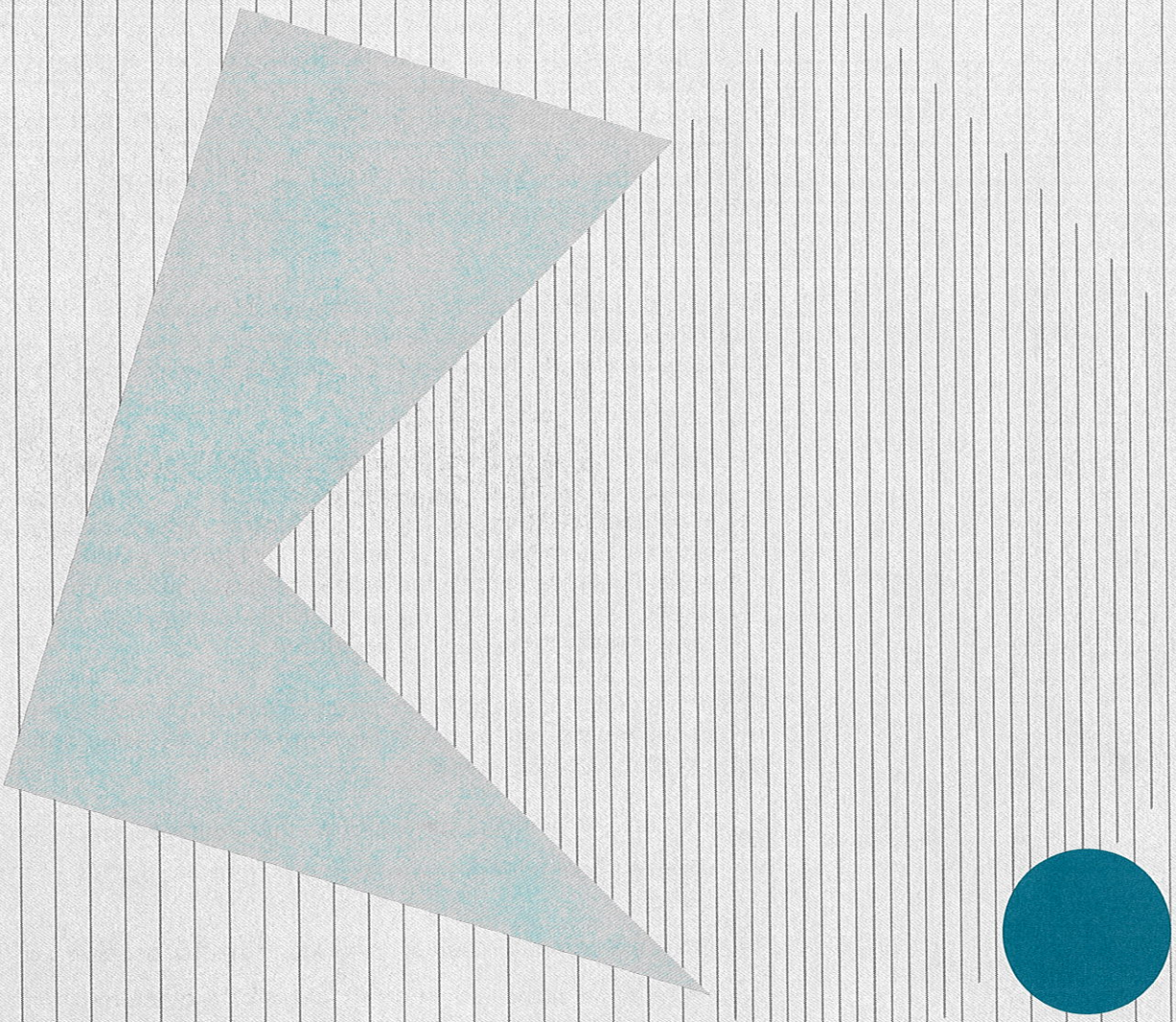
Apple

Color Plotter User's Manual

Part I: Reference



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.

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Introduction

Before connecting your Apple Color Plotter and putting it to work, you should read at least a portion of this manual. It contains important information that will save you time and frustration.

Part I: How your plotter works.

Part II: How to use the plotter with your Apple computer.

This manual consists of two books. Part I, which you are reading now, describes the plotter itself and tells you how it works. Part II describes how to use the plotter with your particular Apple computer system. Both parts are arranged so you can look up information when you need it. After you have gone through them a first time, you will find that they are useful as permanent reference volumes.

What to look for in Part I.

Here is a summary of what Part I of this manual contains:

- Chapter 1, "Getting to Know Your Plotter," tells you what the plotter is and what it can do. This chapter contains pictures that will help you identify the plotter's parts and controls.
- Chapter 2, "Pens and Paper," shows you how to change and position paper, install the marking pens, and get the best quality image.
- Chapter 3, "Installation and Testing," leads you through the process of preparing your plotter to communicate with your Apple computer. Details on connecting the plotter to your particular type of Apple computer are given in Part II of this manual.
- Chapter 4, "Care and Handling," tells you how to take care of your plotter so that you will always get the results it was designed to produce.
- Chapter 5, "Controlling the Plotter," describes all the controls and program commands you can use to make your plotter perform.
- Chapter 6, "Troubleshooting," gives you valuable suggestions on what to do if your plotter doesn't behave properly.

- Appendixes A through D contain useful technical information referred to throughout the rest of this manual.

What to look for in Part II.

Part II of this manual is written with your particular Apple system in mind. Here are some of the things it tells you:

- How to adjust or configure your computer so that it can communicate with your plotter.
- How to send instructions from your computer to your plotter. Both programmers and non-programmers will find it easy to learn how to produce drawings by sending messages through the Apple computer.
- How to control your plotter with BASIC and Pascal program statements.

You can skip parts of this manual at first, reading them later when you need to. This table lists the parts you should read before doing certain tasks:

Task	Part I Chapters 1	2	3	4	5	6	Part II
Setting up and testing your plotter	•		•				•
Operating your plotter but not programming it	•	•		•		•	
Writing control messages (for non-programmers)	•				•		•
Writing programs to control your plotter	•				•		•

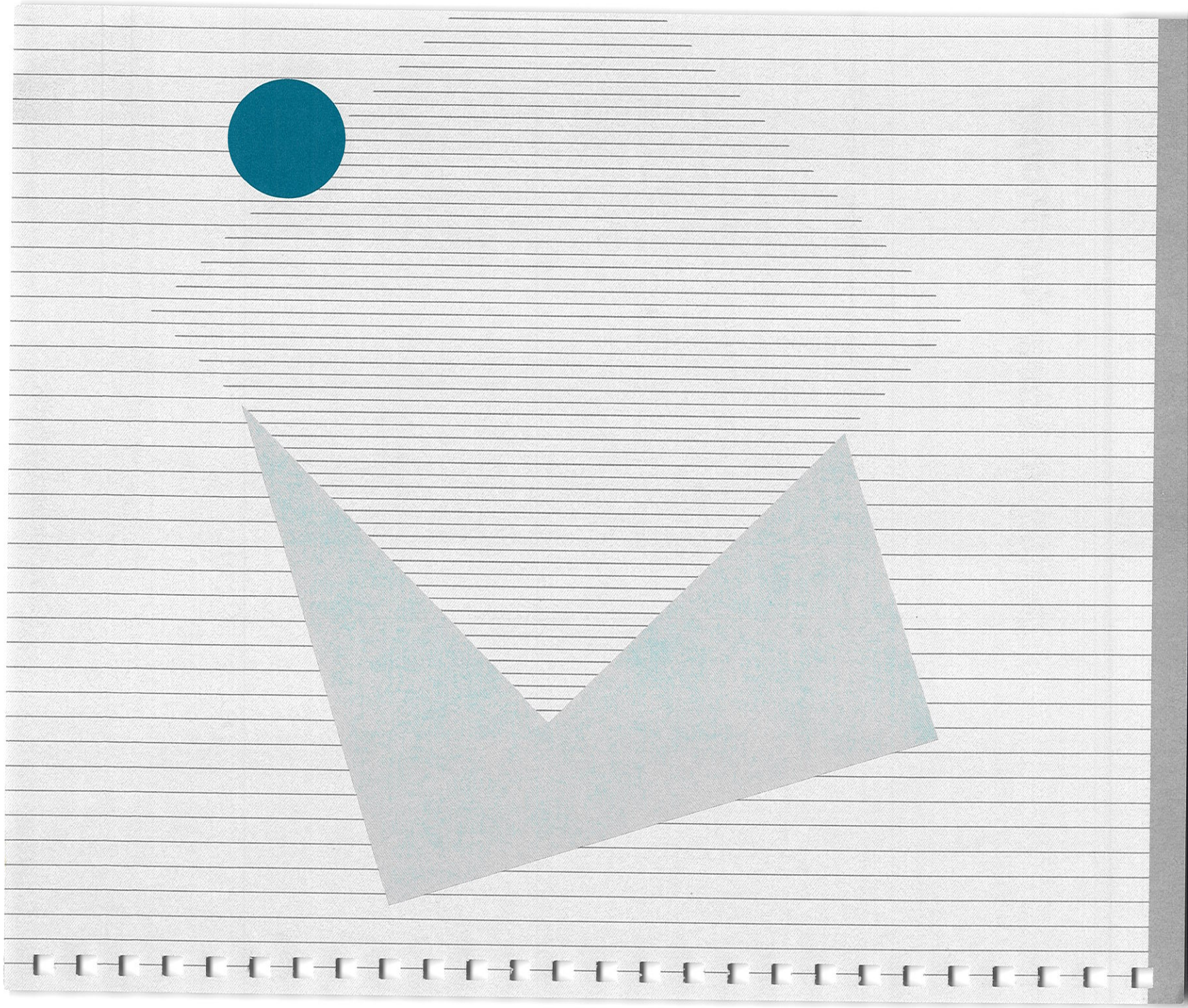
Warning

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.

Chapter 1

Getting to Know Your Plotter



Getting to Know Your Plotter

This chapter introduces you to the Apple Color Plotter and tells you about some of the things it can do.

Now your Apple computer can make pen-and-ink drawings.

The Apple Color Plotter is a desk-top machine that draws permanent pictures under the control of your Apple computer. It lets your computer create graphs, engineering layouts and drawings, architectural drawings, artworks for printing, and complex mathematical curves. Your computer can even use it to play games.

How the Apple Color Plotter works.

You place a sheet of paper or transparent film as large as 11 by 17 inches in your Apple Plotter. As your computer sends it commands, the plotter slides the paper back and forth while moving colored pens into various positions. It draws lines, circles, curves, and symbols in any combination of available colors, all rapidly and automatically. It also writes ordinary text anywhere on the sheet in any size, vertically or horizontally, or at any angle in between. It makes clear, precise images of reproduction quality.

The Apple Plotter is smart.

Your Apple Color Plotter contains its own microprocessor. This means that it is smart enough to add several data processing functions to the commands you send it. For example, you can tell it to compress or expand its vertical and horizontal scales independently; this permits you to produce perspective drawings and conic curves without having to write complicated program routines. When you use the plotter to write printed text, you can take advantage of its built-in capabilities to enlarge, compress, and rotate the lettering, while choosing from a complete selection of English and international characters.

In short, your Apple Color Plotter adds a whole new range of capabilities to your Apple computing system.

Names of Parts

Unpacking instructions are in the carton.

If your Apple Color Plotter is still in its box, unpack it now. You will find a sheet of unpacking instructions lying on top as soon as you open the carton. Save all the packing materials; they will come in handy when you want to store or transport your plotter. After you have finished unpacking your plotter, place it on a table in front of you so you can easily find its parts.

You need the correct Accessory Kit to match your computer.

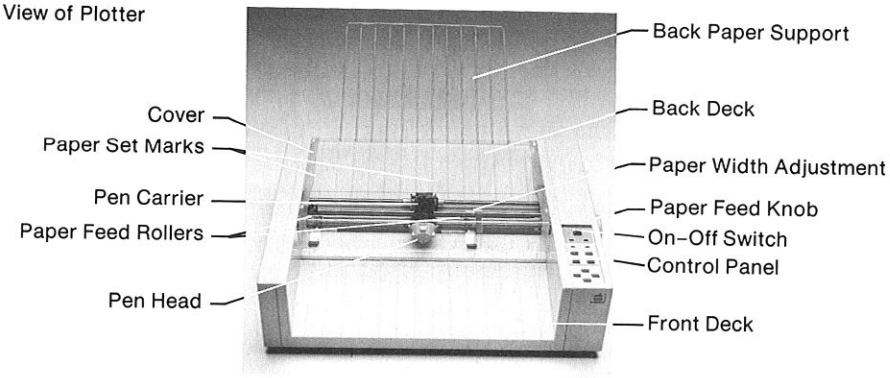
Make sure that you have the correct Apple Color Plotter Accessory Kit for your specific Apple computer system. The model type of your computer should be marked on the Accessory Kit box. In addition to Parts I and II of this manual, the Accessory Kit contains pens, electrical cables, and other items you will need.

Find the parts of your plotter in Figures 1-1 and 1-2.

Now look at Figures 1-1 and 1-2. Figure 1-1 shows a front view of your plotter with the cover raised. The parts of your plotter that are mentioned in this manual are all clearly labeled.

Before you try to hook up your plotter or turn it on take a minute to find these parts and learn their names.

Figure 1-1. Front View of Plotter



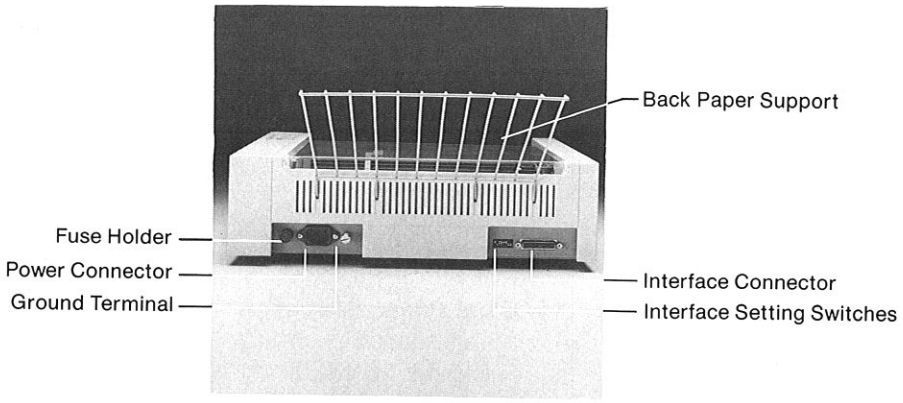
The front of the machine.

These are the parts you should look for in Figure 1-1:

- The **Control Panel** is on the right side as you face the plotter, over the Apple logo. We'll discuss the name and function of each control in a minute.
- The **Paper Feed Knob** is located on the right side of the machine. It allows you to wind paper in and out of your plotter, as described in Chapter 2.
- The **On-Off Switch** is located in the top center of the Control Panel.
- The **Front Deck** is the flat area in front of the cover. You put the paper down on it before sliding it into the plotter.
- The **Back Paper Support** is the wire assembly that fits into the back of the machine and rises behind it. This supports the paper in back as it slides in and out while your plotter is working.
- The **Cover** fits over the entire center of the machine and is hinged in back. Raise it now by lifting the front so that it looks like Figure 1-1. It can only go half-way up; do not try to force it further.
- The **Pen Carrier** is a black, plastic assembly that the beige **Pen Head** fits into. When your plotter is working, it travels from left to right along a horizontal metal bar. In Figure 1-1, it is shown in center position. The Pen Head is discussed in Chapter 2.
- The **Paper Width Adjustment** is a light-colored arm sticking up to the right of the Pen Carrier. Do not try to set it now; wait until you read Chapter 2.
- There are two **Paper Feed Rollers**. They are small wheels made of metal and plastic. One of them is attached to the lower part of the Paper Width Adjustment; the other is located to the far left, on the other end of the horizontal metal shaft.
- The horizontal surface just in front of the Back Paper Support is called the **Back Deck**. If you look at it carefully, you will see two position marks molded into it. These **Paper Set Marks** help you start each sheet at the correct position. When you load paper into your plotter, you will feed it under the Paper Feed Rollers and onto the Back Deck, stopping when its edge reaches these marks. All of this is explained in Chapter 2.

The back of the machine.

Now turn your plotter around and look at the back. Compare what you see with Figure 1-2.



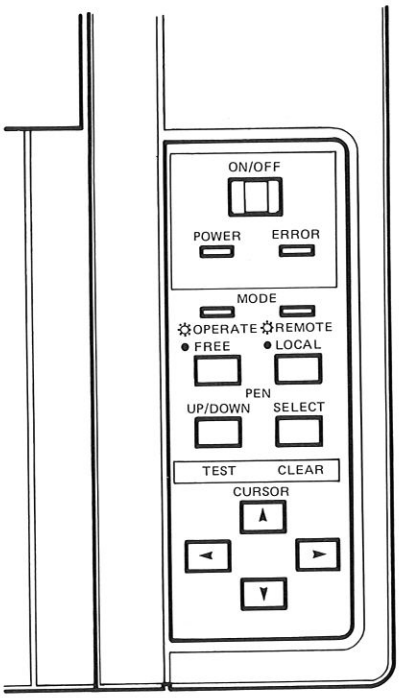
- On the far left end is a **Fuse Holder**. The fuse protects your plotter from damage if something goes wrong with its electrical circuits. If you ever need to change the fuse, refer to Chapter 6.
- Next to the Fuse Holder is the **Power Connector**. This is where you will plug in the power cord.
- The large metal screw is a **Ground Terminal**. If your power source does not have a 3-prong (grounding) connector, you will have to run a wire from this terminal to an electrical ground circuit. This is explained in Chapter 3.
- On the right side of the back of your plotter, you will see a row of eight tiny switches. These are the **Interface Setting Switches**. Their function is explained in Chapter 3.
- On the far right end is a multi-pin electrical connector. This is the **Interface Connector**. Here is where you will plug in the cable to your computer, as described in Chapter 3.
- Figure 1-2 also shows how the **Back Paper Support** plugs into the slots in the back of the plotter's case.

Controls

The Control Panel.

While your plotter is on the table in front of you, before you hook it up or try to turn it on, take a minute to identify and understand its controls. They are all located on the **Control Panel**, which is on the right side of the machine. Compare what you see with Figure 1-3.

Figure 1-3. Plotter Control Panel



Its buttons and lights.

Here are brief descriptions of what the various buttons and lights are for. You will learn exactly how to use them later, when you read Chapter 5.

- The **On-Off Switch** on the Control Panel controls all the plotter's electrical power. You push it once to turn the machine on and once again to turn it off. When you turn the power on, your plotter adopts the Automatic Set-Up Commands described in Chapter 5. When you turn it off, even for just a moment, your plotter forgets all the commands you have given it.
- The yellow **Power Light** on the Control Panel glows to remind you that the On-Off Switch is on.

- You push the **Operate/Free Switch** once to turn on the **Operate Light** (Operate position) and once again to turn it off (Free position). You must change this switch to Operate position (Operate Light on) before putting your plotter to work making a drawing; you must change it to Free position (Operate Light off) when you want to put in a new sheet of paper.
- The **Remote/Local Switch** works the same way—one push for Remote position (green **Remote Light** on), a second push for Local position (green light off). Remote position means that your plotter accepts only commands sent to it by your computer; Local position means that it responds only when you push the buttons on its Control Panel.
- The red **Error Light** goes on whenever your computer issues a command that your plotter can't obey. The reasons why this might happen are discussed in Chapter 5.

Buttons on the lower part of the Control Panel.

The remaining panel controls have two functions. When the green Operate Light is on and the Remote Light is off, they let you move the paper around in your plotter and make lines on it without any commands coming from your computer. When both green lights are off, some of these panel buttons initiate built-in test and reset routines. Here are the details:

Operate Light: **on**.

Remote Light: **off**.

This is what the lower panel buttons do when the Operate Light is on and the Remote Light is off:

- The **Pen Up/Down Button** lets you lower the pen onto the paper or raise it free. One push moves the pen either way.
- The **Pen Select Button** lets you change to a different color pen. Each time you push it, the Pen Head rotates one quarter turn so that a different pen comes into position to draw on the paper.
- The four **Motion Buttons** let you move the pen to any position on the paper. They are like the cursor controls on your computer keyboard. You can move the pen diagonally by pushing two at a time. If you have lowered the pen (with the Pen Up/Down Button), your plotter will draw a line as it goes.

Both green lights **off**.

This is what the lower panel buttons do when both green lights are off:

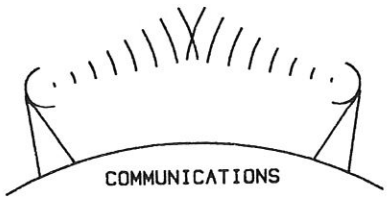
- The **Pen Up/Down Button** starts your plotter making an automatic test drawing. This procedure is discussed in Chapter 3. If you start the automatic drawing by mistake, you can stop it by turning the plotter's Power Switch off.
- The **Pen Select Button** clears all commands from your plotter's memory and returns the Pen Head to position 1. This is discussed in Chapter 5.

What Your Plotter Can Do

A summary of your plotter's capabilities.

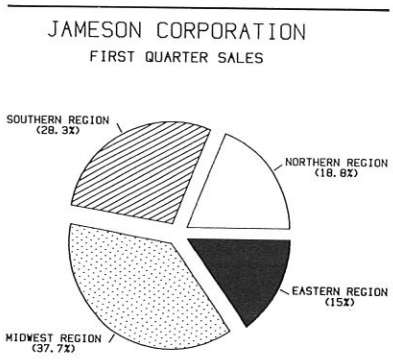
Your Apple Color Plotter can draw practically anything you could draw by hand, except faster and more precisely. Computer control gives it capabilities that would be hard to achieve with hand work. The software commands that tell it what to do are all discussed in Chapter 5. For making engineering drawings, layouts, graphic artworks, and computer-aided diagrams, you can call upon these built-in functions:

- Draw lines, any length and any angle.
- Draw circles and arcs, any location and any radius.
- Draw ellipses and ellipse sectors, any dimensions.
- Draw all the foregoing as solid or broken lines, with any break pattern, in any of eight colors.
- Enlarge or reduce part or all of any figure.
- Enlarge or reduce the horizontal and vertical dimensions separately, to produce perspective views.
- Move parts of a drawing to new locations on the sheet.



Making drawings.

Your Apple Plotter can create a graph of any data sent to it by your computer by drawing a series of points or short line segments. Point plots may be as close as 0.1 mm (0.004 inch) apart on the paper. This permits exact delineation of rapidly changing data or complicated mathematical curves.



Creating graphs.

