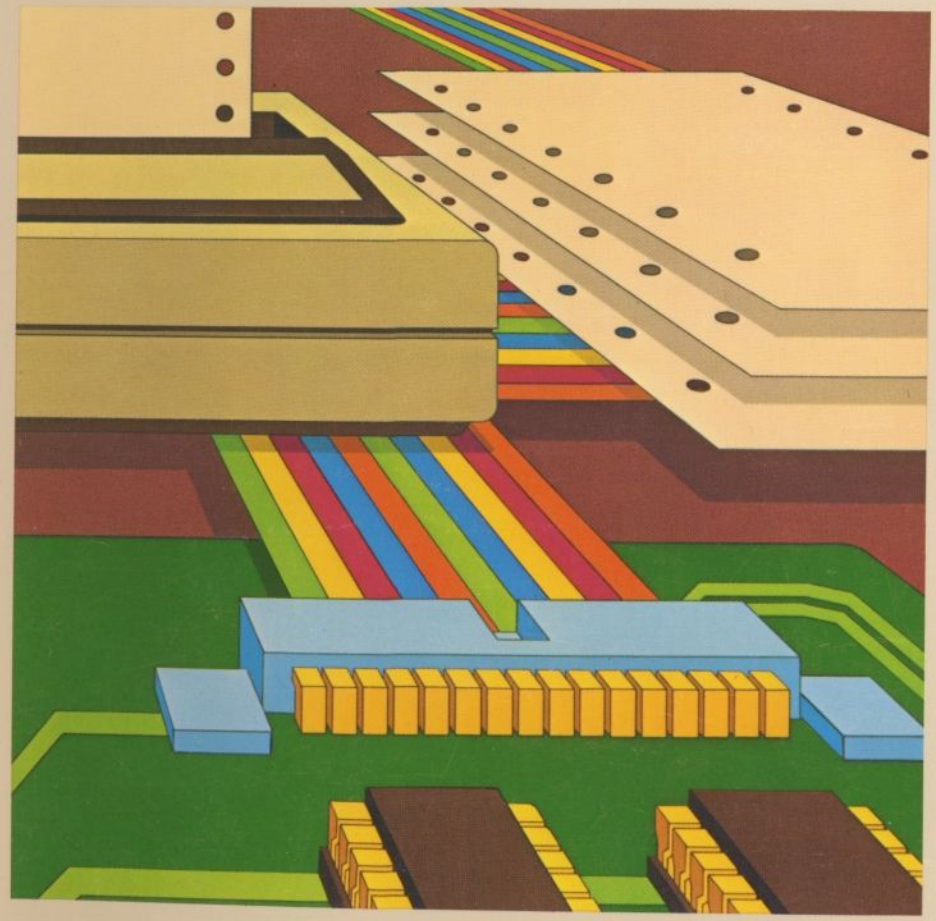
Apple II

Parallel Interface Card

Installation and Operating Manual



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WARNING: This equipment has been certified to comply with the limits for a Class B computing device, pursuant to Subpart J of Part 15 of FCC Rules. Only peripherals (computer input/output devices, terminals, printers, etc.) certified to comply with the Class B limits may be attached to this computer. Operation with non-certified peripherals is likely to result in interference to radio and TV reception.

Apple II

Parallel Interface Card

Installation and Operating Manual

Radio and Television Interference

The equipment described in this manual generates and uses radio frequency energy. If it is not installed and used properly, that is in strict accordance with our instructions, it may cause interference to radio and television reception.

This equipment has been tested and complies with the limits for a Class B computing device in accordance with the specifications in Subpart J of Part 15 of FCC rules. These rules are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that the interference will not occur in a particular installation.

You can determine whether your computer is causing interference by turning it off. If the interference stops, it was probably caused by the computer. If your computer does cause interference to radio or television reception, you can try to correct the interference by using one or more of the following measures:

- Turn the TV or radio antenna until the interference stops.

- Move the computer to one side or the other of the TV or radio.

- Move the computer farther away from the TV or radio.

- Plug the computer into an outlet that is on a different circuit from the TV or radio. (That is, make certain the computer and the TV or radio are on circuits controlled by different circuit breakers or fuses.)

If necessary, you should consult your dealer or an experienced radio/television technician for additional suggestions. You may find the following booklet prepared by the Federal Communications Commission helpful:

"How to Identify and Resolve Radio-TV Interference Problems"

This booklet is available from the U.S. Government Printing Office, Washington, DC 20402, Stock number 004-000-00345-4.

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Preface

The Parallel Interface Card (PIC) provides a firmware-driven, eight-bit parallel interface to printers and other parallel devices, as well as two-way eight-bit parallel communication that can bypass the PIC firmware. The PIC has two sets of firmware: one is identical to the firmware in the earlier Apple II Centronics Printer Card, the other is identical to the firmware in the earlier Apple II Parallel Printer Card. You can change interface characteristics by setting seven switches on the PIC instead of using hand-wired jumper blocks (as on the Parallel Printer Card).

Chapter 1 tells you how to unpack and examine the PIC, and how to set the PIC switches and install the PIC in the Apple II. This chapter also explains how to prepare and connect the cable from the PIC to the printer, if you plan to use a printer with the PIC.

Chapter 2 lists the commands that the PIC recognizes, and gives examples of their use.

Chapter 3 explains how to use the PIC as a general-purpose parallel input/output device.

Chapter 4 describes the PIC's overall theory of operation.

Appendix A discusses the two sets of PIC firmware, and the entry points in the PIC PROM, as well as the Apple II memory locations that the firmware uses.

Appendix B contains the PIC specifications and its schematic diagram.

Appendix C lists the ASCII codes and their equivalents.

A glossary explains the meaning of most important terms as they apply to the PIC.

There are three symbols that set off information of special importance: the hand, the eye, and the STOP sign.

This symbol points to a paragraph that contains especially useful information.

Watch out! This symbol precedes a paragraph that warns you to be careful.

This symbol stands next to a description of the disaster that will ensue if you make some false move.

Chapter 1

Unpacking and Installation

This chapter takes you from the first steps of unpacking and familiarizing yourself with your Apple II Parallel Interface Card (PIC) to the actual installation of the PIC and its cable.

Unpacking

As you unpack your Parallel Interface Card (Figure 1-1), check the contents against the items described on the packing list.

Fill out the pre-addressed warranty card and mail it in. If any items are missing, contact the dealer where you purchased the PIC.

You will need a shielded external cable (not provided as part of the PIC package) to connect the external device--the printer, plotter, or another computer--to your Apple II. Suitable cables are available through your Apple dealer.

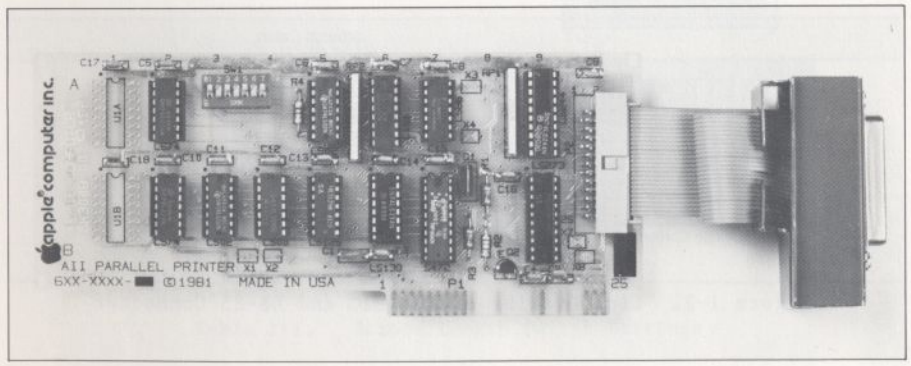


Figure 1-1. Photo of the Parallel Interface Card

A Close Look

Let's examine the Parallel Interface Card for a moment. Carefully pick up the PIC by the edges and put it on a flat surface oriented as shown in Figure 1-1. Now use Figure 1-2 to help identify the main parts of the PIC. Those that you will have to deal with as you prepare it for installation are

- The switches. The switches are numbered from SW1 through SW7. You can see the characters "SW" printed on the PIC, and the numbers 1 through 7 on the switch block. A rocker switch is ON when the top is pushed in, and OFF when the bottom is pushed in. A slide switch is ON when the slide is toward the top edge of the PIC, and OFF when the slide is toward the bottom edge of the PIC.

- The edge connector. It is important not to touch the gold fingers on this connector: they must make a clean electrical contact in the Apple II connector slot when you install the PIC.

- The internal cable. This cable is already attached to the PIC. When installed, it enables you to attach the external cable without opening the Apple II case.

- The DB-25 connector. This is a standard 25-pin connector for attachment of the external cable from the parallel device.

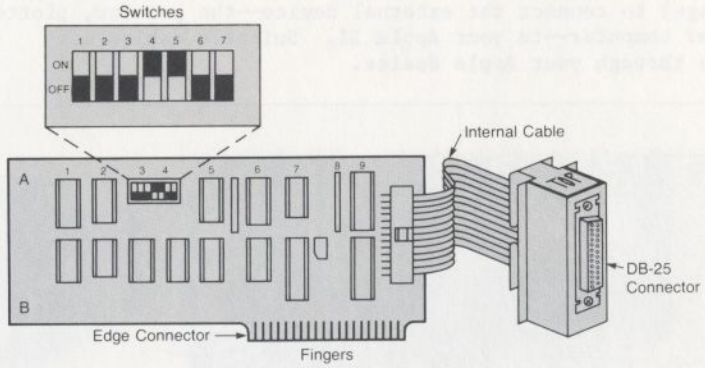


Figure 1-2. Line Drawing of the PIC and DB-25 Connector

Setting the Switches

The PIC has seven switches near its upper left corner (Figure 1-1). These switches tailor the PIC signal characteristics and firmware selection to the attached device.

Most commonly used printers will operate correctly with the following switch settings:

Switch:	SW1	SW2	SW3	SW4	SW5	SW6	SW7
Setting:	OFF	OFF	OFF	ON	ON	OFF	OFF

Some of the printers that work with these settings are the

Anadex 95Ø1	Centronics 7ØØ/779	Epson MX-8Ø
Anadex DP-8ØØØ	Centronix 73Ø/737	Epson MX-1ØØ
Axiom IMP-2	DIP 84	IDS 44Ø/445/46Ø/56Ø
C. Itoh 851Ø/155Ø	NEC PC-8Ø23A-C	Printronix P3ØØ

These settings assume the printer needs a negative strobe lasting 1 microsecond or less, that it sends a negative acknowledge pulse to the Apple, and that it does not have (or is not using) its own automatic linefeed generator.

If you are not familiar with the terms discussed in these sections, consult the glossary for an explanation.

If your printer differs from these characteristics or does not operate with these settings, read the following five subsections of this chapter. Then read the documentation for the printer and decide what switch settings are appropriate.

Strobe Length (SW1 — SW3)

When SW1, SW2, and SW3 are all OFF, the duration of the strobe pulse is 1 microsecond. Using the eight possible ON/OFF combinations of these three switches, you can set the strobe length to any odd number of microseconds from 1 through 15 (Table 1-1).

Strobe Length:	SW1	SW2	SW3
1 microsecond	OFF	OFF	OFF
3 microseconds	ON	OFF	OFF
5 microseconds	OFF	ON	OFF
7 microseconds	ON	ON	OFF
9 microseconds	OFF	OFF	ON
11 microseconds	ON	OFF	ON
13 microseconds	OFF	ON	ON
15 microseconds	ON	ON	ON

Table 1-1. Strobe Length Switch Settings

Strobe Output Polarity (SW4)

If the device expects to receive a strobe pulse of negative polarity, set SW4 ON; if it expects a positive strobe pulse, set SW4 OFF.

