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CHAPTER 3
PROGRAMMING THE GRAPHICS TABLET

APPENDIX A
USE AND CARE

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APPENDIX C
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APPENDIX D
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INTRODUCTION

Welcome to the world of the Apple Graphics Tablet. The Tablet is a device which converts the position and movements of a special pen into numerals which your Apple can use and understand. The programs or "software", supplied with your Tablet tell the Apple how to draw pictures on its high-resolution graphics screen, using the information supplied by the Tablet. These programs turn your Apple and Tablet into an artist's sketchpad, an engineer's drawing board, or a mathematician's chalkboard. With the Tablet and the supplied programs you can draw freehand pictures on the Apple's screen, or use the Apple to draw straight lines, rectangular boxes, open frames, or tiny dots. The pictures you create can easily be saved on Apple diskettes and recalled anytime you want. You can use the Apple to calculate the areas and distances of shapes and lines you draw on the Tablet, and you can change the scale of the figures you draw.

This is the Operation and Reference Manual for the Apple Graphics Tablet. The Graphics Tablet is a "hands-on" product, and the best way to learn how to use it is to take pen in hand and start experimenting. Most of this book is based on the assumption that you have the Graphics Tablet set up in front of you, and are following and doing each example as it is presented. If you try to learn how to use the Tablet without using this manual (or even worse, read the manual without actually using the Tablet), you might pick up most of the simpler commands, but you'll never master the more powerful functions of the Tablet. So read the manual, repeat the examples, and don't be afraid to experiment.

The first chapter of this book describes how to set up your Tablet, and what you need in order to use it. Chapter 2 introduces you to the Graphics Tablet software. This is a set of programs which allow you to use the Tablet to draw pictures on the Apple's high-resolution graphics screen. You do not need to know much about the Apple in order to use the Graphics Tablet. In fact, all you really need to know is how to turn it on. Once you start using the Tablet software, it will guide you each step of the way. You do not need to know how to write programs to use the Tablet skillfully and efficiently.

If you do know how to program, you may be interested in Chapter 3. It will give you assistance in modifying the Graphics Tablet software to your liking, including adding your own features to the Tablet menu. There are also instructions on interfacing directly to the Tablet's firmware, so you can write your own special-purpose programs that will use the Tablet. Listings of the programs which operate the Tablet are supplied in Appendix D.
If you see the symbol 🧵 it means that the following paragraph contains important information about some tablet behavior that you might not anticipate. The symbol 🧵 means that the following paragraph contains special information you should note. Read these sections carefully.

Above all, feel free to play around with the Tablet. The Apple Graphics Tablet is easy to learn, easy to use, and hard to mess up. With some simple maintenance (described in Appendix A), your Tablet will give you years of enjoyment and use. So sit down at your Apple, take pen in hand, and turn to Chapter 1. We'll let you...
WHAT YOU WILL NEED

To use the Apple Graphics Tablet with its supplied software, you will need the following:

1) An Apple II or Apple II Plus computer, with 48K bytes of Random Access Memory (RAM);
2) If you do not have an Apple II Plus, you will need an Applesoft Firmware card (part number A2B00E9), or an Apple Language System (part number A2B00E6) with a BASICS language diskette;
3) an Apple Disk II plug-in controller card with at least one Disk II disk drive;
4) A color or black-and-white video monitor.

In addition, you may wish to have additional Disk II disk drives and controller cards.

The Graphics Tablet was designed to work with most present and future Apple II hardware and software. However, the supplied programs which operate the Graphics Tablet are designed to work with the Apple II DOS disk operating system, versions 3.2 and up. The Graphics Tablet software will not operate under previous versions of DOS or in an Apple Pascal environment.

It is helpful (but not necessary) to have read the following manuals:

1) The Applesoft Tutorial Welcome and Chapter 1 (product number A2L0018)
2) Do’s and Don’ts of DOS Preface through Chapter 2 (product number A2L0012)

If you are using the Apple Language System, be sure to read:

Apple Language System Chapter 3: Using BASIC (product number A2L0024)

UNPACKING

Your Graphics Tablet package contains ten items:

1) The Graphics Tablet and its attached cable
2) The Graphics Tablet’s indicator pen and its attached cable
3) A printed-circuit board (the Graphics Tablet Interface card)
4) A mylar "menu" overlay.
5) Two "graphics tablet software" diskettes.
6) A piece of die-cut, double-sided foam tape.
7) A warranty card.
8) A packing list.
9) This manual.
10) A static cloth.

Save the packing material in case you wish to transport your Tablet -- or in the unlikely event that you must return your Tablet to your dealer for service. If you did not fill out your warranty with your Apple dealer before you brought your Graphics Tablet home, send it in now -- not only does this ensure that any warranty repair your Tablet may need will be done as quickly as possible, but it also puts you on the mailing list for CONTACT, the Apple users' newsletter that keeps you informed of updates and new products.

PLUGGING IN

***** Special Note *****

Before connecting or disconnecting ANYTHING on the Apple or the Graphics Tablet TURN OFF THE POWER. This is a must.

Please pay special attention to this warning. If you try to connect or disconnect something from the inside of your Apple when the power is on, there is a good chance that you may damage its electronics.
The Graphics Tablet and its pen connect to the Interface card, which in turn plugs into one of the eight peripheral connector slots in the inside of the Apple, along the back of the main board. The cables attached to the Tablet and the pen terminate in small sockets, which fit over two sets of pins on the Interface card. The sockets are spaced and keyed so that it is very difficult to attach them incorrectly.

Handle the Interface card as you would handle a high-quality, expensive phonograph record. Grasp it only by the corners or edges, and try not to touch the delicate components or pins. Don't grasp the card by the gold "fingers" — they are the medium through which the Apple communicates to the Tablet and their efficiency is decreased if they are dirty or scratched. The Interface is a precision instrument and should be treated with care.

First attach the Tablet's pen to the Interface card. Place the Interface card on a flat surface with the components face up and the gold "fingers" nearest you. Take the connector at the end of the cable from the Tablet's pen. Notice that the four tiny round holes on the bottom of the connector are keyed to correspond to the set of four pins in the upper right corner of the Interface card. Gently slide this connector over the set of pins. There should be some space between the card and the connector. The finished connection should look like this:

Now attach the Graphics Tablet to the Interface card. Take the connector at the end of the cable from the Graphics Tablet. Gently slide the connector over the set of pins near the top middle of the Interface card. When the connector is properly attached there should be some space between it and the card. The finished connection should look like this:

INSTALLING THE INTERFACE

To install the Graphics Tablet Interface card (which you have already connected to the Tablet and its pen) into the Apple, you will simply plug the Interface card into the back of the computer, as follows:

1. Turn off the power switch at the back left corner of the Apple. This is important to prevent damage to the computer. Don’t unplug the Apple, just turn it off. If you unplug your Apple, you isolate it from the common earth ground, and your Apple and Tablet Interface card could be in danger from static discharges.

2. Remove the cover from the Apple. Do this by pulling up on the back edge of your Apple’s lid until the corner fasteners pop apart, then slide the lid back and lift it off.

3. Before proceeding, touch your hand to the metal power supply case inside your Apple. This will remove any stray static charges from your hands, so you do not damage the static-sensitive components on the Interface card.

4. Inside the Apple, across the rear of the main green board, are eight long, narrow sockets called Peripheral Connectors, or "slots". The leftmost slot (looking from the keyboard end) is called "Slot #0" and the rightmost is called "Slot #7". The Interface card will operate in any slot except #6, but it is customary for the Tablet to use Slot #5, the third one from the right.

5. Grasp the upper corners of the card between the thumbs and forefingers of both hands. Insert the gold "fingers" of the Interface card into the chosen slot in the back of the Apple, rear edge first. Gently push the front edge of the card down until it is level and firmly seated.
6. Take the two cables which you have connected to the Interface card. On the cable attached to the pen there is a black plastic fitting. This is called a strain relief. There is a hole running lengthwise along the bottom of the strain relief, with a slit running the length of the hole. Pry the slit open with your fingernail and slide the cable from the Tablet through the slit and into the hole. The finished strain relief should look like this:

![Strain Relief Image]

Now take the strain relief with its "tail" on top and pointing out the back of the Apple and slide it into the leftmost of the two smaller vertical notches in the back of the Apple’s case. Slide it down to the bottom of the notch. It should be a tight fit. If it doesn’t slide all the way down the first time, pull it out and slide it back in again. The plastic is pliable enough so that it will conform to the slot’s width after about three or four insertions.

7. Snap the top back onto your Apple. Place the Tablet on a flat surface near your Apple, close enough so that the pen can easily reach all parts of the Tablet surface. Make sure that your disk drive and video monitor are connected properly.

BACKING UP THE DISKETTE

Now that your Graphics Tablet is all hooked up, it’s a good time to think about an important rule of thumb. "What rule?" you might ask. The rule is this: Always keep at least one backup copy of any diskette whose information you wish to keep.

The value of a backup copy cannot be overemphasized. Right now, if you were to drop both your Graphics Tablet Software diskettes, and your pet turtle started nibbling on them, or somebody mistook them for square, black Frisbees, or some other catastrophic event occurred which would render them both unreadable, then your Graphics Tablet would be almost useless. Honest. You’d have to write all new programs yourself, or buy another Graphics Tablet Software diskette, in order to use your Tablet.

Take a look at the two Graphics Tablet Software diskettes that came with your Graphics Tablet. Notice that one of them has a small piece of silver tape over the rectangular notch on its edge. This piece of tape is called a write-protect tab. The write-protect tab tells the Apple not to store any more information on the diskette in question. The tab assures that none of the information on the diskette will be accidentally written over. Store this write-protected diskette in a safe place, and use it as your backup copy.

Fortunately, you know better than to leave your Graphics Tablet diskettes lying around where they might be damaged by heat, your pet turtle, or strong magnetic fields. However, you may want to be really careful and keep two backup copies instead of just one. Keeping more than one backup copy insures that your programs will be safe even if one of your backups is accidentally destroyed. If you don’t know how to go about making copies of the Graphics Tablet Software diskette, see Appendix B in this manual for instructions.

Don’t put your Graphics Tablet Software diskettes, or any other diskettes, on top of the Tablet itself! Its magnetic field will wipe out any information on the diskettes.

STARTING UP

After you’ve reassembled your Apple and its peripherals and everything is in order, place your Graphics Tablet Software diskette into Drive 1. Remember to use the one that does not have the silver write-protect tab over the rectangular notch on its edge. Now turn the power on and "boot" the diskette. (If you don’t understand what this means, STOP! Don’t kick your diskette, but read the section called "BOOTING DOS" in Chapter 2 of your DOS manual, or Chapter 3 in the
Language System Manual if you have an Apple Language System. The disk drive will whirr and click for about 15 seconds, then the Graphics Tablet logo will be displayed:

To begin your encounter with the Tablet, press the ESC key. The screen will display the Graphics Tablet "HELLO Menu", which is a list of things you can do with your Graphics Tablet Software diskette. You’ll be using the MENU ALIGNMENT program first.

THE MENU OVERLAY

Included in your Graphics Tablet package is a mylar overlay called the "Graphics Tablet Menu". You will be placing this overlay in the center of the recessed area on the Tablet. The overlay divides the surface of the Tablet into different areas, and each area has a different meaning. Part of the overlay represents the Apple’s high-resolution graphics screen, and another part lets you select which functions of the Tablet you want to use.

Once you attach this overlay to the Tablet, you need to tell the Apple the exact location of the overlay on the surface of the Tablet, and the Apple will help you make sure that you’ve put the overlay on correctly.

ALIGNING THE MENU

Before you use the Tablet, you must first place the overlay on the Tablet and align it. There is a program on your diskette which will assist you in aligning your menu overlay properly. From the Graphics Tablet HELLO menu, press M to select the MENU ALIGNMENT program, and then press RETURN.

The alignment program tells you what slot your Interface card is plugged into and then creates an information file on your diskette. The name of this file is TAB.INFORMATION. All other programs which use the Tablet can read the vital information about your Tablet and menu from this file. After you run the MENU ALIGNMENT program once, you need not run it again, unless you remove your menu overlay from the Tablet or use your Tablet with a different pen.
If you get any other message, you probably slipped somewhere, or the overlay isn't centered on the Tablet surface. Try it again.

Once the overlay is aligned, the Apple will return you to the Graphics Tablet logo. Press Esc to get to the program menu again. Now you can start using your Graphics Tablet.

(If you want to be really sure that your menu is properly aligned, you can run the MENU ALIGNMENT program again. Leave the menu taped down and just poke the proper points with the pen. If everything goes well, then your menu is well-aligned. If not, repeat the MENU ALIGNMENT procedure.)
GET READY

To start using the Graphics Tablet, go to the Graphics Tablet logo, either by re-booting the diskette, completing the MENU ALIGNMENT program, or typing

RUN HELLO

Press ESC. Now press 9 to select GRAPHICS TABLET SOFTWARE and press RETURN. The disk will spin and chug for a while, and the Apple will present you with a blank screen. (If you get a message informing you that the Tablet information file does not exist, press [RETURN] and run the MENU ALIGNMENT program.) In about three seconds, your Tablet will be ready to use.

DRAWING

Touch the point of the Tablet's pen lightly to the surface of the Tablet. Move the pen around. You should see a small "crosshairs" cursor moving around the screen as you slide the pen around. The crosshairs are a locator, and the position and motions of the crosshairs on the screen correspond to the position and motions of the pen on the Tablet. Now press down on the pen so that the point retracts, and start drawing. As you draw on the Tablet, the path you trace will show up on the screen as a thin white line.

The top and sides of the working area of the overlay (the area with the fine mesh gridwork) correspond to the top and two sides of the Apple's screen. However, the working area on the overlay is slightly taller than the screen. To compensate for this difference in height, only the upper 2/3 of the overlay's working area is "mapped onto" the screen. The rest, about 2.5 inches (6.35 cm) at the bottom of the working area, is not usually active. (For information on how to use the full working area, see the WINDOW command.) You might want to find the lower boundary of the working area and mark it with a felt tipped pen on the overlay.

THE MENU

Along the top of the Tablet's Nylor overlay are two rows of 22 squares. Each square in the top row carries the name of a certain command or function which the Tablet software can perform. These two rows of squares are called the Tablet Menu. They let you order functions for the Tablet as you would order food in a restaurant in a foreign country: by pointing to what you want. If you could speak the proper language, you would order dinner by telling the waiter what you would like. But the Tablet's language consists of thousands of magnetic and electrical impulses traveling near the speed of light. Most people can't communicate in this fashion (those who can are mutants, and thus have gone far in the computer world), so you'll have to indicate your choice to the Tablet by pointing at the Menu.

To invoke a command or function, touch the point of the Tablet's pen anywhere inside the corresponding square and press down. Hold the pen down until you hear the Apple beep. If you don't hear a beep, then you haven't fully activated the command, and you should lift the pen and try again.

The second row of boxes, which carry no name, consequently have no function. You can use them for your own programs (see EXTENDING THE MENU in Chapter 3).

The following pages describe each command and its function. To help you locate the square for each command, the section describing that command will be headed with a drawing of the menu and a pen pointing to the proper square.