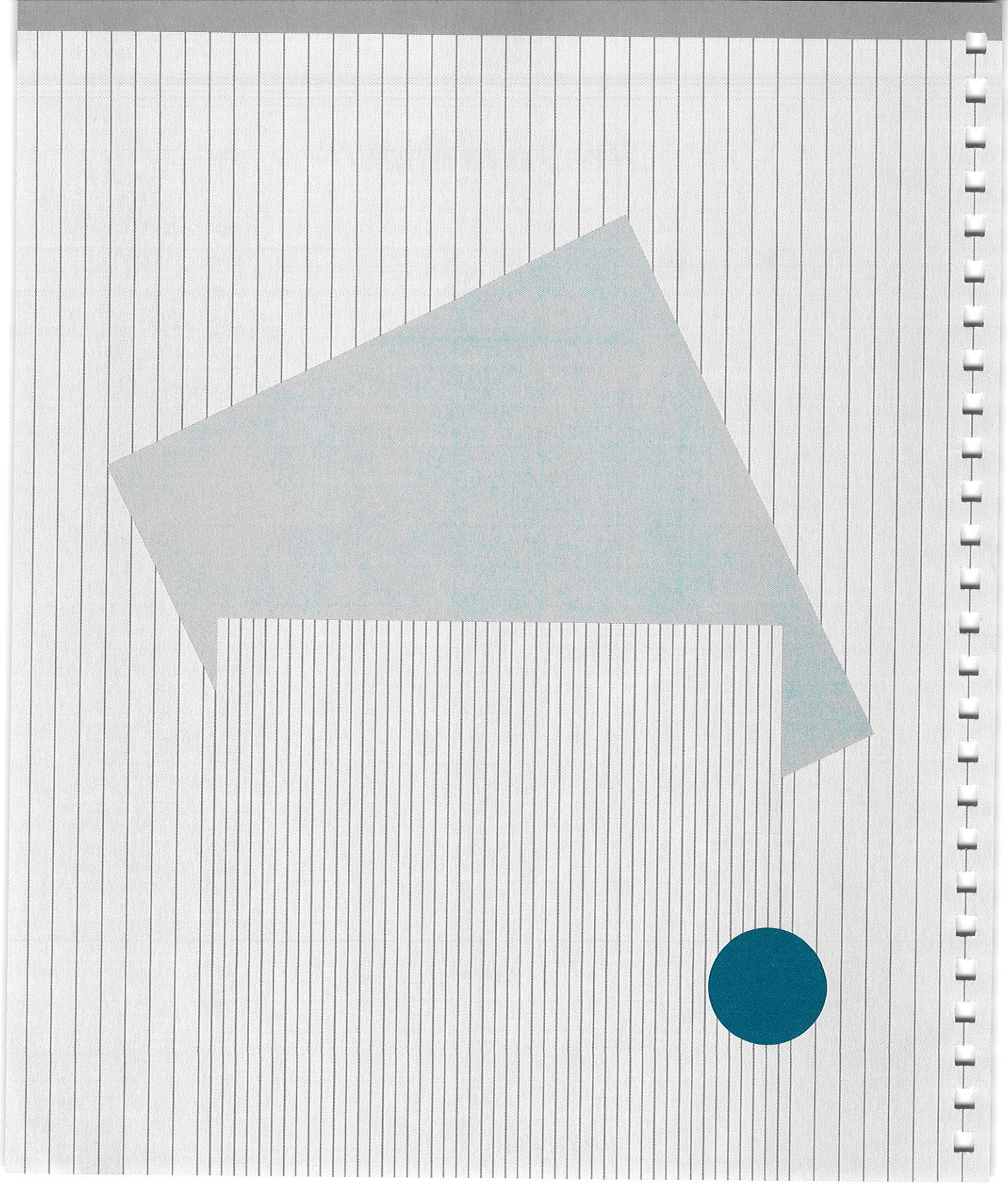
Writing text (this is a sample).

Your plotter has a built-in repertoire of fourteen identifying symbols (diamond, star, triangle, and so on) that you can use in scatter graphs. For line graphs, it offers a virtually unlimited choice of line patterns, plus eight different pen colors.

In response to a single command, your plotter will draw X or Y coordinate axes with tick marks of any size and spacing.

Finally, your Apple Plotter contains built-in alphabets of uppercase and lowercase letters, numbers, and punctuation marks (including international symbols and accents) that it will write on command. The written text may be any size, location, and color, and may be written at any angle across the sheet. This allows you to annotate drawings and graphs, as well as write pages of ordinary text. The lettering style, which resembles typewriting, is clear and attractive.

Pens and Paper



Pens and Paper

This chapter tells you everything you need to know about the paper and pens used by the Apple Color Plotter.

Your Apple Plotter writes on paper or transparency film with special pens.

Your Apple Plotter draws on sheets of plain paper, white or colored. It accepts several sizes and thicknesses of paper. It can also draw on transparency materials, so you can make clear overlays and overhead films.

Eight pen colors, two line widths, two ink types.

Special liquid-ink pens are used with the Apple Plotter. They have precision porous tips, similar to those of high-quality marking pens, that deliver the ink smoothly to the paper or film surface. Pens for your Apple Plotter are presently available in eight different colors, two widths, and two types of ink.

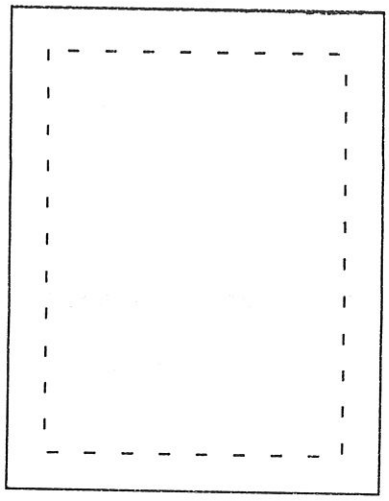
What Paper to Use

For best results, use Apple materials.

For best results, use Apple Color Plotter Paper and Apple Color Plotter Transparency Film. A starter supply is included in your Accessory Kit; additional quantities are available in convenient packages from your Apple dealer. These materials were selected after extensive testing because they give the sharpest lines and the most dependable results. For practice work, you can use ordinary typing paper—but don't expect it to deliver the same quality of image.

Your plotter accepts practically any kind of paper or film.

If you run out of Apple materials, you can use a variety of sheet stock in your Apple Color Plotter: plain white or colored paper, drafting vellum, acetate or mylar film, and high-quality drawing paper. The material you use does not require any prior treatment. However, the sheet should be reasonably flat, and its surface should not be too rough.



Paper width range: 120 to 300 mm (4.7 to 12 inches).

Maximum drawing size: 257 x 391.8 mm (10 x 15.4 inches).

Paper Size

Your plotter grips the paper it uses along two opposite margins. Its pen cannot travel into these margins. This means that the paper you use must be at least 25 mm (about 1 inch) wider than the drawing you want placed on it. To grip the paper securely, your plotter needs at least 15 mm (about 5/8 inch) of margin on the left side of the sheet and at least 10 mm (about 3/8 inch) on the right side. The paper must also be the same width from end to end so that the Feed Rollers will not run off the edge.

You can adjust the distance between the Feed Rollers for any width paper from 120 mm (about 4-3/4 inches) to 300 mm (about 12 inches). The widest drawing you can make is 257 mm (about 10 inches) wide. The longest single drawing you can make will be 391.8 mm (about 15-1/2 inches) from end to end; however, the paper you feed into your plotter can be any manageable length.

Warning
If you are using paper that is more than 11 inches long, make sure that you've installed the Back Paper Support.

Normal paper thickness: 15- to 24-pound stock.

Paper Stock

Avoid using very thin or very heavy materials in your plotter. 15- to 24-pound stock works best. If you want to use thicker material, test a piece first to make sure that it does not cause the Feed Rollers to bind. Apple Color Plotter Paper and Transparency Film have the optimum thickness for smooth operation.

The righthand Feed Roller must be adjusted to the paper width.

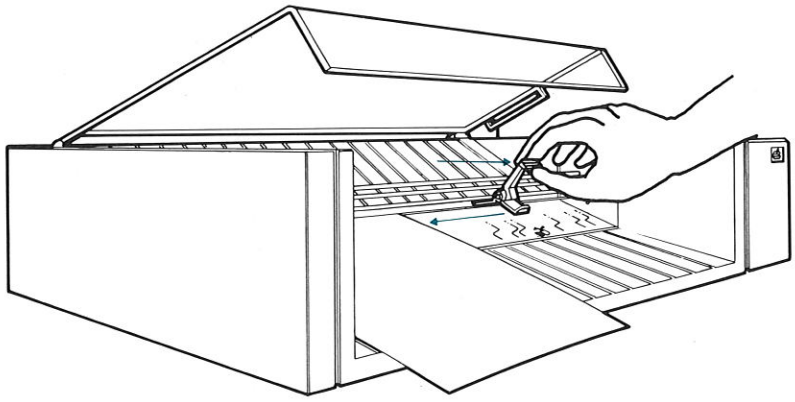
Setting the Width Adjustment

Your Apple Color Plotter uses roller wheels to grip its paper along the right and left margins. The left Feed Roller stays at the far left end. The right Feed Roller, however, slides sideways and must be adjusted to the width of the paper or film you are using.

To set the width adjustment, refer to Figure 2-1 while you do the following:

1. Raise the cover of your plotter. It opens only half-way, but it will stay up if you raise it that far.
2. Place a sheet of the paper you will be using on the Front Deck of the plotter, in position to be fed in, with its left edge about 6 mm (1/4 inch) from the left wall of the plotter.
3. Place your finger behind the tab at the top of the light-colored arm that extends above the right Feed Roller. Pull the arm *horizontally* toward you. Don't try to lift or push the arm; just pull it forward in a direction level with the table. It should move about 1/4 inch. Don't be surprised if it takes some force; it is held back by a heavy spring.
4. With the arm still pulled toward you, slide the right Feed Roller mechanism sideways. Release the arm when it has reached a point where the right Feed Roller is well over the right edge of the paper. Don't move it so far that the edge of the paper runs into the arm itself.
5. Now move the arm and Feed Roller assembly back and forth a short distance until it clicks into a notch. There are notches every 6 mm (about 1/4 inch) along its travel, so you should have no trouble finding one close to where you want it. Until it clicks into a notch, the Feed Roller will not drop down enough to grip the paper.
6. Check to see that your paper feeds properly into the plotter, as described in the next section.

Figure 2-1. Width Adjustment Arm



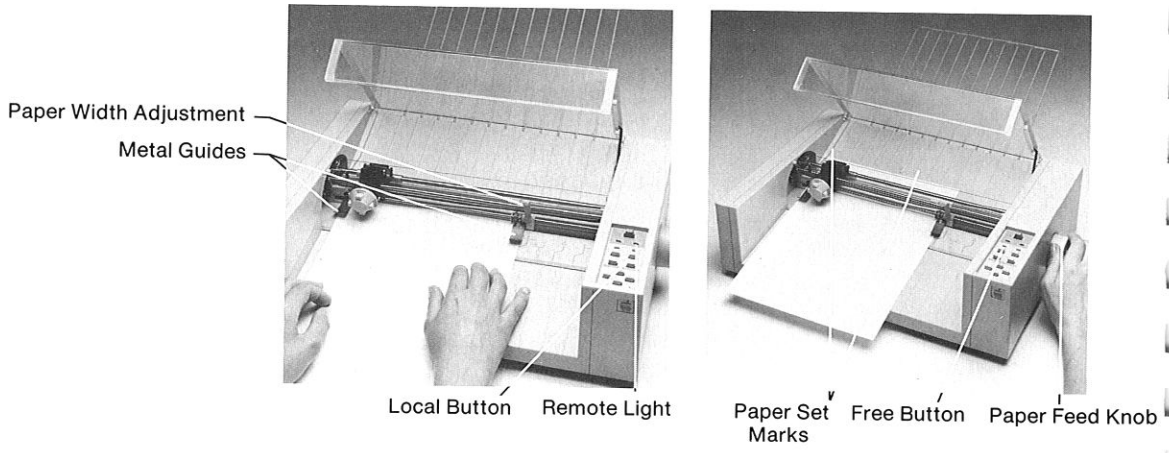
How to change paper.

Inserting and Removing Paper

Changing paper in your Apple Color Plotter is quick and easy. Just look at Figure 2-2 and follow these steps:

1. Make sure that any job your plotter is doing has been completed or has reached a pre-set stopping place.
2. If the green Remote Light on the Control Panel is on, press the Remote/Local Button once; if the green Operate light is on, press the Operate/Free Button once. Both lights should be off before you change paper.
3. If there is paper already in the machine, press the Paper Feed Knob on the right side of your plotter inward; this makes it engage its shaft. Then turn it counterclockwise, feeding the paper out the front of the plotter.
4. Make sure the Width Adjustment is correct for the new paper you are going to feed in.

Figure 2-2. Inserting Paper



5. Place a fresh sheet of paper on the Front Deck and slide it under the two metal guides that extend toward the front from the Feed Rollers.
6. While pushing the paper gently into the machine, press the Paper Feed Knob inward and rotate it clockwise. It should catch the paper and draw it in. If the paper is not feeding straight, crank it out and try again.
7. Rotate the Paper Feed Knob clockwise (still holding it inward) until the far end of the paper has been fed to the Paper Set marks on the Back Deck.
8. If you turned off either or both green lights on the Control Panel in Step 2, turn them back on by pressing the buttons just below them. Press the Operate/Free Button first.

Apple Pens

Pens you can use.

Apple Pens to suit virtually any job are available for use with your Apple Color Plotter. They all fit into the standard Pen Head, so your plotter can automatically switch among them. They come in two types, each with a different type of ink:

- **Paper Pens.** These contain water-base ink, which is preferable for drawing on paper or other semi-absorbent materials. They come in eight colors and two widths of line.
- **Transparency Pens.** These contain oil-base ink in a quick-drying solvent. They draw cleanly on non-absorbent materials such as acetate or mylar film. They come in the same eight colors and two widths as the paper pens.

Don't try to use transparency pens on paper or paper pens on transparency film—you'll get very poor results.

Apple Pen colors.

Each Apple Pen has a precision porous tip that maintains its point throughout the pen's life. The ink supply in each pen is able to draw about 700 meters (2300 feet) of trace. Apple Pens come in eight colors:

Black	Violet
Red	Brown
Blue	Burnt Orange
Green	Gold

Other colors may become available in the future.

Apple Pen widths.

For each of the eight colors listed above, you can get Apple Pens in either 0.3 mm or 0.7 mm widths. These correspond to 0.012 inch (normal) and 0.028 inch (heavy) line thicknesses.

Apple Pen inks.

Finally, all combinations of Apple Pen colors and widths are available with either paper or transparency ink. This makes a total of 32 combinations of color, width, and ink. They all fit into your plotter's Pen Head in any assortment, up to four at any one time.

How to order Apple Pens.

Apple Pens are sold in kits. Each kit contains the most often used combinations of colors, widths, and inks for a particular class of job. For complete details and ordering information, consult your Apple dealer.

Mounting and Removing Pens

Installing Apple Pens.

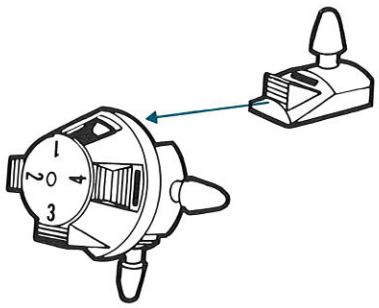
This section tells you how to install and replace Apple Pens in your Apple Color Plotter. There are two steps to the installation of Apple Pens: putting the pens into the Pen Head and installing the Pen Head on the plotter.

Assembling the Pen Head

Figure 2-3 shows how to put the Pen Head together.

Look at Figure 2-3. The Pen Head is a light-colored, cone-shaped plastic part that comes packed with your plotter. Four pens fit into it—any four from the 32 styles available. Each pen snaps in place with its tab sticking out through one of the four rectangular cutouts in the Pen Head. You can place the pens in the Pen Head without removing the plastic caps that protect their tips.

Figure 2-3. Putting Pens in the Pen Head



To remove a pen from the Pen Head, simply push it back out.

Pen numbers.

Notice that there is a small number on the face of the Pen Head where each pen goes. This is the **pen position**, and corresponds to the Pen Select command you will learn about in Chapter 5. When you want to tell your plotter to start using a different pen, you use this number.

Pen style code numbers.

You can tell what color ink each pen contains by looking at the color strip beside its tab. To tell what line width it draws and whether its ink is for paper or transparent film, look at the flat part opposite the tab. You will find one of these codes:

P.3 = Paper ink, thin line (.3 mm)
P.7 = Paper ink, thick line (.7 mm)
T.3 = Transparency ink, thin line (.3 mm)
T.7 = Transparency ink, thick line (.7 mm).

Standard pen loading.

The first time you assemble the Pen Head, put in the following standard color assortment:

position 1 : black
position 2 : red
position 3 : green
position 4 : blue

This standard assortment is useful for testing your plotter. Later you may replace it with any assortment you choose.

Note: You should always load four pens into the Pen Head. Loading fewer than all four will decrease its weight and may leave it unbalanced, compromising the performance of your plotter.

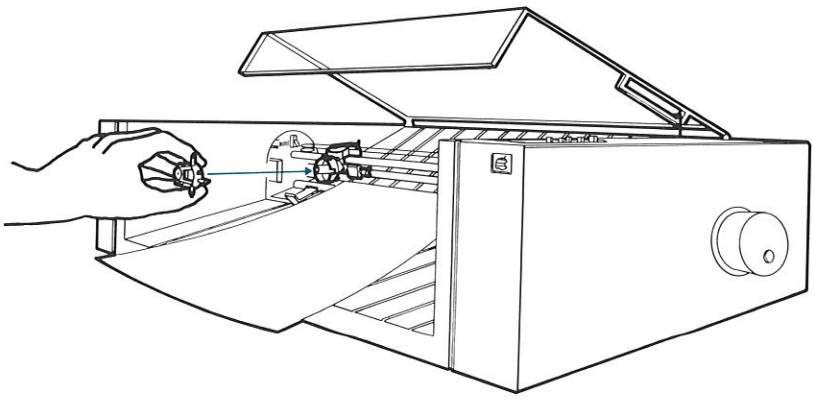
Putting the Pen Head on the Plotter

Putting the Pen Head in place.

Once you have assembled four pens into the Pen Head, you are ready to put the whole Pen Head on your plotter. Refer to Figure 2-4 while you follow this procedure:

1. Remove the protective caps from the pen tips, being careful not to get ink on your fingers.
2. Slip the Pen Head assembly (containing the pens) over the shaft that sticks out toward you from the Pen Carrier. Note that there is a flat on one side of the shaft, so the Pen Head goes only one way. Normally the black pen (position 1) will be down.
3. Push firmly on the Pen Head until it fits up against the black plastic rim of the Pen Carrier.

Figure 2-4. Installing the Pen Head



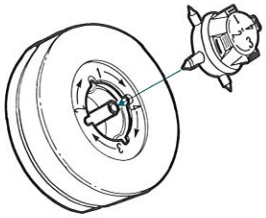
Removing the Pen Head.

To remove the Pen Head from your plotter, pull it firmly forward off the shaft of the Pen Carrier. Either place it immediately in the Pen Capper (described in the next section) or replace the plastic tips that originally covered the pen tips. Set the capped Pen Head assembly aside until you are ready to use it again.

Warning

The pens can easily dry out if left for even a short time without either being used or capped. If this happens, you can sometimes restart them by drawing a few lines by hand with each pen before placing the Pen Head on the plotter. For best results, paper pens should be left uncapped no longer than 2 hours and transparency pens no longer than 15 minutes.

Figure 2-5. Pen Capper

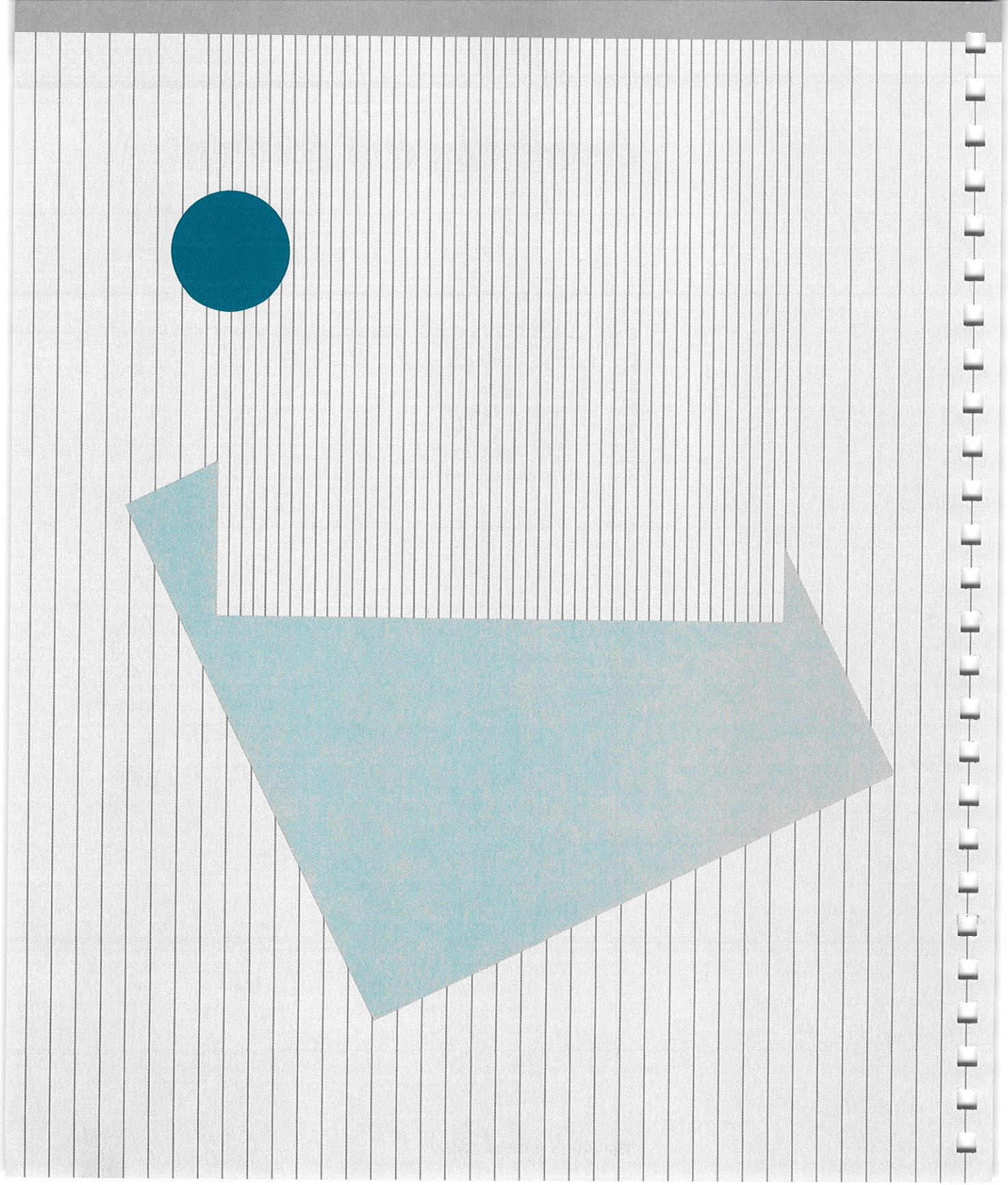


The Pen Capper

Included in your plotter is a handy Pen Capper. It provides a parking place for the Pen Head when you are not using it, and it keeps the pens from drying out. Look at Figure 2-5. You simply plug the Pen Head into the Capper and then twist it one-eighth of a turn clockwise. Note that the numbers on the Capper must correspond to the numbers on the Pen Head; it only goes in one way. You should always keep your plotter pens capped when they are not in use.

