TEK INSTRUCTION MANUAL

070-6441-00
Product Group 58

HC100 PLOTTER

Please Check for
CHANGE INFORMATION
at the Rear of This Manual.

First Printing FEB 1987

Tektronix
COMMITTED TO EXCELLENCE

FCC COMPLIANCE STATEMENT FOR AMERICAN USERS

This equipment generates and uses radio frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Subpart J of Part 15 of FCC rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient the receiving antenna
- Relocate the computer with respect to the receiver
- Plug the computer into a different outlet so that computer and receiver are on different branch circuits.

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

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

This booklet is available from the U.S. Government Printing Office, Washington DC 20402. Stock No. 004-000-00345-4.

WARNING

The connection of a non-shielded printer interface cable to this printer will invalidate the FCC Certification of this device and may cause interference levels which exceed the limits established by the FCC for this equipment.

Specifications subject to change.

NOTE

The HC100 can be configured in any of four different command sets. The unit is shipped from Tektronix configured to run the HP-GL emulation command set. This configuration also has a different self-test plot than that described in the first (User's) section of this manual. For information on this command set, refer to the HP-GL section of this manual. For information of a more general nature, refer to the User's section of the manual. For information on how to change the command set, see Appendix C-2 in the User's Section.

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Introduction

This section of the manual gives a brief description of the features of both the Tektronix HC100 Plotter and the accompanying documentation.

Features of the HC100

- Advanced plotting functions. With a single command, the HC100 creates and cross-hatches rectangles or sections of a pie chart.
- Three standard command sets. The HC100 comes standard with an Epson HI-80 plotting command set, an Epson RX-80 printer command set, and a Graphtec plotter emulator command set.
- Four pens. You can draw with four different colored pens at one time. You can select among ten different colors and three different types of pens.
- Pen cassette. The removable pen cassette allows you to change all four pens quickly. The pens are capped automatically when they are not in use to prevent them from drying out.
- Compact size and light weight. The HC100 is small enough to be easily transported, and it won't take up too much room on your desk.
- Mixed text and graphics. The HC100 can print text anywhere on the page in a multitude of sizes and styles. This feature gives your graphics a professional look.

- High speed plotting. The HC100 draws at 9 inches per second.
- Multi-media plotting. The HC100 works equally well with paper and transparent materials.

About This Manual

The HC100 is a sophisticated plotter. Although it is simple to operate, writing programs for it can be complicated. In many cases, the people who use the HC100 are not the ones that do the programming. Therefore, this manual has been broken into two main sections; a User's Section and a Programmer's Section. Each section has its own contents, chapter and page numbers, and index. Special information may also be required to operate the HC100 in conjunction with various Tektronix instruments. If this is the case, additional sections to this manual will be made available. For complete information, see your Tektronix catalog or contact your Tektronix Field Office.

The first four chapters of this section will help you set up, operate, and maintain your plotter. Chapters 5 through 8 give you an introduction to programming for the HC100.

The Appendixes provide reference information about the types of lines the HC100 can draw, the character set, how the DIP switches are set, and how the parallel interface works.

Chapter 1
Setting Up Your Plotter

You've obviously started to unpack your new plotter because you have already found this manual. You are off to a good start. In this chapter you'll learn how to set up your HC100 and connect it to your computer.

Carefully remove your new HC100 from the packing. Be sure you have all of the items shown in Figure 1-1:

- HC100 Plotter
- A packet of pens
- The registration card
- This User's Manual

Note: It's a good idea to save all the packing materials in case you want to move or ship your HC100 some day.

Finding a Suitable Location

Before you actually set up your plotter, you should give some thought to where you are going to put it. Of course your plotter must sit somewhere near your computer (the length of the cable is the limiting factor). However, you may not want to place your computer and plotter side by side because the plotter does make noise during operation. Here are some additional considerations:

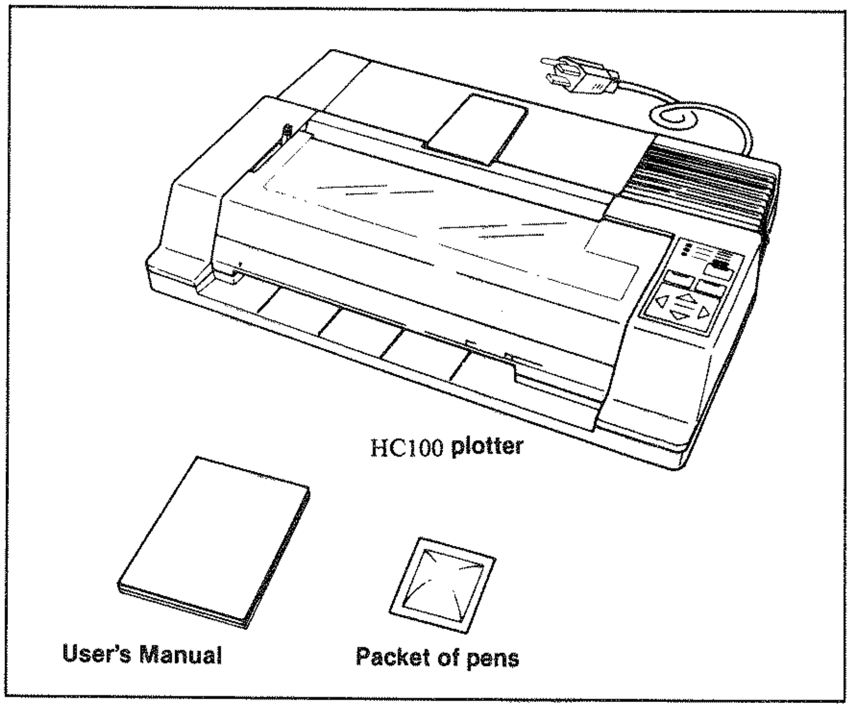


Figure 1-1. Unpacking the HC100

1. Place the plotter on the edge of a desk or table. The plotter needs at least ten inches of free space in front of it to allow the paper to move freely.

2. Place the HC100 on a flat, stable surface. The plotter makes more noise if you place it on a table that moves or vibrates. Also, your graphics may not be as accurate if the table vibrates while the plotter is drawing.

3. Connect the plotter to a grounded electrical outlet (do not use an adapter plug). It's a good idea to choose an outlet which is not controlled by a wall switch that could be accidentally shut off while the plotter is in operation.

4. Protect the plotter from prolonged exposure to direct sunlight, moisture, and dust. Make sure the plotter is not close to a heater or any other heat source.

5. Use the HC100 in areas that are comfortable for you. If you find it too hot, too cold, or too humid, the environment is not right for the HC100; it may not operate properly.

Getting to Know Your HC100

Take a minute to look over your HC100. Figure 1-2 shows the plotter and identifies some of the main parts.

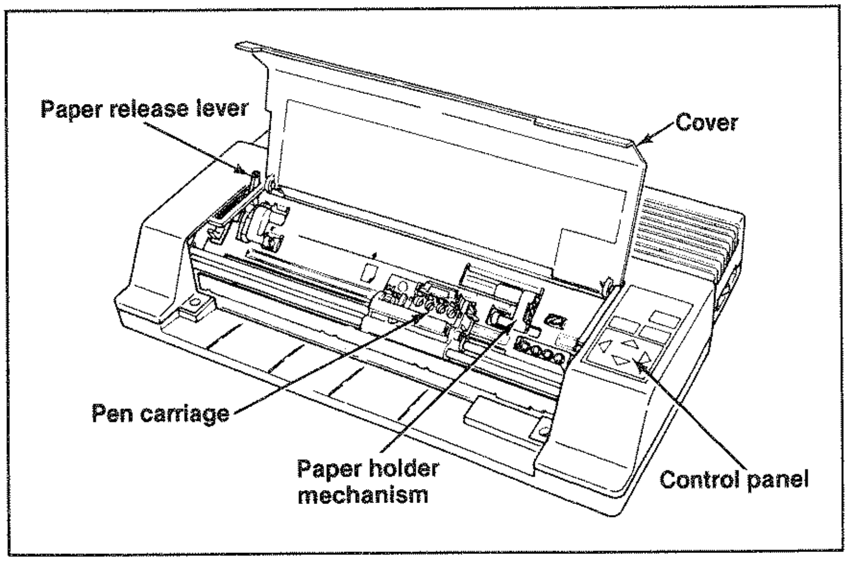


Figure 1-2. The HC100 Plotter

Opening the cover

Across the front of the HC100 Plotter is a smoked-plastic cover that protects the workings of the plotter. Open this cover by raising the front. Once open, the cover remains vertical as shown in the illustration.

You may want to remove the cover sometimes just to get it out of the way. To remove the cover, lift it straight up when it is in the vertical position. The hinges are slotted so that it can be easily removed and reinstalled.

The plotter works without the cover, but the cover cuts noise when the plotter is running, and protects the mechanism from dust. When you first start experimenting with the HC100 you may want to leave the cover off to get a better view of what the plotter is actually doing. Otherwise, it's a good idea to keep the cover on the plotter except when you are changing pens or cleaning the plotter.

What's under the cover

The gray plastic *paper release lever* is on the left. This lever sticks up through the cover when it is closed and controls the mechanism which holds the paper in the plotter. Move the lever back and forth to observe the operation of the *paper holder*. Notice the *paper holder rollers* (two small, black rubber rollers on either side of the paper holder.) When the paper release lever is in the HOLD position, the paper holder rollers are pressed against the *paper feed rollers* (the larger silver rollers you see showing from inside the plotter). The paper is gripped between these two pairs of rollers and when the rollers turn, the paper moves forward and backward in the plotter.

Notice the third paper feed roller. The right hand paper holder roller can be moved so that it is positioned over either of the paper feed rollers on the right. This lets you use different sizes of paper.

You'll find the *pen carriage* on the far right side of the plotter. This device can hold as many as four pens (note the four holes with springs in them) and moves back and forth across the paper when the plotter is operating.

The individual pens are actually held in a *pen cassette* that can be removed from the pen carriage. This lets you quickly change all four pens at once (which you'll learn how to do in Chapter 3).

Finally, a white line runs across the middle of the plotter. This line provides a guide for aligning paper when you insert it into the plotter. Paper loading is discussed in Chapter 3.

The control panel

The control panel is on the right side of the plotter (see Figure 1-3). The control panel consists of a group of indicator lights and touch-sensitive control symbols. The lights show the status of the plotter, and the symbols provide you with a means of controlling the plotter manually. The three lights show the following conditions:

The POWER light glows green when the power is ON.

The ERROR light glows red when the plotter receives an incorrect code from the computer.

The ON LINE light glows green when the plotter is ready to receive information from the computer. When this light is ON, the plotter is *on line*.

The orange square marked ON/OFF controls whether the plotter is on line or not. Each time you press this square, the plotter changes from being on line to being off line, or vice-versa.

In Chapter 2 you'll learn the functions of the other symbols and how to use them to control the movement of your pens.

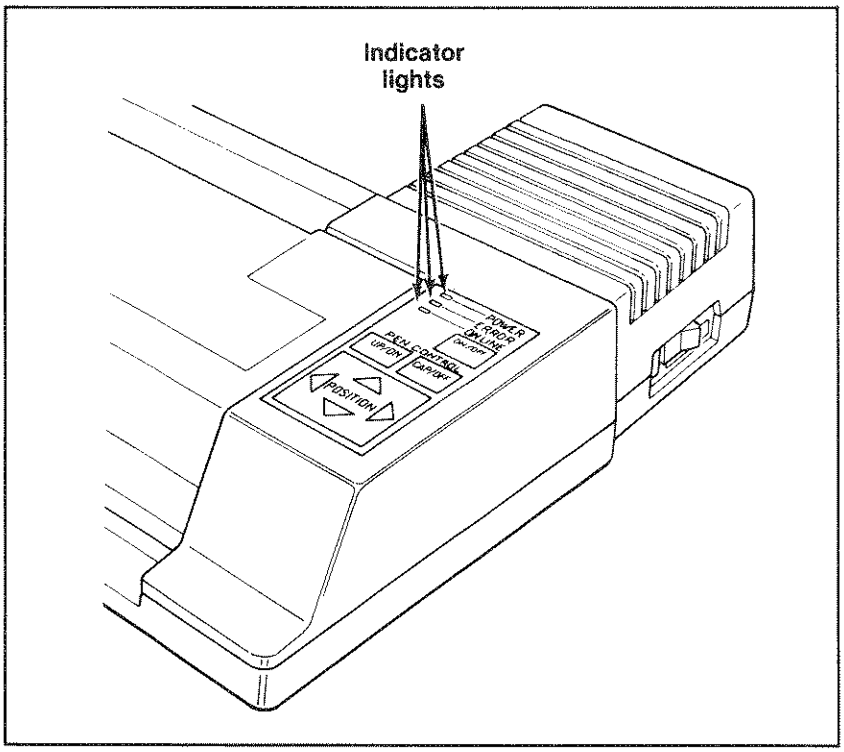


Figure 1-3. The control panel

The paper support

The *paper support* is in the center of the plotter just behind the cover (see Figure 1-4). This paper support snaps up to an angled position to support the top of the paper as it moves back and forth in the plotter.

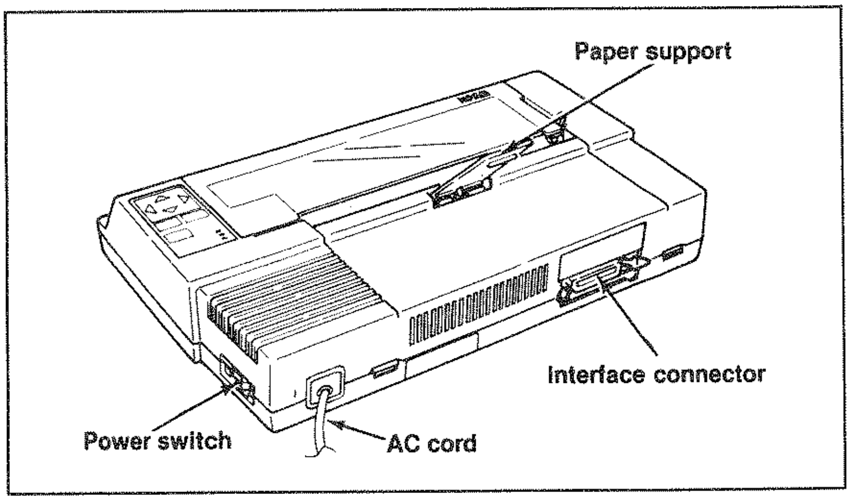


Figure 1-4. The paper support

The interface connector

Looking around the back of the plotter (also shown in Figure 1-4), you'll see the interface connector where the cable from your computer is connected. This connector is for a parallel interface (a serial interface is optional).

The power switch

The HC100 has an AC power cord that is installed into the back of the plotter (and is not removable). The power switch has two positions: the rear of the switch is pressed to turn the plotter ON; the front of the switch is pressed to turn it OFF.

The DIP switches

There are six DIP switches deep inside the HC100 that can affect the way the plotter operates. Most of the switches tell the plotter about options that have been installed, while others control unusual interface requirements.

These switches are set at the factory in the proper positions for most users. We recommend that you try your plotter for awhile before changing any of the settings. Appendix C tells you exactly what all the switches do and how to change them.

Connecting the Plotter to Your Computer

You connect the HC100 plotter to your computer just like you would connect a printer. The HC100 uses a parallel interface (although an optional serial interface is available).

CAUTION: Before you connect any cables, be sure that both the plotter and the computer are turned OFF.

One end of your cable should plug into the connector on the back of the HC100 (if it doesn't, you have the wrong cable). To secure the connection, attach the two clips on the plotter's connector to the cable. If your cable has a ground strap, connect it to the screw just below and to the right of the connector. Figure 1-5 shows this connection.

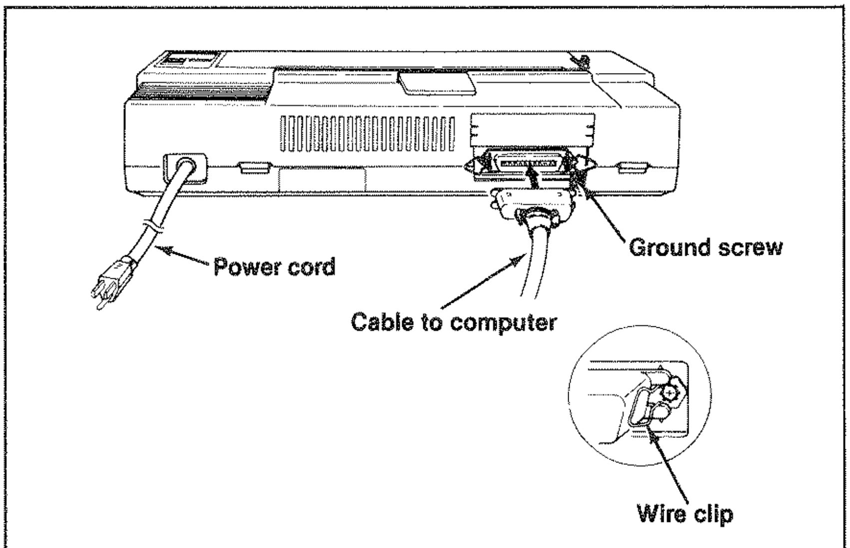


Figure 1-5. Cable connection to the HC100

For many computers, you merely plug the printer cable into the printer port on the computer. Some computers require a printer interface card, either mounted inside the computer or externally. Check your computer installation and operations manual for details on how to connect your computer to a printer. The instructions apply to the HC100 plotter.

Now plug in the power cord.

CAUTION: Make sure that the POWER switch (on the right side of the plotter) is in the OFF position. Plug the power cord into a standard (120 VAC, 60 Hz) grounded electrical outlet (do not use an adapter plug).

Your HC100 plotter is now ready to operate.

Chapter 2
Operating the Plotter

In this chapter, you'll learn how to load the pens and paper. You'll also learn how to use the HC100 control panel and command the plotter.

Loading Pens

First open the pen package that came with your plotter. You should find one blue, one red, one green, and one black pen. (You'll learn more about options for pen selection later.)

To load the pens, lift the smoked-plastic cover by tilting it back. Before you load any pens make sure that the pen carriage is in the extreme right position as shown in the illustration (see Figure 2-1). In this position, the pen selection lever is not in the way of any of the pens.

If the pen carriage is not in the proper position, check to be sure the power is OFF. Then push the flat side of the pen carriage as far as it can be moved to the right side of the printer.

Removing the pen cassette

The pens can be loaded into the pen cassette when it is either in or out of the pen carriage. To remove the pen cassette, first locate the pen cassette release lever that hangs over the back of the pen carriage (see Figure 2-2). Then pull this lever forward and up to slide the pen cassette out of the carriage. It should slide out easily.

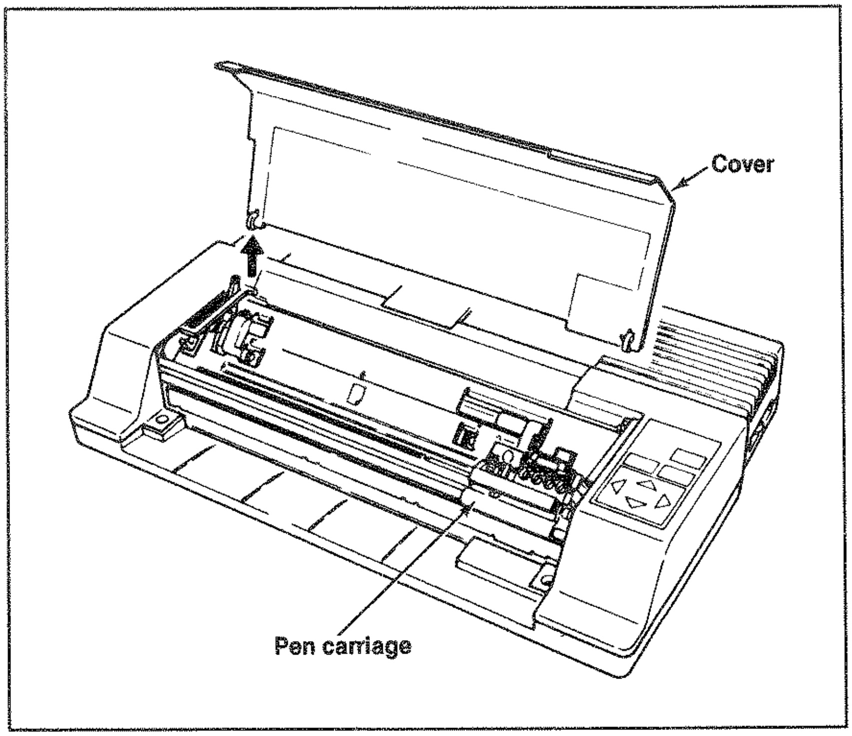


Figure 2-1. Pen carriage in position

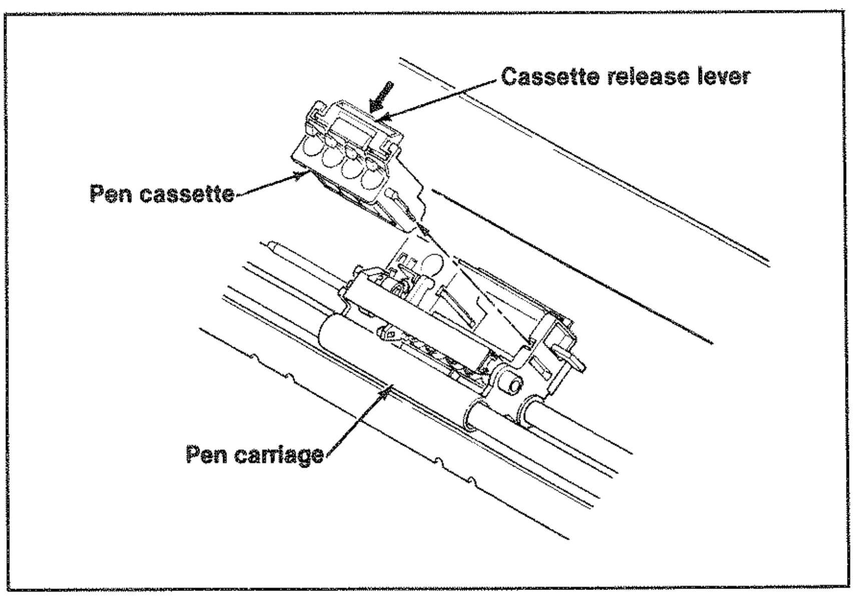


Figure 2-2. Removing the pen cassette

Take a moment to look down through the pen carriage (where the pen cassette was) and you can see the four sockets that the tips of the pens fit into when they are capped. These sockets raise up to cover the tips and keep them from drying out while not in use. The pens are capped when the pen carriage is positioned over these sockets.

Loading the pens

There are four positions to put pens in, and you can put any color in any position. If you look closely at the pen cassette you can see that the pen positions are numbered. We suggest you put the pens in the following order as you work through the examples in this manual.

Position 1 Black

Position 2 Red

Position 3 Green

Position 4 Blue

Note: Position one is the default pen position. You must command the plotter to change pens to create drawing or printing in different colors. If you want your drawing or document to print in one color only, load the pen color of choice into position one.

To load the pens, first remove the cap from the pen and then put the pen into the hole. Press lightly on the colored top of the pen until it latches into place (see Figure 2-3). When you remove a pen, push the latch back and the spring-loaded pen pops up slightly to be lifted out of the cassette.

Now replace the pen cassette in the pen carriage (shown in Figure 2-2). It slides in easily when it is aligned properly. Don't force it, but adjust the alignment until it goes in easily.

That's all there is to loading pens. Now you're ready to load paper into the HC100 plotter.

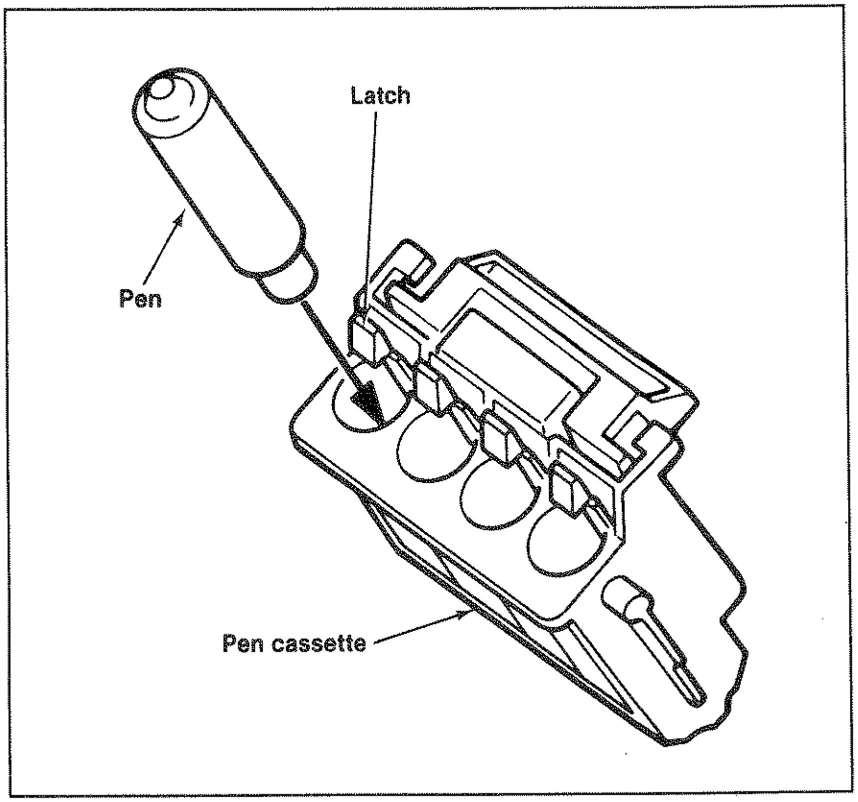


Figure 2-3. Installing pens

Loading Paper

There is only one adjustment to check before loading paper into the HC100 plotter. The right hand paper holder has two positions to accomodate different sizes of paper (Figure 2-4). The most common size paper in the United States is 8½ x 11 inches (and we assume that you are using this paper size). The paper holder for this size paper is marked A4-US, and as indicated by the small arrow, is on the right. (The A4 and B5 sizes are standard metric paper sizes.)

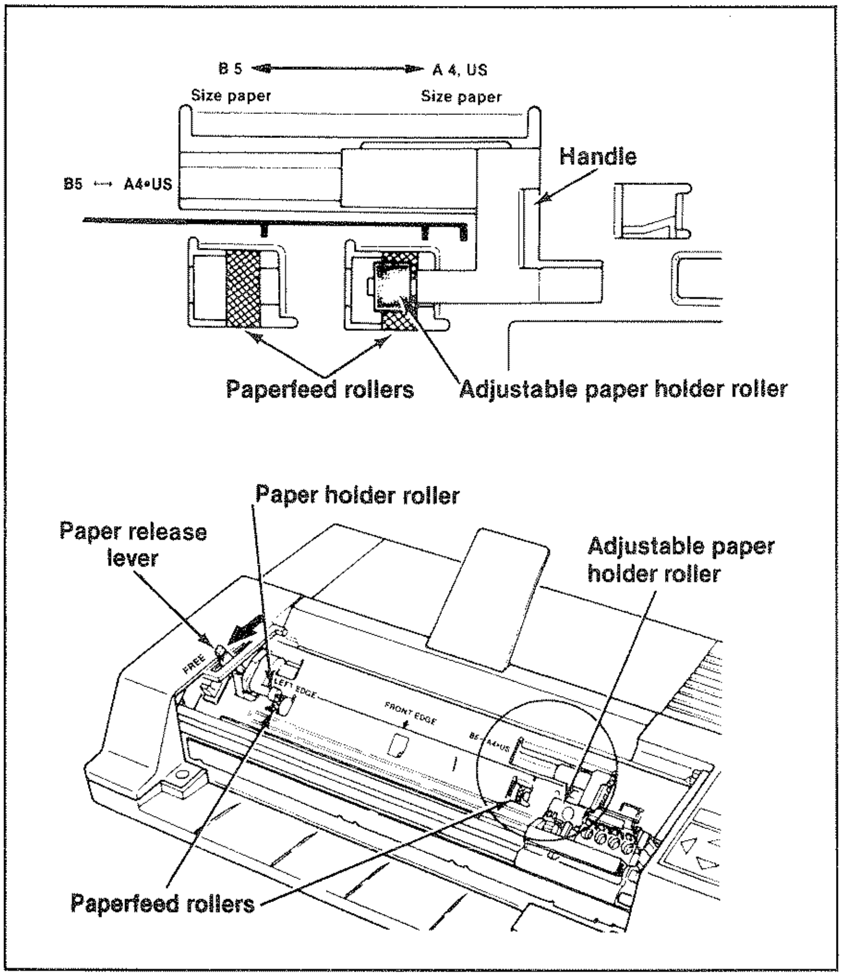


Figure 2-4. Adjusting rollers for paper width

To change the roller adjustment, first raise the paper holders by pulling the paper release lever forward to the FREE position. Slide the paper holder to the correct position. It clicks into place. Now you are ready to load paper.

The white line across the plotter mechanism indicates the proper position of the top edge of the paper. The short vertical line at the left indicates the proper position of the left side of the paper. Use these two lines to position the paper in the plotter as shown in Figure 2-5.

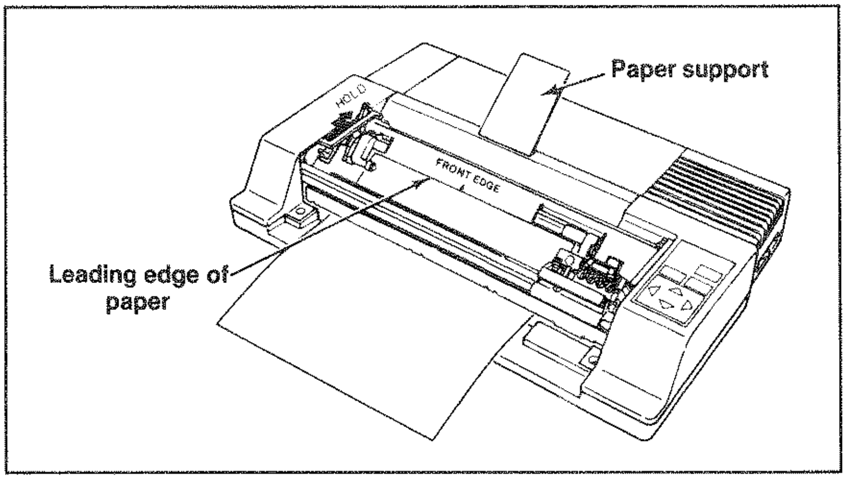


Figure 2-5. Loading paper

When you have the paper aligned properly, move the paper release lever back to the HOLD position to secure it. Now raise the paper support. That's all there is to loading paper—you are ready to use your plotter.

The Self-Test

With pens and paper loaded you are ready to draw something with your plotter. Try the self-test to see if everything is working correctly. Running the self-test is easy and you don't even have to connect the HC100 to your computer.

CAUTION: The HC100 has no way to tell if there is paper loaded or not. If you start the self-test without paper in the plotter, the pens draw on the platen. This ink then marks the back of paper that is subsequently loaded in the plotter. See Chapter 3 for instructions on cleaning the platen.

Check your paper and pens one more time. To try the self-test, press the UP/DN and CAP/OFF buttons at the same time while you turn on the plotter with the power switch (see Figure 2-7). Make sure you hold the buttons down for about two seconds afterwards until the plotter starts. The HC100 produces a drawing that looks like Figure 2-6 (but, of course, yours is in full color as shown in the front of this manual).

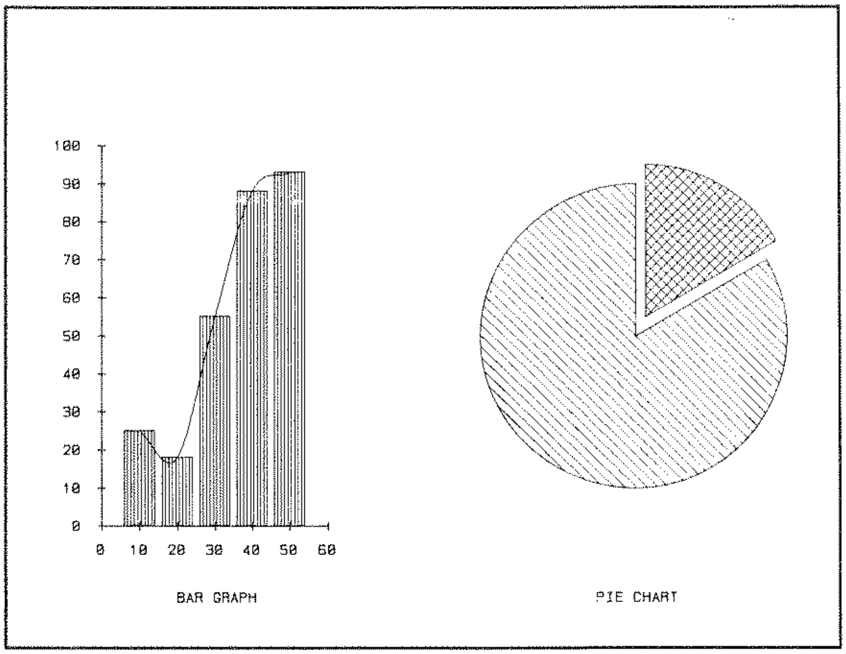


Figure 2-6. The self-test

If the HC100 detects an error during the self-test, the ERROR light flashes and the plotter stops. If this happens, try the self-test again to be sure that it's not just a random occurrence. If the error occurs again, take the plotter to your dealer for service.

If you wish to repeat the self-test you can do so by pressing any of the direction keys (the ones on the control panel with arrows). After doing the self-test, you must turn the plotter OFF, and then back ON again before it functions normally.

The self-test is pretty impressive, isn't it? Notice the text labels of different sizes across the top and bottom. Notice that the bar graph has graduated scales going in both directions. Each of the bars on the bar graph is drawn with one command, including the cross-hatching that fills them in. The curve across the tops of the bars is automatically generated to join each of the points in the bars.

Each section of the pie chart is generated with a single command, and each one shows a different example of the six types of cross-hatching that are possible.

Controlling the Pen and Paper Position

In Chapter 1 you identified the lights on the control panel. Now look at the touch sensitive controls which are shown on the smooth surface of the control panel. Each of these controls acts (and feels) like a button when you press it.

Turn the plotter off, put in a new sheet of paper, and turn it back on. Notice that when you turn on the plotter it assumes that you have loaded a sheet of paper and it immediately moves the paper around, stopping in a slightly different position than when it started.

The plotter is performing a kind of short self-test to be sure that everything is functioning as it should. The plotter quickly tells you if you don't have the paper in correctly. If it is too far out of position, it will be ejected from the plotter.

When this mini-self-test is done, press the ON/OFF button once so that the ON LINE light goes off. This lets you operate the plotter with the control panel buttons. The control panel is shown in Figure 2-7.

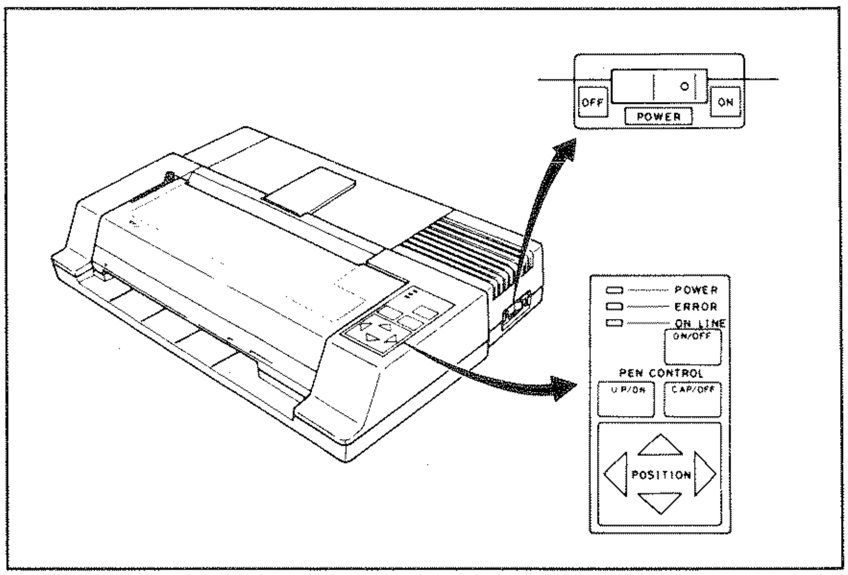


Figure 2-7. The HC100 control panel

ENTER PEN CHANGE 3 TIMES TO POS
PEN CARRIAGE POS.

At the front of the control panel are four triangular buttons around the word POSITION. These buttons allow you to move the pen carriage. Press the button that points to the right and hold it for several seconds. After a brief pause the pen carriage starts moving to the right. Experiment with these four buttons. Notice that you can't run off the edge of the paper—the HC100 knows the width of the sheet and stops at the edge. Try pressing two adjacent buttons at the same time. Both the paper and the pen carriage move to create diagonal movement across the paper.

Try just tapping the buttons momentarily. Notice that the pen carriage barely moves each time a button is tapped (one-tenth of a millimeter). Then, if the button is held down for more than a half of a second it starts moving until the button is released.

Well, so far you've moved the pen carriage all over the paper, but you haven't drawn anything yet. That's because the pen is in the up position. Press the UP/DN button once to lower the pen. Now when you move the pen carriage you draw at the same time. You can raise the pen by pressing the UP/DN button again. Lower the pen and use the direction buttons to draw a square on the plotter. Don't worry—your computer is more accurate than you can be!

The CAP/OFF button returns the pens to the far right pen capped position. Press it once to cap the pen carriage, and press it again to return to the home position.

Note: Always cap the pens when you are finished with the plotter to keep them from drying out. If the plotter is ON, you can cap the pens with the CAP/OFF button (the ON LINE light must be OFF). If the plotter is OFF, you can cap the pens by pushing the flat side of the pen carriage with your finger as far to the right as it goes (see Figure 2-8).

Changing paper

The HC100 plotter tells you when it's time to change paper (assuming your program uses this feature of the HC100). The plotter will extend the paper out the back of the plotter as far as it can, and it will move the pens to the far right. Then the ON LINE light will flash. This is your signal to change the paper, inserting the new sheet so it is aligned with the white line as described above. When you are ready, press the ON/OFF button once and the plotter will resume its operation.

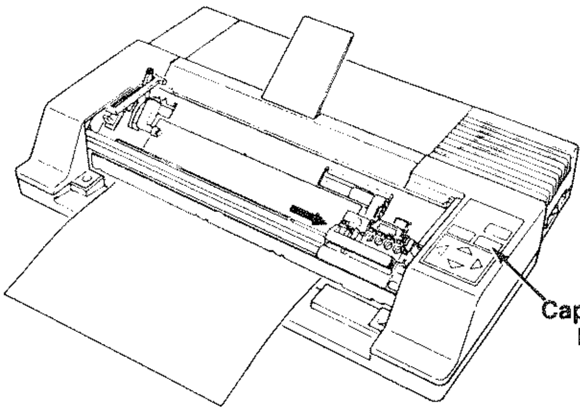


Figure 2-8. Capping the pens

Commanding the Plotter

Chapter 5 discusses how to send codes to the plotter to make it work for you. Chapter 6 lists the codes or commands you use to tell the HC100 how to plot your desired graphic drawing. Chapter 7 gives examples of how to use your word processor, spreadsheet program, BASIC or Logo with your plotter.

Perhaps the easiest way to use the HC100 plotter is with a commercial graphics program. We've listed the general steps in using the HC100 plotter with a commercial graphics package below. (However, you should read your graphics program documentation to get the details.)

Graphics application software

First, you must connect your plotter to your computer. Next, you need to tell your graphics program what kind of plotter you are using. There are many kinds of plotters and they almost all work differently. Most graphics programs have an installation procedure which presents you with a list of the devices supported.

If an HC100 printer driver is not included in your program, an Epson HI-80 driver may also be selected. If neither of these are supported, Graphtec (formerly Watanabe 4675) may also be selected if the HC100 is set to use command set 1 (set DIP Switch 5 ON).

The graphics program needs to know what kind of interface you are using. Unless you have purchased an optional interface (there are several available for the HC100), you are using a *parallel* interface. With a parallel interface you should not have to answer questions about baud rates or stop bits. If your program asks for them anyway, don't be concerned with your answers, they are ignored.

Note: If you are using an optional *serial* interface, you need to answer these questions carefully. See the documentation that came with your optional interface.

Now you should be ready to use your plotter with your graphics program. Start with a simple graph to make sure that everything works correctly.

Using the Plotter as a Printer

Most plotters can produce graphic drawings with printed labels, but they are not capable of printing as with a word processor. The HC100 plotter can operate as a full-featured printer. It uses the same commands as an Epson RX-80 printer (except for bit-image graphics), which are summarized in Chapter 8.

To use your plotter as a printer, turn it on while holding the CAP/OFF button down. Now your plotter will act like an Epson RX-80 printer until you turn it off and back on again.

Note: You can also use software commands to change between plotter and printer command sets; see Chapters 6 and 8.

Chapter 3
Maintenance and Cleaning

The most important maintenance of the HC100 plotter is cleaning. Keeping the plotter clean extends its life and maintains the high quality of its output. In fact, cleaning is the only type of maintenance that you should do. Any service that is not covered in this book should be done only by a qualified technician.

Cleaning the Platen

Two parts need periodic cleaning: the *platen* and the pen caps. The platen is the narrow strip that the pens run across (see Figure 3-1). Use a cotton swab moistened with alcohol to clean the platen.

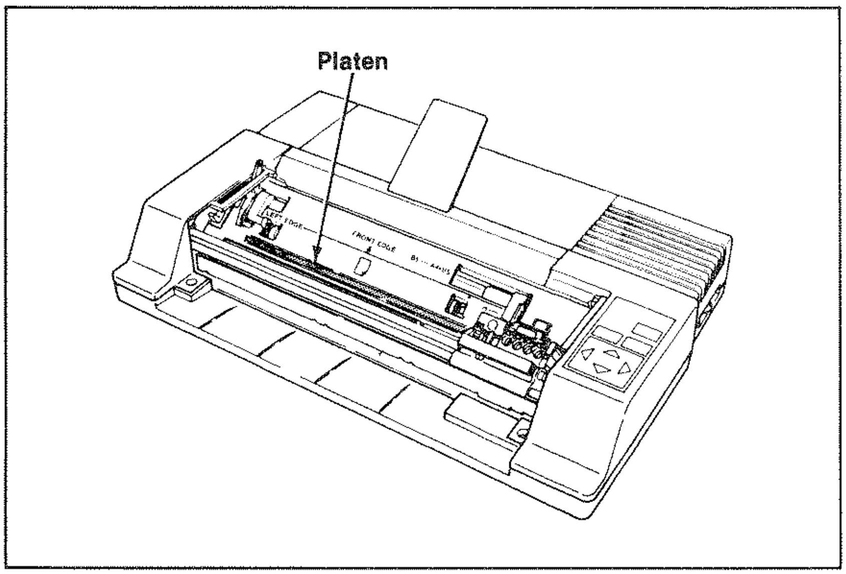


Figure 3-1. The platen

Note: Be careful not to get alcohol on any other parts of the printer as it may discolor the case or remove the white lettering from the plotter.

Clean the exposed part of the platen and then slide the pen carriage across so that the rest of the platen is exposed.

Cleaning the Pen Caps

The pen caps (Figure 3-2) should be cleaned periodically, or when you change pen colors. The ink that is left in the pen cap by the previous pen can cause temporary discoloration. The pen caps can be cleaned with a cotton swab moistened with alcohol.

CAUTION: Remember to push the pen carriage to the extreme right pen-capped position when you are finished cleaning to prevent the pens from drying out.

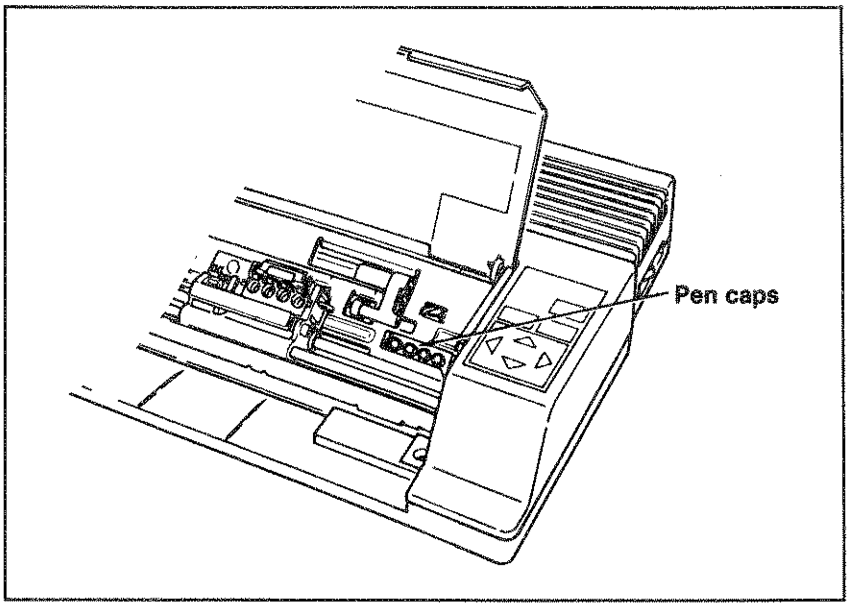


Figure 3-2. Pen caps

Cleaning Contaminated Ballpoint Pens

Ballpoint pens can become contaminated if they are used on papers with waxes or other additives in their coatings. You can tell when a pen has become contaminated because it skips parts of the drawing. The foreign substance coats the ball and prevents it from transferring ink.

Clean contaminated ballpoint pens as follows. Place a drop of liquid dishwashing detergent on a piece of uncoated paper. Mix in about 3 or 4 drops of water. Spread the mixture so that the paper is wet, but there is no puddle of water. Now write in the wet area with the contaminated pen for about 30 seconds using a light pressure. Test the pen on the dry area of the paper to be sure it is working properly.

Chapter 4
Pens and Paper

You can use many kinds of paper (or transparency material), and three different kinds of pens in the HC100 Plotter.

Selecting Paper

The HC100 can use almost any kind of paper, but there are several considerations in selecting the paper that produce the best quality. Generally, the smoother the paper is, the better the quality of the finished drawing.

Many good quality letterhead papers are too rough for high quality work as the pens tend to skip over the bumps. Rough papers also tend to ruin the points on fiber-tip pens.

A good paper to use with the HC100 is the kind made for plain-paper office copiers. It has a fairly smooth surface and is not expensive.

For very high quality work you can use coated paper (like magazines are printed on, but thicker) or special plotter paper. The smooth surface is nearly perfect for the ballpoint pens.

Note: The coating on some papers contains waxes or other additives that contaminate the ballpoint pens and make them skip. Chapter 3 tells you how to clean contaminated pens.

Making transparencies

The HC100 can also make high-quality transparencies for use with a transparency projector. Use a clear acetate film in place of the paper in the plotter. The film is available from your local computer or office supply store. The clear film that is used to make transparencies with a plain paper copier will also work very well. You'll also need special pens - refer to the following section on selecting pens.

Another type of clear film that is used with plain-paper copiers is adhesive drafting film. This is an adhesive backed clear film that is used when you want to add something to an engineering or architectural drawing. This film also works well with the HC100. You can create drawing details with your plotter and then include them on your drawings for making blueprints.

Selecting Pens

When you have determined what paper to use, you should select the pens which produce the best results with that type of paper. There are three types of pens available: water-based ballpoints, water-based fiber-tipped and oil-based fiber-tipped pens.

The water-based pens are designed for paper and the oil-based pens are designed for clear film. The water-based inks won't work on clear film. The ballpoint pens draw a narrower line than the fiber tipped pens (see Figure 4-1).

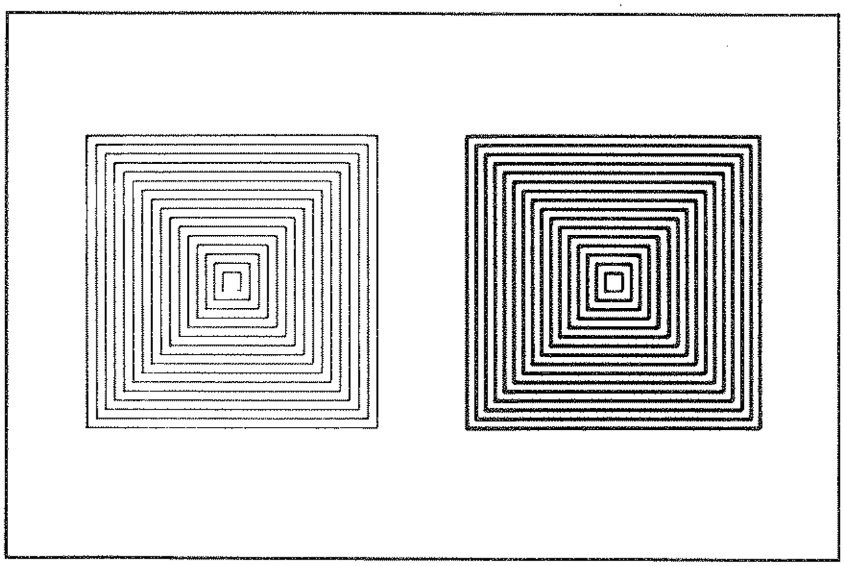


Figure 4-1. Line widths available

There are 10 colors available for the HC100 plotter including: black, red, green, blue, yellow, cyan, magenta, brown, purple, and orange.