<table>
<thead>
<tr>
<th>Command</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RESET</td>
<td>![RESET]</td>
<td>Reset the Tablet to its default state.</td>
</tr>
<tr>
<td>CLEAR</td>
<td>![CLEAR]</td>
<td>Clear the drawing area.</td>
</tr>
<tr>
<td>WINDOW</td>
<td>![WINDOW]</td>
<td>Change the viewing area of the Tablet.</td>
</tr>
<tr>
<td>BE</td>
<td>![BE]</td>
<td>Change the background color.</td>
</tr>
<tr>
<td>DELTA</td>
<td>![DELTA]</td>
<td>Adjust the precision with which the pen draws on the screen.</td>
</tr>
<tr>
<td>SOFT</td>
<td>![SOFT]</td>
<td>Soften the lines drawn by the pen.</td>
</tr>
<tr>
<td>VIEW</td>
<td>![VIEW]</td>
<td>Change the viewing area of the Tablet.</td>
</tr>
<tr>
<td>CALIBR</td>
<td>![CALIBR]</td>
<td>Calibrate the Tablet.</td>
</tr>
<tr>
<td>REDUCER</td>
<td>![REDUCER]</td>
<td>Reduce the size of the drawing area.</td>
</tr>
<tr>
<td>PEN</td>
<td>![PEN]</td>
<td>Change the pen color.</td>
</tr>
<tr>
<td>DRAW</td>
<td>![DRAW]</td>
<td>Draw a line with the stylus.</td>
</tr>
</tbody>
</table>
Tablet, about .039 inches or 0.997 mm) from the last dot plotted. The normal value for Delta is 2. The largest Delta value is 127. This will make the Tablet draw a new line only after the pen has moved a horizontal or vertical distance of 127 dots (4.98 inches, or 12.6 cm) from the last dot plotted.

Associated with the Delta setting is the Audio Feedback feature. When this feature is turned on, the Apple's speaker will emit a click each time the Apple draws a new line. With the Audio Feedback feature enabled, you can actually hear as well as see the effects of different Delta settings.

To look at or change the current Delta setting, touch the pen to the Delta command square. Press it down until you hear the Apple beep. You'll see the following:

```
FAST-DRAW DELTA SETTING
CURRENT DELTA SETTING IS 2.
AUDIO FEEDBACK IS OFF.
NEW DELTA EQUALS 1
```

The first few lines tell you the current Delta setting and whether the Audio Feedback feature is ON or OFF. The Apple will ask you for the new Delta value. If you wish to retain the current Delta value, just press RETURN. If not, type a number between 1 and 127 and press RETURN. Next, you'll be asked whether you want the Audio Feedback ON or OFF. Again, if you wish to retain the current setting, just press RETURN. Otherwise, type the word ON (to produce the clicks) or OFF (to silence the clicks) and press RETURN. The Apple will then return you to the picture you were drawing, with the new Delta and Audio Feedback settings in effect.

Experiment a little with different Delta settings. Set a cup or saucer on the Tablet surface and trace its perimeter several times, using different values for Delta each time. You'll get something which looks like this:

```
THE COLOR MENU
```

The Apple's screen can display six colors: black, white, green, violet, orange, and blue (of course, if you are using a black-and-white monitor, you'll see only various shades of grey). The Apple lets you draw on the screen with all of these colors.

Touch the pen to the command box marked PEN COLOR and press down. The Apple will beep, the screen will clear and the message

```
CONSTRUCTING COLOR MENU
```

will appear at the bottom of the screen. The Apple will proceed to draw eight colored boxes, surrounded by a grey border.

Move the pen lightly across the surface of the Tablet. You'll see a small block drifting around the screen (instead of the usual crosshair). Use the pen to position the block over the color with which you wish to draw, and press down. The color menu will vanish, and you will be looking at the screen on which you were previously drawing. Now, draw! The lines you draw will be in the color you selected. Change colors again and keep drawing. All the rules are the same. Only the colors have been changed.

If, while you're shopping around for a new Penny COLOR, you decide you really don't want to change the color you've got, just press RETURN. Your PEN COLOR will not be changed.
SOME BACKGROUND INFORMATION

When you start drawing with the Graphics Tablet, you’re given a black screen on which to create. You can tell the Tablet that you wish to use a different-colored background by pressing the pen in the BC COLOR (Background COLOR) square. The Apple will present you with a color menu (as for the PEN COLOR command). Pick the color you want to use as a background; for instance, orange. The menu will vanish and the screen will instantly be filled with orange, or whatever color you have chosen.

Using the BG COLOR command will erase everything you had on the screen, so if you want to specify a BackGround COLOR, do it before you start to draw.

Are you trying the examples? Is the BackGround COLOR command working? Is orange your favorite color? Again, if you decide not to change the background COLOR, press RETURN instead of selecting a color. Your BackGround COLOR (and your picture, too) will be left unchanged.

A BRIEF DIGRESSION ON HIGH-RESOLUTION GRAPHICS

By now you must have noticed that there are some funny things going on with the colors. For example, set the BackGround COLOR to green and try to DRAW blue lines across it. Or set the BackGround COLOR to violet, and draw some blue lines. Obviously there’s something wrong. The color “shadows” and the “zebra stripes” which you see on a color television set, or the strange distortions, unevenness, and lack of consistency you observe on a black-and-white monitor, are the results of the Apple’s method of generating colors in its high-resolution graphics display. For more information on the anomalies of the apple’s high-resolution graphics color generation scheme, see Appendix C.

GUIDELINES

To minimize the problems created by the Apple’s high-resolution graphics color scheme, follow these guidelines:

1) Most inconsistencies of the Graphics Tablet colors occur with vertical lines. Use horizontal lines when possible.

2) When you’re drawing with black or white on a colored background, or in color on a black or white background, draw the lines a little thicker than normal by going over them twice. This helps eliminate the broken lines you may get.

3) If you need to place two colored blocks next to each other, stack them vertically, not horizontally. This cures the colored shadows that sometimes appear between colors.

So much for the digression, on with the Tablet.

A CLEAR ALTERNATIVE

If you’re tired of the scribbles and doodles on your screen, press the pen to the CLEAR square. Zap! Your whole screen will be restored to the BackGround COLOR (see the previous section). Draw mode will be restored, and, if you haven’t set one, the BackGround COLOR will be black.

If you have set a VIEWPOINT (described a little farther on in this chapter), then CLEAR will affect only the portion of the screen inside the VIEWPOINT. The rest of the screen will remain unchanged.
LINE UP

So far, you've been happily drawing somewhat rough, freehand lines on the Apple's screen. If you wanted to draw a straight line between two points, you probably tried to draw it with a straightedge (smart, but awkward) or did it freehand (sluggish). "Is there a better way to draw straight lines?" I hear you cry. Well, guess what! Yes, there's a better way to draw straight lines. Press the pen to the box which, for some obscure reason, bears the designation LINES. Now you have entered LINES mode. You will remain in LINES mode until you tell the Apple otherwise. We'll tell you how to do that later.

Meanwhile, since you're in LINES mode, let's draw some lines. Press the pen down anywhere on the Tablet's working area and lift the pen again. See the small dot left on the screen? That will be one endpoint of your line. Now press the pen down at another point in the working area. Zap! There's now a straight line connecting the two points. Press the pen down again at another point, and the Apple will draw another line, this one connecting the new point and the second point. Now rush to your nearest toy store and buy a Connect-the-Dots coloring book. Pick out an interesting page, tape it to your Tablet, and start connecting dots. The figure will magically appear on your screen.

If you want to start a second LINES figure, simply press the pen to the LINES command box again. The next point at which you press the pen will be the beginning of a new figure.

The "straight" lines you draw with your Tablet may not seem absolutely straight to you. This is normal. Lines that are neither horizontal nor vertical are actually made up of tiny zig-zags between dots on the screen.

Once you enter LINES mode, you'll stay in LINES mode until you ask to leave. The proper way to ask to be excused is to press the pen to a box that represents another drawing mode.

DRAW

The mode you were in before you entered LINES mode is called DRAW mode. DRAW mode is the normal state of the Graphics Tablet and is automatically put into effect when you choose the Graphics Tablet Software from the diskette menu. This means that DRAW mode is the default mode.

Whenever you wish to leave a fancy drawing mode (LINES, BOX, FRAME or DOTS), simply press the pen to the command square called DRAW. Your picture will be left intact and you will be able to draw normally until you specify another mode.

YES, SIR, DOTS MY BABY

Once you've got a picture on the screen, you might want to edit or change small portions of it. For example, you've drawn this picture:

and you want to fix up the little "glitches" around the edge. There are a couple of ways to do this: you could set the PEN COLOR to black and DRAW the glitches out, you could erase whole portions of the screen and redraw them, or you could simply erase the whole thing and start over. Fortunately, there's an easier way. Press the pen to the square marked DOTS. You are now in DOTS mode, and will remain in DOTS mode until you specify another. While you are drawing with DOTS, the
Graphics Tablet will let you plot individual points on the screen. Each time you press the pen down in the working area you will plot one, and only one, point on the screen. When you lift the pen up again and press it down in a new place, you will plot another single dot. The dots will be of the color you specified in the most recent PEN COLOR command, or white if you have not selected any other color.

By setting the PEN COLOR to the BackGround COLOR (normally black), setting DOTS mode, centering the crosshairs on the extraneous glitches in the picture, and exercising them one by one, you can turn a rough picture like the previous one into this:

DOTS mode is also handy for adding shading and texture to your pictures. DOTS mode is most useful when used with VIEWPORT and REDUCE, described later in this chapter.

To leave DOTS mode, press the pen in the command square for any other mode (like DRAW, LINES, BOX or FRAME).

THE BIG FRAME-UP

When you’re in the FRAME mode you can draw open rectangular boxes on the screen by specifying two diagonally opposite corner points. To enter FRAME mode, press the pen down in the (surprise!) FRAME command box. Now press the pen down anywhere on the Tablet’s working area and lift it again. A single dot will appear on your screen. Take the pen and press it down at another point on the working area. The Apple will draw an open rectangle with opposite corners at the points you specified. Pick another point and press the pen down. Notice that the FRAME mode doesn’t draw a frame with the new point and previous point (as LINE mode would draw a line between them), but instead uses the new point as a corner of a separate FRAME. Pick and press a fourth point to complete the second FRAME.

Your FRAMEs can be simple, or you can use many FRAMEs to make a larger, more complicated FRAME:

You can draw your FRAMEs in different colors, too. The FRAMEs will be drawn in the current PEN COLOR, or white if you haven’t selected any other color. Beware! Colored FRAMEs may come out with a side or two missing because of the nature of the Apple’s high-resolution graphics screen (see Appendix C). If this happens, re-draw the FRAME, but move the corner points very slightly to one side.

To leave FRAME mode, press the pen in the square for any other mode (such as DRAW, LINES, DOTS, or BOX).

LITTLE BOXES

There’s a white one, and a blue one, And a green one, and an orange one, And they’re all made On the Graphics Tablet And they all look Just the same.

Now FRAMEs are nice, but they’re kind of vapid. You might even go so far as to say they’re empty. If you’re looking for something a little more, well, fulfilling than an ordinary rectangular quadrilateral, then the BOX mode is for you. Press the pen down in the square marked BOX. Now press the pen down at two points on the working area, as you did for FRAME. The Tablet software will give you solid indication that the task is completed by drawing a uniform, monolithic box with corners at the two points you specified.
You will remain BOXed into this mode until you free yourself by pressing the pen down in one of the squares marked DRAW, LINES, DOTS, or FRAME. The BOXes you draw will be of the current PEN COLOR. If you have not specified a different color, your boxes will be white.

SAVING PICTURES FOR POSTERITY

The reason for this is that before the Apple saves the screen onto the diskette, it adds the prefix "PIC:" to your picture name to identify it as a bona fide Graphics Tablet Picture. Since diskette file names will always begin with the letter F (in PIC:), your picture names can begin with whatever you please.

The PIC_flag also implies that the picture file includes the Tablet WINDOW setting (see the WINDOW command). Files which do not contain this information should not carry the PIC_flag.

After you type the name of the picture, press RETURN. If you decide you don't really want to save the picture yet, just press RETURN without typing any name. Your picture will reappear, and you'll be left in DRAW mode.

If you do choose to save your picture, the Apple will then ask you:

DRIVE? —> (DEFAULT=1)

The Apple will save your picture onto the diskette in the disk drive you indicate. The DEFAULT drive is the drive which the Apple thinks you'll want to use, drive 1 the first time and the drive specified previously each time thereafter. Type the drive number you wish to use and press RETURN, or just press RETURN to select the DEFAULT drive. (If you try to specify any drive number other than 1 or 2, the Apple will use the default drive). The drive will whirl and chug for a moment, then your freshly saved picture will reappear, in DRAW mode with PEN COLOR as it was when you left.

If there is already a picture on the selected diskette with the name you specified, the Apple will display the message

A PICTURE ALREADY EXISTS WITH THAT NAME.

CONTINUE (Y OR N)

If you wish to overwrite the current picture which has the name you specified, press Y RETURN. If you don't want to destroy the picture on the diskette, press N RETURN and repeat the SAVE operation using a different picture name (a lone RETURN is accepted as an N response).

If you complete the SAVE procedure, or if your attempt to SAVE a picture is foiled, and you get an error message from the Apple, you will lose any VIEWPORT you may have set (see the VIEWPORT command). If, however, you have aborted the SAVE command with an N RETURN, the VIEWPORT will remain intact.

By now you should have generated some beautiful (well, at least interesting) artwork. It's a shame that you have to erase it, isn't it? Well, you can save the entire picture for later recovery and further work by pressing the pen in the square marked SAVE. Your picture will vanish (temporarily) and the screen will display the message

TYPE A NAME FOR THIS PICTURE.

A picture name can be from 1 to 26 characters long, and may include letters, numbers, and special characters (except the comma). Unlike normal diskette file names, picture names do not need to begin with a letter; you can have picture names such as

1 FOR THE ROAD

or

<<SPACE>> (notice the spaces before the name)
If you receive this message:

THE PICTURE IS LOCKED OR
THE DISK IS FULL OR PROTECTED.

PRESS SPACE BAR TO RETRY.
PRESS [CR] TO ABORT.

then any number of things could be wrong: the diskette is full and can hold no more pictures, the diskette is write-protected, or there's another picture on the diskette with the same name and the file which holds that picture is locked. In the first case, simply use another uninitialized diskette. In the second case, remove the diskette, peel off the write protect tab and reinsert the diskette. In the third case, try another file name. Whatever the problem is, you may press the spacebar to attempt to SAVE the picture again under the same name, or press [RETURN] to cancel the attempted SAVE. Your picture will reappear, and you will be back in DRAW mode.

If you filled up the diskette by trying to SAVE a picture, only part of the picture will actually be stored on the diskette. It is best to delete the partial file from the diskette after you have SAVED the picture on another diskette (see GETTING OUT).

If you receive this message:

I/O ERROR.

PRESS SPACE BAR TO RETRY.
PRESS [CR] TO ABORT.

while attempting to SAVE a picture, then there are problems. Maybe you specified Drive Z when you only have one drive, or the diskette is uninitialized, or the data on it has been destroyed. You could have a faulty disk drive or controller card, or your drive is under the influence of a powerful magnetic field (did you put it on top of your television? Naughty, naughty). There may be no diskette in the drive, or you left the drive door open, or the diskette is crimped and is not rotating. Whatever the cause, press the spacebar to attempt the SAVE again, or press [RETURN] to get back to your picture. Investigate.

