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.
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 084-009-00345-4.

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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 ROM, 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.
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.

![Switches Diagram](image1)

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:

<table>
<thead>
<tr>
<th>Switch:</th>
<th>SW1</th>
<th>SW2</th>
<th>SW3</th>
<th>SW4</th>
<th>SW5</th>
<th>SW6</th>
<th>SW7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting:</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
</tr>
</tbody>
</table>

Some of the printers that work with these settings are:

- Anadex 9501
- Anadex DP-8000
- Axiom MP-2
- C. Itoh 8510/1550

- Centronics 700/779
- Centronics 730/737
- DIP 84
- NEC PC-8023A-C

- Epson MX-80
- Epson MX-100
- IDS 440/445/460/560
- Printronix P3000

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).

<table>
<thead>
<tr>
<th>Strobe Length:</th>
<th>SW1</th>
<th>SW2</th>
<th>SW3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 microsecond</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>3 microseconds</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>5 microseconds</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>7 microseconds</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>9 microseconds</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>11 microseconds</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>13 microseconds</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>15 microseconds</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
</tbody>
</table>

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.
Acknowledging 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.

<table>
<thead>
<tr>
<th>SW6</th>
<th>Firmware</th>
<th>Principal characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>&quot;Centronics&quot;</td>
<td>This firmware does not automatically generate linefeed characters after carriage returns (ROM #341-0019)</td>
</tr>
<tr>
<td>OFF</td>
<td>&quot;Parallel Printer&quot;</td>
<td>This firmware automatically generates linefeeds after carriage returns (ROM #341-0005)</td>
</tr>
</tbody>
</table>

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 0 at the left to 7 at the right. The numbers are printed along the back edge behind the connector slots. For use with BASIC, you must install the PIC in slot #1. For use with Pascal, you may install the PIC in any slot except #0. 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.

<table>
<thead>
<tr>
<th>DB-25 Pin#</th>
<th>Signal Name</th>
<th>DB-25 Diagram</th>
<th>Signal Name</th>
<th>DB-25 Pin#</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Data In, Bit 0</td>
<td></td>
<td>Data In, Bit 4</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>Signal Ground</td>
<td></td>
<td>Acknowledge In</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>Data In, Bit 2</td>
<td></td>
<td>Data In, Bit 1</td>
<td>17</td>
</tr>
<tr>
<td>4</td>
<td>Signal Ground</td>
<td></td>
<td>Data In, Bit 7</td>
<td>18</td>
</tr>
<tr>
<td>5</td>
<td>Data Out, Bit 0</td>
<td></td>
<td>Data In, Bit 5</td>
<td>19</td>
</tr>
<tr>
<td>6</td>
<td>Data Out, Bit 1</td>
<td></td>
<td>Signal Ground</td>
<td>20</td>
</tr>
<tr>
<td>7</td>
<td>(blocked)</td>
<td></td>
<td>Data In, Bit 6</td>
<td>21</td>
</tr>
<tr>
<td>8</td>
<td>Data Out, Bit 2</td>
<td></td>
<td>Data Out, Bit 3</td>
<td>22</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td>Data Out, Bit 4</td>
<td>23</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td>Signal Ground</td>
<td>24</td>
</tr>
<tr>
<td>11</td>
<td>Data Out, Bit 5</td>
<td></td>
<td>Data In, Bit 3</td>
<td>25</td>
</tr>
<tr>
<td>12</td>
<td>Data Out, Bit 6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Data Out, Bit 7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>PIC</th>
<th>Printer Connector Pin Assignments</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB-25 Pins</td>
<td>Centronics Centronics Printronic IDS Epson TI 810, 8510A</td>
</tr>
<tr>
<td>799/799(a)</td>
<td>730/737(b) P300 440(c) MX-80/100 C. Itoh</td>
</tr>
<tr>
<td>1</td>
<td>16, 19 27 14 7 19 19</td>
</tr>
<tr>
<td>2</td>
<td>3 4 2 14 2 2</td>
</tr>
<tr>
<td>3</td>
<td>5 3 5 3 13 3 3</td>
</tr>
<tr>
<td>4</td>
<td>(cable pin 7 must be removed; its hole is blocked on the connector)</td>
</tr>
<tr>
<td>5</td>
<td>8 4 7 12 4 4</td>
</tr>
<tr>
<td>6</td>
<td>9(d) 9 9</td>
</tr>
<tr>
<td>7</td>
<td>10 1 1 1 3 1 1</td>
</tr>
<tr>
<td>8</td>
<td>11 19 19 10 22 10 10</td>
</tr>
<tr>
<td>9</td>
<td>12 18 28 18 35 18</td>
</tr>
<tr>
<td>10</td>
<td>12 12 12 12 12 12</td>
</tr>
<tr>
<td>11</td>
<td>20 13 25 13 4 13 13</td>
</tr>
<tr>
<td>12</td>
<td>22 5 9 5 11 5 5</td>
</tr>
<tr>
<td>13</td>
<td>23 6 11 6 16 6 6</td>
</tr>
<tr>
<td>14</td>
<td>24 16 31 16 7 16 16</td>
</tr>
<tr>
<td>15</td>
<td>25 32 32</td>
</tr>
</tbody>
</table>