Chapter 3

Installation and Testing



Installation and Testing

Setting up your Apple Color Plotter and connecting it to your Apple computer is not difficult. Everything you need is contained in the Accessory Kit that came with the plotter.

Look for hook-up instructions in Part II of this manual.

This chapter deals with the plotter's end of its connection to your computer. The other end is covered in Part II of this manual. Find Part II now and turn to the section that deals with connecting the plotter to your computer.

How to connect your plotter.

When you have both parts of this manual in hand, you are ready to perform the following installation procedure:

1. Set up a workspace for the plotter as described in the next section of this chapter, "Selecting a Workspace."
2. Run the built-in test to see that the plotter is working properly. The section, "Test It Yourself," later in this chapter tells you how to do this.
3. Adjust the switches on the back of the plotter according to the instructions given in the section, "Setting the Interface," later in this chapter.
4. Connect the plotter to your computer, following the instructions in Part II of this manual.
5. Do any performance tests that are described in Part II of this manual to check your completed installation.

Selecting a Workspace

The plotter's workspace: a clean, indoor place near your computer.

You should install your Apple Color Plotter in the same kind of workspace as your Apple computer—clean, indoors, and adequately lighted. The six-foot connecting cable normally limits the distance between your computer and your plotter.

For Detailed Environmental Specs see Chapter 4, "The Working Environment," and Appendix C, "Plotter Specifications."

You need 18 by 24 inches of table area.

Your Apple Color Plotter is designed to operate on a flat, horizontal surface—a desk or table. It needs at least 18 inches (45 cm) of room sideways so that you can reach the Paper Feed Knob on the right side. It needs at least 24 inches (61 cm) of room from front to back. Although the plotter alone is shorter, remember that when it is working, it often feeds paper out in front of itself. Do not place objects in front of the plotter.

7-1/2 inches required behind your plotter.

Your plotter's Back Paper Support is necessary to allow sheets to feed smoothly in and out. To provide space for it, you will need to leave at least 7-1/2 inches (19 cm) free space behind the main body of your plotter.

Test It Yourself

You can test your Apple Color Plotter before you hook it up to your computer. This section tells you how.

Warning

The electric power connection to your plotter must include a ground circuit. If you cannot plug your plotter into a 3-pin, grounded receptacle, delay this test until after you have installed a ground wire. Installation of a ground wire to your plotter is discussed in the "Power and Ground" section later in this chapter.

Built-in test system.

There is a two-step checkout system built into your plotter. It does not need any other equipment to function. The first step tests your plotter's internal memory to see if it retains instructions accurately. The second step tests the mechanical parts to see if they do their job. As soon as your plotter is connected to power and supplied with pens and paper, you can operate this test system.

How to get your plotter going.

Here's how to make your plotter run its self-test:

1. Set your plotter's width adjustment to 8-1/2 inches or larger, as described in Chapter 2.
2. Assemble and install the pen head as described in Chapter 2.
3. Plug in your plotter and turn on its power. The Power Light should go on. All other lights on the Control Panel should be off.
4. Put in a piece of Apple Plotter Paper of a size corresponding to the width adjustment. The paper must be at least 8-1/2 inches wide (across the plotter) and 11 inches long (up and down). By turning the Paper Feed Knob, crank the paper up to the Paper Set marks on the back deck of the plotter. Do not set it beyond these marks.

5. Press the Pen Up/Down Button. Your plotter should begin its automatic test routine.

Error Light on or blinking: faulty memory. Error Light off: memory OK.

6. Watch the Error Light for a few seconds. If it turns on or blinks, something is wrong with your plotter's memory circuits. Your plotter will not be able to function properly and should be returned to your Apple dealer. If the Error Light stays off, your plotter's memory circuits are working correctly. Your plotter will automatically proceed to perform its mechanical test.

Your plotter makes a test drawing.

7. Permanently programmed inside your plotter are the commands for making a drawing. The result looks like Figure 3-1. Your plotter will now create this drawing, using most of its critical moving parts. You can tell from looking at the result whether your plotter is in good mechanical condition. When your plotter has finished making its drawing, turn off the power and remove the paper.

What to look for.

8. Examine the drawing. Are the straight lines straight? Do they appear to be of uniform width and join neatly at corners? Are the circles smooth? And did the pen come back to the same point it started from? Is the lettering neat and even? If the answer to any of these questions is *no*, bring the drawing to your Apple dealer for evaluation.

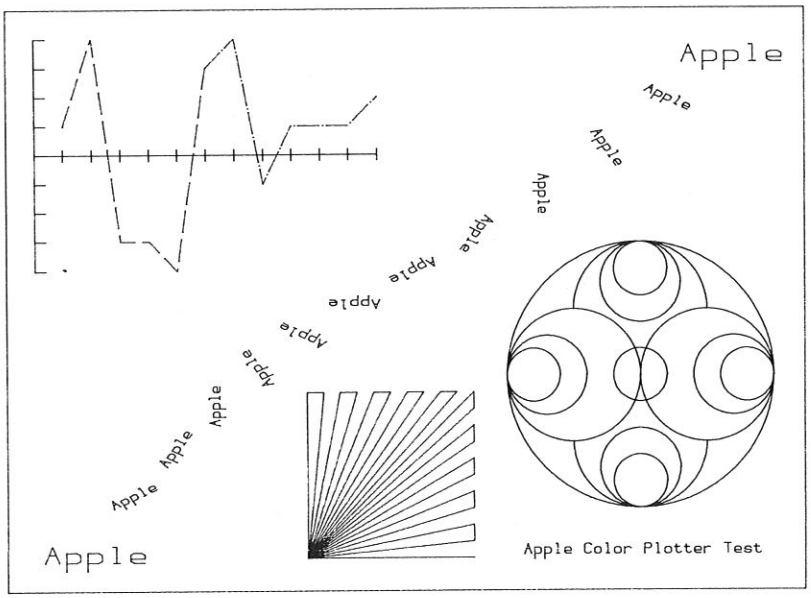


Figure 3-1. Apple Color Plotter Test Drawing

Setting the Interface

Your plotter has an RS232C input.

Your Apple Color Plotter can be connected to virtually any computer. This is because its electrical input conforms to a standard called the **RS232C Interface**. RS232C is the identification number of a computer industry standard; most computers have outputs that conform to it. Thus the code number RS232C defines the kinds of electrical signals the computer is supposed to deliver and the plotter is supposed to receive. In effect, any device with an RS232C input (such as your plotter) can be successfully plugged into any device with an RS232C output (such as your computer).

Interface setting switches are on the back panel.

However, within the RS232C standard there can be variations of signal format and transmission speed to suit different machine-to-machine communication requirements. So your plotter is provided with a set of switches that allows you to set the exact way that its RS232C input will behave. These switches are located on the back panel, just next to the Interface Connector.

The switches should already be correct for your Apple computer.

Your plotter was shipped from the factory with its Interface Switches correctly set for connection to most Apple computers. This setting is shown in Figure 3-2. Look at the back of your plotter now and verify that the switches look like Figure 3-2. If they do not, move them up or down with a pointed tool (such as a toothpick) until they do. The setting shown should be the correct one that will allow your plotter to communicate with your Apple computer; if a different setting is required, it will say so clearly in Part II of this manual.

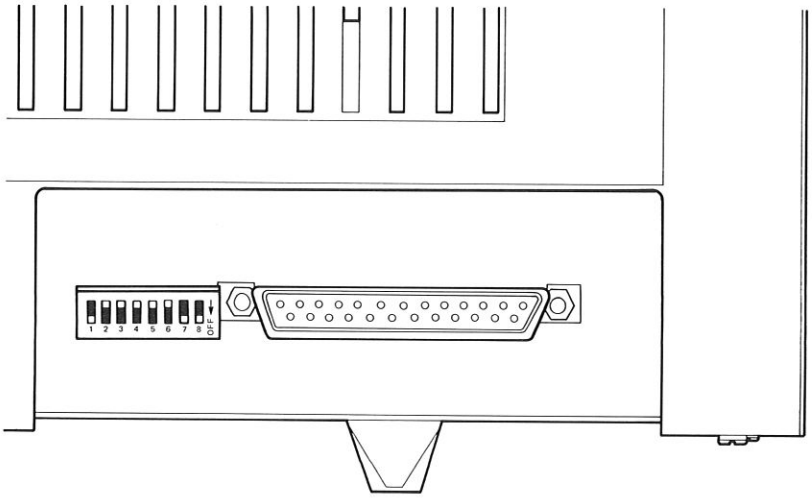


Figure 3-2. Interface Switch Setting for Apple Computers

Switch settings for other computers.

If you are connecting your Apple Plotter to a computer made by a company other than Apple, consult Appendix D, "Interface Specifications." Appendix D contains a description of the function of each switch, together with advice on how to set the interface for connecting the plotter to other computers.

Technical Information: The interface switch configuration shown in Figure 3-2 sets the following parameters on your plotter's RS232C input:

- Communication mode : hardware handshake
- Data byte length : 7 bits
- Parity check : odd
- Transmission rate : 1200 baud

For further interface details, see Appendix D.

Hooking up the plotter.

Electrical Connections

You need to make two electrical connections to finish installing your plotter:

- Power and ground connections
- Data connection to your computer

Power and Ground

The Apple Color Plotter operates from most AC power sources. Your particular unit will be adjusted for one of two voltages: 115 volts 60 Hz or 220 volts 50 Hz.

You can tell which voltage it is adjusted for by looking at the name plate on the Back Panel. Verify that your supply voltage is the same. The standard voltage supplied throughout North America is 115 volts 60 Hz.

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.

If your power source has the correct voltage and there is a proper ground circuit, find the Power Cable that was packed with your plotter. Plug the angled end into the Power Connector on the back of your plotter and the other end into your power source.

Note: For your protection, the cable end that plugs into your plotter is at an angle. When it is plugged in, it covers the fuse holder. In order to remove the fuse you must first unplug the machine.

Computer Hook-Up

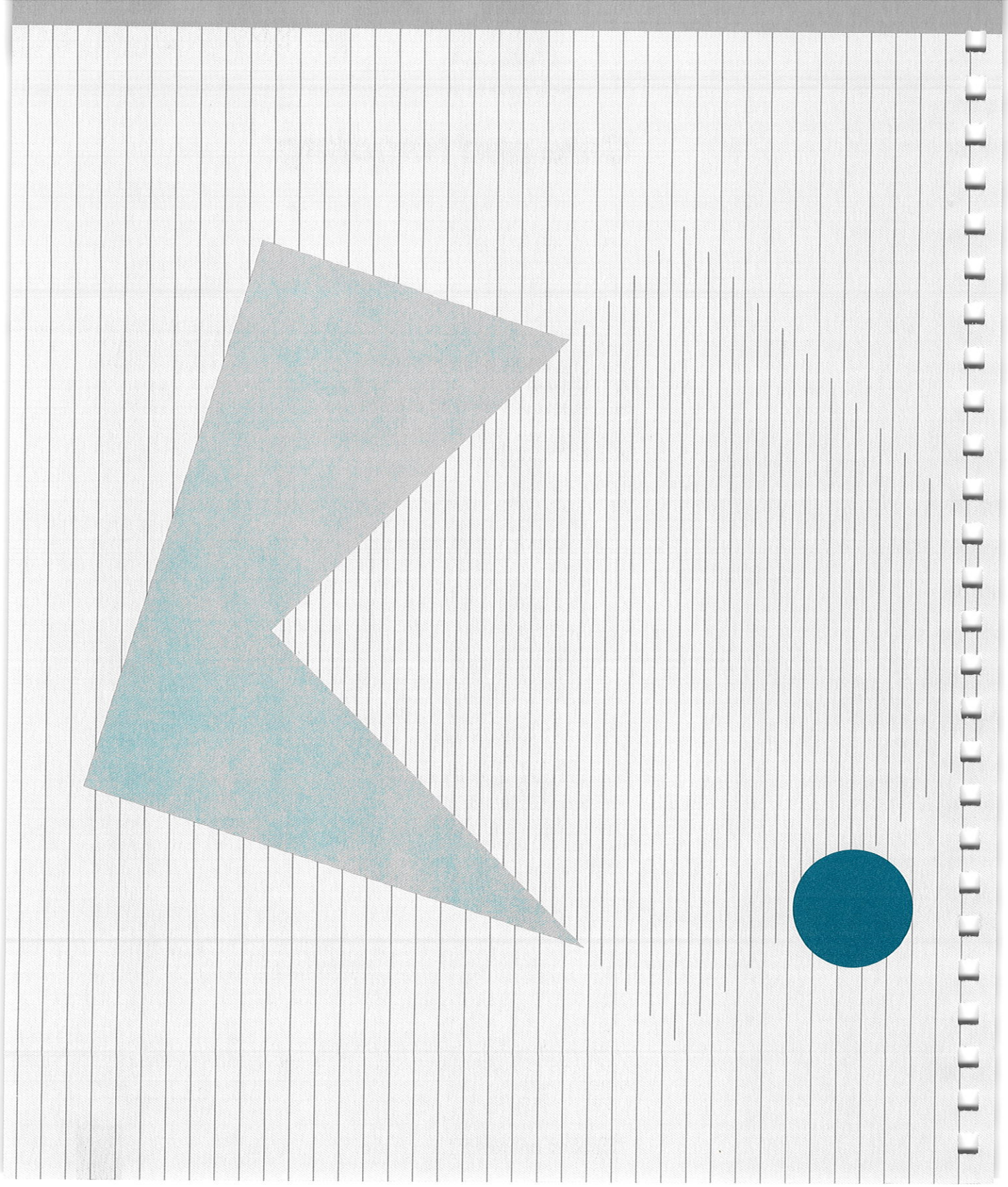
Installing the plotter end of the data cable.

Find the connecting cable that came packed in your Plotter Accessory Kit and plug one end into the Interface Connector on the back of your plotter. Screw the two small screws into the studs on each side so that the connector can't work loose. Then follow the instructions in Part II of this manual to connect the other end to your computer. If your Apple computer requires modification or configuring to communicate with your plotter, Part II contains full instructions.

Warning

You can damage your plotter or your computer, or both, by connecting them together incorrectly. If possible, use the Apple cable that came in your Apple Color Plotter Accessory Kit. If you need a special connecting cable, consult your Apple dealer. Appendix D provides technical details about your plotter's data interface.

Care and Handling



Care and Handling

No regular maintenance is required.

The only parts of the Apple Color Plotter that need regular care are the pens. The rest of the machine is designed to operate without lubrication or maintenance. But this does not mean that you can misuse or neglect it without consequences. Like any precision instrument, your plotter will perform better if you treat it kindly. This chapter contains suggestions for keeping your plotter happy and healthy.

The Working Environment

Temperature and humidity range.

You can set up and operate your Apple Color Plotter in any reasonably clean, indoor location. It will work reliably over a temperature range of 41 to 104 degrees Fahrenheit (5 to 40 degrees Celsius), while the relative humidity varies from 20 to 80 percent. You should not try to operate your plotter in an environment that is outside either of these ranges.

Avoid vibration.

Your plotter is sensitive to vibration, both while operating and in storage. Even though it might work while being subjected to vibration, its service life will be greatly reduced.

Keep the plotter away from steam and chemical fumes.

Your plotter's plastic cover protects the plotter adequately from dust and foreign objects, but it has little effect against liquids and vapors. Spilling any liquid inside your plotter, or exposing it to chemical or solvent fumes (including steam from a coffee maker), can quickly ruin it beyond repair.

Cleaning

Light external cleaning only.

To clean the outside of your Apple Color Plotter, just wipe it with a damp cloth. For thumbprints, add a drop of liquid soap.

Warning
Never use household cleansers, ammonia, or solvents such as cleaning fluid on your Apple Plotter. They will eat the plastic and gum up the mechanism.

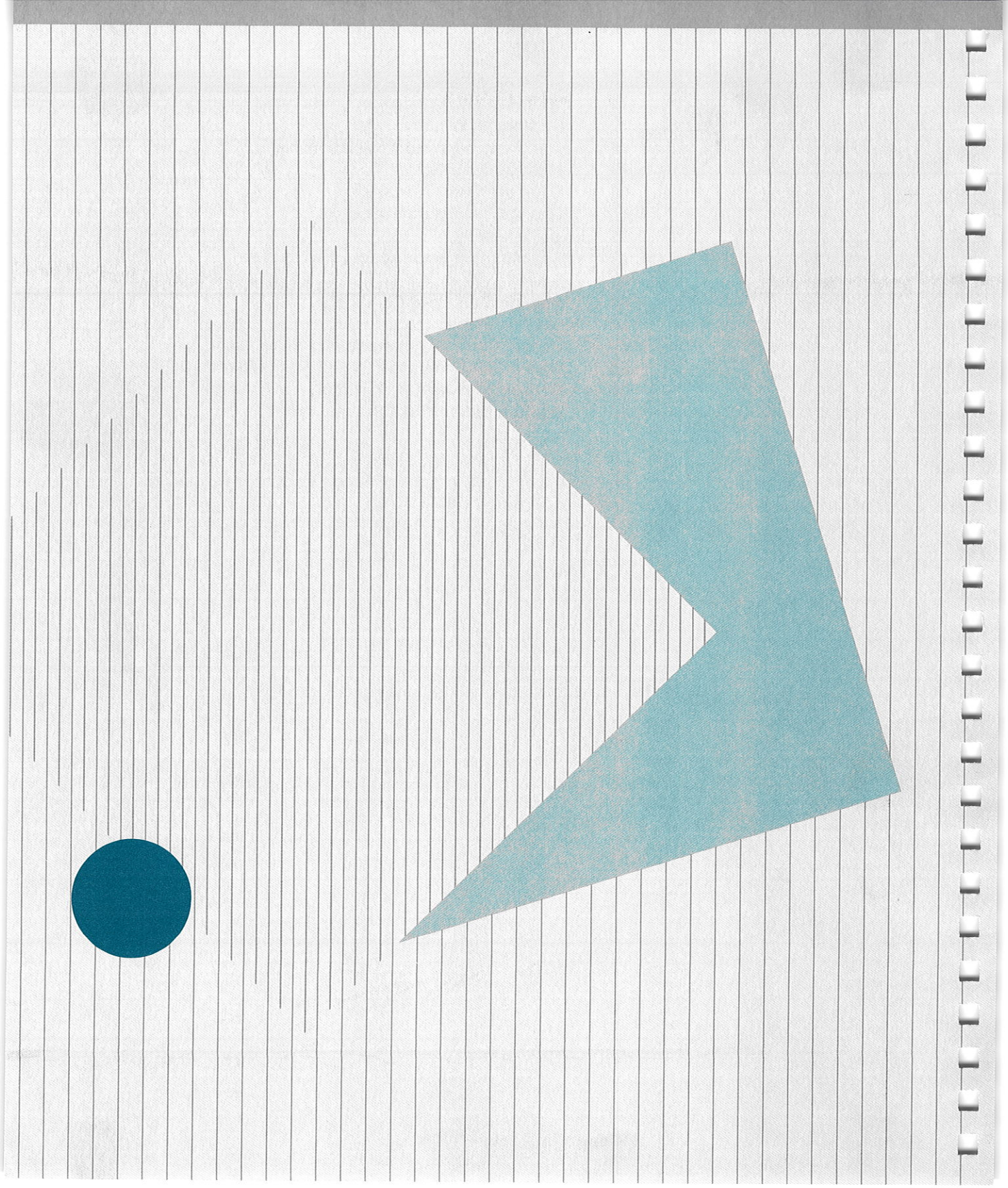
Do not try to clean inside.

The mechanical and electrical parts inside your Apple Color Plotter include precision mechanisms that are easily damaged. Do not try to remove the plastic case or clean inside. It never gets dirty in there anyway.

Transportation and Storage

You were wise to save the original shipping carton, packing materials, and unpacking instructions. Now whenever you want to move your Apple Plotter or put it in storage, you can repack it so it will be completely safe.

Controlling Your Plotter



Controlling Your Plotter

Commands: Special sequences of letters and numbers that tell your plotter what to do.

Your Apple Color Plotter does only what it is told to do. You can use the buttons on its control panel to make it do a few simple actions, but most instructions must come from your computer. These computer **commands** all consist of short sequences of ordinary letters and numbers made up specifically for communication with the Apple Plotter. This chapter explains all about them.

What happens when you turn on the power.

Every time you turn on its power, your plotter automatically gets itself ready to receive instructions. You can see this happening; the Pen Head rotates for about seven seconds until pen 1 is in writing position. During this time, the plotter adopts certain format specifications that are preserved in its permanent memory. You'll find these initial instructions listed later in this chapter in the section, "Automatic Set-Up Commands." After the plotter has finished its setting-up exercises, the green Operate Light and the green Remote Light on the Control Panel will both be off. By turning on one or both of these lights, as explained later in this chapter, you can either operate the panel controls or send commands from your computer to your plotter.

Telling your plotter what to do.

After you have turned on both the Operate and Remote lights, your plotter is ready to receive commands from your computer. The computer commands that the plotter recognizes generally consist of two letters, either alone or followed by more letters or numbers. Certain punctuation marks must be included in the computer commands, as explained later in this chapter in the section, "Command Syntax." If your plotter receives a command it doesn't understand or can't obey, it will ignore it and light the red Error light on its control panel.

Commands wait their turn in the **buffer** memory.

Your computer is capable of issuing commands to your plotter much faster than the plotter can act on them. So the plotter has a built-in memory (called a **buffer**) that can store up to 255 incoming characters. When commands arrive at the plotter faster than it can respond to them, the plotter stores them in its buffer memory and obeys them as soon as it can and in the order received. When there are more than 255 command characters waiting to be acted on, the plotter tells your computer to stop until it has worked off the backlog.

What your plotter can do.

There are many things your computer can tell your plotter to do. They are all described in detail in the rest of this chapter, under these headings:

- Automatic Set-Up Commands
- Working Area Commands
- Drawing Commands
- Text Commands
- Scaling Commands
- Error Detection
- Reset Commands

Some of these may override and cancel the default commands that the plotter adopted when power was turned on.