BROWSING THROUGH THE CATALOG

You can look at the contents of your diskette by pressing the pen in the square marked CATALOG. The Apple will ask you (as above) for the drive number. You can select the DEFAULT drive by pressing [RETURN].

The message
PRESS SPACE BAR TO CONTINUE

will be centered at the top of the screen. The drive will whirr a bit, and the names of all files on the diskette will be presented. Don't press the spacebar yet! The file names which begin in PIC. are your Graphics Tablet pictures, and should all have the annotation B 034 to the left of them. Incidentally, the B denotes that they're BINARY files, and the 034 means that they use 33 diskette sectors, or little over 8K bytes of memory, each. If you see any PIC. files which aren't marked B 034, then they're not complete pictures. Change their names (see GETTING OUT) so you don't mistake them for Graphics Tablet pictures in the future.

If you order a CATALOG of the Graphics Tablet Software diskette, these files will be included:

These are all component programs of the Graphics Tablet package. The only notable file in the GRAPHICS TABLET LOGO, which you'll notice has the notation B 034 to the left of it. (The 034 means that it's
slightly larger than normal Tablet pictures, which are labeled 0033. This causes no problems, however.) This is the picture of the Graphics Tablet Logo frame, which you see when you boot the diskette. You can LOAD this picture and work on it, even though it's not a FIG. file (see LOAD, below, for details).

CATALOG can fall victim to the same I/O ERROR problems as noted in SAVE. See the previous section for details.

If the CATALOG listing is too long for the screen, the listing will pause after displaying 18 files. Press the spacebar to get the rest of the CATALOG.

When you've finished looking at the CATALOG, just press the spacebar. Your picture will instantly reappear on the screen, with PEN COLOR unchanged.

### GETTING LOADED

<table>
<thead>
<tr>
<th>LINES</th>
<th>DOTS</th>
<th>FRAME</th>
<th>BOX</th>
<th>CATALOG</th>
<th>LOAD</th>
<th>SAFE</th>
<th>SEPARATE</th>
<th>SLIDE</th>
<th>AREA</th>
<th>DISTANCE</th>
</tr>
</thead>
</table>

Once you have SAVED a picture on diskette, you can call it back to your screen to be worked on some more, or just bring it out so you can admire it for a minute. Press the pen to the square marked LOAD. The following words will appear:

PLEASE TYPE THE PICTURE NAME.

If you change your mind and don't want to LOAD a new picture, press RETURN. Your previous picture will reappear, and you will be left in DRAW mode with the same PEN COLOR as when you left.

If you do want to LOAD another picture, type the name of the picture which you wish to see, and press RETURN. You don't have to type the FIG, the Apple will supply that for you. The rules for naming pictures are the same as described in the SAVE command.

You will then be asked to specify which drive the diskette with the chosen picture is in. Press RETURN to indicate that it's in the DEFAULT drive, or type the drive number (1 or 2) and press RETURN.

The disk drive will spin for a few moments, then the selected picture will appear on the screen. You will be left in DRAW mode.

LOAD is vulnerable to the same disk I/O ERROR problems as were described in the SAVE section.

You can LOAD picture files which were not created by the SAVE command, as long as they carry the notation 0 033 in their CATALOG listing. One such file is the GRAPHICS TABLET LOGO file on your Graphics Tablet Software diskette. Even though this file doesn't have the FIG. flag in front of its name, it can be LOADed and worked upon like any other picture. If you LOAD this file, and SAVE it again, the new version will have the prefix FIG. attached to the name, and will have the notation 0033 to its left in the CATALOG.

When the Apple sees the FIG. prefix, it infers that the file contains information about the Tablet WINDOW setting along with the picture. The absence of the FIG. flag indicates to the Apple that it should use the default WINDOW setting (see the WINDOW command). In addition, if you have a picture on the diskette whose file name does have the FIG. prefix, you can make the Apple ignore the Tablet WINDOW setting in that file by typing the FIG. prefix at the beginning of the file name when you LOAD it.

If you LOAD a picture which was SAVED on another Apple or Graphics Tablet, it's possible that the Tablet which created that picture uses a slightly different WINDOW setting than yours. The difference usually appears as a discrepancy between the motions of the pen across the working area and of the crosshairs on the screen. If the crosshairs don't correspond to the pen position, then re-LOAD the picture, but type the FIG. prefix at the beginning of the file name. This will make the Apple use the proper WINDOW setting for your Tablet.

With one exception, an attempt to LOAD a picture, whether successful or not, will remove any VIEWPORT you may have set (see the VIEWPORT command). If you have aborted the attempted LOAD with a RETURN, or a RETURN, this rule does not apply.

### GETTING OUT

With the Graphics Tablet, you can perform three simple operations with disk files: SAVE, CATALOG, and LOAD. In order to RENAME or DELETE picture files, you'll have to leave the Graphics Tablet Software and get back to the Apple/OS/DOS command level. To do this, get to DRAW mode and press ESC. The Apple will ask you if you indeed wish to leave.

If you answer Y, you will lose whatever picture you had on the screen! Any other reply will send you back to your artwork, in DRAW mode.
If you answer ☑, then the Apple will run the HELLO program on the diskette, and you will see the Graphics Tablet Logo frame (see Chapter 1, STARTING UP).

Press ☑ again to get to the HELLO menu. Choose ☑ to QUIT and press RETURN. The screen will be cleared and the AppleSoft prompt character (>) will appear in the upper-left corner.

Now you can DELETE, RENAME, LOCK, UNLOCK, or VERIFY any of your picture files on the diskette, or do almost anything else in AppleSoft or with DOS. (For details on how to perform these operations, see Chapters 2 and 4 of your DOS manual.) Remember to include the PIC filename at the beginning of the pictures' file names! To return to the Graphics Tablet software, type

```
RUN HELLO
```

When the Graphics Tablet logo appears, press ☑, select ☑ for Graphics Tablet Software, and press RETURN. You'll be working with the Tablet again, with a blank screen, a white pen, no VIEWPORT, the WINDOW at its default setting, the REDUCER off, and in DRAW mode.

DON'T try to RUN the file GRAPHICS TABLET SOFTWARE directly! It is not a program in itself, but is an EXEC file which runs several programs and sets up some parameters necessary for the well-being of the Tablet software. You should always enter the Graphics Tablet Software by selecting it from the HELLO menu.

**ROOM WITH A VIEWPORT**

<table>
<thead>
<tr>
<th>RESET</th>
<th>CLEAR</th>
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<th>BG COLOR</th>
<th>DELTA</th>
<th>SOFT RESET</th>
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<th>CALIBRATE</th>
<th>REDUCER</th>
<th>PEN COLOR</th>
<th>DRAW</th>
</tr>
</thead>
</table>

Am I to spend the rest of my short life
Confined by these four corners, bright and sharp?
Shall I be limited in my designs
To draw only within this VIEWPORT small?

This cannot be! And yet, there's recompense:
The box which limits, also can protect,
And keep me from destroying what I've wrought.
Confine, protect; the VIEWPORT functions thus.

You can use the VIEWPORT command to select a rectangular area on the screen. Once you set an area for a VIEWPORT, you will be allowed to draw only within that area. This allows you to concentrate on one area of the screen at a time, while protecting the rest of the picture from being accidentally erased or overwritten.

The VIEWPORT appears on the screen as four small "L"-shaped corner marks, one at each corner of the VIEWPORT. Each leg of each "L" is three dots long and one dot high. The VIEWPORT itself is the area enclosed by these four corners (the corners are actually outside the VIEWPORT proper). If you change or remove a VIEWPORT, the corner marks vanish without a trace, leaving the screen under them unchanged.

To specify a VIEWPORT, press the pen to the VIEWPORT square on the Tablet menu. The prompting message

**UPPER LEFT?**

will appear briefly at the bottom of the screen. Position the pen at the spot where the upper-left corner of the VIEWPORT should be (imagine you're drawing a FRAME) and press down. One corner mark will appear, and another prompting message:

**LOWER RIGHT?**

will be displayed:

Position the pen at the opposite (lower-right) corner of your proposed VIEWPORT, and press down. The other three corners of the viewport will appear. This is how the finished VIEWPORT will look:
Unlike FRAME and BOX modes, in which you can specify the corner points in any order, VIEWPORT really does want the second corner point to be below and to the right of the first. If you give the points in reverse order, or specify an impossible VIEWPORT (one which has no height or width), then you will receive the message

PLEASE SPECIFY POINTS CORRECTLY

You will then be asked for both corner points again.

Once you’ve set a VIEWPORT, what do you do with it? Simple, just DRAW. After you specify the two corner points, and you see the four-cornered frame, you will be placed in DRAW mode with the PEN COLOR unchanged. Anything you DRAW outside of the VIEWPORT simply will not show up on the screen; anything you draw inside it, will. Notice that the crosshairs will appear even outside the VIEWPORT, but pressing down on the pen has no effect.

You can change to any other drawing mode (BOX, DOTS, LINES, or FRAME) and it will work normally inside the VIEWPORT. But if, while you’re in one of these modes, you try to specify a point outside the VIEWPORT, you’ll receive the admonition

POINT OUTSIDE VIEWPORT, RESPECIFY.

Just choose another point inside the VIEWPORT. If you want to restart the BOX, FRAME, or LINE you’re drawing, press the pen to the square for the proper mode again.

If you invoke the VIEWPORT command when another VIEWPORT is already active, the Apple will remove the previous VIEWPORT before asking you to specify a new one.

At any time after you have invoked the VIEWPORT command, but before you have finished specifying a new VIEWPORT, you can tell the Apple to give you one of two special VIEWPORTs. One of these is the VIEWPORT you were using before you started to set a new one, and the other is the “default” VIEWPORT (the currently set WINDOW).

To recover the VIEWPORT you had before you started to set a new one, press RETURN before you finish the VIEWPORT command.

To request the default VIEWPORT, press 0 before you finish the VIEWPORT command. The default VIEWPORT is the full screen, or (if you have invoked the WINDOW command) the area within the WINDOW. When the VIEWPORT is set to the full screen, no corner marks appear.

The VIEWPORT command always leaves you in DRAW mode with the PEN COLOR unchanged.

**A BRILLIANT REDUCTION**

Once you’ve set a VIEWPORT, you can use the REDUCER function to shrink the entire Tablet working area into the VIEWPORT on the screen. This allows you to convert large pen motions on the Tablet into small motions on the screen. This lets you make precise, small drawings. When you use the REDUCER in conjunction with the DOTS mode, you can modify very small areas of a picture, setting and resetting individual dots if necessary.

Once the REDUCER is enabled, it will stay in effect until you remove it or change the VIEWPORT. To use the REDUCER, set a VIEWPORT around the area in which you wish to work, then press the pen to the square marked REDUCER. When you hear the Apple beep, the REDUCER is active. If you receive the message

NOT POSSIBLE.

then you have specified a VIEWPORT which is too small or too disproportionately shaped for the REDUCER to function. Such an impossible reduction will leave you with the REDUCER inactive and everything else unchanged.

The screen position of the VIEWPORT determines the minimum possible size into which you can REDUCE. You can REDUCE into smaller VIEWPORTS in the upper-left corner of the screen than in the lower-right corner. Specifically, the smallest possible VIEWPORT size into which you can REDUCE ranges from two screen dots square (at the normal WINDOW setting) in the upper-left corner to 45 dots square in the lower-right.
To disable the REDUCER, press the pen to the REDUCER square again. The Apple will beep and the REDUCER will be disabled. The RESET, SOFT RESET, WINDOW, VIEWPORT, and LOAD commands also disable the REDUCER.

When the VIEWPORT is at its default setting, the REDUCER has no effect.

**OPENING THE WINDOW**

<table>
<thead>
<tr>
<th>RESET</th>
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<th>REDUCER</th>
<th>PEN COLOR</th>
<th>DRAW</th>
</tr>
</thead>
</table>

The WINDOW command works like a VIEWPORT with the REDUCER on, but the other way 'round. Where VIEWPORT with REDUCER lets you draw something large on the Tablet, and have it appear smaller and in a specific place on the screen, the WINDOW lets you draw something small in a specific place on the Tablet and have it appear large on the screen.

You normally set a WINDOW before you begin drawing a picture. Press the pen to CLEAR and then to WINDOW. This will appear on the screen:

Finish a picture of a molehill and tape it to the Tablet’s working area. Now take a pen or a pencil (not the Tablet’s pen!) and draw a box around the significant part of the picture. Take the Tablet’s pen and, following the highlighted instructions on your screen, press it to the upper-left corner of the box. The highlighting will shift:

Press the pen to the lower-right corner. The words will disappear and the drawing screen will return, with a large frame in the middle of the screen. This frame is proportional to and corresponds with the frame around the molehill on the Tablet, and is centered on the screen. Take the pen, set DRAW mode, and trace the molehill. You will make a mountain on your screen out of the molehill taped to the Tablet.

After it’s finished, WINDOW returns you to DRAW mode, with your PEN COLOR unchanged and the VIEWPORT set to the same size as the WINDOW frame on the screen.

The reason that you aren’t shown the screen and crosshairs while you set the WINDOW (as you are when you set a VIEWPORT) is that you’re selecting an area on the Tablet, not the screen. The resulting area on the screen is as large as the Apple can make it, proportional in size to the WINDOW on the tablet, and centered on the screen. Since the WINDOW area on the Tablet bears little relation to the screen before it’s set, the screen and crosshairs are not displayed.

At any time after you have initiated the WINDOW command and before you have completed it, you can use the Apple’s keyboard to indicate that you want the default WINDOW, (the entire working area of the Tablet.)
or that you want to cancel the WINDOW sequence. Press USER at any
time during the WINDOW sequence to cancel it; press B to select the
default WINDOW.

**BROKEN WINDOWS**

If you receive the message

PLEASE SPECIFY POINTS CORRECTLY!

then you've not specified the two corner points in their proper upper-
left, lower-right order, or you've tried to set the WINDOW to an area
on the Tablet that's too small. You will be asked to specify both
corners again. If you want to cancel the attempted WINDOW, press USER.

If the Apple flashes the message

PLEASE STAY WITHIN THE WORK-AREA.

then you've let the pen stray outside the working area of the Tablet's
overlay. You will be prompted again to indicate the corner point.
To cancel the WINDOW command, press USER.

**DRAWING IN THE WINDOW**

Once you've placed a WINDOW on the Tablet, you can use any of the
Tablet's drawing modes (DRAW, LINES, DOTS, FRAME, or BOX) to draw, as
long as you stay within that WINDOW.

You can set the VIEWPORT within the WINDOW on the screen. Once you've
set it, you can even REDUCE into it, and use the entire Tablet area
within the VIEWPORT. When you turn the REDUCER off, you will again be
limited to your WINDOW.

Once you've set a WINDOW, the only way to remove the WINDOW frame is
to set a new WINDOW or use the Tablet RESET command. No other Tablet
command will remove a WINDOW. The REDUCER will allow you to
temporarily override the WINDOW; when you turn off the REDUCER, you
will be left with the previous WINDOW again. Experiment with using
WINDOW and the REDUCER; you'll be surprised at what they can do.