(a) Also Anadex 9501, Anadex DP-8080, Axion IMP-2, DIP 84, NEC PC-8023A-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, 460 and 560.
(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 739 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.

![Diagram of connectors](image)

**Figure 1-4.** Main Types of Connectors on Printer End of 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 390-0042.

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

$<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#$ <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 Transfer command:

T(transfer filename,PRINTER: or T(transfer filename,#6:
PIC Commands

Commands to modify PIC firmware values have the form:

\(<\text{CTRL}-\text{I}>\) \(<\text{command}>\) \(<\text{RETURN}>\)

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

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

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

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:

\[
\begin{align*}
100 & \text{ I$="";} & \text{ :REM DEFINE <CTRL-I>}
110 & \text{ DS="";} & \text{ :REM DEFINE <CTRL-D>}
120 & \text{ PRINT I$;"PR#1);} & \text{ :REM PRINT <CTRL-T>80N}
130 & \text{ PRINT I$;"80N";} & \text{ :REM PRINT <CTRL-T>80N<RETURN>}
\end{align*}
\]

Change Line Width (\(<\text{n}>\text{N}\))

The \(<\text{n}>\text{N}\) command changes the number of characters printed per line from its current value to the one specified by \(<\text{n}>\). Legal values of \(<\text{n}>\) range from 40 through 235. The default line width is 40. This command also turns off the video display. For example, to print data on an 80-column printer, type in

\(<\text{CTRL}-\text{I}>\text{80N}<\text{RETURN}>\)

Restore Video Display (I)

The I command restores the video display as the output device, and changes the line width back to 40.

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 40 when output to the screen is turned back on.

\[
\begin{align*}
10 & \text{ PR#1;} & \text{ :REM TURN ON PIC IN SLOT 1}
20 & \text{ I$ = "";} & \text{ :REM SET I$ TO CONTROL-I}
30 & \text{ PRINT I$;"132 N";} & \text{ :REM SET LINE WIDTH TO 132}
40 & \text{ PRINT "$\text{THIS LINE PRINTS ON THE PRINTER ONLY}$";} & \text{ :REM ALSO TURNS OFF SCREEN}
50 & \text{ PRINT "$\text{THIS LINE PRINTS ON THE PRINTER ONLY}$";} & \text{ :REM RESTORE VIDEO, 40 COLUMNS}
60 & \text{ PRINT "$\text{PRINT "THIS LINE PRINTS ON THE PRINTER AND SCREEN"}$";} & \text{ :REM TURN THE CARD OFF}
70 & \text{ PRINT "$\text{PRINT "THIS LINE PRINTS ON THE PRINTER AND SCREEN"}$";} \text{ :REM TURN THE CARD OFF}
80 & \text{ END;} & \text{ :REM TURN THE CARD OFF}
\end{align*}
\]

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.
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 PRINT statement to use the printer.