Acknowledge Input Polarity (SW5)

If the device sends a negative acknowledge signal to the Apple II, set SW5 ON; if it sends a positive acknowledge signal, set SW5 OFF. The acknowledge actually occurs on the trailing edge of the input pulse.

Firmware Selection (SW6)

The PIC has a 512-byte ROM that contains two 256-byte sections of firmware. One section contains the exact firmware used in the old Apple Centronics Interface Card; the other section contains the firmware used in the old Apple Parallel Printer Interface Card. The position of SW6 selects the firmware that the PIC will use as shown in Table 1-2).

SW6	Firmware	Principal characteristic
ON	"Centronics" (ROM #341-ØØ19)	This firmware does not automatically generate linefeed characters after carriage returns
OFF	"Parallel Printer" (ROM #341-ØØØ5)	This firmware automatically generates linefeeds after carriage returns

Table 1-2. SW6 and Firmware Selection

Many printers have a switch that determines whether or not the printer itself will generate linefeeds automatically after carriage returns. In general, it is best to set the printer so that this feature is disabled, and set SW6 OFF. Note that the Apple II adds a carriage return to the end of every line, and follows a carriage return with a linefeed in BASIC (but not in Pascal).

Some printers don't print out a line until they receive a linefeed character. Turning off automatic linefeed (SW6 ON) may cause some printers to stop printing altogether. If this is the case, make sure a linefeed character precedes the information to be printed (SW6 OFF).

Interrupt or No Interrupt (SW7)

SW7 ON causes the PIC to forward interrupt requests from the device to the Apple II processor. When SW7 is OFF, the PIC does not forward interrupts. Since the Apple II and Apple II Plus do not recognize interrupts, this switch is normally left OFF.

Installing the PIC

This section explains how to install the PIC and its internal cable in the Apple II.

Before connecting or disconnecting anything on the Apple, turn off the power with the switch at the back left corner of the Apple case. THIS IS ABSOLUTELY NECESSARY. If you try to connect or disconnect anything from the inside of your Apple when the power is on, you are likely to damage the circuits.

Do not unplug the Apple, just turn it off. If you unplug the Apple, you will isolate it from earth ground and leave it vulnerable to static discharges.

Remove the Apple cover by pulling up on the two back corners of the cover until the two corner fasteners pop apart. Slide the cover back until it is free of the case and lift the cover off.

Look inside the Apple and locate the power supply case--the rectangular metal box along the left inside the Apple II. To avoid damaging the PIC, touch the power supply case with one hand; this discharges any static charge that may be on your clothes or body.

Along the back inside edge of the Apple you will see eight long narrow slots called connector slots. The connector slots are numbered from Ø at the left to 7 at the right. The numbers are printed along the back edge behind the connector slots. For use with Pascal, you must install the PIC in slot #1. For use with BASIC, you may install the PIC in any slot except #Ø. Typically, the PIC goes in slot #1.

Handle the Parallel Interface Card as you would handle an expensive phonograph record. Grasp it only by the corners or edges, and do not touch the components or pins, especially the gold fingers on the edge connector.

The Apple II has three deep notches along the back of its case. Temporarily set the PIC down near the desired slot. Then take the clamp assembly and slide it down into a notch near the slot that the PIC will be in.

Grasp the upper corners of the PIC and insert the gold fingers of the edge connector into the slot in the back of the Apple, rear edge first. Gently push the front edge of the card down until it is level and firmly seated. Figure 1-3 shows what the PIC looks like installed in slot #1.

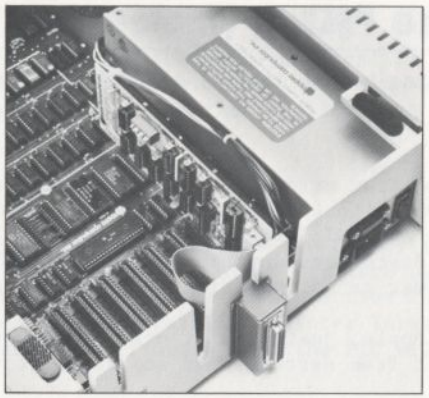


Figure 1-3. PIC in Slot #1 and Clamp Assembly in Notch

Slide the Apple cover in place and press down on the rear corners until the corner fasteners pop into place. The Parallel Interface Card is now installed.

Connector Pin Assignments

The PIC clamp assembly you installed at the back of the Apple has a standard DB-25 connector with 25 pins. Shielded cables with 25-pin connectors on one end are available. If you need help, consult your Apple dealer.

Table 1-3 lists the signal assigned to each pin of the DB-25 connector at the back of the Apple.

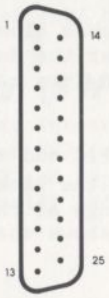
DB-25 Pin#	Signal Name	DB-25 Diagram	Signal Name	DB-25 Pin#
1	Data In, Bit Ø		Data In, Bit 4	14
2	Signal Ground		Strobe Out	15
3	Data In, Bit 2		Acknowledge In	16
4	Signal Ground		Data In, Bit 1	17
5	Data Out, Bit Ø		Data In, Bit 7	18
6	Data Out, Bit 1		Data In, Bit 5	19
7	(blocked)		Signal Ground	2Ø
8	Data Out, Bit 2		Data In, Bit 6	21
9	—		Data Out, Bit 3	22
1Ø	—		Data Out, Bit 4	23
11	Data Out, Bit 5		Signal Ground	24
12	Data Out, Bit 6		Data In, Bit 3	25
13	Data Out, Bit 7			

Table 1-3. DB-25 Connector Pin Assignments

Table 1-4 gives the pin or function on the printer end of each wire for a variety of printers. The letters in parentheses refer to the footnotes at the bottom of the table.

PIC	Printer Connector Pin Assignments					
DB-25 Pins	Centronics 7ØØ/779(a)	Centronics 73Ø/737(b)	Printronix P3ØØ	IDS 44Ø(c)	Epson MX-8Ø/1ØØ	TI 81Ø, C. Itoh 851ØA
1						
2	16,19	27	14	7	19	19
3						
4						
5	2	3	2	14	2	2
6	3	5	3	13	3	3
7	(cable pin 7 must be removed; its hole is blocked on the connector)					
8	4	7	4	12	4	4
9						
1Ø						
11	7	13	7	9	7	7
12	8	15	8	15	8	8
13	9	17	(d)		9(d)	9
14						
15	1	1	1	3	1	1
16	1Ø	19	1Ø	22	1Ø	1Ø
17						
18	18	28	18		35	18
19	12		12	12	12	12
2Ø						
21	13	25	13	4	13	13
22	5	9	5	11	5	5
23	6	11	6	1Ø	6	6
24	16	31	16	7	16	16
25					32	32

(a) Also Anadex 95Ø1, Anadex DP-8ØØØ, Axiom IMP-2, DIP 84, NEC PC-8Ø23A-C, and many other printers that use the "Centronics" standard.
(b) If your Centronics 737 came with a cable from Apple Computer, use the Centronics 779 pin assignments for the cable between the DB-25 and the connector on the printer cable.
(c) Also the IDS 445, 46Ø and 56Ø.
(d) Check device manual: this printer pin may require grounding.

Table 1-4. PIC DB-25 and Printer Connector Pin Assignments

Figure 1-4 shows the main types of connectors you will encounter on parallel printers. Figure 1-5 is a diagram of a sample shielded cable, set up for a Centronics 779 printer.

If you bought a Centronics 737 from an Apple dealer, it came with a cable of its own. In this case you can do one of two things: either use a single DB-25 to 737 cable as described in Table 1-4; or use two cables, a DB-25 to 779 (Table 1-4) connected to the cable that came with the 737 printer.

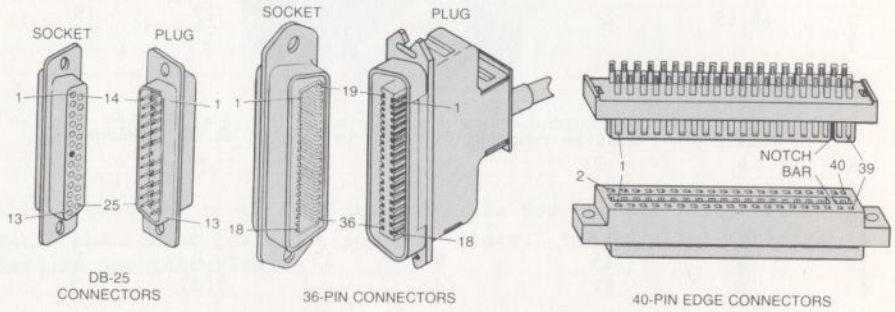


Figure 1-4. Main Types of Connectors on Printer End of Cable

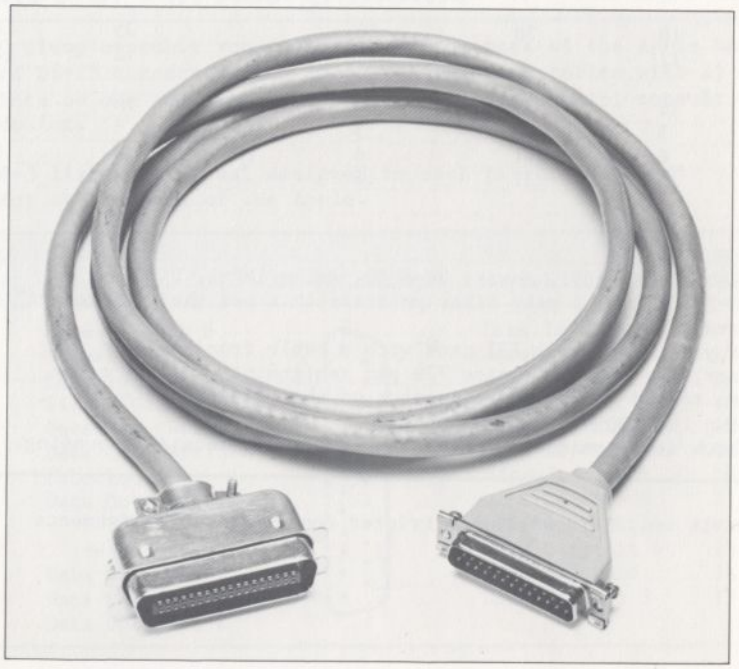


Figure 1-5. A Sample Shielded Cable

Shielding and Grounding Requirements

The cable that connects the Apple computer to the printer must have a built-in shield, with the shield properly terminated at both ends. This is to prevent electromagnetic interference (EMI) to nearby radios, television sets, and communication equipment. You can obtain this type of shielded cable through your Apple dealer, by ordering Apple Part Number 59Ø-ØØ42.

Proper shielding is necessary for the system to comply with Class B Federal Communications Commission limits as defined by Subpart J of Part 15 of the FCC rules. The shield must terminate at and be connected to the back of the Apple. A shielded cable brought into the Apple will not be effective for EMI suppression. Unshielded cables are not recommended.

Make sure that all devices are connected to the same grounded AC power circuit (three-wire wall outlet) as the Apple II. Connecting ungrounded equipment to your Apple II may cause severe electrical damage.

Chapter 2

Running a Printer Via the PIC

In the explanations that follow, s is the number of the slot in which you have installed the PIC; <CTRL-keyname> means "hold down the key marked CTRL or CONTROL while pressing the key called keyname"; <RETURN> denotes the RETURN key, and so forth.

Turning the PIC On and Off

You can turn the PIC on from the keyboard when in monitor mode (which you can get to from BASIC by a CALL -151; prompt character is "*") with the command

```
s<CTRL-P><RETURN>
```

(PIC is in slot s), and turn it off with the command

```
Ø<CTRL-P><RETURN>
```

You can turn on the PIC when in DOS or BASIC with the command

```
PR#s <RETURN>
```

which turns on the PIC. All subsequent output will go to the printer as well as to the screen.