When you specify a WINDOW on the Tablet, the Apple will draw the
WINDOW frame on the screen on top of the current picture. The sides
of the frame are two dots wide, and the top and bottom are one dot
wide. If you set a new WINDOW, the Apple will replace the frame by
drawing over it with the Background COLOR. The WINDOW command can
therefore destroy parts of your previous picture. Also, even though
WINDOW sets the VIEWPORT to the portion of the screen inside the
WINDOW frame, the CLEAR command will clear the entire screen,
including everything outside the VIEWPORT and the WINDOW frame, and
even the frame itself! (The frame will be redrawn after the CLEAR.)
If you reset the VIEWPORT to a slightly smaller size than the WINDOW,
the CLEAR command will work normally and erase only what is within the
VIEWPORT.

The WINDOW information is stored along with the picture information
when you SAVE a picture onto diskette. There is no way to avoid
saving this information. When you LOAD a picture, the Apple will
automatically use the WINDOW setting stored with that picture, if that
picture's diskette file name begins with PIC. If it does not, the
Apple will use the default WINDOW setting for your Tablet. You can
force the Apple to ignore the WINDOW setting stored in a picture file in
three ways:

1) Leave the Graphics Tablet Software (see GETTING OUT) and RENAME
   the file, removing the PIC. prefix from the file name.
   -- or --

2) When you LOAD the picture, type the PIC. flag at the beginning of
   the picture name. (LOAD PIC. filename)
   -- or --

3) Once you have LOADed the picture, press the pen to WINDOW and type
   B to get the default setting.

**RESET**

The RESET command lets you "wipe the slate clean" and begin anew on a
fresh picture. Namely, it:

1) Sets the WINDOW to the normal 11 inch wide, 6.5 inch tall
   rectangle at the top of the working area.

2) Sets the VIEWPORT to the full screen.

3) Sets CALIBRATES to one unit per screen dot, and leaves the unit
   type undefined.

4) Sets the Background COLOR to black, and clears the screen.

5) Sets the PEN COLOR to white and sets DRAW mode.
6) Sets the value of DELTA to 2 and turns the Audio Feedback feature OFF.

7) Sets the default drive number for LOAD, SAVE, and CATALOG to 1.

Using the RESET command is just like restarting the Graphics Tablet software all over again.

**A SOFTER RESET**

<table>
<thead>
<tr>
<th>RESET</th>
<th>CLEAR</th>
<th>WINDOW</th>
<th>BG COLOR</th>
<th>DELTA</th>
<th>SOFT RESET</th>
<th>VIEW PORT</th>
<th>CALIBRATE</th>
<th>REDUCER</th>
<th>PEN COLOR</th>
<th>DRAW</th>
</tr>
</thead>
</table>

The SOFT RESET command is a milder version of RESET. It lets you reset many of your drawing and calculating functions, while leaving your picture, WINDOW settings, and pen color intact. SOFT RESET:

1) Sets the VIEWPORT to the full screen, or to the currently set WINDOW. This is the same as pressing 5 while setting a VIEWPORT.

2) Sets the CALIBRATE unit to 1 and the unit type undefined.

3) Sets the DELTA value to 2 and turns the Audio Feedback feature OFF.

4) Sets DRAW mode.

Nothing else is changed by SOFT RESET. The PEN COLOR, Background COLOR, the WINDOW setting, the default drive number, and so on, all remain the same.

**CALIBRATE**

<table>
<thead>
<tr>
<th>RESET</th>
<th>CLEAR</th>
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<th>DELTA</th>
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<th>VIEW PORT</th>
<th>CALIBRATE</th>
<th>REDUCER</th>
<th>PEN COLOR</th>
<th>DRAW</th>
</tr>
</thead>
</table>

The CALIBRATE command lets you specify a distance on the Tablet surface and use it for measuring with the DISTANCE and AREA functions.

Press the pen to the CALIBRATE square on the menu. The Apple will beep and the brief question:

**BEGINNING POINT?**

will appear at the bottom of the screen. Select a point and press down. Another brief question:

**ENDING POINT?**

will flash at the bottom of the screen. Select another point, say, an inch away from the first and press down. The screen will vanish and the following frame will appear:

![Distance measurement dialog]

The Apple has converted the distance between the two points you specified into its internal "screen units". You now have the opportunity to define how long that distance actually was. If you’ve just arrived from Alpha Centauri, and you specified a distance of about one U.S. inch, that’s about 5 glibbets. Type

```
B RETURN
```

You’ve now defined the length you specified to be 5 Alpha Centauri glibbets. You’re free to change it, of course, and give a distance of 10 chronax, 200 salms, or even half a greton if you so desire (use decimal numbers for fractions, in this case 8.5 gretons).

The CALIBRATE command won’t let you specify negative distances, or distances greater than 999999999. It also won’t let you use a name for your measurement which is more than 10 letters, numbers, or special characters (such as asterisks, brackets, etc.) long.

You can tell the Apple that you’ll agree to use its internal screen units for measurement by answering its questions about unit and name with the RETURN key. Once you’ve specified a distance and unit name in the CALIBRATE command, they will remain as you set them until you: a) reset them with the CALIBRATE command, b) do a RESET or a SOFT RESET, or c) change the Background COLOR, the VIEWPORT setting, or the WINDOW setting.
MISTAKEN CALIBRATION

If you specify an endpoint for the CALIBRATE distance which is outside the current VIEWPORT, you will be asked to indicate the point again.

Once you begin to define a distance for the CALIBRATE command, you can cancel the procedure by pressing the RETURN key.

Don’t change the REDUCER setting after you’ve CALIBRATED your Tablet. If you do, it will shrink your measurements just as it shrunk your Tablet movements, and all your DISTANCE and AREA calculations will be incorrect.

LONG DISTANCE...

<table>
<thead>
<tr>
<th>LINES</th>
<th>DOTS</th>
<th>FRAME</th>
<th>BOX</th>
<th>CATALOG</th>
<th>LOAD</th>
<th>SAVE</th>
<th>SEPARATE</th>
<th>SLIDE</th>
<th>AREA</th>
<th>DISTANCE</th>
</tr>
</thead>
</table>

Once you’ve set a distance and a unit name with the CALIBRATE command, you can use those definitions to calculate the DISTANCE that you move the pen along a path on the Tablet surface.

For example, find a road map (we’ll use one of Central California), unfold it, and tape it to the Tablet so that the legend (with the scale of distance) is in the working area. Use the CALIBRATE command to set the distance and unit name to the scale of distance on the map.

Now point the pen to the DISTANCE square and press down. The Apple will beep, signaling you to take the pen and trace a path on the map. Draw a path from Buttonwillow to Bakersfield, along Route 5. The path will appear on the screen as you draw. When you lift the pen, the Apple will beep again and flash

CALCULATING...

at the bottom of the screen, and then go away and think for a moment. It will soon return, telling you that the DISTANCE you traveled from Buttonwillow to Bakersfield is about 25 miles. After a short delay, you will be returned to DRAW mode.

The path you draw, as it appears on the screen, is just like any other path in DRAW mode, and it is subject to the same DELTA effects as DRAW. Lower DELTA settings will give you more accurate DISTANCES; higher DELTA settings will give you less accurate (albeit quicker) approximations.

If you invoke the DISTANCE command and then decide you don’t want to calculate a distance after all, simply press the RETURN key instead of drawing a path on the Tablet.

There is a limitation on the maximum DISTANCE your path can be. The longest path you can draw for DISTANCE contains 800 points. With a DELTA setting of 2, this is 1600 screen units, or about 59 actual inches on the Tablet. Of course, this will be different if you’re using the WINDOW or REDUCER functions.

... AND AREA CODES

<table>
<thead>
<tr>
<th>LINES</th>
<th>DOTS</th>
<th>FRAME</th>
<th>BOX</th>
<th>CATALOG</th>
<th>LOAD</th>
<th>SAVE</th>
<th>SEPARATE</th>
<th>SLIDE</th>
<th>AREA</th>
<th>DISTANCE</th>
</tr>
</thead>
</table>

The AREA command is a counterpart to the DISTANCE command. But instead of letting you find the DISTANCE between Buttonwillow and Bakersfield, CA, it will let you figure the AREA of Manhattan. Quickly remove the map of Central California and switch to one of the New York City area. Use the CALIBRATE command with the scale of distance on the new map.

Now place the pen on the AREA square and press down. The Apple will respond with a beep. Trace the perimeter of Manhattan. As soon as you lift the pen, the Apple will beep again and flash

CALCULATING...

and sit and think for a few moments. Soon it will return with the area of the island, expressed in the units you set in the CALIBRATE command. It will hold this value on the screen for about five seconds, and then return you to DRAW mode.
Now CLEAR the screen and try it again. This time, don’t go completely around the island, but stop about half an inch away from your starting point. The Apple will obligingly close the curve for you, connecting the ending point directly to the beginning, before it calculates the AREA.

AREA is subject to the same limitations as DISTANCE: you can only draw a path 800 points long, or about 59 Tablet inches with a DELTA setting of 2. As in DISTANCE, a larger DELTA setting will give you less accurate results. And if you had the REDUCER on when you CALIBRATED, don’t turn it off when you are going to calculate an AREA. A press of the CLEAR key will abort the AREA command, just as it will for the DISTANCE command.

Now CLEAR the screen and find the AREA of Manhattan again. This time, go around the island twice. Notice that even though the AREA looks the same on the screen, the number that the Apple will return is about twice the actual AREA of the figure. This is normal: if you go around three times, the Apple will give you a number three times too large, and so on.

If, while drawing around an AREA, you move the pen outside the VIEWPORT, the Apple will act as if you had lifted the pen at that point, close the curve, and figure the AREA.

### SLIDE RULES

<table>
<thead>
<tr>
<th>LINES</th>
<th>DOTS</th>
<th>FRAME</th>
<th>BOX</th>
<th>CATALOG</th>
<th>LOAD</th>
<th>SAVE</th>
<th>SEPARATE</th>
<th>SLIDE</th>
<th>AREA</th>
<th>DISTANCE</th>
</tr>
</thead>
</table>

Once you’ve got a picture on the screen, you don’t have to rest at that. No, you can mobilize your pictures, give them some motivation, see some action! Press the pen to the SLIDE square. The request:

BEGINNING POINT?

will appear briefly at the bottom of the screen. Use the pen to select any point on your picture, and press down. A second request:

ENDING POINT?

will appear. Select another point on the screen, some distance removed from the first. Watch your picture travel across the screen, both vertically and horizontally, until the first point you selected (on the picture) is in the vicinity of the second point (on the screen).

If you decide that a SLIDE isn’t what you want right now, press RETURN to cancel the operation. You’ll be returned to your picture, in DRAW mode.

The SLIDE operation is performed in four directions, with what mathematicians call "toroidal wrap-around". This ponderous phrase means that the picture thinks it’s not on a flat screen, but wrapped around a doughnut: the left side is joined to the right side, and the top is joined to the bottom, so that everything that you SLIDE off one edge of the screen will reappear on the opposite edge. When your SLIDE is complete, you will be returned to DRAW mode.

SLIDE moves the entire screen; there is no way to move only a portion of the screen. Because of the way the Apple places colors on the screen (see A SHORT DIGRESSION...), the SLIDE command can move the picture the exact vertical distance you indicate, but can only come within 14 dots of the horizontal location you specify.

SLIDE will remove the VIEWPORT and WINDOW borders before it moves the picture, but will replace them in their former locations (not SlIDed over) after the SLIDE is complete.

### PRISMATIC APPLE

The SEPARATE function "stripes" your picture, until only one color is left. Press the pen to the SEPARATE square. You will be presented with a color menu, just like in PEN or BackGround COLOR. Remember: The SEPARATE command will destroy parts of your picture. If you want to preserve a picture, be sure to SAVE it before you do a SEPARATE. If you’ve already started a SEPARATE command, just press RETURN to cancel it and return you to DRAW mode.

If you do want to SEPARATE out your picture, select a color from the color menu with the pen and press down. The menu will vanish and your picture will reappear. Quicker than you can pronounce "refraction", your picture will be stripped of all colors except the one you selected. You will be left in DRAW mode, with your BackGround COLOR set to black and your PEN COLOR set to the SEPARATE color you specified.

There is no way to undo a SEPARATION. The SEPARATE command will remove any VIEWPORT or WINDOW before it performs its function, and restore them when it’s finished. SEPARATE works only on the entire screen; there is no way to SEPARATE only a portion of the screen.

You cannot SEPARATE out the color black. If you did, you’d be left with a blank screen! The Apple will deny your attempt to separate out either of the blacks with the message:

NO SEPARATION ON BLACKS.
IN CONCLUSION

Congratulations! If you’ve come this far, and practiced with your Tablet along the way, then you’ve mastered the basic functions of the Apple Graphics Tablet. With a little practice, you can be drawing and manipulating pictures with skill and ease. If you’re interested in doing more with your Tablet, and you’re accustomed to programming in Applesoft BASIC, then you might be interested in looking into Chapter 3. It describes the internal operation of the Graphics Tablet software, and the operating subroutines in the Graphics Tablet itself. You’ll find dozens of new applications for your Tablet. Go ahead, keep drawing, and have fun!

CHAPTER 3
PROGRAMMING THE GRAPHICS TABLET

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THE PROGRAMS

There are four main programs which comprise the Graphics Tablet software. Three of these programs are supplied on your GRAPHICS TABLET SOFTWARE diskette, and the fourth is stored in ROM (Read-Only Memory) on the Tablet Interface card. These programs are:

1) TABLET-CODE APPLESOF: This is a large applications program, written in the Applesoft II BASIC programming language. This is the program which performs all the commands and functions of the Tablet as described in Chapter 2.

2) QUICK-DRAW: This is a machine-language subroutine which is used by the TABLET-CODE APPLESOF program. This subroutine allows an Applesoft program to draw lines on the Apple's high-resolution graphics screen as fast as the Tablet can supply the points. This machine-language subroutine is hidden inside an Applesoft program.

3) Tablet Firmware: This is a set of subroutines permanently stored in ROM on the Tablet's Interface card. These are base-level subroutines for the basic operation of the Tablet. They can be used from any Apple programming language.

4) UTILITIES: This is a package of machine-language subroutines which perform many of the screen manipulation functions of the TABLET-CODE program. This package includes the subroutines which perform the SEPARATE and SLIDE operations. It also includes the shape table used by the Applesoft DRAW command to draw the corner marks for the VIEWPORT. These subroutines are stored in a binary file on the diskette and loaded at location $6000 (decimal 14576) in memory. The length of this file is $330 (816 decimal) bytes.

In addition, there are two other Applesoft programs which are used as part of the Graphics Tablet software package, but don't take part in the actual operation of the tablet. They are:

1) HELLO: This is the program which is executed when you boot the diskette. It is also executed whenever you exit the TABLET-CODE or MENU ALIGNMENT programs. It allows you to select which program you wish to run, and lets you quit if you want to.

2) MENU ALIGNMENT: This is another Applesoft program that sets up an information file on the diskette, called TAB.INFORMATION. This file contains information about what slot the Interface card is in and where the overlay is located on the Tablet.

