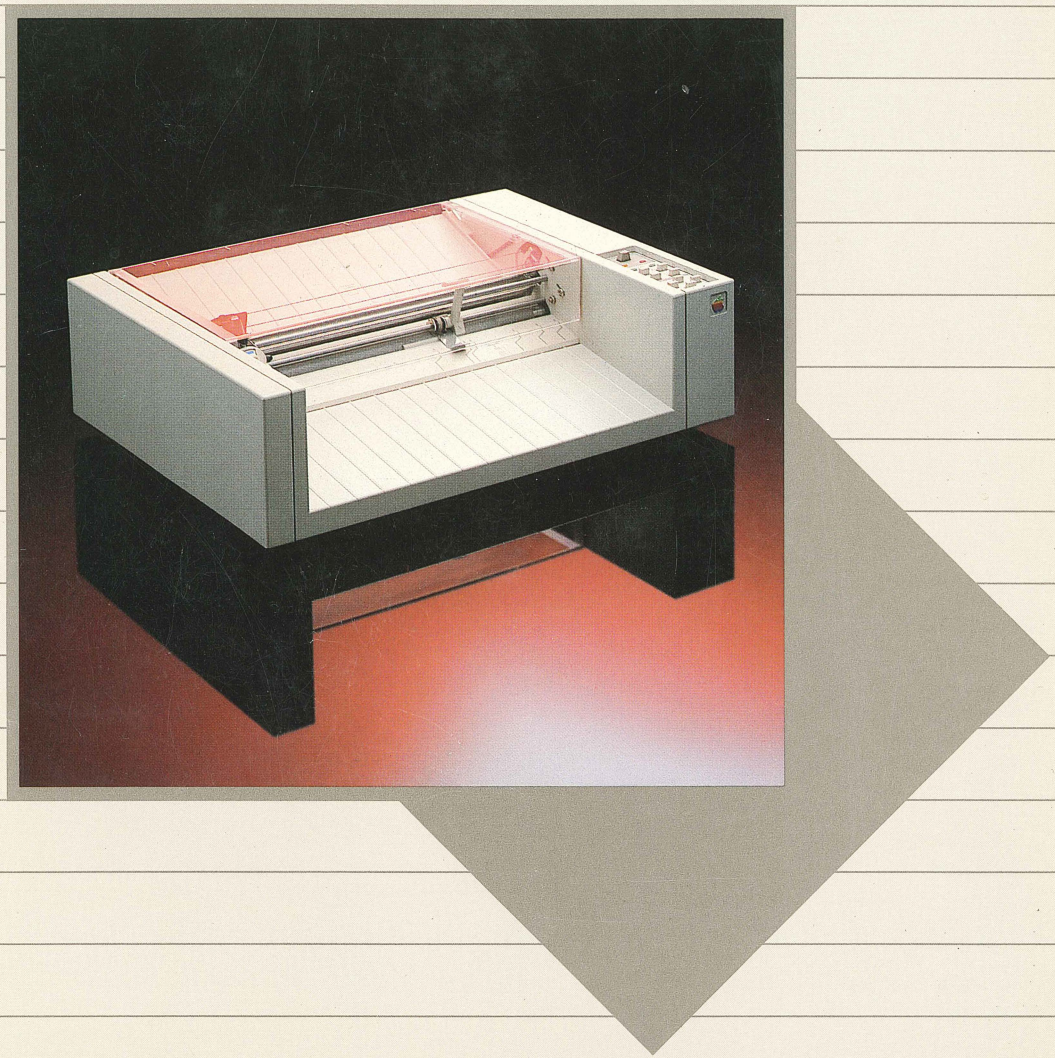
Apple *II*

Color Plotter User's Manual

Part II: Guide to Apple *II*



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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.

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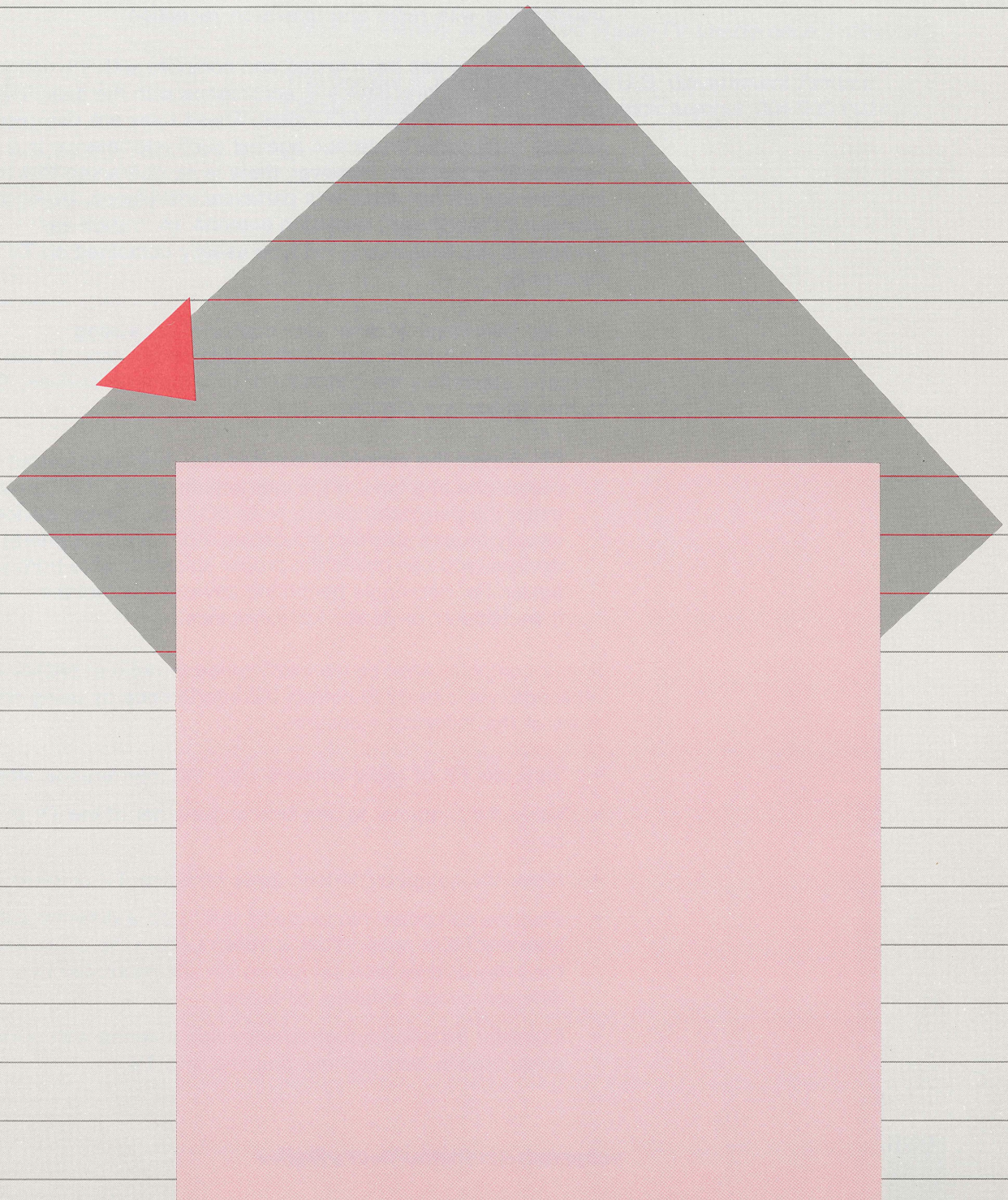