Panel Controls

When to use the panel controls.

Most of the time, your plotter works under the control of your computer. If you want to give it direct commands, you type them on your computer's keyboard. But when you are starting a job, or when you need to make adjustments while a job is in progress, you can use your plotter's panel controls.

The next sections tells you how to use your plotter's panel controls to do these tasks:

- insert and remove paper
- start and halt a job controlled by your computer
- position the pen and make drawings under local control

Names of controls: The following discussion assumes that you have read Chapter 1 and are familiar with the names and locations of your plotter's controls.

Changing Paper

Both green lights must be **off** while you change paper.

The complete procedure for inserting and removing paper is provided in Chapter 2. Whenever you use the Paper Feed Knob to crank paper into or out of your plotter (or adjust the paper position during a job), the green lights over the Operate/Free Button and the Remote/Local Button should both be off. If one or both of the green lights are on, you need to do one of the following:

- If the Operate/Free Light is on, press the Operate/Free Button once to turn it off.
- If both green lights are on, press the Remote/Local Button once and then press the Operate/Free Button once. This will turn them both off.

Other Lights: When you are changing paper, it does not matter whether the Power and Error Lights are on or off. However, their status will affect any job you run after changing paper.

Running a Job

To run a job, first turn **both** green lights **on**.

Both green lights on your plotter's Control Panel must be on before the plotter will accept commands from your computer. If one or both of them are off, you can turn them both on by pressing the Remote/Local Button once.

Stopping and starting the plotter during a job.

While your plotter is under computer control, you can stop the plotter at any time by pressing the Remote/Local Button once. The green light over that button will go off; your plotter will complete the command it is currently working on and then stop. When you press the Remote/Local Button a second time, the green light will go back on, and your plotter will continue where it stopped.

Warning

Do not press the Operate/Free Button while your plotter is stopped in the middle of a job. Doing so may cause your plotter either to lose its place on the sheet or to erase commands that are waiting in its buffer memory, or both.

Local Plotter Control

Making drawings from the Control Panel.

Here are a few things you can make your plotter do by using its panel controls:

- select a different pen
- move the pen to a different part of the sheet
- draw straight lines either horizontally, vertically, or along a 45 degree diagonal

To use the panel drawing controls, you must turn one green light **on** and the other **off**.

Before you can use any of your plotter's drawing controls, the green Operate/Free Light must be on, and the green Remote/Local Light must be off. This condition is the same as when you have halted a job in progress, as just described. To create this condition,

- if both green lights are off, press the Operate/Free Button once.
- if both green lights are on, press the Remote/Local Button once.

Warning

Do not try to draw with the panel drawing controls while the green Operate Light is off. In this condition some buttons have special functions: the Pen Up/Down Button starts the automatic test drawing (see Chapter 3) and the Pen Select Button resets the plotter's command memory.

You can now use the panel controls to manipulate the pen.

Selecting pen color from the Control Panel.

Pushing the **Pen Select Button** once while the Operate Light is on causes your plotter to rotate the Pen Head one-quarter turn so that the next number pen comes into position for drawing. To rotate the Pen Head more than one-quarter turn, you must push the button again after the first action is completed. The selected pen will remain in position after your plotter starts working under computer control until your computer sends either a Pen Select command or one of the Reset Commands (described later in this chapter).

Placing the pen on the paper.

Pushing the **Pen Up/Down Button** once while the Operate Light is on causes the pen to drop down to the paper. Pushing it again causes the pen to be raised free. You can use this control in combination with the Motion Buttons described below to draw straight lines; you simply lower the pen, move it, and then raise it.

Note: If the pen is down when you press the Pen Select Button, it will be raised to change to a new pen and will not return to the down position.

Moving the pen with panel controls.

The **Motion Buttons** are marked with little arrowheads that show the directions of pen motion they cause. (In some cases they move the paper, not the pen, but the result is the same). When you first press one, the motion is quite slow, but after a moment it speeds up. If you release the button and then press it again, the motion becomes slow again. This allows you to move the pen rapidly from one part of your drawing to another, then slow it down to get the exact pen position you want. If the pen is down during these motions, your plotter will draw a line; if it is raised, it will not.

Making diagonal lines.

You can press any two of the Motion Buttons that are next to each other. The result will be a line drawn along a 45 degree diagonal.

Automatic Set-Up Commands

Default Command: What your plotter does unless you tell it otherwise.

When you first turn on your plotter's power, before your computer has given it any instructions, your plotter automatically assumes certain set-up commands. Such automatic instructions are sometimes called **default commands**. They allow the plotter to function right away. Later you can override any of the default

instructions by sending your plotter specific commands. Table 5-1 gives the value of each default instruction and the type of command necessary to override it. Each of the override commands is discussed in detail later in this chapter.

Table 5-1. Default Values

Function	Default Value	Override Command
Paper size	8-1/2" x 11"	SP
Viewport (maximum drawing area)	239.4 x 175.9mm	SP, VP
Measurement Units	1/10 mm	WD
Pen selection	1	PS
Pen speed	10 cm/s	PV
Pen location	X=70mm, Y=0	MA, MR
Pen up/down	up	any draw command
Line pattern	1 (solid)	LT
Repeat interval for line breaks	10.0 mm	LT
Graph axis tick mark length	1.0 mm	XT, YT
Text angle	0 degrees	LR
Letter slant	0 degrees	SL
Text character height	3.0 mm	LS
Text character font	0 (USA)	LF
Error action	Light red lamp for all errors	IM

Command Syntax

Your plotter responds to sequences of letters and numbers.

When your computer controls your plotter, it sends messages that consist of sequences of letters, numbers, and punctuation marks. Each valid message, called a **command**, makes the plotter perform one action: move the pen head to another location on the paper, for example, or draw a line or a circle.

A typical plotter command.

Each command starts with a pair of letters. Some commands consist of nothing else, but most of them also contain a sequence of numbers. The pair of letters tells the plotter *what* to do; the numbers tell it *how much*. For example, the command

```
DR 50, 60
```

tells the Apple Plotter to draw a line from the present position of the pen head (**D**raw **R**elative) to a point 50 measurement units farther along the X axis and 60 measurement units farther along the Y axis. We will talk about X and Y axis measurements, as well as DR and other commands, in more detail later in this chapter.

Commands must be punctuated correctly.

Before you can create messages that your plotter will understand, you must know the **syntax rules** for punctuating its commands. There are two kinds of punctuation that must be present in every message:

- **Separator marks**, which separate numbers from each other; and
- **End-of-command marks**, which separate each command from the one preceding it.

There are several choices of punctuation for each of these two kinds of mark. You may use any combination you wish. Here they are:

Separator Marks	End-of-command Marks
Space	Return
Comma (,)	Line Feed
Plus sign (+)	Semicolon (;)
Minus sign (−)	Colon (:)
	ETX (CONTROL-C)

You have a choice of punctuation.

In most cases, you may use a combination of these marks, if it is more convenient or helps you read the commands. For instance, in the example of a DR command given above, both a comma and a space are used to separate the number 50 from the number 60. Without at least one of these separator marks, the plotter would have read the number as 5060.

The following sections discuss separately the four elements of Apple Plotter commands: letter pairs, separator marks, numbers, and end-of-command marks.

Letter Pairs

AC	IM	LT	PS	UL
CA	LF	MA	PV	VP
CH	LI	MR	RS	WD
DA	LS	PL	SL	XT
DR	LR	PM	SP	YT

Your Apple Color Plotter recognizes 25 different two-letter codes to start a command. They are listed alphabetically in the margin. All of them are discussed in detail in later sections of this chapter.

You can send code letters to your plotter as either uppercase or lowercase characters.

All OK: DR
Dr
dR
dr

In Addition your plotter recognizes three single-character control codes, which you use to reset its memory. These non-punctuated commands are discussed later in this chapter in the "Reset Commands" section.

Separator Marks

Separators: Space
Comma (,)
Plus sign (+)
Minus sign (−)

One or more separator marks must be placed between all numbers. When plus signs (+) or minus signs (−) are used as separator marks, they also become part of the number that follows.

You don't need separators after letter pairs.

Separator marks are optional after letter pairs. They won't hurt, but they're not necessary either.

Rules for combining separator marks.

Here are the rules for combining separator marks when you want to use more than one at a time. You can use

- any number of spaces.
- one comma but not more than one in a separator sequence.
- one plus sign or one minus sign, but it must be immediately before a number.

Correct command punctuation.

Here are a number of different ways to punctuate the command DR 50,60 correctly:

```
DR50 60    DR,50,60    DR+50+60    DR  50, 60
DR 50 60   DR, 50, 60  DR +50 +60  DR50 , +60
```

Incorrect command punctuation.

Here are some examples of incorrectly punctuated plotter commands. If you tried to send one to your Apple Color Plotter, it would ignore it, do nothing, and turn on the Error Light on its control panel:

```
DR 50,,60      (two commas in a single separator sequence)
DR 50 -+60     (two plus or minus signs in a single sequence)
DR 50+ 60      (plus or minus sign not before a number)
```

Numbers

All OK:
```
123
123.4
1.23E+2
```

You can give numerical quantities to your plotter in several ways: as integers, as decimals, or in IEEE floating-point form. Thus all of the following are good ways to tell your plotter to do something for one hundred and twenty three and four-tenths units:

```
1234E-1    0.1234e+03    0000123.4    123.40000
```

Here are the rules for numbers:

- Any number of leading zeros is acceptable—they are all ignored.
- Numbers may be positive or negative. If no sign is given, your plotter assumes that the number is positive.
- Integers must be within the range −32768 to +32767.
- Numbers with decimal points must be within the range −3276.8 to +3276.7. Only one digit after the decimal point is read; further digits are ignored but do not cause an error condition. If you have set the measurement units to something other than tenths of millimeters (see later section, "Scaling Commands"), your plotter will round your numbers down to the next lower point measurable in tenths of millimeters.
- Floating point numbers must express values within the same ranges as integers and numbers with decimal points. The exponent may be one or two digits, and must include a plus sign or a minus sign.

For an explanation of numbers like 1.234e+2, see Appendix B.

Badly formatted numbers.

Here are some examples of badly formatted numbers that your Apple Plotter won't recognize:

```
35000       (outside of range for integers)
3500.0      (outside of range for numbers with decimal points)
35E+3       (expresses a number outside of range)
35e+002     (exponent more than two digits)
35E2        (plus or minus sign missing from exponent)
```

End-of-Command Marks

Command Terminators:
Return
Line Feed
Semicolon (;)
Colon (:)
ETX (CONTROL-C)

When each command is complete, you must send the plotter at least one end-of-command punctuation mark. This tells the plotter to act upon the characters that it has been saving in its input buffer memory and to get ready for a new command. Your choices are shown in the margin. You may send any number of these end-of-command marks in any combination.

For an explanation of ASCII characters, see Appendix B.

ETX is the ASCII character 03, also called CONTROL-C; if you are not sure how to enter it from your computer, consult Part II of this manual. **Return** and **Line Feed** are the standard ASCII characters that cause a printer or screen display to start a new line. **Semicolon** and **colon** are normal punctuation marks.

Writing Text: You must terminate text-writing commands with ETX (CONTROL-C). The other end-of-command marks will make your plotter write what you have sent it, but will not end the command. Only ETX will make your plotter finish writing and stop treating the characters you send it as further text to be written.

Throwing Out the Garbage

How your plotter interprets a command sequence.

Your Apple Plotter has a high level of tolerance for extraneous characters in the command sequences your computer sends it. It can discard quite a bit of unnecessary material without rejecting the whole command as erroneous. Here is how it interprets a sequence of characters:

1. It starts by finding the *first* end-of-command mark in the sequence.
2. Next it finds the *last* valid two-letter code before this first end-of-command mark and treats it as the beginning of its first command.
3. Finally, it looks for valid numbers and correct punctuation following the two-letter code until it has assembled a complete command.
4. It repeats this process for each end-of-command mark after the first, until there are no more end-of-command marks in the sequence.

Your plotter ignores all characters in the sequence that are not picked up by this process without signaling an erroneous command. For example, it would interpret this string of characters:

```
DR,1,2+DR 3,4;DR5,6.123 Hello;
```

as if the following had been sent:

```
DR 3,4;DR5,6.1;
```

without turning on the error light or otherwise informing you that it was ignoring part of a command sequence.

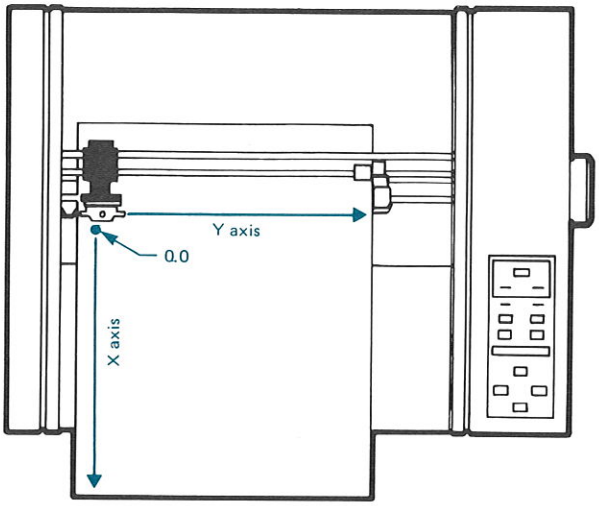
X and Y Measurements

To understand how to use the numbers that follow Apple Plotter commands, you must first understand the way your plotter defines locations on the sheet of paper.

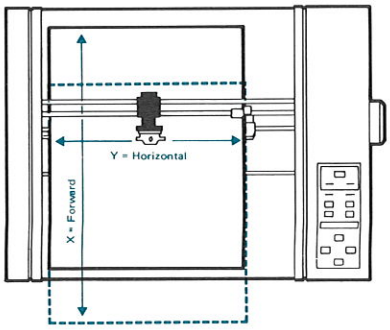
X axis: Front-to-back.
Y axis: Side-to-side.

Look at Figure 5-1. Your plotter uses an **X-Y coordinate system** to find its way around. This is simply a pair of measuring dimensions at right angles, like north-south and east-west on a map. The X axis runs through the plotter from front to back; the Y axis runs across the plotter. The zero point for both axes (called **0,0** or **zero-zero**) is in the upper left corner of the sheet of paper as you face the plotter.

Figure 5-1. The X-Y Coordinate System



X-axis and Y-axis motions.



When you tell your plotter to move the pen from one X-axis number to another, it actually moves the paper backward or forward until the pen is located over the desired spot on the paper. When you send a command that requires a change of Y-axis position, your plotter slides the Pen Head to the left or right. Of course, most commands involve both X-axis and Y-axis motions, so your plotter moves both the pen and the paper at the same time.

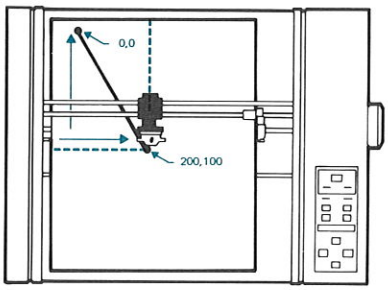
Measurement Units

Measurement Unit: 0.1 mm.

When you first turn on the power, your plotter automatically adopts a pair of measuring scales for motions along the X and Y axes. In both cases, it adopts 1/10 millimeter as the basic measurement unit. Thus if you send it the command

```
MR 50, 60
```

it will move the pen 5 millimeters along the X axis (50 units of 1/10 mm each) and 6 millimeters along the Y axis. These measurements are quite precise; you can use them to make accurate scale drawings.



Changing measurement units.

An Example: Suppose the current pen position is X = 0 and Y = 0, and you tell your plotter to move the pen to the location X = 100, Y = 200. In response to this command, it will move the paper 10 millimeters toward the back of the machine (100 tenths = 10 mm); at the same time it will move the pen head 20 millimeters to the right.

If You Are Working in Inches: Multiply your measurement in inches by 254 to arrive at the proper number for measurement units in tenths of millimeters. For example, for a motion of 1-1/2 inches, use the number 381 (1-1/2 times 254 equals 381).

Later in this chapter (in the "Scaling Commands" section), you will learn how to change these measurement units (for example, to hundredths of an inch), and even make them different for the X and Y axes. For the present discussion, however, you can assume that every distance number used in a plotter command will refer to tenths of millimeters.

Working Area Commands

Viewport: The boundaries of the drawing area.

Your Apple Color Plotter always works within a rectangular area called the **Viewport**. The Viewport's boundary lines are invisible because they exist only in the plotter's command memory. But their effect is real, for if the pen comes to the edge of the Viewport, it will automatically stop. You cannot command your plotter to draw anything outside its current Viewport.

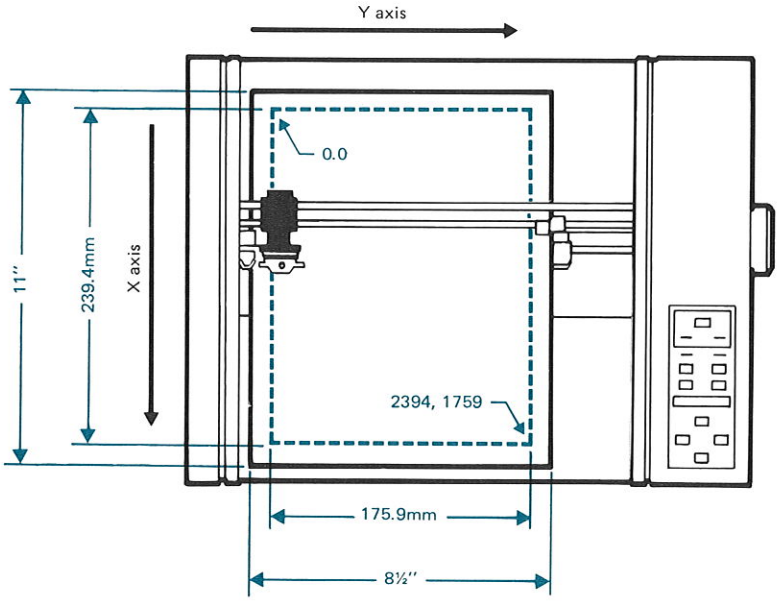
Default Viewport: 239.4 mm x 175.9 mm.

Every time you turn on the power, the Viewport is automatically set to the maximum working area for an 8-1/2 x 11-inch sheet inserted lengthwise in your plotter:

X axis dimension: 239.4 millimeters (2394 measurement units)
Y axis dimension: 175.9 millimeters (1759 measurement units)

This leaves a margin of 20 millimeters all around the working area, between it and the edge of the sheet, as shown in Figure 5-2.

Figure 5-2. Viewport Dimensions for 8-1/2 by 11-Inch Sheet



You can set the Viewport dimensions to any other size you want. There are two principal reasons to make the Viewport smaller or larger than the automatic 239.4 mm by 175.9 mm size:

- To fit a piece of paper that is smaller or larger than 8-1/2 by 11 inches.
- To restrict your drawing to a specific region of the sheet.

Warning

If you load a sheet of a size different from 8-1/2 by 11 inches into your plotter, you must adjust the righthand Feed Roller, as described in Chapter 2. But if you then inadvertantly send your plotter a command that drives the Pen Head too far along the Y axis, it may crash into the Feed Roller. This is not only bad for your plotter; it will throw off subsequent Y-axis measurements unless you reset the whole command memory. The solution is to set the Viewport to the correct size for the paper you are using.

Two good rules:

1. Always set the Viewport to be smaller than the paper you are using.
2. If you are making several drawings on a sheet, set the Viewport to your immediate working area.

How to change the Viewport size.

When the plotter is drawing on a specific part of the sheet, it is often a good precaution to limit the Viewport to the immediate working area. This way, a mistaken drawing command cannot send the pen off to spoil another part of your drawing.

Your Apple Plotter accepts two different commands for changing the dimensions of the Viewport:

- The SP (Size Paper) command automatically adjusts the viewport to the correct dimensions for various standard paper sizes.
- The VP (Viewport) command lets you select any dimensions at all for the Viewport.

These commands are discussed in the next sections.

Setting the Paper Size

Before starting any job, you should send your plotter the following command to let it know what size paper you are using:

Command	Action
SPn (n = 0-8)	Set Viewport for paper size n (see Table 5-2)

SP = Size Paper.

n defines paper size.

The single digit *n* that follows the SP command can be any of the nine numbers 0 through 8; they designate various American and European paper sizes. Several sizes have two different numbers, depending on whether you feed the sheet in sideways or lengthwise. You can find the correct number *n* for your job in Table 5-2.

Note: For each size of paper, the maximum viewport dimensions shown in Table 5-2 allow margins of 20 mm all around, between the viewport and the edges of the sheet. See Figure 5-2.

Table 5-2. Standard Paper Sizes

n	Paper	Maximum Viewport X axis	Y axis
0	8-1/2" by 11" lengthwise (default value)	239.4 mm	175.9 mm
1	8-1/2" by 11" sideways	175.9 mm	239.4 mm
2	11" by 17" (American "B" size)	391.8 mm	239.4 mm
3	297 mm by 420 mm (International "A3")	380 mm	257 mm
4	210 mm by 297 mm ("A4") lengthwise	257 mm	170 mm
5	210 mm by 297 mm ("A4") sideways	170 mm	257 mm
6	257 mm by 364 mm ("B4")	324 mm	217 mm
7	182 mm by 257 mm ("B5") lengthwise	217 mm	142 mm
8	182 mm by 257 mm ("B5") sideways	142 mm	217 mm

Use only SP0 through SP8.

The only valid forms of the SP command are SP0, SP1, and so on, through SP8. If you follow SP with any other number, your plotter will ignore the command and turn on the red Error Light on its Control Panel.

Note: If the plotter is not already at **home status** when you send it an SP command, it will go there. See the section, "Move to Home Status," later in this chapter.

Setting the Viewport

For many plotter jobs, you need only set the paper size as just described. You want the maximum Viewport for the paper you are using, in order to draw anywhere on the sheet. But in some cases you will want to set the Viewport to a smaller size. This protects you from accidentally sending the pen into unwanted regions. Here is the general command that sets the Viewport to any size:

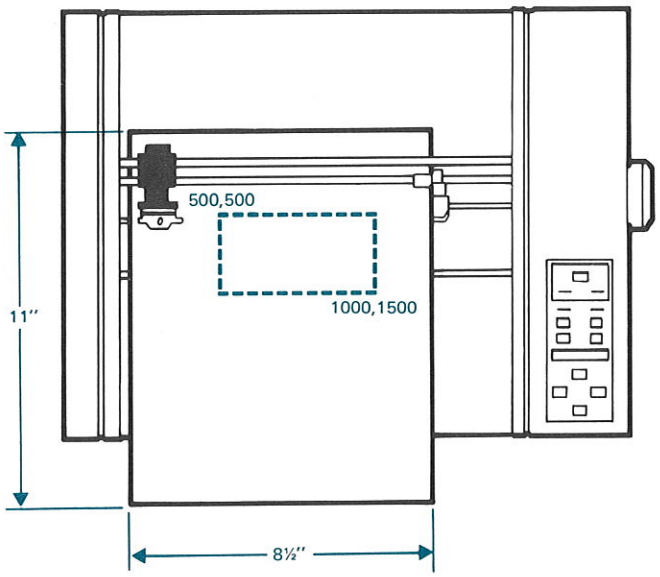
VP = Viewport.