2. If you are printing more than 40 characters per line, be sure to reset the line length to 40 characters before turning off the PIC with the PRINT 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 $08136 (where s is the slot where the PIC is), then the data will appear on Data Out lines 0 through 7, and will remain until the next STORE instruction to $08136 is executed. For example, in BASIC use

POKE (-16256-(8*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.
Table 3-1. PEEK and POKE Addresses

<table>
<thead>
<tr>
<th>Desired Action</th>
<th>PIC is in Slot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load output port</td>
<td>1 -16240 -16224 -16208 -16192 -16176 -16160 -16144</td>
</tr>
<tr>
<td></td>
<td>(§C684+s0)</td>
</tr>
<tr>
<td>Send a strobe</td>
<td>2 -16238 -16222 -16206 -16190 -16174 -16158 -16142</td>
</tr>
<tr>
<td></td>
<td>(§C682+s0)</td>
</tr>
<tr>
<td>Read input port</td>
<td>3 -16237 -16221 -16205 -16189 -16173 -16157 -16141</td>
</tr>
<tr>
<td></td>
<td>(§C683+s0)</td>
</tr>
<tr>
<td>Look at ACK</td>
<td>4 -16236 -16220 -16204 -16188 -16172 -16156 -16140</td>
</tr>
<tr>
<td></td>
<td>(§C684+s0)</td>
</tr>
<tr>
<td>Enable IRQ</td>
<td>5 -16234 -16218 -16202 -16186 -16170 -16154 -16138</td>
</tr>
<tr>
<td></td>
<td>(§C686+s0)</td>
</tr>
<tr>
<td>Disable IRQ &amp;</td>
<td>6 -16233 -16217 -16201 -16185 -16169 -16153 -16137</td>
</tr>
<tr>
<td>auto strobe</td>
<td>(§C687+s0)</td>
</tr>
</tbody>
</table>

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 auto strobe

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 auto strobe 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 auto strobe feature can be disabled by a system reset or via the decoder address §C687+s0.

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 §C687+s0. Current Apple II system software does not process interrupts.

Output data is latched into the 74LS273 register by writing to address §C884+s0 (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 ±0.5 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 accommodate those printers that drive data lines from open collector outputs.

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**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 $C000+8$)
- a list of the firmware entry points
- the actual PIC firmware listings

**Pascal 1.1 Firmware Protocol**

Pascal 1.0 will "accept" user-written peripheral card firmware if the firmware has hexadecimal value $38$ at $C005$ and $18$ at $C007$. 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 $C000$ address space (being the slot number where the peripheral card is installed). This space was chosen instead of the $C800$ space, since under BASIC protocol the $C000$ space is required, while the $C800$ space is optional.

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

Notice that $Ca11 contains $0 if optional offsets follow; non-zero if not
interrupt handling routine offset (optional)

Table A-2 gives the entry point addresses, and the contents of the 6502 registers on entry to and on exit from Pascal 1.1 I/O routines:

<table>
<thead>
<tr>
<th>Addr.</th>
<th>Offset for</th>
<th>X Register</th>
<th>Y Register</th>
<th>A Register</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Ca0D</td>
<td>Initialization</td>
<td>On entry</td>
<td>$Ca</td>
<td>$0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>On exit</td>
<td>error code (unchanged)</td>
<td>(unchanged)</td>
</tr>
<tr>
<td>$Ca0E</td>
<td>Read</td>
<td>On entry</td>
<td>$Ca</td>
<td>$0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>On exit</td>
<td>error code (unchanged)</td>
<td>character read</td>
</tr>
<tr>
<td>$Ca0F</td>
<td>Write</td>
<td>On entry</td>
<td>$Ca</td>
<td>$0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>On exit</td>
<td>error code (unchanged)</td>
<td>(unchanged)</td>
</tr>
<tr>
<td>$Ca10</td>
<td>Status</td>
<td>On entry</td>
<td>$Ca</td>
<td>$0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>On exit</td>
<td>error code (changed)</td>
<td>(unchanged)</td>
</tr>
</tbody>
</table>

Notes: Request code 0 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-3. Pascal 1.1 Peripheral Card Identifiers

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

<table>
<thead>
<tr>
<th>Digit</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>reserved</td>
</tr>
<tr>
<td>$1</td>
<td>printer</td>
</tr>
<tr>
<td>$2</td>
<td>joystick or other X-Y input device</td>
</tr>
<tr>
<td>$3</td>
<td>serial or parallel I/O card</td>
</tr>
<tr>
<td>$4</td>
<td>modem</td>
</tr>
<tr>
<td>$5</td>
<td>sound or speech device</td>
</tr>
<tr>
<td>$6</td>
<td>clock</td>
</tr>
<tr>
<td>$7</td>
<td>mass storage device</td>
</tr>
<tr>
<td>$8</td>
<td>$8-column card</td>
</tr>
<tr>
<td>$9</td>
<td>network or bus interface</td>
</tr>
<tr>
<td>$A</td>
<td>special purpose (none of the above)</td>
</tr>
<tr>
<td>$B-F</td>
<td>reserved for future expansion</td>
</tr>
</tbody>
</table>

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 firmware address space. PIC memory usage is simple and straightforward. The letter s denotes slots s in the Apple.