TABLET-CODE APPLESOF

This is the main operating program for the Graphics Tablet. It is written in Applesoft, and takes up 12K bytes of the Apple's memory. It resides between locations $1000 and $3FFF (decimal 4096 and 16383) of memory. It requires that your Apple have the Applesoft language in ROM or on a Language System Language card. It will not run with cassette or diskette versions of Applesoft.

A source listing of this program appears in Appendix D, along with an outline of subroutines, variables, and special locations. Here is a brief map to the program:

<table>
<thead>
<tr>
<th>Lines</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-160</td>
<td>Initialization. This section reads the Tablet information file, sets up all pertinent Tablet parameters, and initializes and clears Page 2 of the Apple's high-resolution graphics screen. It also places the program and its variables in the proper locations in the Apple's memory, and loads the UTILITIES subroutines.</td>
</tr>
<tr>
<td>170-180</td>
<td>This is the main DRAW mode loop. These two lines take input from the Tablet pen and send it to the QUICK-DRAW subroutine to draw on the screen. The only way out of this loop is to press a key or press the pen outside the Tablet's working area (i.e., on the menu).</td>
</tr>
<tr>
<td>190-194</td>
<td>These lines are executed when you press a key during DRAW mode. If you press any key other than [], nothing happens. If you press [O], you will be asked whether you wish to quit or not. Pressing any key other than [O] will return you to DRAW mode. Otherwise, the HELLO program will be run.</td>
</tr>
<tr>
<td>200-290</td>
<td>These lines sense when you press the pen to the menu. Line 280 is the main menu vector table.</td>
</tr>
<tr>
<td>300-310</td>
<td>The CLEAR command.</td>
</tr>
<tr>
<td>330-410</td>
<td>The LOAD command.</td>
</tr>
<tr>
<td>420-520</td>
<td>The SAVE command.</td>
</tr>
<tr>
<td>530-540</td>
<td>A subroutine to input the disk drive number during LOAD, SAVE, and CATALOG.</td>
</tr>
<tr>
<td>550-560</td>
<td>The SOFT RESET command.</td>
</tr>
<tr>
<td>570-610</td>
<td>The CATALOG command.</td>
</tr>
</tbody>
</table>
620-640 The BackGround COLOR command.

650 The PEN COLOR command.

660 This line lets you reenter LINES, DOTS, BOX, or FRAME mode after a menu selection.

670-670 This subroutine draws the color menu for BackGround COLOR, PEN COLOR, and SEPARATE, and lets you select a color with the pen.

880 Color box low-resolution draw.

890-1120 The WINDOW command.

1130-1140 This subroutine resets the Tablet WINDOW information after a color menu selection.

1150-1290 The VIEWPORT command.

1300 This subroutine causes a 1.15 second delay. It is used to pause while the Apple is displaying a message on the screen.

1310-1320 This subroutine waits until either a key is pressed on the keyboard or the pen is pressed down, and then returns.

1330-1340 This subroutine draws or undraws the four corner marks for a VIEWPORT.

1350-1360 This subroutine draws a single VIEWPORT corner mark.

1380-1390 The REDUCER command.

1400-1440 Turns on the REDUCER.

1460-1560 The DELTA command.

1580-1660 LINES mode.

1680-1720 DOTS mode.

1740-1820 FRAME mode.

1840-1930 BOX mode.

1940-1950 This subroutine is called whenever you specify a point outside of the VIEWPORT for any of the four modes mentioned above.

1970-1980 The AREA command. This section is the drawing loop.

1990-2030 The calculation section for AREA.

2070-2080 The DISTANCE command. This section is the drawing loop.

2090-2120 The calculation section for DISTANCE.

2160-2290 The CALIBRATE command.

2300 A subroutine to blank out the four lines at the bottom of Page 2 of Text mode.

2310 A subroutine to display "BEGINNING POINT?" at the bottom of Page 2 of Text mode and wait for the pen to be pressed down.

2320 A subroutine to display "ENDING POINT?" at the bottom of Page 2 of Text mode and wait for the pen to be pressed down.

2330-2480 The SLIDE command.

2490-2580 The SEPARATE command.

2590-2600 This subroutine resets the Tablet firmware.

2610-2730 Error handling subroutines.

THE MAIN LOOP

The main programming loop of the TABLET-CODE program occurs in lines 170 through 290. Lines 170 and 180 are the main loop for the DRAW mode. The DRAWing is done by the CALL EPX in line 170. This activates the QUICK-DRAW subroutine, which reads the Tablet and draws on the screen. As it draws on the screen, it also places the coordinates for each point plotted into the two arrays called X and Y. It uses the variable N as an index into these arrays, and uses the value of the variable DX as its DELTA value (see the section on the QUICK-DRAW subroutine). The QUICK-DRAW subroutine returns to the Applesoft program when one of four events occur:

1) A key on the keyboard was pressed.

2) The pen was pressed down outside the working area of the Tablet.

3) The pen was lifted after being pressed down.

4) One of the arrays X or Y was filled up.

When QUICK-DRAW terminates, the termination condition code (a number from 0 to 3) is stored in location 700, and the Applesoft program
EXTENDING THE MENU

If you can write programs for the Apple, then you can tailor the TABLET-CODE APPELOSOFT program to your own liking. You can add extra functions and remove or modify existing functions. You can define your own menu selections, or you can even start from scratch and write your own programs to use the Graphics Tablet to do just about anything.

The TABLET-CODE APPELOSOFT program uses almost all of the memory space allotted for it. If you wish to add a function to the code, you must delete some of the program to make room for it. If the program grows any larger, it will not work.

EXAMPLE: INSTANT COLOR MENU

If you’re tired of having to wait for the Apple to redraw the color menu when all you want to do is change the PEN COLOR from white to black, here’s a modification you can make to get instant changes in PEN COLOR. To do it, you’ll have to sacrifice one of the Tablet’s other functions. Since this will mean changing your TABLET-CODE program, it’s important that you not work on the original backup diskette.

Type

NEW LOAD TABLET-CODE APPELOSOFT

to load the unmodified program. To make room for your new code, delete a function you don’t use much (some good candidates for oblivion are SLIDE, SEPARATE, AREA, DISTANCE, and CALIBRATE — they are special-purpose functions and their removal won’t affect the rest of the program). Let’s delete the SLIDE function. Type

DEL 2330,2480

Now you’ve got about 250 more bytes to use for your program. To replace the SLIDE command with a null command, enter the line

2330 GOSUB 1130: GOTO 170

to reset the Tablet and return to DRAW mode if you try to select the non-defunct SLIDE function.
What we'll do is let you choose a new PEN COLOR simply by poking one of the first eight squares in the second row of the menu. Label these squares on your menu with a pencil or pen:

Now for the programming part. In lines 250 through 280, the variables X and Y hold the coordinates of the menu box which was just selected. Y is set to 0 for the top row and 1 for the bottom, and X holds a number between 0 and 21 corresponding to the 22 boxes in each row. So, if you poke the pen to one of the eight boxes of the new color menu, Y will be set to 1 and X will be a number from 0 to 7, depending upon which of the 8 squares you poked. It just so happens that the eight colors in AppleSoft's high-resolution graphics mode are numbered 0 through 7, and they are in the exact same order as the color names you wrote on the second row of the menu! Isn't that lucky? But, first we've got to handle Y. In line 250, if Y is equal to 1, the program goes to line 290, the null function. Let's replace that line with

290 IF X<0 OR X>7 THEN GOSUB 1130: GOTO 170

Now the null function is executed only if the pen was pressed in the second row and not in the first eight boxes. If the pen was pressed in one of the first eight boxes, the next line will be executed. So let's make the next line:

295 PC=X: BCOLOR=PC: GOSUB 1130: GOTO 660

This line sets the Pen Color to the value of X (remember, 0 through 7?) and sets the high-resolution COLOR to that value. Then it resets the Tablet and goes to line 660, which restores the normal color.

And that's it! Now before you RUN it save this version onto a copy of the GRAPHICS TABLET SOFTWARE diskette. You might want to add a REM statement at the beginning, describing the change and date. When you SAVE the program, you must save it under the name TABLET-CODE APPLESOF or you won't be able to use it. Since the version of TABLET-CODE APPLESOF that is on your diskette is LOCKed, you will have to UNLOCK it before you can save the new version.

To use your newly modified program, type

RUN HELLO

press Ctrl, select 0, and press RETURN. When the program is running, you can instantly change colors in midstream, from any mode, by pressing the pen to the box for that color.

EXAMPLE: CIRCLE MODE

Here's another change which is a little more extensive than the previous one. Here are two extra modes, counterparts to BOX and FRAME, which draw open and filled circles rather than rectangles.

You'll specify the location and size of a circle by poking two points on the Tablet: the first one will be the center of the circle and the second will be on the perimeter. Since this will require some extra room, (if you haven't done it already) delete a function such as SLIDE. In fact, you can delete both SLIDE and SEPARATE and use their menu squares to set CIRCLE and DISC mode. On a copy (not either of your original copies) of the GRAPHICS TABLET SOFTWARE diskette, type

LOAD TABLET-CODE APPLESOF
DEL 2330,2390

Now they're gone. Since CIRCLE and DISC need two points, just like BOX and FRAME, we can follow the example of those modes. Type

2330 REM ** CIRCLE MODE **
2340 GOSUB 1130: PRINT DS:"INF":SL: CM=5
2350 RT=2: INPUT X,Y,Z: IF Z<>2 THEN POKE -16368,01: GOTO 2350
2360 IF X<X3 OR X>X4 OR Y<Y3 OR Y>Y4 THEN GOSUB 1940: IF RT=1 THEN 220
2370 IF RT=0 THEN 2350
2380 HPLOT X,Y: TX=X: TY=Y
2390 RT=2: INPUT X,Y,Z: IF Z<>2 THEN POKE -16368,01: GOTO 2390
2400 IF X<X3 OR X>X4 OR Y<Y3 OR Y>Y4 THEN GOSUB 1940: IF RT=1 THEN 220
2410 IF X=0 THEN 2390

At this point, the coordinates of the center of the circle are in TX and TY, and the coordinates of a point on the perimeter are in X and Y. Let's find the radius of the circle now:

2420 R=SQRT((X-TX)^2+(Y-TY)^2)
With a little trigonometry, we know that the horizontal and vertical distance from the center of a circle to any point on the perimeter is given by the simple formulae

\[ \text{DX} = R \cdot \sin(\text{TH}) \quad \text{DY} = R \cdot \cos(\text{TH}) \quad X = TX \quad Y = TY \]

where \( R \) is the radius (derived in line 2420) and \( \text{TH} \) is an angle from 0 to 2\( \pi \). Furthermore, we know that this formula gives us not one, but eight points on the circle:

\[
\begin{align*}
X+DX, Y+DY & \quad X+DX, Y-DY & \quad X-DX, Y+DY & \quad X-DX, Y-DY \\
X+DY, Y+DX & \quad X+DY, Y-DX & \quad X-DY, Y+DX & \quad X-DY, Y-DX
\end{align*}
\]

as \( \text{TH} \) ranges from 0 to \( \pi/4 \) where \( X,Y \) is the center of the circle. So, let's add a loop and the lines to plot the points on the perimeter.

2430 FOR \( \text{TH}=0 \) TO .7854 STEP 1/R
2450 HPLLOT X+DX,Y+DY: HPLLOT X+DX,Y-DY: HPLLOT X-DX,Y+DY:
HPLLOT X-DX,Y-DY
2460 HPLLOT X+DY,Y+DX: HPLLOT X+DY,Y-DX: HPLLOT X-DY,Y+DX:
HPLLOT X-DY,Y-DX
2470 NEXT \( \text{TH} \): GOTO 2350

Now to finish it all up, change the lines

560 ON CR=1 GOTO 170,1380,1680,1740,1840,2330
1380 KE=6: IF KE=1 THEN KE=0: GOSUB 1130: GOTO 560
1390 GOSUB 1400: GOTO 660

These changes let you go back to CIRCLE mode automatically after making a menu selection.

Now unlock the old version of TABLET-CODE APPLESOFT which is on your diskette, (the one on which you're putting your own versions) and then save this new version on your diskette. RUN HELLO and start using the GRAPHICS TABLET SOFTWARE. When you want to draw an open circle, press the pen to the square marked SLIDE. Indicate one point for the center of the circle, and another for a point on the perimeter. The circle will be drawn to specification, and you'll remain in CIRCLE mode until you choose another.

Be forewarned that if you make a CIRCLE which is too large for the screen, then you'll get an error. Just press ESC to get back to DRAW mode. If you don't like this "feature", the following lines will fix the problem:

2425 ON ERR GOTO 2480
2470 NEXT TH: ON ERR GOTO 2650
2475 GOTO 2340
2480 PRINT $S:"PR@": GOSUB 2300: PRINT $S:"P":
VTAB 23: VTAB 12: POKE 41, PEEK(41)+1: PRINT "CIRCLE OFF SCREEN."
2485 GOSUB 1300: PRINT $S:"PR":GOSUB $S:"N,R": GOTO 2650
2490 GOTO 2340

Note that you can still make circles which go out of the VIEWPORT. There's no easy way to prevent this.

EXAMPLE: DISC MODE

The DISC mode is just the same as CIRCLE mode, except that instead of plotting individual points on the perimeter, you'll have to draw lines across the diameter to fill in the circle. Because they have so much code in common, you can make DISC use much of the code from CIRCLE. Here are the changes to CIRCLE to make it do DISCs, too:

2340 CM=5: GOTO 2348
2342 REM ** DISC MODE **
2344 CM=6
2348 GOSUB 1130: PRINT $S:"IN":GOSUB $S:"IN":
2445 IF CR=6 THEN 2464
2462 GOTO 2470
2464 HPLLOT X+DX,Y+DY TO X+DX,Y-DY: HPLLOT X+DX,Y+DY TO X-DX,Y+DY
2466 HPLLOT X+DY,Y+DX TO X-DX,Y+DX: HPLLOT X+DY,Y-DX TO X-DY,Y+DX

To change the menu vector table so that the SLIDE square will activate CIRCLE and the SEPARATE square will activate DISC, change line 280 to read:

280 ON CR=1 GOTO 140,300,490,620,1460,2550,1150,2160,1380,650,290,1580,1680,1740,1840,570,330,420,2342,2330,1970,2070

and make this other change:

660 ON CM+1 GOTO 170,1580,1680,1740,1840,2330,2342

This next line lets you reenter both CIRCLE and DISC modes after you make a menu selection (such as PEN COLOR). Finally, if you added the error handling subroutine described above, then change it so:

2390 ON CM=4 GOTO 2330,2342

Now again SAVE your modified program under the name TABLET-CODE APPLESOFT on the diskette you're using for your experimentation.
THE FIRMWARE

On the Graphics Tablet Interface card is a 2K byte ROM (Read-Only Memory). This ROM contains all the subroutines which read and interpret the signals from the Graphics Tablet. These subroutines can be used easily from any BASIC program.

The Graphics Tablet Firmware performs many functions. Its main purpose is to read the position of the Tablet's pen on the surface of the Tablet, and return that position in a numerical form to a BASIC program. But, it also does much more:

- It lets you supply horizontal and vertical offset information. It will use this offset information in calculating the pen position. This lets you place the origin (where the X and Y coordinates are both 0) anywhere on the Tablet surface. The offsets can be integers from -32767 to +32767.