When you use the command

```
PR#Ø <RETURN>
```

all subsequent output will go to the screen only.

Pascal automatically turns on the PIC as needed. To send a file to the printer in the Pascal Operating System, use one of the two forms of the T(ransfer command:

```
T(ransfer filename,PRINTER:    or
T(ransfer filename,#6:
```

PIC Commands

Commands to modify PIC firmware values have the form:

<CTRL-I> <command> <RETURN>

In the case of the Change Line Width (<n>N) command, there is also a number before the command indicating the new line width to use.

Each command must be preceded by <CTRL-I> (or another control character; see next paragraph) and followed by <RETURN>. The character <CTRL-I> is the same as ASCII code 9 (Appendix B).

You can change <CTRL-I> to any other control character from <CTRL-A> through <CTRL-Z> by simply typing <CTRL-I> followed by the new control character; typing the two in reverse order changes it back. For example, typing <CTRL-I><CTRL-Q> changes the control character to <CTRL-Q>; typing <CTRL-Q><CTRL-I> changes it back. This is useful if you want to list on the printer a program that contains <CTRL-I>.

You can type in these commands at the keyboard or embed them in programs. Here is an example of their use in a BASIC PRINT statement:

```
10Ø  I$=""            :REM DEFINE <CTRL-I>
11Ø  D$=""            :REM DEFINE <CTRL-D>
12Ø  PRINT D$;"PR#1"
13Ø  PRINT I$;"8ØN"
```

Change Line Width (<n>N)

The <n>N command changes the number of characters printed per line from its current value to the one specified by <n>. Legal values of <n> range from 4Ø through 255. The default line width is 4Ø. This command also turns off the video display. For example, to print data on an 8Ø-column printer, type in

<CTRL-I>8ØN<RETURN>

Restore Video Display (I)

The I command restores the video display as the output device, and changes the line width back to 4Ø.

Toggle the Linefeed Switch (K)

The K command causes the PIC to suppress linefeed characters normally sent to the printer after each carriage return character. Type the command again, and the PIC will resume sending all linefeeds.

Some printers don't print out a line until they receive the linefeed character. Turning off linefeed may cause some printers to stop printing altogether.

Here is a BASIC program that sets the printer width to 132, prints a line on the printer only, and then prints another line on both the screen and the printer. Notice that the line width is reset to 4Ø when output to the screen is turned back on.

```
1Ø   PR#1                :REM  TURN ON PIC IN SLOT 1
2Ø   I$ = ""             :REM  SET I$ TO CONTROL-I
3Ø   PRINT I$;"132 N"    :REM  SET LINE WIDTH TO 132
4Ø                        REM  ALSO TURNS OFF SCREEN
5Ø   PRINT "THIS LINE PRINTS ON THE PRINTER ONLY"
6Ø   PRINT I$;"I"        :REM  RESTORE VIDEO, 4Ø COLUMNS
7Ø   PRINT "THIS LINE PRINTS ON THE PRINTER AND SCREEN"
8Ø   PR#Ø                :REM  TURN THE CARD OFF
9Ø   END
```

Command Summary

Table 2-1 summarizes the commands that control the PIC, and indicates the operating environments in which they are available. All commands (except the first two) are followed by a carriage return.

Command	Command Name	Environment	Effect
s<CTRL-P>	Set Output Register	Monitor ROM Autostart ROM	Send output to slot s
Ø<CTRL-P>	Set Output Register	Monitor ROM Autostart ROM	Send output to Apple video screen (slot Ø)
PR#s	PRint	DOS/BASIC	Send output to printer (with PIC in slot s)
PR#Ø	PRint	DOS/BASIC	Send output to slot Ø (that is, disable printer)
T(ransfer filename,#6: or ,PRINTER:	Transfer	Pascal Op Sys	Transfer file to printer (PIC in slot 1)
<n>N	Change Line Width	BASIC	Turn off video and set line width to n (4Ø-255)
I	Restore Video Display	BASIC	Turn on video and set line width to 4Ø
K	Toggle Line-feed Switch	BASIC	Suppress/send linefeeds after carriage returns

Table 2-1. PIC Command Summary

Operating Hints

These three techniques will help you avoid the most common printing problems:

1. In BASIC programs, issue a HOME command, and a CALL -936 (to clear the screen) before issuing a PR#1 staement to use the printer.

2. If you are printing more than 4Ø characters per line, be sure to reset the line length to 4Ø characters before turning off the PIC with the PR#Ø statement.

3. To list a program that has printer control commands (<CTRL-I>) embedded in it, change the control character to <CTRL-somethingelse> before listing the program, and change the control character back to <CTRL-I> afterward.

Chapter 3

General-Purpose Input/Output

The Apple II PIC has circuitry that allows it to pass 8-bit parallel input and output to and from the Apple II without the intervention of firmware. Thus the PIC can function as a general-purpose I/O port. The control addresses for the PIC reside in the Peripheral I/O space (Appendix A). If data is stored at location $CØ8Ø+sØ (where s is the slot where the PIC is), then the data will appear on Data Out lines Ø through 7, and will remain until the next STORE instruction to $CØ8Ø+sØ is executed. For example, in BASIC use

```
POKE (-16256-(s*16)),outputbyte
```

to send a byte of output to the attached device.

Table 3-1, on the next page, gives the PEEK and POKE addresses to use in BASIC for direct execution of PIC functions.

Desired Action:	PIC is in Slot: 1	2	3	4	5	6	7
Load output port ($C08Ø+sØ)	-1624Ø	-16224	-162Ø8	-16192	-16176	-1616Ø	-16144
Send a strobe ($C082+sØ)	-16238	-16222	-162Ø6	-1619Ø	-16174	-16158	-16142
Read input port ($C083+sØ)	-16237	-16221	-162Ø5	-16189	-16173	-16157	-16141
Look at ACK ($C084+sØ)	-16236	-1622Ø	-162Ø4	-16188	-16172	-16156	-1614Ø
Enable IRQ ($C086+sØ)	-16234	-16218	-162Ø2	-16186	-1617Ø	-16154	-16138
Disable IRQ & autostrobe ($C087+sØ)	-16233	-16217	-162Ø1	-16185	-16169	-16153	-16137

Table 3-1. PEEK and POKE Addresses

Chapter 4

Theory of Operation

While reading this section, refer to the block diagram (Figure 4-1) or to the PIC schematic diagram in Appendix B.

All functions on the PIC except for reading the firmware are controlled by the 74LS138 address decoder. This decoder allows the direct performance of the following functions:

- loading a byte into the output port
- sending a 1- to 15-microsecond strobe
- receiving a byte at the input port
- looking at the acknowledge signal and flip-flop
- enabling interrupt requests (if SW7 is also ON)
- disabling interrupt requests and the autostrobe

Although all PIC functions can be controlled directly, in normal printer operation the PROM firmware controls the card. The 512-by-8-bit PROM contains the code sets used in the Apple II Centronics Printer Card and Parallel Printer Card, both of which the PIC replaces. Once the user has selected the code set to use (SW6), the card performs exactly like one of those two earlier Apple products. The code is in the same place, and the PROM remapping functions operate in the same way. To make this possible, the PIC has built into it an autostrobe feature. This feature is enabled when the PROM code is accessed (I/O Select) and automatically generates a slightly delayed strobe output pulse whenever the output port is loaded with data. The autostrobe feature can be disabled by a system reset or via the decoder address $CØ87+sØ.

Interrupt capability is provided by the card for future software enhancements. This capability is disabled by a system reset, by setting SW7 OFF, or via decoder address $CØ87+sØ. Current Apple II system software does not process interrupts.

Output data is latched into the 74LS273 register by writing to address $CØ8Ø+sØ (the same address as used in the two earlier Apple II cards). The output drive capability of this register is limited to about 8 mA at Ø.5 volts. More drive can be provided if an LS374 is used. However, an LS374 requires more DC current, and is not

required for driving most printers. If you substitute an LS374 line driver, solder patch the pin 1 location by cutting the bowtie labelled "X4" and soldering the bridge labelled "X3" (both at location 8A on the PIC).

Input data is read from an LS244 bus interface driver. Pullup resistors are provided on all input data lines to accomodate those printers that drive data lines from open collector outputs.

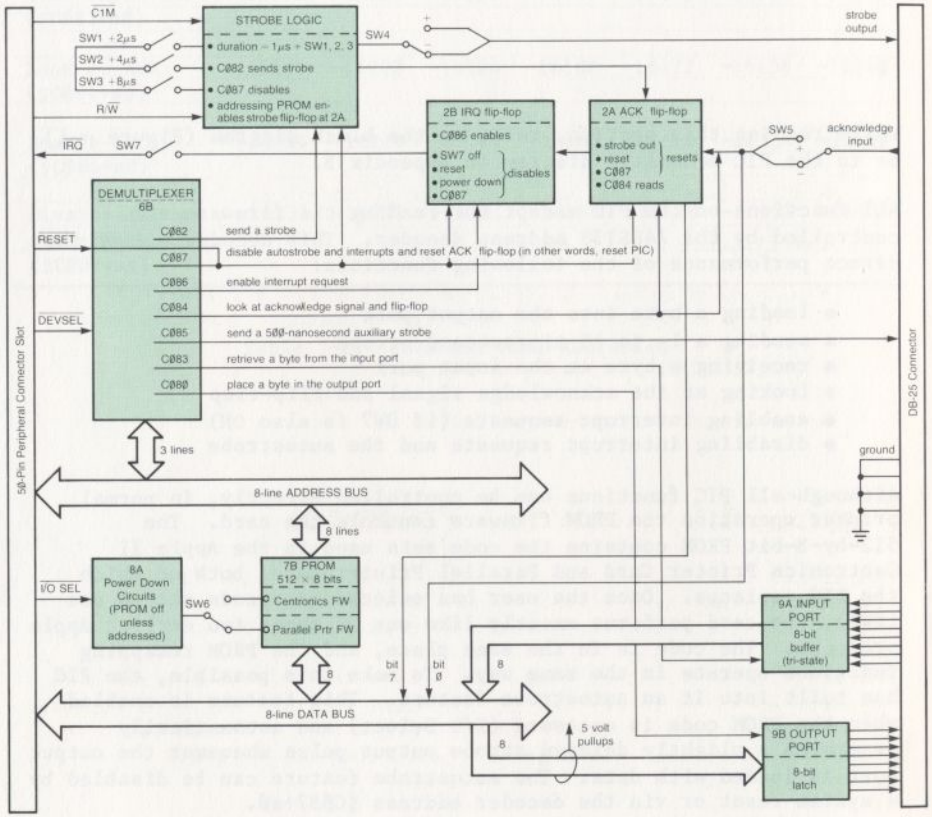


Figure 4-1. Block Diagram of PIC

Appendix A

PIC Firmware

This appendix contains the following information:

- an explanation of the Pascal 1.1 firmware card protocol
- a firmware memory map
- a description of the registers in the PIC's peripheral I/O space (the 16 bytes starting at address $CØ8Ø+sØ)
- a list of the firmware entry points
- the actual PIC firmware listings

Pascal 1.1 Firmware Protocol

Pascal 1.Ø will "accept" user-written peripheral card firmware if the firmware has hexadecimal value $38 at $CsØ5 and $18 at $CsØ7. This version of Pascal uses fixed address entry points.

Pascal 1.1, on the other hand, has a more flexible setup, and also supports more I/O functions. It can make indirect calls to firmware in a (new) peripheral card through addresses in a branch table in the card's firmware. It also has facilities for uniquely identifying new peripheral I/O devices.