You can access the PIC firmware for direct output by presetting the fields NSITRT, MODE, ESCHAR and FLAGS (see Table A-5), and then entering the firmware once at $Ca0D. (The normal entry point is $Ca02.) Data in the accumulator is transmitted on the data lines with a strobe pulse when the responding device is ready.
### 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 $8080+s$, where $s$ is the slot the peripheral interface card is in. The PIC uses seven of these bytes, as shown in Table A-6.

### PIC Firmware Listings

This section contains the listings of the two sets of firmware contained in the PIC ROM. Setting SW6 OFF selects 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 341-0005) and the Centronics Printer Card firmware, (Apple Part Number 341-0019), 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 11/17/77 *
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 -> $CNCO-CNFF *
0000: 21 * $CNCO-CNFF -> $CN90-CNBF *
0000: 22 *
0000: 23 *
0000: 24 * DEFAULT SETTINGS *
0000: 25 *
0000: 26 * ESCAPE CHARACTER IS CTRL-I *
0000: 27 * VIDEO-ALSO AND CRLF ON *
0000: 28 *
0000: 29 * AFTER ESCAPE CHARACTER *
0000: 30 *
0000: 31 * (optional set printer width) *
0000: 32 *
0000: 33 *
0000: 34 * I: SET VIDEO ALSO *
0000: 35 *
0000: 36 * K: CLR CRLF, VID-ALSO *
0000: 37 *
0000: 38 * L: SET CRLF *
0000: 39 *
0000: 40 * M: SET CRLF, VID-ALSO *
0000: 41 *
0000: 42 * N: CLR VIDEO ALSO *
0000: 43 *
0000: 44 *
0000: 45 * CH EQU $24 CURSOR HORIZONTAL INDEX *
0000: 46 * CWL EQU $36 LOW ORDER COUT SWITCH BYTE *
0000: 47 * PWDDT EQU $438 PRINTER WIDTH *
0000: 48 * MSTR EQU $538 MARGIN START *
0000: 49 * MODE EQU $588 AFTER ESC CHAR *
0000: 50 * ESCAR EQU $688 CURRENT ESC CHAR *
0000: 51 * FLAGS EQU $688 B7=VID-ALSO, BO=CRLF *
0000: 52 * COL EQU $738 COLUMN COUNT *
0000: 53 * DEV EQU $0C080 +$20 ACTIVATES THE DEV LINE *
0000: 54 * OUT1 EQU $0DF0 VIDEO OUTPUT ENTRY *
0000: 55 * IORTS EQU $0FF58 FIXED RTS INSTRUCTION *
0000: 56 *
0000: 57 *
0000: 58 * ENTO CLC DEFAULT ENTRY *
0000: 59 * BCS *
0000: 60 * ORG *-1 NORMAL ENTRY *
0000: 61 * EN1 SEC *
0000: 62 * PHA TXA *
0000: 63 * PHA *
0000: 64 * PHA TYA *
0000: 65 * PHA *
0000: 66 * PPH *
0000: 67 * SEI DISABLE INTERRUPTS *
0000: 68 * IORTS RETURNS $CN ABOVE STACK *
0000: 69 * BA TSX CHAR TO Y-REGISTER *
0000: 70 * BA *
0000: 71 * BA *
0000: 72 * BA *
0000: 73 * BA *
0000: 74 * BA *
0000: 75 * BA *
0000: 76 * BA *
0000: 77 * BA *
0000: 78 * BA *
0000: 79 * BA *
0000: 80 * BA *
0000: 81 * BA *
0000: 82 * BA *
0000: 83 * BA *
0000: 84 * BA *
0000: 85 * BA *
0000: 86 * BA *
0000: 87 * BA *
0000: 88 * BA *
0000: 89 * BA *
0000: 90 * BA *
0000: 91 * BA *
0000: 92 * BA *
0000: 93 * BA *
0000: 94 * BA *
0000: 95 * BA *
0000: 96 * BA *
0000: 97 *
0000: 98 *
0000: 99 * ETEST LDA $A080, X PIC Firmware 25
004A:3D 38 07 107 AND COL,X
004D:65 24 108 ADC CH
004F:85 24 109 STA CH
0051:4A 110 ESC CST LSR A MAKE IT POSITIVE
0052:38 111 DEFAULT SEC
0053:BD 6D 112 BCS ESC CST1 BRANCH ALWAYS TAKEN
0055: 113 *