Water-based pens with four of these colors (black, red, green, and blue) are included with your plotter and are available directly from Tektronix. (Refer to the parts list in the Service section of this manual for part numbers for the various types of pens and the pen cassette.) Pens of the other colors can usually be obtained from local computer dealers.

Pen Cassettes

If you find that you are using more than one type of pen and changing pens frequently, you may wish to get more pen cassettes (Figure 4-2). The pen cassette allows you to replace all four pens at once in the HC100.

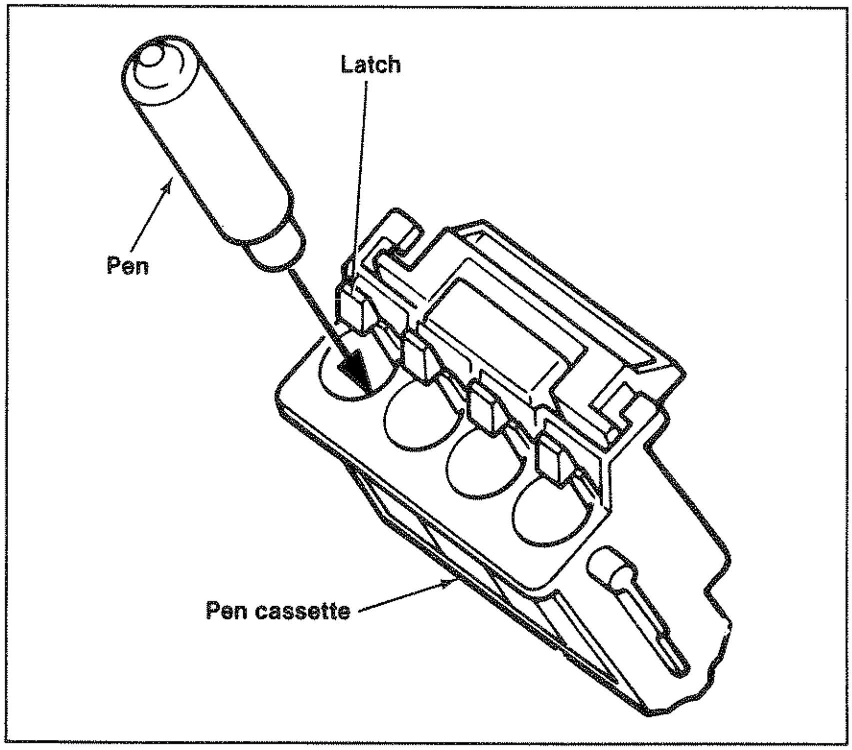


Figure 4-2. The pen cassette

You might have one pen cassette with ballpoint pens and one with fiber-tip pens, or you might have one cassette with four colors, and another with four additional colors. The combinations are almost endless (so you may need lots of pen cassettes).

Chapter 5
Using the Plotter Commands

The Tektronix HC100 can operate as a plotter or a printer. In fact, there are three complete command sets built into it.

Command Sets

The main command set (command set 0) of the HC100 is identical to the Epson HI-80 command set.

Switch to command set 1 and the HC100 acts just like a Graphtec (Watanabe) plotter. The Graphtec plotter isn't as advanced as the HC100, but it has been around longer and there are more software programs that support it.

The last command set that the HC100 understands is the command set for the Epson RX-80 printer (except for bit-image graphics). When you select this command set (called the printer emulator command set), the HC100 acts as an Epson RX-80 printer. This allows you to use the plotter as a printer.

This manual contains a summary of the HC100's main command set (command set 0) in Chapter 6 and a summary of the RX-80 printer emulator command set in Chapter 8. The Programmer's Section of this manual contains more complete information on all three command sets.

How Commands Are Shown in This Manual

The plotter commands in command set 0 are simply groups of letters and numbers. This means there is no difficult syntax to memorize.

(The printer emulator commands are different, and are discussed in Chapter 8.)

Commands consist of two letters, sometimes followed by one or more numbers. For example, the following are valid commands:

CI

DA 100,100, 300, 100

The letters in the commands can be typed in upper or lower case—the plotter understands both.

If there is more than one number, the numbers must be separated by a *delimiter.* A delimiter is usually a comma, but a space can be used instead. Extra spaces are ignored. The numbers in the commands are called *parameters.* They are used to tell the plotter information like how far, or in which direction, to move.

Sometimes parameters are negative numbers. The HC100 interprets a number with a minus sign (hyphen) in front of it as a negative number. Here is an example of a command with negative numbers for parameters:

MR -100,-300

It is important that you understand what each of the parameters means when you use a command. If the plotter gets the wrong number of parameters, or an incorrect parameter, it stops and lights the ERROR indicator.

Ways to Send Commands

Since the commands are made of regular letters and numbers, there are many ways to send the codes to the plotter. You can use your word processor, BASIC, Logo or a spreadsheet. Chapter 7 gives several examples of how to send commands to the plotter.

A Little Background on Plotting

You should understand a few more terms so that you can use your HC100 plotter more easily. You may find it possible to use your plotter with graphics programs without an understanding of this information, but it is definitely necessary to understand this information if you intend to write programs that use the plotter.

The coordinate system

The plotter can position the pen at any point on the paper. How, then does the computer tell the plotter which point it has in mind? All the points that the plotter can reach have an address made of two numbers.

The first of the two numbers in the address tells the plotter how far to move sideways (the long dimension of the paper), and the second number tells the plotter how far to move up and down. The system used by the HC100 plotter (and most other plotters) is called the Cartesian coordinate system (see Figure 5-1).

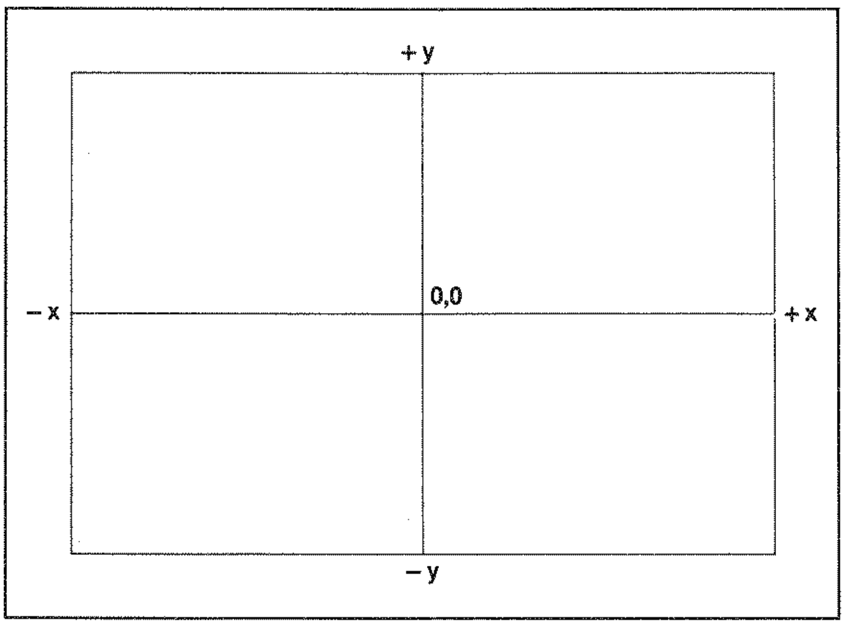


Figure 5-1. The Cartesian coordinate system

The Cartesian coordinate system defines points by their distance along perpendicular axes. Conventionally, the two axes are called the *X-axis* and the *Y-axis*. The point where the two axes cross, and which has the address 0,0, is called the *origin*.

The origin can be anywhere in the drawing area on the HC100, but the default position is in the lower left corner of the paper when it is held with the X-axis horizontal and the Y-axis vertical. Notice that this is the upper-left corner when you are in front of the plotter. When the origin is in the default position, all points in the drawing area have positive (or zero) coordinates. Figure 5-2 shows two possible origins on the paper.

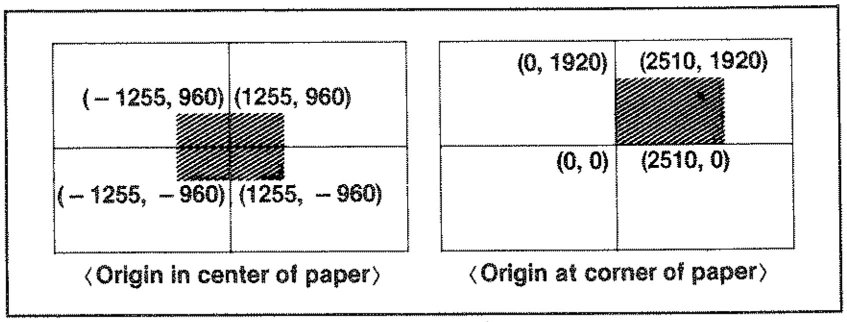


Figure 5-2. Two possible origins on the paper

Defining angles in the coordinate system

You often need to define angles when using a plotter. Angles are used to define the direction of labels and the length of curves to be drawn. As is common in the Cartesian coordinate system, the positive X-axis is taken to have an angle of 0°. Angles are measured in a counter-clockwise direction from this axis. Thus the positive Y-axis is at 90°, the negative X-axis is at 180°, and the negative Y-axis is at 270°. Figure 5-3 shows this.

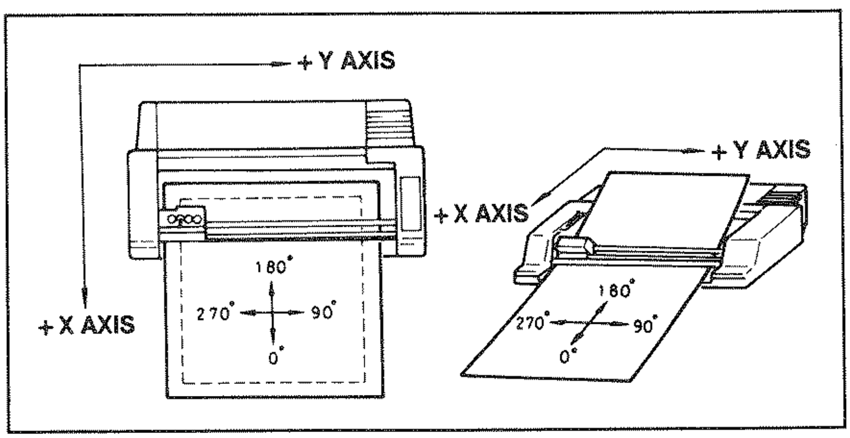


Figure 5-3. Angles on the Cartesian coordinate system

The plotter's units of measure

We have seen that points on the drawing area are defined by coordinates consisting of two numbers. But how far does the plotter move for a given value?

The units of measure that the plotter uses are 0.1 mm. The full length of the plotting area in the direction of the X-axis when using US size paper is 251 mm. Therefore, the maximum value of an X coordinate that the plotter can reach is 2510 (you'll see in a moment what happens if the plotter is given a greater value).

The HC100 measures angles in 0.1°. Therefore, to specify 90° you must send the plotter a value of 900.

The drawing area

The area that the HC100 can draw on changes with the size of paper that you are using. Figure 5-4 shows the size of the drawing area for the three different sheet sizes that the HC100 can handle.

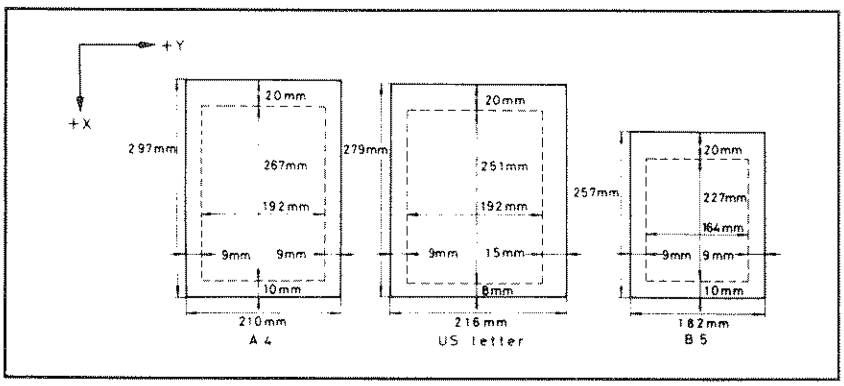


Figure 5-4. Drawing area

Notice that the HC100 cannot draw all the way to the edge of the sheet. Remember that the HC100 has no way to measure the size of sheet you have loaded. If DIP switch 6 is ON, the HC100 assumes that you are using US letter size paper (8-½ x 11 inches). If DIP switch 6 is OFF, you must tell the plotter what size you are loading each time you turn it on (see Appendix C).

Clipping

If you try to draw a figure that is too large for the plotter, the plotter draws what it can and ignores the rest. It still uses the points that are outside the drawing area to calculate the parts of the figure that it can draw, but the pen stops when it comes to the edge of the drawing area. Then the pen moves to the point where the figure comes back onto the paper before continuing to draw (see Figure 5-5).

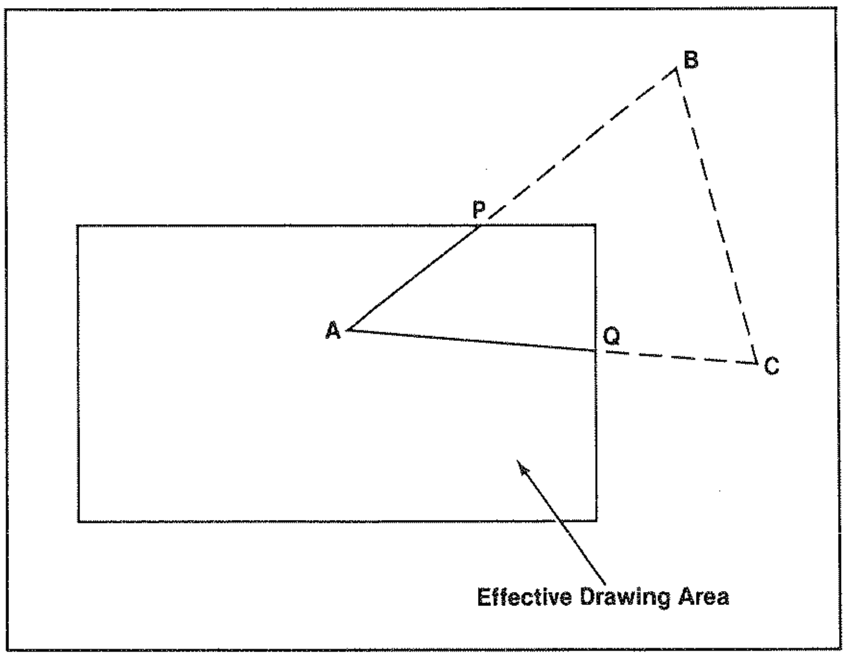


Figure 5-5. Clipping

Chapter 6
HC100 Plotter Command Summary

This chapter summarizes each of the HC100 Plotter commands in command set 0. While this chapter lists all of the plotter commands in command set 0, some of the descriptions and more technical aspects may not be included in all cases. The complete descriptions of all the commands, including examples of their use, can be found in the Programmer's Section of this manual.

The commands are organized into three logical groups: Drawing Commands, Format Commands, and Miscellaneous Commands. The *Function* is what the plotter will do when given the proper command. The *Format* is the correct syntax for the command (see Chapter 5 for details). The *Description* tells how the plotter performs the command and what variable values are used (if any).

The names of the *parameters* indicate the type of value to be entered. For example, the parameter *x-len* calls for a numerical value that is the length along the X-axis. Optional parameters are enclosed in brackets [ ] (for example, see the description of the Axis command later in this chapter). Absolute X and Y coordinates, which indicate distance from the origins, are expressed simply as *x*,*y*. Relative *x* and *y* coordinates, which indicate distance from the current position of the pen, are expressed as *dx*,*dy*.

In general, the value of parameters can range from −16383 to 16383. Parameters that have other limits are noted. The absolute coordinates of a point specified by relative coordinates should stay inside the range −32768 to 32767 or an error will result.

Drawing Commands

Function:
  Draw Absolute

Format:
  DA *x1,y1[, x2,y2 ... , xn,yn]*

Description:
  Draws a line from the current position to *x1,y1*, and then on to *x2,y2*, etc.

Function:
  Draw Relative

Format:
  DR *dx1,dy1[, dx2,dy2 ... , dxn,dyn]*

Description:
  Draws a line from the current position to the relative coordinate *dx1,dy1*, and then on to the relative coordinate *dx2,dy2*, etc.

Function:
  Move Absolute

Format:
  MA *x,y*

Description:
  Moves without drawing to position *x,y*.

Function:
  Move Relative

Format:
  MR *dx,dy*

Description:
  Moves without drawing to the relative coordinate *dx,dy*.

Function:
Label

Format:
LA *text-string*

Description:
Prints *text-string* starting at the current position. The characters in the text string can be changed with the following commands, (which are described in the Format Commands section of this chapter):

CS (Character Set) selects an international character set.
SI (Character Size) sets the size of the character.
EM (Character Emphasis) specifies the weight of the characters.
DI (Character Direction) sets the character direction.
SL (Character Slant) specifies the angle of character slant.
VO (Vertical Offset) specifies a vertical offset from the baseline.

You can change the characters back to normal printing with the RC (Reset Characters) command.

Function:
Circle Absolute

Format:
CA *x,y, rad, start-angle, end-angle*

Description:
Draws a circle segment centered at *x,y* with a radius of rad, starting at *start-angle* and continuing to *end-angle*. If *start-angle* minus *end-angle* is positive the circle is drawn counterclockwise; if *start-angle* minus *end-angle* is negative the circle is drawn clockwise.

Function:
Circle Relative

Format:
CR *rad, start-angle, end-angle*

Description:
Draws a circle segment beginning at the current position with a radius of *rad*, starting at *start-angle* and continuing to *end-angle*. If *start-angle* minus *end-angle* is positive the circle is drawn counterclockwise; if *start-angle* minus *end-angle* is negative the circle is drawn clockwise.

Function:
Curve Absolute

Format:
VA *type, x1,y1, x2,y2 ... , xn,yn*

Description:
Draws a smooth curve connecting the points specified. If type = 0 the curve is open; if type = 1 the curve is closed. There must be at least three points to plot a curve; if only two points are given a straight line is drawn. The curve drawn may not be accurate if the same point is specified as two successive points, if the starting and ending points are the same, or if they are too close together.

Function:
Curve Relative

Format:
VR *type, dx1,dy1, dx2,dy2 ... , dxn, dyn*

Description:
Draws a smooth curve from the current pen position connecting the relative points specified. If *type* = 0 the curve is open; if *type* = 1 the curve is closed. There must be at least three points to plot a curve; if only two points are given a straight line is drawn. The curve drawn may not be accurate if the same point is specified as two successive points, if the starting and ending points, or if they are the same or too close together.

Function:

Axis

Format:

AX *dir, len, div, scale-mark[, start-num, end-num, num-space, num-dir]*

Description:

Draws an axis line and graduates it. The axis is drawn as either a certain number of units or as the total length of the axis.

Axis as a unit length:

dir = 0 draws the Y-axis
dir = 1 draws the X-axis
len = the length of the unit
div = the number of times to draw the unit length
scale-mark = 0 draws a mark and scale value at the origin
scale-mark = 1 does not draw a mark and scale value at the origin
start-num = starting number of scale numbers
end-num = the number of each unit
num-space = the distance between the line scale numbers
num-dir = 0 draws the numbers parallel to the the axis
num-dir = 1 draws the numbers perpendicular to the axis

Axis as the total length:

dir = 2 draws the Y-axis
dir = 3 draws the X-axis
len = the overall length of the axis
div = the number of divisions in the overall length
scale-mark = 0 draws a mark and scale value at the origin
scale-mark = 1 does not draw a mark and scale value at the origin
start-num = starting number of scale numbers
end-num = the end value of the overall length
num-space = the distance between the line scale numbers
num-dir = 0 draws the numbers parallel to the the axis
num-dir = 1 draws the numbers perpendicular to the axis

Function:
Grid

Format:
GR *x-unit, x-num, y-unit, y-num*

Description:
Draws grid lines. Lines are first drawn parallel to the X-axis starting from the current pen position. The length of the grid line is specified by *x-unit* and the number of divisions that are drawn parallel to the X-axis is specified by *x-num*. Lines are drawn second parallel to the Y-axis with the unit length and number of lines specified by *y-unit* and *y-num*, respectively. The parameters *x-num* and *y-num* can range from 0 to 255.

Function:
Hatch Bar

Format:
HB *type, x-len, y-len, pitch, style*

Description:
Draws a rectangle with the current pen position at the lower left corner and hatches it. *Type* = 0 draws the rectangle only, *type* = 1 the hatches only, and *type* = 2 does both. The lengths of the sides are specified by *x-len* and *y-len*. *Style* determines hatch pattern and can range from 0 to 5. The styles of hatching are shown in Appendix B.

Function:
Hatch Pie Section

Format:
HP *type, x,y, rad, start-angle, end-angle, pitch, style[,inner-rad]*

Description:
Draws a circle segment centered at *x,y* with a radius of rad and hatches it. *Type* = 0 draws an outline only, *type* = 1 hatches only, and *type* = 3 does both. The circle segment is drawn starting at *start-angle* and continuing to *end-angle*. *Style* determines hatch pattern and can range from 0 to 5. The styles of hatching are shown in Appendix B. An optional inner radius of *inner-rad* can be used to create a circle segment within the original (resulting in a fan-shape). The inner circle segment is not hatched.

Function:

Absolute Line and Mark

Format:

AM *style, x1,y1[, x2,y2, ... , xn,yn]*

Description:

Connects the points specified by absolute coordinates with lines and marks the points with the specified style of mark. *Style* can range from 0 to 15. The styles of marks are shown in Appendix B.

Function:

Relative Line and Mark

Format:

RM *style[, dx1,dy1, dx2,dy2, ... , dxn,dyn]*

Description:

Connects the points specified by relative coordinates with lines and marks the points with the specified style of mark. Style can range from 0 to 15. The styles of marks are shown in Appendix B.

Function:

Arrow

Format:

AR *style, head-len, head-ang, dx,dy, dir*

Description:

Draws an arrow from the current position to the specified relative position (*dx,dy*). *Style* can range from 0 to 3. The styles of arrows are shown in Appendix B.

Head-len and *head-ang* specify the length and angle of the arrow head, and *dir* determines the end that has the arrow head on it (0 = head on destination point, 1 = current position, and 2 = both.)

Format Commands

Function:
Character Set

Format:
CS *set-num*

Description:
Selects an international character set. *Set-num* can range from 0 to 10. The following table shows the valid values of *set-num* and the character sets selected for each. Appendix A shows the values of *set-num* and the characters that change in the international character sets. The power-on default is the USA character set (*set-num*=0).

Function:
Character Size

Format:
SI *height, width*

Description:
Sets the height and width of characters printed by the LA (Label) command as well as the symbols printed by the AM (Absolute Line and Mark) command and the RM (Relative Line and Mark) command. The minimum value for *height* and *width* is 4. The power-on default for *height* and *width* is 24.

Function:
Character Direction

Format:
DI *angle* -or- DI *rise,run*

Description:
Sets the direction that labels will be printed. A single parameter is taken to be an angle (in 0.1 degree), while two parameters are used to calculate a tangent (tan = *rise/run*). The power-on default is 0°.

Function:
Vertical Offset

Format:
VO *offset*

Description:
Specifies a vertical offset from the baseline for printing characters. Produces superscript (if *offset* is positive) or subscripts (if *offset* is negative). The power on default offset is 0.

Function:
Character Slant

Format:
SL *value*

Description:
Slants the vertical lines of characters. If *value* is positive, the character is slanted clockwise; if *value* is negative, the character is slanted counterclockwise. Typical *value* for italic printing is 55. The parameter *value* can range from −512 to 512. The power-on default value is 0.

Function:
Character Emphasis

Format:
EM *style*

Description:
Produces emphasized characters. *Style* can range from 0 to 3 as follows:

style	emphasis
0	none
1	offset horizontally
2	offset vertically
3	offset obliquely

The power-on default is no emphasis (*style* = 0)

Function:
Reset Characters

Format:
RC

Description:
Resets the character style and size to the default parameters. This command does not affect the drawing parameters.

Function:
Line Type

Format:
LT *style*

Description:
Specifies the type of line to be printed. The line may be solid, broken, dotted, or a mixture. The value of *style* can range from 0 to 8. The styles of lines are shown in Appendix B.

The spacing of the dot-dash combinations is set with the LP (Line Pitch) command. The line type specified alters the lines drawn by these commands:

DA (Draw Absolute)
DR (Draw Relative)
CA (Circle Absolute)
CR (Circle Relative)
VA (Curve Absolute)
VR (Curve Relative)
GR (Grid)
HB (Hatch Bar)
HP (Hatch Pie)
AM (Absolute Line and Mark)
RM (Relative Line and Mark)

Function:
Line Pitch

Format:
LP *pitch*

Description:
Specifies the pitch (spacing) of the line style determined by the LT (Line Type) command. The power-on default pitch is 60 (6 mm). The minimum pitch is 1.

Function:
Input Window

Format:
IW *size* - or - IW *x-min, y-min, x-max, y-max*

Description:
Sets the maximum drawing area. The IW *size* format specifies one of the three standard sizes: 0 = A4, 1 = US letter, 2 = B5. The IW *x-min, y-min, x-max, y-max* format can be used to restrict the maximum drawing area to a particular area on the paper. The value of x can range from 1 to 2670; y can range from 1 to 1920 with US letter size paper.

Function:
Origin

Format:
OR

Description:
Sets the coordinate origin to the current position.

Function:
Input Factor

Format:
IF *numerator, denominator*

Description:
Sets a ratio (*numerator/denominator*) that all coordinates are multiplied by. The value of both *numerator* and *denominator* can range from 1 to 15. The ratio affects all drawing commands except the IW (Input Window) command.

Function:
Pen Velocity

Format:
VS *speed*

Description:
Sets the drawing speed of the pen. *Speed* can be 0 (230 mm/sec) or 1 (100 mm/sec).

Function:
Tick Length

Format:
TL *pos-len, neg-len*

Description:
Sets the length of tick marks drawn on the X- or Y-axis by the AX (Axis) command. The value of *pos-len* is the length of the tick mark above the X-axis and to the right of the Y-axis; the value of *neg-len* is the length of the tick mark below the X-axis and to the left of the Y-axis. These values remain set for subsequent AX commands until reset to other lengths or to the default value of 10. The minimum value of *pos-len* and *neg-len* is 0.

Miscellaneous Commands

Function:
Home Pen

Format:
HO

Description:
Moves the pen to the coordinate origin without drawing. The position of the coordinate origin can be changed with the OR (Origin) command.

Function:
Change Paper

Format:
CH

Description:
Moves the pen to the storage position and moves the paper up (in the full X direction) to facilitate changing the paper. After the paper has been moved, the ON LINE indicator will flash. When you change the paper and press the ON LINE button, the pen moves around the effective drawing area. Pen 1 is then selected. No other drawing parameters are changed.

Function:
Select Pen

Format:
SP *pen-num*

Description:
Selects a pen. When *pen-num* = 1, 2, 3, or 4 the pen is selected according to the pen numbers marked on the pen cartridge. When *pen-num* = 0 the pens are stowed and capped. Using SP0 is the same as pressing the CAP/OFF key except that the on-line switch becomes inactive. Pressing the CAP/OFF key causes pen 1 to be selected and returned to the previous pen position. Using *pen-num* = −1 also caps the pens but any subsequent commands will cause the pen to return to the previous pen position and continue. The CAP/OFF key does not have to be pressed.

Function:
Clear Interface

Format:
CI

Description:
Clears error conditions. If an error has occurred, the error indicator on the top right of the plotter will be lit. This command clears the error state allowing you to continue. It does not reset any other parameters previously specified.

Function:
Initialize Plotter

Format:
IN

Description:
Returns the plotter to the power-on state. The buffer is cleared and the plotter is set to the current DIP switch settings.

Function:
Default Values

Format:
DF

Description:
Sets all values to the default state and returns the pen to the default origin. The buffer is not cleared but the plotter is set to the current DIP switch settings.

Function:
Error Control

Format:
IM *type, action*

Description:
Controls the error processing functions. *Type* determines the types of errors that are handled and *action* determines what type of action is taken. The function of this command is covered in the Programmer's Section of this manual.

Note: IM 31,3 will print error messages in the lower left corner of the page.

Function:
Alternate command set

Format:
AC *set*

Description:
Selects one of the plotter command sets. *Set* = 0 is Epson plotter (the commands described in this chapter) and 1 is Graphtec. Changing plotter command sets does not change previously set drawing parameters or clear the buffer. However, some parameters may not perform exactly the same way in each set.

Function:

Printer Emulator Command Set

Format:

⟨DC2⟩ (which is ASCII 18)

Description:

Puts the HC100 into the command set that emulates an Epson RX-80 printer. Parameters retained and printer commands used are described in Chapter 8. You can switch to the printer command set only from plotter command set 0. If you are in another command set, first switch back to command set 0 and then to the printer emulator command set.

Note: Unlike the other commands described in this section, this command requires a single code: ASCII 18. This code is abbreviated as ⟨DC2⟩ (for Device Control 2); you do not actually send the letters "D" and "C" followed by a "2."

Chapter 7
Plotting Examples

In this chapter you'll learn four ways to create figures with your HC100 plotter. You can use BASIC, your word processing program, the Logo language, and your spreadsheet program.

Creating a Pie Chart With BASIC

BASIC is the most common programming language for microcomputers and it's easy to use the HC100 with BASIC. You simply use LPRINT statements to send commands to the HC100.

The sample program below uses the HC100 to print a pie chart (see Figure 7-1 or a full color example in the front of the manual). It's a very short program which prints a pie chart with up to 12 labeled sections and a title.

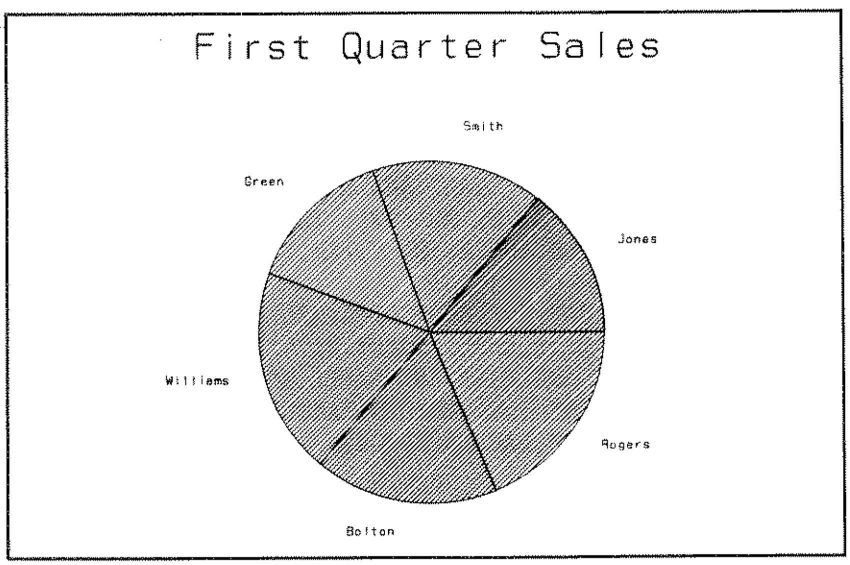


Figure 7-1. Pie chart

Type exactly what you see:

```
100 ' Pie chart program
110 '
120 ' Set up plotter
130 LPRINT "DF"
140 LPRINT "MA 1255, 960"
150 LPRINT "OR"
160 LPRINT "IM 31, 11"
170 ON ERROR GOTO 540
180 DIM LABEL$(12), VALUE(12)
190 '
200 ' Enter values for pie chart
210 CLS
220 PRINT "Pie Chart" : PRINT : PRINT
230 INPUT "Enter title of chart: ", TITLE$
240 FOR PIECE = 1 TO 12
250 INPUT;"Label: ", LABEL$(PIECE)
260 IF LABEL$(PIECE) = "" THEN 310
270 PRINT TAB(25); : INPUT "Value: ", VALUE(PIECE)
280 SUM = SUM + VALUE(PIECE)
290 NUMBER.PIECES = PIECE
300 NEXT
310 '
320 ' Print title
330 LPRINT "MA 0, 800"
340 LPRINT "MR" INT(-36*LEN(TITLE$)) ", 0"
400 ' Print pie sections and labels
410 FOR PIECE = 1 TO NUMBER.PIECES
420 LPRINT "SP" (PIECE MOD 4)+1
430 START.ANGLE = END.ANGLE
440 ANGLE = VALUE(PIECE) / SUM * 360
450 END.ANGLE = START.ANGLE + ANGLE
460 LABEL.ANGLE = START.ANGLE + ANGLE / 2
470 LPRINT "HP 2, 0, 0, 500," INT(START.ANGLE*10)
    "," INT(END.ANGLE*10) ", 10, 3"
480 LPRINT
490 LPRINT "MA" INT(600*COS(LABEL.ANGLE*.0174)) ","
    INT(600*SIN(LABEL.ANGLE*.0174))
500 IF LABEL.ANGLE>90 AND LABEL.ANGLE<270 THEN
    LPRINT "MR" INT(-24*LEN(LABEL$(PIECE))) ", 0"
510 LPRINT "LA" LABEL$(PIECE)
520 NEXT
530 END
540 '
550 ' Error trapping
560 RESUME
```

Type RUN to start the program. You are prompted to enter a title for the pie chart. Create your own pie chart now.

You can type in up to twelve sets of labels and values. A *label* is the name that you want to print next to that section of the pie chart. The *value* is the magnitude of that section of the pie chart. Values do not have to be in percent; the program calculates their proportions.

Note: You do not have to enter twelve sets of labels and values. When you have entered as many as you need, just press the **RETURN** or **ENTER** key and the pie chart is printed.

Now see what the program does. (This program is written in IBM-PC™ BASIC and may need some minor changes for other computers.)

The first section of the program (lines 120-160) sets up the plotter. The origin is moved to the middle of the page so that it is in the center of the pie chart.

The second section (lines 200-300) asks you for your input. Note that no error checking is performed here—a few more lines in the program here would help catch operator errors, but we opted for simplicity to keep the example clear. You can enter up to 12 sets of labels and values, or stop at any time by just pressing **RETURN** (or **ENTER**) instead of entering a new label.

The next section (lines 320-380) prints the title of the pie chart. Line 340 centers the title and lines 350 and 360 change the character size and style. Lines 370 and 380 print the title and line 380 resets the character size to normal.

Now the pie chart is printed (lines 400-530). Here the program starts to get a little complicated. Line 420 selects a pen color. Line 430 sets the starting angle for this section to the ending angle of the last section of the pie. Line 440 calculates the angle of the pie section that we are working on. Next line 450 calculates the ending angle of the current section. The label angle that is calculated in line 460 is half way from the start angle to the end angle; this determines the position of the label outside the pie chart.

Now that you have completed all the calculations you need; you are ready to start plotting. Line 470 sends the command to the plotter to print one section of the pie chart. Some parts of the command are constant and are, therefore, inside of quotes. The angles of the sides of the sections are variable, and the number of degrees must be multiplied by 10. The INT function sends only the whole part of the number to the plotter.

Line 480 contains a lone LPRINT statement. It is in the program for an important reason. When the plotter is drawing and hatching a pie section it can take quite a bit of time. Many computers think that something is wrong with the plotter when it takes that long to complete printing a line. The LPRINT in line 480, and the error routine in lines 550 and 560 (which sends the program right back to try again if it has an error) give the plotter a chance to catch up to the computer.

Line 490 moves the pen into position to print the label. The factor that the label angle is multiplied by (.0174) converts it from degrees to radians (a requirement of IBM BASIC). Line 500 moves the starting point of the labels to the left by the length of the label if it is going to print on the left side of the pie chart. This keeps the labels from printing right over the pie chart. Line 510 then prints the label.

The last section of the program is the error routine (lines 550- 560). This error routine (which depends on line 170 to set it up) sends the program right back to try again on any statement that causes an error. As we have explained, the statement that may cause an error is in line 480, which won't affect the plotter no matter how many times it's tried.

Using Your Word Processor

All the commands the HC100 understands are expressed in combinations of letters and numbers. Therefore, you can use your word processing program to send information to the plotter. Generally, you just type in the commands and then print the file as if you were using a printer. The HC100 interprets the commands and produces a drawing.

If possible, you should tell your word processor that you have a very simple printer, usually called a TTY or draft printer. This prevents your word processing program from inserting its own printer control codes when it prints the file. You should also tell your word processor to use non-document mode if it offers that choice.

Note: Some word processing programs cannot be stopped from sending special codes to the printer. These programs are not suitable for use with the HC100.

Figure 7-2 shows an example of a simple engineering drawing of a bushing.

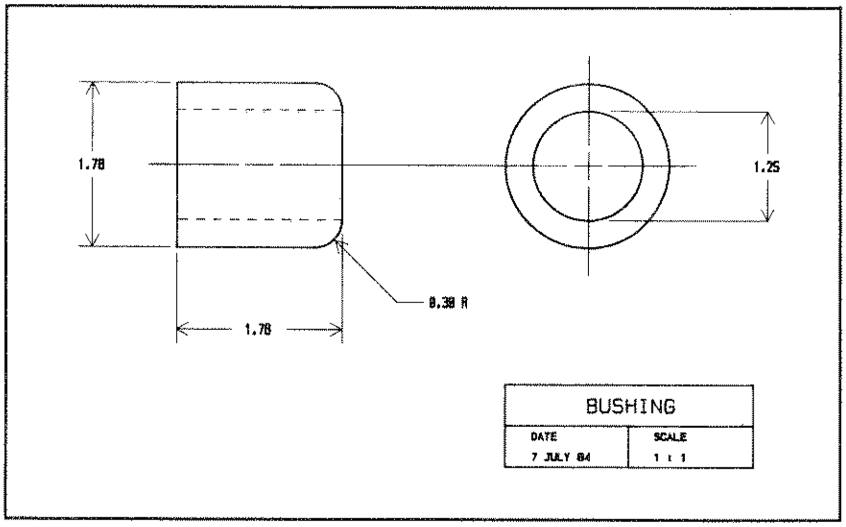


Figure 7-2. An engineering drawing

This drawing can be produced by a list of commands typed into your word processer. Figure 7-3 shows the sketch used to create the bushing drawing. The sketch was made on graph paper so that the positions of the various points could be identified easily. Notice that many of the point coordinates are written on the sketch.

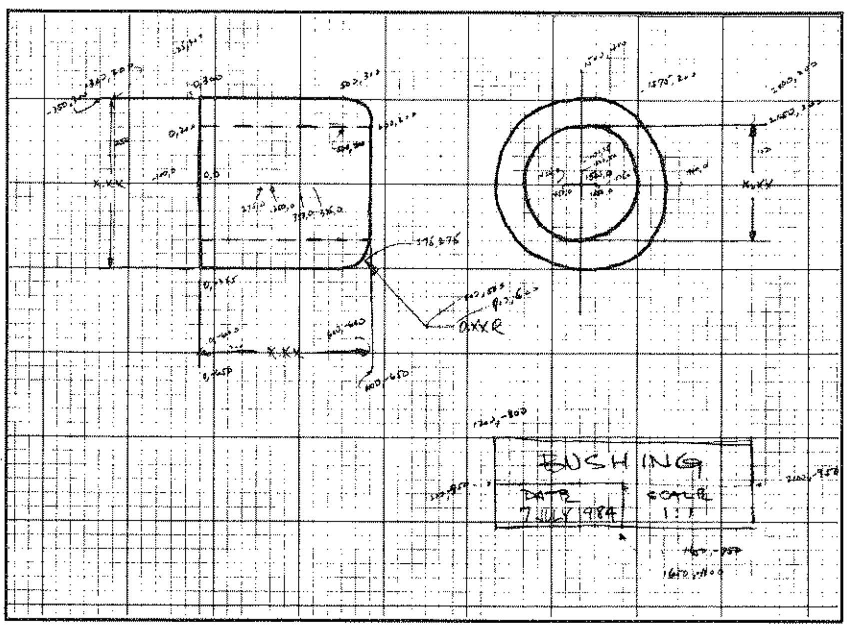


Figure 7-3. Sketch of bushing

You can compare the values used in the command list that follows with those on the sketch. Notice that the origin was moved to the center line at the left edge of the bushing. This made it easy to determine the vertical coordinates since the bushing is symmetrical. The coordinates below the center line are simply the negative of the corresponding coordinates above the center line.

As you look at the command list, notice there are some lines of text mixed in with the plotter commands. These are comments which tell you the purpose of the different sections of the listing.

Each comment is followed by a CI command which resets the error state which is produced when the comments are sent to the plotter. Also notice that the commands are all typed in lower case letters; these work just as well as capitals.

```
ci

Initialize plotter
ci
ma 4ØØ, 126Ø
or
if 8, 1Ø

Outline bushing
ci
ma Ø, 3ØØ
da 5ØØ, 3ØØ
ca 5ØØ, 2ØØ, 1ØØ, 9ØØ, Ø
da 6ØØ, -2ØØ
ca 5ØØ, -2ØØ, 1ØØ, 36ØØ, 27ØØ
da Ø, -3ØØ
da Ø, 3ØØ

Hidden lines
ci
sp 3
lt 1
lp 63
ma Ø, 2ØØ
da 6ØØ, 2ØØ
ma 6ØØ, -2ØØ
da Ø, -2ØØ
lt Ø
```

Center lines

```
ci
sp 4
ma -100, 0
da 225, 0
ma 250, 0
da 350, 0
ma 375, 0
da 1425, 0
ma 1450, 0
da 1550, 0
ma 1575, 0
da 1900,0
ma 1500, 400
da 1500, 75
ma 1500, 50
da 1500, -50
ma 1500, -75
da 1500, -400
```

End view

```
ci
sp 1
ca 1500, 0, 300, 0, 3600
ca 1500, 0, 200, 0, 3600
```

Dimension lines

```
ci
sp 2
ma 1575, 200
da 2150, 200
ma 2150, 200
ar 0, 50, 300, 0, -150, 1
ma 2150, -50
ar 0, 50, 300, 0, -150, 0
ma 2150, -200
da 1575, -200
ma 575, -275
ar 0, 50, 300, 225, -225, 1
da 900, -500
ma 600, -250
da 600, -650
ma 600, -600
ar 0, 50, 300, -200, 0, 1
ma 200, -600
ar 0, 50, 300, -200, 0, 0
```

```
ma Ø, -65Ø
da Ø, -325
ma -25, -3ØØ
da -35Ø, -3ØØ
ma -3ØØ, -3ØØ
ar Ø, 5Ø, 3ØØ, Ø, 25Ø, 1
ma -3ØØ, 5Ø
ar Ø, 5Ø, 3ØØ, Ø, 25Ø, Ø
ma -35Ø, 3ØØ
da -25, 3ØØ

Dimensions
ci
sp 1
si 36, 24
ma -348, -18
la1.78
ma 252, -618
la1.78
ma 925, -518
laØ.3Ø R
ma 21Ø2, -18
la1.25

Title box
ci
sp 1
ma 12ØØ, -8ØØ
hb Ø, 9ØØ, -3ØØ, Ø, Ø
ma 12ØØ, -95Ø
da 165Ø, -95Ø
da 165Ø, -11ØØ
ma 165Ø, -95Ø
da 21ØØ, -95Ø

Text in title box
ci
ma 15ØØ, -9ØØ
si 48, 48
laBUSHING
si 24, 24
ma 13ØØ, -1ØØØ
laDATE
ma 175Ø, -1ØØØ
```

```
laSCALE
ma 1300, -1075
la7 JULY 84
ma 1750, -1075
la1 : 1
```

When the plotter is initialized the origin is moved to the left edge of the bushing at the center line. This makes it easy to draw a symmetrical part.

The drawing is made from left to right, and then the dimension lines are added from right to left. The actual dimensions are added and then the title block is drawn and the title and other information is added.

There is one problem that may arise when using your word processor to send commands to the HC100. Because some of the advanced functions of the HC100 take quite a bit of time, your word processing program may become impatient and report that there is a problem with the plotter. Usually the program asks if you want to continue. Generally, if you wait until the plotter stops, and then reply yes, you can continue.

In some cases, however, a few characters get dropped when the word processor stops. This invariably causes an error on the HC100. If this happens to you, put in a few blank lines in the listing directly after functions that take a long time, like hatched bars and pie sections. The blank lines catch the errors and plotting is not interrupted.

Adapting Logo Programs

Logo is a popular teaching language which has extensive graphics capabilities. Logo programs are made up of procedures (which are similar to subroutines in other computer languages). The definitions of the procedures tell the computer what to do. You only need to define three new procedures to adapt Logo programs to use the HC100.

The first procedure that you need to add is a procedure to set up the plotter. This procedure changes the origin of the plotter to the center of the sheet since Logo's origin is in the center of the screen. It also changes the scale of the plotter by setting an input factor so that the screen of your computer fits on the paper. This procedure is only called once in each program.

The other two procedures are similar; they move the plotter's pen to follow Logo's turtle on the screen. One procedure draws a line while it moves the pen, and the other moves the pen without drawing. These procedures are inserted into the program anywhere there is a command to move the turtle. The first is used if the turtle's pen is down, the other if the turtle's pen is up.

Look at what's in these procedures. The sample procedures listed here are in IBM Logo. Other versions of Logo may require some modifications.

```
TO SETUP
OPEN "LPT1
SETWRITE "LPT1
PRINT [DF]
PRINT [MA 1255, 960]
PRINT [OR]
PRINT [IF 5, 1]
MAKE "X INT (XCOR)
MAKE "Y INT (YCOR)
(PRINT [MA] :X [,] :Y)
END
```

This procedure sets up the plotter. First it opens LPT1 which is the plotter (assuming that it is connected to parallel port number one), and directs all writing to it. Then there is a series of four PRINT commands that initialize the plotter, move the origin to the center of the sheet, and change the scale. Finally the plotter's pen is moved to correspond to the current position of the turtle.

```
TO PLOT
MAKE "X INT (XCOR)
MAKE "Y INT (YCOR)
(PRINT [DA] :X [,] :Y)
END
```

This procedure finds the current position of the turtle and draws a line to the corresponding point on the plotter.

```
TO MOVE
MAKE "X INT (XCOR)
MAKE "Y INT (YCOR)
(PRINT [MA] :X [,] :Y)
END
```

This procedure looks almost the same as the last, but the command to the plotter in the PRINT command is move instead of draw. Use it when the turtle moves with the pen up.

With these three simple procedures you can adapt your Logo programs to use the HC100. As you become comfortable using the plotter with Logo you may want to create your own procedures to change pen colors and do other functions.

Here is a simple program that uses the three procedures that we have seen to adapt a program for the HC100. This program uses a recursive procedure (a procedure that calls itself) to draw a Sierpinski curve (see Figure 7-4).

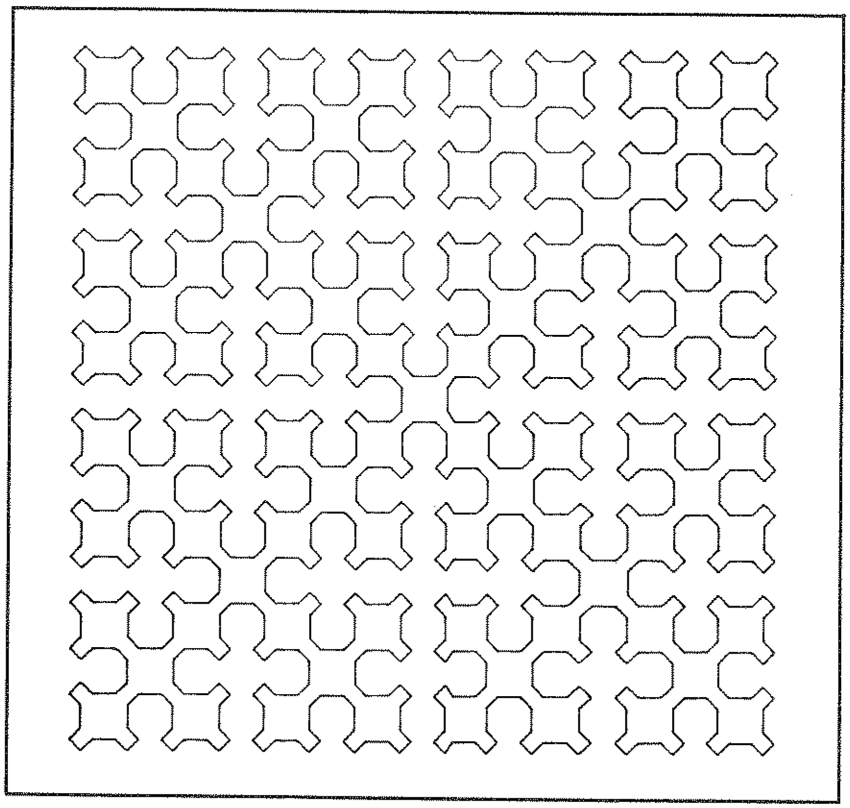


Figure 7-4. The Sierpinski curve

```
TO SIERPINSKI
CLEARSCREEN
FULLSCREEN
HIDETURTLE
SETUP
PENUP
SETPOS [-1ØØ -1ØØ] MOVE
PENDOWN
DRAW.SIERP 6 4
SETWRITE "CON
CLOSE "LPT1
END

TO SETUP
OPEN "LPT1
SETWRITE "LPT1
PRINT [DF]
PRINT [IF 1,1]
PRINT [MA 1255, 96Ø]
PRINT [OR]
PRINT [IM 31, 11]
PRINT [IF 5, 1]
END

TO PLOT
MAKE "X INT (XCOR)
MAKE "Y INT (YCOR)
(PRINT [DA] :X  :Y)
END

TO MOVE
MAKE "X INT (XCOR)
MAKE "Y INT (YCOR)
(PRINT [MA] :X [,] :Y)
END

TO DRAW.SIERP :SIDE :LEVEL
MAKE "DIAGONAL :SIDE / SQRT 2
REPEAT 4 [DRAW.SIDE :LEVEL RIGHT 45 FORWARD
   :DIAGONAL PLOT RIGHT 45]
END

TO DRAW.SIDE :LEVEL
IF :LEVEL = Ø [STOP]
```

```
DRAW.SIDE :LEVEL - 1
RIGHT 45
FORWARD :DIAGONAL PLOT
RIGHT 45
DRAW.SIDE :LEVEL - 1
LEFT 9Ø
FORWARD :SIDE PLOT
LEFT 9Ø
DRAW.SIDE :LEVEL - 1
RIGHT 45
FORWARD :DIAGONAL PLOT
RIGHT 45
DRAW.SIDE :LEVEL - 1
END
```

The three procedures have been added, and the commands to use them have been added in the proper places. Study this program to see how to adapt your programs for use with the HC100 plotter.