- It allows you to give a scaling divisor, from 1 to 32767. You can tell the Tablet firmware to divide all coordinates by this number before it passes them to your BASIC program. This lets you calibrate the Tablet units (200 to the inch) to your own scale.

- It allows you to select among ten different modes on the Apple's screen. Text, low-, and high-resolution graphics (on either Page 1 or Page 2) can be selected, and you can mix text with graphics.

- It automatically displays a flashing cursor on the Apple's screen, given the proper scaling and offset information. Cursors are available or may be suppressed in all screen modes.

- You can tell the Tablet to suppress all output from your Apple.

- You can read not only the position of the pen, but also whether it is within readable distance, whether the pen is up or pressed down, detect pen-down and pen-up movements, and read the keyboard to see if a key has been pressed.

Your programs can communicate to the Firmware subroutines by using the BASIC commands PR$ @ and IN$ @, where @ is the number of the peripheral connector slot in the Apple which holds the Tablet Interface card. (The PR$ command indicates that all subsequent output is to be directed to the Firmware subroutines in a certain slot, and the IN$ command indicates that all subsequent input is to be taken from the Firmware subroutines in the given slot.) When your program wants to stop talking to the Firmware subroutines, it can issue a PR$0 or IN$0 command to direct output or accept input from the normal screen and keyboard.

To avoid alienating DOS (the Disk Operating System), you'll have to issue the PR$ and IN$ commands in the form of DOS commands. See the section on Selecting I/O Devices in your DOS manual.

TABLET CONTROL

To send control information to the Tablet, just execute a PR$ @ command from BASIC and PRINT a string of Tablet Control commands. The Control commands will not be displayed on the Apple's screen; they will be used by the Tablet alone.

There are seventeen Tablet Control commands. These commands take the form of a letter or a word, sometimes followed by a number. Commands are executed in a sequential order as given to the tablet by the user.

Commas are used as delimiters between commands and must not begin or end the command string. Spaces are ignored. A null string issued to the tablet is invalid. Only the first alphabetic character of a command is meaningful; the other alphabetic characters are ignored and may be omitted.

Following is a list of Tablet Control commands. The letter "n" that follows some of these commands represents an integer. The Tablet Control commands are:

- **TEXT n**
  - Sets the Apple's screen to show text mode. `n` determines which page of Text to display and can be either 1 or 2.

- **HGR n**
  - Sets the Apple's screen to show full-screen high-resolution graphics mode. `n` determines which page of graphics to display and can be either 1 or 2.

- **LGR n**
  - Sets the Apple's screen to show full-screen low-resolution graphics mode. `n` determines which page of Graphics to display and can be either 1 or 2.

- **MIXHGR n**
  - Sets the Apple's screen to show high-resolution graphics mode, mixed with four lines of text at the bottom. `n` determines which page of text and graphics to display and can be either 1 or 2.

- **GR n**
  - Sets the Apple's screen to show low-resolution graphics mode, mixed with four lines of text at the bottom. `n` determines which page of text and graphics to display and can be either 1 or 2.
SCALE n
Sets the Tablet scaling divisor to n. All coordinates generated by the Graphics Tablet will be divided by n before they are given to your program. The range for n is 1 to 32767. If you give the Tablet a negative scaling divisor, it will ignore the minus sign and use the positive number. A scale factor of 0 is undefined and will not work.

XOFF n
Sets the Tablet horizontal (X) offset to n. If the R command is enabled, all horizontal coordinates will have n added to them before they are given to your BASIC program. The offset value, n, may range from -32767 to +32767.

YOFF n
Sets the Tablet vertical (Y) offset to n. If the R command is enabled, all vertical coordinates will have n added to them before they are given to your BASIC program (see R command below). The offset value, n, may range from -32767 to +32767.

P
Ignore scaling divisor. None of the coordinates generated by the Tablet will be scaled or offset. The cursor, however, will not ignore scale and offset information.

R
Use scaling divisor. All coordinates generated by the Tablet will be divided by the scaling divisor before they are given to your BASIC program. Then offset values will be added.

AFTER
If the R command is used, the offsets will be added after the scaling operation. This command is turned off (the BEFORE command is reinstated) with any subsequent command which sets a screen mode, including the DEFAULT command.

BEFORE
If the R command is used, the offsets will be added before the scaling operation.

NOPRINT
Disables all on-screen printing. After a NOPRINT command is sent to the Tablet, no new output generated by the Apple will be displayed on the screen. NOPRINT mode is turned off by any other Tablet Control command string or by a BASIC PR# command.

CURSOR OFF
Turns off the sparkling cursor. The cursor will remain off until any other Tablet Control command is sent which sets a screen mode (the DEFAULT command also turns the cursor on).

P
Sets Stream mode. If the pen is within the proximity of the Tablet, the Tablet Firmware will send coordinates each time it is polled, regardless of the pen position or status. This command is turned off (the Q command

is reinstated) with any subsequent command which sets a screen mode, including the DEFAULT command.

Q
Removes Stream mode. The Tablet firmware will send coordinates only when it is polled, and the pen is pressed down.

DEFAULT
Sets the standard (default) Tablet mode:

- HGR 2 screen mode
- SCALE=16
- XOFF=1536
- YOFF=1536
- F (no scaling or offsets)
- BEFORE
- Q (stream mode off)
- CURSOR on
- Printing on

For example, if the Tablet Interface card is in slot number 5 and you want the Tablet to set low-resolution graphics mode, with four lines of text at the bottom, use a scaling divisor of 16, and use the offsets stored in the variables XO and YO, and apply them then before the scaling, you would use this Tablet Control command:

FR#5: PRINT "GR 1, SCALE=16, XOFF=";XO;", YOFF=";YO;", BEFORE":PR#0

Of course, you could shorten it by eliminating extraneous spaces and using only the first letter of each control command name:

FR#5: PRINT "G1,S16,X";XO;",Y";YO;",B":PR#0

Since you are using Apple DOS, you must use DOS's FR# command in order to use both DOS and the Tablet. If you've got the slot number of the interface card in the variable SL, then the same Tablet Control command would read:

PRINT D$;"PR#";SL;PRINT "G1,S16,X";XO;"Y";YO;"B";PRINT D$;"PR#0"

It's important not to add a semicolon (;) or comma (,) at the end of the Tablet Control PRINT string. The Tablet will execute the command only when it receives a RETURN character. A semicolon or a comma after the string will suppress the RETURN; therefore, the Tablet will never carry out your commands because it won't hear the end of them.

Any illegal construct in a Control command, including numbers out of range, will cause the screen to return to text mode and the message

*** TABLET SYNTAX ERROR

to appear on the screen.
ACCEPTING INPUT

Once you’ve told the Tablet what kinds of numbers you expect to be getting from it, you can use the BASIC statements IN# and INPUT to get the pen coordinates and status information from the Tablet.

The Tablet sends its coordinate and status information in this format:

\[ +0000,+0000,+00 \]

\[ \text{X-position Y-position sign status} \]

The X- and Y-position coordinates must be integers from -9999 to +9999. The user is responsible for adjusting the X and Y offsets and the scale value so that values returned by the tablet fall within this range. It is possible to exceed this range, in which case an Applesoft error will be generated. These coordinates indicate the position of the pen on the Tablet. If the R command is in effect, these coordinates indicate the position of the pen plus the offset and divided by the scaler.

The sign and status digits indicate the status of the pen and keyboard. If the sign is negative, then a key has been pressed. The two digits have separate meanings:

\[ \begin{align*}
00 & : \text{Tens digit:} \\
0 & : \text{pen is on scale} \\
1 & : \text{pen is off-scale}
\end{align*} \]

\[ \begin{align*}
00 & : \text{Ooned digit:} \\
0 & : \text{pen is down, and has been down} \\
1 & : \text{pen was just lifted} \\
2 & : \text{pen was just pressed down}
\end{align*} \]

So let’s write a program to read the Tablet and print out the coordinates, without scaling or offsets, on the Text screen. Let’s assume that the slot number of the Interface card is stored in the variable SL.

```
100 PA$SL: PRINT "T1, F, C, P": PR#0: REM INITIALIZE TABLET
110 INF#: INPUT X,Y,Z; INF#: REM READ TABLET
120 PRINT "TEN", Y-POSITION IS ";X;", THE Y-POSITION IS ";Y;:".
130 IF Z<0 THEN PRINT "THE KEYBOARD HAS BEEN PRESSED."
140 IF ABS(Z)>10 THEN PRINT "THE PEN IS OFF-SCALE."
150 Z=ABS(Z); IF Z=10 THEN Z=10: REM GET ONES DIGIT
160 IF Z=0 THEN PRINT "PEN IS DOWN."
170 IF Z=1 THEN PRINT "PEN WAS JUST LIFTED."
180 IF Z=2 THEN PRINT "PEN WAS JUST PRESSED DOWN."
190 PRINT
200 PUKE -16368; O: GUDO 110: REM CLEAR KEYBOARD STROBE, REPEAT
```

This program will work in either Applesoft BASIC or Apple Integer BASIC.

Line 100 sets the Tablet Control parameters. Line 110 gets input from the tablet, and the remaining lines interpret the values and print an explication. Line 200 clears the keyboard strobe (if a key was pressed) and loops back to get another set of values.

This program works in Stream mode, that is, it continually gets input from the Tablet regardless of the position of the pen. If you change the Tablet Control command string to read

```
100 FR#SL: PRINT "T1, F, C, Q": FR#0
```

then the coordinates will be returned only when the pen is pressed down.

Let’s write a subroutine in BASIC which is to return the X and Y coordinates of the next pen press, or return with the variable KY set to 1 if the user presses the F1 key on the keyboard. Let’s assume that the Tablet has been initialized in the main program (see previous example, line 100).

```
200 REM ** SUBROUTINE TO GET A PEN PRESS OR KEYPRESS **
210 KY=0: REM FLAG FOR KEYPRESS
220 INF#: INPUT X,Y,Z: INF#
230 IF Z=2 THEN RETURN: REM PEN DOWN
240 IF Z=0 THEN 260: REM NO KEYPRESS
250 K=PEEK(-16364): REM GET KEYPRESS
260 IF K>13 THEN 280: REM IS IT A RETURN?
270 KY=1: RETURN: REM YES, IT IS.
280 FORK -16368, 0: GUTO 220: REM NO, KEEP LOOKING.
```

FROM MACHINE LANGUAGE

You can perform the same Tablet operations from a machine language program that you can from a BASIC program. Even though machine language programs are a little more difficult to write, they will run faster and use less memory than their BASIC counterparts.

Your machine language program will invoke the various functions of the Graphics Tablet firmware by performing JSR (Jump to Subroutine) operations to subroutines inside the Tablet’s ROM, rather than using the FR# and INF# statements in BASIC. Your program will pass information to the Tablet by storing it in fixed locations in memory, and will receive information from the Tablet by storing it in other fixed locations, instead of using PRINT and INPUT statements as a BASIC program would.

Since the Tablet firmware operates in the same manner regardless of whether it is being driven by a BASIC or a machine language program, this section will explain only the specifics of machine language operation of the Tablet. For a description of the modes and parameters which the Tablet firmware recognizes, please see the previous section.
The Tablet firmware is absolutely located in the Apple's memory at locations $C800$ through $CFFF$. This is a 2K memory space which is shared by all peripherals, and can be used by any one peripheral card at any time. In order to let the Graphics Tablet card take possession of this common ROM space, you must reference two special memory locations. First, you must reference location $C800$. This will turn off all interface cards which may be using the common ROM space. Then you must make at least one reference to any address in the range $C800$ through $CnFF$, where $n$ is the number (from 0 to 7) of the peripheral connector slot which holds the Graphics Tablet interface card. Once this is done, the Tablet's ROM will be placed into its proper memory range and you can reference its subroutines normally.

After you activate the ROM, you should store the slot number of the Graphics Tablet (in the format $Cn$) in location $0F78$. This lets other Apple programs know that the Tablet is active and in use.

Subroutine POINT (location $C902$) lets you read a single point from the Tablet. The coordinates of the point, along with the pen status information, will be stored as a 15-character long ASCII string beginning at location $0200$ and ending with a RETURN code at location $020E$. The format of this string is described in the previous section called ACCEPTING INPUT.

The subroutine DEFAULT (location $C990$) sets all the Graphics Tablet parameters and modes to their default values. It operates the same as the Tablet control command DEFAULT.

The subroutine NREAD (location $C8B9$) allows you to read the pen position and status quickly, and get the result in binary (rather than ASCII, as POINT does). It returns the X and Y coordinates in the following locations:

- XFFL $0281$ Lower byte of X-coordinate
- XFFF $0282$ Upper byte of X-coordinate
- YFFL $0283$ Lower byte of Y-coordinate
- YFFF $0284$ Upper byte of Y-coordinate
- TEM $0280$ Pen status

The X and Y coordinates are numbers from $-32767$ to $+32767$. Notice that this is a greater range than the coordinates passed by POINT. The numbers are in two's complement form, and the high bit of the upper byte of each coordinate determines the sign of that coordinate. The pen status byte is interpreted much the same as it is for POINT: the lower 4 bits represent the pen status and the upper bit represents the keyboard status.

The SCALE subroutine (location $C870$) is normally called immediately after NREAD. It performs a scaling and offset operation on the X and Y coordinates generated by NREAD and places the results in these four locations:

- TXXL $0285$ Lower byte of scaled X-coordinate
- TXXH $0286$ Upper byte of scaled X-coordinate
- TYYL $0287$ Lower byte of scaled Y-coordinate
- TYYH $0288$ Upper byte of scaled Y-coordinate

These values are also in two's complement form and range from $-32767$ to $+32767$.

The CURSOROUT subroutine (location $C8F0$) is normally called immediately after an NREAD. CURSOROUT calls SCALE and uses the scaled results to place a cursor on the Apple's screen. The cursor is placed by an exclusive-OR operation, so another call to CURSOROUT using the same coordinates will remove the cursor and leave the screen unchanged.

The CURSOROUT subroutine places the cursor on the screen which the Tablet was told to display. It is not necessarily the screen which the Apple is currently displaying. If you manually change the screen setting after calling DEFAULT or setting the Tablet PAGE parameter (see below), then the Apple may be displaying a video mode which is different from the one in which the Tablet is displaying a cursor.