I/O Routine Entry Points

The I/O routine entry point branch table is located near the beginning of the CsØØ address space (s being the slot number where the peripheral card is installed). This space was chosen instead of the $C8ØØ space, since under BASIC protocol the $CsØØ space is required, while the $C8ØØ space is optional.

The branch table locations that Pascal 1.1 uses are given in Table A-1.

Address	Contains
$CsØD	initialization routine offset (required)
$CsØE	read routine offset (required)
#CsØF	write routine offset (required)
$Cs1Ø	status routine offset (required)
$Cs11	$ØØ if optional offsets follow; non-zero if not
$Cs12	control routine offset (optional)
$Cs13	interrupt handling routine offset (optional)

Table A-1. Pascal 1.1 Branch Table

Notice that $Cs11 contains $ØØ only if the control and interrupt handling routines are supported by the firmware. Apple II Pascal 1.Ø and 1.1 do not support control and interrupt requests, but such requests may be implemented in future versions of the Pascal BIOS and other future Apple II operating systems.

Table A-2 gives the entry point addresses, and the contents of the 65Ø2 registers on entry to and on exit from Pascal 1.1 I/O routines:

Addr.	Offset for	X Register	Y Register	A Register
$CsØD	Initialization			
	On entry	$Cs	$sØ	
	On exit	error code	(unchanged)	(unchanged)
$CsØE	Read			
	On entry	$Cs	$sØ	
	On exit	error code	(unchanged)	character read
$CsØF	Write			
	On entry	$Cs	$sØ	character to write
	On exit	error code	(unchanged)	(unchanged)
$Cs1Ø	Status			
	On entry	$Cs	$sØ	request (Ø or 1)
	On exit	error code	(changed)	(unchanged)
Notes:	Request code Ø means, "Are you ready to accept output?"			
	Request code 1 means, "Do you have input ready?"			
	On exit, the reply to the status request is in the carry bit: carry clear means "No"; carry set means "Yes".			

Table A-2. I/O Routine Offsets and Registers under Pascal 1.1

Device Identification

Pascal 1.1 uses four firmware bytes to identify the peripheral card. Both the identifying bytes and the branch table are near the beginning of the $CsØØ ROM space (Table A-3).

Address	Value
$CsØ5	$38
$CsØ7	$18
$CsØB	$Ø1 (the Generic Signature of new firmware cards)
$CsØC	$ci (the Device Signature; see below)

Table A-3. Pascal 1.1 Peripheral Card Identifiers

The first digit, c, of the Device Signature byte identifies the device class (Table A-4).

Digit	Class
$Ø	reserved
$1	printer
$2	joystick or other X-Y input device
$3	serial or parallel I/O card
$4	modem
$5	sound or speech device
$6	clock
$7	mass storage device
$8	8Ø-column card
$9	network or bus interface
$A	special purpose (none of the above)
$B-F	reserved for future expansion

Table A-4. Device Class Digit of Device Signature

The second digit, i, of the Device Signature byte is a unique identifier for the card, assigned by Apple Technical Support.

Although version 1.1 of Pascal ignores Device Signatures, applications programs can use them to identify specific devices.

PIC Firmware Memory Usage

Table A-5 is an overall map of the locations that the PIC uses, both in the Apple and in the PIC's own fimware address space. PIC memory usage is simple and straightforward. The letter s denotes slot s in the Apple.

You can access the PIC firmware for direct output by presetting the fields MSTRT, MODE, ESCHAR and FLAGS (see Table A-5), and then entering the firmware once at $CsØØ. (The normal entry point is $CsØ2.) Data in the accumulator is transmitted on the data lines with a strobe pulse when the responding device is ready.

Addresses	Name of area	Contents
$ØØØØ-$ØØFF	Page Zero	I/O hooks:
$24	CH	Cursor horizontal index
$36	CSWL	BASIC output hook (not for Pascal)
$Ø4xx-$Ø7xx (selected locations)	Peripheral Slot Scratchpad RAM	Locations (8 per slot) in Apple's pages $Ø4 through $Ø7. PIC uses six of them:
$578+s	PWDTH	Printer width
$5F8+s	MSTRT	Margin start
$678+s	MODE	Escape sequence indicator in bit 7 (determines whether firmware exits by RTS or JMP COUT1)
$6F8+s	ESCHAR	Current escape character (CTRL-I)
$778+s	FLAGS	Flags: bit 7 = "video also" bit Ø = <CR> <LF>
$7F8+s	COL	Current column count
$CØ(8+s)Ø - $CØ(8+s)F	Peripheral Card I/O Space	Locations (16 per slot) for general I/O; PIC uses 7 bytes (Table A-6)
$CsØØ-$CsFF	Peripheral Card ROM Space	One 256-byte page reserved for the firmware of card in slot s; SW6 selects FW (Table 1-2); remapped:
$CsØØ-$Cs3F		Mapped into addresses $Cs4Ø-$Cs7F
$Cs4Ø-$Cs7F		Mapped into addresses $CsØØ-$Cs3F
$Cs8Ø-$CsBF		Mapped into addresses $CsCØ-$CsFF
$CsCØ-$CsFF		Mapped into addresses $Cs8Ø-$CsBF
$C8ØØ-$CFFF	Expansion ROM	PIC does not use this space.

Table A-5. PIC Memory Map

Peripheral I/O Space

The PIC, like all other cards inserted in the Apple II, has 16 bytes of Peripheral I/O space allocated to it. These 16 bytes begin at location $CØ8Ø+sØ, where s is the slot the peripheral interface card is in. The PIC uses seven of these bytes, as shown in Table A-6.

Address (+sØ)	Function
$CØ8Ø	Load output port on write; automatically send a strobe if $Csxx space has been previously addressed
$CØ81	Not used
$CØ82	Send a strobe regardless of $CØ8Ø or $Csxx addressing
$CØ83	Read the input port
$CØ84	Read ACK status (bit 6) and ACK flip-flop status (bit 7)
$CØ86	Enable interrupt capability
$CØ87	Disable the interrupt; reset the ACK flip-flop; disable the autostrobe feature

Table A-6. PIC $CØ8x+sØ Addresses

PIC Firmware Listings

This section contains the listings of the two sets of firmware contained in the PIC ROM. Setting SW6 OFF seclects the "Parallel" firmware. Setting SW6 ON selects the "Centronics" firmware. These sets of firmware are identical to the Apple II Parallel Printer Card firmware (Apple Part Number 341-ØØØ5) and the Centronics Printer Card firmware, (Apple Part Number 341-ØØ19), respectively.