Plotting with Spreadsheets

You can use the HC100 to make graphs by setting up plotting commands on your spreadsheet. This can be very useful if you have a spreadsheet program which doesn't support graphics or if you want to take advantage of the state-of-the-art plotting offered by the HC100 plotter.

This section explains the general concepts of plotting with spreadsheets and offers some helpful hints. You'll learn how to draw a bar chart with SuperCalc.

Note: If you use a spreadsheet program other than SuperCalc you may have to make slight changes to adapt the HC100 to your particular spreadsheet.

General concepts and hints

You can use any of the HC100's command sets with your spreadsheet program, but command set 0 is the most powerful. It is used here to demonstrate the versatility of the HC100.

The spreadsheet file is divided into two areas: the normal worksheet area and the plotter command area. The normal worksheet area consists of the usual information and formulas. The plotter command area incorporates the information from the worksheet area into commands for the plotter.

Many of the concepts of developing spreadsheets are used in setting up graphics data. Formulas are used whenever possible so that changing information is a matter of changing one entry. Let your spreadsheet program do the work for you!

Enter your graphics plotting commands just as you would spreadsheet information. You can use all of the same spreadsheet functions to format the plotter commmands. When you're finished you'll use the output command to print the spreadsheet in basically the same way as you would a normal worksheet. As you'll see later in the bar chart example, only the rows that contain plotter commands are sent to the plotter.

Here are some additional hints to keep in mind when you set up your graphics data:

1. Each command must be entered in a separate row because the carriage return at the end of the row executes each command when the spreadsheet is printed.

2. Use cell values for information like the coordinates of the origin of your graph and perhaps pen colors. Enter these values in cells below your worksheet area, but above the plotter command area. Be sure that they are not in the same rows as plotter commands. Using cell values for this information makes it easy to find and change. You can use labels next to these cells if you find it helpful (remember to put the labels in a separate cell from the actual value).

3. You should enter the beginning of each command, the parameters, and the delimiters (usually commas) in separate cells. This provides built-in flexibility for changes. For example, for the command MA 300,400 you would enter MA in the first cell, 300 in the second cell, the comma (,) in the third cell, and 400 in the fourth cell. Remember that the MA and the comma must be entered as text entries.

4. To develop X and Y coordinates of points on your graph, use the cell values of your origin points in formulas whenever possible. Build formulas based on your origin points to move to other points on your graph.

5. When using commands that take a long time, insert a blank row (or two) after them to give the plotter time to finish each command. You'll find that less errors occur while the HC100 is plotting.

6. Be sure that nothing else is on the spreadsheet in the same rows as plotter commands. Any other entries in these rows cause errors when they are sent to the plotter.

Of course the best way to help you get started is to show you an example. So here goes.

Drawing a bar chart with SuperCalc

The bar chart shown in Figure 7-5 was drawn using the SuperCalc spreadsheet program. The actual spreadsheet is shown in Figure 7-6. If you use another spreadsheet program you can still use this example. Similar rules apply in setting it up, but the formulas may be slightly different.

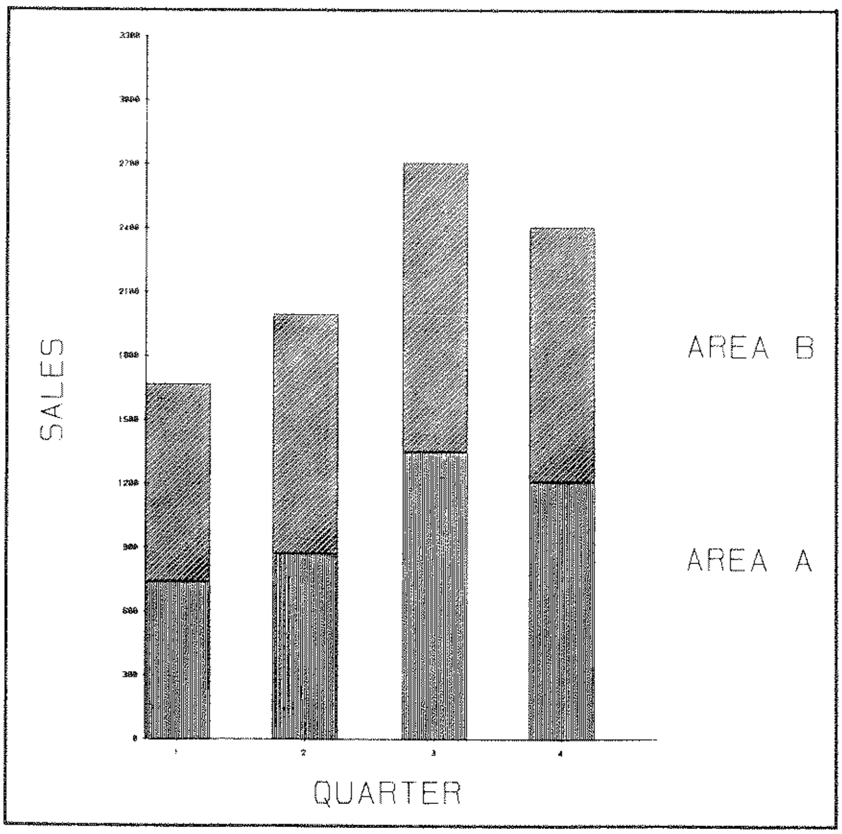


Figure 7-5. Bar chart drawn using SuperCalc

```
  :     A      ::     B      ::     C      ::     D      ::     E      ::     F      ::     G      ::     H      :
 1:
 2:SALESMAN                  1ST QTR      2ND QTR      3RD QTR      4TH QTR
 3:
 4:AREA A
 5:Jones                     237          323          475          468
 6:Smith                     268          237          449          412
 7:Green                     234          313          426          351
 8:
 9:TOTAL                     SUM(C5:C7)   SUM(D5:D7)   SUM(E5:E7)   SUM(F5:F7)
10:
11:AREA B
12:Williams                  326          379          461          369
13:Bolton                    289          356          437          372
14:Rogers                    312          386          457          453
15:
16:TOTAL                     SUM(C12:C14) SUM(D12:D14) SUM(E12:E14) SUM(F12:F14)
17:
18:
19:
20:******       HI-80        GRAPHICS     PLOTTING     DATA         ******
21:
22: 2           600
23:             300
24:CI
25:IM31,2
26:IF1,2
27:SP1
28:
29:MA           700          ,            400
30:AX2,3300,11,0,0,3300,30,1
31:
32:MA           B29          ,            D29
33:DR           B22*4        ,            0
34:MA           B29+(B23/2)  ,            D29
35:AX1,         B22          ,            3,0,1,1,50,0
36:SI100,100
37:MA           B29+(B33/3)  ,            D29-300
38:LAQUARTER
39:MA           B29-400      ,            D29+1400
40:DI900
41:LASALES
42:DI0
43:MA           B29+B33+300  ,            2200
44:LAAREA B
45:MA           B43          ,            1200
46:LAAREA A
47:
48:SP2
49:MA           B29          ,            D29
50:HB           A22          ,            B23          ,            C9           ,            10,0
51:
52:SP4
53:MA           B29          ,            D49+F50
54:HB           A22          ,            B23          ,            C16          ,            10,3
55:
56:SP2
57:MA           B53+B22      ,            D29
58:HB           A22          ,            B23          ,            D9           ,            10,0
59:
60:SP4
61:MA           B57          ,            D57+F58
62:HB           A22          ,            B23          ,            D16          ,            10,3
63:
64:SP2
65:MA           B61+B22      ,            D29
66:HB           B62+B27      ,            B23          ,            E9           ,            10,0
67:
68:SP4
69:MA           B65          ,            D65+F66
70:HB           A22          ,            B23          ,            E16          ,            10,3
71:
72:SP2
73:MA           B69+B22      ,            D29
74:HB           A22          ,            B23          ,            F9           ,            10,0
75:
76:SP4
77:MA           B73          ,            D73+F74
78:HB           A22          ,            B23          ,            F16          ,            10,3
79:
80:DF
81:SP0
```

Figure 7-6. Spreadsheet used to draw bar chart

The actual worksheet is developed in rows 1 through 16. The totals in rows 9 and 16 are used to determine the height of the bars for AREA A and AREA B, respectively.

Several constants are shown in rows 22 and 23. Plotter commands are in rows 24 to 81. Notice that some rows are blank. As previously mentioned, this gives the plotter time to carry out commands that take longer.

Rows 22 and 23 contain values which can later be changed to alter the graphs. These cells are used in formulas in the plotter commands. By changing the constant, SuperCalc automatically changes all the appropriate commands.

Cell A22 contains the value which determines the type of bar to be drawn by the HB command. The value is 2 in this example which draws a box and hatches it.

Cell B22 contains the value for the separation of the bars and B23 the width (*x-length*) of the bars. These values are also used later when the hatched bars are actually drawn.

The plotter commands start at row 24. The first several rows set up the plotter and change the input ratio so that all coordinates are multiplied by one-half.

Row 29 uses the MA command to move the pen to the absolute coordinates 700,400 which is the origin of the graph. Cell B29 contains the x coordinate and cell D29 contains the y coordinate. Since these coordinates are used later, each value is entered in a separate cell. Row 30 draws the Y-axis with the AX command. Row 32 moves the pen back to the axes origin (note that the origin is now specified in terms of cell values and not absolute numbers).

The next three rows (33 to 35) contain formulas to develop an X-axis flexible to the number of bars you want to draw. This example draws eight bars (representing the four fiscal quarters of the graph in AREA A and B). By changing the values in these formulas you can, for example, draw bars representing the months of the year.

Row 33 draws a line which is longer than the X-axis to be drawn in row 35. This is done by entering the formula B22*4 into cell B33 so that the plotter draws a relative line four times as long as the bar separation (600). The *dx,dy* coordinates become 2400,0.

Row 34 moves the pen back along the X-axis with the MA command. In cell B34 the absolute *x* coordinate is B29 plus (B23/2) or 700 + half a bar width. The absolute *y* coordinate is 400.

With the pen position now at the coordinates 850,400 row 35 draws the X-axis as three lengths of 600 each with the AX command.

Rows 36 to 47 select the character size and direction as well as the position of each label. The rest of the rows (49 to 75) select the pen color and draw the hatched bars.

As the plotter draws each hatched bar, it must first locate the starting point. The MA commands in rows 50, 53, 57, 60, 64, 67, 71, and 74 accomplish this. The first one is easy. It's the axes' origin (700,400) in row 50. The *x* coordinates for subsequent bars are determined as follows.

If the pen is moving from an AREA A to an AREA B bar, the *x* coordinate remains the same. If the pen is moving from an AREA B to an AREA A bar, the *x* coordinate is determined by adding the bar separation constant of 600 to the origin constant of 700; then subsequent *x* coordinates are determined by adding 600 again to the previous new total.

Determining the *y* coordinates follows a different pattern. If the pen is moving from an AREA B to an AREA A bar, the *y* coordinate is always the origin constant of 400. If the pen is moving from an AREA A to an AREA B bar, the *y* coordinate is determined by adding the total *y* length of the previous AREA A bar (actually the spreadsheet totals) to the origin constant of 400.

Each of the bars are drawn with the HB commands in rows 51, 54, 58, 61, 65, 68, 72, and 75. The type of hatched bar is expressed as the constant 2 (A22) which draws the bar and hatches it. The *x* length is the constant 300 (B23). The y length of all the bars are determined by the spreadsheet totals in rows 9 and 16. At the end of these rows, the pitch is 10 and the style of hatching pattern alternates (*style* = 0 for AREA A; *style* = 3 for AREA B).

When all the hatched bars have been drawn, the DF command in row 77 sets all the values to the default state and returns the pen to the plotter's origin (0,0). Row 78 caps the pens with the command SPØ (the number zero).

Before you print the file, turn off the borders (/GB), for the plotter cannot read the borders and an error occurs. Be sure that the page width is set to 132 columns (use the /Output — Setup option). Then use the output command to print rows A24 to H81 (/Output,Display, A24:H81⟨RET⟩Printer).

Your printout should look like Figure 7-5 (only yours will be in full color). If you get any errors, go back and compare your file with Figure 7-6, correct the errors, and reprint rows A24 to H81.

Using the concepts given here you should be able to produce nice graphics with your HC100 plotter and any spreadsheet program.

Chapter 8
Printer Emulator Command Summary

This chapter summarizes the printer commands used when the printer emulator command set is selected. In the printer command set, the HC100 acts like an Epson RX-80 printer and formats and prints text. Although the HC100 does not have all capabilities of an Epson dot-matrix printer (specifically, bit image graphics), it does handle most of the standard printing functions. There are also commands that are unique to the HC100.

The printer command set is selected in the following ways:

1. By holding the CAP/OFF button down while turning the power switch on.

2. By sending the code ⟨DC2⟩ (which is ASCII 18)

The printer commands are organized into five logical groups: Vertical Spacing commands, Horizontal Spacing commands, Print Style commands, and Miscellaneous commands. Each command is described in terms of its function and format.

The *function* is what the plotter does when given the proper command. The *format* is the correct syntax for the ASCII code that the plotter understands. When *n* (or another italic letter) is used as a variable, it stands for a numerical value. The *description* is how the plotter performs the command and what variable values are used (if any).

While this chapter lists all of the printer commands used by the HC100 plotter, the descriptions are not complete in all cases. The complete description of all the commands can be found in the Programmer's Section of this manual.

The ASCII codes used in this chapter are represented by abbreviated names between angle brackets, like this: ⟨ESC⟩. This chart provides the decimal values of the codes that the names represent.

NAME	VALUE
⟨NUL⟩	0
⟨BS⟩	8
⟨HT⟩	9
⟨LF⟩	10
⟨VT⟩	11
⟨FF⟩	12
⟨CR⟩	13
⟨SO⟩	14
⟨SI⟩	15
⟨DC2⟩	18
⟨DC4⟩	20
⟨ESC⟩	27
⟨GS⟩	29
⟨DEL⟩	127

Vertical Spacing Commands

Function:
Line feed

Format:
⟨LF⟩

Description:
Returns the print head to the left margin and advances the paper one line.

Function:
One-time *n*/216 inch line feed

Format:
⟨ESC⟩ "J" *n*

Description:
Advances the paper *n*/216 inches (*n* can range from 0 to 255). It does not execute a carriage return.

Function:
Set 1/8 inch line spacing

Format:
⟨ESC⟩ "0"

Description:
Sets the line spacing for subsequent line feed commands to 1/8 inch.

Function:
Set 7/72 inch line spacing

Format:
⟨ESC⟩ "1"

Description:
Sets the line spacing for subsequent line feed commmands to 7/72 inch.

Function:
Set 1/6 inch line spacing

Format:
⟨ESC⟩ "2"

Description:
Sets the line spacing for subsequent line feed commands to 1/6 inch.

Function:
Set *n*/216 inch line spacing

Format:
⟨ESC⟩ "3" *n*

Description:
Sets the line spacing for subsequent line feed commands to *n*/216 inch (*n* can range from 0 to 255).

Function:
Set *n*/72 inch line spacing

Format:
⟨ESC⟩ "A" *n*

Description:
Sets the line spacing for subsequent line feed commmands to *n*/72 inches (*n* can range from 0 to 85).

Function:
Auto line spacing for extended height characters

Format:
⟨GS⟩ "F" *n*

Description:
Adjusts the line spacing to 7/4 the height of the characters on the previous line. This command is used to prevent overlapping characters of one line with characters of the next line when changing the character height.

Function:
Form feed

Format:
⟨FF⟩

Description:
Ejects the paper, stows and caps the pens, and flashes the on-line indicator for paper changing.

Function:
Set page length by lines

Format:
⟨ESC⟩ "C" *n*

Description:
Sets the length of the page to *n* lines (*n* can range from 1 to 127). The page length must not exceed the effective drawing area.

Function:
Set page length by inches

Format:
⟨ESC⟩ "C" ⟨NUL⟩ *n*

Description:
Sets the page length to *n* inches (*n* can range from 1 to 22). The page length must not exceed the effective drawing area.

Function:
Set bottom margin

Format:
⟨ESC⟩ "N" *n*

Description:
Sets a bottom margin of *n* lines (*n* can range from 1 to 127). When the bottom margin is reached a form feed (FF) is automatically sent.

Function:
Cancel bottom margin

Format:
⟨ESC⟩ "O"

Description:
Sets the bottom margin to 0 lines. The command uses the letter "O", not the number zero.

Function:
Vertical tab

Format:
〈VT〉

Description:
Advances the paper to the next vertical tab position. If no vertical tabs have been set, this code advances the paper one line.

Function:
Absolute vertical tab

Format:
〈ESC〉 "f" 1 *n*

Description:
Moves the paper to line *n* (*n* can range from 1 to 254).

Function:
Set vertical tabs

Format:
〈ESC〉 "e" 1 *n*

Description:
Sets vertical tabs at every *n* positions (*n* can range from 1 to 255).

Horizontal Spacing Commands

Function:
Carriage return

Format:
〈CR〉

Description:
Returns the print head to the left margin. If auto-line feed is on then the paper is advanced one line also.

Function:
Set right margin

Format:
⟨ESC⟩ "Q" *n*

Description:
Sets a right margin at *n* character columns of the current character width (*n* can range from 1 to 255). This command must be sent at the beginning of a line. If a line to be printed exceeds the right margin a carriage return and line feed are inserted to keep the line from exceeding the right margin.

Function:
Set left margin

Format:
⟨ESC⟩ "l" *n*

Description:
Sets the left margin at *n* character positions of the current character width (*n* can range from 1 to 160). If the value of *n* is too large, that is, if it results in a left margin greater than 8 inches, the command is ignored. This command should be placed at the beginning of a line and uses the lower-case letter "l", not the number one.

Function:
Horizontal tab

Format:
⟨HT⟩

Description:
Advances the print head to the next horizontal tab position. The default tab settings are every 8 characters.

Function:
Absolute horizontal tab

Format:
⟨ESC⟩ "f" ⟨NUL⟩ *n*

Description:
Moves the pen to column *n*, counting from the left margin and using the current character width (*n* can range from 1 to 137).

Function:
Set horizontal tabs

Format:
〈ESC〉 "e" 〈NUL〉 *n*

Description:
Sets horizontal tabs at every *n* character positions of the current character width (*n* can range from 1 to 255).

Print Style Commands

Function:
Select elite width print

Format:
〈ESC〉 "M"

Description:
Selects elite width (12 characters per inch) printing.

Function:
Cancel elite width print

Format:
〈ESC〉 "P"

Description:
Cancels elite width printing and returns to pica width (10 characters per inch) printing.

Function:
One-line expanded width print

Format:
〈SO〉

Description:
Selects expanded (double width) printing for the remainder of the current line (unless explicitly canceled sooner).

Function:

One-line expanded width print

Format:

⟨ESC⟩ ⟨SO⟩

Description:

Selects expanded (double width) printing for the remainder of the current line (unless explicitly canceled sooner). This command is the same as ⟨SO⟩.

Function:

Cancel one-line expanded width print

Format:

⟨DC4⟩

Description:

Cancels one-line expanded (double width) printing before the end of the line.

Function:

Expanded width print on/off

Format:

⟨ESC⟩ "W" *n*

Description:

Turns expanded (double width) printing on ($n=1$) or turns expanded width printing off ($n=0$).

Function:

Select compressed width print

Format:

⟨SI⟩

Description:

Selects compressed width (17.16 charcters per inch) printing.

Function:

Select compressed width print

Format:

⟨ESC⟩ ⟨SI⟩

Description:

Selects compressed width (17.16 charcters per inch) printing. This command is the same as ⟨SI⟩.

Function:
Cancel compressed width print

Format:
⟨DC2⟩

Description:
Cancels compressed width printing.

Function:
Set character height

Format:
⟨GS⟩ "H" *n1 n2*

Description:
Sets the character height. Character height is determined by the following formula: character height = $0.1 \times (n1 \times 256 + n2)$ mm

Function:
Set character width

Format:
⟨GS⟩ "W" *n1 n2*

Description:
Sets the character width. Character width is determined by the following formula: character width = $0.1 \times (n1 \times 256 + n2)$ mm.

Function:
Select emphasized print

Format:
⟨ESC⟩ "E"

Description:
Selects emphasized printing.

Function:
Cancel emphasized print

Format:
⟨ESC⟩ "F"

Description:
Cancels emphasized printing.

Function:
Select double-strike print

Format:
⟨ESC⟩ "G"

Description:
Selects double-strike printing.

Function:
Cancel double-strike print

Format:
⟨ESC⟩ "H"

Description:
Cancels double-strike printing.

Function:
Select italic print

Format:
⟨ESC⟩ "4"

Description:
Selects the italic character set.

Function:
Cancel italic print

Format:
⟨ESC⟩ "5"

Description:
Cancels italic printing and returns you to the normal character set.

Function:
Select italic print and define slant

Format:
⟨GS⟩ "I" *n1 n2*

Description:
Select italic printing and define the degree of slant at which the characters will be printed. The angle of slant is calculated by:
Tan (angle) = $n1 + n2/256$.

Function:
Underline on/off

Format:
⟨ESC⟩ "-" *n*

Description:
Turns underlining on ($n=1$) or turns underlining off ($n=0$).

Function:
Select superscripts or subscripts

Format:
⟨ESC⟩ "S" *n*

Description:
Selects superscripts ($n=0$) or selects subscripts ($n=1$).

Function:
Cancel superscripts and subscripts

Format:
⟨ESC⟩ "T"

Description:
Cancels superscripts and subscripts.

Function:
Select international character set

Format:
⟨ESC⟩ "R" *n*

Description:
Selects one of the 11 international character sets. The following table shows the valid values of *n* and the character sets selected for each. You must use the codes for 0 to 10, not the characters. Appendix A shows the values of *n* and the characters that change in the international character sets.

Miscellaneous Commands

Function:
Backspace

Format:
⟨BS⟩

Description:
Moves the pen one character to the left. This allows you to over-strike characters.

Function:
Delete

Format:
⟨DEL⟩

Description:
Deletes the character immediately preceding it, unless the character has already been printed.

Function:
Initialize printer

Format:
⟨ESC⟩ "@"

Description:
Resets the printer to the power-on state but remains in the printer emulator command set.

Function:
Return pen to home position

Format:
⟨ESC⟩ "⟨"

Description:
Returns the pen to the left margin of the same line.

Function:

Select printing direction

Format:

⟨GS⟩ "D" n

Description:

Prints lines along the X- or Y-axis. When $n = 0$ the lines are printed as they normally would be in a document (along the Y-axis). When $n = 1$ lines are printed the long way as they would be on a normal graph (along the X-axis).

Function:

Pen velocity

Format:

⟨ESC⟩ "s" n

Description:

Sets the drawing speed of the pen to 230 mm/sec ($n=0$) or 100 mm/sec ($n=1$).

Function:

Select pen

Format:

⟨GS⟩ "C" n

Description:

Selects a pen. When $n = 1, 2, 3,$ or 4 the pen is selected according to the pen numbers marked on the pen cartridge. When $n = 0$ the pens are stowed and capped. You must use the code 0 to 8 or 255, not the characters. Using $n = 0$ is the same as pressing the CAP/OFF key except that the on-line switch becomes inactive. Pressing the CAP/OFF key causes pen 1 to be selected and returned to the previous pen position. Using $n = 255$ also caps the pens but any subsequent commands cause the pen to return to the previous pen position and continue. The CAP/OFF key does not have to be pressed.

Function:
Plotter command set

Format:
<GS> "G"

Description:
Puts the HC100 into one of the the plotter command sets. If you used the CAP/OFF and power-on switches to select the printer command set then the plotter command set to be used is determined by DIP switches 4 and 5. If you selected the printer command set by using <DC2> (ASCII 18) then you'll return to plotter command set 0 regardless of the DIP switch settings.

Appendix A

HC100 Character Set

	8	P	h
!	9	Q	i
"	:	R	j
#	;	S	k
$	<	T	l
%	=	U	m
&	>	V	n
'	?	W	o
(	@	X	p
)	A	Y	q
*	B	Z	r
+	C	[	s
,	D	\	t
-	E	]	u
.	F	^	v
/	G	_	w
0	H	`	x
1	I	a	y
2	J	b	z
3	K	c	{
4	L	d	¦
5	M	e	}
6	N	f	~
7	O	g	

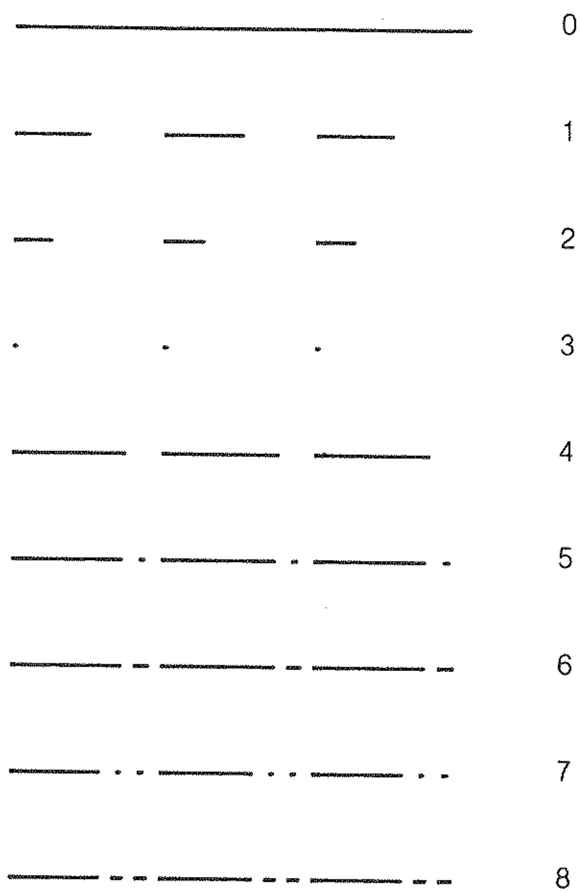
International Character Sets

	ASCII CODE (decimal)											
	35	36	64	91	92	93	94	96	123	124	125	126
0 U.S.A.	#	$	@	[	\	]	^	`	{	¦	}	~
1 France	#	$	à	°	ç	§	^	`	é	ù	è	¨
2 Germany	#	$	§	Ä	Ö	Ü	^	`	ä	ö	ü	ß
3 England	£	$	@	[	\	]	^	`	{	¦	}	~
4 Denmark	#	$	@	Æ	Ø	Å	^	`	æ	ø	å	~
5 Sweden	#	¤	É	Ä	Ö	Å	Ü	é	ä	ö	å	ü
6 Italy	#	$	@	°	\	é	^	ù	à	ò	è	ì
7 Spain	₧	$	@	¡	Ñ	¿	^	`	¨	ñ	}	~
8 Japan	#	$	@	[	¥	]	^	`	{	¦	}	~
9 Norway	#	¤	É	Æ	Ø	Å	Ü	é	æ	ø	å	ü
10 Denmark II	#	$	É	Æ	Ø	Å	Ü	é	æ	ø	å	ü

Appendix B
Symbols and Line Styles

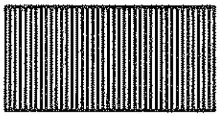
This appendix shows the various line types, symbols and types of hatching possible with the HC100.

Line Types

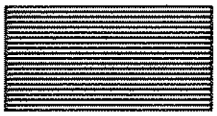


Hatch Types

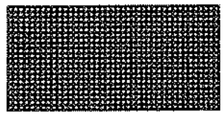
HATCH TYPE 0



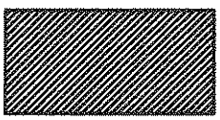
HATCH TYPE 1



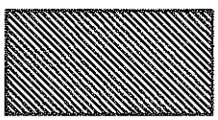
HATCH TYPE 2



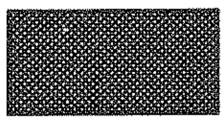
HATCH TYPE 3



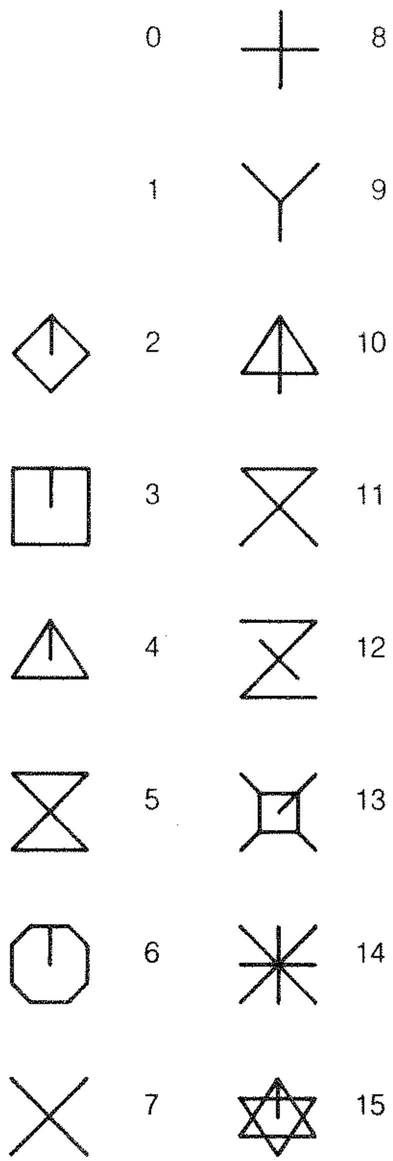
HATCH TYPE 4



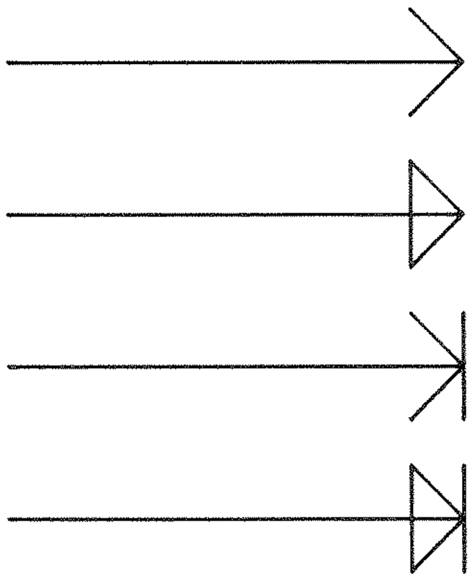
HATCH TYPE 5



Mark Types



Arrow Types



0

1

2

3

Appendix C
DIP Switches

The DIP (dual in-line package) switches affect the way the plotter operates; they give the plotter information about any options that may be installed. The DIP switches allow you to adjust the HC100 for your specific printing or plotting needs.

Also, not all computers interact the same way with the HC100. The DIP switches let you make changes to best suit the way your computer sends information to your plotter.

Before you change any DIP switch settings, you should read about how they affect the HC100's operation.

DIP Switch Settings Explained

Actually the DIP switch is one assembly containing 6 individual switches. As you can see in the illustration closeup (Figure C-1), the individual switches are numbered 1 through 6 and they can be moved to an OFF or ON position (notice the word "ON" in the lower left corner of the switch).

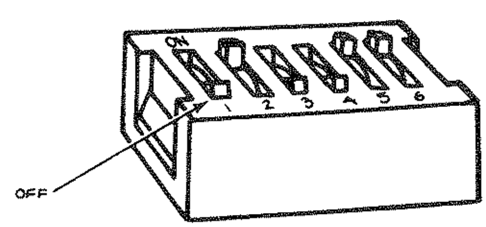


Figure C-1. The HC100 DIP switches

The functions of the six switches are summarized in Table C-1.

Table C-1 DIP switch settings

Switch	Function	Off	On	Factory
1	SLCT IN signal	Not fixed	Fixed	On
2	Automatic line feed	Disable	Enable	Off
3	RAM buffer option	Disable	Enable	Off
4	ROM option	per ROM specification		Off
5	Plotter command set	Set 0	Set 1	Off
6	Plotter area	By control panel	US letter	On

Switch 1 is used to control the select signal. Most computers require that the select signal be fixed (switch is in the ON position). If your computer requires that the select signal not be fixed, set the switch to the OFF position.

Switch 2 controls whether or not the HC100 does an automatic line feed each time it receives a carriage return while it is in the printer mode. Some computers do not send line feeds to a printer (or plotter). If your computer is like this, then switch 2 must be in the ON position.

Note: If you are using the printer emulator command set and you are getting a double line feed between lines, then both the computer and the plotter are sending a line feed. To remedy this, set DIP switch 2 to the OFF position.

Switch 3 is used when the option RAM has been installed. This RAM can be used as a print buffer or for storing user-defined characters which are downloaded into the RAM from the plotter command set 0. These characters can then be printed with either the plotter command set 0 or printer emulator command set. The user-defined commands require an option ROM.

WARNING: If you turn OFF the HC100, all information in the buffer is lost.

To use the option RAM as a print buffer switch 3 must be in the ON position; for user-defined characters switch 3 must be in the OFF position .

Switch 4 and switch 5 are used to decide which command set the HC100 uses when the power is turned on or when an initialization command is received.

Switch 4 is only used when an optional ROM has been installed. If no option ROM is installed, switch 4 is ignored.

Switch 5 selects the plotter command set. Command set 0 (Epson plotter) is selected when switch 5 is in the OFF position. Command set 1 (Graphtec emulator) is selected when switch 5 is in the ON position.

Switch 6 lets you set the effective drawing area (discussed in Chapter 3) for different paper sizes. The paper size can also be changed using the IW command (command set 0). The effective drawing area for US letter size paper is set with switch 6 in the ON position. When this switch is in the OFF position, the paper size must be set when the plotter is turned on by pressing the pen position buttons on the control panel as follows:

Up arrow = B5 paper size
Left arrow = US letter size
Down arrow = A4 paper size

Setting the DIP Switches

Setting the DIP switches is not difficult. However, the DIP switches are located inside the HC100. You have to open the upper case to get at them.

WARNING: **Before you open the upper case, be sure that the plotter is turned off and the power cord is unplugged from the AC outlet.**

Opening the upper case

Follow these steps:

1. If you haven't already done so, turn the power switch OFF and unplug the power cord.
2. Remove the smoked-plastic cover to expose the two retaining screws located at the front of the plotter (Figure C-2).

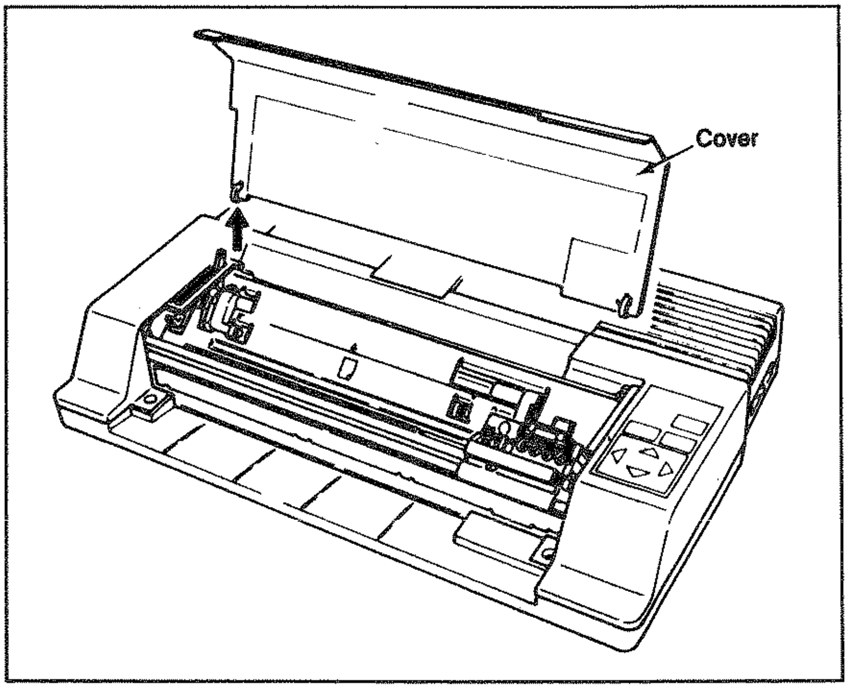


Figure C-2. Removing the plastic cover

3. Using a #2 Phillips screwdriver, remove the two retaining screws (Figure C-3).

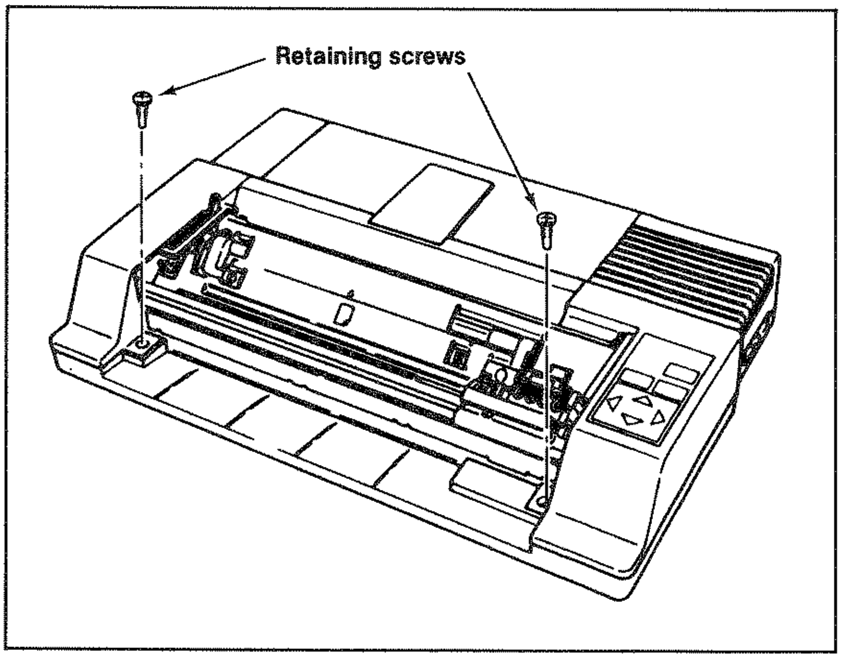


Figure C-3. Removing the retaining screws

4. Slowly tilt up the front of the case but be careful not to pull back too far or you may loosen the wires attached to the connector or the upper case (Figure C-4).

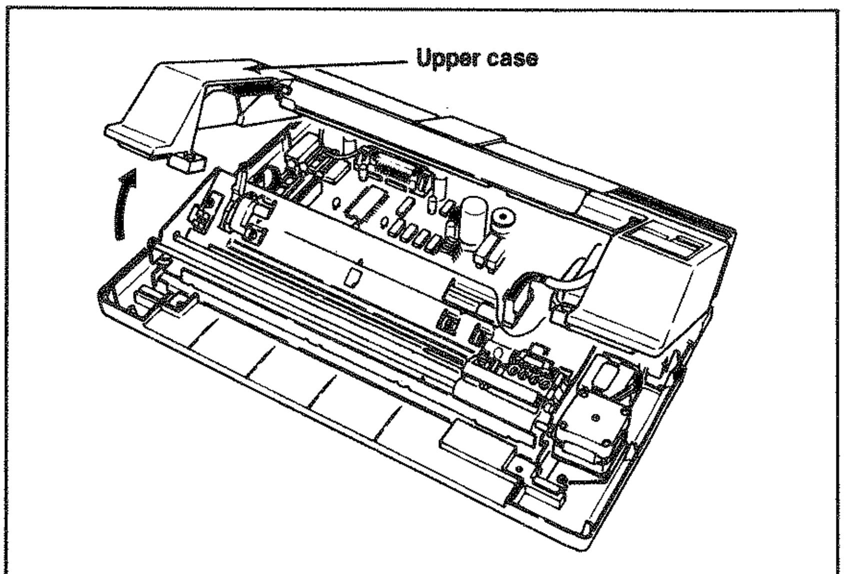


Figure C-4. Tilting open the upper case

Changing the DIP switches

While tilting the upper case back with one hand, you can now change the DIP switch positions with the other hand using a ballpoint pen or matchstick. The DIP switches are located on the main circuit board next to the interface connector (Figure C-5).

CAUTION: Again, be careful not to pull back too far on the upper case while you're changing the DIP switch settings. You may loosen the wires attached to the connector or the upper case. Also be careful not to damage any of the other parts while poking around inside the plotter.

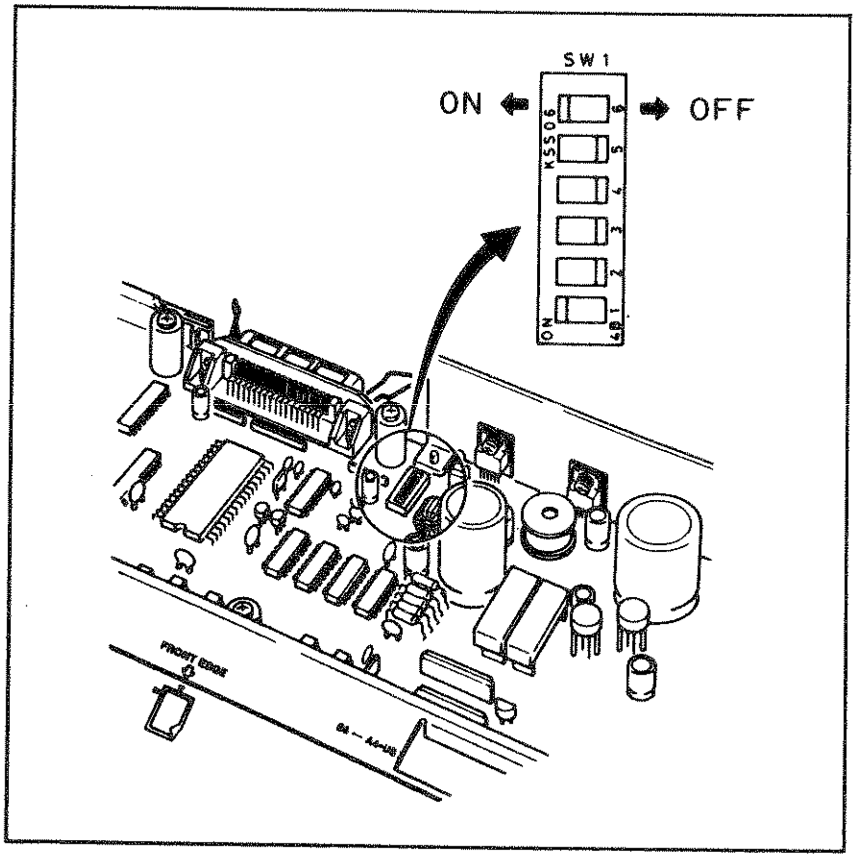


Figure C-5. Location of DIP switches

Replacing the upper case

After you have set the DIP switches (and before you reinstall the upper case), recheck to be sure they are set the way you want them. Then simply reverse the steps you used to open the upper case:

1. Carefully lower the upper case (making sure you don't pinch any of the wires) and replace the retaining screws. Do not tighten the screws too tightly or you may strip the threads.
2. Replace the smoked-plastic cover and plug the power cord back in.
3. When you're ready to use the plotter again, load the desired type of paper and turn the power switch on. The HC100 records the new DIP switch settings.

Note: These switch settings are recorded only when the power is turned ON or when an initialization command is sent to the plotter telling it to read the settings again.

Appendix D
Parallel Interface

The HC100 uses a parallel interface to communicate with the computer; this appendix describes it.

Connector pin assignments and a description of respective interface signals are shown in Table D-1.

Table D-1. Parallel interface pin assignments

Signal Pin	Return Pin	Signal	Direction	Description
1	19	STROBE	IN	STROBE pulse to read data in. Pulse width must be more than 0.5 microseconds at the receiving terminal.
2 3 4 5 6 7 8 9	20 21 22 23 24 25 26 27	DATA 1 DATA 2 DATA 3 DATA 4 DATA 5 DATA 6 DATA 7 DATA 8	IN IN IN IN IN IN IN IN	These signals represent information of the 1st to 8th bits of parallel data, respectively. Each signal is at HIGH level when data is logical 1 and LOW when it is logical 0.
10	28	ACKNLG	OUT	Approximately 12 microsecond pulse. LOW indicates that data has been received and that the plotter is ready to accept more data.
11	29	BUSY	OUT	A HIGH signal indicates that the plotter cannot receive data. The signal goes HIGH in the following cases: 1) during data entry 2) during printing 3) when Off-Line 4) during plotter-error state.
12	30	PE	OUT	Always held LOW

Table D-1, continued

Signal Pin	Return Pin	Signal	Direction	Description
13	—	—	—	Pulled up to +5 volts through 3.3K ohm resistance.
14	—	AUTO FEED XT	IN	When this signal is LOW, the paper is automatically fed 1 line after printing. (The signal level can be fixed to this by setting DIP switch 2-4 to ON.) (Printer mode only)
15	—	NC	—	Unused.
16	—	0V	—	Logic ground level.
17	—	CHASSIS GND	—	Plotter's chassis ground, which is isolated from the logic ground.
18	—	NC	—	Unused.
19 - 30	—	GND	—	Twisted-pair return signal ground level.
31	—	INIT	IN	When this level becomes LOW, the plotter controller is reset to its initial state and the print buffer is cleared. This level is usually HIGH; its pulse width must be more than 50 microseconds at the receiving terminal.
32	—	ERROR	OUT	This level becomes LOW when the printer is in: 1) Off-line state 2) error state.
33	—	GND	—	Same as for Pins 19 - 30.
34	—	NC	—	Unused.
35	—	—	—	Pulled up to +5V through 3.3K ohm resistance.
36	—	SLCT IN	IN	Data entry to the plotter is possible only when this level is LOW; DIP switch 1 is set for this at the factory.

Notes:

1. The column heading "Direction" refers to the direction of signal flow as viewed from the plotter.
2. "Return" denotes the twisted-pair return, to be connected at signal ground level. For the interface wiring, be sure to use a twisted-pair cable for each signal and to complete the connection on the return side. To prevent noise, these cables should be shielded and connected to the chassis of the host computer and the plotter.
3. All interface conditions are based on TTL level. Both the rise and the fall times of each signal must be less than 0.2 microseconds.

4. Data transfer must be carried out by ignoring ACKNLG or BUSY signal. (Data transfer to this plotter can be carried out only after configuration of the ACKNLG signal or when the level of the BUSY signal is LOW.)

Data Transfer Sequence

Interface timing

Figure D-1 shows the timing for the parallel interface.

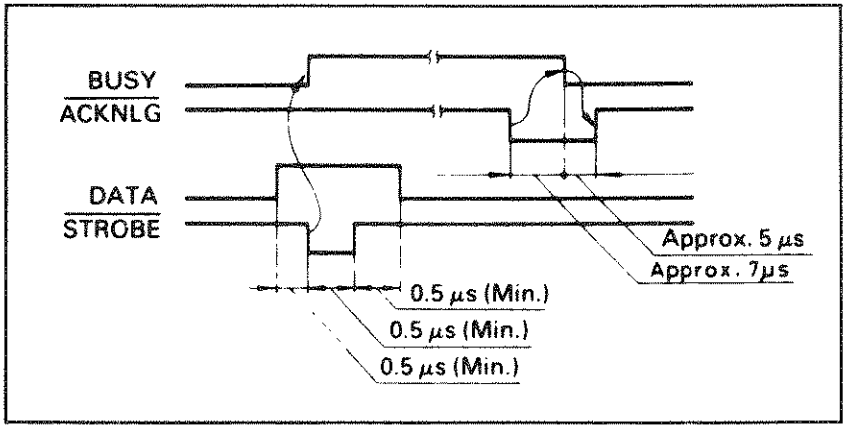


Figure D-1. Parallel interface timing

Signal relationships

Table D-2 shows the way data entry is handled in the on-line and off-line states by showing the relationships between six signal sets.

Table D-2. Signal relationships

On-Line	SLCT IN	ERROR	BUSY	ACKNLG	DATA ENTRY
OFF	HIGH/LOW	LOW	HIGH	Not generated	Disabled
ON	HIGH	HIGH	LOW/HIGH	Generated after data entry	Enabled*
ON	LOW	HIGH	same	same	Enabled (normal entry)

*Data entry will be acknowledged, but the input data will be lost until DC1 is input.