0055:1B 114 *
0055:1B 115 SETFLG CLC
0056:6A 116 EOR A
0057:3D B8 06 117 AND FLAGS,X
005A:00 02 118 BCC SETFLG1
005C:87 81 119 EOR #$81
005E:90 B8 06 120 SETFLG1 STA FLAGS,X
0061:BD 53 121 BNE DONE
0063: 122 *
0063: 123 *
0063:A0 0A 124 DIG LDY #$0A
0065:7D 38 05 125 DLOOP ADC MSTR,X ADD 10*MSRT TO DIG AND STORE IN PRINTER WIDTH (MARGIN)
0068:88 126 DEY
0069:0D FA 127 BNE DLOOP
0068:9D B8 04 128 STA PWDT,X
0069:9D 38 05 129 MINT STA MSTR,X UPDATE MARGIN START
0071:88 130 SEC INDICATE 'AFTER ESC CHAR'
0072:BD 43 131 BCS DONE1 BRANCH ALWAYS
0074: 132 *
0074: 133 *
0074: 134 VIDEO EQUI MUST KEEP CURSOR HORIZ.
0074:C5 24 135 CMP CH IN RANGE OF PWDT
0076:90 3A 136 BCC SETCH BRANCH IF >40
0078:68 137 PLA
0079:48 138 TAY
007A:68 139 PLA
007B:4A 140 TAX RESTORE REGISTERS AND
007C:68 141 PLA END WITH VIDEO OUT
007D:4C 0D FD 142 JMP COUT1
0080: 143 *
0080: 144 *
0080: 145 *
0080:90 FE 146 BCC IMAGE 'WAIT FOR READY'
0082:80 FE 147 BCS IMAGE (ESCTST & DEFAULT)
0084: 148 *
0084: 149 *
0084: 150 *
0084: 151 *
0084:99 80 CD 152 OUT STA DEV,Y OUTPUT CHAR TO PRINTER
0087:90 37 153 BCC PWDT LOOP IF WAS TAB
0089:49 07 154 EOR #$07 IF CR, MAKE IT LF
008B:88 155 TAY COPY TO REG,Y
008C:49 0A 156 EOR #$0A
008E:0A 157 ASL A CARRIAGE RETURN IN 7 LSB'S?
008F:BD 06 158 BNE FINISH BRANCH IF NOT CR
0091:88 159 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 88 06 162 FINISH LDA FLAGS,X FOR CRLF CHECK (BIT 0)
009A:4A 163 LSR A BRANCH IF LAST CHAR NOT CR
009B:70 02 164 BVS FINISH1
009D:00 23 165 BCS ESCST1
009F:0A 166 FINISH1 ASL A CHECK HI ORDER BIT OF FLAGS
00A0:10A 167 STA LDA #$27
00A1:9A 27 168 LDA #27 ASL A LOADED JUST FOR VIDEO MODE
00A3:80 CF 169 BCS VIDEO CHECK FOR WITHIN 8 CHARS
00A5:BD 38 07 170 LDA COL,X OF PRINTER WIDTH
00A8:FD 88 04 171 SBC PWDT,X
00AB:CF 88 172 CMP #$0F
00AD:90 03 173 BCC SETCH IF NO, THEN DONE
00AF:69 27 174 ADC ASC ADD 32 (FORMING 32-39)
00B1:AC 58 FF 175 LDS IORTS DUMMY LDY ABSOLUTE
00B2: 176 ORG*-2
00B2:9A 00 177 SETCH LDA #$D
00B4:85 24 178 STA CH
00B6:18 179 DONE CLC
00B7:7E 88 05 180 DONE1 ROR MODE,X
00BA:68 181 PLA
00BB:48 182 TAY
00BC:68 183 PLA
00BD:AA 184 TAX
00BE:68 185 PLA
00BF:0A 186 RTS
00C0: 187 *
00C0: 188 *
00C0:90 27 189 ORG ENTO+$0C0 TAKEN WHEN PRINTER READY
00C2:BD 00 190 PRNT BCC PRNT1
00C4:10 11 191 ESCST1 BCS +2
00C6: 192 BPL ESCST2
00C6: 193 *
00C6: 194 *
00C6:99 89 195 LDA #$89 DEFAULT CHARACTER (CONTROL-I)
00C8:9D 38 06 196 STA ESCCHAR,X
00C8:9D 88 06 197 LDA FLAGS,X VIDEO ALSO, CRLF ON
00C8:9A 28 198 LDA #$28
00CD:9D B8 04 199 STA PWDT,X
00D3:49 02 200 LDA #$ENT1
00D5:85 36 201 STA CSWL SET FOR NORMAL ENTRY
00D7:98 202 ESCST T2 TYA MOVE CHAR TO REG-A
00DB:5D 38 06 203 EOR ESCCHAR,X
00DB:80 204 ASL A ESC CHAR (7LSB'S)
00DC:FO 90 205 BEQ MINIT BRANCH IF YES
00DE:5E 88 05 206 LSR MODE,X NO, CLR 'AFTER ESC CHAR'
00E1:98 207 TYA SAVE CHAR ON THE STACK
00E2:48 208 PHA
00E3:4A 209 TXA
00E4:0A 210 ASL A GENERATE NMS10 AS AN INDEX TO
00E5:0A 212 ASL A THE DEVICE LINE (REG-Y)
00E6:0A 213 ASL A
00E8:4A 214 TAY