Parallel Printer Firmware

```
0000:                    1         ORG  $0
0000:                    2 ********************************
0000:                    3 *  PRINTER CARD I FIRMWARE     *
0000:                    4 *                              *
0000:                    5 *       P1-2  (341-0005)       *
0000:                    6 *                              *
0000:                    7 *     WOZ      11/1/77         *
0000:                    8 *     APPLE COMPUTER INC.      *
0000:                    9 *     ALL RIGHTS RESERVED      *
0000:                   10 *                              *
0000:                   11 *    REVISED   3 / 17 / 1978   *
0000:                   12 *       HUSTON AND SANDER      *
0000:                   13 *                              *
0000:                   14 *  ------------------------    *
0000:                   15 *   P R O M  ADDRESSING        *
0000:                   16 *  ------------------------    *
0000:                   17 *                              *
0000:                   18 *  $CN00.CN3F --> $CN40.CN7F   *
0000:                   19 *  $CN40.CN7F --> $CN00.CN3F   *
0000:                   20 *  $CN80.CNBF --> $CNC0.CNFF   *
0000:                   21 *  $CNC0.CNFF --> $CN80.CNBF   *
0000:                   22 *                              *
0000:                   23 *  ------------------------    *
0000:                   24 *       DEFAULT SETTINGS       *
0000:                   25 *  ------------------------    *
0000:                   26 *                              *
0000:                   27 *   ESCAPE CHARACTER IS CTRL-I  *
0000:                   28 *    VIDEO-ALSO AND CRLF ON    *
0000:                   29 *                              *
0000:                   30 *  ------------------------    *
0000:                   31 *    AFTER  ESCAPE  CHARACTER  *
0000:                   32 *  ------------------------    *
0000:                   33 *                              *
0000:                   34 *  (OPTIONAL SET PRINTER WIDTH) *
0000:                   35 *                              *
0000:                   36 *        I:  SET VIDEO ALSO    *
0000:                   37 *        J:  CLR CRLF, VID-ALSO *
0000:                   38 *        K:  CLR CRLF          *
0000:                   39 *        L:  SET CRLF          *
0000:                   40 *        M:  SET CRLF, VID-ALSO *
0000:                   41 *        N:  CLR VIDEO ALSO    *
0000:                   42 *                              *
0000:                   43 ********************************
0000:                   44 *
0024:                   45 CH      EQU  $24       CURSOR HORIZONTAL INDEX
0036:                   46 CSWL    EQU  $36       LOW ORDER COUT SWITCH BYTE
04B8:                   47 PWDTH   EQU  $4B8      PRINTER WIDTH
0538:                   48 MSTRT   EQU  $538      MARGIN START
05B8:                   49 MODE    EQU  $5B8      AFTER ESC CHAR
0638:                   50 ESCHAR  EQU  $638      CURRENT ESC CHAR
06B8:                   51 FLAGS   EQU  $6B8      B7=VID-ALSO, B0=CRLF
0738:                   52 COL     EQU  $738      COLUMN COUNT
```



```
C080:                   53 DEV     EQU  $0C080    +$N0 ACTIVATES THE DEV LINE
FDF0:                   54 COUT1   EQU  $0FDF0    VIDEO OUTPUT ENTRY
FF58:                   55 IORTS   EQU  $0FF58    FIXED RTS INSTRUCTION
0000:                   56 *
0000:                   57 *
0000:18                 58 ENT0    CLC            DEFAULT ENTRY
0001:B0 FE              59         BCS  *
0002:                   60         ORG  *-1
0002:38                 61 ENT1    SEC            NORMAL ENTRY
0003:48                 62         PHA
0004:8A                 63         TXA
0005:48                 64         PHA
0006:98                 65         TYA
0007:48                 66         PHA
0008:08                 67         PHP
0009:78                 68         SEI             DISABLE INTERRUPTS
000A:20 58 FF           69         JSR  IORTS     RETURNS $CN ABOVE  STACK
000D:BA                 70         TSX
000E:68                 71         PLA
000F:68                 72         PLA
0010:68                 73         PLA
0011:68                 74         PLA
0012:A8                 75         TAY             CHAR TO Y-REGISTER
0013:CA                 76         DEX
0014:9A                 77         TXS             GET $CN FROM ABOVE STACK
0015:68                 78         PLA
0016:28                 79         PLP             RESTORE STATUS
0017:AA                 80         TAX             $CN TO REG X
0018:90 38              81         BCC  DEFAULT
001A:BD B8 05           82         LDA  MODE,X    AFTER ESC CHAR?
001D:10 19              83         BPL  ESCTEST   BRANCH IF NO
001F:98                 84         TYA             CHAR TO REG-A
0020:29 7F              85         AND  #$7F      MASK OUT BIT 7
0022:49 30              86         EOR  #$30      ALTER BITS
0024:C9 0A              87         CMP  #$0A      "0"-"9"?
0026:90 3B              88         BCC  DIG       BRANCH IF YES
0028:C9 78              89         CMP  #$78      "H"-"O"?
002A:B0 29              90         BCS  SETFLG    YES, SET OR CLR FLAGS
002C:49 3D              91         EOR  #$3D      CHECK FOR CARRIAGE RETURN
002E:F0 21              92         BEQ  ESCTST    DON'T CHANGE ESC CHAR IF CR
0030:98                 93         TYA             GET ORIGINAL CHAR AGAIN
0031:29 9F              94         AND  #$9F      MAKE IT A CTRL CHAR
0033:9D 38 06           95         STA  ESCHAR,X  STORE NEW ESC CHAR
0036:90 7E              96         BCC  DONE      BRANCH ALWAYS TAKEN
0038:                   97 *
0038:                   98 *
0038:BD B8 06           99 ESCTEST LDA  FLAGS,X
003B:30 14             100         BMI  ESCTST
003D:A5 24             101         LDA  CH
003F:DD 38 07          102         CMP  COL,X
0042:B0 0D             103         BCS  ESCTST
0044:C9 11             104         CMP  #$11
0046:B0 09             105         BCS  ESCTST
0048:09 F0             106         ORA  #$0F0
```

```
004A:3D 38 07  107          AND  COL,X
004D:65 24     108          ADC  CH
004F:85 24     109          STA  CH
0051:4A        110 ESCTST   LSR  A          MAKE IT POSITIVE
0052:38        111 DEFAULT  SEC
0053:B0 6D     112          BCS  ESCTST1   BRANCH ALWAYS TAKEN
0055:          113 *
0055:          114 *
0055:18        115 SETFLG   CLC
0056:6A        116          ROR  A
0057:3D B8 06  117          AND  FLAGS,X
005A:90 02     118          BCC  SETFLG1
005C:49 81     119          EOR  #$81
005E:9D B8 06  120 SETFLG1  STA  FLAGS,X
0061:D0 53     121          BNE  DONE
0063:          122 *
0063:          123 *
0063:A0 0A     124 DIG      LDY  #$0A
0065:7D 38 05  125 DLOOP    ADC  MSTRT,X   ADD 10*MSTRT TO DIG AND STORE
0068:88        126          DEY             IN PRINTER WIDTH (MARGIN)
0069:D0 FA     127          BNE  DLOOP
006B:9D B8 04  128          STA  PWDTH,X
006E:9D 38 05  129 MINIT    STA  MSTRT,X   UPDATE MARGIN START
0071:38        130          SEC             INDICATE 'AFTER ESC CHAR'
0072:B0 43     131          BCS  DONE1     BRANCH ALWAYS
0074:          132 *
0074:          133 *
0074:          134 VIDEO    EQU  *         MUST KEEP CURSOR HORIZ.
0074:C5 24     135          CMP  CH        IN RANGE OF PRWDTH
0076:90 3A     136          BCC  SETCH     BRANCH IF >40
0078:68        137          PLA
0079:A8        138          TAY
007A:68        139          PLA
007B:AA        140          TAX             RESTORE REGISTERS AND
007C:68        141          PLA             END WITH VIDEO OUT
007D:4C F0 FD  142          JMP  COUT1
0080:          143 *
0080:          144 *
0080:          145          ORG  ENT0+$80
0080:90 FE     146          BCC  *         IMAGE 'WAIT FOR READY'
0082:B0 FE     147          BCS  *         IMAGE (ESCTST & DEFAULT)
0084:          148 *
0084:          149 *
0084:          150 *
0084:          151 *
0084:99 80 C0  152 OUT      STA  DEV,Y     OUTPUT CHAR TO PRINTER
0087:90 37     153          BCC  PRNT      LOOP IF WAS TAB
0089:49 07     154          EOR  #$7       IF CR, MAKE IT LF
008B:A8        155          TAY             COPY TO REG,Y
008C:49 0A     156          EOR  #$0A
008E:0A        157          ASL  A         CARRIAGE RETURN IN 7 LSB'S?
008F:D0 06     158          BNE  FINISH    BRANCH IF NOT CR
0091:B8        159          CLV             INDICATE THAT IT WAS CR
0092:85 24     160          STA  CH        RESET CURSOR HORIZ.
```



```
0094:9D 38 07  161          STA  COL,X     CLEAR COLUMN COUNT
0097:BD B8 06  162 FINISH   LDA  FLAGS,X   FOR CRLF CHECK (BIT 0)
009A:4A        163          LSR  A
009B:70 02     164          BVS  FINISH1   BRANCH IF LAST CHAR NOT CR
009D:B0 23     165          BCS  ESCTST1
009F:0A        166 FINISH1  ASL  A         CHECK HI ORDER BIT OF FLAGS
00A0:0A        167          ASL  A
00A1:A9 27     168          LDA  #$27      LOADED JUST FOR VIDEO MODE
00A3:B0 CF     169          BCS  VIDEO
00A5:BD 38 07  170          LDA  COL,X     CHECK FOR WITHIN 8 CHARS
00A8:FD B8 04  171          SBC  PWDTH,X   OF PRINTER WIDTH
00AB:C9 F8     172          CMP  #$0F8
00AD:90 03     173          BCC  SETCH     IF NO, THEN DONE
00AF:69 27     174          ADC  #$27      ADD 32 (FORMING 32-39)
00B1:AC 58 FF  175          LDY  IORTS     DUMMY LDY ABSOLUTE
00B2:          176          ORG*-2
00B2:A9 00     177 SETCH    LDA  #$0
00B4:85 24     178          STA  CH
00B6:18        179 DONE     CLC
00B7:7E B8 05  180 DONE1    ROR  MODE,X
00BA:68        181          PLA
00BB:A8        182          TAY
00BC:68        183          PLA
00BD:AA        184          TAX
00BE:68        185          PLA
00BF:60        186          RTS
00C0:          187 *
00C0:          188 *
00C0:          189          ORG  ENT0+$0C0
00C0:90 27     190 PRNT     BCC  PRNT1     TAKEN WHEN PRINTER READY
00C2:B0 00     191 ESCTST1  BCS  *+2
00C4:10 11     192          BPL  ESCTST2
00C6:          193 *
00C6:          194 *
00C6:A9 89     195          LDA  #$89      DEFAULT CHARACTER (CONTROL-I)
00C8:9D 38 06  196          STA  ESCHAR,X
00CB:9D B8 06  197          STA  FLAGS,X   VIDEO ALSO, CRLF ON
00CE:A9 28     198          LDA  #$28
00D0:9D B8 04  199          STA  PWDTH,X
00D3:A9 02     200          LDA  #>ENT1
00D5:85 36     201          STA  CSWL      SET FOR NORMAL ENTRY
00D7:98        202 ESCTST2  TYA             MOVE CHAR TO REG-A
00D8:5D 38 06  203          EOR  ESCHAR,X
00DB:0A        204          ASL  A         ESC CHAR? (7LSB'S)
00DC:F0 90     205          BEQ  MINIT     BRANCH IF YES
00DE:5E B8 05  206          LSR  MODE,X    NO, CLR 'AFTER ESC CHAR'
00E1:98        207          TYA
00E2:48        208          PHA             SAVE CHAR ON THE STACK
00E3:8A        209          TXA
00E4:0A        210          ASL  A
00E5:0A        211          ASL  A         GENERATE N*$10 AS AN INDEX TO
00E6:0A        212          ASL  A           THE DEVICE LINE (REG-Y)
00E7:0A        213          ASL  A
00E8:A8        214          TAY
```

```
00E9:BD 38 07  215 PRNT1   LDA  COL,X
00EC:C5 24     216         CMP  CH        IF COLUMN>= CURSOR HORIZ
00EE:68        217         PLA             THEN USE CHAR
00EF:B0 05     218         BCS  CTLTST
00F1:48        219         PHA
00F2:29 80     220         AND  #$80      ELSE GEN BLANK (7 LSB'S)
00F4:09 20     221         ORA  #$20        FOR TAB CATCH-UP
00F6:2C 58 FF  222 CTLTST  BIT  IORTS
00F9:F0 03     223         BEQ  PRNT2     INCR COLUMN COUNT
00FB:FE 38 07  224         INC  COL,X       IF NOT A CONTROL CHAR
00FE:70 84     225 PRNT2   BVS  OUT       TAKEN WHEN PRINTER READY

SYMBOL TABLE    SORTED BY SYMBOL

  24 CH          0738 COL          FDF0 COUT1          36 CSWL
  F6 CTLTST        52 DEFAULT      C080 DEV            63 DIG
  65 DLOOP         B7 DONE1          B6 DONE           00 ENT0
  02 ENT1        0638 ESCHAR         38 ESCTEST        C2 ESCTST1
  51 ESCTST        D7 ESCTST2        9F FINISH1        97 FINISH
06B8 FLAGS       FF58 IORTS          6E MINIT        05B8 MODE
0538 MSTRT         84 OUT            E9 PRNT1          C0 PRNT
  FE PRNT2       04B8 PWDTH          B2 SETCH          5E SETFLG1
  55 SETFLG        74 VIDEO

SYMBOL TABLE    SORTED BY ADDRESS

  00 ENT0          02 ENT1           24 CH             36 CSWL
  38 ESCTEST       51 ESCTST         52 DEFAULT        55 SETFLG
  5E SETFLG1       63 DIG            65 DLOOP          6E MINIT
  74 VIDEO         84 OUT            97 FINISH         9F FINISH1
  B2 SETCH         B6 DONE           B7 DONE1          C0 PRNT
  C2 ESCTST1       D7 ESCTST2        E9 PRNT1          F6 CTLTST
  FE PRNT2       04B8 PWDTH        0538 MSTRT        05B8 MODE
0638 ESCHAR      06B8 FLAGS        0738 COL          C080 DEV
FDF0 COUT1       FF58 IORTS
```