Radio and Television Interference

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 with 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, 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, especially if you use a "rabbit ear" television antenna. (A "rabbit ear" antenna is the telescoping-rod type usually contained on TV receivers.)

You can determine whether your computer is causing interference by turning it off. If the interference stops, it was probably caused by the computer or its peripheral devices. To further isolate the problem:

- Disconnect the peripheral devices and their input/output cables one at a time. If the interference stops, it is caused by either the peripheral device or its I/O cable. These devices usually require shielded I/O cables. For Apple peripheral devices, you can obtain the proper shielded cable from your dealer. For non-Apple peripheral devices, contact the manufacturer or dealer for assistance.

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 than the TV or radio. (That is, make certain the computer and the radio or television set are on circuits controlled by different circuit breakers or fuses.)
- Consider installing a rooftop television antenna with coaxial cable lead-in between the antenna and TV.

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

''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.

Table of Contents

Introduction to Part II

This version of Part II is for Apple II owners

This book is a continuation of Part I of the *Apple Color Plotter User's Manual*. We have published it as a separate volume because it contains information that is specific to your Apple II, II Plus, or IIe system. Other versions of Part II, covering other Apple computers, are available.

Warning

If your computing system is not based on an Apple II, II Plus, or IIe you have the wrong book, and probably the wrong Apple Color Plotter Accessory Kit as well. Check with your Apple dealer.

Read Part I first

We strongly recommend that you read at least the Introduction and Chapter 1 of Part I before trying to read this book. The discussion in Part II assumes that you are familiar with certain material presented in Part I.

Warning

This equipment is intended to be electrically grounded.

This product is equipped with a three-prong power cord. As a safety feature, the plug is designed to fit only into a polarized, grounded three-hole outlet. If you don't have such an outlet, have a licensed electrician install one (and a grounding conductor, if necessary) where you will use the computer. Do not defeat the purpose of the grounded plug.

Connecting the Plotter to Your Computer

Do Chapter 3 in Part I first

Chapter 3 of the *Apple Color Plotter User's Manual, Part I* (hereafter referred to as Part I) explains how to set up your Apple Color Plotter and get it ready to accept commands from your computer. Read that chapter first and follow its directions, before trying to make the final connection.

This chapter tells you how to prepare your computer

When you have finished the installation procedure described in Part I, Chapter 3, you are ready for this chapter. It tells you how to get your Apple II system ready to communicate with your plotter, and how to complete the hookup.

What You Need

To complete the installation of your Apple Color Plotter, you will need the following items:

1 Apple II Super Serial Card, no. 670-8020
1 *Super Serial Card Installation and Operating Manual*
1 connecting cable, Apple no. 590-0037-B

You need a Super Serial Card and the correct connecting cable

The Apple II Super Serial Card can be obtained from your Apple dealer. If your system includes a modem or a serial-input printer, your computer may already contain a Super Serial Card. The connecting cable is included in your Apple Color Plotter Accessory Kit, Apple II version.

Warning

The Super Serial Card is the *only* Apple output card that will work properly with the Apple Color Plotter. Other communication cards (including the Apple Serial Interface Card, versions P8 and P8A) may appear to work; but they do not contain the hardware handshake feature that prevents your computer from overfilling your plotter's input buffer. This means that they can handle only short sequences of plotter commands.

Installing the Super Serial Card

What the Super Serial Card is

The Super Serial Card is an electronic circuit board that converts commands from your computer into electrical signals that your plotter can understand. It plugs into one of the connector slots inside your Apple II computer. Included with it is a short, flat cable; one end of this cable plugs into a connector on the card and the other end has a metal fitting that fits in one of the slots in the back of your computer.

To install the Super Serial Card, follow these steps:

Warning

Before opening your Apple computer, make sure that the power switch is turned off. *This is important;* you can easily damage your computer by working on it while the power is on. Leave the power cord plugged in, however, to maintain the grounding circuit.

1. Check to see that the triangle mark on the jumper block of your Super Serial Card is pointing to the word TERMINAL. This places the card in printer mode, as described in the *Super Serial Card Installation and Operating Manual.* If the jumper block needs to be reversed, gently unplug it from the board (by using an IC extractor or by prying it up with a small screwdriver), turn it around, and plug it back in.
2. Set the switches on your Super Serial Card as shown in Figure 1-1. Their positions should be as follows:

SW1:	1	Off	SW2:	1	On
	2	On		2	Off
	3	On		3	Off
	4	On		4	On
	5	Off		5	Off
	6	On		6	Off
	7	On		7	Off

How to install it

3. Open the case of your Apple computer and install the Super Serial Card in slot 2, as described in the *Super Serial Card Installation and Operating Manual.* Install its connector on the back panel of your computer.