Command	Action
VPa,b,c,d	Viewport: rectangle from corner a,b to corner c,d

VP command takes four numbers.

The VP command works only if it is followed by four numbers, accompanied by the Separator Marks described earlier (in the section, "Command Syntax"). They correspond to the X-axis and Y-axis coordinates of two opposite corners of the rectangular Viewport, expressed in tenths of millimeters. Look at the example in Figure 5-3.

Figure 5-3. Example of Viewport



Limits on Viewport numbers.

The numbers (*a*, *b*, *c*, *d*) in the Viewport command are subject to these restrictions:

- *a* and *c* must be within the range 0 to 3918.
- *b* and *d* must be within the range 0 to 2570.
- *c* must be larger than *a* and *d* must be larger than *b*.

Viewport command units: 0.1 mm.

Viewport command numbers always refer to tenths of millimeters, and are always measured from the zero-zero point on the upper left corner of the sheet as you face the plotter.

If you send your plotter an SP (Size Paper) command, it will override any previous Viewport command. It will set the Viewport to the values shown in Table 5-2.

Warning

Unless you want to change the measurement units by which your drawing commands are interpreted, you must accompany every change of Viewport with a change of Window. Your plotter's Window is discussed in detail in the section, "Scaling Commands," later in this chapter. For present purposes, just remember this rule: **every time you send a VP command, follow it with a WD command using the same numbers.** This will preserve your plotter's 1/10 millimeter measurement scale.

Creating the Viewport of Figure 5-3.

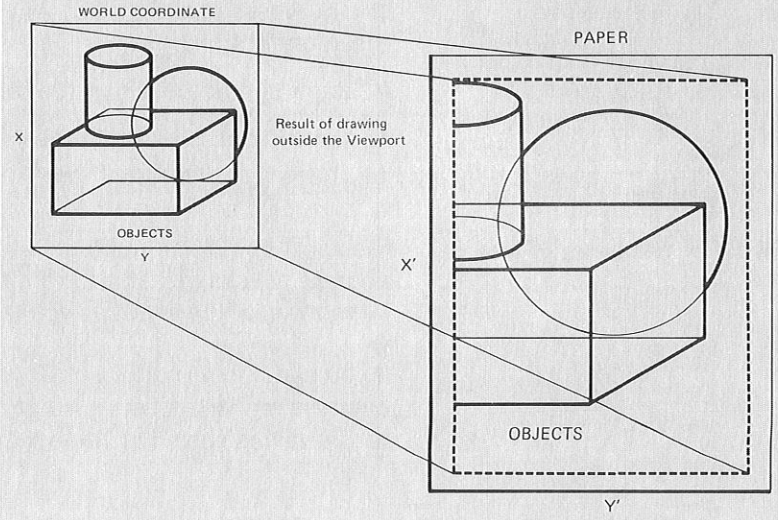
You would create the Viewport shown in Figure 5-3 with the command

```
VP 500, 500, 1000, 1500
```

It would establish rectangular boundaries inside the sheet, and limit all drawings to that area. In accordance with the warning just given, you would immediately follow this Viewport command with the corresponding Window command:

```
WD 500, 500, 1000, 1500
```

Note: Attempting to draw outside the Viewport does not lead to disaster. If part of your drawing lies outside the Viewport rectangle, your plotter simply sends its pen up to the limit and then waits until it is able to draw something inside again. It does not lose its place on the sheet. The effect is as if your drawing had been "sliced off" at the edge of



the Viewport. When this happens, the red Error Light may or may not go on, depending on how you set the error commands (see the section, "Error Detection," later in this chapter).

Drawing Commands

Kinds of drawing commands.

When your Apple Color Plotter is making a drawing, it draws one element at a time in response to commands from your computer. Some commands tell it to draw lines, curves, or shapes; others tell it to select a different pen color or move to a different point on the sheet. This section describes all the commands you need to make drawings with your plotter.

Select Pen Color

Command	Action
PSn (n = 1-4)	Puts number n pen in drawing position

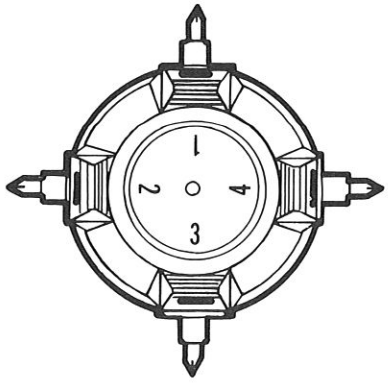
PS = Pen Select.

Your plotter can hold any 4 of 32 different pens.

As explained in Chapter 2, the Pen Head on your Apple Plotter can hold up to four pens at one time. Apple Plotter pens come in eight colors, two widths of line, and two inks (paper or transparency)—a total of 32 different styles. From this variety you can choose any four pens (the same or different) and place them in the Pen Head in any combination.

Use PS to change pens.

The Pen Select command—PS followed by the digit 1, 2, 3, or 4—tells your plotter to use that number pen for subsequent drawing commands. Your plotter doesn't select pen colors, only positions in the Pen Head; the resulting color depends on which pen you previously loaded there.



The pens are numbered counterclockwise (looking at the front of the plotter), with 1 cycling to drawing position when the plotter's power is turned on. These numbers are marked on the front of the Pen Head. To select a new pen, your plotter stops what it is doing and sends the Pen Head to the far left end. The Pen Head rotates clockwise until the selected pen is pointing down, then returns to where it was. What color it draws now depends on what pen you had loaded into that numbered position. If the selected number was already in drawing position, your plotter will ignore the PS command.

Use only digits 1 through 4 with PS.

The only valid commands are PS1, PS2, PS3, and PS4. Your plotter will ignore any other variations and turn on its Error Light.

Suggestion: Since it takes about two seconds to go from one pen number to the next, your plotter can spend considerable time making a drawing that requires a lot of color switching. You can save time by loading the Pen Head with only the colors you will be using. For example, if your drawing uses only black and red, put black pens in positions 1 and 3, red pens in positions 2 and 4. This way, your plotter will never have to cycle more than one step to change pen colors. It also helps to group together all the commands that use the same pen.

Pen selection remains until canceled.

Every time you turn the power on, your plotter cycles pen 1 into drawing position. Each subsequent pen selection will remain until you cancel it either by

- Making another pen selection;
- Sending your plotter a Control-R character (see below under "Reset Commands");
- Turning power off and back on; or by
- Pressing the Pen Select Button while the Operate Light is off.

Select Pen Speed

Command	Action
PVn (n = 1-10)	Changes drawing speed to n centimeters per second

PV = Pen Velocity.

Use PV to get a heavier line.

Normally your Apple Plotter draws at a rate of 10 cm per second (about 4 inches per second, or about 20 feet per minute). The plotter adopts this speed every time the power is turned on. However, you may sometimes find it desirable to slow the pen down. This produces a more heavily inked line, but of course the drawing takes more time. Some transparent films require a slower pen motion to make an even line.

Range of choices: PV1 through PV10 (1 through 10 cm/sec).

You can select any speed from 1 to 10 cm/sec by sending your plotter a PV command. PV5, for example, selects a pen speed of 5 cm/sec.

When not marking, the pen always moves at maximum speed.

The speed you select is used only when your plotter is actually making marks; when the Pen Head is moving with the pen raised, it always travels at the maximum 10 cm/sec. The speed you select is used for all marking tasks, including lines, circles, arcs, broken lines, coordinate axes, and written text.

Your pen-speed selection remains until you change or erase it.

Once you have selected a new pen speed, it will remain in force until you either select another pen speed or send your plotter one of the reset characters discussed in the section, "Reset Commands," later in this chapter.

Move to Home Status

Command	Action
CH	Moves to position for changing paper

CH = Command Home status.

Use CH when it is time to change paper.

Your plotter's **home status** is one in which the pen is at the far left end of its travel and the paper is in the position it was when you loaded it—adjusted to the Paper Set Marks on the Back Deck. This corresponds to a pen position of X = 70 mm (700 measurement units), Y = 0. You can return your plotter to home status any time by sending it the CH command. You normally do this at the end of a job when it is time to put in a fresh sheet of paper.

No numbers, just CH.

Because there is only one home status, there are no numbers following the CH command. This command also ignores the rule that the pen cannot move outside the Viewport (see above, "X and Y Measurements").

Note: When you turn the control panel's Operate Light off, your plotter will feed the paper sheet to load position anyway.

Movement Commands

Moving the pen to a new location.

When you send a movement command to your plotter, it raises the pen and positions it over another part of the sheet, ready to draw at a new location. There are two movement commands:

Command	Action
MAx,y	Move pen to absolute location x,y
MRx,y	Move pen x and y units from current location

MA = Move Absolute.
MR = Move Relative.

Use MA to move around on the sheet.

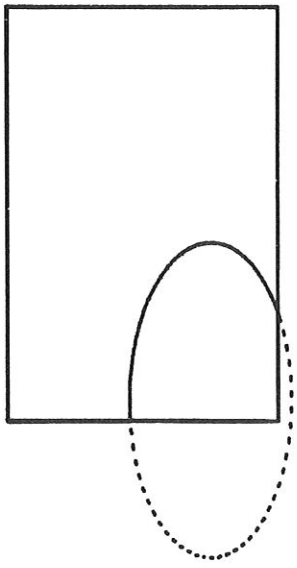
When you send your plotter an MA command, it raises the pen and moves it to a specific location on the sheet. For example, the command MA50,60 sends the pen to coordinates X = 50, Y = 60 (note that X is always written before Y). If you subsequently use relative motion and drawing commands (discussed later in this chapter), then the placement of the subsequent part of your drawing will be determined entirely from the absolute location you specified by the MA command.

Use MR to make figures you can move as one unit.

The MR command is like the MA command, but instead of sending the pen to an absolute location on the sheet, the MR command sends it to a location that is measured relative to its current position. For example, MR50,60 raises the pen and sends it from where it is to a spot 50 *more* measurement units along the X axis and 60 *more* measurement units along the Y axis. If the pen started at absolute coordinates X = 100, Y = 100, then MR50,60 sends it to X = 150, Y = 160. You can use MR commands to create unitary drawings in local areas; by adding an MA command at the beginning, you can transport a whole drawing to another part of the sheet.

x and *y* are measured in measurement units.

The two numbers that follow the MA or MR command represent measurement units along the X and Y coordinates. Unless you have changed the measurement scale with a WD command (see the section, "Scaling Commands," later in this chapter), they will represent tenths of millimeters. They can be negative numbers. If you don't include signs for either or both, your plotter will assume they are positive.



The Viewport (see the section, "Working Area Commands," earlier in this chapter) establishes limits on MA and MR movements. If you send your plotter an MA or MR command that would carry its pen outside the maximum working area defined by the Viewport, the pen moves only as far as the limit lines.

Note: When an MA or MR command exceeds the Viewport limits, no error results. The pen simply goes up to the edge of the Viewport and then stops. Your subsequent drawing may then be sliced off at the limit line. However, the plotter keeps track of your commands, illegal though they may be, and does not lose its place on the sheet. For example, the sequence

```
MR 5000, 6000; MR -5000,-6000
```

will carry the plotter's pen back to its original position, even though the location X = 5000, Y = 6000 is outside the Viewport.

Draw a Straight Line

Your plotter always draws straight lines from the current pen position.

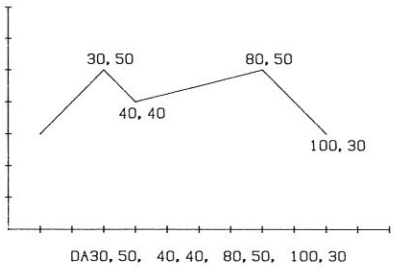
Your plotter can draw straight lines at any angle, and of any length within the Viewport. Every straight line starts from the current pen position. It goes from there to a second location, which may be defined either in absolute or relative terms:

Command	Action
DAx,y(,x,y...)	Draw straight line(s) to location(s) x,y
DRx,y(,x,y...)	Draw straight line(s) x and y units farther

(quantities in parentheses are optional parts of the command)

DA = Draw Absolute.
DR = Draw Relative.

When you send your plotter a DA command, it draws a line from the current pen position to a specific location on the sheet. For example, the command DA50,60 draws a line from wherever the pen is now to the location X = 50, Y = 60. This command is particularly useful for drawing linear graphs.



DR measures from the current pen position.

The DR command is like the DA command. But instead of drawing a straight line to an absolute location on the sheet, the DR command draws a straight line to a location that is measured relative to the current pen position. For example, DR50,60 draws a straight line from where the pen is now to a spot 50 *more* units along the X axis and 60 *more* units along the Y axis. If the pen starts at absolute coordinates X = 100, Y = 100, for example, the command DR50,60 draws a line to X = 150, Y = 160.

Use DR with MR to make portable figures.

You can use DR and MR commands to create unitary drawings in local areas; by adding an MA command at the beginning, you can transport a whole drawing made with DR and MR commands to another part of the sheet.

You can use multiple number pairs with DA and DR commands.

Unlike the other Apple Plotter drawing commands, DA and DR may be followed by multiple pairs of coordinate numbers. Look at the following example. Starting from a pen position of X = 50, Y = 60, either of the commands

```
DA 150,60 150,160 50,160 50,60
```

or

```
DR 100,0 0,100 -100,0 0-100
```

causes the plotter to draw a square (100 units on each side) and then return to the starting point. Note that the DA command

sequence, containing absolute locations, draws a square only if the pen is already at a specified place (X = 50, Y = 60); the DR command sequence draws a square anywhere on the sheet, starting from the current pen position.

Warning
The total length of the command (including letter pair, numbers, separator marks and end-of-command mark) must not exceed 255 characters.

x and *y* are measured in measurement units.

The two numbers that follow the DA or DR command represent measurement units along the X and Y coordinates. Unless you have changed the measurement scale with a WD command (see the section, "Scaling Commands," later in this chapter), they will represent tenths of millimeters. They can be negative numbers. If you don't include signs, your plotter will assume they are positive.

You cannot use DA or DR to go outside the Viewport.

The Viewport (see the section, "Working Area Commands," earlier in this chapter) constitutes a limit on DA and DR actions. If you send your plotter a DA or DR command that would carry its pen outside the Viewport, the pen will move only as far as the limit lines.

Note: If your DA or DR command would carry the pen outside the Viewport, the same rule applies as with Motion commands (see earlier section in this chapter). The pen will stop at the edge of the Viewport, but your plotter will not lose its place on the sheet.

Plot a Point

Point-by-point plotting.

When drawing graphs and mathematical curves, you may want to order your plotter to draw a single point at a time. Here is the command:

Command	Action
PM1	Make a single point mark at current pen location

PM = Plot Mark.

Use PM1 with MA or MR to draw graphs.

The PM1 command simply makes your plotter peck once at the paper, marking a single point. This is useful when you have to plot a graph of values that are not ordered, or are so scattered that a line graph would be confusing. Between PM1 commands, you can move the pen around by sending MA or MR commands.

Draw a Circle or Arc

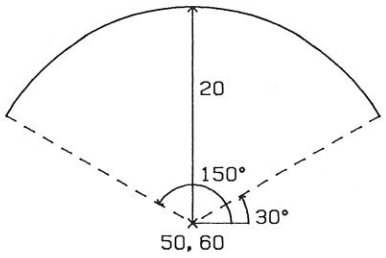
Drawing curves.

Your Apple Plotter will draw a circle, or part of a circle, of any size in response to a single command:

Command	Action
CAr(,x,y)	Draw circle of radius r (and center x,y)
ACr,a,b(,x,y)	Draw arc of radius r from angle a to angle b (around center x,y)

(quantities in parentheses are optional parts of the command)

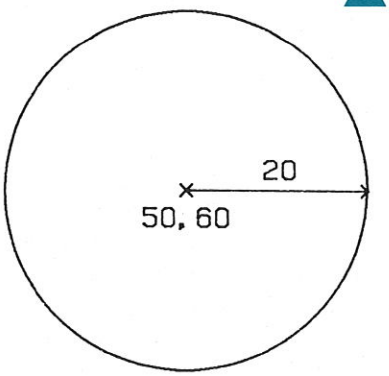
CA = Circle Absolute.
AC = Arc Command.



AC20, 30, 150, 50, 60

When you send your plotter either a CA or an AC command, it draws a smooth circular curve. In both cases, the first number after the letter pair (*r* in the format above) gives the radius of curvature. With the CA command, this defines a full circle, which is drawn counterclockwise back to the starting point.

When you send your plotter an AC (arc) command, you must also specify two angles, *a* and *b*. They determine the starting and ending points for the arc. These angles are measured from a line parallel to the X axis passing through the center of curvature; if positive, they are measured counterclockwise, and if negative, they are measured clockwise. Angle numbers may range from −3276.8 to +3276.7. However, your plotter divides numbers that are less than −359.9 or more than +359.9 by a multiple of 360 until they fall between these quantities.



CA20, 50, 60

Warning

If you establish two different measurement scales on the X and Y axes, the actual angles that appear on the sheet are different from your commands. In addition, circles and arcs are drawn as ellipses and ellipse sectors. See the section, "Scaling Commands," later in this chapter.

Circles and arcs may be placed either absolutely or relatively:

CAr = draw circle around current pen position.
ACr,a,b = draw arc around current pen position.
CAr,x,y = draw circle around coordinates x,y.
ACr,a,b,x,y = draw arc around coordinates x,y.

If you want to draw a circle or arc using the **current pen position** as the center, then the numbers just discussed are sufficient: radius for the CA command, and radius and two angles for the AC command. However, you may add two numbers to either command. If present, they indicate the **X and Y coordinates** of the center of the circle or arc. When these x and y numbers are present, the pen leaves its current position and goes to the location specified before starting to draw.

Warning

Circle and arc commands change the current pen position. In the case of circles, the pen is moved one radius farther along the X axis. With arc commands, the pen stops where it has finished drawing.

Line Pattern Commands

You're not limited to solid lines.

Your Apple Plotter is not limited to drawing only solid lines; it can draw broken lines, too, in virtually any pattern. There are three line pattern commands. The first command allows you to choose a standard line pattern from a built-in selection. The second command allows you to design your own pattern of line breaks and store it in your Apple Color Plotter's memory. The third command tells your plotter to use this completely new line pattern that you have designed.

Command	Action
LTp(,k)	Use standard pattern p; (repeat length = k)
ULd1,m1 (,d2,m2,..d6,m6)	Custom line pattern: draw length 1, move length 1 (draw length 2, move length 2, etc. up to 6)
LT0(,k)	Use custom line pattern; (repeat length = k)

(quantities in parentheses are optional parts of the command)

LT = Line Type.
UL = User's Line.

Repeat length = 0 to 32767 units.

You can choose any of the standard line patterns shown in Figure 5-4 by sending your plotter an LT command. LT must be followed immediately by the pattern number *p* (1 through 9). If you send no other number, the pattern will repeat every 100 measurement units. But you can add a second number *k* to specify a different repeat length in measurement units. The second number may specify a repeat length anywhere from 0 to 32767 measurement units. For example, the command

```
LT2,50
```

tells your plotter to draw every line as a series of dots (pattern *p* = 2) and space the dots 50 measurement units apart (repeat

length $k = 50$). Without the number 50, it would automatically space the dots 100 measurement units apart.

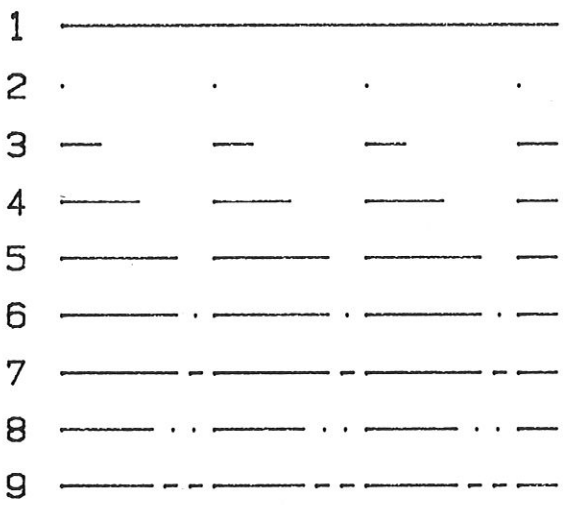


Figure 5-4: Standard Line Patterns

Once you send your plotter an LT command, it uses that pattern for all drawings until you send a reset command or another LT command. To return to solid lines, send the command LT1. However, only certain types of drawings are affected by LT:

Affected by LT Command	Not Affected
Straight lines	Coordinate axes
Circles	Text and symbols
Arcs	Error messages

When one LT command supersedes another, the pattern length *k* remains unless it is changed by the new command. For example, the sequence LT 2,50; LT3 results in the command LT3,50.

By the way: If the plotter comes to the end of a line without having finished a whole repetition of the line pattern, it starts the next line it draws with the part of the repetition that was left over. This is a useful feature, for it means that when you draw a broken-line graph, the pattern will be uniform, even though the graph consists of many short line segments. But sometimes it is a bother. For instance, when you draw a circle using a broken line, the pattern seldom comes out even when the circumference is completed. The part left over forms the beginning of the next line your plotter draws. If you want to start the next line with a whole pattern, just send the LT command again; this resets the line pattern.

Designing your own custom line pattern.

You are not limited to the standard line patterns shown in Figure 5-4; you can design your own pattern and tell the Apple Color Plotter to use it for all line drawings. The UL command defined earlier allows you to store a custom line pattern in the plotter's memory. A subsequent LT0 command (with or without a repeat length number) will then choose this custom line pattern, just as if it were one of the standard patterns.

How to do it.

The letter pair UL can be followed by up to 6 pairs of numbers (with separator marks). Each pair of numbers defines a drawing interval and a space interval along the custom line. If the repeat length you specify when choosing the custom line pattern (the number following the LT0 command) is not equal to the sum of all drawing and space intervals you originally specified, then they are all scaled up or down to fit the repeat length.

Example: Suppose you wish to specify a line in which alternate segments two and three units long are separated by spaces one unit long. You could send this command to your plotter:

```
UL200,100,300,100
```

At any later time (if the command memory has not been reset), the command LT0 causes all subsequent lines, circles and arcs to be drawn with this pattern. LT0 alone adopts the default repeat length of 100 units, and the pattern just specified is scaled down until it all fits into a 100-unit length. To draw the pattern with the actual lengths shown, you must use LT0,700 (because 700 = 200 + 100 + 300 + 100).