You can pass parameters to the Tablet firmware by storing the proper values in special memory locations. Here are the locations used by the Tablet firmware:

- The MSLOT parameter (location $97F8$) contains the number of the slot (in the format $Cn$) into which the Graphics Tablet Interface card is plugged.
- The PAGE parameter (location $93B8$) holds the code for the current video mode:
  - $20$ high-resolution page 1
  - $40$ high-resolution page 2
  - $01$ low-resolution page 1
  - $02$ low-resolution page 2
  - $21$ Mixed high-resolution page 1
  - $42$ Mixed high-resolution page 2
  - $05$ Mixed low-resolution page 1
  - $06$ Mixed low-resolution page 2
  - $04$ Text page 1
  - $08$ Text page 2
  - $00$ No cursor

If you set the high bit of the PAGE byte, then the scale and offset factors will be applied.
The HPAGE parameter (location $0438+HSLCT) holds some of the same information as the PACE parameter. The lower six bits of HPAGE are derived from the lower six bits of PACE exclusion-0ed with the constant $222. The upper two bits represent the A, S, P, and Q parameters:

Bit 7 ON: Stream mode on    Bit 7 OFF: Stream mode off
Bit 6 ON: Offset after scale Bit 6 OFF: Offset before scale

The scale and offset parameters are stored in the following locations:

SCALE $0488+HSLCT Lower byte of scaling divisor
SCAL $0538+HSLCT Upper byte of scaling divisor

OFFX $0588+HSLCT Lower byte of X-offset
OFFXH $0438+HSLCT Upper byte of X-offset

OFFY $0688+HSLCT Lower byte of Y-offset
OFFYH $0738+HSLCT Upper byte of Y-offset

The scaling divisor is a binary integer from 0 to 32767. The offsets are two's complement binary numbers from -32767 to +32767.

QUICK DRAW

The QUICK-DRAW program is a machine language subroutine which acts as an intermediary between the Tablet Firmware and an Applesoft program. Since an Applesoft program using HPLT cannot draw on the High-Resolution Screen fast enough to keep up with the movements of the pen across the Tablet, the QUICK-DRAW subroutine talks directly to the Tablet and plots the points on the high-resolution screen. QUICK-DRAW also makes the points plotted available to the Applesoft program.

QUICK-DRAW must run on an Apple with at least 16K bytes of memory, the Applesoft II BASIC programming language in ROM or the Language System, and a Graphics Tablet Interface card. The Graphics Tablet Firmware must be activated by an IN# command before QUICK-DRAW can be called.

The QUICK-DRAW subroutines are hidden inside an Applesoft program. When you RUN QUICK-DRAW, the Applesoft program will store the subroutines in the memory range $0000-$FFFF (decimal 3072-4095). The entry point for the subroutines will be placed in memory locations $2F0 and $2F1 (decimal 752 and 753). Your Applesoft program, which you will RUN right after you RUN QUICK-DRAW, can PEEK at these locations and get the entry point by executing this line:

100 EPX=$PEEK(752)+256*$PEEK(753)

The QUICK-DRAW subroutine deals directly with four Applesoft variables. When you CALL the QUICK-DRAW subroutines, it takes the coordinates of the points it receives from the Tablet and places them in the two Applesoft arrays XX and YY. It uses the Applesoft variable NL as an index into these arrays. The subroutine also uses the contents of the variable DX as a DELTA value. It is the QUICK-DRAW subroutine which controls the DELTA and Audio Feedback features of the Tablet software.

You must dimension the arrays XX and YY prior to calling QUICK-DRAW. Also, you must assign a non-zero value to DX. The DX value is used as described in the DELTA function in Chapter 2; if the value of DX is negative, then the Audio Feedback feature will be turned off.

The QUICK-DRAW subroutine will return control to the Applesoft program under any of four conditions:

1) A key on the keyboard was pressed before the pen was pressed down.
2) The pen was moved to a place on the Tablet which does not correspond to a position in the current VIEWPORT.
3) The pen was lifted after being pressed down inside the VIEWPORT.
4) There is no more room in the arrays XX and YY to store coordinate values.

When one of these conditions arises, the code for that termination condition will be stored in location $2BC (decimal 700) and control will be returned to the Applesoft program.

You can define a VIEWPORT for the QUICK-DRAW subroutines by storing:

- the coordinate of the left edge in locations 3089 and 3090;
- the coordinate of the right edge plus one in locations 3091 and 3092;
- the coordinate of the top edge in location 3093; and
- the coordinate of the bottom edge plus one in location 3094.

See lines 1100 and 1120 of the TABLET-CODE APPLESOFT program for an example of how to pass VIEWPORT coordinates to the QUICK-DRAW subroutine.

BY ANY OTHER NAME

You can change the names of the variables which QUICK-DRAW will use by executing a special CALL to QUICK-DRAW. Normally, QUICK-DRAW uses these variable names:

DX for the DELTA value        NZ for the index into the arrays
XX for the X-coordinate array  YY for the Y-coordinate array
You can change these four variable names to be whatever you like. However, they must always be of the integer variable type (denoted by the percent sign (%) following the name). To rename the variables, use this format:

220 CALL EP%,DELTAX%,NUMBER%,XVAL%,YVAL%

Since Applesoft only recognizes the first two letters of a variable name, this will make QUICK-DRAW use the variable DEZ for its DELTA, NUX for N%, XVX for XX%, and XVZ for Y%. If you want to change only one of the names, just leave the others out, but keep the proper number of commas:

230 CALL EP%,INX%,

will make QUICK-DRAW use the variable INX instead of N%. You must keep the variable names in the order EZ,NUX,XX%,Y%.
CARE OF THE MENU OVERLAY

You can write on the clear plastic menu overlay with most anything; soft (Number 2) pencils, felt-tip pens, permanent markers, crayons, and the like. However, ball-point pens tend not to write well on the overlay, and colored or hard lead pencils also have problems.

You can wipe the overlay clean of most marks or doodles you have drawn using a soft cloth and a mild soap-and-water solution. Most marks from felt-tip or "permanent" markers can be removed easily. Some markers, however, will leave truly permanent scars on the overlay; it's a good idea to test any marker on an inconspicuous corner of the overlay before you use it to draw all over your Tablet. To be safe, use felt-tip markers designed for use on acetate or mylar (or for use with overhead projectors). These will give you visible, non-smearing colors, but the marks will wipe off without a trace.

If you are getting inexplicable "glitches" on your screen you probably have a static problem. The solution is simple: Wipe the overlay with the static cloth that came with your Graphics Tablet. A treatment with the cloth should remove any excess static from the overlay.

CARE OF THE TABLET

Your Graphics Tablet is constructed of a solid wood base, protected below by a sheet metal baseplate and above by a molded, snap-on plastic cover. If the top cover gets dirty, it can be cleaned with a soft cloth and a mild soap-and-water solution. Don't use any abrasives or strong detergents on the surface or case of the Tablet: they may scratch or damage the plastic. If possible, keep the Tablet covered when you aren't using it.

DON'T leave anything which has a strong magnetic field on or near the Tablet. This will disrupt its natural magnetic orientation and make it malfunction. Keep your diskettes off the Tablet! Its magnetic field may alter or erase the information on them. Don't place disk drives, televisions, electric motors, magnets, or large, heavy metallic objects on top of the Tablet.

Keep the Tablet in a cool, dry place. Don't leave it in direct sunlight or in a car trunk or some other hot, stuffy place. Too much heat will warp its cover.

Be careful with the Tablet when you're moving it from place to place. Don't drop it or jar it. Even though it's pretty solid, it can be seriously damaged by a bad fall.

CARE OF THE INTERFACE

The Interface card is really the most delicate part of the Graphics Tablet. When inserting, removing, or transporting it, be very careful not to bend any of its pins or components. To be safe, always carry it in the box in which it was shipped, nested in protective foam. Keep it away from strong electrical or magnetic fields, and don't even think of touching it if there's a lot of static electricity in the area.

If you've been inserting and removing the Interface card into the Apple a lot, then it's possible that the metal "fingers" have gotten dirty and are not making good contact with the Apple. In this case, the easiest way to clean the fingers is to just use an ordinary pencil eraser and rub all of the gunk off. If you want to be thorough, use cotton swabs and rubbing alcohol to clean the fingers on the card.

IF IT DOESN'T WORK

If you've exposed your Tablet to bad magnetic influences or it's been bumped and jarred a lot, it may develop "dead spots" on its surface, spots where the pen won't draw. These aren't permanent, they're just a loss of magnetic orientation in certain spots of the Tablet. Take the Tablet to your Apple service center. The service center should have the proper equipment to reorient your errant Tablet and make it work again.
APPENDIX B
BACKING UP YOUR DISKETTES

72 With Two Disk Drives
72 With One Disk Drive
WITH TWO DISK DRIVES

If your Apple has two disk drives, you can easily make a copy of either GRAPHICS TABLET SOFTWARE diskette by using the diskette copying program on your Apple SYSTEM MASTER diskette. You will need three diskettes:

1) One of the GRAPHICS TABLET SOFTWARE diskettes, enclosed with your Tablet;
2) The SYSTEM MASTER diskette, enclosed with your Disk II; and
3) a blank, uninitialized diskette. If you like, you can use a preinitialized diskette, but all information on that diskette will be destroyed.

Boot your system using the SYSTEM MASTER diskette (see your DOS manual, or, if you have an Autostart ROM, see your Autostart ROM manual) and type

RUN COPY

After the disk drive stops whirring, place the GRAPHICS TABLET SOFTWARE backup diskette in one drive, and place the blank diskette in the other. The GRAPHICS TABLET SOFTWARE diskette will be the "Original", and the blank diskette will be the "Duplicate". Follow the instructions in the section on using the COPY program in your DOS manual.

Once you've copied the diskette, label the duplicate so you'll know what it is. Then put the original away in a safe place. If you ever lose or destroy the duplicate, then before you start to use the original, make another copy of it. It's also a good idea to periodically make duplicate copies of the diskettes which hold your pictures.

WITH ONE DISK DRIVE

If your Apple has only one disk drive, then you'll have to copy all the programs which comprise the GRAPHICS TABLET SOFTWARE package one by one, loading each program from the original diskette and saving it to the duplicate. It's a lengthy procedure, but well worth your trouble.

Boot your system using the GRAPHICS TABLET SOFTWARE diskette. Press ESC to get to the HELLO menu, select Q to QUIT, and press RETURN. Now remove the diskette and write-protect it by sticking a write-protect tab (a thin but sturdy strip of tape will do) over the square notch on the left side of the diskette. This is important! It will prevent you from accidentally destroying anything on the original diskette. Now insert a blank, uninitialized diskette in the drive. You can use a preinitialized diskette, but all information on it will be destroyed. Type

INIT HELLO

and press RETURN. You're now initializing the diskette with the HELLO program from the GRAPHICS TABLET SOFTWARE diskette. This takes about a minute.

Now switch to the GRAPHICS TABLET SOFTWARE diskette and type LOAD MENU ALIGNMENT

Now switch to the duplicate diskette and type SAVE MENU ALIGNMENT

Now switch to the GRAPHICS TABLET SOFTWARE diskette and type LOAD TABLET-CODE APPLESOFT

Now switch to the duplicate diskette and type SAVE TABLET-CODE APPLESOFT

Now switch to the GRAPHICS TABLET SOFTWARE diskette and type LOAD QUICK-DRAW

Now switch to the duplicate diskette and type SAVE QUICK-DRAW

Now switch to the GRAPHICS TABLET SOFTWARE diskette and type LOAD UTILITIES

Now switch to the duplicate diskette and type BS\SAVE UTILITIES, A$9000, L$330

Now switch to the duplicate diskette and type BS\SAVE GRAPHICS TABLET LOGO, A$2000, L$2000

Now enter this program:

NEW

10 D$=CHR$(4)
20 PRINT D$;"OPEN GRAPHICS TABLET SOFTWARE"
30 PRINT D$;"WRITE GRAPHICS TABLET SOFTWARE"
40 PRINT "RUN QUICK DRAW"
50 PRINT "RUN TABLET-CODE APPLESOFT"
60 PRINT D$;"CLOSE GRAPHICS TABLET SOFTWARE"
70 END
RUN

This short program creates an EXEC file called GRAPHICS TABLET SOFTWARE, whose function is to set up the Apple to RUN the programs which make the Graphics Tablet work. You need to have this file on every duplicate diskette you make; if you’re going to be making many duplicate copies, you might want to SAVE this short program so you don’t have to retype it every time you need it.

To SAVE this program, type

SAVE FILEMAKER

Then, whenever you’re making a duplicate, put in this diskette and type

LOAD FILEMAKER

put in the duplicate diskette, and type

RUN

That’s all there is. Once you’ve copied the diskette, label the duplicate so you’ll know what it is and put it away in a safe place. If you ever lose or destroy the original, then before you start to use the duplicate, make another copy of it.
UNUSUAL COLOR EFFECTS...

You may have already noticed that a few strange things happen when you try to use certain combinations of colors with the Graphics Tablet. Don't worry: these are normal, predictable phenomena which are caused not by the Tablet, but by the Apple itself.

The Graphics Tablet displays its pictures using the Apple's high-resolution graphics mode. In this mode, there are 53,760 individual dots on the screen, and six colors (black, white, orange, blue, green, and violet). The Apple should therefore need several hundred thousand individual "bits" of information to form a picture. But the Apple uses only 65,536 bits of information (organized into 8,192 eight-bit "bytes") to form the picture! The reason the Apple can display such complex pictures using so little memory is the same reason that sometimes the colors don't appear normal: not all colors can be used in all places on the screen, and each dot is limited in the number of colors it can be.

This specialization of function causes some combinations of colors to work differently than you might expect. There are three different effects which are caused by the limitation in the color scheme. They occur in all drawing modes, but only where one color borders another and the borderline is not horizontal. For example, the color problems could occur on the two vertical sides of a frame but not on the top or bottom. Here are the three effects:

1) Dashed Lines. When you draw black or white lines on a colored field (or vice versa), non-horizontal lines will tend to become dashed and incomplete, and vertical lines may not appear at all.

2) Zebra Stripes. When you draw colored lines on a colored field, non-horizontal lines don't appear their normal colors, but instead are sometimes black-and-white striped. Vertical lines will appear either completely black or completely white.

3) Color Flip. When you draw with one color (or black or white) across a colored field, sometimes a seven-dot wide area around a non-horizontal line will change color. This will result in a colored "shadow" appearing around the line.

These effects occur in various combinations, depending upon the colors you use.

...AND HOW TO GET THEM

The table on the next page illustrates seven different combinations of the effects mentioned above, and what color combinations produce which effects. To use the table, find the pen color you're using along the left side of the table. Then look on the top edge of the table and find the color of the area on the screen across which you want to draw. Where the row for the pen color and the column for the field color intersect, there's a number. Find the number in the legend to the table and read about the effect you'll get.