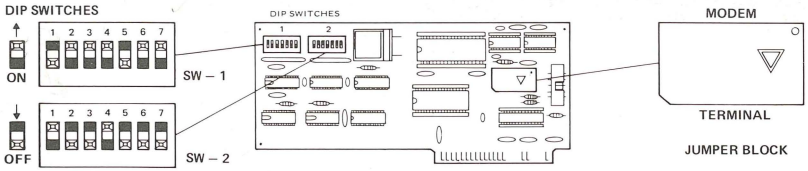


Figure 1-1. Super Serial Card Switches

Install the card in slot 2

Note that you are plugging the Super Serial Card into the slot usually reserved for modem communication, even though you have configured the card for printer mode, which normally earmarks it for slot 1. This is OK; it will work as well in slot 2 as in slot 1. Using slot 2 is preferable so that slot 1 is left free for a printer interface card. Moreover, some graphics programs for the Apple Color Plotter are written with the assumption that the Super Serial Card is in slot 2.

Technical Information: The installation just described configures any Apple II computer to communicate in the following serial data mode:

- Interface: RS232C with hardware handshaking
- Data byte length: 7 bits
- Parity check: none
- Transmission rate: 1200 baud
- Software access: slot 2: Pascal: REMOUT:
  BASIC: #2
  (if plugged into slot 1: Pascal: PRINTER:
  BASIC: #1)

Hooking Up the Plotter

Installing the connecting cable

Chapter 3 of Part I covers the installation of the connecting cable on your plotter. You can now plug the other end of the cable into the connector from the Super Serial Card that you just installed on the back of your Apple computer. Gently tighten the two little screws on the cable head, so that it won't work loose.

Warning
As always, be sure both the plotter and the computer are switched off before connecting them.

Your Apple Color Plotter should now be ready to function as part of your Apple II computing system.

Testing Your Installation

You need a program to test your installation

Except for a few panel control operations (described in Part I, Chapter 5), your plotter responds only to software commands issued by your computer. So to test your finished hookup, you must run a program. There are several ways you can do this:

- Load a standard graphics program into your computer.
- Use a text editor or word processing program.
- Write a short program yourself in BASIC or Pascal.

If you are not able to perform any of these procedures, ask your Apple dealer for assistance.

First turn on your plotter's two green lights

The first step is to turn on both your plotter and your computer and press the Remote/Local button on your plotter's control panel once, thereby lighting its two green lights. Then follow one of the procedures below.

Testing With a Graphics Program

A graphics program does it all

Your Apple dealer carries graphics programs that are specifically designed to operate the Apple Color Plotter. When you place the disk in your computer's disk drive and turn on your system, the program automatically sends your computer a complete vocabulary of plotter commands. You can then test your hookup just by trying one of the routines described in the user's guide that came with the program disk.

Warning

Read the manual that came with the program to make sure that it is specifically adapted for the Apple Color Plotter. There are many graphics programs on the market, but only those that have been written for the Apple Color Plotter are capable of operating it.

Testing With a Word Processing Program

You can test your hookup by typing a few plotter commands into a disk file and then telling your computer to send the file contents to your plotter. This procedure is described in more detail in Chapter 2 under Using Word Processing Programs. Plotter commands are

described in Part I of this manual, in Chapter 5. A simple command for test purposes is

```
PM1;
```

This will make your plotter drop its Pen Head and then raise it. You can execute this test without having to put paper into your plotter or install its pens.

Chapter 2 explains how to use a word processing program with your plotter

Writing a Test Program

If you are familiar with BASIC or Pascal, the easiest way to test your plotter hookup is to write and execute a short program. Here are some examples:

BASIC:
```
10 PR# 2
20 PRINT "PM1;"
30 PR# 0
40 END
```

Pascal:
```
PROGRAM TEST;
VAR ACP : TEXT;
BEGIN
REWRITE (ACP, 'REMOUT:');
WRITE (ACP, 'PM1;');
CLOSE (ACP)
END.
```

What the test programs do

Either program will cause your plotter to drop its Pen Head once and then raise it. The BASIC program does this by switching program output to your plotter (line 10), sending it the sequence PM1; (line 20), and then returning output to your monitor screen. If your computer has an 80-column text card installed in slot 3, change line 30 to PR# 3. The Pascal program does it by opening your plotter as a device under its Pascal unit name REMOUT: and then writing the string PM1; to it.

Note: If you installed the Super Serial Card in slot 1 instead of slot 2, change line 10 of the BASIC program to PR# 1. In the Pascal program, replace REMOUT: with PRINTER:.

If It Doesn't Work

Don't be discouraged if your plotter hookup doesn't work the first time. Just go back and check the following:

- Did you verify the setting of the switches on the back of your plotter, as described in Part I, Chapter 3?
- Did you run the plotter's built-in test, following the instructions in Part I, Chapter 3?
- Did you set both the jumper block and the switches on the Super Serial Card, as described in this chapter?
- Did you use the correct Apple cable to connect your plotter?
- Were both green lights on the plotter Control Panel lit, as well as the yellow Power light?
- Did you run the test according to the directions just given?

If the answer to all these questions is yes, and your installation still doesn't work, consult your Apple dealer.

Using Packaged Software

The Apple Color Plotter is designed for non-programmers

You don't need to be a programmer to work with the Apple Color Plotter. There are pre-written programs available with which you can perform most of the jobs that your plotter is capable of doing.

Some jobs your plotter can do using prewritten programs:
Engineering drawings
Advertising art
Printed forms
Floor plans
Flow charts
Logic diagrams
Organization charts
Architectural details
Custom graph forms
Circuit diagrams
Animation cels

Using a standard word processing program, you can assemble files of plotter commands and instruct your plotter to perform them in any combination you want. With packaged graphics programs, you can create drawings of virtually any description. Either way, you can use all of the features of your Apple Color Plotter without ever having to create your own computer program. This chapter tells you how.