Centronics Printer Firmware

```
0000:          ORG  $0
0000:  ********************************
0000:  *   PRINTER II FIRMWARE        *
0000:  *  INTELLIGENT INTERFACE       *
0000:  *                              *
0000:  *        P9-00  (341-0019)     *
0000:  *                              *
0000:  *    J.R. HUSTON  7/13/78      *
0000:  *                              *
0000:  *     APPLE COMPUTER INC.      *
0000:  *     ALL RIGHTS RESERVED      *
0000:  *  ---------------------------- *
0000:  *    P R O M   ADDRESSING      *
0000:  *  ---------------------------- *
0000:  *                              *
0000:  *   $CN00.CN3F --> $CN40.CN7F  *
0000:  *   $CN40.CN7F --> $CN00.CN3F  *
0000:  *   $CN80.CNBF --> $CNC0.CNFF  *
0000:  *   $CNC0.CNFF --> $CN80.CNBF  *
0000:  *                              *
0000:  *  ---------------------------- *
0000:  *       DEFAULT SETTINGS       *
0000:  *  ---------------------------- *
0000:  *                              *
0000:  *  ESCAPE CHARACTER IS CTRL-I  *
0000:  *   PRINT/VIDEO SET 40 COLUMNS *
0000:  *         VIDEO IS ENABLED     *
0000:  *                              *
0000:  *  ---------------------------- *
0000:  *  AFTER  ESCAPE  CHARACTER    *
0000:  *  ---------------------------- *
0000:  *                              *
0000:  *  (OPTIONAL SET PRINTER WIDTH) *
0000:  *                              *
0000:  *     N:  SET NO VIDEO MODE    *
0000:  *     O:  SET VIDEO ON MODE    *
0000:  *                              *
0000:  * SETTING NO VIDEO MODE SENDS  *
0000:  *  80 COLUMN MODE CHARACTER TO *
0000:  *  PRINTER (CENTRONICS MICRO)  *
0000:  *                              *
0000:  *  ---------------------------- *
0000:  *                              *
0000:  *  NOTE ALL REGISTERS ARE      *
0000:  *   RESTORED TO THEIR ORIGINAL *
0000:  *   VALUES ON EXIT             *
0000:  *                              *
0000:  ********************************
0000:  *
0024:  CH      EQU  $24      CURSOR HORIZONTAL INDEX
0036:  CSWL    EQU  $36      LOW ORDER COUT SWITCH BYTE
04B8:  PWDTH   EQU  $4B8     PRINTER WIDTH
```

```
0538:            53 MSTRT   EQU  $538       MARGIN START
05B8:            54 MODE    EQU  $5B8       AFTER ESC CHAR
0638:            55 ESCHR   EQU  $638       CURRENT ESC CHAR
06B8:            56 FLAGS   EQU  $6B8       B7=VID-ALSO, B0=CRLF
0738:            57 COL     EQU  $738       COLUMN COUNT
C080:            58 DEV     EQU  $0C080     +$N0 ACTIVATES DEV LINE
FDED:            59 COUT    EQU  $0FDED     CHARACTER OUT ROUTINE
FDF0:            60 COUT1   EQU  $0FDF0     VIDEO OUT ROUTINE
FF58:            61 IORTS   EQU  $0FF58     FIXED RTS INSTRUCTION
0000:            62 *
0000:            63 *
0000:18          64         CLC             DEFAULT ENTRY
0001:B0 FE       65         BCS  *
0002:            66         ORG  *-1
0002:38          67 ENT1    SEC             NORMAL ENTRY
0003:48          68         PHA
0004:8A          69         TXA
0005:48          70         PHA               SAVE REGISTERS ON STACK
0006:98          71         TYA
0007:48          72         PHA
0008:08          73         PHP
0009:78          74         SEI              DISABLE INTERRUPTS
000A:20 58 FF    75         JSR  IORTS      RETURNS $CN ABOVE STACK
000D:BA          76         TSX
000E:68          77         PLA
000F:68          78         PLA
0010:68          79         PLA
0011:68          80         PLA
0012:A8          81         TAY              CHAR TO Y-REGISTER
0013:CA          82         DEX
0014:9A          83         TXS              GET $CN FROM ABOVE STACK
0015:68          84         PLA              RECOVER $CN (SLOT HI ADDR)
0016:AA          85         TAX              $CN TO REG X
0017:28          86         PLP
0018:B0 19       87         BCS  NOTDF      BRANCH ON NORMAL ENTRY
001A:A9 89       88         LDA  #$89       SET DEFAULT CONDITIONS
001C:9D 38 06    89         STA  ESCHR,X    ESC CHARACTER IS CONTROL-I
001F:9D B8 06    90         STA  FLAGS,X    MAKE VIDEO ALSO MODE
0022:A9 28       91         LDA  #$28       DECIMAL 40
0024:9D B8 04    92         STA  PWDTH,X    ESTABLISH PRINTER WIDTH
0027:9D B8 05    93         STA  MODE,X     CLEAR 'AFTER ESC' MODE
002A:A9 02       94         LDA  #>ENT1      CHANGE COUT VECTOR TO
002C:85 36       95         STA  CSWL         NORMAL ENTRY POINT
002E:A9 9E       96         LDA  #$9E       SET PRINTER TO 40 COLUMNS
0030:20 ED FD    97         JSR  COUT       (MICROPRINTER ONLY)
0033:            98 *
0033:BD B8 05    99 NOTDF   LDA  MODE,X     CHECK FOR 'AFTER ESC CHAR'
0036:10 27      100         BPL  ESTST      BR IF NOT 'AFTER ESC' MODE
0038:98         101         TYA              GET CHARACTER
0039:29 7F      102         AND  #$7F       CHECK FOR DIGIT
003B:49 30      103         EOR  #$30
003D:C9 0A      104         CMP  #$0A       IS IT A DIGIT?
003F:90 29      105         BCC  DIGIT      YES, SET VIDEO MODE
0041:C9 7E      106         CMP  #$7E       IS IT A 'N' OR 'O'?
```



```
0043:B0 0F      107         BCS  SETFG      YES, SET VIDEO MODE
0045:49 3D      108         EOR  #$3D       IS IT A CARRIAGE RETURN?
0047:F0 13      109         BEQ  CLRMD      YES, OUTPUT IT
0049:98         110         TYA              GET ORIGINAL CHARACTER AGAIN
004A:2C 58 FF   111         BIT  IORTS      IF IT IS A CONTROL CHARACTER
004D:D0 66      112         BNE  DONE       THEN SAVE AS NEW 'ESC' CHAR
004F:9D 38 06   113         STA  ESCHR,X    OTHERWISE, IGNORE IT
0052:90 61      114         BCC  DONE       BRANCH ALWAYS TAKEN
0054:           115 *
0054:4A         116 SETFG   LSR  A          TRANSFER BIT 0 OF ACCUM TO
0055:7E B8 06   117         ROR  FLAGS,X    BIT 7 OF 'FLAGS'
0058:30 5B      118         BMI  DONE       BRANCH IF VIDEO ON MODE
005A:A0 1D      119         LDY  #$1D       SET PRINTER TO 80 COLUMNS
005C:9D B8 05   120 CLRMD   STA  MODE,X     CLEAR 'AFTER ESC' MODE
005F:38         121 ESTST   SEC
0060:B0 5E      122         BCS  ESCT1      BRANCH ALWAYS TAKEN
0062:           123 *
0062:68         124 VIDEO   PLA
0063:A8         125         TAY
0064:68         126         PLA              RESTORE REGISTERS
0065:AA         127         TAX
0066:68         128         PLA
0067:4C F0 FD   129         JMP  COUT1      END WITH VIDEO OUT
006A:           130 *
006A:           131 *
006A:A0 0A      132 DIGIT   LDY  #$0A       LAST*10+NEW
006C:7D 38 05   133 DLOOP   ADC  MSTRT,X
006F:88         134         DEY
0070:D0 FA      135         BNE  DLOOP
0072:9D B8 04   136         STA  PWDTH,X    SAVE UPDATED PRINTER WIDTH
0075:9D 38 05   137 MINIT   STA  MSTRT,X    SAVE AS LAST TOTAL
0078:38         138         SEC
0079:B0 3B      139         BCS  DONE1      INDICATE  'AFTER ESC' MODE
007B:4A 52 48   140         DCI  'JRHM'
007E:CD
007E:           141         ORG  *-1
007E:07 78      142         DFB  $07,$78
0080:           143 *
0080:           144 *
0080:B0 FE      145         BCS  *          IMAGE FOR ESCTST1
0082:90 FE      146         BCC  *          IMAGE FOR PRNT1
0084:           147 *
0084:           148 *
0084:68         149 OUT     PLA              GET CHARACTER TO BE OUTPUT
0085:2C 58 FF   150 CTRL    BIT  IORTS      CHECK FOR CONTROL CHAR
0088:F0 03      151         BEQ  OUT1       DON'T COUNT CONTROL CHAR
008A:FE 38 07   152         INC  COL,X      UPDATE COLUMN COUNT
008D:08         153 OUT1    PHP
008E:99 80 C0   154         STA  DEV,Y      OUTPUT TO PRINTER
0091:49 8D      155         EOR  #$8D       IS IT A CARRIAGE RETURN
0093:0A         156         ASL  A          CHECK ONLY 7 LOW BITS
0094:D0 05      157         BNE  FINISH     BRANCH IF IT WASN'T CR
0096:85 24      158         STA  CH         RESET COUNTERS
0098:9D 38 07   159         STA  COL,X
```

```
009B:28          160 FINISH  PLP             IF CARRY CLEAR
009C:90 24       161         BCC   PRNT        OUTPUT ANOTHER CHAR
009E:BD B8 06    162         LDA   FLAGS,X    TEST FOR VIDEO MODE
00A1:0A          163         ASL   A
00A2:B0 BE       164         BCS   VIDEO      BRANCH IF B7 OF FLAGS=1
00A4:BD 38 07    165         LDA   COL,X      CHECK FOR WITHIN 8 CHARS OF
00A7:FD B8 04    166         SBC   PWDTH,X    PRT WIDTH FOR BASIC LISTINGS
00AA:C9 F8       167         CMP   #$0F8      WITHIN 8 CHARACTERS?
00AC:90 03       168         BCC   SETCH      NO, RESET CURSOR HORIZONTAL
00AE:69 27       169         ADC   #$27       YES, FORM 32-39 SO BASIC WILL
00B0:AC          170         DFB   $0AC       FORMAT OUTPUT (DUMMY LDY ABS)
00B1:A9 00       171 SETCH   LDA   #0          ON NO VIDEO, KEEP CURSOR AT 0
00B3:85 24       172         STA   CH         SAVE CALC'D CURSOR POSITION
00B5:18          173 DONE    CLC              IND. NOT 'AFTER ESC' MODE
00B6:7E B8 05    174 DONE1   ROR   MODE,X     UPDATE MODE
00B9:68          175         PLA
00BA:A8          176         TAY
00BB:68          177         PLA
00BC:AA          178         TAX              RESTORE REGISTERS
00BD:68          179         PLA
00BE:60          180         RTS              RETURN DIRECTLY
00BF:EA          181         NOP
00C0:            182 *
00C0:            183 *
00C0:B0 02       184 ESCT1   BCS   TEST       WHEN PRINTER READY (NORMAL)
00C2:90 28       185 PRNT    BCC   PRNT1      WHEN PRINTER READY (TAB)
00C4:            186 *
00C4:            187 *
00C4:BD B8 06    188 TEST    LDA   FLAGS,X    CHECK VIDEO STATUS
00C7:30 14       189         BMI   TEST1      BRANCH IF VIDEO ON
00C9:A5 24       190         LDA   CH         TEST FOR COMMA FUNCTION
00CB:DD 38 07    191         CMP   COL,X
00CE:B0 0D       192         BCS   TEST1      BRANCH IF NO TAB
00D0:C9 11       193         CMP   #$11
00D2:B0 09       194         BCS   TEST1      BRANCH IF NOT COMMA FUNCTION
00D4:09 F0       195         ORA   #$0F0      DO MOD 16 ON CURSOR POSTION
00D6:3D 38 07    196         AND   COL,X      SO IT FUNCTS WITH APPLESOFT
00D9:65 24       197         ADC   CH           AND INTEGER BASIC
00DB:85 24       198         STA   CH         UPDATE CURSOR HORIZONTAL
00DD:98          199 TEST1   TYA                GET CHARACTER AND TEST FOR
00DE:5D 38 06    200         EOR   ESCHR,X    'ESC' CHARACTER
00E1:0A          201         ASL   A          (LOWER 7 BITS ONLY)
00E2:F0 91       202         BEQ   MINIT      BRANCH ON 'ESC'CHARACTER
00E4:98          203         TYA
00E5:48          204         PHA              SAVE IT WHILE CALCULATING $NO
00E6:8A          205         TXA              GET $CN
00E7:0A          206         ASL   A
00E8:0A          207         ASL   A          SHIFT IT LEFT 4 BITS
00E9:0A          208         ASL   A
00EA:0A          209         ASL   A          TO FORM $NO
00EB:A8          210         TAY              SAVE IT IN Y FOR OUTPUT PORT
00EC:BD 38 07    211 PRNT1   LDA   COL,X      IF COL<CH THEN TAB
00EF:DD B8 04    212         CMP   PWDTH,X    IF COL=PWDTH, FORCE A CR
00F2:F0 07       213         BEQ   FORCR
```



```
00F4:C5 24       214         CMP   CH         IF COL<CH THEN TAB
00F6:B0 8C       215         BCS   OUT        BRANCH ON NO TAB
00F8:A9 A0       216         LDA   #$0A0      SPACES UNTIL COL>=CH
00FA:2C          217         DFB$2C DUMMY     BIT INST TO SKIP 2 BYTES
00FB:A9 8D       218 FORCR   LDA   #$8D       OUTPUT A CARRIAGE RETURN
00FD:18          219         CLC              INDICATE CHAR STILL ON STACK
00FE:90 85       220         BCC   CTRL       BRANCH ALWAYS TAKEN
```

SYMBOL TABLE SORTED BY SYMBOL

```
  24 CH          5C CLRMD     0738 COL       FDF0 COUT1
FDED COUT        36 CSWL        85 CTRL      C080 DEV
  6A DIGIT       6C DLOOP       B5 DONE        B6 DONE1
  02 ENT1      0638 ESCHR       C0 ESCT1       5F ESTST
  9B FINISH    06B8 FLAGS       FB FORCR     FF58 IORTS
  75 MINIT     05B8 MODE      0538 MSTRT       33 NOTDF
  84 OUT         8D OUT1        C2 PRNT        EC PRNT1
04B8 PWDTH       B1 SETCH       54 SETFG       DD TEST1
  C4 TEST        62 VIDEO
```

SYMBOL TABLE SORTED BY ADDRESS

```
  02 ENT1        24 CH          33 NOTDF       36 CSWL
  54 SETFG       5C CLRMD       5F ESTST       62 VIDEO
  6A DIGIT       6C DLOOP       75 MINIT       84 OUT
  85 CTRL        8D OUT1        9B FINISH      B1 SETCH
  B5 DONE        B6 DONE1       C0 ESCT1       C2 PRNT
  C4 TEST        DD TEST1       EC PRNT1       FB FORCR
04B8 PWDTH     0538 MSTRT     05B8 MODE      0638 ESCHR
06B8 FLAGS     0738 COL       C080 DEV       FDED COUT
FDF0 COUT1     FF58 IORTS
```

Appendix B

Specifications and Schematics

This appendix contains the specifications and a schematic diagram of the PIC. Use the schematic with Chapter 5, Theory of Operation.