Effect of scaling commands on line patterns.

All the line patterns just discussed will change dimensions if you change your plotter's measurement scale. For a complete discussion, see the section, "Scaling Commands," later in this chapter.

Coordinate Axis Commands

One of the more useful jobs your plotter can do is make graphs. To help you create easy-to-read graph forms, your plotter makes entire coordinate axis drawings in response to a pair of single commands:

XT = X-axis Tick-marks.
YT = Y-axis Tick-marks.

Command	Action
XTp,q,r(,tp,tn)	Draw X-axis coordinate (see text for details)
YTp,q,r(,tp,tn)	Draw Y-axis coordinate (see text for details)

(quantities in parentheses are optional parts of the command)

How to specify coordinate axes.

To draw coordinate axes, you send the Apple Color Plotter either an XT or a YT command. The two commands are treated identically; their only difference is that XT draws an axis along the X dimension and YT along the Y dimension. You must follow each command with at least three numbers—*p*, *q*, and *r*. The last two numbers—*tp* and *tn*—are optional. Here's what these numbers mean:

p is a drawing mode selector that determines the meaning of *q*.

p, q, and r. The first number (*p*) following the XT or YT letter pair must be either 0, 1, 2, or 3. It determines the significance of the next number *q*:

If p is	then q specifies	Initial Tick?
0	the length of each interval between ticks	yes
1	the total length of the coordinate axis	yes
2	the length of each interval between ticks	no
3	the total length of the coordinate axis	no

p = mode
q = interval length or total length
r = number of intervals

Each coordinate axis consists of a straight line with right-angle tick marks at intervals along it. You can specify it either by telling your plotter the length of each tick interval and how many intervals to draw ($p = 0$ or $p = 2$), or by telling it the total length of the axis and how many intervals to divide the axis into ($p = 1$ or $p = 3$). The third number, *r*, always specifies the number of intervals, up to 255. For example, the following two specifications are identical:

p	*q*	*r*
0	50	20
1	1000	20

In both cases, you are telling your plotter to draw an axis 1000 units long with 20 intervals between tick marks, each interval being 50 units long.

p = 0 or 1: initial tick.
p = 2 or 3: no initial tick.

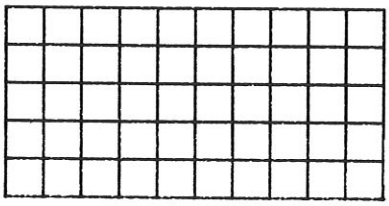
There is another feature you can specify by the mode number *p*. If it is 0 or 1, your plotter draws the first tick mark at the beginning of the axis; if it is 2 or 3, it draws the first tick mark at the end of the first interval. Since you can draw any coordinate axis either forward or backward (by making *q* positive or negative), you can choose to omit the tick mark at either end.

tp = positive tick length.
tn = negative tick length.

tp and tn. You can specify any length for the tick marks drawn at right angles to the coordinate axis. If you make them very long, you can use them to draw a grid. An example is shown in Figure 5-5. The number *tp* is the length of each tick mark in the positive direction; *tn* is its length in the negative direction. You don't need to include these numbers in your XT or YT commands; if you don't, your plotter will assume that you want 1 mm ticks in both directions. If you do include them, your plotter will remember the values and append them to all subsequent XT or YT commands.

Figure 5-5. Drawing a grid

```
XT1, -500, 10, 250, 0
YT3, 250, 5, 500, 0
```



Text Writing Commands

Adding written text to your drawings.

Your Apple Color Plotter doubles as a printer. Its permanent memory contains instructions for writing uppercase and lowercase letters, numbers, and punctuation marks (including symbols and international characters). All you have to do is send it a few short format commands followed by a string of text characters. It translates your characters into drawing instructions and writes them neatly anywhere on the sheet.

The command for writing text is simple:

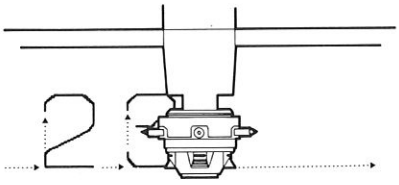
Command	Action	
PL<text>	Write <text>	(end with CONTROL-C)

PL = Print Lettering.

Command characters after PL are written out.

To tell your plotter to write text, just send it the PL command followed immediately by the text to be written. It stores the characters you send until it receives a colon, semicolon, carriage return, line feed, or CONTROL-C; then it starts writing. It continues to store and write all the characters you send it until you terminate the writing process by sending it a CONTROL-C character.

Important: The CONTROL-C character is the *only* end-of-command mark that ends the writing command started by PL. The other end-of-command marks (colon, semicolon, carriage return, line feed) make your plotter write out the text it has stored; but afterward, your plotter continues to treat new characters as text to be written.



Text written by the Apple Color Plotter starts with the current pen position at the lower left corner of the first character. After it has finished writing, the pen ends up at the lower left corner of the character position following the one last written.

Control Characters

Your plotter recognizes these control characters (for an explanation of decimal and hex codes, see Appendix B).

Besides writing all the letters, numbers, and punctuation marks that are on a normal keyboard, your Apple Color Plotter responds to certain special characters:

Character	Decimal	Hex	Action
CONTROL-H	8	$08	Backspace (also changes left margin)
CONTROL-J	10	$0A	Line feed
RETURN	13	$0D	Carriage return
CONTROL-Q	17	$11	(see section on "Reset Commands")
CONTROL-R	18	$12	(see section on "Reset Commands")
CONTROL-U	21	$15	(see section on "Reset Commands")

What the control characters do.

Here are some notes on what these control characters do:

- **Backspace** moves the pen back one character. If there is a character already written there, the next character is written on top of it. This command also resets the left margin position; the next carriage return returns the pen to the position of the latest backspace, not the beginning of the original line.
- **Line feed** moves the pen down one line without returning it to the left end of the line.

- **Carriage return** moves the pen to the left end of the line, or to the last backspacing position, without moving down to the next line. If you do not add a line feed character, the plotter writes the next line on top of the previous one.

For a complete list of all the characters that your plotter can write, see Appendix B.

Warning
Null characters (ASCII code 0) produce unpredictable effects in the Apple Color Plotter and should not be sent to it.

Text Format Commands

You can write text and symbols in any size and direction, in other languages as well as in English.

There are three format commands you can give your plotter to select the way it writes text:

- A **size** command that allows you to choose any size lettering from tiny to enormous.
- A **line orientation** command that allows you to write lines of text on the sheet horizontally, vertically, or at any angle in between (even upside-down).
- A **letter slant** command that allows you to tilt the vertical lines in your lettering, producing a range of italic typestyles.
- Two **font selection** commands. One command changes certain punctuation marks into the special characters necessary to write British, German, French, Swedish, Italian, or Spanish text. The other command tells your plotter to draw one of a selection of special symbols.

Automatic format commands.

The foregoing format commands all have default values that are adopted automatically each time power is turned on:

Function	Default Value	Override Command
Size	30 units	LS
Line orientation	0 degrees	LR
Letter slant	0 degrees	SL
Font selection	#0 (USA)	LF

Resetting the text format.

Whenever the text format is different, you can restore the above values by sending the plotter a single text reset command (see the section, "Reset Commands," later in this chapter).

All of these commands are discussed in the sections that follow.

Select Text Size

Command	Action
LSh	Subsequent text letters will be h units high

LS = Letter Size.

Set the letter size to anything you want; default size is similar to typewriter pica.

The LS command followed by a number establishes the letter height for subsequent text. When you turn on the power or send the plotter a reset character, the letter height is automatically set to 30 measurement units (3 mm when the measurement scale is tenths of millimeters). This corresponds roughly to the size of pica typewriting—your plotter writes 8.47 characters to the inch horizontally and 5.64 lines to the inch vertically. You can subsequently set the text size to anything else (up to 32767 measurement units) or retain the 30-unit height. If you set it to less than 1.5 mm, however, your plotter may not be able to write some characters legibly.

When you set the letter height, it not only determines the height of each character, but also the width and other proportions as follows:

- Width = 2/3 of letter height
- Space between characters = 1/3 of letter height
- Space between lines = 1/2 letter height

These relationships are shown in Figure 5-6.

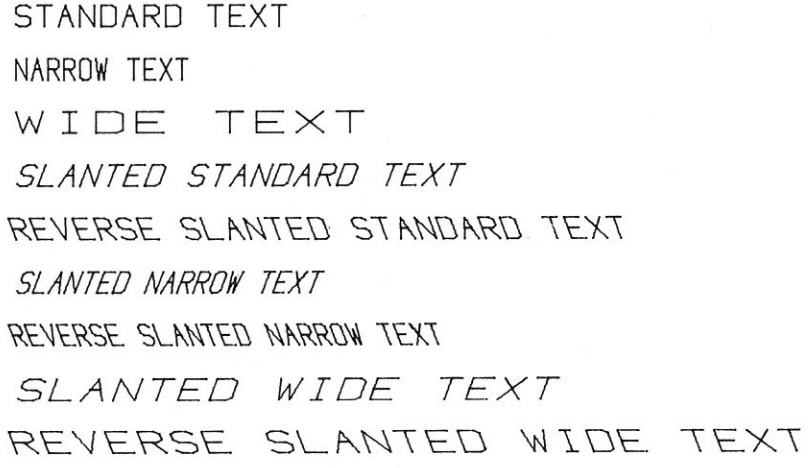


Figure 5-6. Text Character Proportions

Select Line Orientation

Your Apple Color Plotter writes lines of text at any angle. You simply tell it how many degrees from the X axis to tilt the line, using the LR command:

Command	Action
LRk	Tilt subsequent text lines k degrees from X axis

LR = Line Rotation.

Text angle is measured counterclockwise in degrees.

The number *k* following the LR command represents degrees. If it is positive, your plotter measures the angle in a counterclockwise direction; if it is negative, in a clockwise direction. If it is larger than 359.9, only the amount over a multiple of 360 is recognized (in mathematical terms, it is reduced modulo 360). If the number is larger than 32767, the LR command is ignored, and the plotter turns on its Error Light.

To print horizontally, use LR90.

The default orientation for writing text is along the X axis—sideways as you face the plotter. To print text along the Y axis (the *normal* way when paper is inserted in your plotter lengthwise), send your plotter the command LR90.

Note: If you establish different X and Y axis scales, both the letter shapes and line orientation angles become distorted. See the section, "Scaling Commands," later in this chapter.

Select Letter Slant

You can tell your Apple Color Plotter to write slanted (*italic*) lettering, with either a forward or a backward slope:

Command	Action
SLk	Slant all lettering k degrees from vertical

SL = Slant Lettering.

Letter slant is measured from a line vertical to the line orientation.

The number *k* following the SL command represents degrees, measured from a line at right angles to the text line orientation. If it is positive, each letter is slanted forward; if it is negative, each letter is slanted backward. This number cannot be less than -85 or more than +85. Once you have established a letter slant, your plotter uses it for all lettering and written symbols, regardless of letter size or line orientation. Letter strokes in the same direction as the line orientation remain unchanged, but letter strokes that would normally run at a right angle to the line orientation become slanted.

Select Character Font

Writing foreign languages.

Your plotter has an international education; it writes other languages as well as English. Included in its standard selection of characters are 10 punctuation marks that you can change into special symbols or accented letters. They help you write text in German, French, Swedish, Italian, Spanish, and British English, as well as in American English.

International characters are substituted for certain punctuation marks.

Normally, your plotter writes the following ten punctuation marks as shown here:

@ [\ ] ‘ { | } ~

After it has received a font selection command, however, the plotter substitutes new characters for some or all of these marks. The substitute characters are shown in Figure 5-7.

Figure 5-7. International Character Fonts

Command	Action
LFn (n = 0-6)	Substitute font n as shown in Figure 5-7

LF = Letter Font.

Default font selection = 0.

Notice that font 0, shown in Figure 5-7, contains the original punctuation marks; this is the American font. It is the one that is automatically selected every time you turn on the plotter's power switch.

Font selection remains until reset or superseded.

After you have selected a new international character font with the LF command, your selection remains in force until you send the plotter a reset or a new LF command. You can also restore the original punctuation marks by sending the command LF0.

```
LF2

PL[pfel
LF0

Äpfel
```

Example: Suppose you want to tell your plotter to write the German word *Äpfel* (apples) with an umlaut (two dots) over the letter *A*. You first send the command LF2 to select the German letter font. As you see in Figure 5-7, this assigns the German capital-A-umlaut character to the normal left bracket mark. You then send the word *[pfel*. Because the bracket mark has been reassigned, your plotter will write *Äpfel* instead of *[pfel*. Your plotter will write other punctuation marks as German characters until you send an LF0 command to restore the American font.

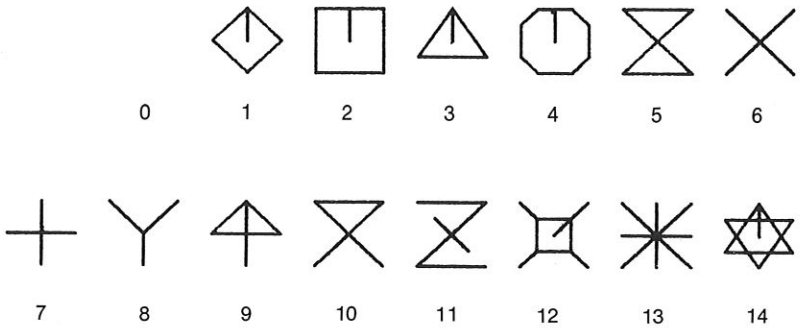
Writing Symbols

Choose from a selection of 14 symbols.

In addition to ordinary text and international characters, your plotter's memory contains instructions for drawing 14 special symbols. These symbols are shown in Figure 5-8. They have several uses:

- Identify points in scatter graphs.
- Label graph traces and drawing details.
- Identify reference notes in written text.

Figure 5-8. Plotter Symbols



Each time you send your plotter a PM command, it writes the selected symbol once around the current pen position:

Command	Action
PMn (n = 2-15)	Write Symbol n as shown in Figure 5-8

PM = Plot Mark.

Symbols are connected to their center points.

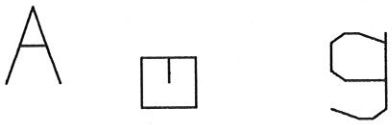
Note that each symbol contains a line drawn to its center. The pen starts from this center before drawing the symbol, and returns to it afterward. Thus you may use each symbol to identify a specific point in a graph or drawing, by drawing the symbol around that point. The built-in connecting line makes it clear exactly what spot the symbol refers to.

Symbols can be any size and orientation.

The Apple Color Plotter symbols are controlled by the same size and orientation commands as written text. This means that you can tell your plotter to draw them any size you want and rotate them to any orientation. By rotating them, you can create additional symbols. For instance, the arrow (PM10) can be made to point in any direction by preceding it with a LR (line rotate) command.

Symbols 2/3 the height of letters.

The vertical height of symbols is 2/3 the height of text letters. So when specifying their size with the LS (letter size) command, use a number 1-1/2 times the actual height desired. For instance, to draw symbols 60 measurement units high, precede them with an LS90 command.



Caution: Symbols may be freely mixed with written text. However, bear in mind that symbols are drawn around the current pen position, whereas text letters start with the pen in their lower left corner and finish with the pen repositioned to the lower left corner of the next character. This means that you must use MR commands to shift the current pen position before and after drawing each symbol.

Scaling Commands

Default scale unit is 1/10 millimeter.

When you turn on its power or send it an SP (Size Paper) command, your Apple Color Plotter automatically chooses a scale unit of 0.1 millimeter for both the X and the Y axes. From then on, until you tell it differently, it interprets the numbers in your motion commands as measurements in tenths of millimeters.

Why change scale units?

However, you can change the scale unit. Moreover, you can (if you want) establish different scale units for the X and Y axes. This capability allows you to do several new things with your plotter:

- Make accurately scaled drawings in other units—for example, hundredths or sixty-fourths of an inch.
- Modify the geometry of your drawings (by setting different X and Y scale units) to create ellipses and perspective views.
- Write text and symbols in condensed or extended type styles.

Your Plotter's Window

Viewport: the physical working area.

In an earlier part of this chapter, we discussed your plotter's Viewport—its maximum working area on the physical paper sheet. Except when you are changing paper, you cannot command the pen to move outside the Viewport. The Viewport boundaries are always defined in units of 1/10 millimeter, starting from the *zero-zero* point in the upper left corner of the sheet.

Window: the numerical working area.

But how does your plotter know when it has been commanded to move outside the Viewport? Inside your plotter's memory is a second working area definition—one that refers only to the numbers included in your commands. This is the **Window**. You might say that it establishes the plotter's "numerical working area." You can set the boundaries of the Window to any numbers you want (within the plotter's overall number handling capability).

The Window is a map of the Viewport.

Your plotter automatically translates the numerical boundaries of the Window into the physical boundaries of the Viewport so that the Window numbers you have set now correspond to physical positions on the paper sheet. Henceforth every numerical position inside the Window defines a physical location in the Viewport. In effect, the Window becomes a map of the Viewport, assigning numbers to its physical area.

Setting the Window

You set the numerical boundaries of the window in exactly the same way as you set the physical boundaries of the Viewport. Here is the command:

Command	Action
WDa,b,c,d	Window: rectangle from corner a,b to corner c,d

WD = Window Dimensions.

Rules for Window numbers.

You can choose any numbers for *a*, *b*, *c*, and *d*, provided you observe these rules:

- They must all be within the range −32768 to +32767.
- *c* must be positive with respect to *a*, and *d* must be positive with respect to *b* (the Window cannot have a negative dimension).

Window commands vs Viewport commands.

The Viewport command, described earlier in this chapter, has the same form: VPa,b,c,d. The Viewport numbers refer to tenths of millimeters on the sheet; the Window numbers refer to the quantities in your drawing commands. These two parallel commands determine how all drawing command numbers are translated into sheet locations. Thus Window *a* becomes the numerical equivalent of Viewport physical position *a*, Window *b* scales Viewport *b*, and so on.

If you send your plotter an SP (Size Paper) command, it overrides any previous Window command. It sets the Window to the values shown in Table 5-2.

The Viewport-Window Relationship

Understanding Figure 5-9.

Let's look at an example. Figure 5-9 illustrates the relation between a sample Viewport and a sample Window in your plotter.

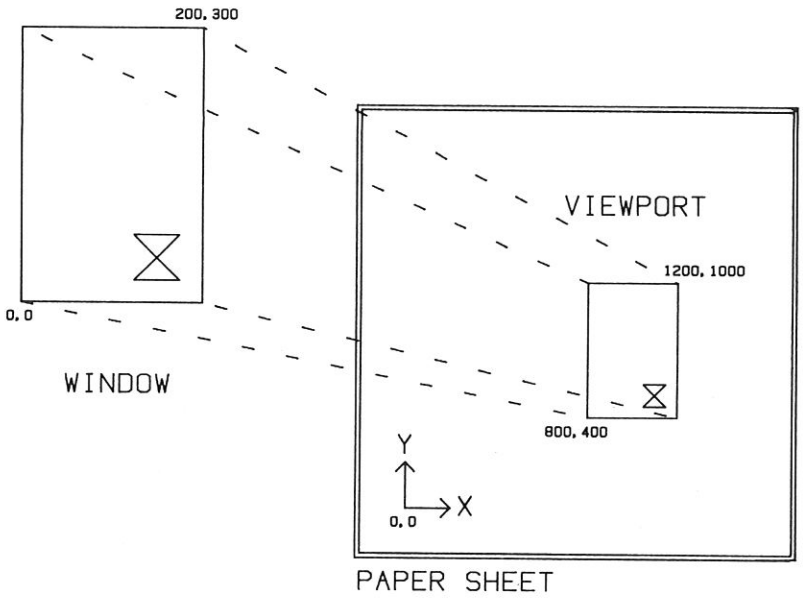


Figure 5-9. Viewport and Window

In Figure 5-9 the Viewport runs from 80 to 120 mm along the X axis and from 40 to 100 mm along the Y axis. Thus, it defines a 40 x 60 mm rectangular working area on the physical sheet. Since every Viewport is measured in units of 0.1 mm, you would set up the one shown in Figure 5-9 by sending your plotter this command:

```
VP 800, 400, 1200, 1000
```

The Window shown in Figure 5-9 is also a rectangle; it covers plotter command numbers from 0 to 200 in the X dimension and from 0 to 300 in the Y dimension. You would set it up by sending this command:

```
WD 0, 0, 200, 300
```

Once these two commands—Viewport and Window—are entered into your plotter's memory, it uses them to interpret every motion or drawing command you send it. For example, the Move Absolute command MA0,0 would send the pen to the position X = 80.0 mm, Y = 40.0 mm, because the 0,0 corner of the Window would now constitute the "map location" of the 800,400 corner of the Viewport. The hourglass-shaped drawing that is centered on the location 150,50 in the Window would be placed at the position 1100,500 on the sheet.

Measurement Scales

Window-Viewport relationship determines measurement units.

You can use the Window and Viewport commands to establish virtually any relationship between the numbers in your plotter commands and the physical locations on the paper sheet. Consider the example shown in Figure 5-9. Because the Window dimensions are 200 by 300, while the Viewport dimensions are 40 by 60 millimeters, every unit in a drawing command moves the pen 1/5 millimeter. Drawings and written text are twice as large as they were under the *standard* 1/10 millimeter scale. If you changed the Window dimensions to 157 by 236, all drawing commands would become scaled in units of 1/100 inch (see the section, "Changing Measurement Units," later in this chapter).

In the absence of a Window command, you get 0.1 mm scaling.

What happens if you don't use the Window command? Whenever you turn on the power or use the Size Paper (SP) command, your plotter automatically sets both the Viewport and the Window. It uses the same numbers for both. Since the Viewport numbers refer to tenths of millimeters, that becomes the scale for Window numbers as well. This is why drawing commands are *normally* interpreted in 1/10 millimeter units. Unless you send your plotter a new VP or WD command, the 1/10 millimeter scale remains.

Changing the Viewport. In our earlier description of the Viewport command, you were warned to set a new Window whenever you change the Viewport. If you don't, your plotter calculates its measurement scales by comparing the old Window to the new Viewport. To retain a scale of 1/10 millimeter units, simply accompany each new VP command with a WD command containing the same numbers.

Different X and Y Scales

Making distorted drawings.

What happens if the Viewport and Window are not the same shape? Suppose, for example, that you set the Viewport to 40 by 60 millimeters (as shown in Figure 5-9) but set the Window to 200 by 200. The result will be different scale units for the X and Y axes. Your plotter will continue to interpret drawing command numbers along the X axis in units of 0.2 mm, but it will interpret numbers along the Y axis in units of 0.3 mm. Drawings and lettering become "stretched" 50 percent in the Y dimension; circles are drawn as ellipses and squares become rectangles. Your plotter is able to convert plan views into projected views. Lettering becomes condensed or extended, depending on whether it is written along the X or Y axis.