Note: ERROR status is assumed to result only in off-line state, and the ERROR status does not always mean SLCT IN.

Appendix E
Specifications of the Tektronix HC100

Drawing

Effective drawing area	10.50 in (267 mm) x 7.56 in (192 mm)
Maximum drawing speed	9 in/sec (230 mm/sec) along pen axis
Maximum resolution	0.004 in (0.1 mm)
Pen response speed	15 times/sec
Pen movement precision	Better than 0.012 in (0.3 mm) for a single pen Better than 0.020 in (0.5 mm) for different pens
Pen change precision	Within 0.012 in (0.3 mm)
Pen-up time	2 seconds during operation
Drawing modes	Self-test Epson plotter Graphtec emulator
Printing mode	Epson RX-80 printer emulator
Character types	96 ASCII characters 32 international characters (for 11 countries)
Pen Selection	Water-based ballpoint (10 colors) Water-based fiber-tipped (10 colors) Oil-based fiber-tipped (10 colors)

Pen colors	Standard: black, red, green, and blue Optional: yellow, cyan, magenta, brown, purple, and orange
Paper sizes	US letter size: 11 x 8½ in (279 mm x 216 mm) ISO A4: 297 mm x 210 mm ISO B5: 257 mm x 182 mm
Paper types	Standard paper Clear acetate film Adhesive drafting film

Plotter

Dimensions	Height: 3.19 in (81 mm) Width: 16.34 in (415 mm) Depth: 10.71 in (272 mm)
Weight	9.9 lb (4.5 kg)
Number of pens	4 in removable cassette
Power required	Voltage: 108 to 132 VAC Frequency: 49.5 to 60.5 Hz Power Consumption: 30 VA maximum
Temperature ranges	Operating: 5° to 35°C Stored: −30° to 70°C, stored
Humidity	10 to 80%, non condensing
Plotter MTBF	1000 hours (50% duty ratio), pens excluded
Pen drawing life	Water-based ballpoint 1300 ft (400 m) Water-based fiber-tipped 650 ft (200 m) Oil-based fiber-tipped 1300 ft (400 m)

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Introduction

The following gives a brief description of the features of the Tektronix HC100 Plotter and this section of the manual.

HC100 Features

Your HC100 has a long list of features. Here are just a few of the highlights:

- **Accurate high-speed plotting.** The HC100 combines superior accuracy with a drawing speed of 9-inches per second.
- **Advanced plotting functions.** The HC100 creates and cross-hatches rectangles or pie chart sections with a single command.
- **Three standard command sets.** The HC100 comes standard with an Epson HI-80 plotting command set, an Epson RX-80 printer command set, and a Graphtec plotter emulator command set.
- **Mixed text and graphics.** This feature lets you print text anywhere on the page, in several sizes and styles.
- **Multi-media plotting.** The HC100 works equally well with paper or transparency materials.
- **Four pens.** Four different color pens are available at any time. You can select among ten different colors and three different types of pens.
- **Pen cassette.** You can quickly change all four pens by simply removing the pen cassette. The pens are capped automatically to prevent drying out when not in use.

- **Compact size and light weight.** The HC100 takes up very little space and is small enough to be transported easily.

About This Manual

This manual has been broken into two main sections; a User's Section and a Programmer's Section. Each section has its own contents, chapter and page numbers, and index. Special information may also be required to operate the HC100 in conjunction with various Tektronix instruments. If this is the case, additional sections to this manual will be made available. For complete information, see your Tektronix catalog or contact your Tektronix Field Office.

This Programmer's Section contains all of the detailed information required to fully utilize the HC100's three standard command sets.

Chapters 1 and 2 of this manual cover how the HC100 plots and how to send commands to the plotter. Chapters 3 through 11 show you how the commands work (with detailed explanations of each command) as well as examples of their use. Chapters 12 through 14 are reference summaries for each of the three command sets used by the HC100.

The appendixes provide easy access to technical details such as the symbols and line styles drawn, default settings, error handling procedures, and technical specifications of the HC100.

Chapter 1
Theory of Operation

The HC100 plotter can be used with any programming language which produces text output. In order to write your own programs for use with the HC100, you need to know how the plotter actually determines where to position the pen and how to draw from point to point. The terms described in this chapter help you use the plotting commands in your programs.

Plotting with the HC100

The HC100 can position the pen at any point on the paper. The HC100 plotter (and most other plotters) uses the Cartesian coordinate system to determine where to position the pen.

The Cartesian coordinate system

The Cartesian coordinate system (shown in Figure 1-1) defines points by their distance along perpendicular *axes*. Conventionally the two axes are called the X-axis and the Y-axis. On the HC100 the X-axis is oriented in the direction that the paper moves, and the Y-axis is oriented in the direction that the pen moves.

Each point position is called an *address* and is made of two numbers. The first of the two numbers determines the point along the X-axis, the second number determines the Y-axis.

The point where the two axes cross, and which has the address 0,0, is called the *origin*. The default position is in the lower left corner of the paper when it is held with the X-axis horizontal and the Y-axis vertical. Notice that this is the upper-left corner when you are in front of the plotter. When the origin is in the default position, all points in the drawing area have positive (or zero) coordinates.

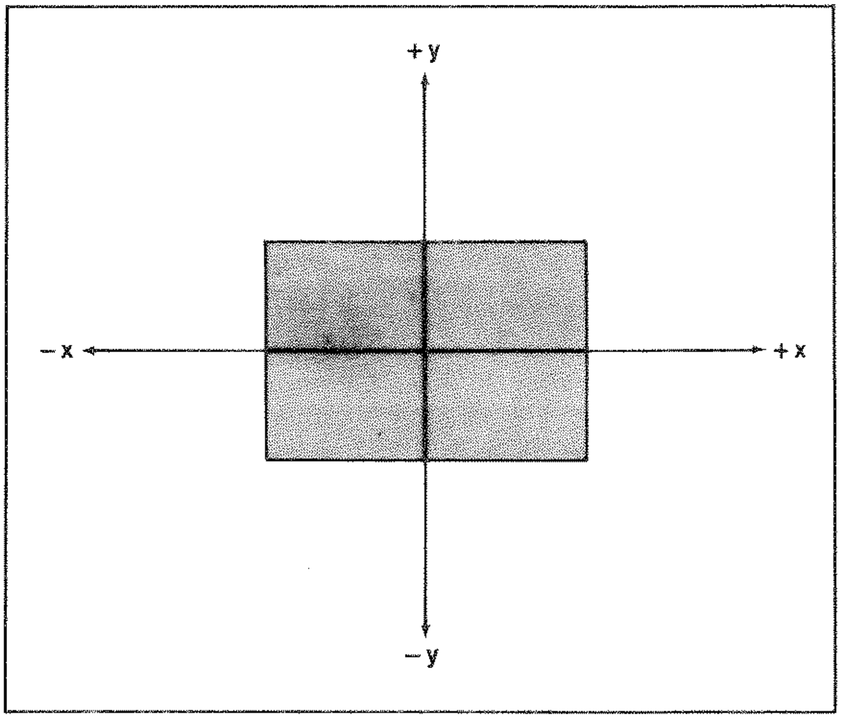


Figure 1-1. Cartesian coordinate system

The origin can be changed to any point in the drawing area. Figure 1-2 shows two possible origins on the paper.

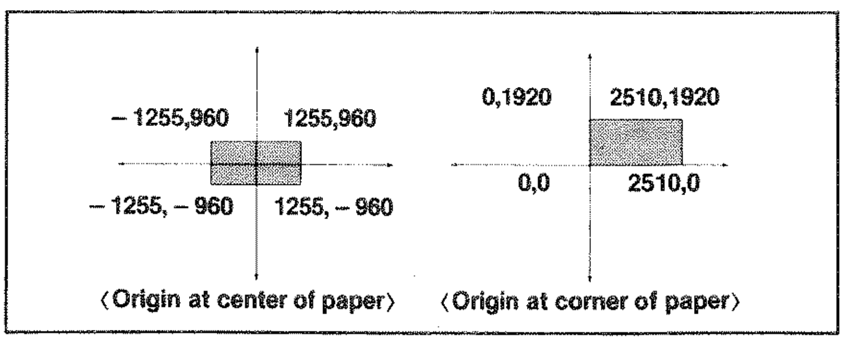


Figure 1-2. Two possible origins on the paper

Defining angles in the coordinate system

Angles are used with the HC100 plotter to define the direction of labels, and the length of curves. As is common in the Cartesian coordinate system, the positive X-axis is taken to have an angle of 0°. Angles are measured in a counterclockwise direction from this axis. Thus the positive Y-axis is at 90°, the negative X-axis is at 180°, and the negative Y-axis is at 270° (see Figure 1-3).

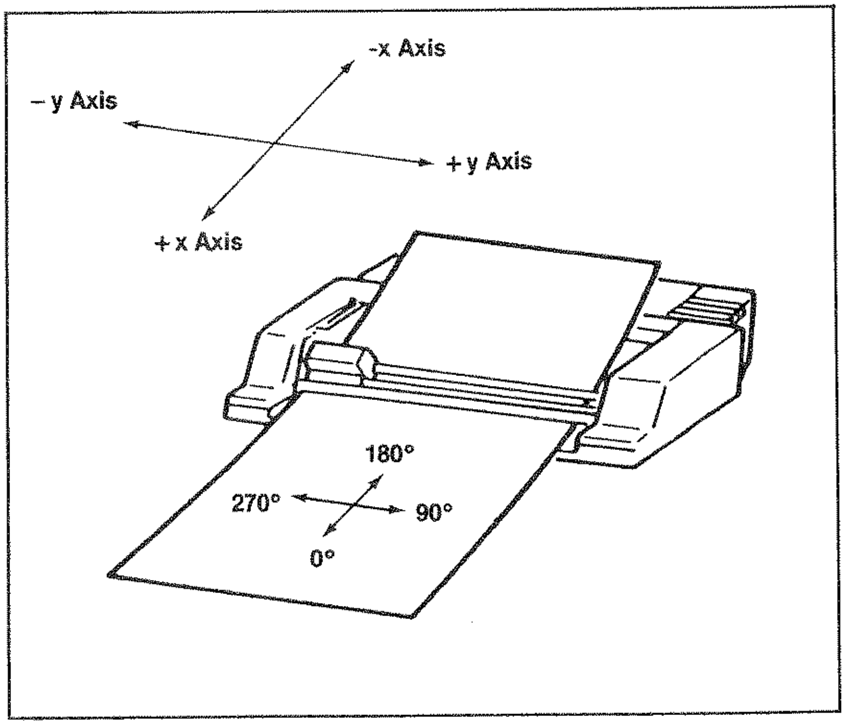


Figure 1-3. Angles on the Cartesian coordinate system

The plotter's units of measure

The HC100 plots in increments of 0.1 mm. When using US (United States) size paper (8½ x 11 inches), the full length of the X-axis direction is 251 mm. Therefore, the maximum value of an X coordinate is 2510 (you will see what happens if the plotter is given a greater value in a moment).

Units of measure for drawing figures and printing characters may be scaled to ratios other than the (default) ratio of 1:1. For example, a scaling ratio of 2:1 doubles the units of measure so that a value of 1 represents 0.2 mm.

The HC100 measures angles in 0.1°. For example, to specify 90° you must send the plotter a value of 900.

There are several default units of measure set by the HC100. For example, the scaling ratio is set to 1:1 and the line pitch to 6 mm. (Default settings for all command sets are summarized in Appendix E.)

The Effective Drawing Area

The area that the HC100 can draw on is called the *effective drawing area* which changes with the size of paper used. Figure 1-4 shows the drawing area for the three different sheet sizes used by the HC100. Notice that you cannot draw to the edge of the sheet.

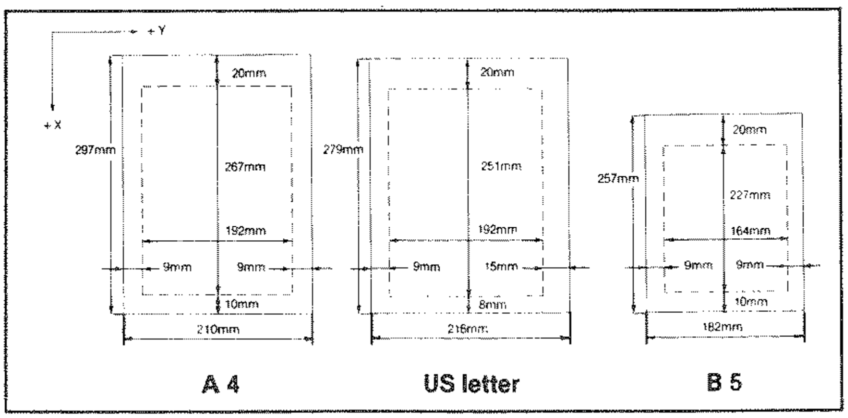


Figure 1-4. Drawing area

The HC100 cannot actually measure the size of the sheet loaded. If DIP switch 6 is on, the HC100 assumes you are using U.S. letter size paper. If DIP switch 6 is off, you must tell the plotter what size you are loading each time you turn it on (see Appendix C in the User's Section of this manual for details).

Clipping

If you try to draw a figure that takes the pen outside of the effective drawing area, the plotter draws what it can and ignores the rest. This plotting action is called *clipping*. The HC100 uses the points that are outside the drawing area to calculate the parts of the figure it can draw. The pen draws to the edge of the effective drawing area, then moves (without drawing) to the point that the figure comes back onto the paper before continuing to draw (see Figure 1-5).

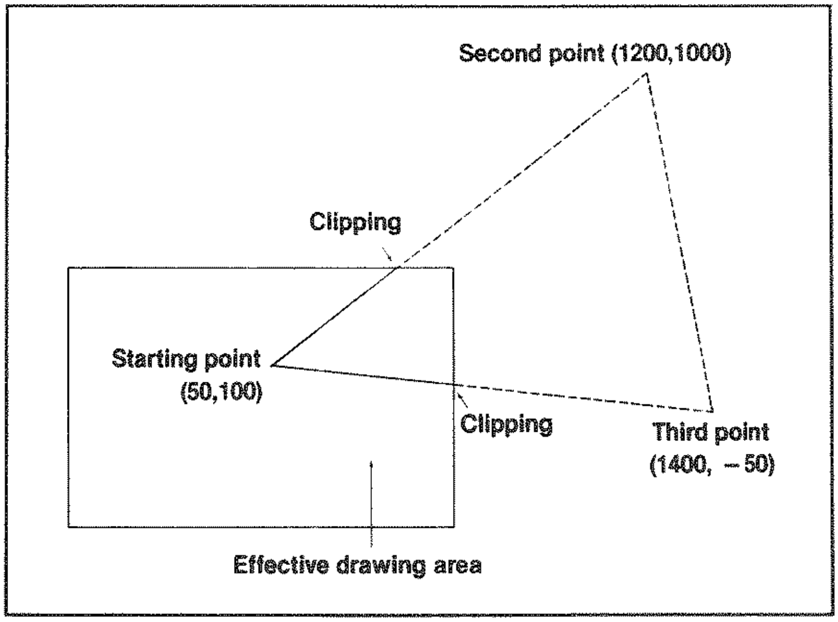


Figure 1-5. Clipping

Portrait vs. landscape

Most of the time, graphs and charts are drawn with the width being the longest dimension of the paper. This type of paper position is called the *landscape* position. You can change the direction of plotting so that the height of the drawing is the longest dimension. This orientation is the *portrait* position. Figure 1-6 shows portrait vs. landscape positioning.

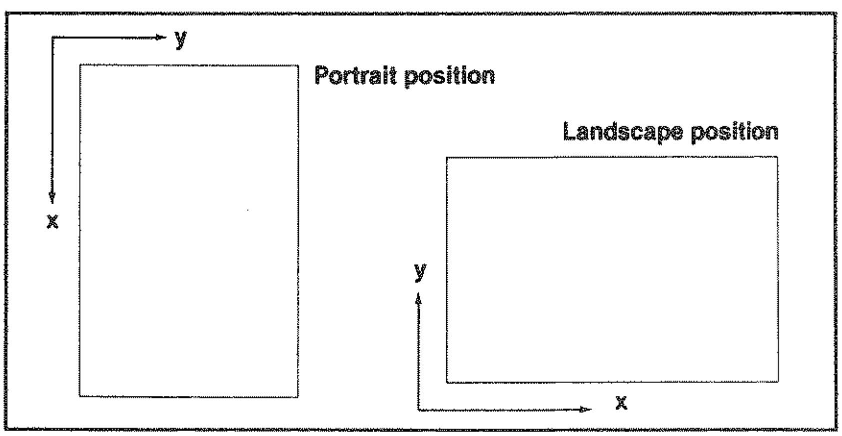


Figure 1-6. Portrait and landscape positions

When you determine points and angles for portrait and landscape drawings, remember to think in terms of which way the picture is drawn. While the actual drawing changes position, the direction of X-axis and the Y-axis remains the same.

Chapter 2
Sending Commands to the Plotter

This chapter describes the use of the Epson HI-80 plotter emulator command set (command set 0).

Plotter Command Syntax

The plotter commands are simply groups of letters and numbers that are easy to remember and understand. Commands consist of two letters, sometimes followed by one or more numbers. For example, the command syntax for the move absolute command is:

MA *x*,*y*

The letters "MA" identify the command. The letters *x* and *y* represent variable *parameters* that give the distance from the origin in the X and Y directions. The comma is a *delimiter* that separates the number representing the X distance from the number representing the Y distance.

Looking at this command in more detail, a unique two-letter name identifies the command. The name can be in capital or lowercase letters, or a mixture of both. When the HC100 receives the two letters in the command shown above, it knows that you want to move the pen to a new location. The plotter then expects to see two parameters telling it where you want to move to. These two parameters, represented by *x* and *y*, are numbers represented by the ASCII codes for each digit.

For example, using an *x* parameter of 100, the actual codes to represent the number 100 to the HC100 would consist of ASCII 49 followed by ASCII 48 followed by ASCII 48 again (all decimal). Don't let this confuse you—this is how your computer wants to send numbers to the plotter. Just type numbers in your word processor, or use LPRINT from BASIC (either with strings or numeric variables).

The HC100 interprets only whole numbers (integers). If you send it a number with a decimal fraction, it ignores the decimal point and any digits after the decimal.

For example:

DA 50.65,100.32

is interpreted as

DA 50,100

This does not cause an error, so if the accuracy of your figure is not affected by this truncation, there's no reason to worry about it.

To send a negative number to the plotter you just precede the number with a minus sign (hyphen). Numbers without a sign, or preceded by a plus sign, are considered positive.

Examples of valid commands using positive and negative numbers include:

MA 50,100
MA +50,+100
MA −50,−100
MA 50,−100
MA +50,−100

The comma *delimiter* separates the two numbers. The HC100 recognizes a comma or a space as a delimiter. Extra spaces between parameters are ignored. This gives you a lot of flexibility in the way that you send parameters to the plotter.

The command

DR 50,100

for example, could also be expressed as:

DR 50 100
DR 50 , 100
DR 50,   100

If required parameters are not included in a command, an error results.

For example, the command:

MA 50

would result in an error because two parameters are required.

Extra parameters are ignored. The last two parameters in the command:

HB 2, 80, 250, 9, 0, 200, 100

are ignored because the command requires only five parameters.

Zero value parameters can be skipped, but require a comma to save their places.

For example, the commands:

MA 0,100
HP 2, 500, 500, 100, 0, 800, 10, 0, 200

can also be expressed as

MA ,100
HP 2, 500, 500, 100, , 800, 10, , 200

All commands end with a *terminator*. You don't need to think about this normally, because the normal terminator is the carriage return (ASCII 13 decimal), that your computer adds to every line it sends to the plotter. It does mean, however, that you cannot normally put more than one command on a line.

You can also use a 〈NUL〉 (ASCII 0 decimal) as a terminator. The command:

LPRINT "DA 200,300"; CHR$(0); "MA 200,400"

could be substituted for

LRPINT "DA 200,300"
LPRINT "MA 200,400"

Using BASIC

The HC100 plotter was designed to be used easily with the BASIC programming language because BASIC is so widely used.

You can simply use the LPRINT statement (or the statement that your computer uses to send information to the printer) to send commands to the HC100.

Any of the following statements work:

```
LPRINT "MA 100,100"
```

The statement above treats the entire command within the quotes as a string of text.

```
LPRINT "MA" 100, 100
```

This statement uses numeric constants for the parameters. The comma between the two numbers prevents BASIC from treating them as one number. The comma is not sent to the plotter but the space after the comma is interpreted by the plotter as the delimiter.

```
X = 100 : Y = 100
LPRINT "MA", X, Y
```

This statement uses numeric variables for the parameters. BASIC converts these numeric variables to characters as it sends them to the printer. The space between X and Y is the delimiter.

```
X = 100 : Y = 100
LPRINT "MA"; X; ","; Y
```

This last statement is almost the same as the previous one. This time the comma between the quotes acts as the delimiter instead of the spaces as in the previous statements. Both ways work equally well.

You can use your HC100's printer command set to prove that all of these forms produce valid commands. Turn the plotter ON with the CAP/OFF button held down to use the printer command set. Then send the BASIC statements shown above. The HC100 prints the text that is sent by the computer and you can see just what the plotter is receiving. (This can be a good debugging aid.)

Conventions Used in This Book

The HC100 is a very flexible machine. Almost any plotting parameter can be changed at will. Therefore, if your plotting parameters are not the same at the time you run an example, the same results as those in this book may not be produced.

So as not to define the state of every plotting parameter for every example, this manual assumes that all examples begin with all plotting parameters in the default state (see Appendix E for default settings).

To be sure that your plotter is in this state, simply turn it OFF and back ON before you run each example. (In Chapter 4, you'll see how to use plotter commands to reset parameters on the HC100.)

It is also assumed that the DIP switches in your plotter are set as they came from the factory (see Appendix C in the User's Section of this manual) and that you are using US letter size paper.

Chapter 3

Absolute and Relative Commands

With the Tektronix HC100 plotter, you can use commands to move or draw to specified points on the effective drawing area. These points can be specified with either absolute coordinates or relative coordinates depending on the program you write. This chapter describes the use of these commands.

Absolute Commands

The absolute *commands* require that you specify *absolute* coordinates on the drawing area. The absolute coordinates of a point, represented by the parameters *x* and *y*, are the X and Y distance from the origin (0,0) of the drawing area.

Move absolute (MA)

The most basic command is the *move absolute* (MA) command. This command moves the pen (without drawing) to a point specified by the *x,y* parameters on the drawing area. The format of the move absolute command is:

MA *x,y*

For example, to move the pen to the absolute coordinates (1255,960) which is the center of the paper, the command is:

MA 1255,960

Figure 3-1 shows how this command moves the pen in this example (assuming that you started at the origin).

Draw absolute (DA)

The *draw absolute* (DA) command draws a line from the current pen position to a point specified by the *x,y* parameters on the drawing area. The format of the draw absolute command is:

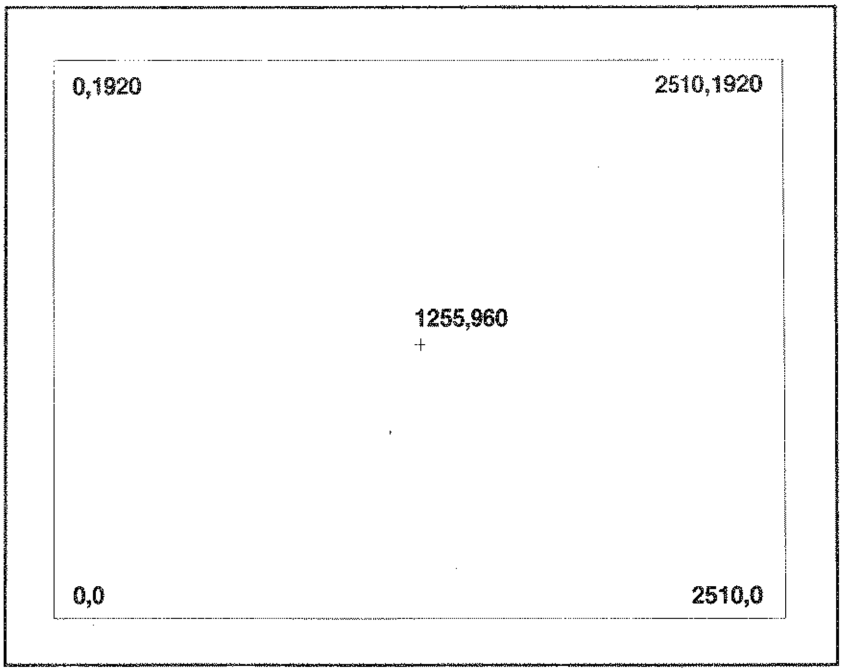


Figure 3-1. Move absolute (MA) command

DA *x,y [, x1,y1, x2,y2, ..., xn,yn]*

As with the move absolute command, you can draw to a single point (x,y) such as 500,500. You can also draw to more than one point with additional pairs of parameters. Each pair is represented in the command as *x1,y1, x2,y2,* and so on (...,) to *xn,yn*. These parameters are optional but you must specify both the *x* and *y* coordinates of each additional pair. The plotter connects the points with lines. For example, starting at the point (1255,960), the command:

DA 1255,1360, 1655,1360, 1655,960, 1255,960

draws a box with the lower left corner at (1255,960) as shown in Figure 3-2. Notice that the pairs of parameters are grouped in the command. This format lets you see the *x,y* parameters more easily and does not affect how the command is executed.

To mark a point on the drawing area, first use the move absolute command to move to the point, then use the draw absolute command to draw to the same point.

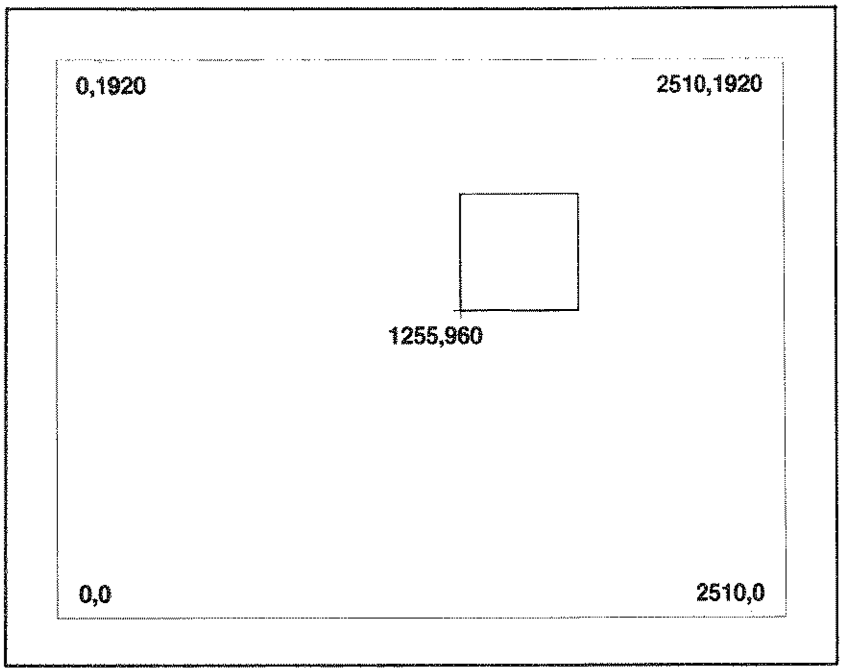


Figure 3-2. Draw absolute (DA) command

Circle absolute (CA)

With the *circle absolute* (CA) command, the HC100 draws a circle, or part of a circle, around a given point. This command requires five parameters. The format of the circle absolute command is:

CA *x*,*y*, *radius*, *start-angle*, *end-angle*

The *x* and *y* parameters give the absolute location of the center of the circle. The *radius* is the radius of the circle or arc drawn. The *start-angle* is the angle of the beginning of the arc measured from the X-axis in a counter-clockwise direction. The *start-angle* is measured in tenths of a degree. The *end-angle* is the angle of the end of the arc measured in the same way.

To draw a full circle, *start-angle* is 0 (0°) and *end-angle* is 3600 (360°).

For example, the command:

CA 1255,960, 200, 0, 3600

draws a complete circle (0, 3600 or 360°) with a radius of 200 centered at the center of the drawing area (1255,960).

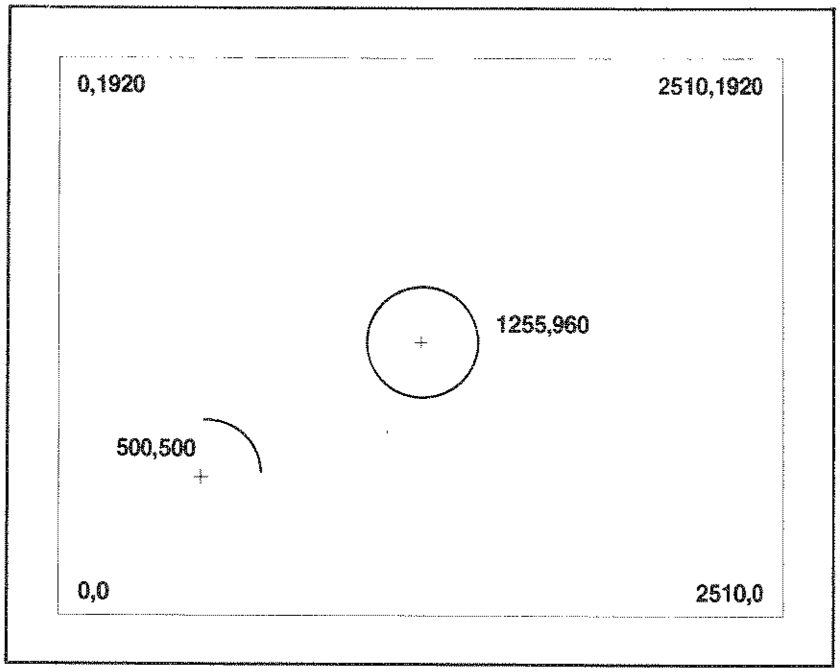


Figure 3-3. Circle absolute (CA) command

The command:

CA 500,500, 200, 0, 900

draws an arc of one-fourth of a circle (0, 900 or 90°), with the same radius, centered at the position 500,500. The results of both commands are shown in Figure 3-3.

Relative Commands

All three of the absolute commands described above have counterparts that use *relative* instead of absolute coordinates on the drawing area. The relative coordinates of a point, represented by *dx* and *dy*, are the X and Y distance from the current pen position.

Move relative (MR) and draw relative (DR)

The *move relative* (MR) command and the *draw relative* (DR) command look just like the absolute commands, except the points specified in the commands are expressed as *relative points*. The format of the move relative command is:

MR *dx*,*dy*

and the format of the draw relative command is:

DR *dx,dy [, dx1,dy1, ..., dxn,dyn]*

Relative points are indicated by *dx* and *dy* and are measured as distances from the current position of the pen (instead of the absolute coordinates from the origin). To illustrate this, study the following three commands:

MA 1255,960

MR 200,200

DR 200,400

To start at a common point for this example, the move absolute (MA) command moves the pen to the center of the drawing area (1255,960). The second command is a move relative (MR) command that moves the pen, without drawing, 200 units in the X direction and 200 units in the Y direction. The new location of the pen is 1455,1160. The last command, a draw relative (DR) command, then draws a line to a point that is 200 units in the X direction and 400 units in the Y direction from the previous point. The pen location is now 1655,1560. Figure 3-4 shows how the plotter moves when it executes these three commands.

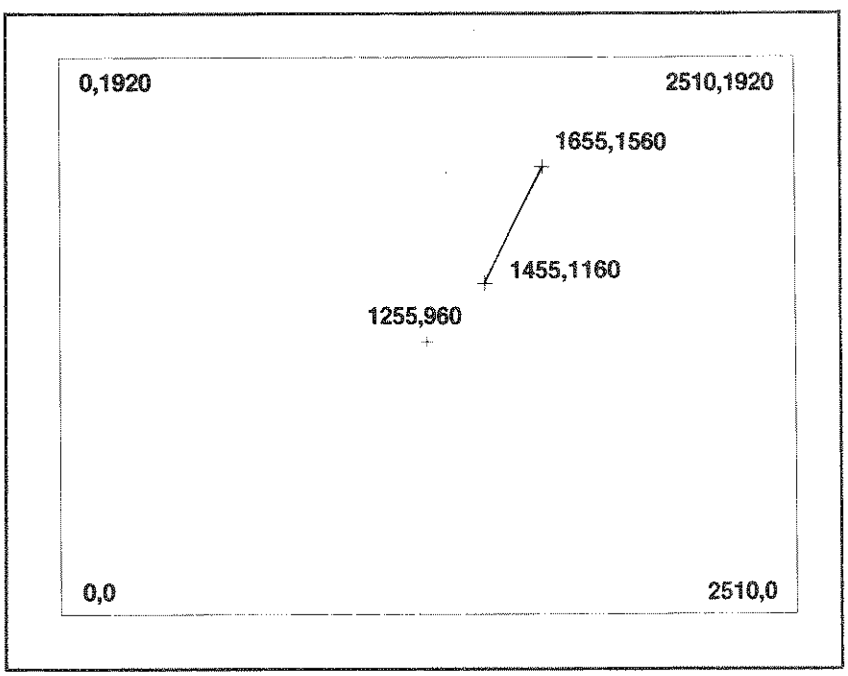


Figure 3-4. Move relative (MR) and draw relative (DR) commands

The draw relative command can be used to create subroutines that will draw the same shape anywhere on the drawing area. For example, the command:

DR 200,0, 0,200, −200,0, 0,−200

draws a square with each side 200 units long and with the lower-left corner of the square at the current pen location.

Circle relative (CR)

The *circle relative* (CR) command is a shortened version of the circle absolute command. All the parameters are the same, except that *x* and *y* are not necessary because this is a relative command. The circle, or part of a circle, that is drawn starts at the current position. The format of the circle relative command is:

CR *radius, start-angle, end-angle*

All the parameters have the same meanings as with the circle absolute command. The *radius* is the radius of the circle or arc drawn. The *start-angle* is the angle of the beginning of the arc measured from the X-axis in a counterclockwise direction. The *start-angle* is measured in tenths of a degree. The *end-angle* is the angle of the end of the arc measured in the same way. To draw a full circle, *start-angle* is 0 (0°) and *end-angle* is 3600 (360°).

Try changing the examples used for the circle absolute (CA) command to demonstrate the circle relative command. The commands will look like this:

CR 200, 0, 3600

CR 200, 0, 900

Chapter 4
Miscellaneous Commands

In this chapter you'll learn how to clear errors and reset the HC100 as well as how to make pen and paper changes. The miscellaneous commands will help you use the other HC100 commands more efficiently.

Clearing Errors

When the HC100 recognizes an error it usually freezes and lights the ERROR indicator. There are several commands that clear error conditions.

Clear interface (CI)

The *clear interface* (CI) command clears the plotter's input buffer and resets the error indicator, allowing the plotter to continue. It does not, however, affect any other plotter settings. The clear interface command has no parameters; the format is simply:

CI

It's a good idea to use the clear interface command [or the default (DF) command shown below] at the beginning of all of your programs. These commands ensure that a pre-existing error condition does not prevent the plotter from working.

Home pen (HO)

The *home* (HO) command has two functions. First, it clears error conditions like the clear interface command. Second, it has the added benefit of moving the pen to the coordinate origin. The format is:

HO

The HO command has no parameters.

Default values (DF)

The *default* (DF) command clears errors and returns most of the plotter's settings to their default states (see the table in Appendix E). The coordinate origin is set to the lower left of the page and the pen is returned to this point.

The default command has no parameters; the format is simply:

DF

This is a good command to include at the beginning of your program because it returns the plotter to a known state.

Initialize plotter (IN)

The *initialize plotter* (IN) command has the same effect as turning the plotter OFF and ON. All of the plotter's settings are reset to their default states, which are shown in Appendix E of this manual. DIP switch settings are shown in the User's Section of this manual.

The initialize command has no parameters. The format is:

IN

Note: The plotter *does not* keep track of the position of the paper during the initialize plotter command; it assumes you have loaded a new piece of paper to the FRONT EDGE mark. If you execute an initialize plotter command with the paper in any other position, it may be ejected from the plotter.

Changing Pens and Paper

You can use many kinds of paper (or transparency material) and three different kinds of pens in the HC100 plotter. The HC100 has commands that facilitate pen and paper selection and a pen speed command is included to adapt to different plotting situations.

Select pen (SP)

You will undoubtedly want to use your HC100 plotter with pens of different types and colors. For example, you may want to draw different colored bars in a bar chart or different colored sections in a pie chart. You may even want to combine ballpoint and fiber-tipped pens in one drawing. (See the User's Section for details on pen selection.)

The *select pen* (SP) command is used to either select a new pen or cap all the pens. The command looks like this:

SP *pen-num*

The parameter *pen-num* can have a value of −1 (minus one) through 8. The values of 1 through 4 select the pen corresponding to the numbers marked on the pen cassette. The values of 5 through 8 repeat the same sequence of pens (i.e. they select *pen-num* 1 through 4).

A *pen-num* of 0 is almost the same as pressing the CAP/OFF button. The pen carriage moves to the pen-capped position at the extreme right of the plotter, and the plotter freezes until you press the CAP/OFF button to release it. The ON LINE light remains lit, but the ON/OFF button does not work. If you press the CAP/OFF button, the pen returns to the position it was in prior to the SP command.

A *pen-num* of −1 also moves the pen carriage to the pen-capped position, but any command (or even a carriage return) that follows causes the pen to move back to the position it was in prior to the SP command.

Change paper (CH)

While plotting with the HC100, you may want to change the paper at some point in your program, or change to a different paper type. (See the User's Section for details on paper selection).

The *change paper* (CH) command moves the paper to a position that makes it easy to remove. The command has no parameters; the format is:

CH

The pens move to the pen-capped position and the ON LINE indicator blinks to remind you to change the paper. Press the ON/OFF button after you've loaded the new sheet. The pens will return to where they were before the command was executed.

The change paper command is a good command to use at the end of your program because it lets you change the paper each time a program is run.

Pen speed (VS)

Although the HC100is highly accurate, you may want to slow down the drawing speed to create extra high quality plotting. The *pen speed*

(VS) command does this. The command is:

VS *speed*

where *speed* is either 0 (for full speed) or 1 (for reduced speed). At full speed, the pen draws at 230 mm/sec; at slow speed, it draws at 100 mm/sec.

Reducing the drawing speed is especially effective when drawing on plastics and other very smooth surfaces.

Chapter 5
Plotting Commands

In this chapter you will learn how to draw axes for graphs, plot points on the graph, and draw bar charts, pie charts, and grids. These tasks may sound complicated, but you'll soon see just how simple they are with the advanced HC100 plotter.

Drawing an Axis

Most graphs start with X and Y axes that are developed as reference points to plot values on the graph. Both the X and Y axes can be drawn *and* labeled with the *axis* (AX) command.

Axis (AX)

The *axis* (AX) command has eight parameters, four of which are required, and four of which are optional. The axis is drawn from the current pen position. The format of the command, including all eight parameters, looks like this:

AX *dir, len, div, scale-mark [, start-num, end-num, num-space, num-dir]*

Let's first look at the four required parameters:

AX *dir, len, div, scale-mark*

An axis is drawn parallel to either the X-axis or the Y-axis. If *dir* is 0 or 2, an X-axis is drawn; if *dir* is 1 or 3, a Y-axis is drawn.

When an axis is drawn, it represents an established number of divisions on the graph. For example, an axis may show five divisions in multiples of 100 each: 100, 200, 300, 400, and 500. The axis command interprets how these divisions are drawn in two different ways depending on the value of *dir*.

If *dir* is 0 or 1, then the *len* parameter indicates the length of one division of the axis; the *div* parameter indicates the number of these divisions that are to be drawn. If *dir* is 2 or 3, then the *len* parameter gives the overall length of the axis and the *div* parameter gives the number of divisions that this overall length is to be divided into.

After the axis is drawn, divisions are automatically marked by ticks at each division. The *scale-mark* parameter lets you decide if you want a tick (scale mark) drawn at the axis origin. If *scale-mark* is 0, a scale mark is drawn at the origin; if *scale-mark* is 1, a scale mark is not drawn at the origin.

You can also label an axis with numbers that show the values of each division on the graph. This feature is done with the four optional parameters in the AX command. By adding the four options, the command now looks like this:

> AX *dir, len, div, scale-mark, start-num, end-num, num-space, num-dir*

The parameter *start-num* indicates the starting value of the scale numbers (the origin of the graph). If *scale-mark* is 1, however, this number will not print.

The parameter *end-num* is interpreted two different ways depending on the value of *dir*. If *dir* is 0 or 1, then *end-num* indicates the increment in value of the scale numbers for each division of the axis. The scale numbers are calculated by adding the value of *end-num* to the previous scale number.

If *dir* is 2 or 3, then *end-num* is the value of the last scale number on the axis. The scale numbers are equal divisions between the value of *start-num* and *end-num*. Figure 5-1 shows how the parameters *len* and *end-num* change with different values of *dir*.

The parameter *num-space* specifies the distance between the closest point on the scale numbers and the axis line. The plotter takes into account the size and direction of the characters so that this distance is maintained.

The parameter *num-dir* determines the direction that the scale numbers are printed. If *num-dir* is 0 then the scale numbers are printed with their baseline parallel to the axis. If *num-dir* is 1 then the scale numbers are printed with their baseline perpendicular to the axis. In Figure 5-2 the scale numbers are parallel to the axis on the X-axis (the horizontal axis) and perpendicular to the axis on the Y-axis (the vertical axis).

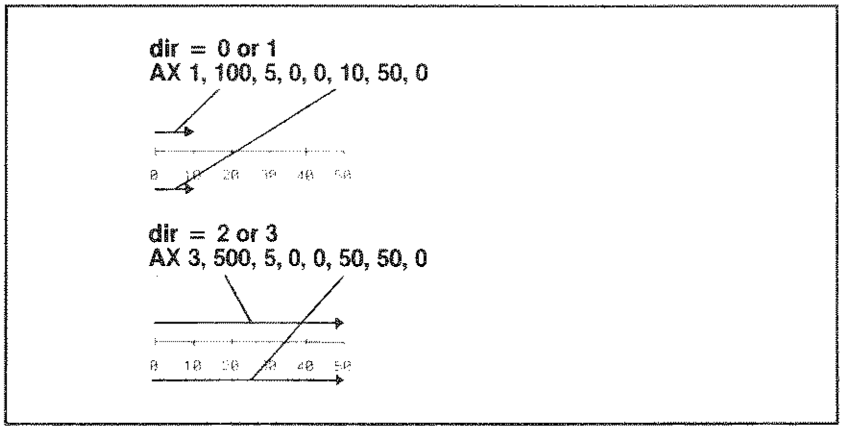


Figure 5-1. Axis (AX) command changes with different values of dir

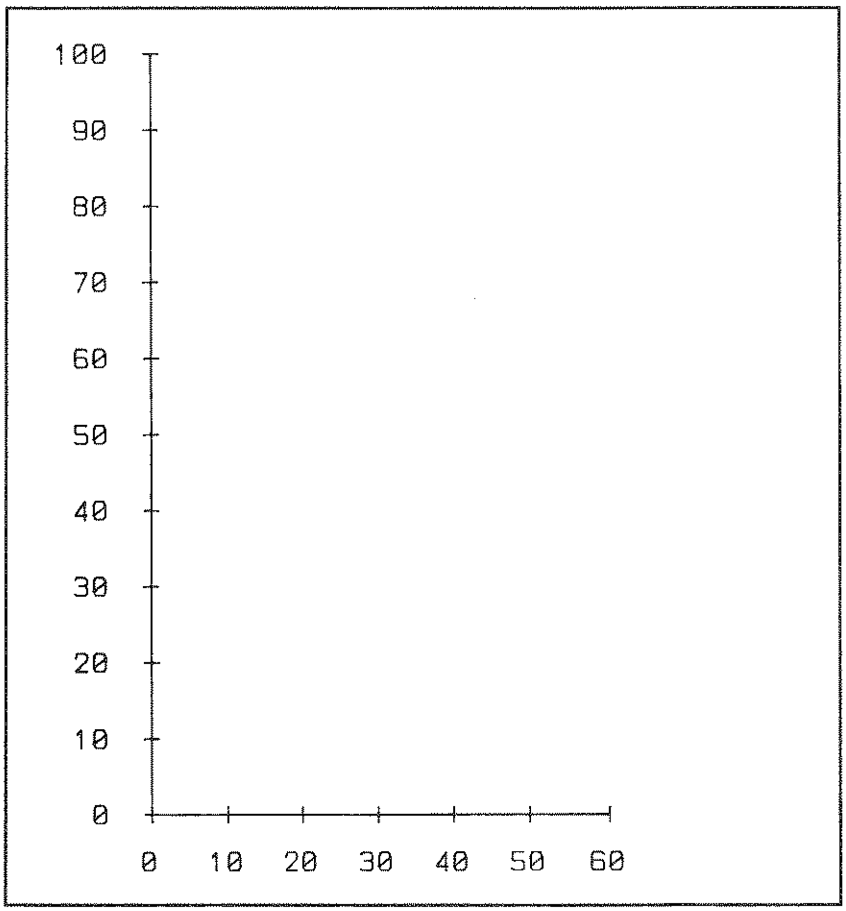


Figure 5-2. Examples of the axis (AX) command

Examples using the axis command

Here are two examples of the axis command. The results are shown in Figure 5-2. Notice that a move absolute (MA) command precedes the axis command. The axis command starts from the current position. It is important to place the pen at the proper point before you use the axis command.

```
MA 500,500
AX 1, 100, 6, 0, 0, 10, 50, 0
MA 500,500
AX 2, 1000, 10, 0, 0, 100, 50, 1
```

In the first axis command, *dir* has a value of 1 (draw X-axis, Figure 5-2). The following paramaters (*len*, *div*, and *end-num*) are given in terms of one division. There are six divisions, each 100 long. The starting scale number (*start-num*) is 0, and is drawn at the origin (*scale-mark* = 0). The increment of scale numbers (*end-num*) is 10. The scale numbers are drawn parallel to the axis (*num-dir* = 0), and at a distance (*num-space*) of 50 from the axis.

Again, a move absolute command appears between the two axis commands. The first axis command leaves the pen at the far end of the axis when it finishes; the pen must be moved back to the origin before executing the second axis command.

In the second axis command, *dir* has a value of 2 (draw Y-axis, Figure 5-2). The following parameters (*len*, *div*, and *end-num*) are given in terms the entire axis. There are 10 divisions, each 1/10 of 1000, or 100 long. The starting scale number (*start-num*) is 0, and is printed at the origin (*scale-mark* = 0). The last scale number (*end-num*) is 100. The scale numbers are drawn perpendicular to the axis (*num-dir* = 1), and at a distance (*num-space*) of 50 from the axis.

Although the axis command has several parameters compared to many of HC100's other commands, it saves a tremendous amount of work in drawing axes for graphs. Think of all the individual tasks the axis commands accomplished in the previous example by drawing the two axes, with tick marks and scale numbers.

Plotting Points on a Graph

Several of the HC100 commands make plotting graphs easy. The plotter can draw both straight and curved line graphs, bar graphs, pie charts, and grids.

Absolute (AM) and relative (RM) line and mark

The plotter has both *absolute* (AM) and *relative* (RM) *line and mark* commands that are similar to the draw commands, except for two things. First, they don't start at the current position. Second, they make a *mark* at each of the points specified. Otherwise they are similar; they draw lines connecting the points given.

The two commands look like this:

AM *style, x1,y1 [, x2,y2, ..., xn,yn]*

RM *style, dx1,dy1 [, dx2,dy2, ..., dxn,dyn]*

The parameter *style* determines the style of mark that is used. The value of *style* can range from 0 to 15. The styles of marks are shown in Appendix B.

In the absolute line and mark (AM) command, *x1* and *y1* specify the point at which the first mark is made. The plotter then draws a line to *x2,y2* and makes another mark, and so on (...,) to *xn,yn*.

In the relative line and mark (RM) command, *dx1* and *dy1* specify the point, relative to the current position, at which the first mark is made. The plotter then draws a line to *dx2,dy2* (relative to *dx1* and *dy1*) and makes another mark, and so on (...,) to *dxn,dyn*.

The parameters beyond the first points in each command are considered optional. You can make a single mark at the current position by not specifying any coordinates with both the AM and RM commands. You can make a single mark at any point in the drawing area by specifying *x1,y1* in the AM command.