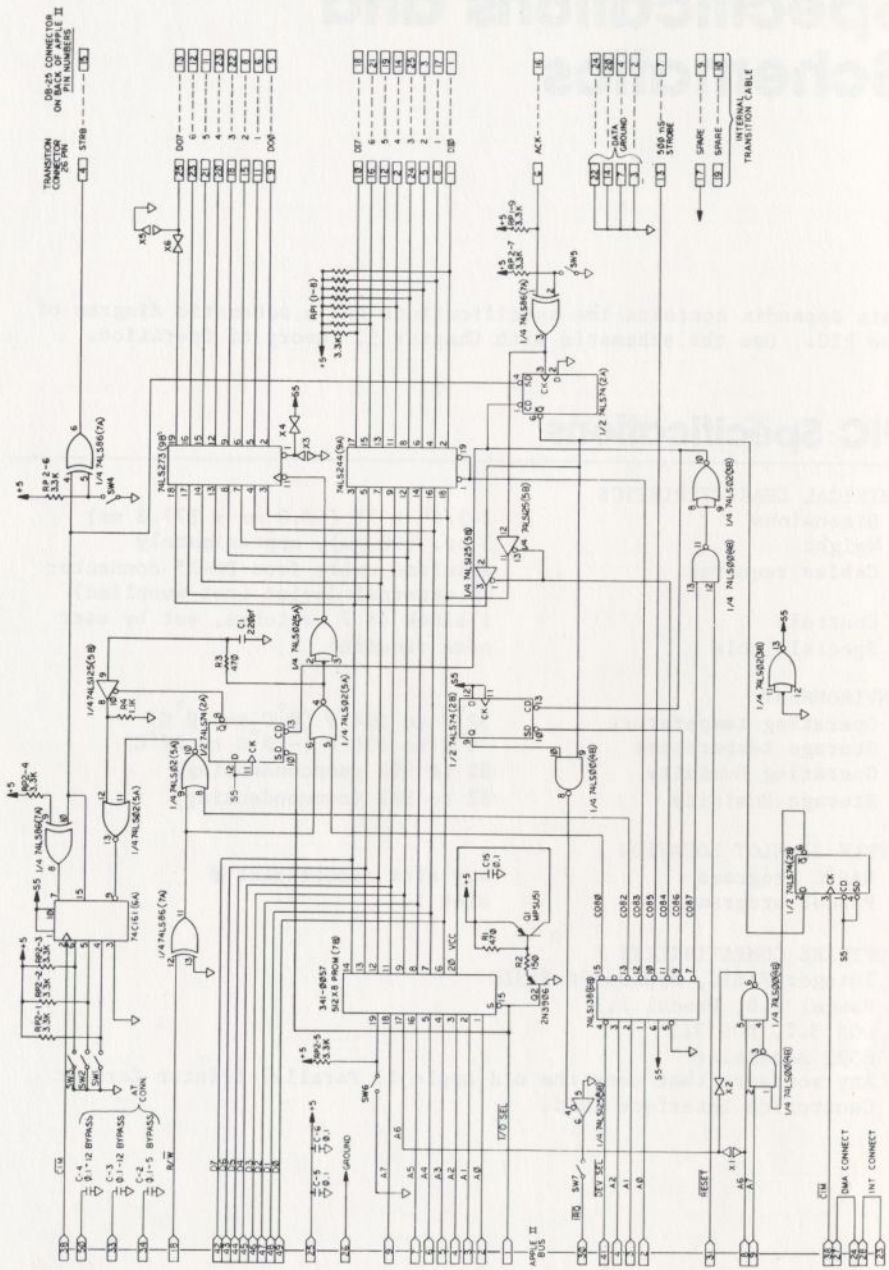
PIC Specifications

PHYSICAL CHARACTERISTICS	
Dimensions	2-3/4" x 7" (68.8 mm x 177.8 mm)
Weight	3 oz. (90 gm), approximately
Cables required	shielded cable from DB-25 connector to external device (not supplied)
Controls	1 block of 7 switches, set by user
Special Tools	none required
ENVIRONMENT	
Operating temperature	32°F to 104°F (0°C to 40°C)
Storage temperature	-4°F to 158°F (-20°C to 70°C)
Operating humidity	0% to 90% (noncondensing)
Storage Humidity	0% to 90% (noncondensing)
APPLE II SLOT LOCATION	
BASIC programs	any slot except slot 0
Pascal programs	slot 1

SOFTWARE COMPATIBILITY

Integer BASIC, Applesoft BASIC
Pascal 1.0, Pascal 1.1
DOS 3.2, DOS 3.3
6502 Assembler
Any software that uses the old Apple II Parallel Printer Card or Centronics Interface Card.

Schematic Diagram



Appendix C

ASCII Code Table

The table below shows the entire ASCII character set, and how to generate each character. Not all characters are available directly from the Apple II keyboard. However, various 8Ø-column cards and other peripheral interfaces have hardware or firmware that generates lowercase and special ASCII characters.

Here is how to interpret this table:

- The BINARY column has the 7-bit code for each ASCII character.
- The LOW DEC column gives the decimal equivalent of the 7-bit binary value. This value is the same if the binary code has 8 bits and the high-order bit is Ø.
- The LOW HEX column gives the corresponding hexadecimal value.
- The LOW OCT column gives the corresponding octal value.
- The HI DEC column gives the decimal equivalent of the 7-bit binary value if a high-order bit equal to 1 is appended to it; for example, 11ØØ1ØØØ for the letter H.
- The HI HEX column gives the corresponding hexadecimal value.
- The HI OCT column gives the corresponding octal value.
- The ASCII CHAR column gives the ASCII character name.
- The INTERPRETATION column spells out the meaning of special symbols and abbreviations where necessary.
- The WHAT TO TYPE column indicates what keystrokes generate the ASCII character from the unaided Apple II keyboard. Characters not accessible are labeled "n/a." The numbers to the right of this column refer to footnotes.
- Angle brackets enclose the names of single keys (like <ESC> for the ESC key), or enclose keystrokes involving more than one key (like <CTRL-SHIFT-M>, which means "hold down CTRL and SHIFT while pressing M.")

7-BIT BINARY	LOW DEC	LOW HEX	LOW OCT	HI DEC	HI HEX	HI OCT	ASCII CHAR	INTERPRETATION	WHAT TO TYPE	
ØØØØØØØ	Ø	ØØ	ØØØ	128	8Ø	2ØØ	NUL	Blank (null)	<CTRL-@>	
ØØØØØØ1	1	Ø1	ØØ1	129	81	2Ø1	SOH	Start of Header	<CTRL-A>	
ØØØØØ1Ø	2	Ø2	ØØ2	13Ø	82	2Ø2	STX	Start of Text	<CTRL-B>	
ØØØØØ11	3	Ø3	ØØ3	131	83	2Ø3	ETX	End of Text	<CTRL-C>	
ØØØØ1ØØ	4	Ø4	ØØ4	132	84	2Ø4	EOT	End of Transm.	<CTRL-D>	
ØØØØ1Ø1	5	Ø5	ØØ5	133	85	2Ø5	ENQ	Enquiry	<CTRL-E>	
ØØØØ11Ø	6	Ø6	ØØ6	134	86	2Ø6	ACK	Acknowledge	<CTRL-F>	
ØØØØ111	7	Ø7	ØØ7	135	87	2Ø7	BEL	Bell	<CTRL-G>	
ØØØ1ØØØ	8	Ø8	Ø1Ø	136	88	21Ø	BS	Backspace	<CTRL-H>	1
ØØØ1ØØ1	9	Ø9	Ø11	137	89	211	HT	Horizontal Tab	<CTRL-I>	
ØØØ1Ø1Ø	1Ø	ØA	Ø12	138	8A	212	LF	Linefeed	<CTRL-J>	
ØØØ1Ø11	11	ØB	Ø13	139	8B	213	VT	Vertical Tab	<CTRL-K>	
ØØØ11ØØ	12	ØC	Ø14	14Ø	8C	214	FF	Form Feed	<CTRL-L>	
ØØØ11Ø1	13	ØD	Ø15	141	8D	215	CR	Carriage Return	<CTRL-M>	2
ØØØ111Ø	14	ØE	Ø16	142	8E	216	SO	Shift Out	<CTRL-N>	
ØØØ1111	15	ØF	Ø17	143	8F	217	SI	Shift In	<CTRL-O>	
ØØ1ØØØØ	16	1Ø	Ø2Ø	144	9Ø	22Ø	DLE	Data Link Escape	<CTRL-P>	
ØØ1ØØØ1	17	11	Ø21	145	91	221	DC1	Device Control 1	<CTRL-Q>	
ØØ1ØØ1Ø	18	12	Ø22	146	92	222	DC2	Device Control 2	<CTRL-R>	
ØØ1ØØ11	19	13	Ø23	147	93	223	DC3	Device Control 3	<CTRL-S>	
ØØ1Ø1ØØ	2Ø	14	Ø24	148	94	224	DC4	Device Control 4	<CTRL-T>	3
ØØ1Ø1Ø1	21	15	Ø25	149	95	225	NAK	Neg. Acknowledge	<CTRL-U>	4
ØØ1Ø11Ø	22	16	Ø26	15Ø	96	226	SYN	Synchronization	<CTRL-V>	
ØØ1Ø111	23	17	Ø27	151	97	227	ETB	End of Text Blk.	<CTRL-W>	
ØØ11ØØØ	24	18	Ø3Ø	152	98	23Ø	CAN	Cancel	<CTRL-X>	
ØØ11ØØ1	25	19	Ø31	153	99	231	EM	End of Medium	<CTRL-Y>	
ØØ11Ø1Ø	26	1A	Ø32	154	9A	232	SUB	Substitute	<CTRL-Z>	
ØØ11Ø11	27	1B	Ø33	155	9B	233	ESC	Escape	<ESC>	
ØØ111ØØ	28	1C	Ø34	156	9C	234	FS	File Separator	n/a	
ØØ111Ø1	29	1D	Ø35	157	9D	235	GS	Group Sep	<CTRL-SHIFT-M>	
ØØ1111Ø	3Ø	1E	Ø36	158	9E	236	RS	Record Sep	<CTRL-SHIFT-N>	
ØØ11111	31	1F	Ø37	159	9F	237	US	Unit Separator	n/a	
Ø1ØØØØØ	32	2Ø	Ø4Ø	16Ø	AØ	24Ø	SP	Space	spacebar	
Ø1ØØØØ1	33	21	Ø41	161	A1	241	!		!	
Ø1ØØØ1Ø	34	22	Ø42	162	A2	242	"		"	