Using Word Processing Programs

Your plotter understands ordinary letters and numbers

As explained in Part I, Chapter 5, your plotter responds to sequences of ordinary numbers, letters, and punctuation marks. You can tell your computer to send it a list of commands in the same way that you tell it to send a business letter to a printer, only now your file contains expressions such as "MR1250,460;" instead of "Dear Mr. Jones."

A word processor lets you talk to your plotter

This means that you can use standard word processing programs (such as Apple Writer or the Pascal Editor) to create and store sequences of plotter commands. You can follow the same procedures that you use to send text files to a printer, or display them on your monitor screen; but this time you send them to your plotter.

In general, using a word processing program to control your plotter requires two steps:

1. Type the command sequences you want, following the directions in Part I, Chapter 5; store them either in temporary memory or in a disk file.
2. Send the result to your plotter, using either its slot number (normally 2) or its Pascal unit name REMOUT:.

How to do it

The plotter takes the place of a printer or other output device in this procedure. The word processing program helps you assemble and edit the commands you want to send to it. For further details about editing plotter commands, consult the operating manual for the particular program you are using.

A Typical Word Processor: Apple Writer

Apple Writer is handy for editing plotter commands

Apple Writer II is available from your Apple dealer. It is a program with two parts: word processing and print formatting. Its word processing routines help you assemble, edit, and store sequences of plotter commands. The print formatter transmits these commands to your plotter.

Before using the Apple Writer print formatter to send commands to your plotter, you must tell it which slot in your Apple II contains the Super Serial Card. You do this by changing the print destination (PD) in Apple Writer's list of Print/Program Commands. Here's how:

1. From the Apple Writer editor menu, press (CONTROL)-(P) and type ?. This will bring its current list of formatting instructions to the monitor screen.
2. Type PD2 to change Apple Writer's print destination to slot 2 (or PD1 if you plugged the Super Serial Card into slot 1).

Setting the Apple Writer print destination

3. Press (RETURN) to return to the editor menu.

Sending the Apple Writer file to your plotter

Once you have set the Apple Writer print destination as just described, you can send its current working file to your plotter by typing (CONTROL)-(P)NP when the editor menu is showing. Your plotter will perform the tasks specified by the commands you have written in the Apple Writer file.

Note: Apple Writer's CONTROL-V command provides a handy way to enter nonprinting characters into a file. Such characters are sometimes needed in plotter commands. See below, Entering Control Characters From the Apple II Keyboard.

A Sample Job

Using disk files to build up drawings

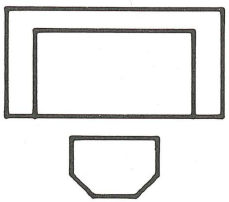
With a word processing program such as Apple Writer, you can create disk files of instructions for making plotter drawings. In the case of complex drawings, you can store the commands for different parts in separate files; you can then duplicate the parts in various positions and combinations on the sheet to achieve the result you want.

An example

Here is an example. As part of an office reorganization, several proposals have been made for arranging the furniture and partitions. By creating accurate floor plans on your Apple Color Plotter, you can visualize the results and make an intelligent choice among the proposals.

Start with a sketch on squared paper

The first step is to use your word processing program to create permanent disk files of the commands necessary to draw a plan view of each item of furniture. You can easily calculate these commands by sketching the item on squared paper, where each square corresponds to a certain number of measurement units on the plotter's X or Y axis.



For instance, a file containing the following commands will order your plotter to make a schematic drawing of a desk and chair:

```
MR75-150;DR-150,0;DR0,300;DR150,0;DR0-
300;MR0,40;
DR-120,0;DR0,220;DR120,0;MR30-
50;DR50,0;DR30-30;
DR0-60;DR-30-30;DR-50,0;DR0,120;MR-105-60;
```

Use relative commands

Note that the commands are expressed in *relative* motions (MR and DR commands); this is because you want to be able to place your drawing anywhere on the sheet.

Positioning your drawings

By repeatedly sending this file of commands to your plotter, you can draw multiple copies of your desk-and-chair diagram at different locations on your plan of the office floor space. To position the pen each time, you can either use the Motion Buttons

on your plotter's Control Panel or you can copy your drawing sequence several times into a larger file containing absolute pen motion (MA) commands. By using the plotter's scaling commands you can reduce or enlarge each drawing. With pen select commands you can emphasize details in contrasting colors. You can enter text-writing commands to provide neat, legible notations. The finished product will be accurate and professional.

Using the Pascal Editor

You can use the editor program that comes with the Apple II Pascal package as a word processor, to create files of commands and transmit them to your plotter. However, Pascal Editor fills the end of every file with characters that cause your plotter to register an error. To overcome this effect, include the following heading and ending in each file you write:

```
;IM0,31;
...your commands...
IM0,0;
```

You need a special file heading and ending with Pascal Editor

The two IM commands turn on error checking at the start of your command sequence and turn it off at the end. The semicolon at the start of the file acts as a plotter end-of-command mark; it purges the garbage characters that were left in your plotter's buffer memory by the previous file.

Sending Pascal text to your plotter

After you have created a plotter command file with the Pascal Editor, you can transmit it by using your plotter's Pascal unit name as the destination. Pascal knows your plotter as REMOUT: if the Super Serial Card is in slot 1, or PRINTER: if it is in slot 2. You can send your text directly from the editor by choosing `Write to a file name and return`; or you can write it to a disk file. You can send a disk file to your plotter at any time by using the Pascal Filer Transfer command (T).