Warning

If you set different X and Y scales, your plotter no longer interprets angular commands as true angles. The relation between the angle commanded and the angle actually drawn is given by this formula:

$$\Theta c = \arctan\left[\frac{VxWy}{VyWx}\tan\Theta t\right]$$

where
- Θc is the angle contained in the command
- Θt is the angle actually drawn
- Vx is the X dimension of the Viewport
- Vy is the Y dimension of the Viewport
- Wx is the X dimension of the Window
- Wy is the Y dimension of the Window.

Where to find more information.

A full discussion of the possibilities of Window-Viewport interactions is beyond the scope of this User's Manual. For further information, consult a text such as *Fundamentals of Interactive Computer Graphics* by Foley and van Dam (Addison-Wesley, 1982).

Changing Measurement Units

How to change measurement units.

The Window command is often used simply to change the overall scale of a drawing without distorting it. For instance, you may wish to command your plotter to interpret the numbers in your drawing commands in hundredths of an inch instead of tenths of millimeters. Changing your plotter's overall scale requires two steps:

1. Determine the dimensions of the Viewport currently in force.
2. Send your plotter a Window command containing the Viewport dimensions multiplied by a scale factor.

How to determine the current Viewport dimensions.

Unless you have sent your plotter a specific VP command, the **current Viewport dimensions** will have been set by the latest SP (Size Paper) command. You can find them in Table 5-2, earlier in this chapter. If you have not sent an SP command, they will be the default Viewport dimensions—X = 2394, Y = 1759.

Common scale factors.

To change the drawing scale, you must send your plotter a **Window command** derived from the current Viewport dimensions. To calculate its numbers, multiply the Viewport dimensions by a factor that expresses the difference between the scale units you want and the Viewport's 0.1 millimeter units. Here are some common factors:

Hundredths of an inch:	0.3937
Thousandths of an inch:	3.9370
Sixty-fourths of an inch:	0.2520
Printer's points (1/72 inch):	0.2835

Example: Suppose that you have just turned the power on (so the default Viewport is in force), and you wish to change the drawing scale to hundredths of an inch. When the power was turned on, the following command was automatically entered in your plotter's memory:

```
VP 0, 0, 2394, 1759
```

Multiplying these numbers by the factor 0.3937 (see above list) gives a Window command of

```
WD 0, 0, 943, 693.
```

After you send this Window command to your plotter, all subsequent drawing commands move the pen in units of 1/100 inch.

Error Detection

What happens when you send a bad command.

Your Apple Color Plotter contains built-in circuits that analyze each command you send. If it discovers that it cannot execute the command completely and exactly, it will ignore the command and tell you that something is wrong. Your plotter can call for help in three ways:

- By turning on the red Error Light on its Control Panel.
- By turning on the red Error Light and refusing to accept further commands.
- By turning on the red Error Light, refusing to accept commands, and writing a message in the corner of the sheet.

Error status remains until you cancel it.

In each case, your plotter keeps its Error Light on until you reset its error circuitry as described in the next section.

You can choose the kinds of errors your plotter will recognize and what it will do about them. This section tells you how.

Selecting the Error Action

When you turn on the power, your Apple Color Plotter automatically adopts the simplest level of action for telling you if it has received a bad command—turning on the red Error Light and nothing more. But at any later time, you can add to this level of action (or return to it) by sending your plotter one of these IM commands:

Command	Action
IM64(,x)	Reject further commands until reset
IM192(,x)	Write message; then reject commands until reset
IM0(,x)	Turn on Error Light only, until reset

For the meaning of *x* in these IM commands, see the section, "Selecting Error Types," later in this chapter.

An example.

For example, if you send your plotter the command IM64, it will henceforth not only turn on the red Error Light when it receives a bad command, but also stop in its tracks until you reset its error circuits. To return it merely to signaling with the Error Light, you would send the command IM0.

The written error message.

The message your plotter writes when the IM192 command is in force typically looks like this:

```
ERR NO.  1 ERR CMD:BADCODE
```

where BADCODE is an exact rendering of the command it couldn't carry out (up to 20 characters). This message is written with a text height of 3.0 millimeters and a rotation of 0 degrees. The E of ERR starts at absolute position X = 10.0 mm, Y = 3.0 mm. The message cannot be moved to any other location and is unaffected by the text format and scaling commands. The ERR NO. is the error key number, explained in the section, "Selecting Error Types," later in this chapter.

Selecting Error Types

Using the second number (*x*) in the IM command.

There are five different ways that a command can be erroneous. You can tell your plotter to recognize any combination of them (or none, or all) by adding a second number to the IM command just discussed. This number must be within the range 0 to 31; you calculate it by adding up the key numbers for each type of error:

Types of error.

Key	Error Type Recognized
1	Command letters not in the plotter's vocabulary
2	Number(s) too large (e.g. outside range -32768 to +32767)
4	Not enough numbers to make a complete command
8	Unacceptable command syntax
16	Command would carry pen outside Window

Default: All error types recognized.

When you turn on the power, the Apple Color Plotter adopts an error type number of 31; this means it recognizes all five error types (1 + 2 + 4 + 8 + 16 = 31). You can change this at any time by sending an IM command with a different quantity for its second number.

Here is an example: In writing a program that draws a graph of certain input values, you are concerned that these values might either exceed the numerical capacity of the plotter or that they might try to drive the trace off the chart. If this happens, you want to stop graphing so the condition can be corrected. To accomplish this, you add the sequence IM64,18 to the initial set-up commands sent to your plotter. Your plotter interprets this sequence as follows:

- IM: This is an Error Detection Command.
- 64: Besides turning on the red Error Light, certain errors are to cause the plotter to refuse further commands.
- 18: These errors are those with key numbers 2 and 16 (2 + 16 = 18); that is, conditions in which either the command numbers are too large or the pen motion would go outside the maximum plotting area.

Your plotter will continue to reject all commands containing other types of errors, but will not turn on the Error Light because of them or otherwise notify you.

Resetting an Error Condition

As explained earlier, after your plotter informs you of an error (turns on the red Error Light or stops accepting commands), it maintains that action until you reset its error circuits. You can reset an error condition in two ways:

- By taking one of the actions discussed later in this chapter in the section, "Reset Commands."
- By sending the following special Error Reset Command:

Command	Action
RS	Reset error status

RS = Reset Status.

The RS command has no effect on any other commands; it simply cancels your plotter's error status. It turns off the red Error Light; if an IM64 or an IM192 command is in force, it also permits the plotter to accept new commands.

Note: If your plotter has been refusing commands because of an error condition, any commands it receives between the time it went into error status and the time you reset it will be lost.

Reset Commands

Ways to cancel previous commands.

You can tell your Apple Color Plotter at any time to clean out its memory and forget previous commands. There are several ways you can do this:

- You can turn its power off and then back on. This resets everything and restores the automatic set-up commands listed in Table 5-1.
- You can press the Pen Select Button while the Operate Light is out; this has the same effect as turning the power off and on.
- You can send your plotter a reset command while the Remote Light is on. There are four different commands you can send, each of which will clear your plotter's memory to a different level. These four commands are discussed in more detail below.

Note: The first three reset commands discussed below are all single ASCII control codes. Unlike other plotter commands, they do not require punctuation and do not follow the syntax rules given earlier in this chapter.

Cancel Current Command and Reset Error

Character	Dec	Hex	Action
Control-Q	17	$11	Cancels current command; resets error status

Control-Q (ASCII DC1) erases the mistake you just made.

For an explanation of ASCII codes, see Appendix B.

Whenever a Control-Q character occurs within a command being sent to your plotter, the plotter ignores that command and resets any error status that either exists already or would have resulted from the command. This happens even if the Control-Q character is part of a sequence of text that the plotter is writing; all unwritten text is discarded. Control-Q is sometimes also called the ASCII Device Control Code DC1.

Cancel All Commands Except Pen Selection

Character	Dec	Hex	Action
Control-U	21	$15	Cancels all commands except pen selection

Control-U (ASCII NAK) returns all default values except pen selection.

For an explanation and list of command default values, see the section, "Automatic Set-Up Commands," earlier in this chapter.

Whenever your Apple Plotter receives a Control-U character, it cancels all commands currently in force, with one exception: the current pen selection remains. Control-U thus produces the following effects:

- All commands except pen selection are either forgotten or replaced by the automatic set-up commands listed in Table 5-1.
- The command in which the Control-U character occurs is likewise canceled.
- If the plotter has been writing text, all unwritten text is discarded, and all format commands (such as character size) return to their default values.
- Any existing error status is canceled.
- The paper sheet is returned to home position, with its back edge at the Paper Set Marks on the Back Deck.

Control-U is sometimes also called the ASCII NAK (*Negative Acknowledge*) character.

Warning

Among the previous commands canceled by this and the next (Control-R) character are any special set-up commands you may have sent at the beginning. So if the automatic set-up values (such as a paper size of 8-1/2 by 11) are wrong for your present job, you must immediately follow the canceling character with a new sequence of special set-up commands.

Return to Power-Up Condition

Character	Dec	Hex	Action
Control-R	18	$12	Resets plotter to automatic set-up commands

Control-R (ASCII DC2) wipes it all clean.

If you send a Control-R character to the Apple Plotter, it accomplishes the same result as sending a Control-U (see foregoing command) with the additional effect of returning the pen head to pen selection 1. Obeying this command takes about seven seconds because of the time required mechanically to cycle the pen head. Afterward, the plotter is in the same condition as if the power had just been turned on. Control-R is sometimes also called the ASCII Device Control Code DC2.

Restore Default Text Format

Command	Action
LI	Sets text writing format back to default values

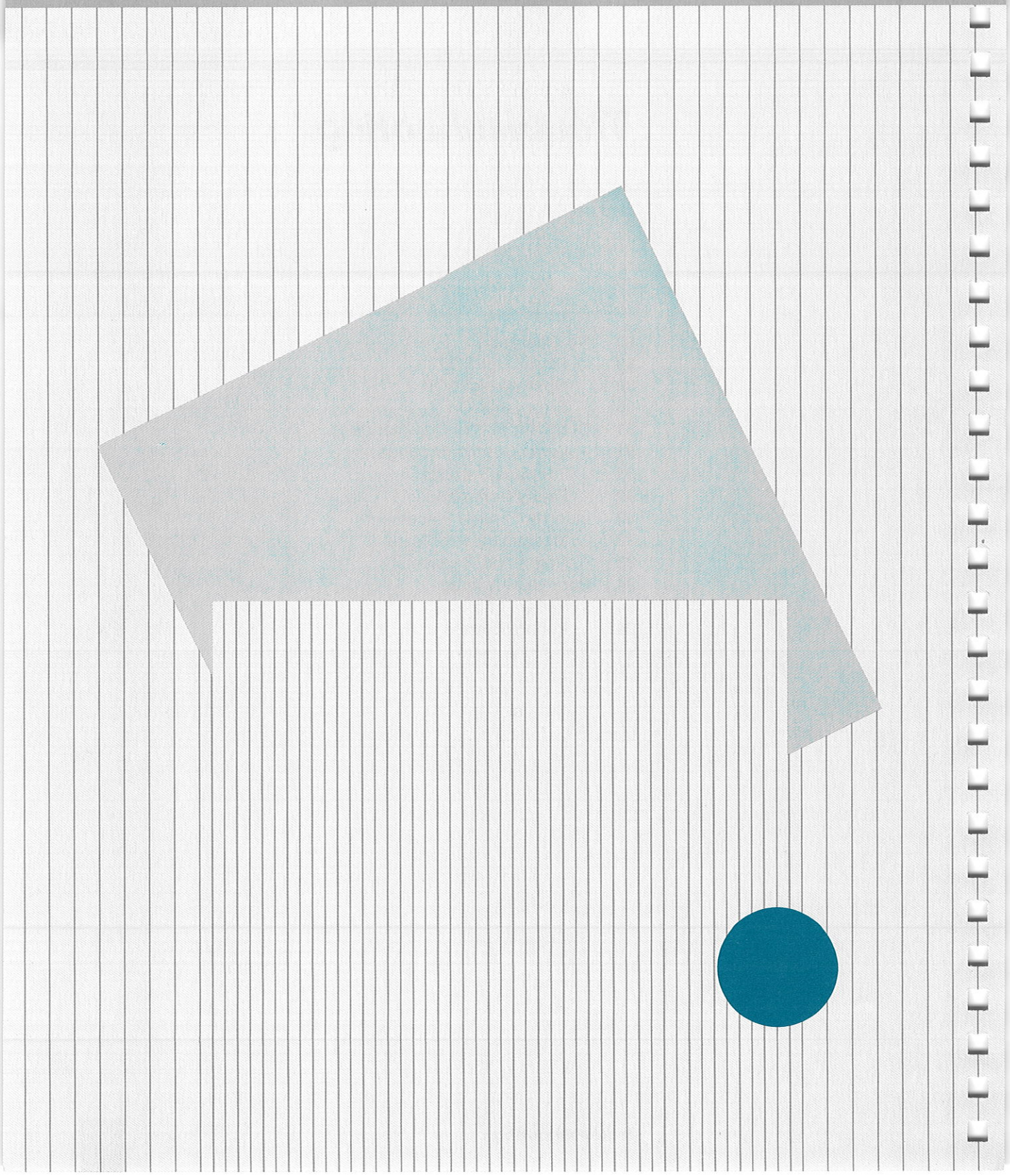
LI = Letter Initialize.

Restoring original text format.

In an earlier section, "Text Commands," we described the text format values that the Apple Color Plotter adopts when the power is turned on. You can return to these settings at any time by sending the LI command. Unlike the previous three reset commands, this command consists of two characters and requires an end-of-command mark after it. It restores the following text format specifications without affecting any other plotter commands:

- Letter size (height) = 30 measurement units
- Line orientation = 0 degrees from X axis
- Letter slant = 0 degrees from text line
- Character font = American

Troubleshooting



Troubleshooting

The Apple Plotter is designed to do its job with a minimum of problems. However, like every precision machine it can occasionally go wrong. Should this happen to you, here are some suggestions.

No Operation

What to do if your plotter is dead.

Your Apple Plotter is provided with indicator lights to tell you whether or not it is ready to work. If your plotter does nothing at all, look for these indications:

Power Light Off

If the yellow Power Light is not glowing, check these possibilities:

- The Power Cord is unplugged, either at the wall or at the plotter. Make sure of the connection.
- The power is not on. Push the On-Off Switch once.
- The fuse inside your plotter is blown. See the instructions that follow.

Fixing a blown fuse.

To Change the Fuse: A spare fuse was packed in a small plastic envelope and included with your plotter. It is a glass tube with metal tips, 1-1/4 inches long. If you do not have a spare fuse, you can buy one at an electronics supply store. Ask for a type 3AG-SB, 1/2 ampere 250 volt slow-blow fuse. To replace the fuse, follow these steps:

1. Unplug the Power Cord from the back of the plotter. The fuseholder is located to the left of the power connection, covered by the Power Cord.
2. With a screwdriver or small coin (such as a dime), push the slotted plug in the fuseholder inward and then rotate it one-quarter turn counterclockwise. It should pop out by itself.
3. Pull out the inner part of the fuseholder. Remove the fuse from it. If it is blown, there will be a gap in the metal strip inside the glass tube.
4. Place the new fuse in the holder (pointing either way).
5. Place the holder back in the machine. With the coin or screwdriver, turn it clockwise until it goes in; then turn it one-quarter turn farther until it stays.
6. Plug the Power Cord back into the plotter.

Operate Light Off

Turning on the Operate Light.

Your plotter cannot function unless both the yellow Power Light and the green Operate Light are on. Once the Power Light is on, you can turn on the Operate Light by pressing the button underneath it. For a more detailed discussion of these Panel Controls, see the beginning of Chapter 5.

Error Light On

Turning off the Error Light.

Under certain conditions (see Chapter 5, "Error Detection"), when the red Error Light is lit, your plotter will refuse to accept further commands from your computer. However, you can still operate your plotter manually, using the Panel Controls described at the beginning of Chapter 5. To turn off the red Error Light, either turn the plotter's Power Switch off and then back on, or press the Pen Select button while the Operate Light is off.

Does Not Follow Commands

Why your plotter might not obey your computer.

Like all data processing systems, your Apple Color Plotter responds to computer commands only when conditions are exactly right. There are three general areas where problems might arise:

- The **panel control settings** may be incorrect for your plotter to respond to computer control.
- The **interface settings** of your computer and your plotter may not correspond.
- **Individual commands** from your computer may not be acceptable to your plotter.

Panel Control Settings

Panel configuration for computer control.

Your plotter's control panel should have the following appearance for it to follow computer commands:

- Yellow Power Light **on**
- Both green lights (Operate and Remote) **on**
- Red error light **off**

Your plotter will sometimes accept computer commands while the red Error Light is on; however, this indicates something is wrong that should be corrected. For complete details on Panel Control settings, see the appropriate sections in Chapter 5.

Interface Settings

The importance of setting the interface.

Before you try to operate your plotter with your computer, you must set the Interface Switches that are located on its Back Panel. Usually, you must also adjust or configure your computer as well. The objective is to make them "talk the same language"—communicate with the same character speed and format.

Where to find further information.

You can find instructions for setting the plotter's end of the interface in Chapter 3. Instructions for adjusting or configuring your Apple computer are given in Part II of this manual. If you are not using an Apple computer, determine the manufacturer's specifications for its RS232C output port, and then set your plotter's Interface switches as described in Appendix D.

How to Check the Interface. The best way to check for interface problems is to try running some of the programs on the disk included in your Accessory Kit. If they do nothing but turn on the red Error Light, then your computer and your plotter are probably not communicating in the same way.

Faulty Commands

A checklist for your plotter commands.

If your plotter generally obeys your computer but occasionally fails to do something you think it should, the problem may be with the syntax of specific commands. Read Chapter 5 again and check the following:

- Are you using proper separator and end-of-command marks?
- Are you using a valid 2-letter code, and are you following it with the required number or set of numbers?
- Is the number(or numbers) you are using within the valid range?
- Is there a conflict between your working area and scaling commands (SP, VP, WD) and motion or drawing commands that may be trying to carry the pen outside the working area? In the absence of other instructions, your plotter's default commands do not allow it to execute an X-axis number above 2394 or a Y-axis number above 1759. Remember that the pen simply stops when it reaches the edge of the Viewport.

Incorrect Image Placement

If the pen doesn't go where you tell it to.

Normally your Apple Plotter positions its markings precisely in response to your commands. You can use it to make accurate scale drawings. If it fails to do this, you should look for problems in these areas:

- Mechanical interference with the free movement of the paper or Pen Head.
- Conflicts among plotter commands.

Mechanical Problems

If the paper becomes displaced.

Your plotter doesn't use much force when pulling the paper in and out, so any friction or load on the paper sheet can displace it. Once the paper has been moved with respect to the plotter's feeding mechanism, there is no way the plotter can figure out how to put it back. Here is a checklist to help prevent such an occurrence:

- Is anything touching the Paper Feed Knob?
- Is the paper sheet free to travel all the way both behind and in front of the plotter?
- Is the paper exceptionally heavy or thick? Does it pass easily through the Feed Rollers?
- Is the paper wrinkled or curled? A "hump" between the Feed Rollers can cause it to crawl to one side.

Command Problems

Several plotter commands combine to determine exactly where the pen will go. Beside the obvious motion and drawing instructions, they include the working area and scaling commands. Here are some things to look for when your drawings aren't appearing where you expect them:

- **Syntax errors.** A misplaced comma or a missing semicolon can make a big difference. Sometimes an intended command will be misread or ignored without causing an error action. Read Chapter 5, "Command Syntax."
- **Old commands** never die until you tell them to. Are you running your present job while your plotter's memory contains instructions from a previous job? Don't count on the automatic set-up commands being in force unless you have just turned on power or started your job with a reset command. If in doubt, clear the command memory by pressing the Pen Select button while the Operate Light is off.
- **Scaling commands** must be carefully installed. Remember that the WD command establishes number scales on the basis of the Viewport currently in force. Those number scales then affect every subsequent pen motion.
- **Current pen position.** Most commands change the current pen position; if your next action is based on the pen being in a specific place, you may have to calculate its position after the previous command.

Poor Quality Image

Getting the best-looking line.

Your Apple Plotter is designed to produce neat, crisp drawings on a variety of materials. If it doesn't, the fault may lie either with the paper or the pens. Here are some pointers:

Paper Problems

What to watch for in paper.

For best results, use the plotter paper carried by your Apple dealer. It is a selected white bond stock with a smooth, reproduction-quality finish. If you run out of Apple paper or do not need quality results, you can use a range of different materials. If you do, look out for these problems:

- **Too thin or too thick.** The material you use should pass easily under the Feed Rollers, without either slipping or binding. See Chapter 2.
- **Surface texture.** A rough or pebbly surface may cause the pen to wiggle or skip while trying to draw even lines.
- **Absorbency.** Excessively absorbent paper may produce ragged lines, with a noticeable dot wherever the pen stops.
- **Surface materials.** Your plotter is designed to draw cleanly on drafting vellum, parchment, and plastic film (see Chapter 2). However, if there is any material (such as oil, fixatif, or pounce) already on the surface, it may clog the pen.