1. Or use left-arrow (←) key.
2. Or use <RETURN> key.
3. Normal PIC command character.
4. Or use right-arrow (→) key.

7-BIT BINARY	LOW DEC	LOW HEX	LOW OCT	HI DEC	HI HEX	HI OCT	ASCII CHAR	INTERPRETATION	WHAT TO TYPE
Ø1ØØØ11	35	23	Ø43	163	A3	243	#		#
Ø1ØØ1ØØ	36	24	Ø44	164	A4	244	$		$
Ø1ØØ1Ø1	37	25	Ø45	165	A5	245	%		%
Ø1ØØ11Ø	38	26	Ø46	166	A6	246	&		&
Ø1ØØ111	39	27	Ø47	167	A7	247	'	Closing Quote	'
Ø1Ø1ØØØ	4Ø	28	Ø5Ø	168	A8	25Ø	(		(
Ø1Ø1ØØ1	41	29	Ø51	169	A9	251	)		)
Ø1Ø1Ø1Ø	42	2A	Ø52	17Ø	AA	252	*		*
Ø1Ø1Ø11	43	2B	Ø53	171	AB	253	+		+
Ø1Ø11ØØ	44	2C	Ø54	172	AC	254	,	Comma	,
Ø1Ø11Ø1	45	2D	Ø55	173	AD	255	-	Hyphen	-
Ø1Ø111Ø	46	2E	Ø56	174	AE	256	.	Period	.
Ø1Ø1111	47	2F	Ø57	175	AF	257	/		/
Ø11ØØØØ	48	3Ø	Ø6Ø	176	BØ	26Ø	Ø		Ø
Ø11ØØØ1	49	31	Ø61	177	B1	261	1		1
Ø11ØØ1Ø	5Ø	32	Ø62	178	B2	262	2		2
Ø11ØØ11	51	33	Ø63	179	B3	263	3		3
Ø11Ø1ØØ	52	34	Ø64	18Ø	B4	264	4		4
Ø11Ø1Ø1	53	35	Ø65	181	B5	265	5		5
Ø11Ø11Ø	54	36	Ø66	182	B6	266	6		6
Ø11Ø111	55	37	Ø67	183	B7	267	7		7
Ø111ØØØ	56	38	Ø7Ø	184	B8	27Ø	8		8
Ø111ØØ1	57	39	Ø71	185	B9	271	9		9
Ø111Ø1Ø	58	3A	Ø72	186	BA	272	:		:
Ø1111Ø1	59	3B	Ø73	187	BB	273	;		;
Ø1111ØØ	6Ø	3C	Ø74	188	BC	274	<		<
Ø1111Ø1	61	3D	Ø75	189	BD	275	=		=
Ø11111Ø	62	3E	Ø76	19Ø	BE	276	>		>
Ø1111111	63	3F	Ø77	191	BF	277	?		?
1ØØØØØØ	64	4Ø	1ØØ	192	CØ	3ØØ	@		@
1ØØØØØ1	65	41	1Ø1	193	C1	3Ø1	A		A
1ØØØØ1Ø	66	42	1Ø2	194	C2	3Ø2	B		B
1ØØØ11	67	43	1Ø3	195	C3	3Ø3	C		C
1ØØ1ØØ	68	44	1Ø4	196	C4	3Ø4	D		D
1ØØ1Ø1	69	45	1Ø5	197	C5	3Ø5	E		E
1ØØ11Ø	7Ø	46	1Ø6	198	C6	3Ø6	F		F
1ØØ111	71	47	1Ø7	199	C7	3Ø7	G		G
1Ø1ØØØ	72	48	11Ø	2ØØ	C8	31Ø	H		H
1Ø1ØØ1	73	49	111	2Ø1	C9	311	I		I
1Ø1Ø1Ø	74	4A	112	2Ø2	CA	312	J		J
1Ø1Ø11	75	4B	113	2Ø3	CB	313	K		K
1Ø11ØØ	76	4C	114	2Ø4	CC	314	L		L
1Ø11Ø1	77	4D	115	2Ø5	CD	315	M		M
1Ø111Ø	78	4E	116	2Ø6	CE	316	N		N
1Ø1111	79	4F	117	2Ø7	CF	317	O		O
11ØØØØ	8Ø	5Ø	12Ø	2Ø8	DØ	32Ø	P		P
11ØØØ1	81	51	121	2Ø9	D1	321	Q		Q

7-BIT BINARY	LOW DEC	LOW HEX	LOW OCT	HI DEC	HI HEX	HI OCT	ASCII CHAR	INTERPRETATION	WHAT TO TYPE
1Ø1ØØ1Ø	82	52	122	21Ø	D2	322	R		R
1Ø1ØØ11	83	53	123	211	D3	323	S		S
1Ø1Ø1ØØ	84	54	124	212	D4	324	T		T
1Ø1Ø1Ø1	85	55	125	213	D5	325	U		U
1Ø1Ø11Ø	86	56	126	214	D6	326	V		V
1Ø1Ø111	87	57	127	215	D7	327	W		W
1Ø11ØØØ	88	58	13Ø	216	D8	33Ø	X		X
1Ø11ØØ1	89	59	131	217	D9	331	Y		Y
1Ø11Ø1Ø	9Ø	5A	132	218	DA	332	Z		Z
1Ø11Ø11	91	5B	133	219	DB	333	[	Opening Bracket	n/a
1Ø111ØØ	92	5C	134	22Ø	DC	334	\	Reverse Slant	n/a
1Ø111Ø1	93	5D	135	221	DD	335	]	Closing Bracket	<SHIFT-M>
1Ø1111Ø	94	5E	136	222	DE	336	^	Circumflex	^
1Ø11111	95	5F	137	223	DF	337	_	Underline	n/a
11ØØØØØ	96	6Ø	14Ø	224	EØ	34Ø	`	Opening Quote	n/a
11ØØØØ1	97	61	141	225	E1	341	a		n/a
11ØØØ1Ø	98	62	142	226	E2	342	b		n/a
11ØØØ11	99	63	143	227	E3	343	c		n/a
11ØØ1ØØ	1ØØ	64	144	228	E4	344	d		n/a
11ØØ1Ø1	1Ø1	65	145	229	E5	345	e		n/a
11ØØ11Ø	1Ø2	66	146	23Ø	E6	346	f		n/a
11ØØ111	1Ø3	67	147	231	E7	347	g		n/a
11Ø1ØØØ	1Ø4	68	15Ø	232	E8	35Ø	h		n/a
11Ø1ØØ1	1Ø5	69	151	233	E9	351	i		n/a
11Ø1Ø1Ø	1Ø6	6A	152	234	EA	352	j		n/a
11Ø1Ø11	1Ø7	6B	153	235	EB	353	k		n/a
11Ø11ØØ	1Ø8	6C	154	236	EC	354	l		n/a
11Ø11Ø1	1Ø9	6D	155	237	ED	355	m		n/a
11Ø111Ø	11Ø	6E	156	238	EE	356	n		n/a
11Ø1111	111	6F	157	239	EF	357	o		n/a
111ØØØØ	112	7Ø	16Ø	24Ø	FØ	36Ø	p		n/a
111ØØØ1	113	71	161	241	F1	361	q		n/a
111ØØ1Ø	114	72	162	242	F2	362	r		n/a
111ØØ11	115	73	163	243	F3	363	s		n/a
111Ø1ØØ	116	74	164	244	F4	364	t		n/a
111Ø1Ø1	117	75	165	245	F5	365	u		n/a
111Ø11Ø	118	76	166	246	F6	366	v		n/a
111Ø111	119	77	167	247	F7	367	w		n/a
1111ØØØ	12Ø	78	17Ø	248	F8	37Ø	x		n/a
1111ØØ1	121	79	171	249	F9	371	y		n/a
1111Ø1Ø	122	7A	172	25Ø	FA	372	z		n/a
1111Ø11	123	7B	173	251	FB	373	{	Opening Brace	n/a
1111ØØ	124	7C	174	252	FC	374	|	Vertical Line	n/a
1111Ø1	125	7D	175	253	FD	375	}	Closing Brace	n/a
1111111Ø	126	7E	176	254	FE	376	~	Overline (Tilde)	n/a
1111111	127	7F	177	255	FF	377	DEL	Delete/Rubout	n/a

Glossary

Acknowledge: A signal arriving from the printer or other device on DB-25 connector pin 16 to indicate that it has successfully received a byte of data.

Buffer: A memory area in a computer or other device that can hold information temporarily. Buffers improve the performance of computer systems by compensating for differences in speed between one device and another, or between one type of activity (single-byte transfers) and another (block transfers).

Carriage Return: A specific ASCII character (decimal 13; see Appendix C) that ordinarily causes a printer to place the subsequent character at the beginning of the next line of text. On a manual typewriter, carriage return and linefeed usually go together: the platen is shifted to the right and the paper is advanced one or more lines in a combined motion. Computer people, being analytical, always treat them separately.

Character: Any symbol that has a widely-understood meaning. In computers, letters, numbers and punctuation marks are all characters.

Device: A piece of computer hardware, such as a disk drive or printer or terminal.

Diskette: A flat, circular piece of flexible plastic, coated with a fine metallic powder, onto which information is recorded magnetically.

Handshake: A kind of communications protocol in which the receiving device, when it has successfully gotten a character or block of characters, sends back an acknowledging signal, thereby triggering the next transmission.

In Check: An error condition somewhere in a device (usually a printer) of sufficient severity that the computer should not attempt to transmit data to that device.

Input: Information (data) arriving at a computer or device.

Interface: Some combination of hardware, firmware, and software that makes possible the connection of two pieces of equipment that cannot be connected directly to each other.

Least Significant Bit (LSB): The right-hand bit of a binary number as written down; its positional value is Ø or 1 (that is, Ø or 1 times 2 to the Ø power).

Linefeed: An ASCII character (decimal 1Ø; see Appendix C) that causes a printer to advance the paper one line. Without linefeeds, some printers keep printing over and over again on the same line.

Most Significant Bit (MSB): The left-most bit of a binary number as written down. This bit represents Ø or 1 times 2 to the power one less than the total number of bits in the binary number. For example, in the binary number 1ØØØØ, the 1 represents 1 times 2 to the fourth power, or sixteen.

Online: Under control of the Apple II; opposite of offline, or under control of the human operator.

Output: Data leaving a computer or device.

Parallel Interface: A type of interface in which all bits of a given character are transferred simultaneously, using a separate data line for each bit.

Parameter: A variable that can have one of a specific set of values.

Peripheral Connector Slot: In an Apple II, a 5Ø-pin slot designed to hold, and transfer signals to and from, an interface card.

PIC: The Apple II Parallel Interface Card, subject of this manual.

PROM: A Programmable ROM: a type of ROM that is not programmed when it is manufactured, but rather is programmed later by a physical process, such as shining a coded pattern of light onto a special region on the PROM's surface.

Radio Frequency Interference (RFI): Electromagnetic noise at frequencies that cause disturbances in nearby televisions, radios, and other radio frequency receivers.

Read Only Memory (ROM): An integrated circuit that contains programs that can be read and used, but not rewritten or changed.

Serial Interface: A type of interface in which all bits of a given character are transmitted along the same data line in a stream, one after the other. (See Parallel Interface.)

Strobe: A brief signal pulse sent by the Apple II to a receiving device on DB-25 pin 15 to indicate that a valid byte is present on the data lines, ready to be read.

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