In the following example, both commands produce the same results: they draw a line connecting five points on a graph. The only difference is that the AM command uses absolute coordinates and the RM command uses relative coordinates. Note the move absolute (MA) command before the relative line and mark command starts the line from a known position. Figure 5-3 shows the results of these commands (on the axes drawn earlier).

```
AM 14, 600,750, 700,680, 800,1050, 900,1380, 1000,1430

MA 500,500
RM 14, 100,250, 100,-70, 100,370, 100,330, 100,50
```

Curve absolute (VA) and curve relative (VR)

You may need to draw a graph with a curved line connecting a

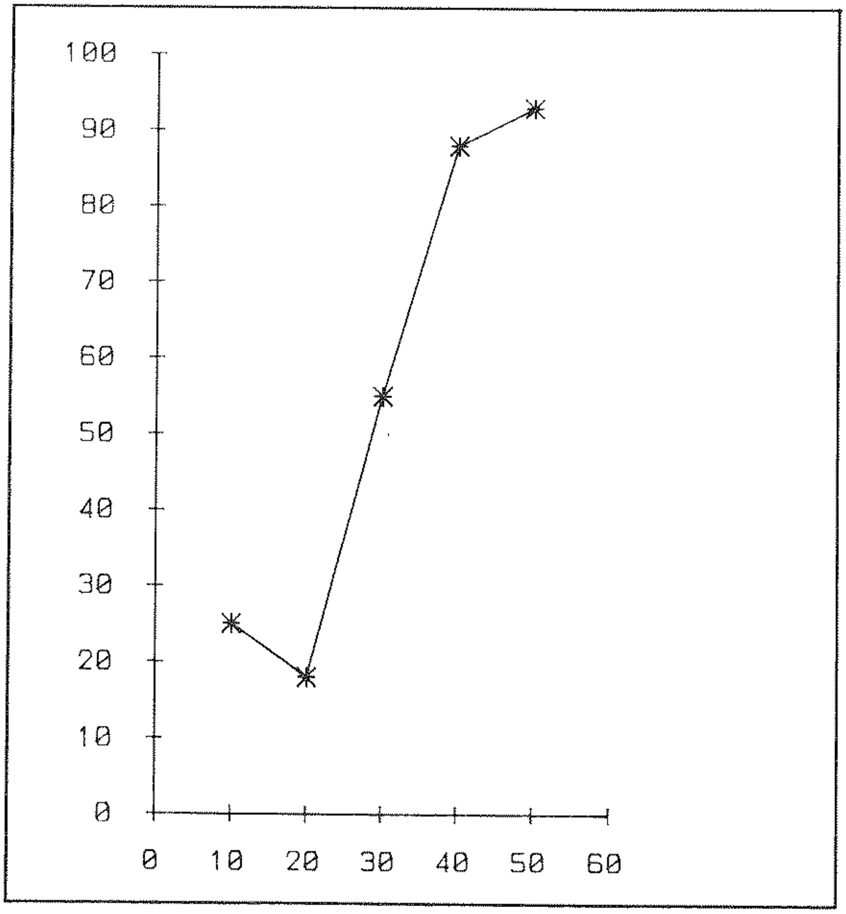


Figure 5-3. Absolute (AM), relative (RM) line and mark commands

series of points. On many plotters a lot of programming might be required, but on the HC100 it can be done with a choice between two commands.

The *curve absolute* (VA) and *curve relative* (VR) commands work much like the line and mark commands, except they connect the points with curved lines and they don't make marks at each point.

The formats of the commands are:

VA *type, x1,y1, x2,y2, ..., xn,yn*
VR *type, dx1,dy1, dx2,dy2, ..., dxn,dyn*

The parameter *type* tells the plotter whether the curve is to be open (*type* = 0) or closed (*type* = 1). In a closed curve the first and last specified points of the curve are connected. The points are defined just as they are in the line and mark commands.

In the curve absolute (VA) command, *x1* and *y1* specify the starting point of the curve. The plotter then draws a curve to *x2,y2,* and so on (...,) to *xn,yn*.

In the curve relative (VR) command, *dx1* and *dy1* specify the starting point, relative to the current position. The plotter then draws a curve to *dx2,dy2* (relative to *dx1* and *dy1*), and so on (...,) to *dxn,dyn*.

The following examples plot the same points used with the line and mark commands in Figure 5-3. Since *type* has a value of 0, the curve is open. Figure 5-4 shows the results.

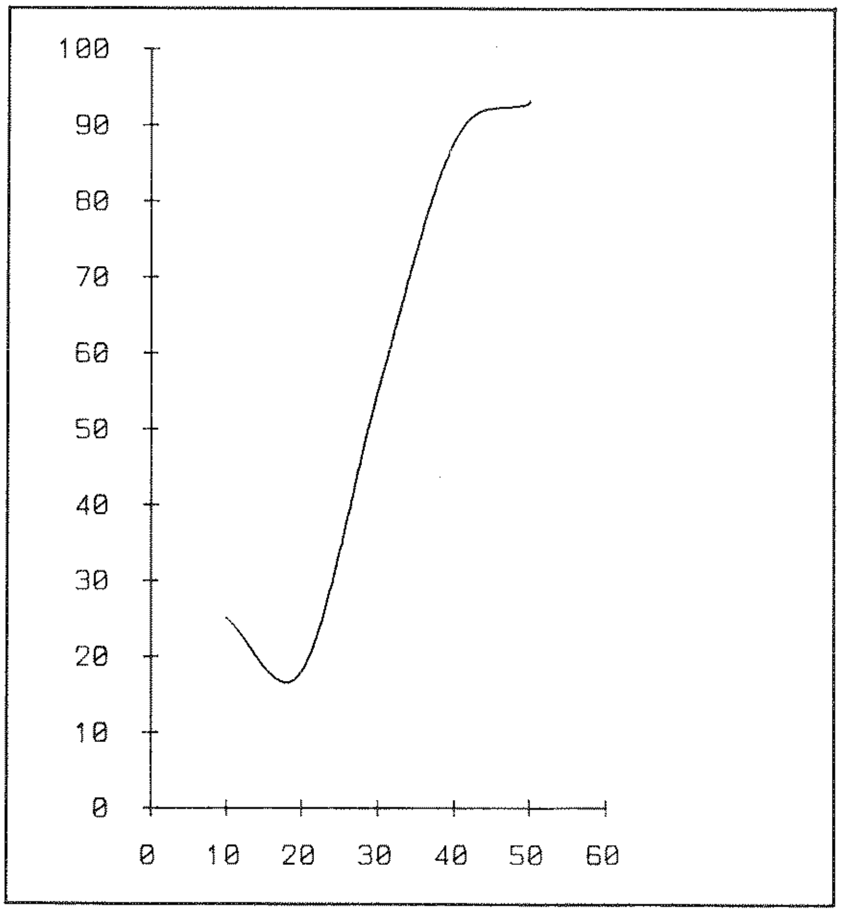


Figure 5-4. Curve absolute (VA) and curve relative (VR) commands

VA 0, 600,750, 700,680, 800,1050, 900,1380, 1000,1430

MA 500,500
VR 0, 100,250, 100, −70, 100,370, 100,330, 100,50

The curve commands do not make marks like the line and mark commands. If you want to draw a curve with marks, first use the curve command in the normal way. Then use individual line and mark commands to make a mark at each point. Be sure you specify only one point with each command. To make five marks, you repeat the command five times, with different points specified. The following commands produce the results shown in Figure 5-5.

AM 7, 600,750
AM 7, 700,680
AM 7, 800,1050
AM 7, 900,1380
AM 7, 1000,1430
VA 0, 600,750, 700,680, 800,1050, 900,1380, 1000,1430

Drawing Bar Graphs

Bar graphs are used to graphically represent all types of information. The HC100 makes drawing bar graphs practically effortless. You can draw a complete bar, including the cross-hatching, with just one command: the *hatched bar* (HB) command. On many other plotters, drawing a bar requires extensive programming.

Hatched bar (HB)

The format of the *hatched bar* (HB) command looks like this:

HB *type, x-len, y-len, pitch, style*

The parameter *type* specifies the type of bar to be drawn. If *type* is 0, only the outline of the bar is drawn. If *type* is 1, only the cross-hatching is done. And if *type* is 2, both the outline and the cross-hatching are drawn. The *type* option allows several variations. For example, you can draw the bar outline and the cross-hatching with different colors (using two hatched bar commands with a select pen (SP) command between them). You can also draw rectangles by themselves (*type* = 0) rather than drawing from point to point with the draw absolute (DA) or draw relative (DR) commands.

The parameters *x-len* and *y-len* determine the lengths of the sides of the rectangle. The rectangle starts at the current position, which is the lower left of the rectangle when *x-len* and *y-len* are positive.

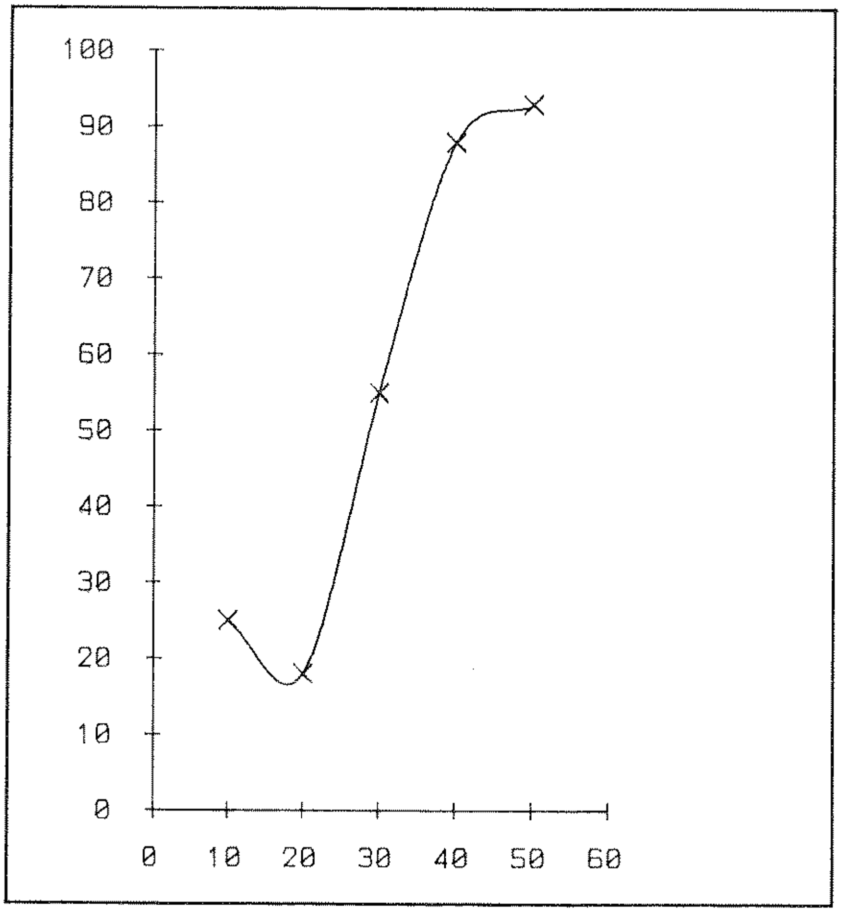


Figure 5-5. A curve with points marked

The parameter *pitch* determines the spacing between the cross-hatching lines. A value of 1 for *pitch* makes the bar solid. A value of 0 for *pitch* draws only the bar outline (which is the same as using a value of 0 for *type*).

The parameter *style* determines the type of cross-hatching. *Style* can have a value of 0 through 5. The six styles of cross-hatching are shown in Appendix B.

The following example draws hatched bars marking the same values used in the previous examples (see Figure 5-6).

```
MA 560,500
HB 2, 80, 250, 9, 0

MA 660,500
HB 2, 80, 180, 9, 0

MA 760,500
HB 2, 80, 550, 9, 0

MA 860,500
HB 2, 80, 880, 9, 0
```

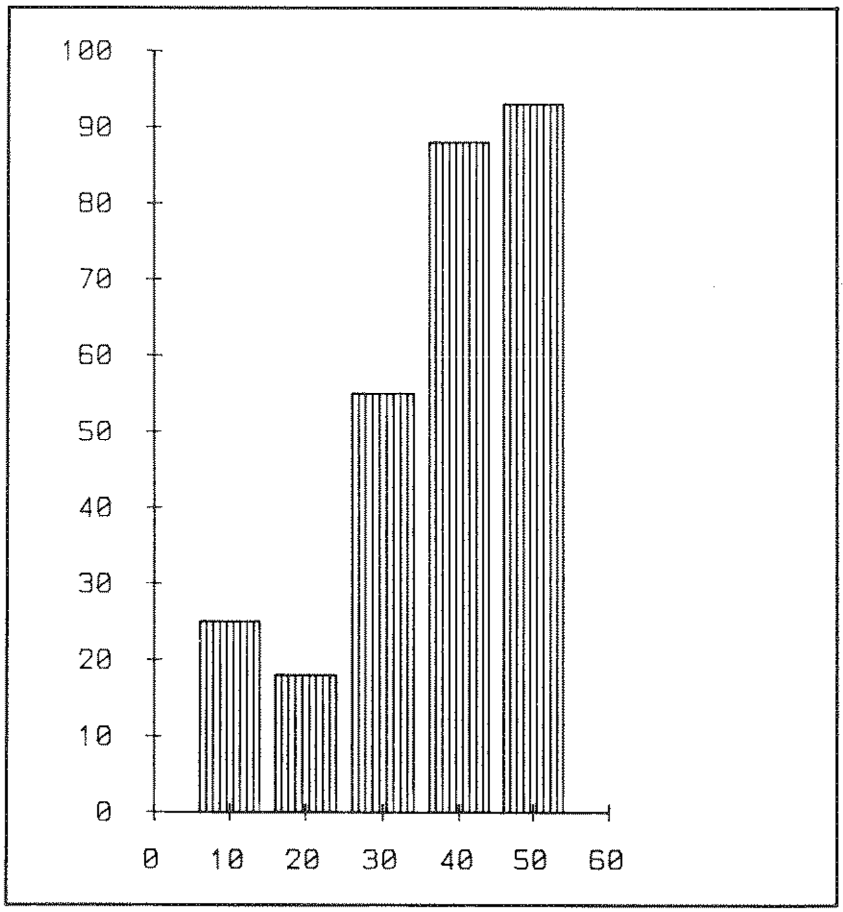


Figure 5-6. Hatched bar (HB) command

MA 960,500
HB 2, 80, 930, 9, 0

Note that each hatched bar command is preceded by a move absolute (MA) command so the current position is at the lower left of the bar to be drawn. The bars are 80 wide (*x-len*) and the height varies (*y-len*). The *type* is 2 which draws both the outline and the cross-hatching. The *pitch* of the cross-hatching is 10.

Drawing Pie Charts

With most plotters, drawing a pie chart is very complicated. The programming required to make cross-hatched pie sections can fill several pages. The HC100's advanced design once again makes it simple, using just one command: the *hatched pie* (HP) command.

Hatched pie (HP)

The *hatched pie* (HP) command draws and cross-hatches a pie section. It has more parameters than any other command (by one) but is still not too difficult to master. The command looks like this:

HP *type, x,y, rad, start-ang, end-ang, pitch, style [, inner-rad]*

The parameter *type*, as in the hatched bar command, determines the type of pie section drawn. If type is 0, only the outline of the pie section is drawn. If *type* is 1, only the cross-hatching is done. And if *type* is 2, both the outline and the cross-hatching are drawn.

The parameters *x* and *y* are absolute coordinates that specify the center point of the pie section, while *rad* specifies the radius. The parameter *start-ang* determines the angle of the first side of the pie section, and *end-ang* determines the angle of the second side (see Chapter 1 for how the HC100 interprets angles).

The parameter *pitch* determines the spacing between the cross-hatching lines. A value of 1 for *pitch* makes the pie section solid. A value of 0 for *pitch* draws only the pie section outline (which is the same as using a value of 0 for *type*).

The parameter *style* determines the type of cross-hatching. *Style* can have a value of 0 through 5. The six styles of cross-hatching are shown in Appendix B.

The parameter *inner-rad*, which is optional, specifies the radius of an inner circle drawn inside the pie section.

Here is an example of the hatched pie command:

HP 2, 1000,1000, 400, 900, 2000, 10, 0, 100

This command draws the pie section shown in Figure 5-7. The outline and cross-hatching is drawn (*type* = 2). The center is at 1000,1000. The first side (*start-ang*) is at 90° and the second side (*end-ang*) is at 200°. The *inner-rad* is 100 so an inner circle with a radius of 100 is drawn inside the pie section.

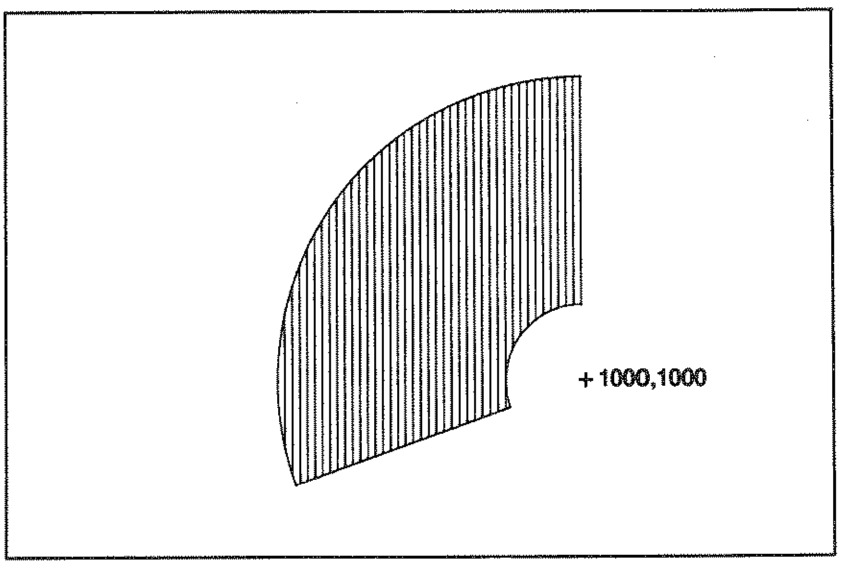


Figure 5-7. Hatched pie (HP) command

Drawing Grids

Along with bar graphs and pie charts, grids are also useful and easy to create on the HC100. You can draw a grid with only one command: the *grid* (GR) command.

Grid (GR)

The *grid* (GR) command draws grid lines in both X and Y directions. The format of the grid command is:

GR *x-unit, x-num, y-unit, y-num*

The parameter *x-unit* specifies the length of one division in the X direction while *x-num* specifies the number of divisions drawn perpendicular to the X-axis. The parameter *y-unit* specifies the length of one division in the Y direction while *y-num* specifies the number of divisions drawn perpendicular to the Y-axis.

The number of lines drawn perpendicular to the X- or Y-axis is *x-num* + 1 or *y-num* + 1. For example, a grid with five divisions in each direction is formed by six lines in each direction (as shown in Figure 5-8). The value of *x-num* or *y-num* can range from 0 to 255. If *x-num* = 0, no lines are drawn perpendicular to the X-axis; if *y-num* = 0, no lines are drawn perpendicular to the Y-axis.

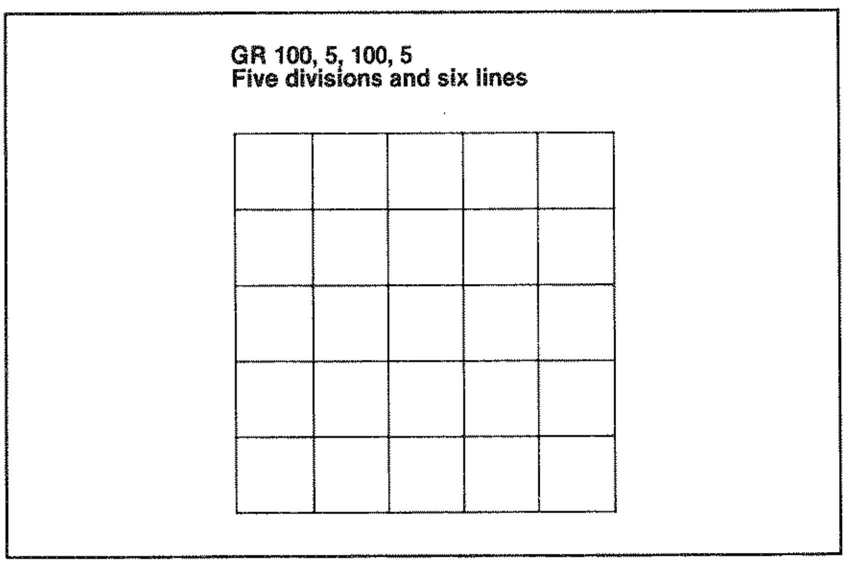


Figure 5-8. A grid with five divisions in each direction

The grid is drawn starting at the current position which is the lower left corner of the grid if both *x-unit* and *y-unit* are positive. The type of line used to draw the grid is determined by the line type (LT) command.

Here is another example of the grid command:

GR 175, 5, 50, 5

This example draws the grid shown in Figure 5-9. There are 6 lines spaced 175 apart in the X direction and 6 lines drawn 50 apart in the Y direction. Note that this command produces 6 lines with 5 spaces between them, not 5 lines.

Since the pen draws the grid lines in alternating directions, its position when the command is completed is not always at the same position on the grid. Where the pen stops depends on how many lines it draws.

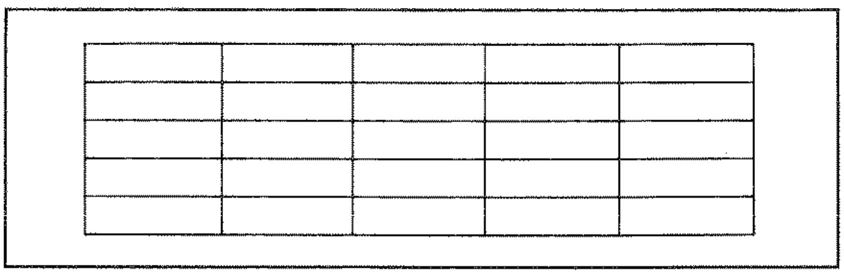


Figure 5-9. Grid (GR) command

Chapter 6
Labels

Good graphics require labels and titles to make them meaningful. Eight commands are used to make labeling your graphics fast and versatile.

Labels can be positioned anywhere in the drawing area and each character can be modified to achieve a tremendous variety of styles. In this chapter, you'll see how to print characters, make changes to them, and reset them to their default characteristics.

Label (LA)

The most basic of these commands is the *label* (LA) command. The label command consists of the letters LA followed by the characters that you want to print, like this:

LAThis is a Title

The command prints:

This is a Title

Note: There is no space between the LA and the word "This." If you put in a space, it will be inserted when the line is printed.

The label command starts printing at the current position. The pen starts at the lower left of the first character, and ends at the lower right of the last character. (Although this chapter refers to *printing*, the HC100 actually *draws* each character just as it would draw any other figure.) The width of a character includes some space on the right side to keep the characters properly spaced (see Figure 6-1).

When you are printing more than one line of text, you must use the move absolute (MA) command to move to the beginning of the next line. The carriage return at the end of the LA command is just a terminator and does not move the pen to a new line.

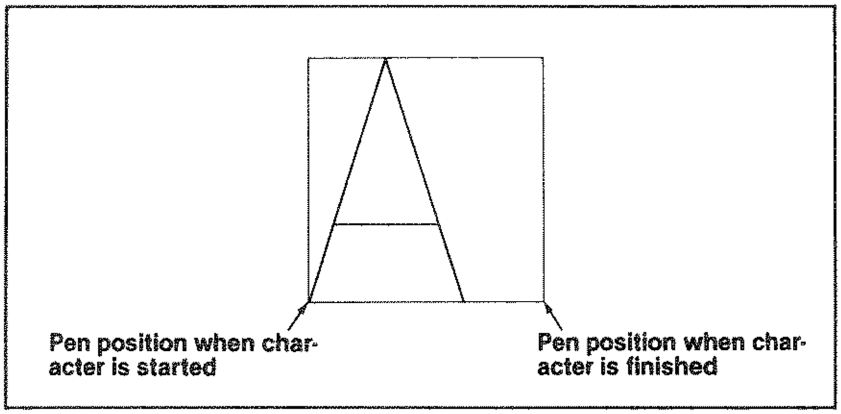


Figure 6-1. Starting and ending points for the label (LA) command

Using just the LA command prints characters in the *default* style. There are, however, commands to change the size, shape, direction, and position of the characters that you print.

Character size (SI)

The default character size is 24 wide by 24 high. The *character size* (SI) command changes the width, height, or both of these dimensions. The format of the character size command is:

SI *height, width*

The parameter *height* specifies the character's height, and *width* specifies the character's width. The two parameters do not have to be equal. You can make characters that are compressed or extended by making the *width* less than or greater than the *height*. Making the *height* 1½ times the *width* makes a pleasing character shape. You can make characters as large as you like.

The following examples print characters of several sizes and shapes. The results are shown in Figure 6-2.

```
MA 500,1000
LADefault characters

MA 500,900
SI 36, 24
LAHeight 1-1/2 times the width

MA 500,700
SI 100, 100
LAH & W = 100
```

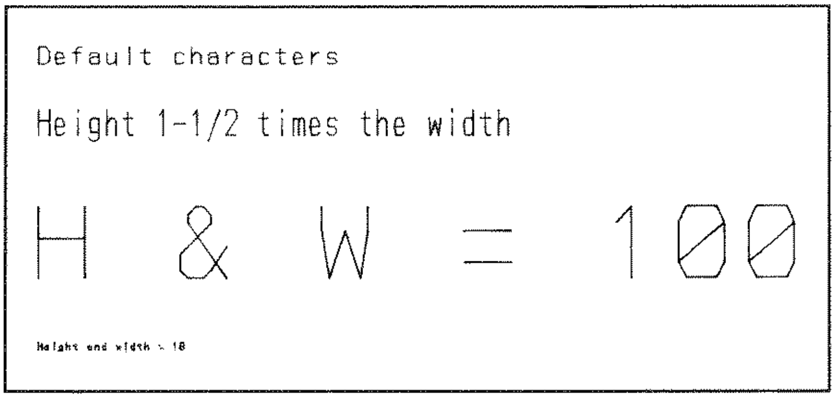


Figure 6-2. Character size (SI) command

MA 500,600
SI 10, 10
LAHeight and width = 10

Character direction (DI)

The HC100 prints characters in any direction that you want. The *character direction* (DI) command determines the direction that characters are printed. The DI command has the effect of rotating the character *baseline* (the imaginary line on which the characters sit) around the current pen position.

There are two different formats of the character direction command. They are:

DI *angle*
DI *run, rise*

In the first format, the single parameter *angle* specifies the angle of the baseline. For example, DI 900 changes the angle to 90 degrees. In the second format, the two parameters *run* and *rise* determine the angle of the baseline as shown in Figure 6-3.

This example shows how labels are printed at different angles using the format DI *angle*:

MA 1000,1000
DI 450
LA 45 degrees

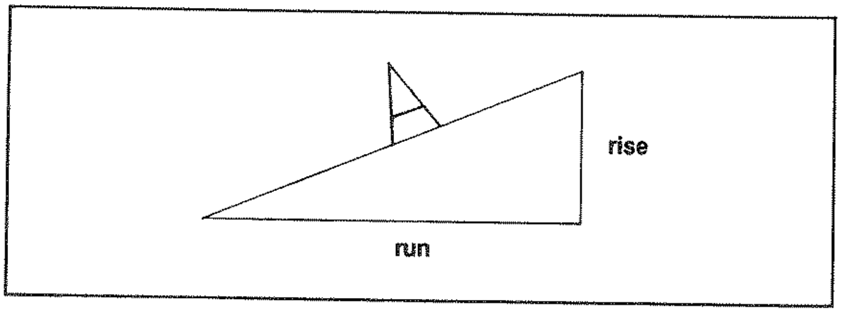


Figure 6-3. Angle of the baseline determined by rise and run

MA 1000,1000
DI 1350
LA   135 degrees

MA 1000,1000
DI 2250
LA   225 degrees

MA 1000,1000
DI 3150
LA   315 degrees

The move absolute (MA) command moves the pen to the same position each time a label (starting with five spaces) is printed with the label (LA) command. Figure 6-4 shows the results.

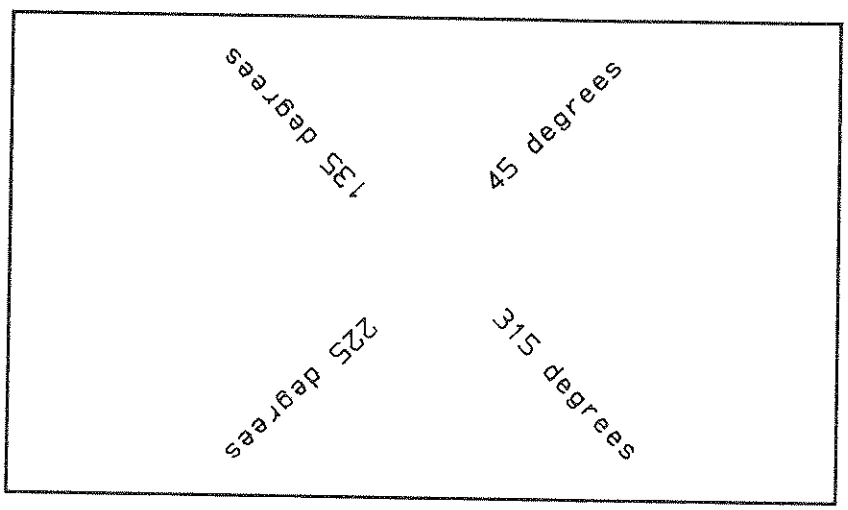


Figure 6-4. Character direction (DI) command

Character emphasis (EM)

The HC100 creates emphasized characters by drawing each character twice. It can do this in three different ways after it has drawn the character the first time: by moving up slightly, by moving sideways slightly, and by moving both up and sideways. The *character emphasis* (EM) command is:

EM *style*

The parameter *style* specifies which style of emphasized characters you want. Figure 6-5 shows the effects of the valid values of *style*. If *style* is 0, the characters are printed in the regular way, with no emphasis. If *style* is 1, the characters are offset horizontally. If *style* is 2, the characters are offset vertically. If *style* is 3, the characters are offset both horizontally and vertically.

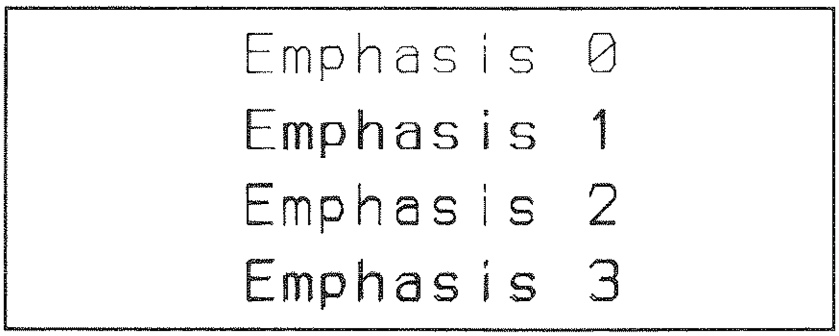


Figure 6-5. Character emphasis (EM) command

Character slant (SL)

The *character slant* (SL) command lets you create slanted, or italic, letters. All the vertical lines in these letters are slanted; the horizontal lines remain horizontal. The format of the character slant command is:

SL *value*

The parameter *value* determines how much the letters slant. The formula for calculating *value* is: *value* = 256 x tan(*angle*). For general use, it may be simpler to use Figure 6-6, which shows a range of different slants, to select a *value* that you like.

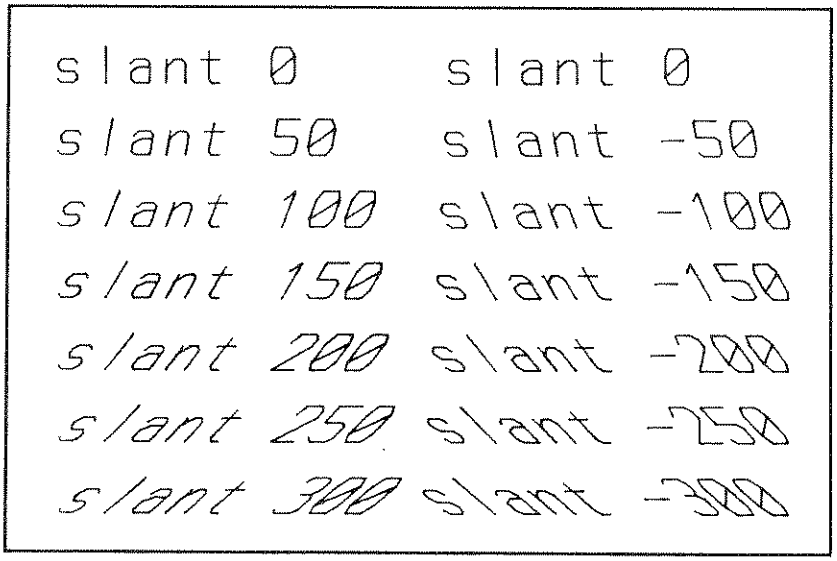


Figure 6-6. Character slant (SL) command

Character set (CS)

The HC100 has eleven international character sets (much the same as Epson's dot-matrix printers) to provide characters more useful for users in different countries. The *character set* (CS) command selects which set you wish to use and looks like this:

CS *set-num*

The parameter *set-num* can range from 0 to 10 and selects one of the international character sets listed in Table 6-1. The characters that change are shown in Appendix A.

Table 6-1. International character sets

set-num	Country
0	USA
1	France
2	Germany
3	England
4	Denmark
5	Sweden
6	Italy
7	Spain
8	Japan
9	Norway
10	Denmark II

Vertical offset (VO)

The *vertical offset* (VO) command moves the characters up or down from the normal baseline. (Remember, the baseline is the imaginary line on which the characters sit.) This command is used to print superscripts or subscripts and its format is:

VO *offset*

The parameter *offset* is the amount measured perpendicular to the baseline, even if the baseline is rotated. If *offset* is positive, the character is printed above the baseline (as with a superscript). If *offset* is negative, the character is printed below the baseline (as with a subscript). Figure 6-7 shows an example of the effect of using the vertical offset command.

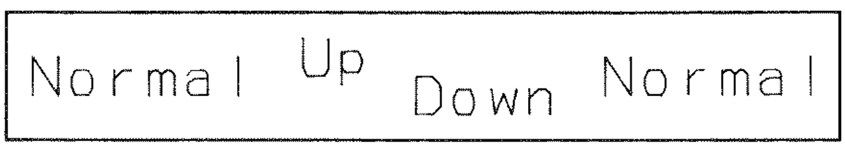


Figure 6-7. Vertical offset (VO) command

Reset characters (RC)

The *reset characters* (RC) command restores the default values of all the character-related settings. The RC command has no parameters; its format is simply:

RC

This command resets the character attributes set by the commands shown in Table 6-2 to their default values.

Table 6-2. Character reset default values

Command	Default value
Character set (CS)	0 (USA)
Character size (SI)	24 x 24
Character direction (DI)	0°
Vertical offset (VO)	0
Character slant (SL)	0
Character emphasis (EM)	0

The following example shows how the RC command works:

```
MA 1200,500
SI 50,50
DI 1350
LAResetting the charac
RC
LAters to their default values
```

Figure 6-8 shows the results. The characters start printing at a size of 5.0 mm x 5.0 mm in the direction of 135 degrees from the baseline. The RC command resets the characters to 2.4 mm x 2.4 mm at 0 degrees.

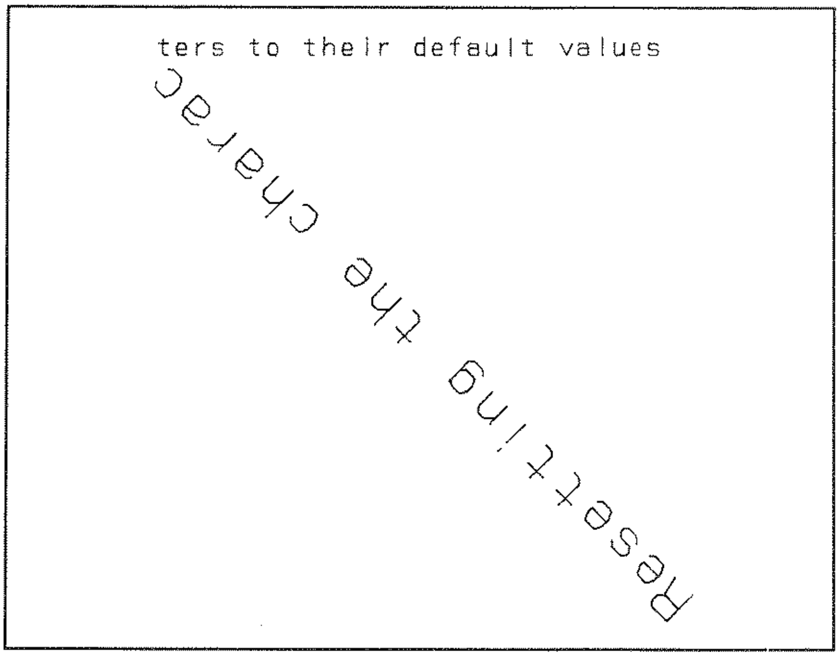


Figure 6-8. Reset characters (RC) command

Chapter 7
Formats and Line Types

With the HC100, you can make adjustments to most of the commands used to produce different results. You have already seen how to select different types of bar graphs and pie charts and change the cross-hatching patterns. In the previous chapter, you changed the character style.

In this chapter you'll see that the style of lines can also be changed. You can change line types, line pitch, tick length (of an axis), and arrows with the HC100.

Line type (LT)

The *line type* (LT) command lets you select any of nine different types of lines. The command requires one parameter and looks like this:

LT *type*

The parameter *type* can range from 0 through 8, and selects the style of line that you want to use. The line types available are shown in Figure 7-1.

Line pitch (LP)

Each type of line drawn with the line type (LT) command is made of a pattern that is repeated over and over. The length of one pattern is called the *pitch* of the line and can be changed with the *line pitch* (LP) command which looks like this:

LP *pitch*

The parameter *pitch* sets the pitch of the line. The default value of *pitch* is 60. This command enables you to draw lines to fit the scale of your drawing. Figure 7-2 shows the patterns created by changing the value of *pitch*. Note that the line pitch command has no effect on a solid (*type* = 0) line.

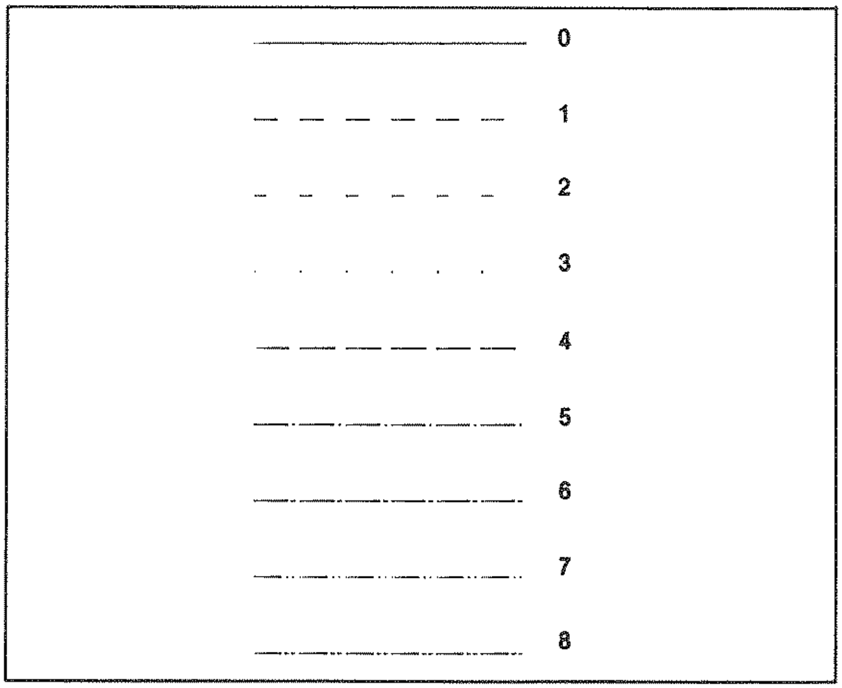


Figure 7-1. Line type (LT) command

Figure 7-3 shows examples of the same line (*type* = 5) drawn with three different pitches.

Tick length (TL)

The *tick length* (TL) command is used to adjust the length of the ticks drawn by the axis (AX) command. The format of the tick length command is:

TL *pos-len, neg-len*

The parameter *pos-len* specifies the tick length in the positive direction from the axis; *neg-len* specifies the tick length in the negative direction. The default value for both *pos-len* and *neg-len* is 10.

You can draw ticks that extend only one way from the axis, by making one of the parameters zero. Figure 7-4 shows examples of several different lengths of ticks.

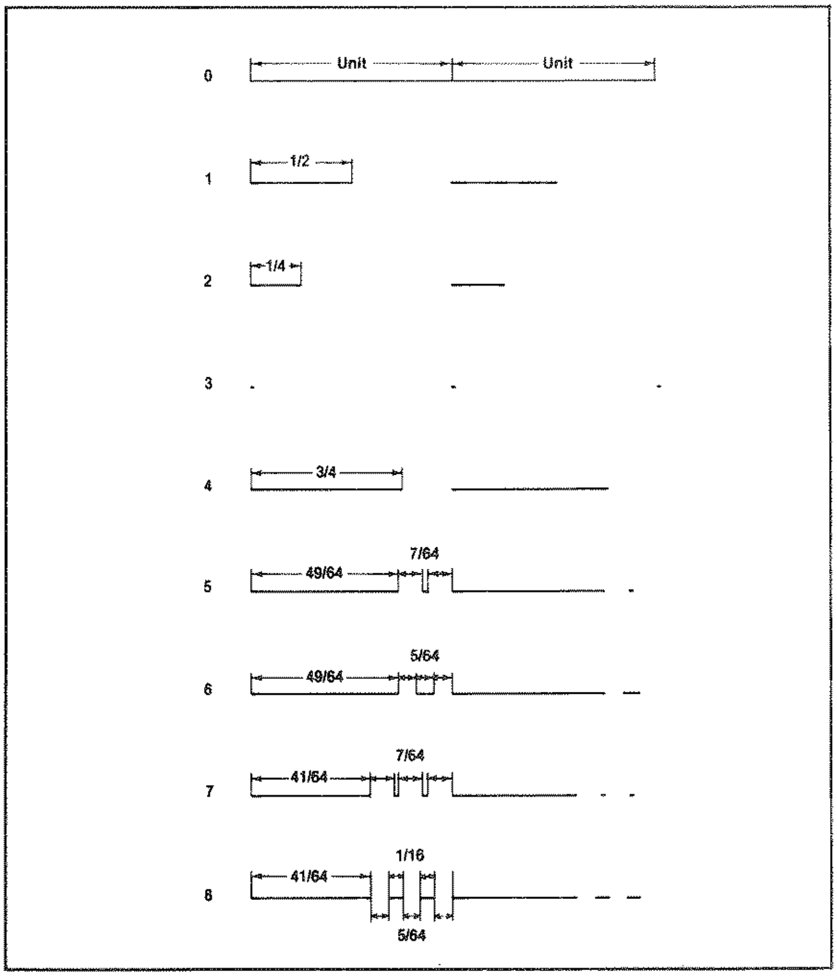


Figure 7-2. Pitch of line type patterns

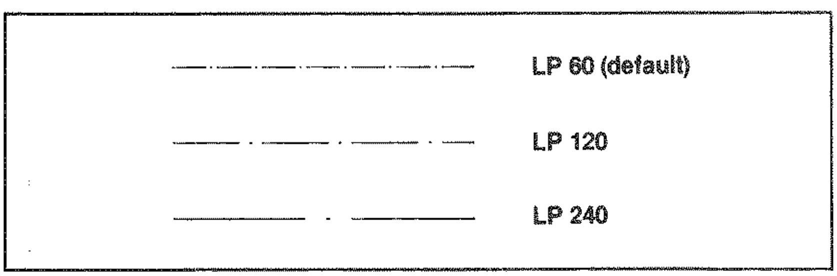


Figure 7-3. Line pitch (LP) command

Arrow (AR)

Arrows are used in many different applications, and are reasonably complicated to plot, especially if they happen to be set at odd angles. The *arrow* (AR) command does all the complex calculations and drawing for you.

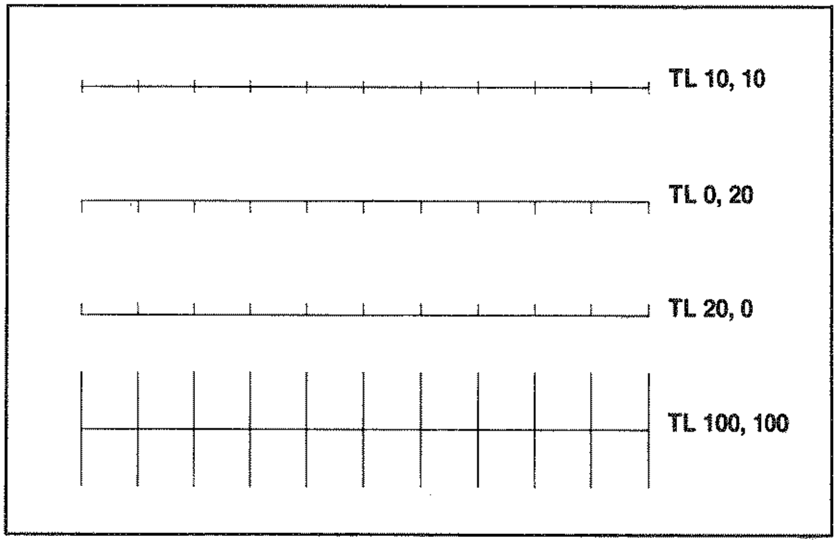


Figure 7-4. Tick length (TL) command

The format of the arrow command is:

AR *style, head-len, head-ang, dx,dy, dir*

The first three parameters define what the arrow looks like. The last three determine where it points.

The parameter *style* can range from 0 through 3 and selects the type of arrow drawn (shown in Figure 7-5). The parameters *head-len* and *head-ang* specify the size and shape of the arrow head. Figure 7-6 shows how values for *head-len* and *head-ang* are determined.

The parameters *dx* and *dy* determine the length of the arrow. The arrow starts at the current position and is drawn to the relative coordinates *dx* and *dy*. The parameter *dir* specifies the end on which the arrow head is drawn. If *dir* is 0, the arrow head is drawn at the destination end of the arrow. If *dir* is 1, the arrow head is drawn at the beginning of the arrow. And, if *dir* is 2, the arrow head is drawn at both ends of the arrow.

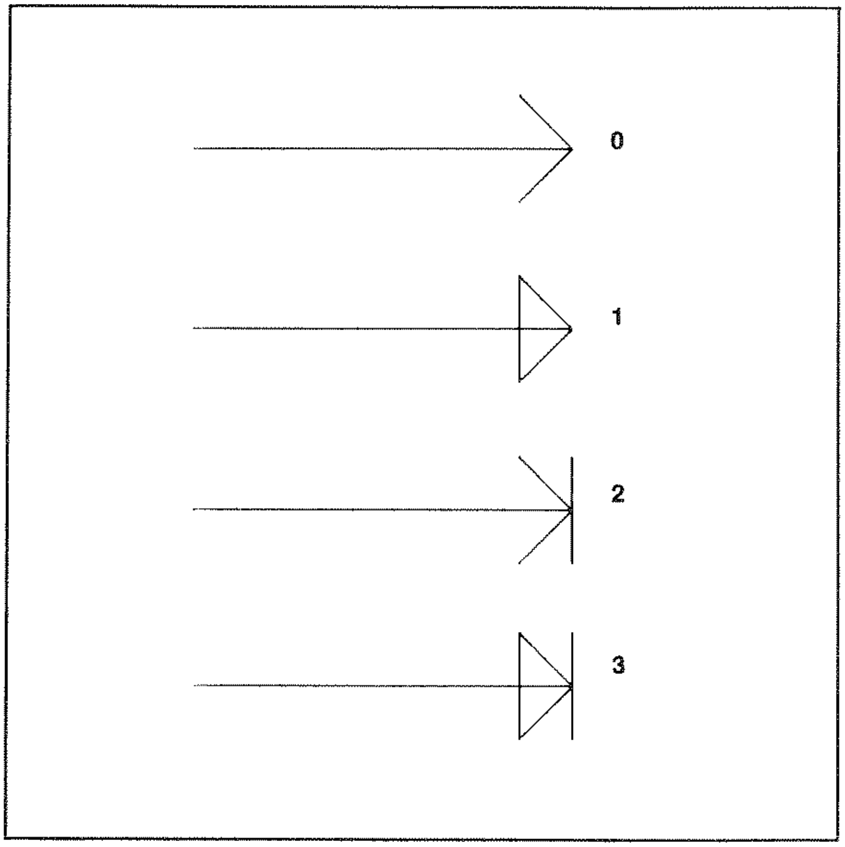


Figure 7-5. Arrow types

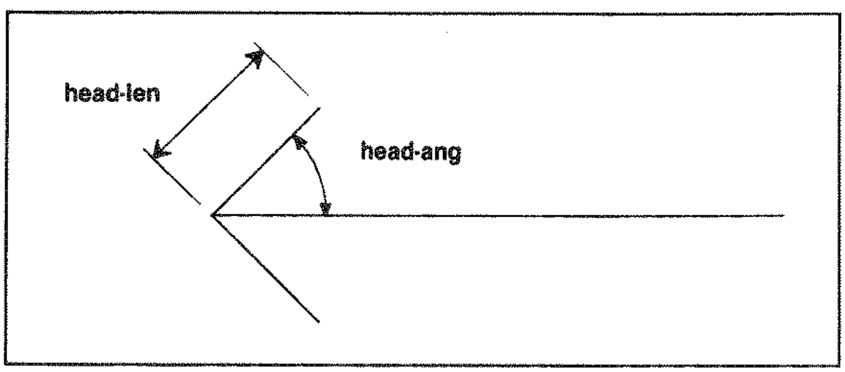


Figure 7-6. Changing the size and shape of the arrow head

The following examples of the arrow command draw the arrows shown in Figure 7-7.