Entering Control Characters From the Apple IIe Keyboard

Some commands for the Apple Color Plotter include non-printing *control characters*. You normally enter control characters from your Apple IIe keyboard by holding down CONTROL while you press the required letter key. But if you are entering such characters while using certain word processing programs, you must also hold down ☆. This sets the eighth bit of the ASCII code

Use ☆ with control characters

and prevents the character from appearing as an instruction to the word processing program. Here is a list of the control characters that your plotter recognizes:

Command	Hold Down These Keys	Press This Key
Control-C (ETX)	☐ CONTROL	C
Backspace	☐ CONTROL	H
Line Feed	☐ CONTROL	J
Carriage Return	☐	RETURN
Control-Q Reset	☐ CONTROL	Q
Control-U Reset	☐ CONTROL	U
Control-R Reset	☐ CONTROL	R

Entering Control Characters From the Apple II Keyboard

Some word processing programs refuse Apple II control characters

The Apple II keyboard does not have an ☐ key to neutralize control characters. For this reason, you may find it difficult to enter control characters into text files when using certain word processing programs. The Pascal Editor, for example, recognizes CONTROL-C as a command to quit the current editing routine, and will not pass it on to the file you are constructing. This can create problems when you are trying to enter text-writing commands for your plotter, which must terminate with CONTROL-C.

Apple Writer accepts control characters

Apple Writer II solves this problem with its CONTROL-V command, which allows you to enter nonprinting control codes into your file. To enter a CONTROL-C character, for example, you press the following sequence of keys:

CONTROL-V
CONTROL-C
CONTROL-V

For further details, see the *Apple Writer II Operating Manual*.

Using Packaged Graphics Programs

Notes on graphics programs

Graphics programs allow you to create pictures—graphs, drawings, diagrams, layouts—on your monitor screen and then transfer them to your plotter. No two graphics programs are alike;

for details about each one, consult its user's manual. There are, however, some general pointers to keep in mind:

- Make sure that your program has been adapted to drive the Apple Color Plotter. The plotter's vocabulary of commands is different from that of any other make. Unless your program speaks its language, your plotter won't be able to obey it. If you're not sure, ask your Apple dealer.
- If the program asks you for a destination name for your plotter, enter 2 (or 1 if you plugged your Super Serial Card into slot 1).
- Remember that your plotter can't make a drawing as rapidly as your computer can generate it on the monitor screen. Complex images with heavily inked areas may take several minutes to complete.

New graphics programs for the Apple Color Plotter are published frequently; check with your Apple dealer to get the latest details.

Programming Techniques

While you can do many jobs with your Apple Color Plotter just by sending it files of commands, other jobs may require you to do some programming. By telling your Apple computer how to generate its own plotter commands, you open up all the possibilities of computer-generated graphics. This chapter contains a few pointers to help you.

Before You Read Further: This chapter assumes that you are familiar with at least one of the Apple II higher-level programming languages—Integer BASIC, Applesoft, or Pascal.

Using BASIC

Apple BASIC

There are two versions of BASIC available for Apple II computers: Integer BASIC and Applesoft. Integer BASIC is the simplest version. Applesoft is Apple's extended form of BASIC, containing additional commands and improved capabilities.

BASIC versus Pascal

BASIC is a good, easy language for writing short programs to operate your plotter. However, writing very long or complicated routines in BASIC can become laborious. If your goal is to create elaborate programs you should consider using Pascal instead. Pascal is discussed in the next section of this chapter.

Switching output to your plotter

With BASIC, you send commands to your plotter by switching the entire program output from the monitor to the plotter and then executing output instructions such as PRINT. Output switching is performed by the command PR# followed by a reference number. This number is the number of the slot into which you have plugged the Super Serial Card, normally 2. Thus the typical output switching instruction is PR# 2; you can either execute it immediately or give it a line number and include it in a program.

Switching output back to the monitor

When you want to switch output back to the monitor screen, use PR# 0. If you are using an 80-column text card plugged into slot 3 (if you have an Apple II) or the Auxiliary Slot (if you have an Apple IIe), use PR# 3 instead.

Using DOS: When running BASIC with the Apple II Disk Operating System (DOS), you should preface each PR# statement with a (CONTROL)-(D) character. See Chapter 10 of the *Apple II DOS Manual*.

After you have switched program output to your plotter, as just described, you can send commands to it with PRINT statements. For example, the instruction

PRINT commands in BASIC

```
PRINT "DR50,60;"
```

will tell your plotter to draw a line from the current pen position to a point 50 units farther along the X axis and 60 units farther along the Y axis. For explanations of all plotter commands, see Chapter 5 in Part I of this manual.

The foregoing example does not contain a plotter end-of-command mark, because each PRINT statement automatically inserts a Return character at the end. If you string several plotter commands together on one BASIC instruction line, however, you must include internal end-of-command marks (such as semicolons) to allow the plotter to distinguish them. Notice their use in this example:

Plotter end-of-command marks in BASIC

```
PRINT "DR50,60;" : PRINT "DR60,70;DR70,80;";"DR80,90;"
```

Remember that every PL command (to make the plotter write text) must be terminated by a (CONTROL)-(C) character. In Applesoft you can create this character by the instruction PRINT CHR$(3). In Integer BASIC you must quote it in the program.

Plotter command statements in BASIC may of course contain variables in place of fixed characters. For instance, the following group of program lines accomplishes the same result as the fixed statement PRINT "DR50,60":

Using variables in BASIC

```
50 A$ = "DR"
51 YLOC = 60
52 PRINT A$; "50,"; YLOC
```

Don't forget that in Integer BASIC string variables such as A$ must be dimensioned with a DIM statement before they can be used.

Using DATA and READ

You can also use DATA and READ statements in BASIC to send long strings of plotter commands from your program text.

Program efficiency

With both BASIC and Pascal, the speed with which your program generates commands for your plotter usually does not matter. Because it is a mechanical device, the plotter will almost always lag behind. This means that you can write relatively inefficient routines without worrying about creating delays in the overall program execution time.

Using Pascal

Pascal compared to BASIC

Pascal allows you to write complex program routines with fewer statements than BASIC, and the resulting source text is more readable as well. It is a language well suited to operating the Apple Color Plotter.

Talking to your plotter in Pascal

Pascal treats the Apple Color Plotter as if it were an external text file to which you write plotter commands. Thus the first steps when creating a Pascal program to operate your plotter are to declare a file variable for it and then open that file using the REWRITE procedure:

```
PROGRAM EXAMPLE;

VAR ACP :  TEXT;  {Plotter declared as a text file}

BEGIN
REWRITE (ACP, 'REMOUT:');  {Open plotter as an output}
    . . .
```

"ACP" is just an example of a filename for your plotter; you could call it "XYZ" or "MYPLOTTER".