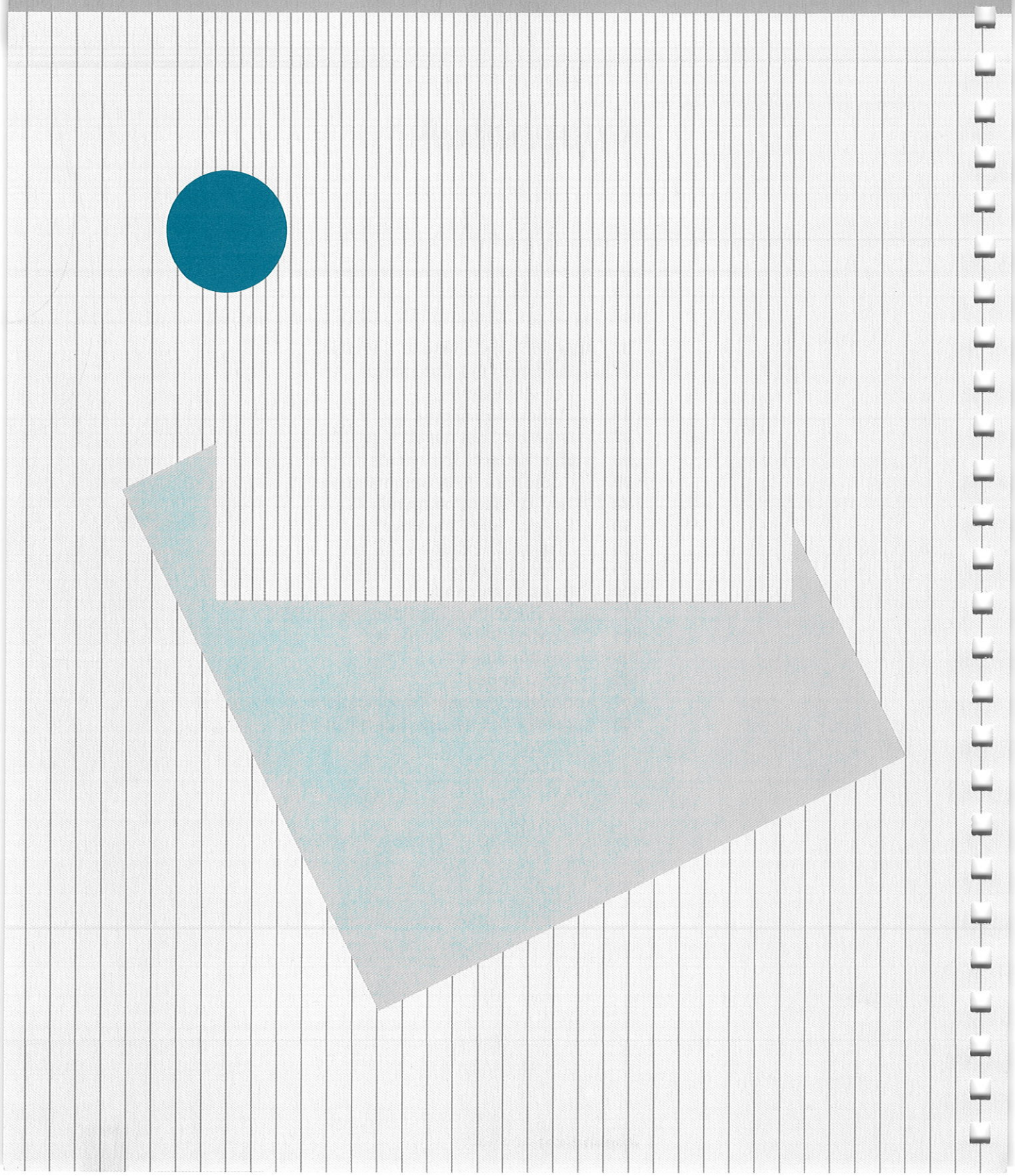
Pen Problems

Taking care of your Apple pens.

Apple pens are the best quality available for use with your plotter. They should draw clean, even lines as long as you maintain them properly. Here are some pointers:

- **Keep them capped.** Most pen problems start with their drying out.
- **Use the right pen speed.** Although the automatic pen speed of 10 centimeters per second is right for most materials, when using plastic film, you may get a more even line by reducing the speed. See Chapter 5.
- **Watch for clogging.** As just mentioned above ("Paper Problems"), loose surface materials on the paper may tend to fill up the pores in the nylon tip, resulting in uneven ink flow.

Appendixes



Command Summary

Working Area Commands

Command	Action
SPn (n = 0-8)	Set Viewport for paper size n (see Table 5-2)
VPa,b,c,d	Viewport: rectangle from corner a,b to corner c,d

Pen Commands

Command	Action
PSn (n = 1-4)	Puts number n pen in drawing position
PVn (n = 1-10)	Changes drawing speed to n centimeters per second

Motion Commands

Command	Action
CH	Moves to position for changing paper
MAx,y	Move pen to absolute location x,y
MRx,y	Move pen x and y units from current location

Drawing Commands

Command	Action
DAx,y(,x,y...)	Draw straight line(s) to location(s) x,y
DRx,y(,x,y...)	Draw straight line(s) x and y units farther
PM1	Make a single point mark at current pen location
CAr(,x,y)	Draw circle of radius r (and center x,y)
ACr,a,b(,x,y)	Draw arc of radius r from angle a to angle b (around center x,y)

Line Pattern Commands

Command	Action
LTp(,k)	Use standard pattern p; (repeat length = k)
ULd1,m1 (,d2,m2,..d6,m6)	Custom line pattern: draw length 1, move length 1 (draw length 2, move length 2, etc. up to 6)
LT0(,k)	Use custom line pattern; (repeat length = k)

Coordinate Axis Commands

Command	Action
XTp,q,r(,tp,tn)	Draw X-axis coordinate (see Chapter 5)
YTp,q,r(,tp,tn)	Draw Y-axis coordinate (see Chapter 5)

if p is	then q specifies	initial tick?
0	the length of each interval between ticks	yes
1	the total length of the coordinate axis	yes
2	the length of each interval between ticks	no
3	the total length of the coordinate axis	no

Text Writing Commands

Command	Action
PL<text>	Write <text> (end with CONTROL-C)
LSh	Subsequent text letters will be h units high
LRk	Tilt subsequent text lines k degrees from X axis
SLk	Slant all lettering k degrees from vertical
LFn (n = 0-6)	Substitute Font n as shown in Figure 5-7
PMn (n = 2-15)	Write Symbol n as shown in Figure 5-8

Special Text Characters

Character	Dec	Hex	Action
CONTROL-H	8	$08	Backspace (also changes left margin)
CONTROL-J	10	$0A	Line feed
RETURN	13	$0D	Carriage return
CONTROL-Q	17	$11	(see section on "Reset Commands")
CONTROL-R	18	$12	(see section on "Reset Commands")
CONTROL-U	21	$15	(see section on "Reset Commands")

Scaling Command

Command	Action
WDa,b,c,d	Window: rectangle from corner a,b to corner c,d

Error Detection

Command	Action
IM64(,x)	Reject further commands until reset (,Key)
IM192(,x)	Write message; reject commands until reset (,Key)
IM0(,x)	Turn on Error Light only, until reset (,Key)
RS	Reset error status

Key	Error Type Recognized
1	Command letters not in the plotter's vocabulary
2	Number(s) too large (e.g. outside range -32768 to +32767)
4	Not enough numbers to make a complete command
8	Unacceptable command syntax
16	Command would carry pen outside Window

Reset Commands

Character	Dec	Hex	Action
Control-Q	17	$11	Cancels current command; resets error status
Control-U	21	$15	Cancels all commands except pen selection
Control-R	18	$12	Resets plotter to automatic set-up commands

Command	Action
LI	Sets text writing format back to default values

Floating Point, Hex, ASCII

This appendix describes some of the special ways that numbers are written so computers can understand them.

Floating Point Numbers

Why floating point numbers?

When numbers are very large or very small, writing them out in full can be laborious. It may also represent useless work, since small computers usually don't recognize more than 6 or 7 significant decimal digits in their computations (except when they are running special **long integer** programs). So it is usually more convenient for both human being and computer to write large and small numbers in **floating point** form.

A typical floating point number.

A typical floating point number might look like this:

12.3e06

This represents the large number 12,300,000. The floating point format consists of three parts:

1. A sequence of up to 6 significant digits, which may or may not contain a decimal point as well: in this case, 12.3.
2. A capital or small letter *E*.
3. A one-digit or two-digit number (up to 30 or so), with or without a plus or minus sign, which states how many positions to move the decimal point: in this case, 06.

Interpreting floating point numbers.

To convert a floating point number into a **real** number, you add zeros wherever necessary. In the example above, the decimal point is moved six digits to the right (because 06, with an understood plus sign, follows the letter e); since there is only one digit (3) presently to the right of the decimal, the remaining five digits must be zeros. The same rule works in the other direction: 12.3e-06 becomes 0.0000123 (decimal point moved to the left past the digits *12* and four additional zeros).

Examples.

Here are some examples to help you understand these numbers:

Floating Point	Real Numbers
12.34E+1	123.4
1234e-3	1.234
1.234e10	12340000000
1234E-09	0.000001234

Size Limits: The rules for size limits of floating point numbers are somewhat complex. You can read about them in most Pascal programming manuals. However, you need not be concerned about floating point size limitations in the numbers that your Apple Plotter can understand.

Hex Numbers

Why hex numbers?

Because your computer *thinks* in binary numbers, you must sometimes think that way too. But straight binary numbers, though convenient for computers, tend to be unwieldy for human beings. In human communication they are usually replaced with base-16 numbers, also called hexadecimal or **hex** numbers.

Hex numbers use the ten ordinary (decimal) numerals to represent 0 through 9, plus the capital letters *A* through *F* to represent 10 through 15. Each hex digit represents four binary digits:

Hex	Binary	Hex	Binary	Hex	Binary	Hex	Binary
0	0000	4	0100	8	1000	C	1100
1	0001	5	0101	9	1001	D	1101
2	0010	6	0110	A	1010	E	1110
3	0011	7	0111	B	1011	F	1111

Converting binary to hex.

Thus to convert an 8-bit binary number into a 2-digit hex number, simply replace the first four bits with the first hex digit and the last four bits with the second hex digit.

ASCII Codes

What are ASCII codes?

There are 256 possible 8-bit binary numbers, from 00000000 to 11111111. Of these the first 128 (from 00000000 to 01111111) are assigned to characters and commands used in data processing and communication. The standard assignment is called ASCII (American Standard Code for Information Interchange).

ASCII Code Chart.

The remaining 128, which differ from the first 128 only because their most significant binary digit is *1* instead of *0*, are not officially assigned. Nevertheless they are often called *high ASCII characters*.

The following chart lists the 128 standard ASCII character assignments. For each one, it gives the decimal and hexadecimal equivalents.

7-Bit Binary	Low Dec	Low Hex	Low Oct	Hi Dec	Hi Hex	Hi Oct	ASCII Char	Interpretation
0000000	0	00	000	128	80	200	NUL	Blank (null)
0000001	1	01	001	129	81	201	SOH	Start of Header
0000010	2	02	002	130	82	202	STX	Start of Text
0000011	3	03	003	131	83	203	ETX	End of Text
0000100	4	04	004	132	84	204	EOT	End of Transm.
0000101	5	05	005	133	85	205	ENQ	Enquiry
0000110	6	06	006	134	86	206	ACK	Acknowledge
0000111	7	07	007	135	87	207	BEL	Bell
0001000	8	08	010	136	88	210	BS	Backspace
0001001	9	09	011	137	89	211	HT	Horizontal Tab
0001010	10	0A	012	138	8A	212	LF	Linefeed
0001011	11	0B	013	139	8B	213	VT	Vertical Tab
0001100	12	0C	014	140	8C	214	FF	Form Feed
0001101	13	0D	015	141	8D	215	CR	Carriage Return
0001110	14	0E	016	142	8E	216	SO	Shift Out
0001111	15	0F	017	143	8F	217	SI	Shift In
0010000	16	10	020	144	90	220	DLE	Data Link Escape
0010001	17	11	021	145	91	221	DC1	Device Control 1
0010010	18	12	022	146	92	222	DC2	Device Control 2
0010011	19	13	023	147	93	223	DC3	Device Control 3
0010100	20	14	024	148	94	224	DC4	Device Control 4
0010101	21	15	025	149	95	225	NAK	Neg. Acknowledge
0010110	22	16	026	150	96	226	SYN	Synchronization
0010111	23	17	027	151	97	227	ETB	End of Text Blk.
0011000	24	18	030	152	98	230	CAN	Cancel
0011001	25	19	031	153	99	231	EM	End of Medium
0011010	26	1A	032	154	9A	232	SUB	Substitute
0011011	27	1B	033	155	9B	233	ESC	Escape
0011100	28	1C	034	156	9C	234	FS	File Separator
0011101	29	1D	035	157	9D	235	GS	Group Sep
0011110	30	1E	036	158	9E	236	RS	Record Sep
0011111	31	1F	037	159	9F	237	US	Unit Separator
0100000	32	20	040	160	A0	240	SP	Space
0100001	33	21	041	161	A1	241	!	
0100010	34	22	042	162	A2	242	"	

7-Bit Binary	Low Dec	Low Hex	Low Oct	Hi Dec	Hi Hex	Hi Oct	ASCII Char	Interpretation
0100011	35	23	043	163	A3	243	#	
0100100	36	24	044	164	A4	244	$	
0100101	37	25	045	165	A5	245	%	
0100110	38	26	046	166	A6	246	&	
0100111	39	27	047	167	A7	247	'	Closing Quote
0101000	40	28	050	168	A8	250	(	
0101001	41	29	051	169	A9	251	)	
0101010	42	2A	052	170	AA	252	*	
0101011	43	2B	053	171	AB	253	+	
0101100	44	2C	054	172	AC	254	,	Comma
0101101	45	2D	055	173	AD	255	-	Hyphen
0101110	46	2E	056	174	AE	256	.	Period
0101111	47	2F	057	175	AF	257	/	
0110000	48	30	060	176	B0	260	0	
0110001	49	31	061	177	B1	261	1	
0110010	50	32	062	178	B2	262	2	
0110011	51	33	063	179	B3	263	3	
0110100	52	34	064	180	B4	264	4	
0110101	53	35	065	181	B5	265	5	
0110110	54	36	066	182	B6	266	6	
0110111	55	37	067	183	B7	267	7	
0111000	56	38	070	184	B8	270	8	
0111001	57	39	071	185	B9	271	9	
0111010	58	3A	072	186	BA	272	:	
0111011	59	3B	073	187	BB	273	;	
0111100	60	3C	074	188	BC	274	<	
0111101	61	3D	075	189	BD	275	=	
0111110	62	3E	076	190	BE	276	>	
0111111	63	3F	077	191	BF	277	?	
1000000	64	40	100	192	C0	300	@	
1000001	65	41	101	193	C1	301	A	
1000010	66	42	102	194	C2	302	B	
1000011	67	43	103	195	C3	303	C	
1000100	68	44	104	196	C4	304	D	
1000101	69	45	105	197	C5	305	E	
1000110	70	46	106	198	C6	306	F	
1000111	71	47	107	199	C7	307	G	
1001000	72	48	110	200	C8	310	H	
1001001	73	49	111	201	C9	311	I	
1001010	74	4A	112	202	CA	312	J	
1001011	75	4B	113	203	CB	313	K	
1001100	76	4C	114	204	CC	314	L	
1001101	77	4D	115	205	CD	315	M	
1001110	78	4E	116	206	CE	316	N	
1001111	79	4F	117	207	CF	317	O	
1010000	80	50	120	208	D0	320	P	
1010001	81	51	121	209	D1	321	Q	

7-Bit Binary	Low Dec	Low Hex	Low Oct	Hi Dec	Hi Hex	Hi Oct	ASCII Char	Interpretation
1010010	82	52	122	210	D2	322	R	
1010011	83	53	123	211	D3	323	S	
1010100	84	54	124	212	D4	324	T	
1010101	85	55	125	213	D5	325	U	
1010110	86	56	126	214	D6	326	V	
1010111	87	57	127	215	D7	327	W	
1011000	88	58	130	216	D8	330	X	
1011001	89	59	131	217	D9	331	Y	
1011010	90	5A	132	218	DA	332	Z	
1011011	91	5B	133	219	DB	333	[	Opening Bracket
1011100	92	5C	134	220	DC	334	\	Reverse Slant
1011101	93	5D	135	221	DD	335	]	Closing Bracket
1011110	94	5E	136	222	DE	336	^	Circumflex
1011111	95	5F	137	223	DF	337	_	Underline
1100000	96	60	140	224	E0	340	`	Opening Quote
1100001	97	61	141	225	E1	341	a	
1100010	98	62	142	226	E2	342	b	
1100011	99	63	143	227	E3	343	c	
1100100	100	64	144	228	E4	344	d	
1100101	101	65	145	229	E5	345	e	
1100110	102	66	146	230	E6	346	f	
1100111	103	67	147	231	E7	347	g	
1101000	104	68	150	232	E8	350	h	
1101001	105	69	151	233	E9	351	i	
1101010	106	6A	152	234	EA	352	j	
1101011	107	6B	153	235	EB	353	k	
1101100	108	6C	154	236	EC	354	l	
1101101	109	6D	155	237	ED	355	m	
1101110	110	6E	156	238	EE	356	n	
1101111	111	6F	157	239	EF	357	o	
1110000	112	70	160	240	F0	360	p	
1110001	113	71	161	241	F1	361	q	
1110010	114	72	162	242	F2	362	r	
1110011	115	73	163	243	F3	363	s	
1110100	116	74	164	244	F4	364	t	
1110101	117	75	165	245	F5	365	u	
1110110	118	76	166	246	F6	366	v	
1110111	119	77	167	247	F7	367	w	
1111000	120	78	170	248	F8	370	x	
1111001	121	79	171	249	F9	371	y	
1111010	122	7A	172	250	FA	372	z	
1111011	123	7B	173	251	FB	373	{	Opening Brace
1111100	124	7C	174	252	FC	374	|	Vertical Line
1111101	125	7D	175	253	FD	375	}	Closing Brace
1111110	126	7E	176	254	FE	376	~	Overline (Tilde)
1111111	127	7F	177	255	FF	377	DEL	Delete/Rubout

Plotter Specifications

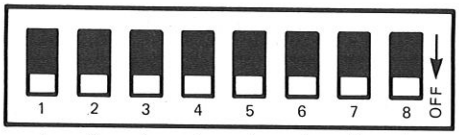
Model Number	410
Plotting Method	X-axis paper motion combined with Y-axis pen motion
Driving Method	Stepper motors
Pen Type	Liquid ink, porous plastic tip
Pen Selection	4 in head, software selectable
Relative Position Accuracy	+ 1% + 0.3 mm
Position Repeatability	Same pen: + 0.2 mm Different pen: + 0.4 mm
Position Resolution	0.1 mm
Plotting Speed	up to 10 cm/sec in either axis
Maximum Plotting Area	X axis: 391.8 mm Y axis: 257.0 mm
Paper Width (Y axis)	Minimum: 120 mm Maximum: 300 mm
Paper Thickness	Minimum: 0.05 mm (0.002″) Maximum: 0.8 mm (0.031″)
Power Options	103.5-126.5 V 57-63 Hz 200-250 V 48-52 Hz
Power Consumption	33 Watts maximum
Data Interface	ASCII Serial (see Appendix D)
Weight	Net: 6 kg (13.2 lb) Shipping: 10 kg (22 lb)
Dimensions	Width: 412 mm (16.2″) Depth: 300 mm (11.8″) Height: 122 mm (4.8″)

Environment	Temperature: Operating: 5 to 40 deg C Storage: -20 to 65 deg C Humidity: 20-80% r.h. at 40 deg C
Electromagnetic Compatibility	Certified to comply with the limits set for radio frequency interference when used with a Class B computing device.

Interface Specifications

Interface Form	RS232C with hardware handshaking
Data Form	Asynchronous serial ASCII
Byte Length	7 or 8 bits (switch selectable)
Transmission Format	Start signal: 1 bit Stop signal: 0, 1, 1.5, or 2 bits (switch selectable)
Parity	None, odd, or even (switch selectable)
Transmission Speed	75, 150, 300, 600, 1200, 2400, 4800, or 9600 baud (switch selectable)
Input Buffer Capacity	255 bytes
Interface Connector	DB-25SA-J4; standard 25-pin RS232
Pin Assignments	Pin 1 Protective ground Pin 3 Data input (from computer) Pin 4 + 12 VDC Pin 7 Data return (signal ground) Pin 20 Data terminal ready (to computer)
Signal Levels	On (Space) +5 to +15 V Off (Mark) -15 to -5 V
Signal Load Impedance	3000 to 7000 ohms
DIP Switch Assignments	See Figure D-1 on page 110.

Figure D-1. DIP Switch Functions



Baud rate

6	7	8	
ON	ON	ON	9600
ON	ON	OFF	4800
ON	OFF	ON	2400
ON	OFF	OFF	1200
OFF	ON	ON	600
OFF	ON	OFF	300
OFF	OFF	ON	150
OFF	OFF	OFF	75 bauds

Stop bit

4	5	
ON	ON	Invalid
OFF	ON	1 bit
ON	OFF	1½ bit
OFF	OFF	2 bit

Parity

2	3	
	ON	Odd parity
	OFF	Even parity
ON		No parity
OFF		Parity

Data length

1	
ON	7 bit
OFF	8 bit

Glossary

artwork: A formal drawing, usually in ink, intended to be reproduced or displayed.

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.

Binary: The number system used by most digital computers. Every binary number consists of a string of zeros and ones; the farthest right (least significant) digit has a value of 1, the next a value of 2, then 4, 8, 16, and so on.

Bit: A single binary digit, consisting of either a zero or a one.

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.

Byte: A binary number of fixed length. In the Apple Color Plotter, bytes are 8 bits long. Every character processed by the printer can be expressed as one byte, using the ASCII code.

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.

Configuration: In the Apple III computer, a description of how a particular machine is connected to devices such as printers and disk drives, including the codes it uses to exchange information. This description is contained in a disk file called SOS.DRIVER, which the user must edit to conform to any changes in the way the Apple system is arranged.

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>.

Default Command: A command automatically present when no superseding command has been received. The Apple Color Plotter assumes a set of default commands every time power is turned on. These are listed in Chapter 5.

Device: A piece of equipment connected to a computer. The Apple Color Plotter is a device, along with the Monitor, disk drives, etc.

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").

Film: Plastic sheet stock, usually transparent, on which the Apple Color Plotter can draw by using its transparency pens.

Floating-point Number: A number expressed in exponential format, such as "1.23E+2"; see Appendix B.

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.

Hardware: In computer technology, the physical machinery; opposed to software, the program instructions.

Hex, Hexadecimal: The base-16 number system (ordinary decimal numbers are base-10). Hexadecimal numerals consist of 0, the numerals 1-9, and the capital letters A-F. See Appendix B.

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.

Leading Zero: A zero occurring at the beginning of a number, deleted by most computing programs.

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

LSB, Least Significant Bit: The farthest right digit in a binary number.

Measurement Unit: The physical distance on the sheet corresponding to the number 1 in a plotter command. Thus a motion command of 5 will move the pen 5 measurement units on the sheet, and so on.

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

Microprocessor: A small circuit component (about the size of a postage stamp) that performs a complete set of basic computing functions.

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

MSB, Most Significant Bit: The farthest left digit in a binary number (excluding leading zeros).

Overhead Projector: A machine used in teaching and lecturing that projects the image of a clear plastic film onto a screen behind it.

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.

Scatter Graph: A graph in which data are depicted as disconnected points in a two-dimensional field.

Separator Mark: A punctuation mark used to separate one number from another. See Chapter 5.

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.

<space>: An ASCII character (hex 20) that commands a device such as a plotter to place a blank space one character wide in the text.

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

Terminator: See End-of-Command Mark.

Tick Mark: The small right angle mark on a coordinate axis that indicates each measurement interval.

Transparency, Overhead: A drawing on clear plastic film, to be projected onto a screen by an Overhead Projector.

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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