AR 0, 100, 450, 500,0, 2

AR 1, 100, 300, 500,0, 0

AR 2, 25, 300, 500,0, 1

AR 3, 100, 600, 500,0, 2

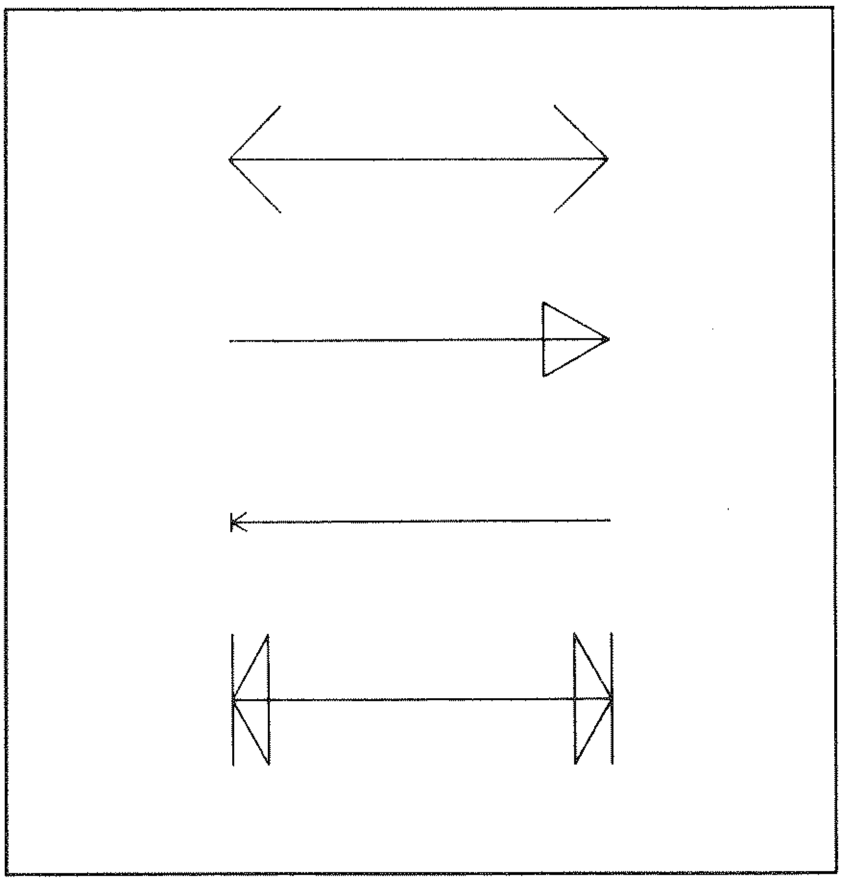


Figure 7-7. Arrow (AR) command

Chapter 8
Positioning and Scaling

The HC100 lets you position and scale your graphics with a few simple commands. You can even set the drawing area of your paper in two different ways with the same command.

Changing the Coordinate Origin

In Chapter 1, you learned that the HC100 uses the coordinate system to plot points and the x,y coordinates 0,0 are the origin. In some applications it may be more useful to change the origin to a different position, such as the center of the drawing area (1255,960).

Origin (OR)

With the *origin* (OR) command, you can place the origin of the plotter's coordinate system anywhere on the sheet. The command has no parameters; it is simply:

```
OR
```

The origin command changes the coordinate origin to the current position. The plotter then recognizes this position as the *new coordinate origin* (point 0,0) for all points that are subsequently used.

For example, the following commands change the origin to the center of the drawing area.

```
MA 1255,960
OR
```

These commands set the new origin at the center of the page. The plotter now considers point 1255,960 as point 0,0. Subsequently the points to the left and below the center have negative coordinate values, as shown in Figure 8-1.

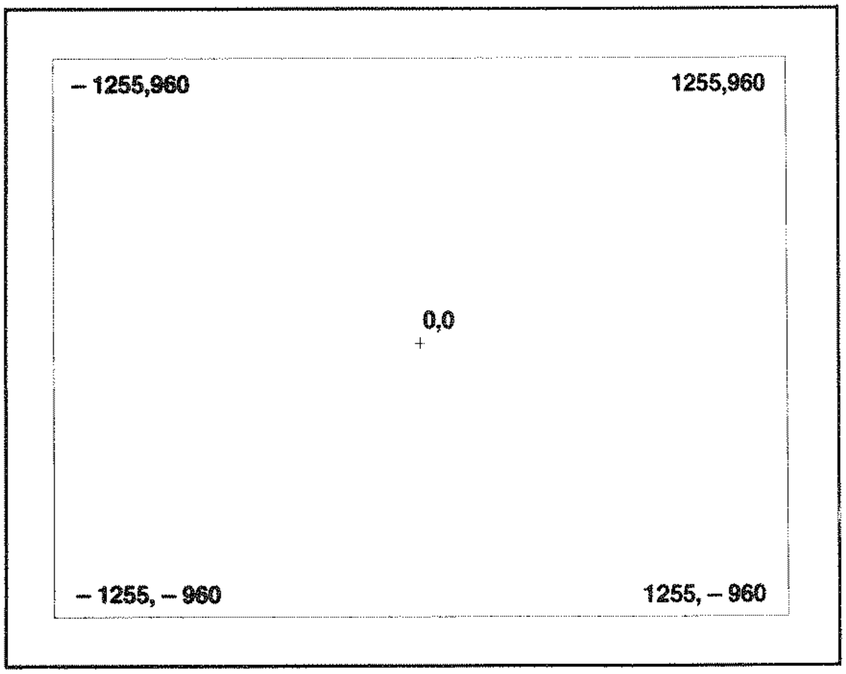


Figure 8-1. Origin (OR) command

Establishing the Drawing Area

With a wide range of plotting needs, you will undoubtedly use a similar variety of paper sizes and drawing formats. With the HI-80, you can set the drawing area of your paper in two ways with one command.

Input window (IW)

First, the *input window* (IW) command can be used to tell the plotter what size paper you intend to use. Second, it can be used to reduce the drawing area of the plotter to less than the full page.

Adjusting the paper size

The HC100 uses three different sizes of paper; B5, A4 and US letter size. The actual sizes of these sheets are shown in Table 8-1. The first two sizes are metric sizes, the third is the standard size of letterhead paper used in the United States.

Table 8-1. HC100 paper sizes

Paper size	Sheet size (mm)	Sheet size (in)
A4	297 x 210 mm	$11\frac{5}{8}$ x $8\frac{1}{4}$ in
US letter	279 x 216 mm	11 x $8\frac{1}{2}$ in
B5	257 x 182 mm	$10\frac{1}{8}$ x $7\frac{3}{16}$ in

To change paper sizes, the format is:

IW *size*

The parameter *size* specifies which of the three paper sizes is to be used: for A4, *size* = 0; for US letter, *size* = 1; for B5, *size* = 2.

It is important to use the input window command to tell the plotter when you are changing the size of the paper, to prevent the plotter from drawing off the edge of the sheet (or not using the full drawing area available). The default drawing areas are shown in Table 8-2.

Table 8-2. Default drawing areas

Paper size	Drawing area (mm)	Drawing area (in)
A4	267 x 192 mm	$10\frac{2}{5}$ x $7\frac{1}{2}$ in
US letter	251 x 192 mm	$9\frac{4}{5}$ x $7\frac{1}{2}$ in
B5	227 x 164 mm	$8\frac{4}{5}$ x $6\frac{2}{5}$ in

Note: Remember that the paper pressure roller must be moved when switching to, or from, B5 size paper.

Reducing the drawing area

Sometimes you may want to draw only part of a figure. To do this, you can restrict the drawing area to less than the full drawing area with the second format of the input window command. The command in its second format creates a *window* in the drawing area. The plotter will only draw inside this window, clipping any lines that extend outside the window.

The format is:

IW *x-min,y-min, x-max,y-max*

The parameters define two opposite corners of the drawing window: *x-min* and *y-min*, the lower left corner, and *x-max* and *y-max* at the upper right corner. If any side of the window is outside of the drawing area, then the edge of the drawing area is taken as the edge of the window. The following example defines the window shown in Figure 8-2.

IW 250,250, 2250,1450

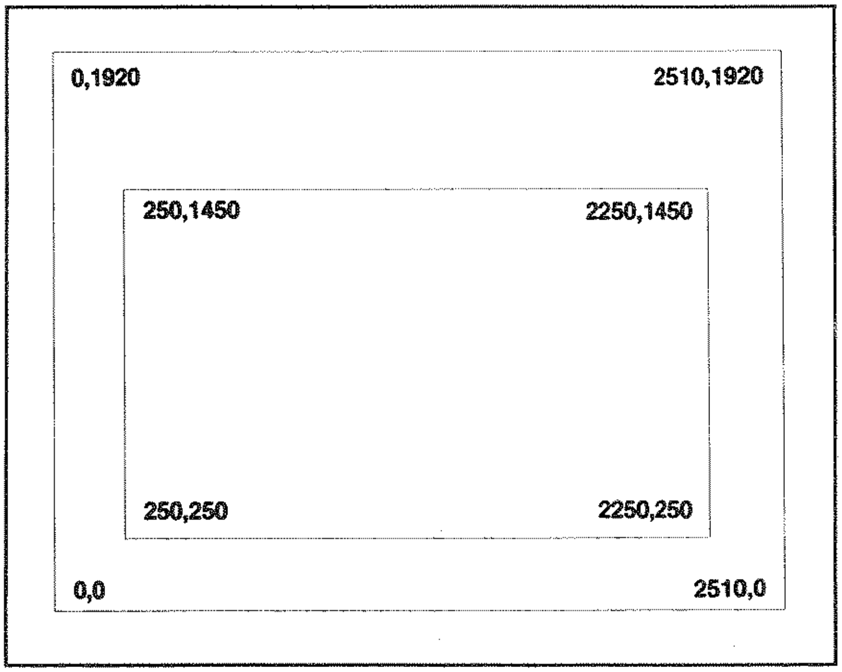


Figure 8-2. Input window (IW) command

Changing the Scale of Figures

Changing the scale of your figures would be a phenomenal task if you had to recalculate and re-input all your parameters. Your plotter automatically does these calculations for you with the input factor (IF) command.

Input factor (IF)

With the *input factor* (IF) command, you change the scale of the entire figure at once. The command can be used to enlarge or reduce the scale. The format looks like this:

IF *numerator, denominator*

The two parameters are divided to calculate the scale. For example:

IF 1, 2

divides 1 by 2, which reduces the scale to one half (1/2) the original size. The parameters can have values from 1 through 15. By choosing the correct values for the parameters you can get any magnification or reduction in scale from 1/15 scale to 15 times as large. Notice that you can get non-integer values by selecting the correct parameters; to get a magnification of 1.5, for example, use *numerator* = 3 and *denominator* = 2 (3/2 = 1.5).

Figure 8-3 was created by the following commands. Notice that all the moving and plotting commands are the same for each triangle—the only change is the scale set by the IF command.

```
MA 100,100
DA 100,100, 200,300, 500,100, 100,100

IF 1, 2
MA 100,100
DA 100,100, 200,300, 500,100, 100,100

IF 2, 1
MA 100,100
DA 100,100, 200,300, 500,100, 100,100
```

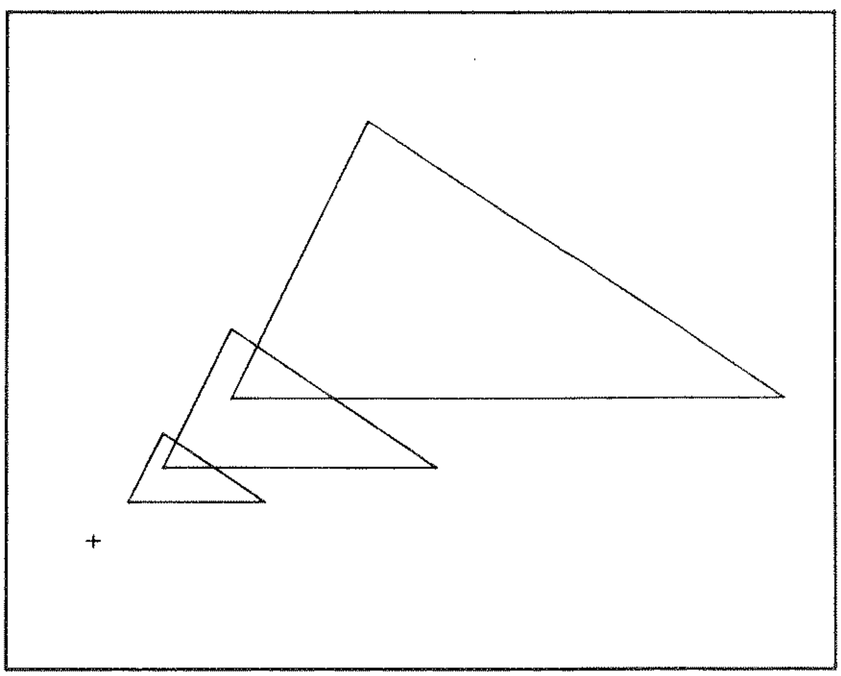


Figure 8-3. Input factor (IF) command

Chapter 9
Changing Command Sets

Two commands are used to change from one command set to another. You use them when running a program that was written for a plotter with a different set of commands. Or you may use them to integrate the printer emulator command set with a plotting program.

Alternate Command Set (AC)

The *alternate command set* (AC) command is used to select one of the command sets used by the HC100. The format of the command is:

AC *set*

The parameter *set* specifies the command set you want to select. The command switches between the two plotting command sets. If *set* = 0, the plotter changes to the Epson plotting commands (the commands explained throughout this manual) and if *set* = 1, the Graphtec emulator command set is selected (explained in Chapter 13).

Plotting parameters are not changed when you change command sets.

Printer Emulator Command Set

The printer emulator command set lets you use your HC100 plotter as a printer. Most of the printer emulator commands are the same as those used by Epson's dot-matrix printers with the addition of some commands unique to the plotter. The command to select the printer emulator set is:

⟨DC2⟩

This is the only command in the Epson plotting command set that consists of a single code, which is the ASCII code 18 decimal. No carriage return is required after this code.

Most plotting settings are not changed when switching to the printer emulator command set. Appendix G shows how the settings relate within the different command sets.

Chapter 10
Error Handling

As you have probably found out by now, the HC100 stops and lights the ERROR indicator when it encounters an error. But it is not always clear which command is in error. In this chapter, you'll see how to make the HC100 report which command has caused an error and how to continue plotting after the error occurs.

Types of Plotting Errors

The HC100 divides plotting errors into five different types; which are defined as follows:

1. *Command error*. You have used a command that the HC100 does not recognize. Check the two-letter command to be sure it is correct. For example, using CP for the change paper command results in this error. The correct command is CH.

2. *Parameter range error.* You have used a parameter that is outside the allowable range. For example, the command MA 1000, 19000 results in this error because 19000 is greater than the allowable range of 16383.

3. *Missing parameter error*. You have not supplied enough parameters for the command. For example, the command CA 100, 100 results in this error because the parameters for the radius and two angles are missing.

4. *Delimiter error*. You have used the wrong delimiter between parameters. Delimiters can only be commas and spaces. A delimiter error may occur as the result of the BASIC language outputting a number in scientific notation, such as 3.45678E04. The "E" causes this error (and the number will be misinterpreted by the HI-80). You can use a LPRINT USING statement to be sure that BASIC outputs numbers in the proper format.

5. *Overflow error*. The results of a calculation have exceeded the allowable range (−32768 to +32767). This is usually the result of using relative commands that would move the pen outside of the allowable range. This error also occurs if you attempt to divide by zero, such as in a command like IF 1, 0.

Finding Errors with the HC100

There are two methods for finding errors with the HC100. One is to switch the HC100 into the printer command set and read what the plotter is receiving from the computer; the other is to use the error reporting facilities of the HC100.

Using the printer command set to find errors

Many errors are caused when the plotter does not receive the same information that your program sends. Sounds illogical since computers never make mistakes, do they?

No, computers don't make *many* mistakes, but they can get overly helpful at times. One of the most common causes of errors with the HC100 is BASIC's inclination to put in a carriage return and line feed after every 80 characters. If you are trying to send a command to the plotter that is more than 80 characters long, then most BASICs insert a carriage return and a line feed after the first 80 characters. This is to keep your printer from printing past the right margin, but it certainly doesn't help when you're using a plotter! There is a solution, which you'll see momentarily, but first: how to find the problem.

If BASIC inserts a carriage return and a line feed in the middle of your command, this is now going to look like two commands to the plotter, and the second one is *not* going to be a valid command since it doesn't start with a valid two-letter format. The plotter attempts to execute the first command (the first part of the original command), and may in fact succeed. Then it encounters the second command (the second part of the original command). This stops the plotter and lights the ERROR indicator.

If you look at the commands in your program, there is no indication why the plotter is giving you an error. Everything you are sending to the plotter is correct. But everything the plotter receives is not correct.

Switching to the printer command set

One method of diagnosis is to switch the plotter to the printer command set. This prints out all the plotting commands as text and lets you compare what the plotter is receiving to what your program is sending. Switching to the printer command set is easy. Just turn the plotter ON while you hold down the CAP/OFF switch. The plotter remains in the printer command set until you turn it OFF and back ON again, or until you give it the software command to change to the plotter command set.

Figure 10-1 shows an example of plotter commands printed on the plotter using the printer command set.

```
ma 500, 1500
ar 0, 100, 450, 500, 0, 0
ma 1050, 1500
la0

ma 500, 1200
ar 1, 100, 450, 500, 0, 0
ma 1050, 1200
la1
```

Figure 10-1. Plotting commands printed on the plotter

A solution to the problem

There is an easy solution to the problem of BASIC inserting a carriage return and a line feed every 80 characters. With most versions of BASIC you can prevent this by using a statement like this:

WIDTH "LPT1:", 255

or

WIDTH LPRINT 255

Check the BASIC manual for your computer to see which form of this command you should use.

Reporting Errors with the HC100

The HC100 has a built in error reporting facility that makes it easy to tell what errors have occurred while plotting. You can also specify several types of error reporting that best suit your situation. The command used to activate the error reporting facility is the *error control* (IM) command.

Error control (IM)

The *error control* (IM) command selects the kinds of errors to report and how to report them. The error control command looks like this:

IM *type, action*

The parameter *type* specifies which of the five error types are to be reported. Each of the five error types has a value as shown in Table 10-1. The parameter *type* is the sum of the values of all the error types that you want to include. The most common value for *type* is 31, which is the sum of all five error types.

Table 10-1. Error type values

Error type	Type value
Command error	1
Parameter range error	2
Missing parameter error	4
Delimiter error	8
Overflow error	16

Error types not included in the parameter *type* are ignored. That is, the command that contains the error is not executed, and the plotter moves on to the following command.

The parameter *action* specifies what kind of action the HC100 is to take when it encounters an error. Table 10-2 lists the possible values of *action* and a description of the action taken by the HC100.

Table 10-2. Error descriptions with values of action

action	Error description
0 or 8	The ERROR indicator is lit. The command containing the error is skipped and execution continues with the next command. The ERROR indicator remains lit until cleared by an error releasing command.
1 or 9	The ERROR indicator is lit, execution halts, and all commands are ignored until an error releasing command is received. (This is the default state.)
2 or 10	The ERROR indicator is lit. The error type and first ten characters of the command containing the error are printed in the lower left of the drawing area. The command containing the error is skipped and execution continues with the next command. The ERROR indicator remains lit until cleared by an error releasing command.
3 or 11	The ERROR indicator is lit. The error type and first ten characters of the command containing the error are printed in the lower left of the drawing area. Execution halts, and all commands are ignored until an error releasing command is received.

If you use a value of *action* between 8 and 11, the error signal on the parallel interface is also set to LOW when an error is encountered. Nothing happens if a serial interface is used.

Figure 10-2 shows how the HC100 prints errors in the lower left of the drawing area. If you have more than one error, the error messages print on top of each other.

```
PARAMETER INSUFFICIENT ERROR!!  CMD:HB 0, 400,
```

Figure 10-2. A typical error message

Chapter 11
Epson Plotting Command Reference

This chapter is a summary of the commands used when the Epson plotting command set is selected. The commands are organized into nine logical groups:

- Absolute and Relative Commands
- Miscellaneous Commands
- Plotting Commands
- Label Commands
- Format and Line Type Commands
- Positioning and Scaling Commands
- Changing Command Sets Commands
- Error Handling Commands

The following format is used to describe each command:

Function:
What the plotter does when given the proper command.

Format:
The correct syntax for the command. The *parameters* are named to help indicate what value is entered. For example, the parameter *x-len* calls for a numerical value that is the length along the X-axis. Optional parameters are enclosed in brackets [ ] e.g. AX *dir, len, div, scale-mark [,start-num, end-num, num-space, num-dir]*. Absolute X and Y coordinates are expressed simply as *x,y* while relative X and Y coordinates are expressed as *dx,dy*.

Parameters:
What variable values are used (if any) and how each variable affects the plotter's actions.

Remarks:

How the plotter performs the command, interaction with other commands, etc.

Examples:

Provides a demonstration of the command and a printout of the result.

Units of Measure

When you are using the Epson plotting commands, you can change the unit of measure as you please. The default unit of measure is 0.1 mm, but the unit of measure can range from .0067 mm to 1.5 mm. Because of this ability to scale the unit of measure (by using the input factor (IF) command), *no* units are shown in this chapter when referring to distances used in the commands. For example, assuming the default unit of measure, a distance of 6.0 mm is represented as 60.

Angles are always measured in 0.1°. For example, 90° is represented as 900. Angles are measured from the positive X-axis as explained in Chapter 1.

Absolute and Relative Commands

Move absolute

Function:

Moves without drawing to position x,y.

Format:

MA x,y

Parameters:

The parameters x and y define the point the pen moves to.

Remarks:

The parameters must be in the range -16383 to 16383.

This command references points as absolute positions relative to the coordinate origin.

Examples:

MA 500,1200

This command moves the pen to the point 500,1200. See Figure 11-1.

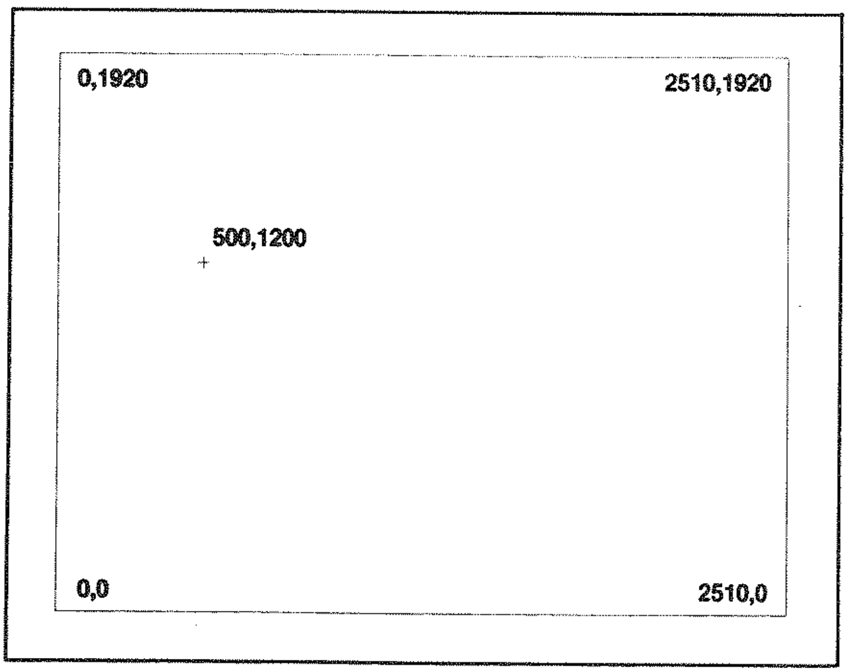


Figure 11-1. Move absolute (MA) command

Draw absolute

Function:

Draws a line from the current position to the absolute location *x1,y1*, and then on to *x2,y2*, etc.

Format:

DA *x1,y1 [, x2,y2 ... , xn,yn]*

Parameters:

The parameters *x1* and *y1* define the point at the end of the first line segment.

The parameters *x2* and *y2* define the point at the end of the second line segment.

xn and *yn* define the point at the end of the *n*th line segment.

Remarks:

Parameters must be included in pairs, an *x* value and a *y* value, which together specify a point.

You can include as many pairs of parameters as you like with this command. The pen draws successive lines between the points defined by the pairs of parameters.

The parameters must be in the range −16383 to 16383.

This command references points as absolute positions relative to the coordinate origin.

The type of line used is determined by the line type (LT) command.

Examples:

Both examples below assume that the current position is the origin (point 0,0).

DA 400,500

This command draws a line from the current position to the point 400,500. See Figure 11-2.

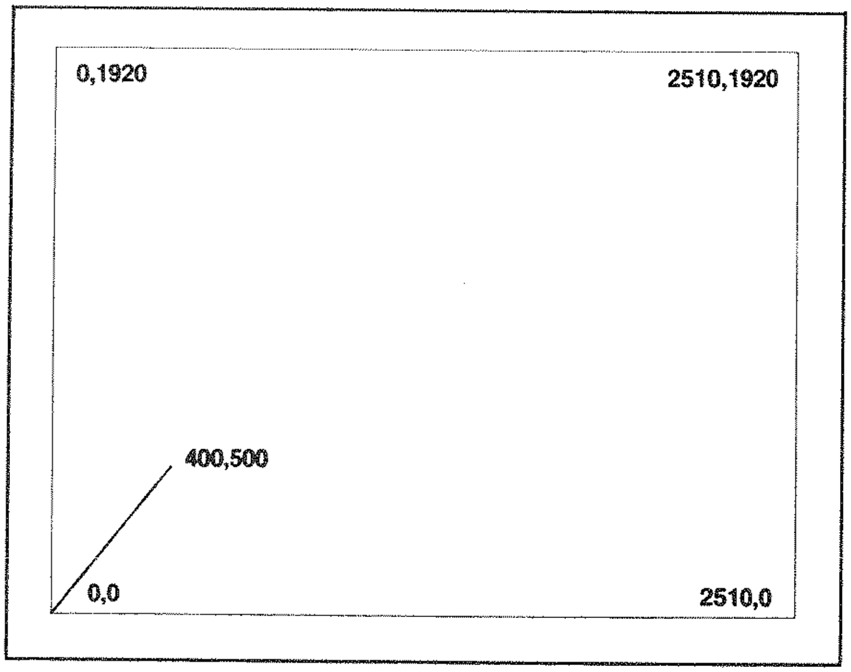


Figure 11-2. Draw absolute (DA) command

DA 300,600, 500,700

This command draws a line from the current position to the point 300,600 and then draws a line from the point 300,600 to the point 500,700. See Figure 11-3.

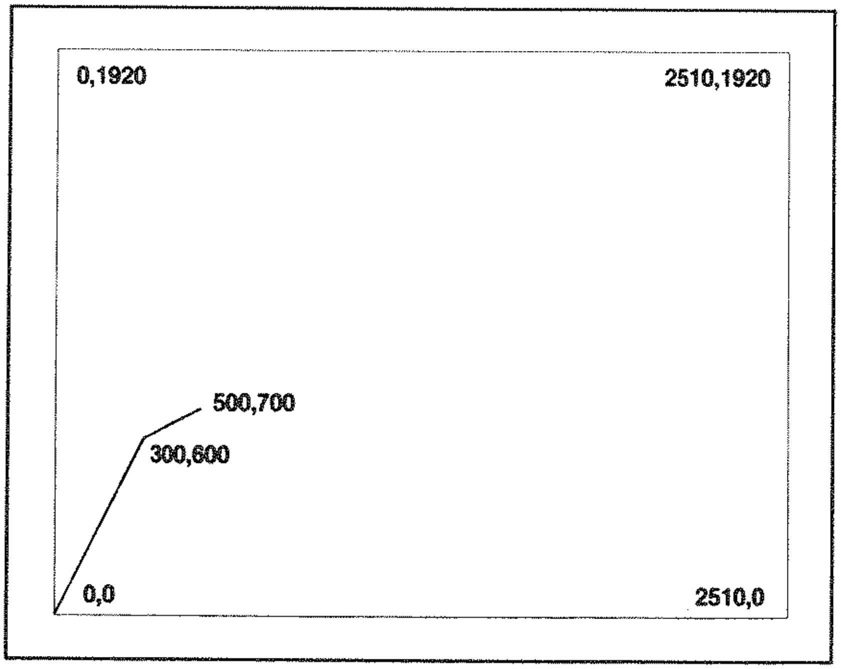


Figure 11-3. Draw absolute (DA) command

Circle absolute

Function:

Draws a circle or circle segment beginning at an absolute position.

Format:

CA *x,y, rad, start-angle, end-angle*

Parameters:

The parameters *x* and *y* specify the center of the circle.

The parameter *rad* specifies the radius of the circle.

The parameter *start-angle* specifies the starting angle of the arc. The parameter *start-angle* is given in 1/10 of degrees, measured counterclockwise from the positive X-axis.

The parameter *end-angle* specifies the ending angle of the arc. The parameter *end-angle* is given in 1/10 of degrees, measured counterclockwise from the positive X-axis.

Remarks:

The parameters must be in the range −16383 to 16383.

If the absolute coordinate of any point on the circle is outside the range −32768 to 32767, an error will result.

This command references the center point as an absolute position relative to the coordinate origin.

The arc is drawn in a counterclockwise direction if *end-angle* is greater than *start-angle*.

The arc is drawn in a clockwise direction if *start-angle* is greater than *end-angle*.

The type of line used is determined by the line type (LT) command.

Examples:

CA 1300,800, 200, 0, 900

This command draws a quarter of a circle (90°) whose end radii are parallel to the X-axis and Y-axis. The center is at the point 1300,800 and the radius is 200. The arc is drawn from the X-axis to the Y-axis, since *end-angle* is greater than *start-angle*. See Figure 11-4.

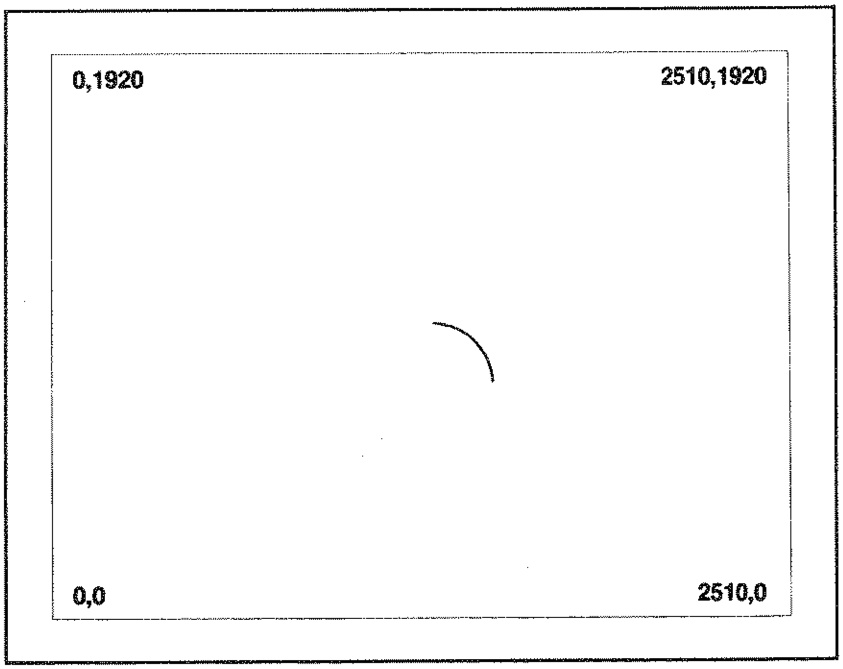


Figure 11-4. Circle absolute (CA) command

CA 1300,800, 200, 0, 3600

This command draws a full circle. The center is at the point 1300,800 and the radius is 200. The circle is drawn counterclockwise, since *end-angle* is greater than *start-angle*. See Figure 11-5.

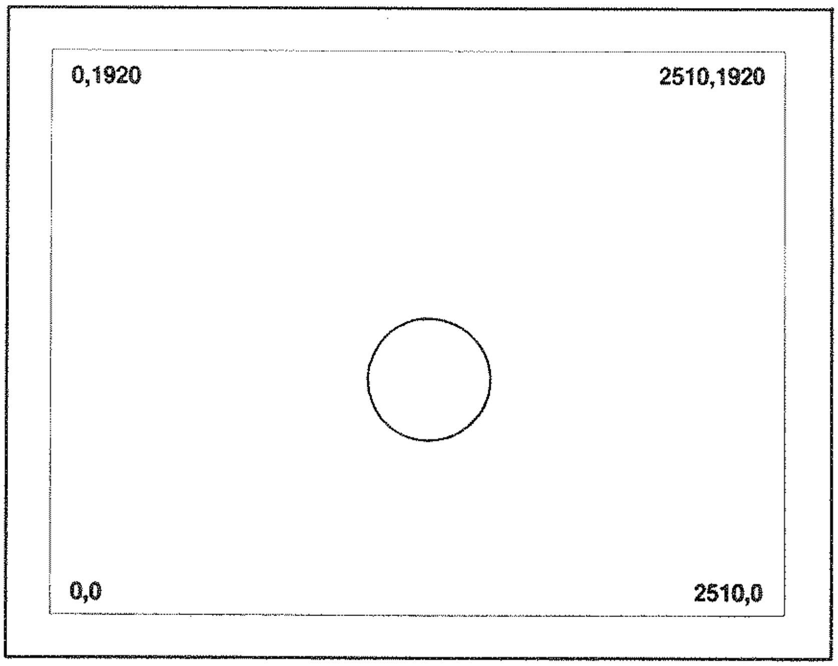


Figure 11-5. Circle absolute (CA) command

CA 1000,500, 300, 0, −900

This command draws a quarter of a circle (90°) whose end radii are parallel to the X-axis and Y-axis. The center is at the point 1000,500 and the radius is 300. The arc is drawn clockwise, since *end-angle* is less than *start-angle*. See Figure 11-6.

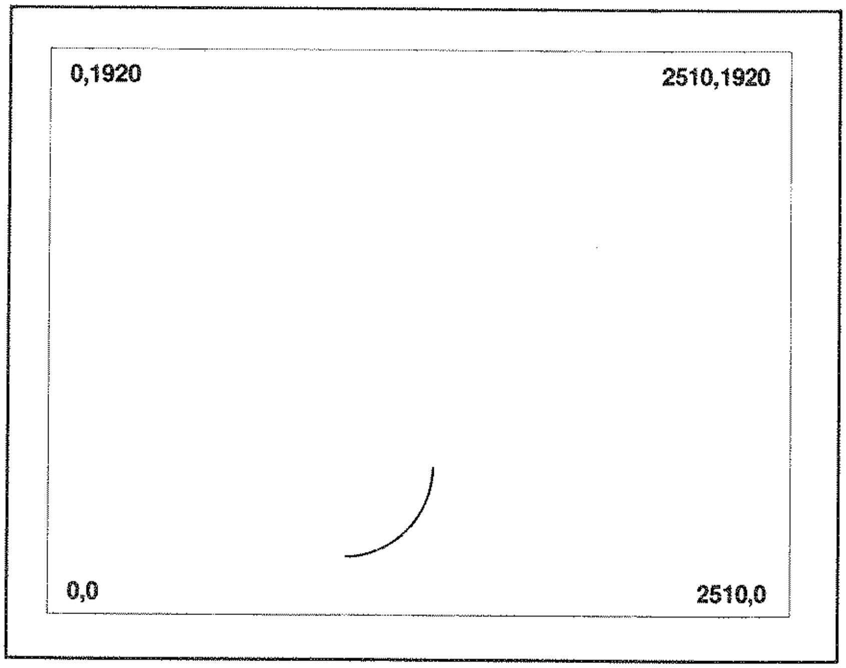


Figure 11-6. Circle absolute (CA) command

Move relative

Function:

Moves without drawing to the relative coordinate *dx,dy*.

Format:

MR *dx,dy*

Parameters:

The parameters *dx* and *dy* define the distance to the point the pen moves to, measured from the current position.

Remarks:

The point is defined relative to the current position. The *dx* value defines a distance from the current position in the X direction. The *dy* value defines a distance from the current position in the Y direction.

The parameters must be in the range −16383 to 16383.

If the absolute coordinate of the point is outside the range −32768 to 32767, an error will result.

Examples:

MR 300,600

This command moves the pen to the point that is 300 away in the X direction and 600 away in the Y direction. See Figure 11-7.

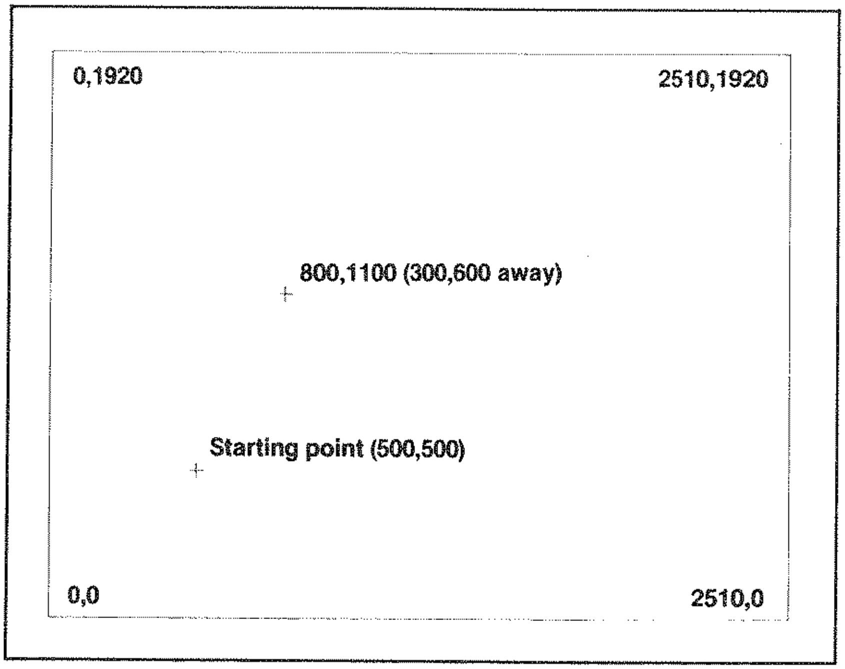


Figure 11-7. Move relative (MR) command

Draw relative

Function:

Draws a line from the current position to a point that is a distance *dx1, dy1* from the current position, and then on to a point that is a distance *dx2, dy2* from the first point, etc.

Format:

DR *dx1,dy1 [, dx2,dy2 ... , dxn,dyn]*

Parameters:

The parameters *dx1* and *dy1* define the distance to the point at the end of the first line segment, measured from the current position.

The parameters *dx2* and *dy2* define the distance to the point at the end of the second line segment, measured from the current position.

The parameters *dxn* and *dyn* define the distance to the point at the end of the *n*th line segment, measured from the current position.

Remarks:

Parameters must be included in pairs consisting of a *dx* value and a *dy* value, which together specify a distance to a point.

You can include as many pairs of parameters as you like with this command. The pen draws successive lines between the points defined by the pairs of parameters.

The parameters must be in the range −16383 to 16383.

The points are defined relative to the current position (or the position of the previous point). The *dx* value defines a distance from the current position in the X direction. The *dy* value defines a distance from the current position in the Y direction.

The type of line used is determined by the line type (LT) command.

If the absolute coordinate of any point is outside the range −32768 to 32767, an error will result.

To draw just a dot at the current position, use DR 0,0 (or DR,).

Examples:

DR 300,200

This command draws a line from the current position to a point that is 300 away in the X direction and 200 away in the Y direction. See Figure 11-8.

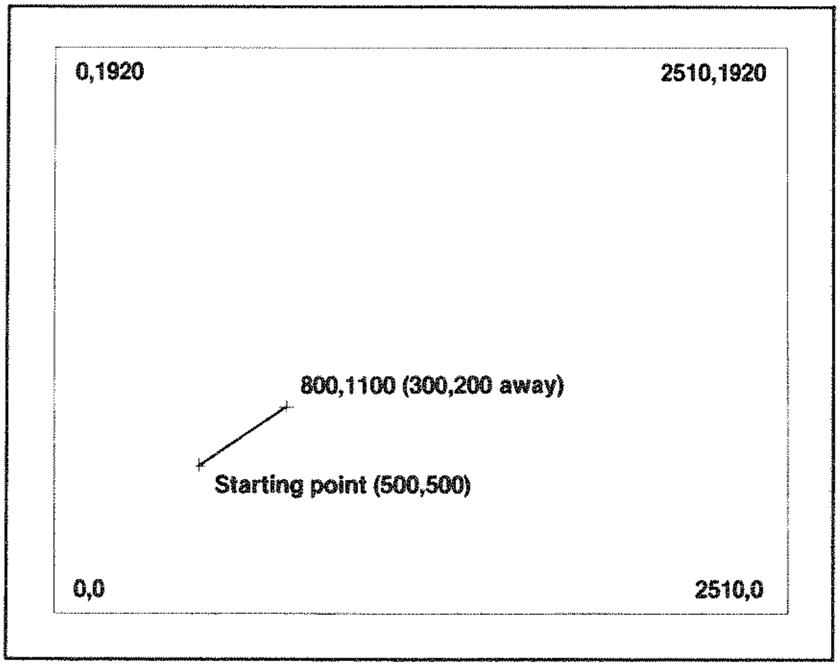


Figure 11-8. Draw relative (DR) command

DR 400,0, 0,400, −400,0, 0,−400

This command draws a square, with sides 400 long, starting at the current location. See Figure 11-9.

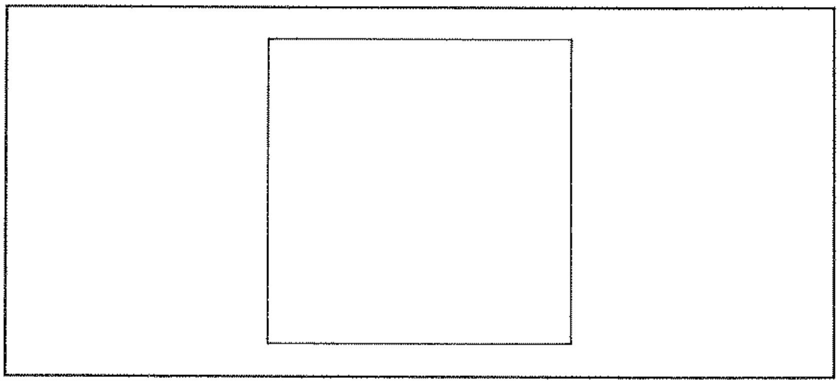


Figure 11-9. Draw relative (DR) command

Circle relative

Function:

Draws a circle or circle segment beginning at the current position.

Format:

CR *rad, start-angle, end-angle*

Parameters:

The parameter *rad* specifies the radius of the circle.

The parameter *start-angle* specifies the starting angle of the arc. The parameter *start-angle* is given in 1/10 of degrees, measured counterclockwise from the positive X-axis.

The parameter *end-angle* specifies the ending angle of the arc. The parameter *end-angle* is given in 1/10 of degrees, measured counterclockwise from the positive X-axis.

Remarks:

The parameters must be in the range −16383 to 16383.

If the absolute coordinate of any point on the circle is outside the range −32768 to 32767, an error will result.

The arc is drawn in a counterclockwise direction if *end-angle* is greater than *start-angle*.

The arc is drawn in a clockwise direction if *start-angle* is greater than *end-angle*.

The type of line used is determined by the line type (LT) command.

Examples:

CR 200, 0, 1800

This command draws half of a circle (180°) whose end radii are parallel to the X-axis. The circle is drawn counterclockwise because *start-angle* is less than *end-angle*. The radius is 200. See Figure 11-10.

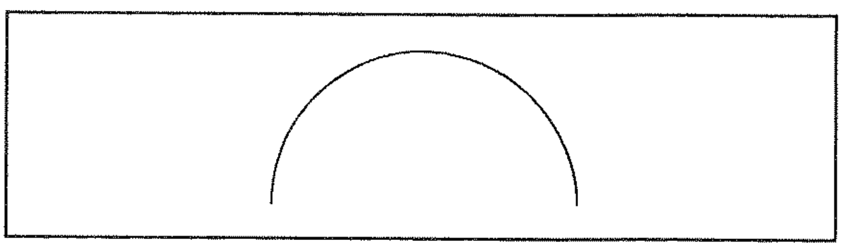


Figure 11-10. Circle relative (CR) command

CR 300, 0, 3600

This command draws a full circle with a radius of 300. See Figure 11-11.

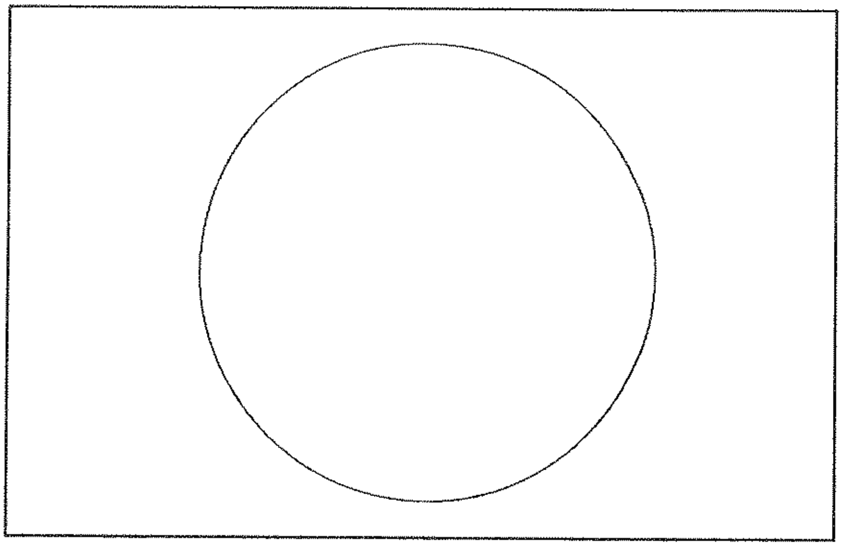


Figure 11-11. Circle relative (CR) command

Miscellaneous Commands

Clear interface

Function:
Clears error conditions.

Format:
CI

Parameters:
No parameters are required.

Remarks:
This command resets error conditions. It turns off the ERROR indicator and allows the plotter to continue normal operations.

If the plotter is set to stop on error conditions, any commands between the one that caused the error, and the clear interface (CI) command are ignored.

No plotting parameters are reset by this command.

Examples:
CI

Home pen

Function:
Moves the pen to the coordinate origin.

Format:
HO

Parameters:
No parameters are required.

Remarks:
This command is the equivalent of the command MA 0,0.

This command resets an error condition.

Examples:

HO

This command moves the pen to the origin.

Default values

Function:

Sets all values to the default state and returns the pen to the default coordinate origin.

Format:

DF

Parameters:

No parameters are required.

Remarks:

This command resets all the plotting parameters to the default settings as shown in Table 11-1. The pen returns to the default coordinate origin.

Table 11-1. Default plotting parameters

Command		Default value
Character set	CS	Set 0 (USA)
Character size	SI	24 x 24
Vertical offset	VO	0
Character direction	DI	0°
Character slant	SL	0
Character emphasis	EM	0 (no emphasis)
Line type	LT	0 (solid)
Line pitch	LP	60
Input window	IW	max size
Input factor	IF	1:1
Pen speed	VS	0 (high speed)
Tick length	TL	10 x 10
Select pen	SP	1
Error control	IM	31,1 (stop on all errors)

Examples:

DF

Initialize plotter

Function:

Returns the plotter to the power ON state.

Format:

IN

Parameters:

No parameters are required

Remarks:

This command returns the plotter to the power ON state. All plotting parameters are reset to the default settings as shown in Table 11-1.

The plotter executes the power ON reset sequence and moves the pen around the drawing area. If this command is executed when the paper is not aligned with the FRONT EDGE line, the paper may be ejected from the plotter.

Examples:

IN

Select pen

Function:

Selects a pen, or stows and caps the pens.

Format:

SP *pen-num*

Parameters:

The parameter *pen-num* specifies the pen (*pen-num* = 1 through 8), or the pen-capped option (*pen-num* = −1 or 0).

Remarks:

The pen positions are marked on the pen cassette as shown in Figure 11-12.

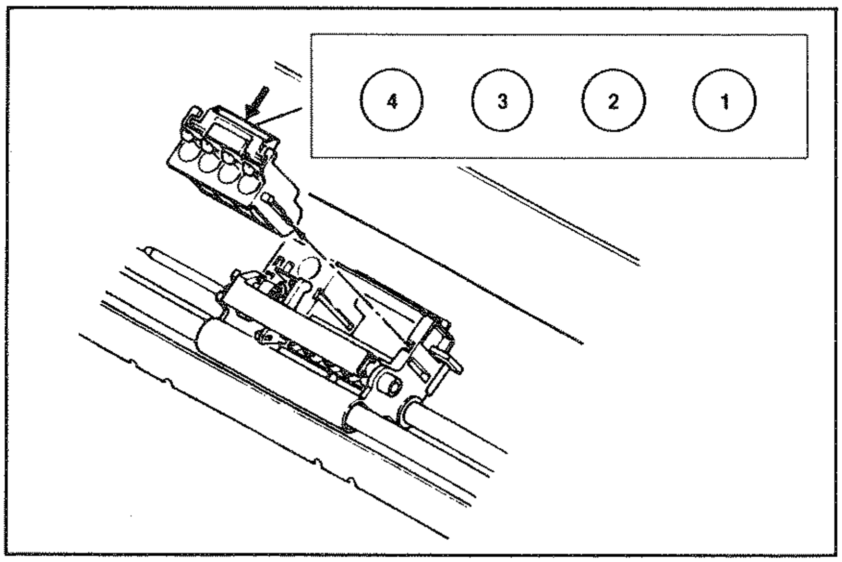


Figure 11-12. Pen numbers

The parameter *pen-num* can be any integer value from −1 through 8.