Warning
The Pascal RESET procedure cannot be used to open the plotter file.

Once you have declared the plotter as a text file and opened it with REWRITE, you can send commands to it at any time by using WRITE or WRITELN statements:

```
WRITE (ACP, 'DR50,60;');
WRITELN (ACP, 'DR50,60');
```

Sending commands in Pascal using WRITE and WRITELN

Both of these statements send the plotter (previously declared as the text file ACP) the command DR 50, 60—namely, draw a line from the current pen location to a location 50 units farther along the X axis and 60 units farther along the Y axis. Note that the WRITE statement includes a semicolon to terminate the command, whereas the WRITELN statement does not need to. This is because the WRITELN procedure automatically sends a Return character after its text message; your plotter recognizes both semicolon and Return as valid end-of-command marks. To create the CONTROL-C character needed to terminate plotter text-writing commands, use the Pascal function CHR(3).

Caution: Don't try to use the Pascal UNITWRITE procedure with your plotter unless you understand it thoroughly. UNITWRITE is difficult to control and offers practically no advantages over WRITE or WRITELN.

Commands containing variables

Of course you are not confined to sending fixed-text commands to your plotter. If your Pascal program contains a variable declared as real or integer (for example, YLOC), a statement such as

```
WRITELN (ACP, 'DR50,' YLOC);
```

will order your plotter to draw a line from the current pen location to a point 50 units away on the X axis and YLOC units away on the Y axis.

Using the PUT procedure

You can also use the Pascal PUT procedure to send commands to your plotter one character at a time:

```
ACP^:= 'D';
PUT (ACP);
```

Here the dynamic character variable ACP^ (created when ACP was opened by the REWRITE procedure) is assigned a value—in this example, the letter D. Its value is then sent to the plotter by PUT. This technique is useful when you want to operate your plotter by transferring commands one character at a time from another device, such as your Apple keyboard or a disk file. For an example see the utility program FILEPLOT, later in this chapter.

Ending with CLOSE

After your Pascal program is finished operating your plotter, it should contain a CLOSE statement:

```
CLOSE (ACP);
```

This will remove all the internal Pascal file links that were created by the REWRITE procedure.

Utility Programs

Here are three short, handy programs that you can add to your repertoire of computer tools. They are called KEYPLOT, KEYFILE, and FILEPLOT. You can write KEYPLOT in either Integer BASIC, Applesoft, or Pascal; KEYFILE and FILEPLOT are available only in Pascal. This is what these programs do:

- KEYPLOT allows you to type commands directly from your computer keyboard to your plotter.
- KEYFILE allows you to type plotter commands to a disk file.
- FILEPLOT transfers the contents of a disk file to your plotter.

KEYPLOT

KEYPLOT connects your keyboard to your plotter

KEYPLOT is a simple program that connects the Apple keyboard as an input device to the plotter as an output device. It allows you to type commands directly into your plotter. It maintains the connection until you type in a command line consisting of a single semicolon.

Use a new PL command for each line of text writing

If you are using KEYPLOT to write text on your plotter, type a separate line for each line of text to be written. Begin each line with a new PL command. For example:

```
PLfirst line
PLsecond line
```

There are two versions of KEYPLOT in BASIC (one for Integer BASIC and one for Applesoft), plus one for Apple Pascal. You can easily tell which kind of BASIC is in your computer by noticing which line prompting character it displays:

Line prompting characters:
> for Integer BASIC
] for Applesoft

Integer BASIC:

```
>10 DIM A$(40)
>20 INPUT A$
>30 IF A$=";" THEN END
>40 PR# 2:  PRINT A$
>50 PRINT "" : REM CONTROL-C
>60 PR# 0
>70 GOTO 20
```

Notes: When you enter the Integer BASIC version, type CONTROL-C between the quotes in line 50. In line 40, the number is the slot number of the Super Serial Card. Line 60 should be PR# 3 if you are using an 80-column text card.

Applesoft:

```
]10  INPUT A$
]20  IF A$=";" THEN END
]30  PR# 2
]40  PRINT A$ CHR$(13) CHR$(10) CHR$(3)
]50  PR# 0
]60  GOTO 10
```

Note: When using the Applesoft version KEYPLOT, avoid placing commas in your plotter commands.

Pascal:

```
PROGRAM KEYPLOT;
VAR     COMMANDS : STRING;
        ACP : TEXT;
BEGIN
    REWRITE (ACP, 'REMOUT:');
    WHILE COMMANDS <> ';' DO
        BEGIN
            READLN (COMMANDS);
            WRITELN (ACP, COMMANDS);
            WRITE (ACP, CHR(3))
        END;
    CLOSE (ACP)
END.
```

KEYPLOT terminates each line with CONTROL-C

Note that in all three versions a CONTROL-C character (ASCII 3) is inserted at the end of each line of keyboard input. This assures that you will exit from your plotter text-writing (PL) commands. If you prefer, you can omit this feature and enter each CONTROL-C manually (see the sections of Chapter 2 on entering control characters from the Apple II and Apple IIe keyboards.

KEYFILE

KEYFILE writes a disk file from your keyboard

KEYFILE provides a convenient way to construct disk files of plotter commands. It first asks you for the pathname of the file you want to create; after you enter the name it constructs the file on disk and writes your subsequent keyboard entries to it. You terminate KEYFILE and close the file by entering a line consisting of a single semicolon.

KEYFILE adds CONTROL-C to each line

As with KEYPLOT, KEYFILE ends each line of input with a CONTROL-C character, which is automatically written to the file. This means you must start each line of plotter-written text with a new PL command, but do not need to worry about terminating each text command.