About BLACK1, WHITE1, BLACK2, and WHITE2: Due to the vagaries of the Apple's color generation scheme, there are two instances each of the colors black and white. When you look at the Tablet color menu (see the section on Pen Color in Chapter 2), you'll see that there are two black squares and two white squares along with the four colored squares. The black and white in the top row are BLACK1 and WHITE1; the ones in the bottom row are BLACK2 and WHITE2. The reason for the duplication is that the 1's cause fewer problems when used with green and violet than do the 2's, and similarly the 2's go better with blue and orange than do the 1's. When this book refers to black or white, it means BLACK1 or WHITE1.
<table>
<thead>
<tr>
<th>PEN COLOR</th>
<th>BLACK1</th>
<th>GREEN</th>
<th>VIOLET</th>
<th>WHITE1</th>
<th>BLACK2</th>
<th>ORANGE</th>
<th>BLUE</th>
<th>WHITE2</th>
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<tr>
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<td>4</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>BLUE</td>
<td>4</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>WHITE2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

FIELD COLOR

Color Effects Table

LEGEND:

0: No effect.
1: Colors appear as expected; no anomalies.
2: DASHED LINES on non-horizontal lines; vertical lines may disappear.
3: ZEBRA STRIPING on non-horizontal lines; vertical lines appear solid black or white.
4: DASHED LINES with a COLOR FLIP.
5: Pure COLOR FLIP: non-horizontal lines appear "chunky" and wider than normal.
6: ZEBRA STRIPING with a COLOR FLIP.
VARIABLE ATLAS

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A$</td>
<td>General-purpose input string</td>
</tr>
<tr>
<td>AR</td>
<td>Calculated area for AREA command</td>
</tr>
<tr>
<td>B$</td>
<td>Input string for picture name in LOAD and SAVE</td>
</tr>
<tr>
<td>B1-B6</td>
<td>Temporary variables for WINDOW</td>
</tr>
<tr>
<td>BG</td>
<td>Background Color (defaults to 0)</td>
</tr>
<tr>
<td>BX</td>
<td>Pointer into the QUICK-DRAW subroutines</td>
</tr>
<tr>
<td>D$</td>
<td>String for slot number</td>
</tr>
<tr>
<td>DF</td>
<td>Termination code of QUICK-DRAW subroutines</td>
</tr>
<tr>
<td>CR</td>
<td>Current Command mode: 0 = DRAW</td>
</tr>
<tr>
<td>D1</td>
<td>1 = LINES</td>
</tr>
<tr>
<td>D2</td>
<td>2 = DOTS</td>
</tr>
<tr>
<td>D3</td>
<td>3 = DPRK</td>
</tr>
<tr>
<td>D4</td>
<td>4 = BOK</td>
</tr>
<tr>
<td>D5</td>
<td>DELTA setting (0=127; negative if Audio Feedback is off)</td>
</tr>
<tr>
<td>DF</td>
<td>Default drive number for LOAD, SAVE, CATALOG</td>
</tr>
</tbody>
</table>
### SUBROUTINES

<table>
<thead>
<tr>
<th>Entry</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>530</td>
<td>Inputs drive number from keyboard</td>
</tr>
<tr>
<td>670</td>
<td>Displays color menu; returns chosen color in PC</td>
</tr>
<tr>
<td>880</td>
<td>Draws a single box of the color C9 on the low-resolution graphics screen. The box will be X8 blocks tall, and its upper-left corner will be at (X9, Y9).</td>
</tr>
<tr>
<td>1040</td>
<td>Draws the WINDOW on the high-resolution screen in the current ECOLOR.</td>
</tr>
<tr>
<td>1070</td>
<td>Sets scaling information for Tablet; falls into subroutine at 1090</td>
</tr>
<tr>
<td>1090</td>
<td>Turns off REDUCER, removes WINDOW frame and sets WINDOW to its default values, resets CALIBRATE setting, and falls into subroutine at 1120</td>
</tr>
<tr>
<td>1120</td>
<td>Stores WINDOW setting in memory for QUICK-DRAW</td>
</tr>
<tr>
<td>1130</td>
<td>Resets Tablet scaling information (with REDUCER, if active)</td>
</tr>
<tr>
<td>1280</td>
<td>Prints prompt &quot;LOWER-BRIGHT?&quot;</td>
</tr>
<tr>
<td>1290</td>
<td>Prints prompt &quot;UPPER-LEFT?&quot;</td>
</tr>
<tr>
<td>1300</td>
<td>Delay 1.1 seconds</td>
</tr>
<tr>
<td>1310</td>
<td>Wait for the pen to be down or a keypress. If pen is down, return with coordinates in X,Y; if keypress, return with X&lt;0. Draws or undraws the four VIEWPORT corner marks.</td>
</tr>
<tr>
<td>1330</td>
<td>Draws or undraws a single VIEWPORT corner mark. The corner’s coordinates are in X8,Y8 and the rotation factor is in H. Turns on the REDUCER.</td>
</tr>
<tr>
<td>1350</td>
<td>Returns with KT=1 if the last pen press was in the menu area; otherwise displays &quot;POINT OUTSIDE VIEWPORT. RESPECIFY!&quot;</td>
</tr>
<tr>
<td>1400</td>
<td>Performs an AREA calculation on the polygon whose vertices are in the arrays X1,Y1, X2,Y2. Returns with the area in AK.</td>
</tr>
<tr>
<td>1940</td>
<td>Performs a DISTANCE calculation on the closed curve whose points are in the arrays X1,Y1. Returns with the distance in DT.</td>
</tr>
<tr>
<td>1990</td>
<td>Adds the value of DT to the end of string B$, and prints it centered on the screen.</td>
</tr>
<tr>
<td>2090</td>
<td>Clears out the bottom four lines of the Page 2 Text screen.</td>
</tr>
<tr>
<td>2120</td>
<td>Displays the prompt &quot;BEGINNING POINT?&quot;</td>
</tr>
<tr>
<td>2300</td>
<td>Displays the prompt &quot;ENDING POINT?&quot;</td>
</tr>
<tr>
<td>2310</td>
<td>Reinitializes the Tablet with the scaling factor in SF, the X-offset in XF, and the Y-offset in YF.</td>
</tr>
</tbody>
</table>

**Temporary variables used in delay loops:**

- DT: Calculated distance for DISTANCE command
- DX, DY: Temporary variables used in AREA and DISTANCE: the vertical and horizontal distance between a point and the next one.
- E$: Temporary input string for SAVEZ
- EPZ: The beginning address of the QUICK-DRAW subroutines
- GF: X screen offset values for WINDOW
- H: Widely used as a temporary variable.
- HF: Y screen offset values for WINDOW
- LT: Length of menu, in Tablet units
- M#: Maximum number of points for DISTANCE or AREA calculation
- MD: Height and width of each menu command square, in Tablet units
- NZ: Index into arrays XZ and YZ, used by QUICK-DRAW
- PC: Pen color (0-7), defaults to 3 (white)
- PI: Number of points per inch on the Tablet
- RD: Flag for REDUCER mode: 1=on, 0=off.
- KT: A return flag for LINES, DOTS, FRAME, and BOX modes whose value indicates the phase of the operation:
  - 0 = Operation was just initialized.
  - 1 = Menu selected; operation cancelled.
  - 2 = Operation in progress.
- S$: Scale setting for menu
- S2: Scale setting for WINDOW after LOAD
- SF: Scale Factor — see XF, YF
- SL: Slot number of Tablet Interface card (read from info file)
- T1-T9: Temporary variables
- TX, TY: Temporarily holds an X,Y position (for BOX, LINES, FRAME, SLIDE)
- W: User CALIBRATE units
- W$: Name of user CALIBRATE units
- WM: CALIBRATE multiplier (WM= Tablet units / W)
- X,Y: General-purpose coordinate pair for high-resolution screen
- XZ,YZ: Arrays (of length M2) which hold coordinates of points plotted in DRAW, AREA, and DISTANCE. They are filled by the QUICK-DRAW subroutines.
- X1,Y1: Coordinates for upper-left corner of WINDOW on Tablet
- X2,Y2: Coordinates for lower-right corner of WINDOW on Tablet
- X3,Y3: Coordinates for upper-left corner of VIEWPORT on screen
- X4,Y4: Coordinates for lower-right corner of VIEWPORT on screen
- X5,Y5: Default values for X1,Y1
- X6,Y6: Default values for X2,Y2
- X8,Y8: Temporary X,Y coordinates (for VIEWPORT and color menu)
- X9,Y9: """
- XA, YA: Width and height of menu overlay
- XB,YB: Coordinates for lower-right corner of WINDOW on screen
- XF, YF: Current Tablet offset factors
- XH, YH: Coordinates for upper-left corner of overlay on Tablet
- XL, YL: Coordinates for lower-right corner of overlay on Tablet
- XM, YM: Coordinates for upper-left corner of working area on Tablet
- XT, YT: Coordinates for upper-left corner of WINDOW on screen
- Z: Pen up/down value:
  - 0 = pen is down, and has been down.
  - 1 = pen is up
  - 2 = pen newly down
  - 10 = pen is off-scale

Negative numbers indicate that a key has been pressed.

Temporary variable used in delay loops.
SPECIAL LOCATIONS

These special memory locations are used by the TABLET-CODE
APPLESOFT program. The decimal addresses are given on the left;
hexadecimal equivalents are in parentheses and preceded by a dollar
sign ($):

Location  Use

41 ($29)  This location contains the high part of the memory
          address of the beginning of the current line on the
          Text screen. A PEEK 41, PEEK(41)+4 operation will
          cause the next printed line to appear on Page 2,
          rather than Page 1, of Text mode.

103,104  ($67,588)  This pair of locations holds the address of the
          beginning of the current Applesoft program in
          memory.

222 ($DE)  This location holds the ON ERR GOTO code of the
           last error generated.

232,233  ($88,5X9)  This pair of locations holds the address of the
          beginning of the current shape table for the
          Applesoft DRAW and ZDRAW commands.

700 ($2BC)  Holds the termination code from the QUICK-DRAW
           subroutines.

752,753  ($2F0,$2F1)  After the QUICK-DRAW program is RUN, this pair
           of locations will hold the memory address of the
           beginning of the QUICK-DRAW subroutine.

766,767  ($2FF,$2FF)  These locations are used to pass the selected
          color to the SEPERATE subroutine.

3089-3094  ($C11-$C16)  These locations are used to pass VIEWPORT information
          to the QUICK-DRAW subroutine.

16632,16633  ($40F8,$40F9)  These locations are in the memory range used by the
          high-resolution graphics Page 2, but their contents
          are neither displayed on the screen or affected by
          normal screen operations. These two locations are
          used to store the value of SZ during a SAVE.

16504-16511  ($4078-$407F)  These are also locations in the high-resolution Page 2
          which are not displayed. These eight locations are
          used to store the values of XI, X2, Y1, and Y2 during
          a SAVE.

24576 ($6000)  This is the entry point for the machine language
          subroutine which performs a SEPERATE.

24911 ($614F)  This is another entry point for SEPERATE.

25175 ($6257)  Entry point for a one-dot SLIDE down.

25218 ($6282)  Entry point for a one-dot SLIDE up.

25261 ($62AD)  Entry point for a 14-dot SLIDE right.

25308 ($62DC)  Entry point for a 14-dot SLIDE left.

-16368 ($C010)  A PEEK or POKK to this location will clear the Apple's
                  keyboard strobe, causing any recent keypress to be
                  ignored.

62454 ($F3F6)  This subroutine in the Applesoft ROM fills the entire
               high-resolution screen with the most recent COLOR
               plotted.

-956 ($FC42)  This subroutine in the Apple's Monitor ROM clears the
              text screen from the current cursor position to the
              end of the screen.

-868 ($FC9C)  This subroutine in the Apple's Monitor ROM clears the
              text screen from the current cursor position to the
              end of the line.

ROM CODE

SOURCE FILE: BITPAD35.1P
SOURCE FILE: BITPAD35.2P

0000: 1 *************
0004: 0
0008: 4  + BIT PAD Firmware
000C: 5  + COPYRIGHT APPLE COMPUTER
0010: 6  + 7/30/79
0014: 7  + W SANDER
0018: 8  +
001C: 9  +
0020: 10 +
0024: 11 +*************
0028: 12 CH EQU $24
002C: 13 HBASL EQU $2A
0030: 14 HBASH EQU $2B
0034: 15 BSAL EQU $26
0038: 16 SOUL EQU $36
003C: 17 SOUTH EQU $3F
0040: 18 ING EQU $200
0044: 19 IN1 EQU $201
0048: 20 IN2 EQU $202
004C: 21 IN3 EQU $203
0050: 22 IN4 EQU $200
0054: 23 RETURN FLAG LOCATION
0058: 24 HIGH NIBBLE - RETURN SCALED VALUE
005C: 25 XFLH EQU $281
0060: 26 XFLH EQU $282
0064: 27 YFLH EQU $283
0068: 28 YFLH EQU $284
006C: 29 TFLX EQU $285
0070: 2A TFLX EQU $284
0074: 2B 2C 2D 2E 2F 30 31 32 33 34 35 36 37 38 39 3A 3B 3C 3D 3E 3F H
0078: 00 04 08 0C 10 14 18 1C 20 24 28 2C 30 34 38 3C 40 44 48 4C 50 54 58 60 64 68 6C 70 74 78 80 84 88 90 94 98 A0 A4 A8 AC C0 C4 C8 C C D0 D4 D8 DC E0 E4 E8 EC F0 F4 F8 FC FF
C75A:0B 326 LORES PDP LDA $24F0
C75B:AF F0 327 PLA LDA
C75D:28 328 PLA PLA
C75E:50 D0 329 BNE LORI
C75F:4F FF 330 EDR #OFF
C760:4B 331 LORI PHA
C761:3B 332 TYA
C766:0A 333 STA A
C76A:0A 334 STA A
C76B:20 DE C0 335 JSR LOCLC
C76C:6B 336 PLA
C76D:2A 327 EDR ($8B16) Y STA ($8B16) Y
C76E:4C 50 C0 339 JMP OUT
C771:340
C771:341 * HIRES CURSOR ROUTINE
C771:342
C771:343
C771:344

C771:345
C771:346 HIRES LDA
C773:2D A5 02 346 STA COUNT
C776:BA 347 TXA
C777:3B 348 SEC
C779:EB 50 349 SBC #5
C77A:4B 350 TXA
C77B:00 02 351 BCS LOOP
C77D:0C 9A 02 352 LOOP DEC TEMX
C77E:A0 353 LOOP LDV #5
C782:AD A5 02 354 LOOP LDA COUNT
C785:29 89 C9 355 CTRL LOOP CMP CTROMLY
C788:54 FF 356 BES OUTSIDE
C78A:6B 357 DEV
C78B:7F 358 PLE
C78C:6B 359 PLA
C78E:2B 4C CA 360 JSR WINCHM
C791:4B 361 PHA
C792:60 0A 362 BCS OUTSIDE
C794:20 F0 C0 363 JSR BESCLC
C797:AC 78 00 364 LDV HNDX
C799:81 2A 365 EDR ($8B16) Y STA ($8B16) Y
C79C:91 2A 366 STA OUTSIDE
C79D:49 0C 367 JSR OUTSIDE
C800:2D A5 02 368 CMP COUNT
C803:FO 0E 369 SBC A
C805:9D 1D 370 BCS B
C807:4F 371 INX
C80A:0D 00 372 BNE C
C80A:EE 8B 02 373 INC TEMX
C80C:DE A5 02 374 DEC COUNT
C80C:4C 00 C9 375 JMP LOOP
C80D:2A 376 A TXA
C80E:1E 00 377 SBC #5
C80E:4A 378 TAX
C80F:5A 379 PLA
C817:4B 380 PLA LDV TEMX
C81A:E9 00 381 SBC #6
C81B:0D 04 382 STA TEMX
C81F:6B 383 PLA
C82C:3B 384 PLA
C82C:38 385 PHA
C82C:48 386 PLA
C82C:5B 387 CLC
C82C:65 01 388 ADC #91
C82C:8B 389 PHA
C82C:CE A9 02 390 DEC COUNT
C82C:FF 02 391 BEQ OUT
C82E:0D 80 392 POINTER PLA
C830:4F 393 PLA
C832:93 2B 395 STA HNDX
C834:98 396 PLA
C835:95 2A 397 STA HSB1
C837:60 398 RTS
APPENDIX E
SCHEMATIC DIAGRAM