Apple II Parallel Interface Card
PIC Firmware
Centronics Printer Firmware

```
0000: ORG $0
0000: 0000: PRINTER II Firmware
0000: PRINT/VIDEO SET 40 COLUMNS
0000: VIDEO IS ENABLED
0000: AFTER ESCAPE CHARACTER
0000: (OPTIONAL SET PRINTER WIDTH)
0000: N: SET NO VIDEO MODE
0000: O: SET VIDEO ON MODE
0000: SETTING NO VIDEO MODE SENDS
0000: 80 COLUMN MODE CHARACTER TO
0000: PRINTER (CENTRONICS MICRO)
0000: NOTE ALL REGISTERS ARE
0000: RESTORED TO THEIR ORIGINAL
0000: VALUES ON EXIT
0000: CURSOR HORIZONTAL INDEX
0000: LOW ORDER COUT SWITCH BYTE
0000: PRINTER WIDTH
```

Apple II Parallel Interface Card
0043: B0 0F 107 BCS SETFG
0045: 5F 30 108 EOR #$3D
0047: F0 13 109 BEQ CLRM
0049: 98 110 TYA
004A: 2C 5B FF 111 BIT IORTS
004B: 0D 66 112 BNE DONE
004F: 9D 38 06 113 STA ESCR,X
0050: 29 60 114 BCC DONE
0054: 8A 115 *
0054: 4A 116 SETFG
0055: 7E B8 06 117 ROR FLAGS,X
0058: 30 58 118 BMI DONE
005A: 40 1D 119 LDY #$1D
005C: 9D B8 05 120 CLRM STA MODE,X
005F: 38 121 ESTST SEC
0060: 80 5E 122 BCS ESC1
0062: 123 *
0062: 68 124 VIDEO PLA
0063: 4A 125 TAY
0064: 68 126 PLA
0065: AA 127 TAX
0066: 68 128 PLA
0067: 4C FD FF 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: 0D FA 135 BNE DLOOP
0072: 9D B8 04 136 STA PWDHT,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
007A: 52 48 140 DCI 'JRM1'
007C: CD
007E: 141 ORG *
007E: 07 78 142 DBF $07,78
0080: 143 *
0080: 80 0F 144 *
0083: 29 0E 146 BCS *
0084: 147 *
0084: 148 *
0084: 68 149 OUT PLA
0085: 2C 5B FF 150 CTRL BIT IORTS
0088: F0 03 151 BEQ OUT1
008A: FE 38 07 152 INC COL,X
008B: 08 153 OUT1 PHP
008B: 99 80 CO 154 STA DEV,X OUTPUT TO PRINTER
008D: 8D 155 EOR #$8D
0093: 0A 156 ASL A
0094: D0 05 157 BNE FINISH
0095: 85 24 158 STA CR
0098: 9D 38 07 159 STA COL,X
009B: 38 2B 160 STA COL,X
009D: 8B 05 160 BCS SETFG
009E: 8B 05 160 EOR #$3D
009F: F0 13 160 BEQ CLRM
00A1: 99 88 160 TYA
00A8: 5B FF 160 BIT IORTS
00A9: 0D 66 160 BNE DONE
00AF: 9D 38 06 160 STA ESCR,X
00B0: 29 60 160 BCC DONE
00B4: 8A 160 *
00B4: 4A 160 SETFG
00B5: 7E B8 06 160 ROR FLAGS,X
00B8: 30 58 160 BMI DONE
00BA: 40 1D 160 LDY #$1D
00BC: 9D B8 05 160 CLRM STA MODE,X CLEAR 'AFTER ESC' MODE
00BD: 121 ESTST SEC
00BE: 80 5E 160 BCS ESC1
00BF: 122 *
00C0: 68 124 VIDEO PLA
00C3: 4A 125 TAY
00C4: 68 126 PLA
00C5: AA 127 TAX
00C6: 68 128 PLA
00C7: 4C FD FF 129 JMP COUT1 END WITH VIDEO OUT
00C8: 130 *
00C8: 131 *
00C8: A0 0A 132 DIGIT LDY #$0A LAST*10+NEW
00CA: 7D 38 05 133 DLOOP ADC MSTRT,X
00CC: 88 134 DEY
00CD: 0D FA 135 BNE DLOOP
00CE: 9D B8 04 136 STA PWDHT,X SAVE UPDATED PRINTER WIDTH
00D1: 9D 38 05 137 MINIT STA MSTRT,X SAVE AS LAST TOTAL
00D4: 38 138 SEC