Here is the Pascal listing for KEYFILE:

```
PROGRAM KEYFILE;
  VAR     COMMANDS : STRING;
          OUTFILE : TEXT;
  BEGIN
      WRITE ('Pathname of file: ');
      READLN (COMMANDS);
      REWRITE (OUTFILE, COMMANDS);
      WHILE COMMANDS <> ';' DO
          BEGIN
              READLN (COMMANDS);
              WRITELN (OUTFILE, COMMANDS);
              WRITE (OUTFILE, CHR (3))
          END;
      CLOSE (OUTFILE, LOCK)
  END.
```

FILEPLOT

FILEPLOT reads a disk file to your plotter

FILEPLOT sends commands from a disk file to your plotter. It asks for the pathname of your disk file (complete name, please) and then empties the file into your plotter.

Here is the Pascal listing for FILEPLOT. It has been written to illustrate the Pascal PUT procedure discussed earlier under Using Pascal.

```
PROGRAM FILEPLOT;
   VAR      INFILE, ACP : TEXT;
            FILENAME : STRING;
   BEGIN
        WRITE ('Pathname of file:  ');
        READLN (FILENAME);
        RESET (INFILE, FILENAME);
        REWRITE (ACP, 'REMOUT:');
        WHILE NOT EOF (INFILE) DO
            BEGIN
                ACP^  := INFILE^ ;
                PUT (ACP);
                GET (INFILE)
            END;
        CLOSE (ACP)
   END.
```

A Few Programming Tips

As you write programs for your Apple Color Plotter, you will discover many ways to exploit its capabilities. This manual has been confined to describing the basic tools you need; there isn't room for a complete discussion of graphic programming techniques. But here are some miscellaneous hints to get you started.

Text-Writing Options

Lettering tricks

You can achieve many typographical effects when writing text with your Apple Color Plotter. These are just a few of the possibilities:

- Italics: Use the SL command to give your lettering a forward or backward slant, for dynamic emphasis. An angle between 10 and 25 degrees is normal for slanted lettering.
- Boldface: Write the same text twice, starting the second time from a position 0.2 mm farther along both the X and Y axes.
- Condensed or extended face: Change the Window command to vary the ratio between X-axis and Y-axis measurements, thereby stretching or compressing your lettering. If you do this on a line-by-line basis, you can write text in lines of equal length (right-justified blocks).

Using Symbols

Options for drawing symbols

You will find many uses for the symbols that your Apple Color Plotter writes in response to your PM commands. They are particularly handy because they can be modified in a number of ways:

- You can draw them virtually any size, using the LS command.
- You can rotate them to any angle with the LR command.
- You can tilt their vertical lines with the SL command.

The X and + symbols (PM7 and PM8), in particular, can perform many graphics jobs when enlarged and rotated. Other symbols are also useful. Here, for example, is a sequence of commands that draws a line with arrowheads on each end, for dimensioning a mechanical drawing:

An example

```
LR 90; PM 10;
DR 500, 0;
LR -90; PM 10;
```

Broken-Line Graphs

The Apple Color Plotter is particularly useful for converting statistical data into broken-line graphs. A common way of doing this is to write a program loop that sends the plotter a series of Draw Absolute (DA) commands, incrementing the X-axis value each time while using data quantities to determine the Y-axis value. For example, the following Pascal fragment graphs the values in the array DATABANK in 100-unit steps:

Graphing the quantities in a Pascal array

```
VAR     ACP : TEXT;
        DATABANK : ARRAY [1..10] OF REAL;
        N : INTEGER;
    . . .

REWRITE (ACP, 'REMOUT:');
FOR N := 1 TO 10 DO
        WRITELN (ACP, 'DA', N * 100, ',', DATABANK [N]);
CLOSE (ACP);
    . . .
```

Tricks with graphs

Here are some things to remember about graphs:

- You can select any line pattern (including a custom pattern) by using the LT command. The pattern will appear to repeat continuously, regardless of how the line bends.
- You can change trace color at any time, using the PS command; for example, you can identify parts of the graph that are outside limits by switching to red. Your plotter will change the pen and return to its place on the graph.
- You can attach symbols to the graph trace, using the PM command. Your plotter will draw each symbol with a line attached to the graph trace and return the pen to its former position.

The available combinations of line patterns, colors, and symbols allow you to identify a large number of separate traces on a single graph field.

Solid Areas

Solid colors

You can make your Apple Color Plotter fill in areas with solid colors, by writing a program that draws closely parallel lines. To minimize the time necessary to fill in a space, use wide (0.7 mm) pens and write your program so that it draws back and forth, not just in one direction. To fill circles or pie shapes, use CA or AC commands with increasing or decreasing radius values.

Crosshatching

Your Apple Color Plotter also does a fine job of filling areas with crosshatching. Draw parallel lines, as with solid colors, but space them farther. By selecting different colors and line patterns, you can produce a variety of different styles of hatching. You can use the XT and YT commands to draw rectangular grid patterns, as explained in Part I, Chapter 5.

Drawing Arcs

Arcs are useful for making such drawings as pie charts and engineering diagrams. As explained in Part I, Chapter 5, you tell your Apple Color Plotter to draw arcs by using the CA command. You specify the radius, the starting and stopping angles, and (optionally) the coordinates of the center of curvature. However, there are two areas where you need to take extra care:

Be careful when specifying arc commands

- The direction in which the arc is drawn depends on the numerical relation between its starting and stopping angles;

- The new pen position after the AC command will be wherever the arc ends.

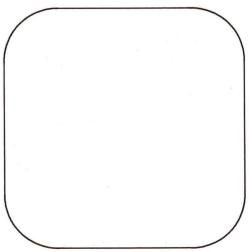
How to draw arcs clockwise or counterclockwise

Every arc is a portion of a circle defined by two end points. Starting from the first end point, the arc to the other end point may be drawn either clockwise or counterclockwise around the circle, with different results. The rule is: If the angle of the second end point is larger than the angle of the first, the arc will be drawn *counterclockwise*; if it is smaller, it will be drawn *clockwise.*

Using angles outside the range 0 to 359 degrees

You can use angles that are less than 0 or more than 359 degrees to create the drawing direction you want. Thus to draw an arc clockwise from 100 to 200 degrees, specify its end points as 100 and -160 degrees (360 - 160 = 200). To draw an arc counterclockwise from 200 to 100 degrees, specify its end points as 200 and 460 degrees (360 + 100 = 460).