When *pen-num* is −1, the carriage moves to the extreme right, pen-capped position. When the next command (or even just a carriage return) is received, the pen returns to its position prior to the SP −1 command.

When *pen-num* is 0, the carriage moves to the extreme right, pen-capped position. You must press the CAP/OFF key for the HC100 to resume operation.

When *pen-num* is 1 through 4, the respective pen is selected.

When *pen-num* is 5 through 8, the sequence of pens is repeated (SP 5 selects pen 1, SP 6 selects pen 2, etc.).

After the pen is selected, it returns to the point prior to the SP command.

The default pen number is 1.

The initialize (IN) command and the default (DF) command both reset this to the default value.

Examples:

SP 2

This command selects pen number 2.

SP 7

This command selects pen number 3.

Change paper

Function:

Moves the pen to the pen-capped position and moves the paper in the full X direction to facilitate changing the paper.

Format:

CH

Parameters:

No parameters are required.

Remarks:

This command moves the pen carriage to the far right, pen-capped position. The paper moves up so that it can be released and removed and the ON LINE indicator flashes, indicating that the paper needs to be changed. When the paper has been replaced (aligned with the FRONT EDGE line), press the ON LINE button to continue. The pen then moves around the edge of the drawing area indicating the current window size. Finally, pen 1 is selected and placed on the point where the pen was before the command was executed.

No drawing parameters are changed other than the pen number.

Examples:

CH

Pen speed

Function:

Sets the drawing speed of the pen.

Format:

VS *speed*

Parameters:

The parameter *speed* specifies how fast the pen moves. The parameter *speed* can be 0 (fast) or 1 (slow).

Remarks:

The fast pen speed (*speed* = 0) is 230 mm/sec, the slow pen speed (*speed* = 1) is 100 mm/sec.

When the pen is moving diagonally, the actual pen speed is the result of the velocity in both the X and Y directions. For example, when the pen is moving at 45°, the pen speed is 1.414 times the specified velocity.

The slow pen speed may produce better quality drawings on some materials.

The fast pen speed is the default.

The initialize (IN) command and the default (DF) command both reset this to the default value.

Examples:

VS 1

This command sets the pen speed to 100 mm/sec.

Plotting Commands

Axis

Function:

Draws an axis line and graduates it. Optionally adds scale numbers.

Format:

AX *dir, len, div, scale-mark [, start-num, end-num, num-space, num-dir]*

Parameters:

The parameter *dir* specifies whether the axis is an X-axis (*dir* = 0 or 2) or a Y-axis (*dir* = 1 or 3). Also specifies whether *len* is interpreted as the length of one scale division (*dir* = 0 or 1) or the overall length of the axis line (*dir* = 2 or 3).

The parameter *len* specifies the length of one scale division (*dir* = 0 or 1) or the overall length of the axis line (*dir* = 2 or 3).

The parameter *div* specifies the number of scale divisions (maximum of 255).

The parameter *scale-mark* specifies whether a scale mark is made at the origin (*scale-mark* = 0), or a scale mark is not made at the origin (*scale-mark* = 1).

The following optional parameters are used to label the axis, and may be omitted if not required. All four of the parameters must be omitted along with the leading comma. When they are omitted, the axis is drawn unlabeled.

The parameter *start-num* specifies the starting value of the scale numbers.

The parameter *end-num* specifies the increment in value of the scale numbers for each division of the axis (*dir* = 0 or 1), or specifies the value of the last scale number on the axis (*dir* = 2 or 3).

The parameter *num-space* specifies the distance from the axis line to the nearest part of the scale numbers.

The parameter *num-dir* specifies whether the scale numbers are printed parallel to the axis line (*num-dir* = 0) or perpendicular to the axis line (*num-dir* = 1).

Remarks:

The parameters must be in the range −16383 to 16383 (except as otherwise noted).

Table 11-2 shows the interrelation of the parameters of the axis command.

Table 11-2. Interrelation of the axis command parameters

dir	**Axis**	***len***	***end-num***
0	Y	division length	increment amount
1	X		
2	Y	overall length	last number
3	X		

The axis line starts at the current position.

The tick length can be changed with the tick length (TL) command.

Characters are drawn according to the settings of the character size (SI), character slant (SL), vertical offset (VO), and character emphasis (EM) commands.

The scale numbers are centered on the tick marks, however, a vertical offset can change this. If the character size is such that the size of the characters is greater than the unit length, the characters will overlap.

Both the axis line and the ticks are drawn as solid lines, regardless of the setting of the line type (LT) command.

When *dir* is 2 or 3, *len* is divided by *div* to find the length of a division. If the result of this division is not an integer, then the remainder is discarded. This results in a slightly shorter line than would be expected. For example, if *len* = 1000, and *div* = 13, then the unit length is 76, since 1000/13 = 76.9231. This results in an overall axis line 12 shorter than expected (76 x 13 = 988).

When *dir* is 2 or 3, the difference between *start-num* and *end-num* is divided by *div* to find the increment for the scale numbers. If the result of this division is not an integer, then the remainder is ignored. This can result in incorrect scale numbers. For example, specifying *start-num* as 0, *end-num* as 105, and *div* as 6 gives an increment of 17 since 105/6 = 17.5. The scale would be marked in units of 17, but the end value would be 102, since this is 6 x 17.

To draw an axis in the negative direction, make *len* negative.

Examples:

MA 500,500
AX 1, 100, 6, 0, 0, 10, 50, 0
MA 500,500
AX 2, 1000, 10, 0, 0, 100, 50, 1

This example draws the axes shown in Figure 11-13. In the first axis command (which draws the X-axis), *dir* has a value of 1 so the other parameters (*len*, *div*, and *end-num*) are given in terms of one division. In the second axis command (which draws the Y-axis), *dir* has a value of 2 so the other parameters (*len*, *div*, and *end-num*) are given in terms of the entire axis.

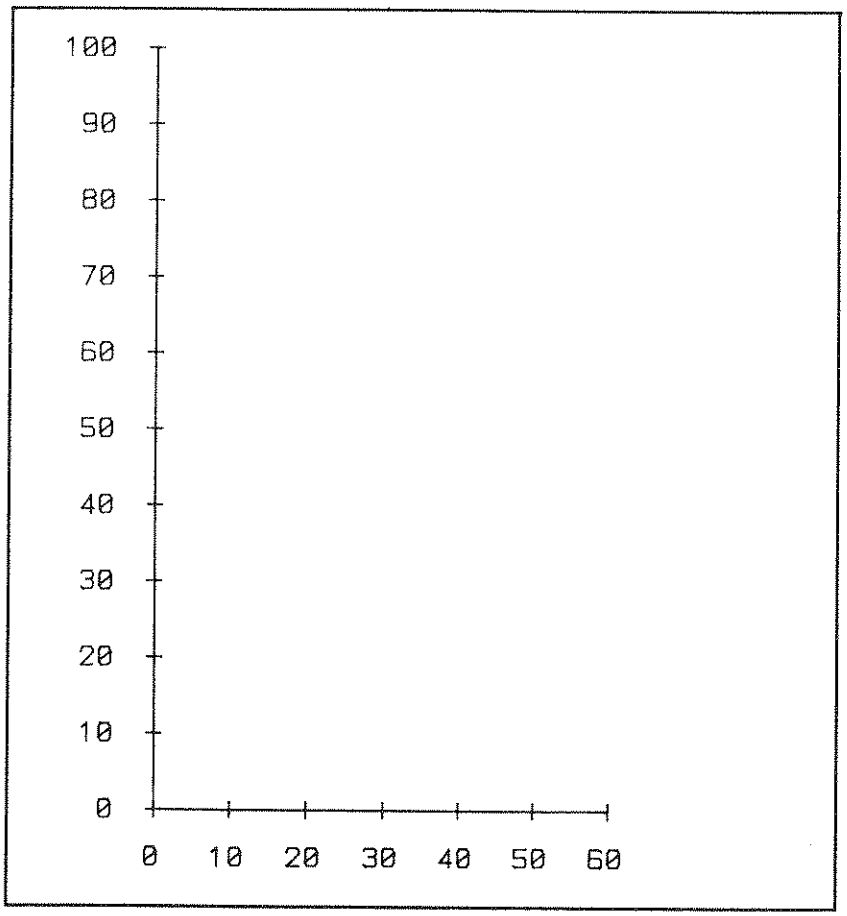


Figure 11-13. Axis (AX) command

Absolute line and mark

Function:

Connects the specified points by lines and marks the points with the specified style of mark.

Format:

AM *style, x1,y1 [, x2,y2, ... , xn,yn]*

Parameters:

The parameter *style* defines the type of marks made; *style* can range from 0 to 15.

The parameters *x1* and *y1* define the point where the first mark is made which is the beginning of the first line segment.

The parameters *x2* and *y2* define the point where the second mark is made which is the end of the first line segment.

The parameters *xn* and *yn* define the point where the *n*th mark is made which is the end of the $(n-1)$th line segment.

Remarks:

Parameters must be included in pairs, an *x* value and a *y* value, which together specify a point.

You can include as many pairs of parameters as you like with this command. The pen draws successive lines between the points defined by the pairs of parameters.

The parameters must be in the range −16383 to 16383.

This command references points as absolute positions relative to the coordinate origin.

The types of marks are shown in Figure 11-14.

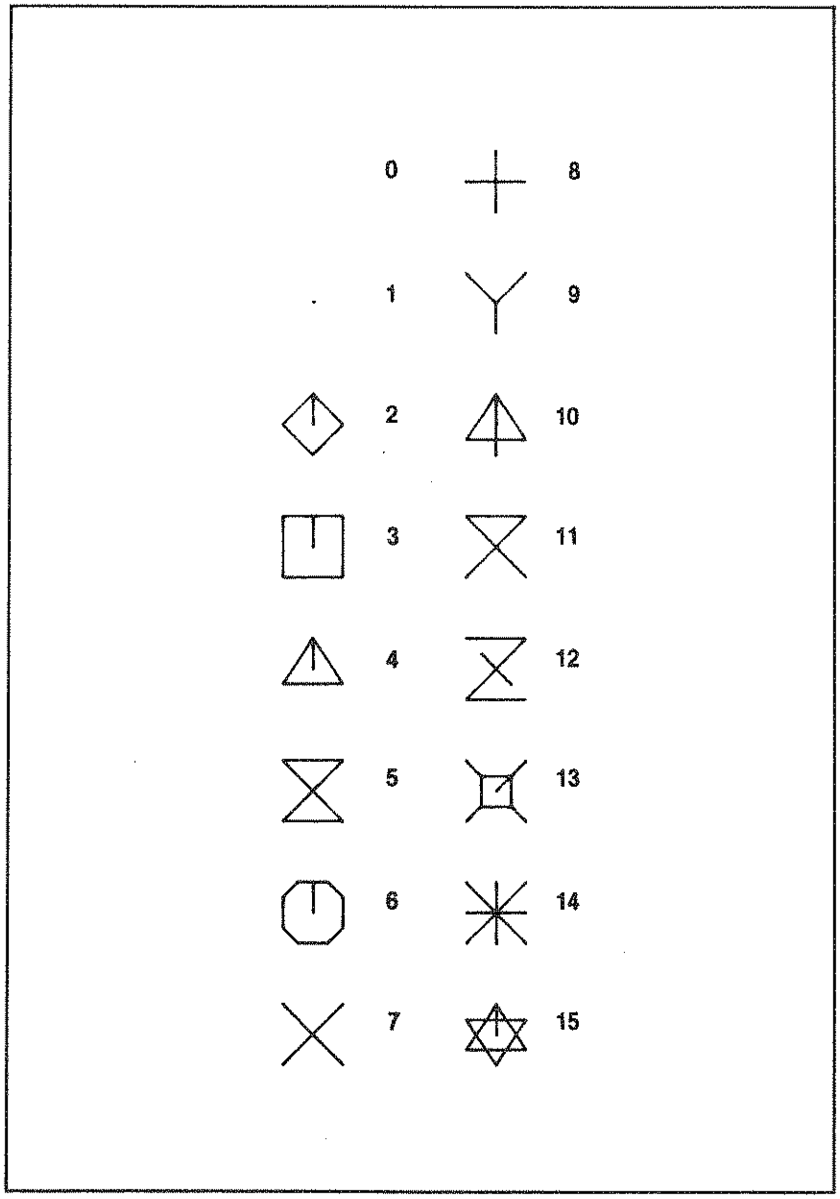


Figure 11-14. Mark types

If no coordinates are given a mark is placed at the current position. If *x1,y1* are given, the pen moves to that position and makes a mark.

The type of line used is determined by the line type (LT) command. The size of the mark is determined by the character size (SI) command.

Examples:

AM 14, 600,750, 700,680, 800,1050, 900,1380, 1000,1430

This command creates Figure 11-15. The marks are type 14.

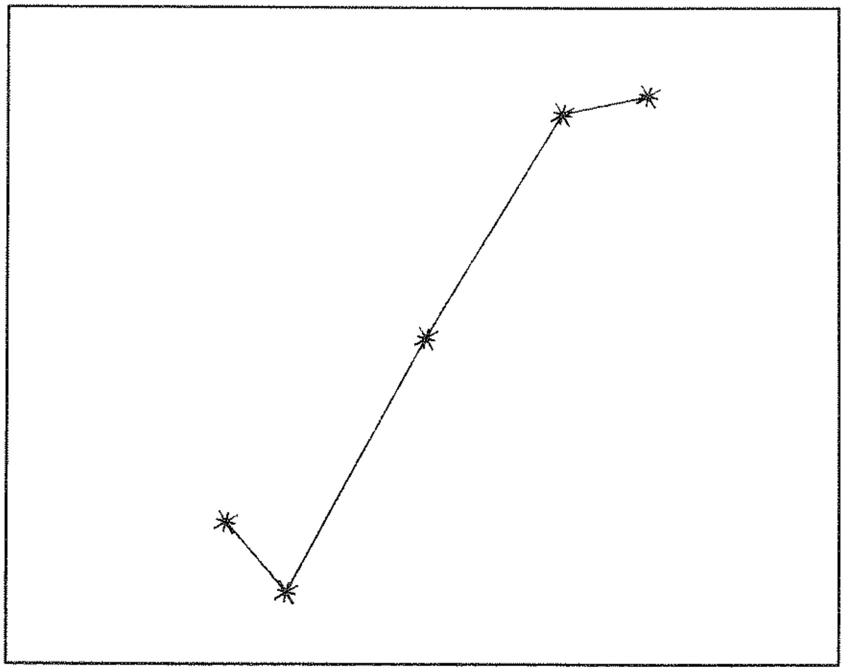


Figure 11-15. Absolute line and mark (AM) command

Relative line and mark

Function:

Connects the specified relative points by lines and marks the points with the specified style of mark.

Format:

RM *style, dx1,dy1 [, dx2,dy2, ... , dxn,dyn]*

Parameters:

The parameter *style* defines the type of marks made; *style* can range from 0 to 15.

The parameters *dx1* and *dy1* define the distance to the point at the end of the first line segment, measured from the current position.

The parameters *dx2* and *dy2* define the distance to the point at the end of the second line segment, measured from the first position.

The parameters *dxn* and *dyn* define the distance to the point at the end of the *n*th line segment, measured from the $(n - 1)$th position.

Remarks:

Parameters must be included in pairs consisting of a *dx* value and a *dy* value, which together specify a point.

You can include as many pairs of parameters as you like with this command. The pen draws successive lines between the points defined by the pairs of parameters.

The parameters must be in the range −16383 to 16383.

The points are defined relative to the current position (or the position of the previous point). The *dx* value defines a distance from the current position in the X direction. The *dy* value defines a distance from the current position in the Y direction.

If the absolute coordinate of any point is outside the range −32768 to 32767, an error will result.

The types of marks are shown in Figure 11-14.

If no coordinates are given a mark is placed at the current position.

The type of line used is determined by the line type (LT) command. The size of the mark is determined by the character size (SI) command.

Examples:

MA 500,500

RM 2, 100,250, 100, −70, 100,370, 100,330, 100,50

This command creates Figure 11-16. The marks are type 2.

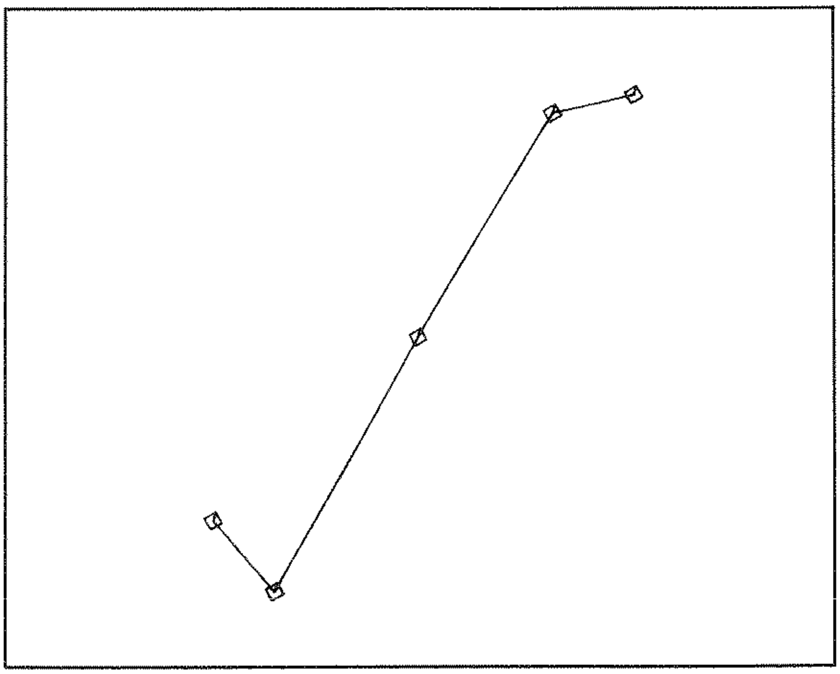


Figure 11-16. Relative line and mark (RM) command

Curve absolute

Function:

Draws a smooth curve connecting the series of points specified.

Format:

VA *type, x1,y1, x2,y2, x3,y3 [, ... , xn,yn]*

Parameters:

The parameter *type* specifies if the curve is open or closed. If *type* = 0 the curve is open (the ends are not joined), if *type* = 1 the curve is closed (the ends are joined).

The parameters *x1* and *y1* define the first point on the curve.

The parameters *x2* and *y2* define the second point on the curve.

The parameters *x3* and *y3* define the third point on the curve.

The parameters *xn* and *yn* define the *n*th point on the curve.

Remarks:

Parameters must be included in pairs, an *x* value and a *y* value, which together specify a point.

You can include as many pairs of parameters as you like with this command. The pen draws successive lines between the points defined by the pairs of parameters.

The parameters must be in the range −16383 to 16383.

This command references points as absolute positions relative to the coordinate origin.

There should be at least three points on the curve. If only two points are given, a straight line is drawn.

The same location should not be given as two successive points. Although no error is generated, the curve is not smooth but shows a sharp point.

If a point is given as both the starting and ending point on a closed curve, it has the same effect as giving the same point twice and the same problem (as described above) results.

If the first and last points are too far apart or too close together, the results are unpredictable. The first and last points may not be joined or an error may be generated.

The type of line used is determined by the line type (LT) command.

Examples:

VA 0, 600,750, 700,680, 800,1050, 900,1380, 1000,1430

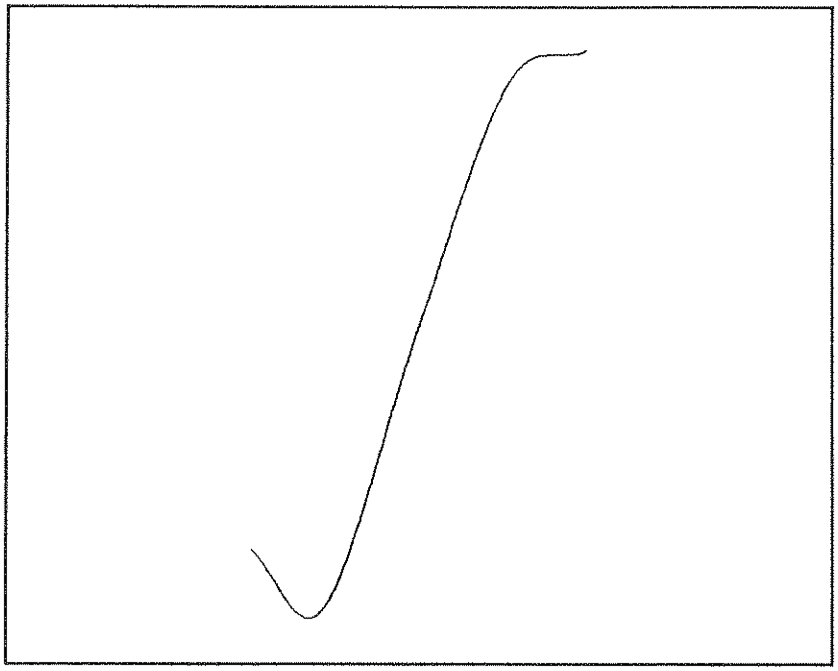


Figure 11-17. Curve absolute (VA) command

This command produces the curve shown in Figure 11-17. The curve is open (the ends are not connected) because *type* is 0.

VA 1, 1255,960, 1455,1160, 1655,960, 1455,760, 1055,1160, 855,960, 1055,760

This command produces the curve shown in Figure 11-18. The curve is closed (the ends are joined) because *type* is 1.

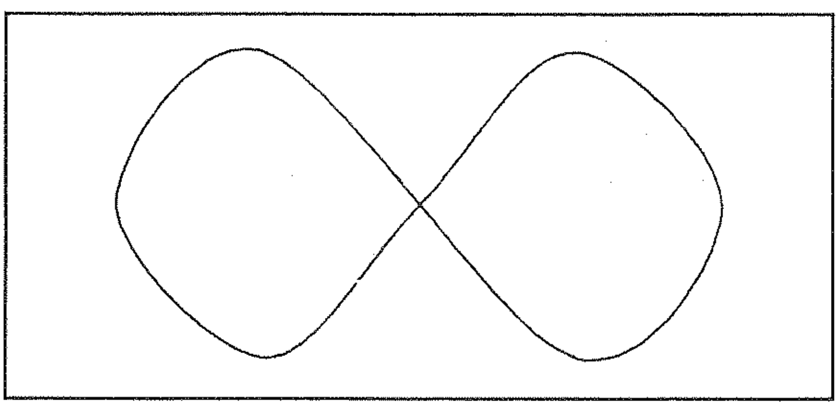


Figure 11-18. Curve absolute (VA) command

Curve relative

Function:

Draws a smooth curve connecting the relative points specified.

Format:

VR *type, dx1,dy1, dx2,dy2, dx3,dy3 [, ... , dxn,dyn]*

Parameters:

The parameter *type* specifies if the curve is open or closed. If *type* = 0 the curve is open (the ends are not joined), if *type* = 1 the curve is closed (the ends are joined).

The parameters *dx1* and *dy1* define the distance from the current position to the first point on the curve.

The parameters *dx2* and *dy2* define the distance from first point to the second point on the curve.

The parameters *dx3* and *dy3* define the distance from the second point to the third point on the curve.

The parameters *dxn* and *dyn* define the distance from (n − 1)th point to the nth point on the curve.

Remarks:

Parameters must be included in pairs, a *dx* value and a *dy* value, which together specify a distance to a point.

You can include as many pairs of parameters as you like with this command. The pen draws successive lines between the points defined by the pairs of parameters.

The points are defined relative to the current position (or the position of the previous point). The *dx* value defines a distance from the current position in the X direction. The *dy* value defines a distance from the current position in the Y direction.

The parameters must be in the range −16383 to 16383.

If the absolute coordinate of any point is outside the range −32768 to 32767, an error will result.

There should be at least three points on the curve. If only two points are given, a straight line is drawn.

The same location should not be given as two successive points. Although no error is generated, the curve is not smooth but shows a sharp point.

If a point is given as both the starting and ending point on a closed curve, it has the same effect as giving the same point twice and the same problem (as described above) results.

If the first and last points are too far apart or too close together, the results are unpredictable. The first and last points may not be joined or an error may be generated.

The type of line used is determined by the line type (LT) command.

Examples:

MA 1000,1000

VR 0, 400,0, −200,−200, −400,400, −200,−200

This example produces the curve shown in Figure 11-19. The curve is open (the ends are not connected) because *type* is 0.

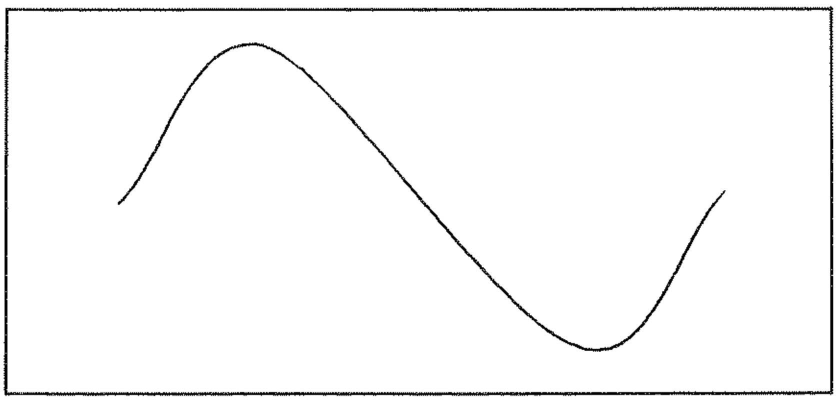


Figure 11-19. Curve relative (VR) command

MA 500,500

VR 1, 0,0, 100,330, 100,50, −350,−580, 50,−170, 100,370

This example produces the curve shown in Figure 11-20. The curve is closed (the ends are joined) because *type* is 1. Note that the first pair of coordinates are 0,0 so that the curve starts at the current position.

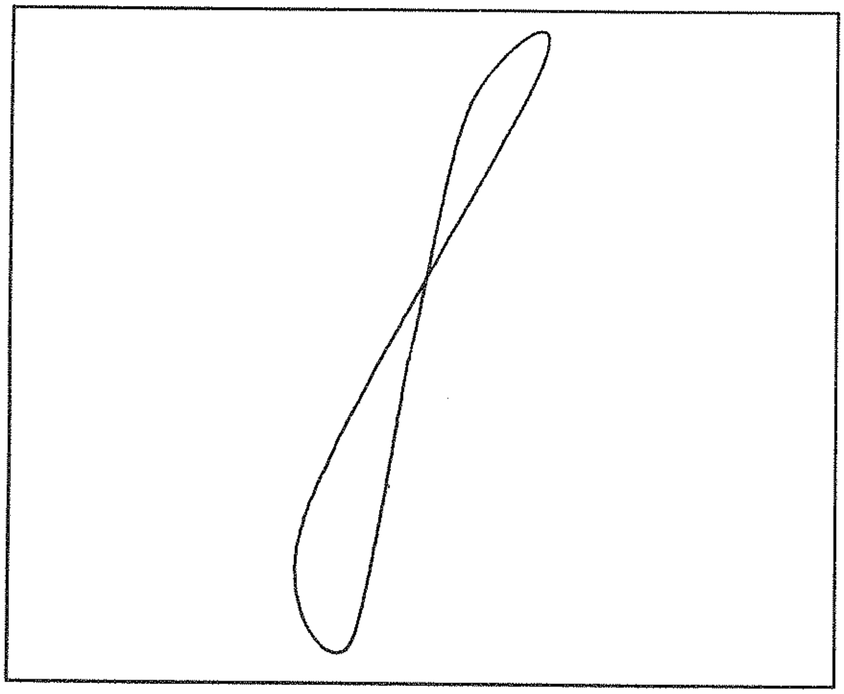


Figure 11-20. Curve relative (VR) command

Hatched bar

Function:

Draws a rectangle and hatches it.

Format:

HB *type, x-len, y-len, pitch, style*

Parameters:

The parameter *type* determines the format of the hatched bar that is drawn. If *type* = 0 it draws the rectangle only, if *type* = 1 it hatches only, if *type* = 2 it does both.

The parameter *x-len* specifies the overall length of the bar, parallel to the X-axis.

The parameter *y-len* specifies the overall length of the bar, parallel to the Y-axis.

The parameter *pitch* specifies the distance between the lines used to create the hatching.

The parameter *style* determines the hatch pattern and can range from 0 to 5.

Remarks:

The parameters must be in the range −16383 to 16383 except as noted.

The bar is drawn starting at the current position. The current position is the lower left corner of the bar if both *x-len* and *y-len* are positive.

If *pitch* = 1 a solid bar is produced (at normal magnification).

Figure 11-21 shows the results using the three possible values of *type*.

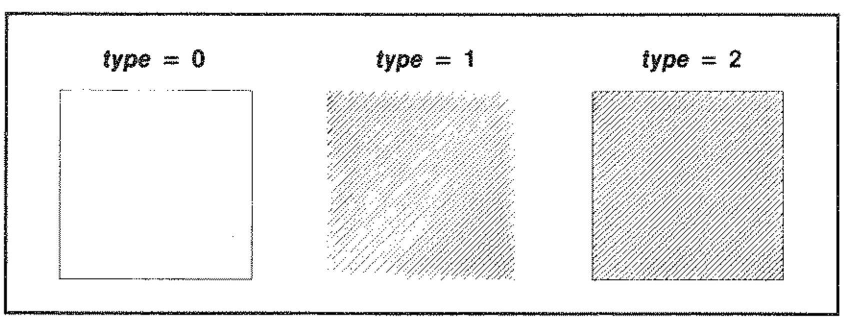


Figure 11-21. Three values of type

The type of line used to draw both the border and the hatching is determined by the line type (LT) command. If you wish to use different types of lines for the border and the hatching, first draw just the border by setting *type* = 0, then change the line type and draw just the hatching by setting *type* = 1.

Since the pen draws the hatching lines in alternating directions, its position when this command is completed depends on the number of lines drawn. The number of lines drawn in the hatching is determined by *pitch*.

The styles of hatching are shown in Figure 11-22.

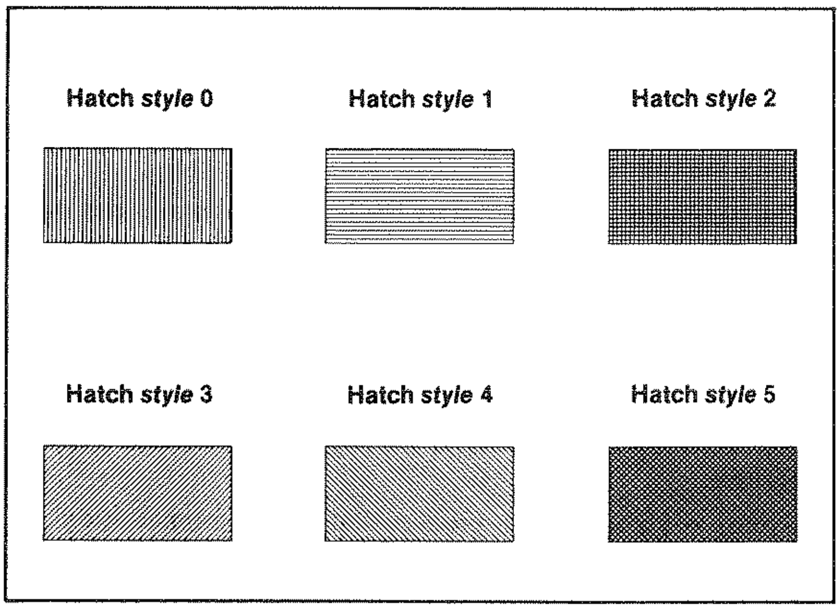


Figure 11-22. Styles of hatching

Examples:

HB 2, 80, 250, 9, 0

This command creates the bar shown in Figure 11-23. It is 80 wide, 250 high, and the hatching is drawn with a pitch of 9. Since *type* = 2 both the border and the hatching (*style* = 0) are drawn.

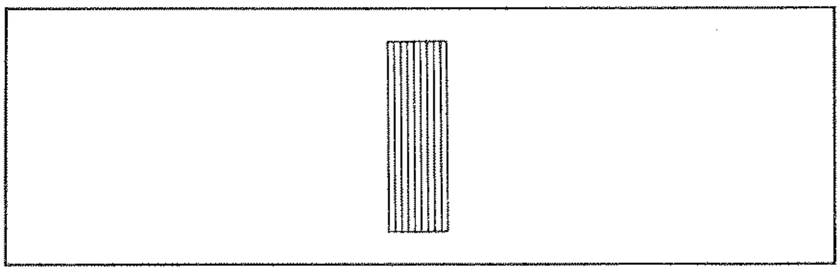


Figure 11-23. Hatched bar (HB) command

Hatched pie

Function:

Draws a circle segment centered at x,y with a radius of *rad* and hatches it, starting at *start-angle* and continuing to *end-angle*.

Format:

HP *type, x,y, rad, start-angle, end-angle, pitch, style[, inner-rad]*

Parameters:

The parameter *type* determines the format of the hatched bar that is drawn. If *type* = 0 it draws the rectangle only, if *type* = 1 it hatches only, if *type* = 2 it does both.

The parameters x and y specify the location of the center of the circle.

The parameter *rad* defines the radius of the outer circle.

The parameter *start-angle* specifies the starting angle of the pie section. The parameter *start-angle* is given in 1/10 of degrees, measured counterclockwise from the positive X-axis.

The parameter *end-angle* specifies the ending angle of the pie section. The parameter *end-angle* is given in 1/10 of degrees, measured counterclockwise from the positive X-axis.

The parameter *pitch* specifies the distance between the lines used to create the hatching.

The parameter *style* determines the hatch pattern and can range from 0 to 5.

The parameter *inner-rad* specifies the radius of an optional inner (blank) circle. This parameter (and the preceding comma) can be omitted, in which case the pie section is drawn from the center of the circle.

Remarks:

The parameters must be in the range −16383 to 16383.

If *pitch* = 1 a solid bar is produced (at normal magnification).

Figure 11-24 shows the results using the three possible values of *type*.

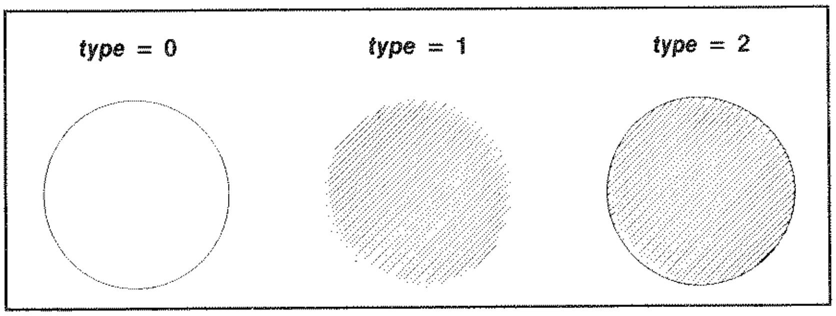


Figure 11-24. Three values of type

The type of line used to draw both the border and the hatching is determined by the line type (LT) command. If you wish to use different types of lines for the border and the hatching, first draw just the border by setting *type* = 0, then change the line type and draw just the hatching by setting *type* = 1.

Since the pen draws the hatching lines in alternating directions, its position when this command is completed depends on the number of lines drawn. The number of lines drawn in the hatching is determined by *pitch*.

The styles of hatching are shown in Figure 11-22.

If the absolute coordinate of any point on the circle is outside the range −32768 to 32767, an error results.

Examples:

HP 2, 1000,1000, 400, 900, 2000, 10, 0

This command draws the pie section shown in Figure 11-25. It is centered at the point 1000,1000 and has a radius of 400. The pie section goes from 90° to 200° and is hatched with style 0 hatching on a pitch of 10.

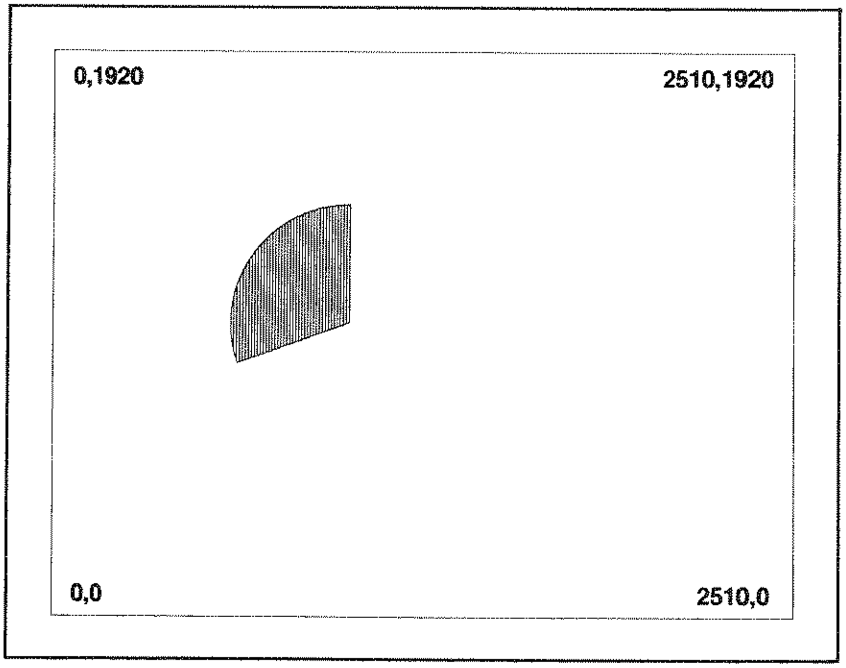


Figure 11-25. Hatched pie (HP) command

HP 2, 1000,1000, 600, 0, 800, 10, 0, 200

This command draws the pie section shown in Figure 11-26. It is centered at the point 1000,1000 and has a radius of 600. The pie section goes from 0° to 80° and is hatched with style 2 hatching on a pitch of 10. There is an inner blank circle with a radius of 200.

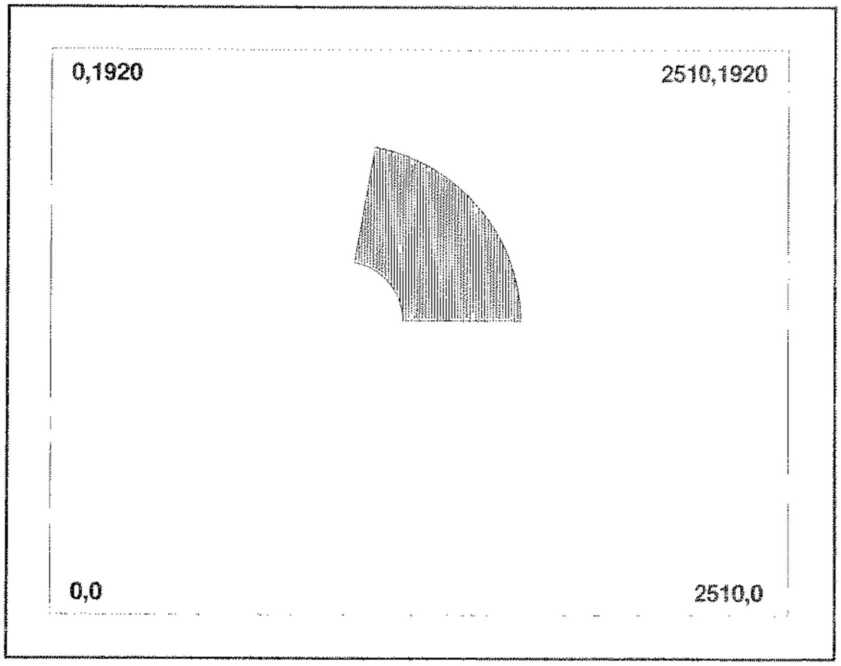


Figure 11-26. Hatched pie (HP) command

Grid

Function:

Draws grid lines.

Format:

GR *x-unit, x-num, y-unit, y-num*

Parameters:

The parameter *x-unit* specifies the length of one division in the X direction.

The parameter *x-num* specifies the number of divisions drawn perpendicular to the X-axis. This parameter can have a value from 0 to 255.

The parameter *y-unit* specifies the length of one division in the Y direction.

The parameter *y-num* specifies the number of divisions drawn perpendicular to the Y-axis. This parameter can have a value from 0 to 255.

Remarks:

There are *x-num* + 1 lines drawn perpendicular to the X-axis unless *x-num* is 0. When *x-num* is 0, no lines are drawn perpendicular to the X-axis, but *y-num* lines of length *y-len* are drawn.

There are *y-num* + 1 lines drawn perpendicular to the Y-axis unless *y-num = 0*. When *y-num* = 0, no lines are drawn perpendicular to the Y-axis, but *x-num* lines of length *x-len* are drawn.

The parameters must be in the range −16383 to 16383 except as noted.

The grid is drawn starting at the current position. The current position is the lower left corner of the grid if both *x-unit* and *y-unit* are positive.

The type of line used to draw the grid is determined by the line type (LT) command.

Since the pen draws the grid lines in alternating directions, its position when this command is completed is not always at the same position on the grid (depending on the number of lines in the grid).

Examples:

GR 100, 10, 100, 10

This command draws the grid shown in Figure 11-27. There are eleven lines spaced 100 apart in each direction. Note that this command produces 11 lines with 10 spaces between them, not 10 lines.

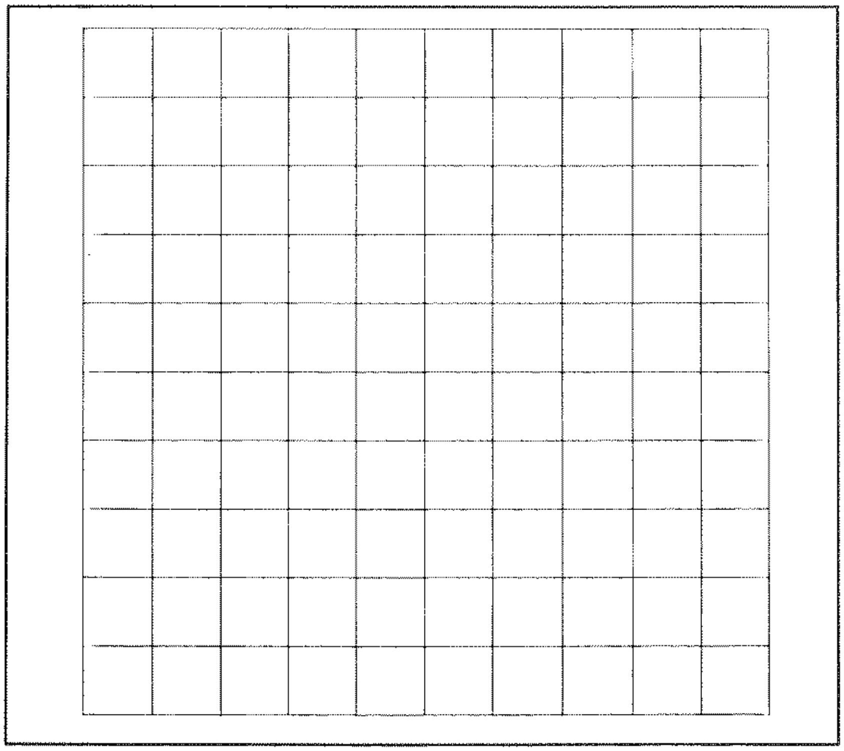


Figure 11-27. Grid (GR) command

Labels

Label

Function:

Prints a text string starting at the current position.

Format:

LA *text-string*

Parameters:

The parameter *text-string* is a string of ASCII characters to be printed.

Remarks:

The characters in *text-string* must have ASCII codes between 32 and 255.

Some codes in the range do not have characters assigned. If no character is assigned, then none are printed.

Each character is drawn inside of an imaginary box whose default dimensions are 24 x 24. The character is drawn in the box as shown in Figure 11-28. The bottom left corner of the box is the current position, and the lower right corner of the box is the pen position when the character has been drawn. Note that the box includes space on the right side of the character so that the characters don't run together.

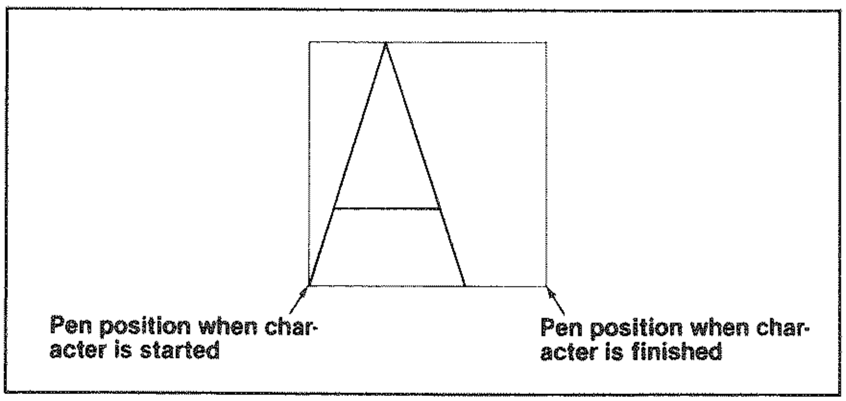


Figure 11-28. Character format

When all the characters in *text-string* are printed, the pen is left at the ending position of the last character. The carriage return at the end of the command does not move the pen to a new line, it only terminates the command. You must move the pen to the beginning of the next line with either the move absolute (MA) or the move relative (MR) command.

If a character would be drawn outside of the effective drawing area, it is clipped in the same way as any other type of plotting would be.

The following commands affect the way characters are drawn:

character set	(CS)
character size	(SI)
character emphasis	(EM)
character direction	(DI)
character slant	(SL)
vertical offset	(VO)
reset characters	(RC)

If a space is inserted between the command "LA" and the first character printed, then the space is printed as a space.

Examples:

LAAlways read the manual

LA before you have a problem.

This example prints one line as shown in Figure 11-29. Note that the space before the word "before" is printed.

```
Always read the manual before you have a problem.
```

Figure 11-29. Label (LA) command

Character size

Function:

Sets the height and width of characters.

Format:

SI *height, width*

Parameters:

The parameter *height* specifies the height of the characters.

The parameter *width* specifies the width of the characters, including the space on the right.

Remarks:

This command also adjusts the size of the marks created by the absolute line and mark (AM) and the relative line and mark (RM) commands.

The parameters must be in the range 4 to 16383.

You can change only the height of the characters by omitting the *width* parameter and the comma.

The actual character width of the normal ASCII characters is $^{2}/_{3}$ of the *width* parameter. The space on the right side of each character is $^{1}/_{3}$ of the *width* parameter. Therefore, the total space from the starting position of one character to the starting position of an adjacent character is equal to the parameter *width*.

The default values for *height* and *width* are both 24.

The reset character (RC) command, the initialize (IN) command, and the default (DF) command all reset this to the default value.

Examples:

SI 24, 64

LALook at the size

This example prints with characters 24 high and 64 wide as shown in Figure 11-30.

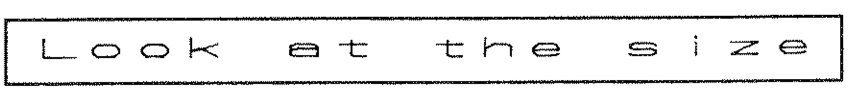


Figure 11-30. Character size (SI) command

Character direction

Function:

Sets the direction that labels are printed.

Format:

DI *angle* -or- DI *run, rise*

Parameters:

The parameter *angle* specifies the angle that labels are printed. The parameter *angle* is given in $^1/_{10}$ degrees and is measured counterclockwise from the positive X-axis.

The parameter *run* specifies the length of the adjacent side of a right triangle formed by the desired baseline and the X-axis (see Figure 11-31).

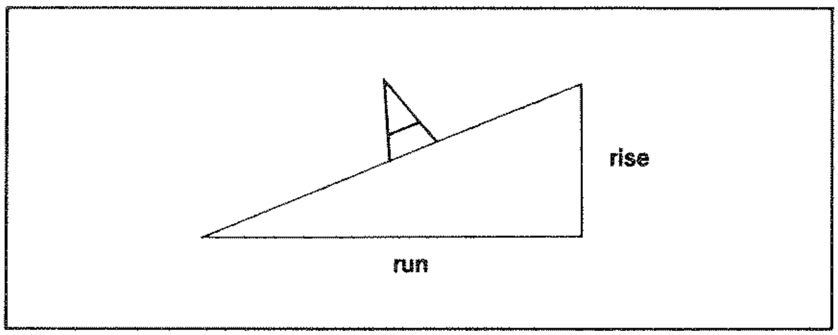


Figure 11-31. Angle of the baseline determined by rise and run

The parameter *rise* specifies the length of the opposite side of a right triangle formed by the desired baseline and the X-axis.

Remarks:

A single parameter is taken to be an *angle* (in 0.1 degrees), while two parameters are used to calculate an angle by use of the tangent (tan = *rise/run*).

The parameters must be in the range −16383 to 16383.

Positive values of *angle* cause rotation in the counterclockwise direction.

Negative values of *angle* cause rotation in the clockwise direction.

The values of *run* and *rise* must not be zero at the same time or an overflow error will result.

Either the value of *run* or the value of *rise* must have a value greater than 1 or the results are not predictable.

Figure 11-32 shows how the positive and negative values of *run* and *rise* affect the direction of the baseline.