00D9: B0 3B 139 BCS DONE1 INDICATE 'AFTER ESC' MODE
00DA: 52 48 140 DCI 'JRM1'
00DC: CD
00DE: 141 ORG *
00DF: 07 78 142 DBF $07,78
00E0: 143 *
00E0: 80 0F 144 *
00E3: 29 0E 146 BCS *
00E4: 147 *
00E4: 148 *
00E4: 68 149 OUT PLA
00E5: 2C 5B FF 150 CTRL BIT IORTS
00E8: F0 03 151 BEQ OUT1
00EA: FE 38 07 152 INC COL,X
00EB: 08 153 OUT1 PHP
00EC: 99 80 CO 154 STA DEV,X OUTPUT TO PRINTER
00ED: 8D 155 EOR #$8D
00F3: 0A 156 ASL A
00F4: D0 05 157 BNE FINISH
00F5: 85 24 158 STA CR
00F8: 9D 38 07 159 STA COL,X
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 g), 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.
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 80-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 0.
- 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, 11001000 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.")
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1. Or use left-arrow (<-) key.
2. Or use <RETURN> key.
4. Or use right-arrow (->) key.
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<td>77</td>
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<td>123</td>
<td>7B</td>
<td>173</td>
<td>251</td>
<td>FB</td>
<td>373</td>
<td>{ Opening Brace n/a</td>
<td></td>
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<tr>
<td>11110000</td>
<td>124</td>
<td>7C</td>
<td>174</td>
<td>252</td>
<td>FC</td>
<td>374</td>
<td>} Vertical Line n/a</td>
<td></td>
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<tr>
<td>11110001</td>
<td>125</td>
<td>7D</td>
<td>175</td>
<td>253</td>
<td>FD</td>
<td>375</td>
<td>) Closing Brace n/a</td>
<td></td>
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<tr>
<td>11110010</td>
<td>126</td>
<td>7E</td>
<td>176</td>
<td>254</td>
<td>FE</td>
<td>376</td>
<td>~ Overline (tilde) n/a</td>
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<tr>
<td>11110011</td>
<td>127</td>
<td>7F</td>
<td>177</td>
<td>255</td>
<td>FF</td>
<td>377</td>
<td>DEL Delete/Rubout n/a</td>
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**Glossary**

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 0 or 1 (that is, 0 or 1 times 2 to the 0 power).

Linefeed: An ASCII character (decimal 10; 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 0 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 10000, 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 50-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.

ROM: 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 burning a coded pattern of light onto a special region on the ROM'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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