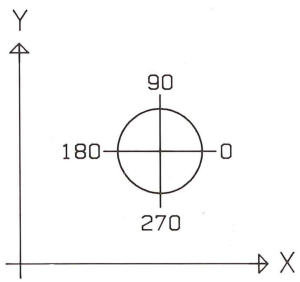
For example, the following sequence of arc and line commands draws a square with rounded corners, moving counterclockwise. Note the specification of an angle of 360 degrees (instead of 0 degrees) in the first arc:



```
MA 500, 300;
DR 500, 0;
AC 200, 270, 360, 1000, 500;
DR 0, 500;
AC 200, 0, 90, 1000, 1000;
DR -500, 0;
AC 200, 90, 180, 500, 1000;
DR 0, -500;
AC 200, 180, 270, 500, 500;
```

The relationship between arc angles and the X and Y axes of the plotter is shown in Figure 3-1.

Figure 3-1. Arc Angles



Finding the end points of arcs

To draw another element (such as a straight line) to meet one end of an arc, you need to know where the arc begins and ends. In the foregoing example, the arcs are all quarter-circles and hence it is easy to calculate the X-Y coordinates of their end points. When you specify arcs with odd angles, however, you will need to use trigonometric formulas to locate their end points.

Specifying arcs without using angles

You can specify an arc by the position of its end points rather than its angles, by using the Window (WD) and Viewport (VP) commands. Recall that these commands allow you to "slice" any figure off along lines parallel to the X or Y axis. When you specify a circle (or an arc longer than you need) within a restricted Window area, your plotter will draw an arc that terminates at the edges of the Window.

For example, the following sequence of commands draws two arcs that meet to form a lens shape along the axis Y = 1000, by slicing off two circles at that line:

An Example

```
VP 0, 1000, 2000, 2000;
WD 0, 1000, 2000, 2000;
CA 700, 1000, 500;
VP 0, 0, 2000, 1000;
WD 0, 0, 2000, 1000;
CA 700, 1000, 1500;
```

Glossary

ASCII: Acronym for "American Standard Code for Information Interchange"; the code in which information is sent to the Apple Color Plotter. It assigns a unique binary number to each character. See Appendix B.

BASIC: A widely used programming language. Several versions are available for use on Apple computers, including Integer BASIC, Applesoft, and Business BASIC.

Buffer: A memory area that holds information temporarily until it can be processed. The Apple Color Plotter has an input buffer, which stores excess incoming text until the mechanism has time to act on it.

Character: Any letter, number, punctuation mark, or control code that can be acted upon by the plotter. There are 128 possible characters, corresponding to the range of 7-bit binary numbers.

Clear: To erase information or commands from memory, as when the Apple Color Plotter clears its set-up commands.

Command: A sequence of characters sent to the Apple Color Plotter to tell it to do something.

Control Key: The key located near the Shift Key on the Apple keyboard. If held down while another key is pressed, it changes the resulting character.

Coordinate Axis: A figure used with broken-line graphs to define the scale, consisting of a straight horizontal or vertical line intersected by tick marks at regular intervals.

Coordinate System: The arrangement of X and Y axes by which the space in which the plotter works is defined. See Chapter 5.

CR, Carriage Return: See <ret>.

DIP Switch: A small switch, which can be operated manually. There is a set of 8 DIP switches located on the Back Panel of the Apple Color Plotter. See Chapter 3 and Appendix D.

Disk: In Apple computers, a circular sheet of magnetic recording material permanently sealed inside a plastic envelope. When placed in a disk drive, it is used to record and play back data and programs.

Disk Drive: A device that records and reads computer disks, somewhat like a phonograph.

Editor: A program that helps the user create and change text files by providing commands to insert and delete text, etc.

End-of-Command Mark: A punctuation mark used to separate commands sent to the plotter. Also called a "command terminator." See Chapter 5.

Error Condition: The state of the plotter after it has detected a fault in one or more commands sent to it, indicated by turning on the red Error Light. The error condition remains until you reset it.

Execute: To perform the actions specified by a program command or sequence of commands.

File: In a computer, a collection of data with a name. Apple files are normally stored on disks (see entry "Disk").

Font: The collection of printed shapes in which a machine such as the Apple Color Plotter writes characters.

Graph: A pictorial representation of data in the form of a broken line, set of bars of different length, etc.

Graphics: Referring to the capabilities of a device such as a plotter to create designs and pictures.

Interface: In computer hardware, the equipment that accepts electrical signals from one part of a system and renders them into a form that can be used by another part.

LF, Line Feed: An ASCII character (hex code 0A) that instructs a device such as a plotter to start writing one line farther down.

Memory: Any part of a computer system that stores data.

Monitor: In computers such as the Apple, a device with a viewing screen that displays data to the user.

Override: To modify or cancel a long-standing instruction with a temporary one.

Pascal: A higher-level programming language with statements that resemble English sentences, available for all Apple computers.

<ret>, Return: An ASCII character (hex 0D) that instructs a device such as a plotter to start printing at the left end of the line.

Scale: The relation between plotter command numbers and physical distances on the sheet. There may be different scales in the X and Y axes.

Set-Up Commands: Commands sent to the plotter at the start of a job to establish its measurement units, working area, etc.

Sheet: The piece of paper or film on which the plotter draws.

Software: In general, programs and program instructions; opposed to hardware, the machinery that executes software.

Syntax: The rules for arranging characters in commands so that the plotter is able to interpret them.

Terminator: See End-of-Command Mark.

Viewport: The plotter's working area expressed as a physical rectangle on the sheet. See Chapter 5.

Window: The plotter's working area expressed as the range of command numbers that it is programmed to accept. See Chapter 5 for a detailed discussion.

Working Area: The spatial area to which all drawing and writing operations of the plotter are confined.

X axis, Y axis: The two dimensions by which locations on the sheet are defined. In the Apple Color Plotter, the X axis runs between front and back, the Y axis from side to side.

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20525 Mariani Avenue
Cupertino, California 95014
(408) 996-1010
TLX 171-576

030-0743-A