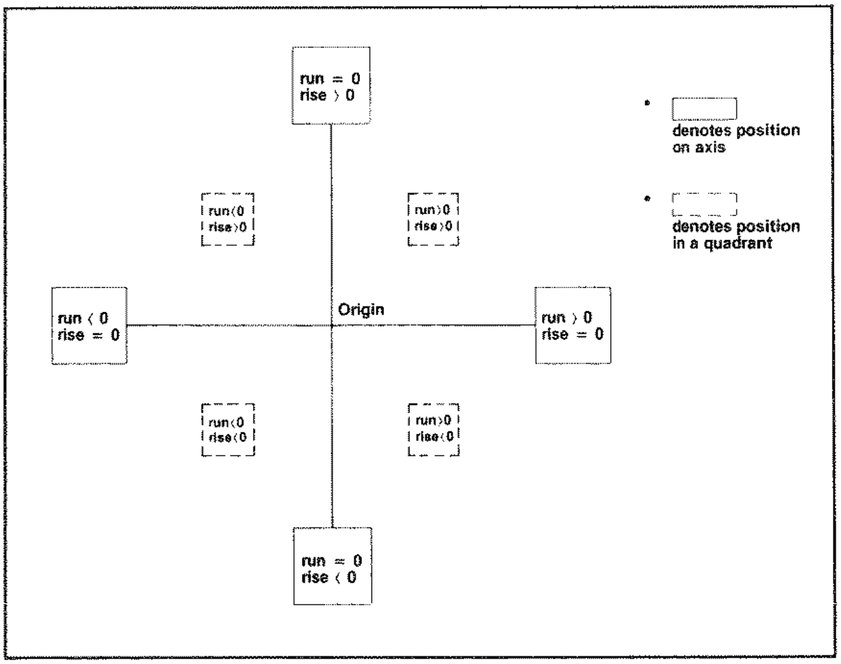


Figure 11-32. Angle of baseline determined by signs of run and rise

The default *angle* is 0 degrees (parallel to the X-axis).

The reset character (RC) command, the initialize (IN) command, and the default (DF) command all reset this to the default value.

Examples:

DI 450

LAThis is printed at 45 degrees

This example prints Figure 11-33. As usual, the angle is measured from the positive X-axis.

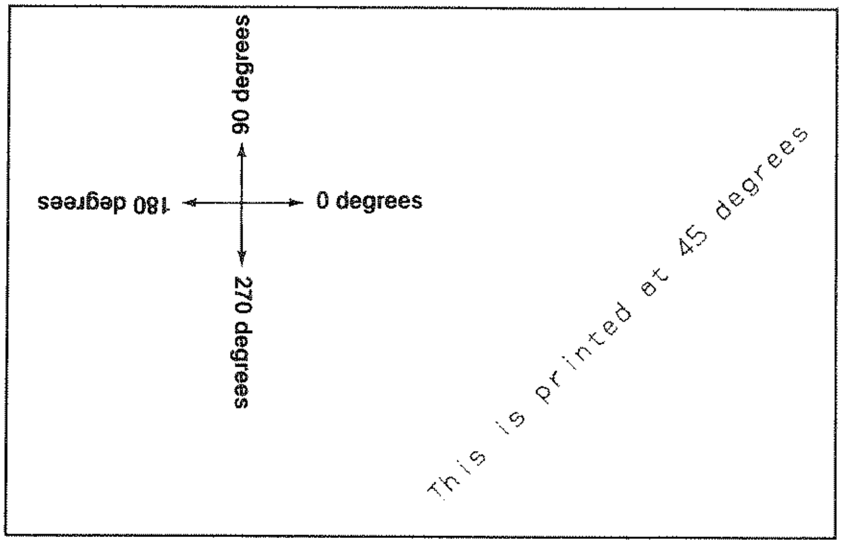


Figure 11-33. Character direction (DI) command

DI −10, 10

LAThis is in the second quadrant

This example prints Figure 11-34. Because *run* is negative and *rise* is positive, it is in the second quadrant (i.e. between 90 and 180 degrees).

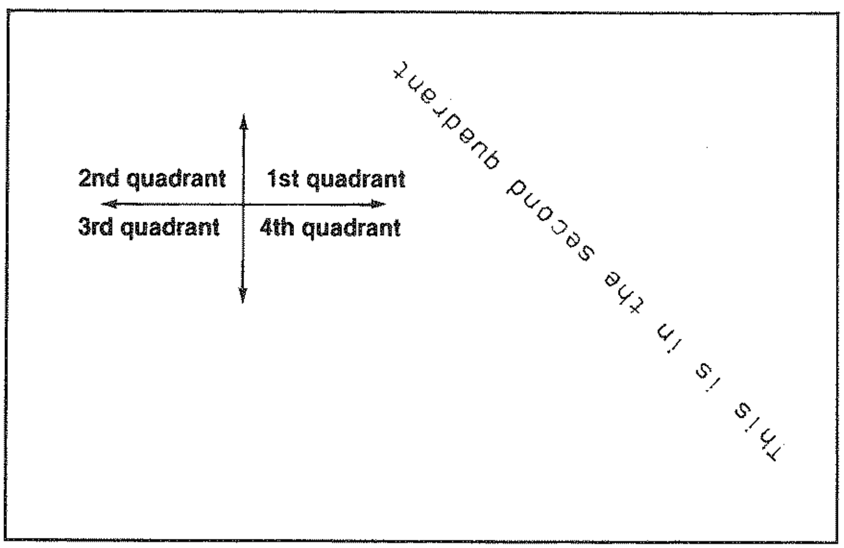


Figure 11-34. Character direction (DI) command

Character emphasis

Function:
Produces emphasized characters.

Format:
EM *style*

Parameters:
The parameter *style* determines the type of emphasis; *style* can range from 0 (no emphasis) to 3.

Remarks:
Emphasized characters are drawn twice, with a slight offset. The value of *style* determines the direction of the offset (see Figure 11-35):

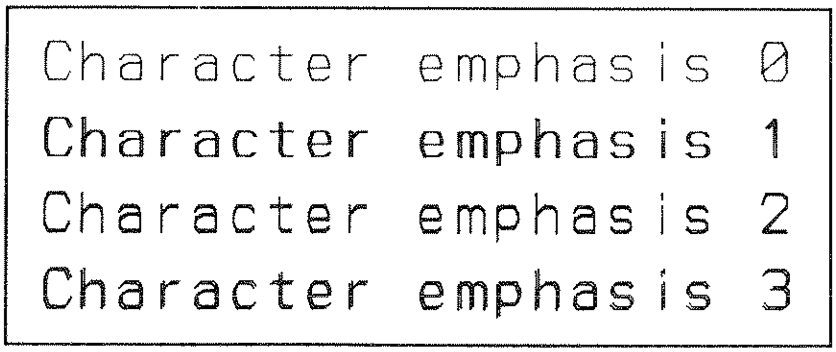


Figure 11-35. Value of style determines the direction of offset

style = 0, there is no emphasis (normal printing).
style = 1, the character is redrawn offset horizontally.
style = 2, the character is redrawn offset vertically.
style = 3, the character is redrawn offset both horizontally and vertically.

The horizontal or vertical offset is $1/16$ of the horizontal or vertical dimension.

The maximum offset is 0.3 mm. If $1/16$ of the dimension of the character is greater than 0.3 mm, then the offset is 0.3 mm.

The default *style* is 0 (no emphasis).

The reset character (RC) command, the initialize (IN) command, and the default (DF) command all reset this to the default value.

Examples:

SI 50,50

EM 3

LAThis is offset obliquely

This example prints the label shown in Figure 11-36. The character size is set by the SI command. The characters are printed twice, offset both horizontally and vertically.

Figure 11-36. Character emphasis (EM) command

Character slant

Function:
Slants the vertical lines of characters.

Format:
SL *value*

Parameters:
The parameter *value* determines the slant of the characters.

Remarks:
The parameter *value* must be in the range −512 to 512.

The angle of inclination is related to *value* by the expression tan (angle) = *value* / 256.

Lines of the characters which are parallel to the baseline remain parallel to the baseline.

If *value* is positive, the characters are slanted to the right.

If *value* is negative, the characters are slanted to the left.

Figure 11-37 shows some typical values for the parameter *value*.

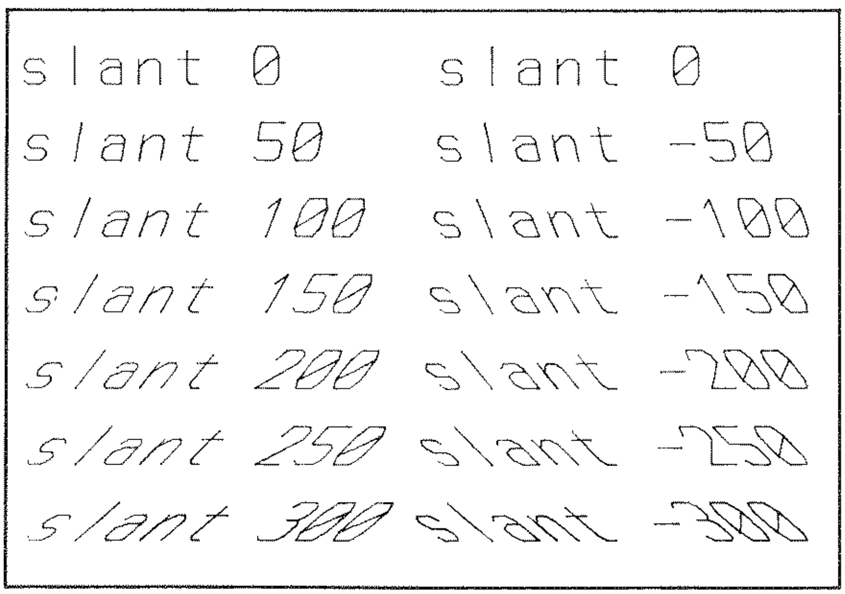


Figure 11-37. Typical values for the character slant (SL) command

The default *value* is 0.

The reset character (RC) command, the initialize (IN) command, and the default (DF) command all reset this to the default value.

Examples:

SL 100

LAThis is slant 100

This example produces the label shown in Figure 11-38. This is a slant of approximately 21 degrees.

This is slant 100

Figure 11-38. Character slant (SL) command

Character set

Function:

Selects the character set used when printing characters with the label (LA) command.

Format:

CS *set-num*

Parameters:

The parameter *set-num* specifies the character set and can range from 0 to 10.

Remarks:

The values of *set-num* and the corresponding character sets are shown in Table 11-3.

Table 11-3. International character sets

set-num	Country
0	USA
1	France
2	Germany
3	England
4	Denmark
5	Sweden
6	Italy
7	Spain
8	Japan
9	Norway
10	Denmark II

The default character set is 0 (USA).

The 12 characters that change are shown in Figure 11-39.

0 USA	#	$	@	[	\	]	^	`	{	¦	}	~
1 France	#	$	à	°	ç	§	^	`	é	ù	è	¨
2 Germany	#	$	§	Ä	Ö	Ü	^	`	ä	ö	ü	ß
3 England	£	$	@	[	\	]	^	`	{	¦	}	~
4 Denmark	#	$	@	Æ	Ø	Å	^	`	æ	ø	å	~
5 Sweden	#	¤	É	Ä	Ö	Å	Ü	é	ä	ö	å	ü
6 Italy	#	$	@	°	\	é	^	ù	à	ò	è	ì
7 Spain	₧	$	@	¡	Ñ	¿	^	`	¨	ñ	}	~
8 Japan	#	$	@	[	¥	]	^	`	{	¦	}	~
9 Norway	#	¤	É	Æ	Ø	Å	Ü	é	æ	ø	å	ü
10 Denmark II	#	$	É	Æ	Ø	Å	Ü	é	æ	ø	å	ü

Figure 11-39. International characters

The reset character (RC) command, the initialize (IN) command, and the default (DF) command all reset this to the default value.

Examples:

CS 1

LA@ la belle {toile

This command selects the character set for France. The label (LA) command prints the French phrase ("under the beautiful stars") shown in Figure 11-40.

```
à la belle étoile
```

Figure 11-40. Character set (CS) command

Vertical offset

Function:

Specifies a vertical offset from the baseline for printing characters.

Format:

VO *offset*

Parameters:

The parameter *offset* specifies a vertical offset from the normal baseline.

Remarks:

The parameters must be in the range −16383 to 16383.

If *offset* is a positive number, the character is printed above the normal baseline.

If *offset* is a negative number, the character is printed below the normal baseline.

The offset is measured perpendicular to the baseline.

This command produces superscripts or subscripts.

The default vertical offset is 0.

The reset character (RC) command, the initialize (IN) command, and the default (DF) command all reset this to the default value.

Examples:

MA 500,1000

SI 50, 50

LANormal

VO 25

LA Up

VO −25

LA Down

VO 0

LA Normal

This example produces the labels shown in Figure 11-41.

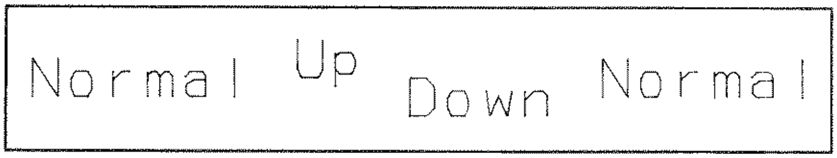


Figure 11-41. Vertical offset (VO) command

Reset characters

Function:

Resets the character style and size to the default values.

Format:

RC

Parameters:

No parameters are required.

Remarks:

Resets the character attributes set by the commands shown in Table 11-4 to their default values.

Table 11-4. Character reset default values

Command		Default value
Character set	CS	Set 0 (USA)
Character size	SI	24 x 24
Vertical offset	VO	0
Character direction	DI	0°
Character slant	SL	0
Character emphasis	EM	0 (no emphasis)

Examples:

SI 50, 50

DI 900

LALarge letters, 90 degrees

RC

LAReset to regular letters, 0 degrees

This example prints large letters going straight up, then resets the character attributes and prints default-sized characters. The results are shown in Figure 11-42.

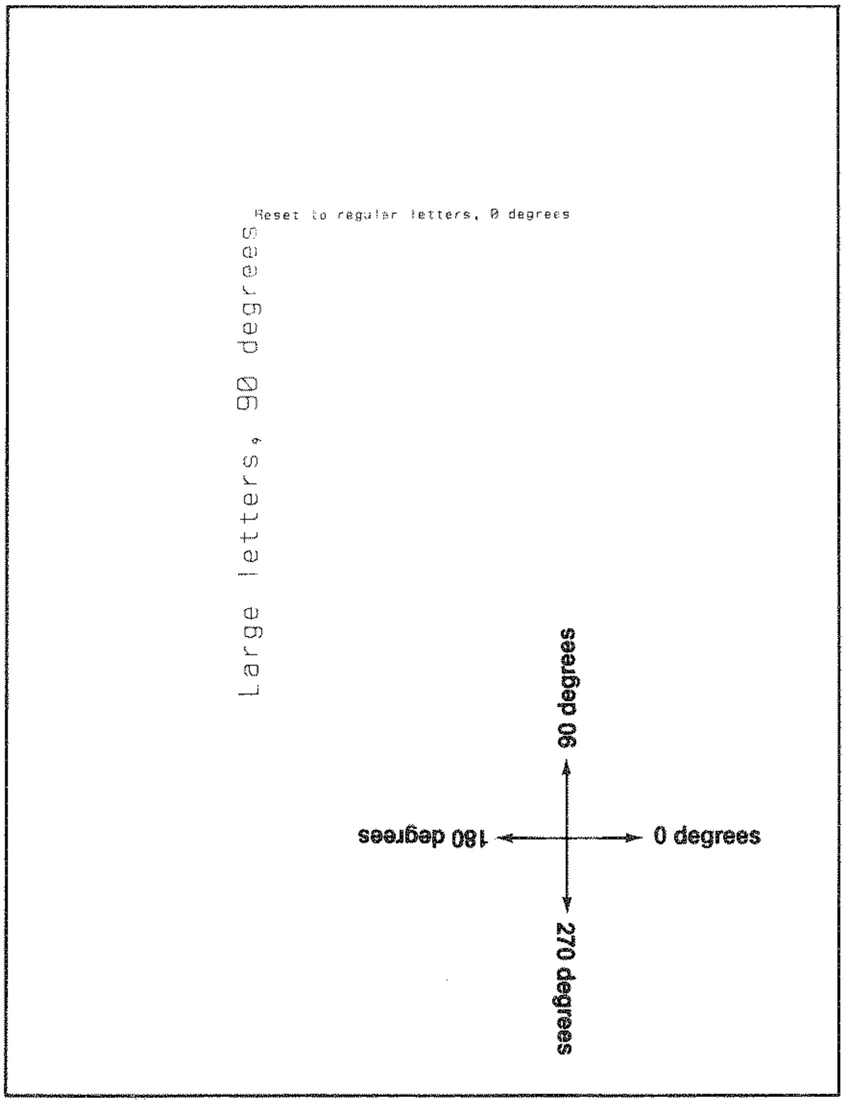


Figure 11-42. Reset characters (RC) command

Formats and Line Types

Line type

Function:
Specifies the type of line printed.

Format:
LT *style*

Parameters:
The parameter *style* specifies the type of line used; *style* can range from 0 (normal, solid line) to 8.

Remarks:
The line types that can be drawn are shown in Figure 11-43.

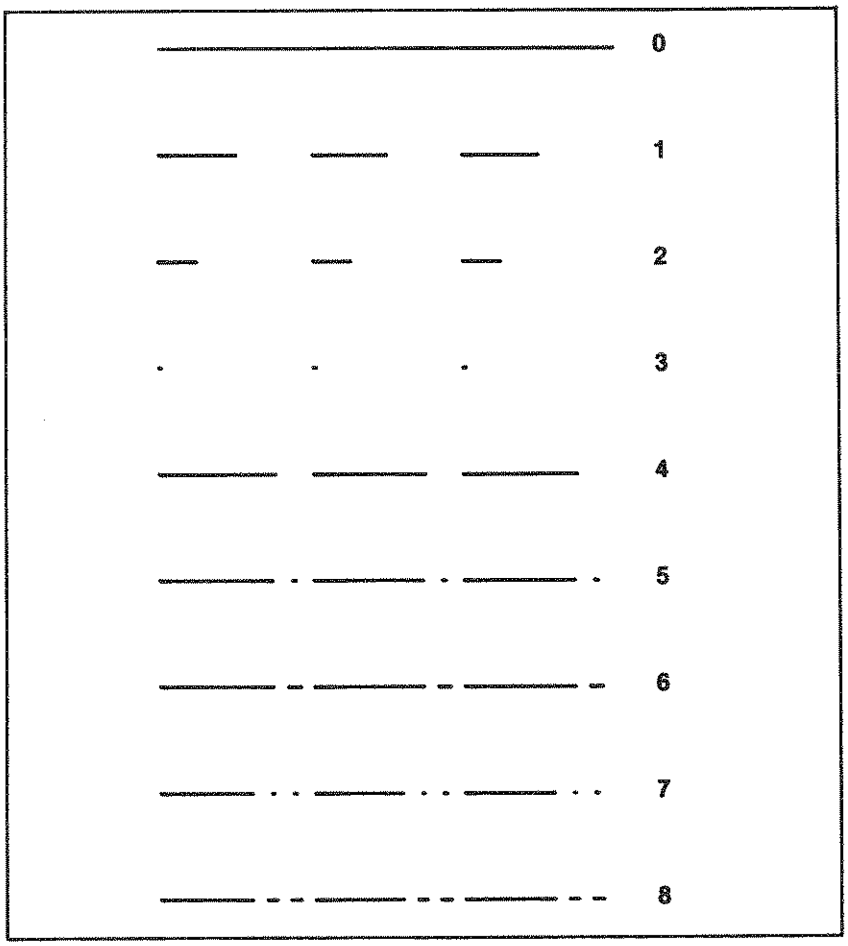


Figure 11-43. Line types

The following commands use the type of line determined by this command:

draw absolute	(DA)
draw relative	(DR)
circle absolute	(CA)
circle relative	(CR)
curve absolute	(VA)
curve relative	(VR)
grid	(GR)
hatched bar	(HB)
hatched pie section	(HP)
absolute line and mark	(AM)
relative line and mark	(RM)

The pitch of the line types can be set with the line pitch (LP) command. The pitch of each line type is shown in Figure 11-44.

The default line type is 0 (solid line).

The initialize (IN) command and the default (DF) command both reset this to the default value.

Examples:

MA 500,1000

LT 1

DR 1000,0

This command selects a dashed line as shown in Figure 11-45.

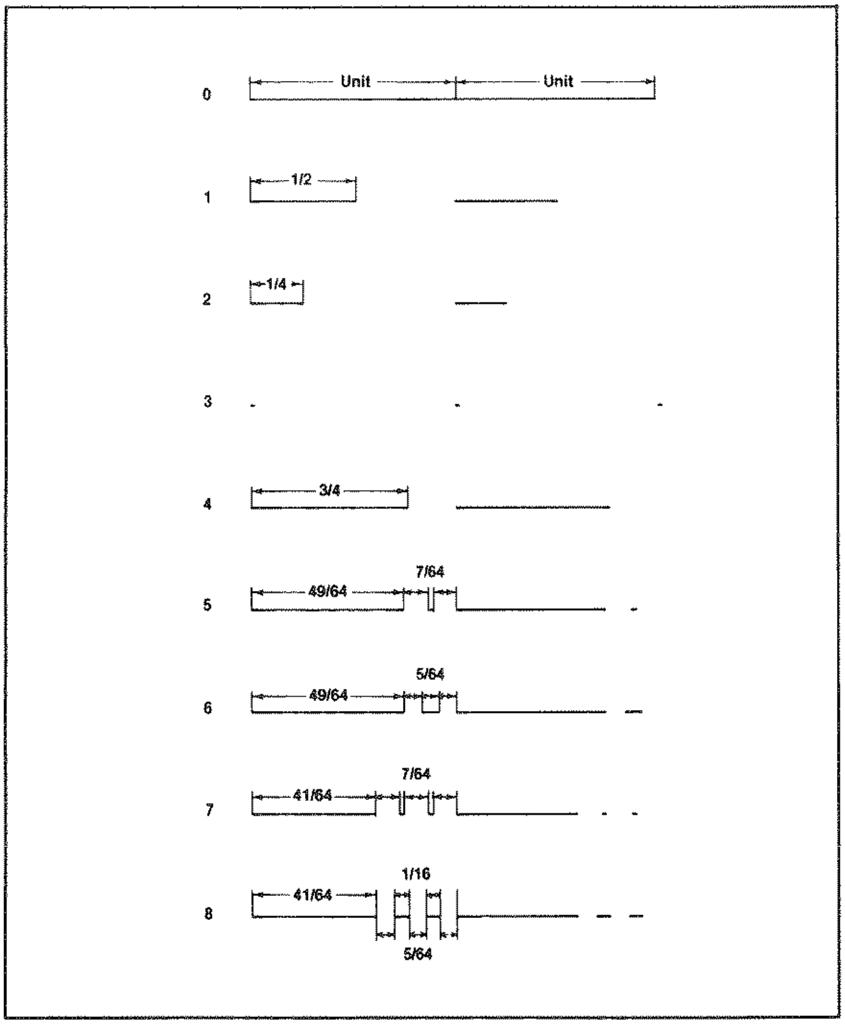


Figure 11-44. Pitch of the line types

Figure 11-45. Line type (LT) command

Line pitch

Function:

Specifies the pitch of the line style determined by the line type (LT) command.

Format:

LP *pitch*

Parameters:

The parameter *pitch* sets the length of one pitch of the current line type.

Remarks:

The parameter *pitch* must be in the range 1 to 16383.

The pitch of each line type is shown in Figure 11-44.

The line pitch does not have any effect on a solid line (line type 0).

The default value of *pitch* is 60.

The initialize (IN) command and the default (DF) command both reset this to the default value.

Examples:

MA 500,1000

LT 2

DR 500,0

MA 500,900

LP 120

DR 500,0

The results of this example are shown in Figure 11-46. The pitch of the second line is doubled, from the default of 60 to a new value of 120.

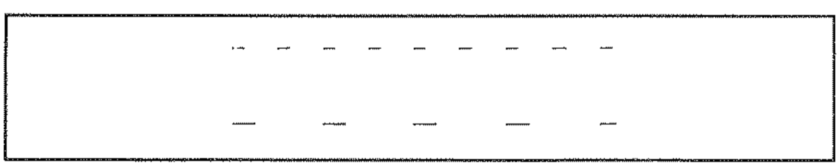


Figure 11-46. Line pitch (LP) command

Tick length

Function:

Sets the length of tick marks drawn by the AX command.

Format:

TL *pos-len, neg-len*

Parameters:

The parameter *pos-len* specifies the distance that the tick mark should extend from the axis line in the positive direction.

The parameter *neg-len* specifies the distance that the tick mark should extend from the axis line in the negative direction.

Remarks:

The parameters must be in the range 0 to 16383.

The tick lines are always drawn solidly, regardless of the setting of the line type (LT) command.

The default value of both parameters is 10.

The initialize (IN) command and the default (DF) command both reset this to the default value.

Examples:

TL 5, 20

This example sets the tick length to 5 in the positive direction and 20 in the negative direction. Figure 11-47 shows an axis made with the tick length set as above.

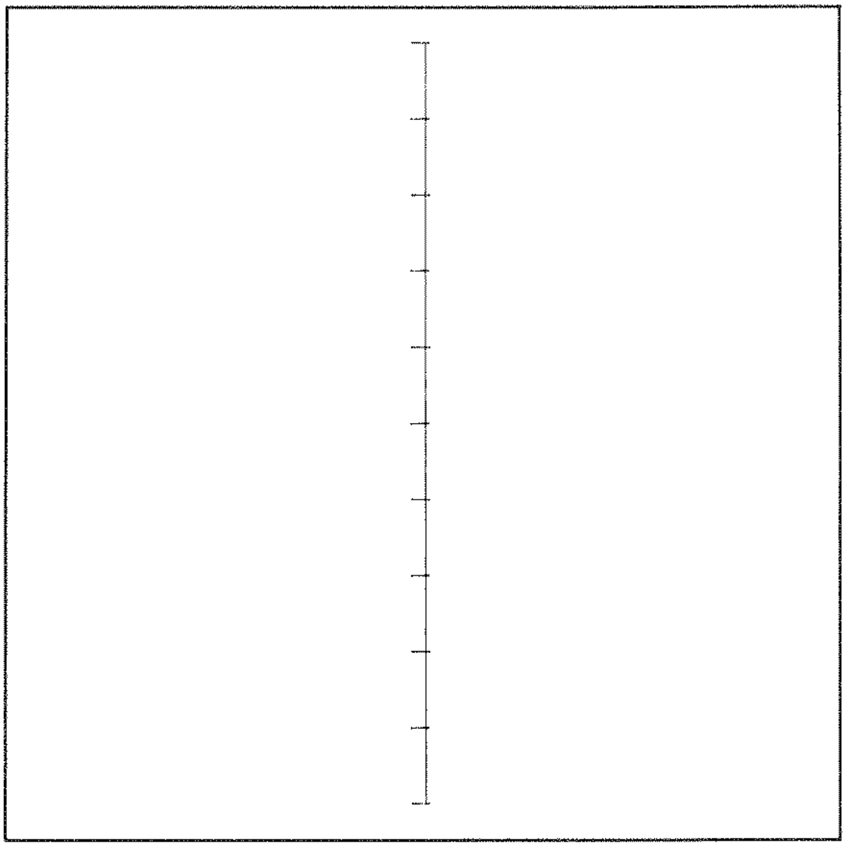


Figure 11-47. Tick length (TL) command

Arrow

Function:

Draws an arrow from the current position to the specified relative position.

Format:

AR *style, head-len, head-ang, dx,dy, dir*

Parameters:

The parameter *style* determines the form of the head of the arrow; *style* can range from 0 to 3.

The parameter *head-len* specifies the length of the arrow head.

The parameter *head-ang* specifies the angle between the shaft and the lines of the arrow head. The parameter *head-ang* is given in 1/10 degrees.

The parameters *dx* and *dy* specify the position of the end of the arrow, relative to the current position.

The parameter *dir* determines the position of the head of the arrow. If *dir* = 0, the head is drawn at the destination point. If *dir* = 1, the head is drawn at the starting point (the current position). If *dir* = 2, heads are drawn at both ends of the arrow.

Remarks:

The end of the arrow is defined relative to the current position. The *dx* value defines a distance from the current position in the X direction. The *dy* value defines a distance from the current position in the Y direction.

The parameters must be in the range −16383 to 16383.

If the absolute coordinate of any point is outside the range −32768 to 32767, an error results.

The styles of arrow heads are shown in Figure 11-48.

Examples:

AR 1, 100, 300, 500,0, 0

MR −500, −200

AR 2, 25, 300, 500,0, 1

MR −500, −200

AR 3, 100, 600, 500,0, 2

These examples draw the arrows shown in Figure 11-49.

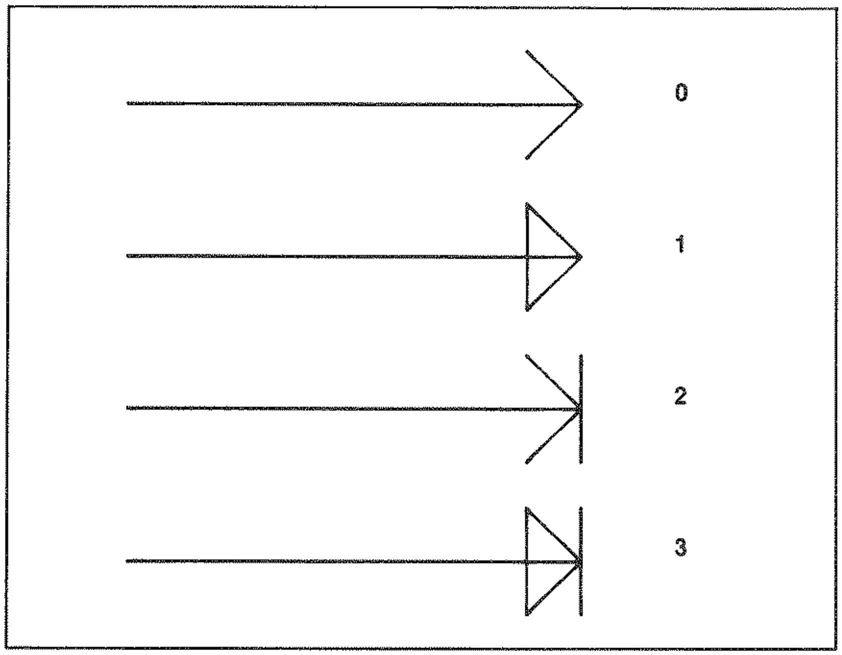


Figure 11-48. Styles of arrow heads

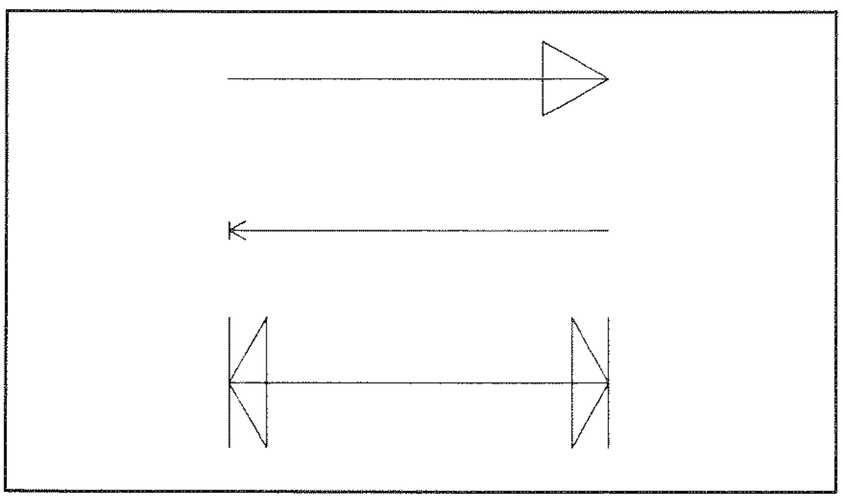


Figure 11-49. Arrow (AR) command

Positioning and Scaling

Origin

Function:

Sets the coordinate origin to the current position.

Format:

OR

Parameters:

No parameters are required.

Remarks:

Moving the origin does not change the size of the drawing area, but it does change the coordinates of the points on the drawing area.

Programs using this command should reset the origin to the default position before setting a new one. This ensures that the new origin is set at the same point each time the program is run. Otherwise, you set subsequent origins relative to the previous one, and not relative to the default origin (see Figure 11-50).

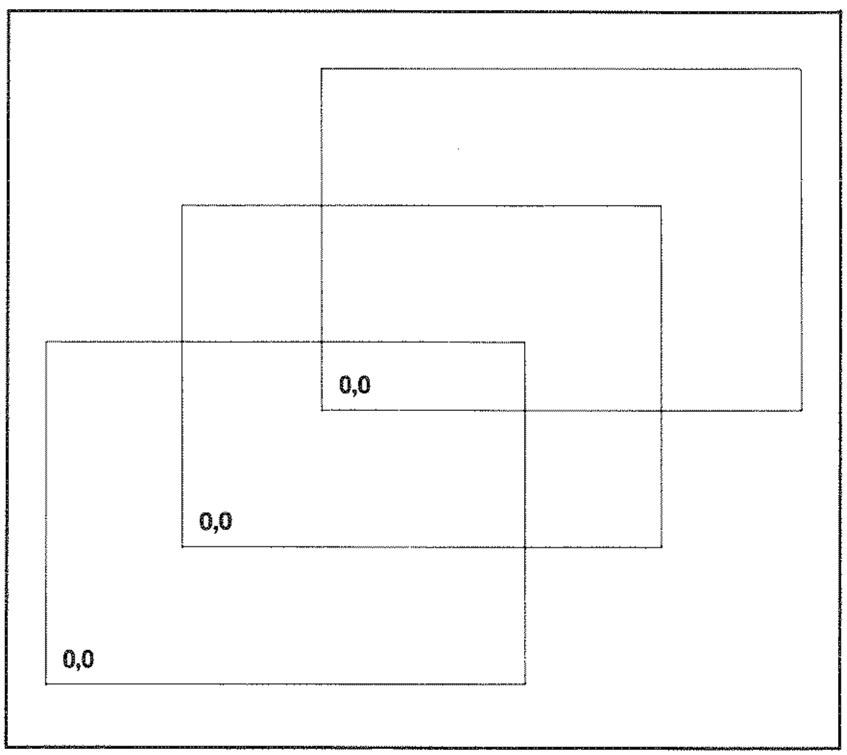


Figure 11-50. Incorrect use of the origin command

This command always sets the origin at the current pen position. If you move the pen to a position that is not on the drawing area, the pen moves to the edge of the drawing area and stops. The origin command that follows sets the origin at the edge of the paper instead of the destination you wanted to move to. Since the position at which the pen stops is dependent on both its starting and ending points, where it stops at the edge of the drawing area is not easily predicted.

The coordinate origin is reset to the lower left corner of the paper by the initialize plotter (IN) or default (DF) commands.

Examples:

DF

MA 1255,960

OR

This example moves the origin to the center of the drawing area. The new coordinates of the drawing area are as shown in Figure 11-51.

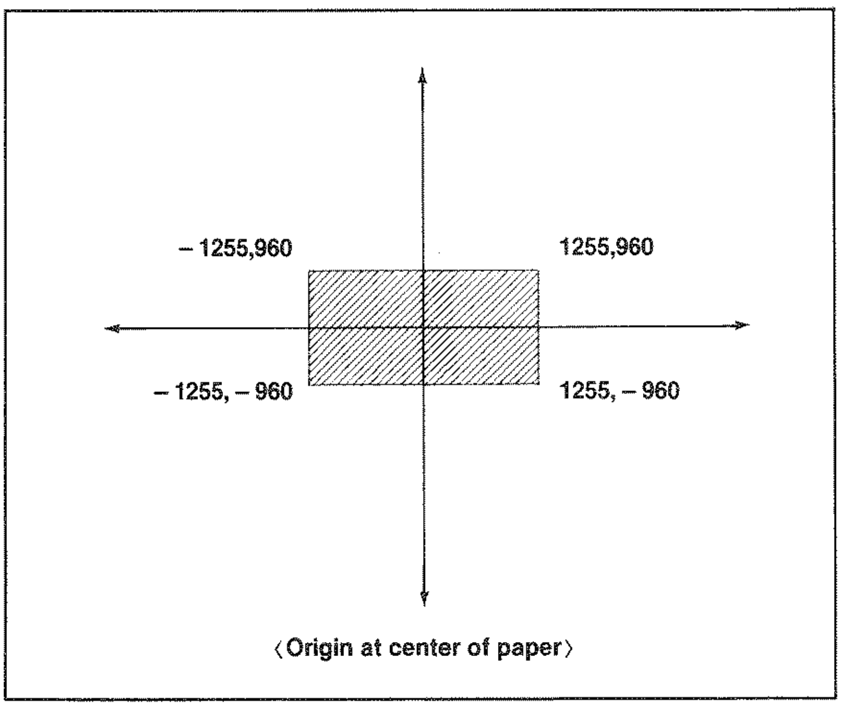


Figure 11-51. Origin (OR) command

Input window

Function:

Sets the maximum drawing area.

Format:

IW *size* - or - IW *x-min,y-min, x-max,y-max*

Parameters:

The parameter *size* specifies the size of paper used; *size* can range from 0 to 2.

The parameters *x-min* and *y-min* specify the lower left corner of a drawing window.

The parameters *x-max* and *y-max* specify the upper right corner of a drawing window.

Remarks:

A single parameter is taken to be a *size*, while four parameters are used to specify the opposite corners of a window on the drawing area.

The IW *size* format specifies one of the three standard sizes: size = 0 for A4 paper, *size* = 1 for US letter paper, and *size* = 2 for B5 paper. The dimensions of the paper sizes are shown in Table 11-5.

Table 11-5. HC100 paper sizes

Paper size	Sheet size (mm)	Sheet size (in)
A4	297 x 210 mm	11 5/8 x 8 1/4 in
US letter	279 x 216 mm	11 x 8 1/2 in
B5	257 x 182 mm	10 1/8 x 7 3/16 in

The IW *x-min,y-min, x-max,y-max* format specifies a rectangular area on the paper that is the new drawing area. Drawings are clipped at the edges of this area.

This command references points as absolute positions relative to the coordinate origin.

The difference of *x-max* − *x-min* must be in the range of 1 to 2670.

The difference of *y-max* − *y-min* must be in the range of 1 to 1920.

If any side of the window is outside of the maximum drawing area for the paper size, then the edge of the drawing area is taken as the edge of the window. The default drawing areas are shown in Table 11-6.

Table 11-6. Default drawing areas

Paper size	Drawing area (mm)	Drawing area (in)
A4	267 x 192 mm	$10\frac{2}{5}$ x $7\frac{1}{2}$ in
US letter	251 x 192 mm	$9\frac{4}{5}$ x $7\frac{1}{2}$ in
B5	227 x 164 mm	$8\frac{4}{5}$ x $6\frac{2}{5}$ in

The magnification ratio does not affect this command. This command always works in units of 0.1 mm.

This command also defines the limits of movement of the pen which can be made using the position keys.

The default paper size is US letter size, if DIP switch 6 is ON.

The initialize (IN) command and the default (DF) command both reset this to the default value.

Examples:

IW 1

Sets the plotter to use US letter size paper.

IW 100,100, 1200,1200

Creates a drawing area 1100 units on a side, with the lower left corner at the point 100,100, as shown in Figure 11-52.

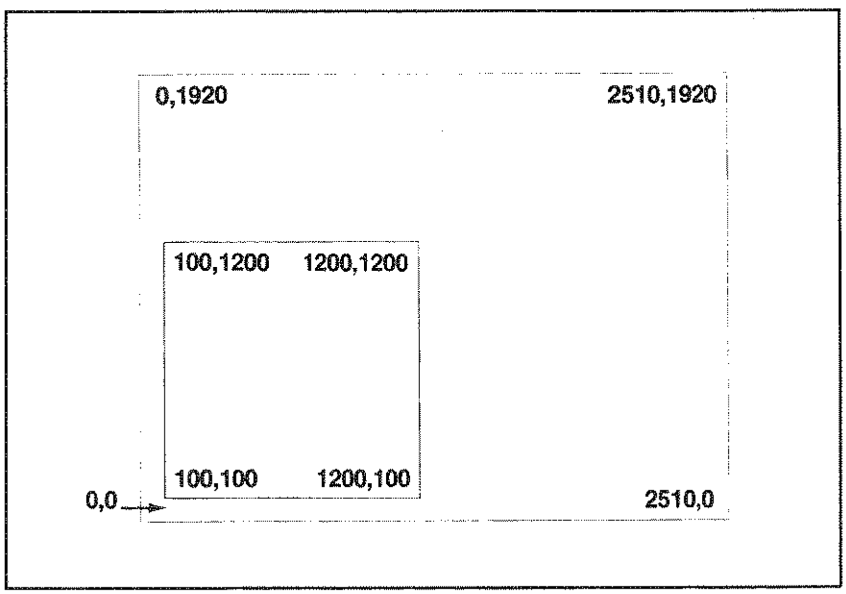


Figure 11-52. Input window (IW) command

Input factor

Function:

Sets a ratio that all coordinates and distances are multiplied by.

Format:

IF *numerator, denominator*

Parameters:

The parameter *numerator* is an integer in the range of 1 to 15.

The parameter *denominator* is an integer in the range of 1 to 15.

Remarks:

The ratio is calculated by dividing *numerator* by *denominator*.

A ratio of less than 1 (a reduction in size) can be made by making *denominator* greater than *numerator*.

A ratio greater than 1 (an enlargement in size) can be made by making *denominator* less than *numerator*.

Non-integer ratios can be made by selecting the proper values of the parameters. For example, *numerator* = 3 and *denominator* = 2 results in an enlargement of 150% (1½ times larger).

All drawing commands are affected by this command. Absolute commands plot to points scaled by the ratio. Relative commands move distances scaled by the ratio.

The only command that is not affected by this command is the input window (IW) command.

The default ratio is 1:1.

The initialize (IN) command and the default (DF) command both reset this to the default ratio.

Examples:

```
MA 100,100
DA 100,100, 200,300, 500,100, 100,100

IF 1, 2
MA 100,100
DA 100,100, 200,300, 500,100, 100,100

IF 2, 1
MA 100,100
DA 100,100, 200,300, 500,100, 100,100
```

Figure 11-53 was created by this example. Notice that all the moving and plotting commands are the same for each triangle—the only change is the scale set by the IF command.

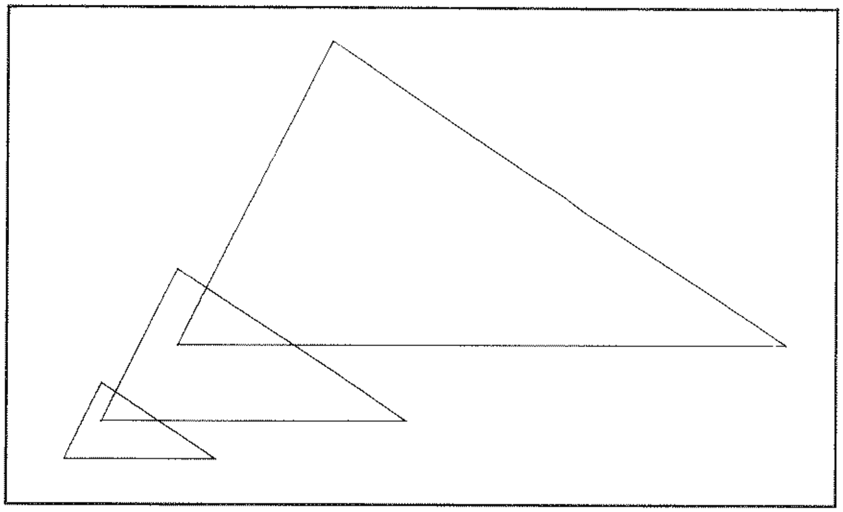


Figure 11-53. Input factor (IF) command

Changing Command Sets

Alternate command set

Function:

Selects one of the plotting command sets.

Format:

AC *set*

Parameters:

The parameter *set* specifies the command set.

Remarks:

This command switches between the plotting command sets: Epson (*set* = 0) and Graphtec emulator (*set* = 1).

Additional optional command sets may be added in the future. Check the manual for your optional command set for the proper value of *set*.

Plotting parameters are not changed when you change command sets.

Examples:

AC 1

This command selects the Graphtec emulator command set.

Printer emulator

Function:

Puts the HC100 into the printer emulator mode.

Format:

<DC2> (which is ASCII 18)

Parameters:

No parameters are required.

Remarks:

This command effectively transforms the HC100 into an Epson RX-80 printer. The HC100 accepts all the RX-80 commands (except for bit-image graphics comands) with the addition of some commands unique to the plotter's features.

This is the only command in the Epson plotting command set that consists of a single code, which is the ASCII code 18 decimal. No carriage return is required after this code.

Most plotting settings are not changed when switching to the printer emulator command set. Appendix G shows how the settings relate in the different command sets.

Examples:

<DC2>

This command switches to the printer emulator command set.

Error Handling

Error control

Function:

Controls the error processing functions.

Format:

IM *type, action*

Parameters:

The parameter *type* specifies the types of errors that are acted on.

The parameter *action* specifies the action to take when an error is encountered.

Remarks:

There are five error *types* which are assigned values as shown in Table 11-7.

Table 11-7. Error type values

Error type	Type value
Command error	1
Parameter range error	2
Missing parameter error	4
Delimiter error	8
Overflow error	16

The value of *type* is the sum of the values of the error types that you want the HC100 to act on.

The default value of *type* is 31, which is the sum of the values of all the error types.

The parameter *action* specifies what kind of action the HC100 is to take when it encounters an error.

If *action* = 0 or 8, the ERROR indicator is lit. The command containing the error is skipped and execution continues with the next command. The ERROR indicator remains lit until cleared by an error releasing command.

If *action* = 1 or 9, the ERROR indicator is lit, execution halts, and all commands are ignored until an error releasing command is received. (This is the default state.)

If *action* = 2 or 10, the ERROR indicator is lit. The error type and first ten characters of the command containing the error are printed in the lower left of the drawing area. The command containing the error is skipped and execution continues with the next command. The ERROR indicator remains lit until cleared by an error releasing command.

If *action* = 3 or 11, the ERROR indicator is lit. The error type and first ten characters of the command containing the error are printed in the lower left of the drawing area. Execution halts, and all commands are ignored until an error releasing command is received.

If you use a value of *action* between 8 and 11, then the error signal on the parallel interface is also set to LOW when an error is encountered. Nothing happens if a serial interface is used.

The default value for *action* is 1.

The home (HO) command, clear interface (CI) command, initialize (IN) command, and default (DF) command reset an error condition.

When an error message is printed (if *action* is 2, 3, 10, or 11), up to ten characters of the command are printed in default size characters. If you have more than one error they are printed on top of each other. Figure 11-54 shows a typical error message.

```
PARAMETER INSUFFICIENT ERROR!!  CMD:AR 0, 100,
```

Figure 11-54. A typical error message

The initialize (IN) command and the default (DF) command both reset this to the default value.

Examples:

IM 31, 3

This example instructs the plotter to print all error messages when an error is encountered and then stop with the ERROR indicator lit.

Chapter 12
Graphtec Command Set Reference

This chapter is a summary of the plotter commands used when the Graphtec emulator command set is selected. In the Graphtec command set (called *command set 1*), the HC100 acts like a Graphtec plotter. Although it does not have all the flexibility of the Epson plotter command set (*command set 0*), the Graphtec emulator command set is useful if you have already written (or intend to write) programs that use Graphtec plotter commands.

To select the Graphtec emulator command set, use the *alternate command set* (AC) command while in the Epson plotter mode. The format of the command is:

AC *set*

The parameter *set* = 1 selects the Graphtec command set and *set* = 0 returns you to the Epson plotter command set.

The Graphtec plotter commands are organized into six logical groups:

- Absolute and Relative Commands
- Miscellaneous Commands
- Plotting Commands
- Label Commands
- Line Type Commands
- Changing Command Sets Commands

The following format is used to describe each command:

Function:
What the plotter does when given the proper command.

Format:

The correct syntax for the function. The *parameters* are named by what value is entered. For example, the parameter *len* calls for a numerical value that is the length along either the X-axis or the Y-axis. Absolute X and Y coordinates are expressed simply as x, y while relative X and Y coordinates are expressed as dx, dy. Optional parameters are enclosed in brackets [ ].

Parameters:

What variable values are used (if any) and how the variable affects the plotter's actions. All units of measure are in 0.1 mm (100 = 10 mm) and angles are measured in 0.1° (900 = 90°).

Remarks:

How the plotter performs the command, interaction with other commands, etc.

Examples:

Provides a demonstration of the command and a printout of the result.

Draw absolute

Function:

Draws a line from the current position to the absolute location *x1,y1*, and then on to *x2,y2*, etc.

Format:

D *x1,y1 [, x2,y2 ... , xn,yn]*

Parameters:

The parameters *x1* and *y1* define the point at the end of the first line segment.

The parameters *x2* and *y2* define the point at the end of the second line segment.

The parameters *xn* and *yn* define the point at the end of the *n*th line segment.

Remarks:

Parameters must be included in pairs, an *x* value and a *y* value, which together specify a point.

You can include as many pairs of parameters as you like with this command. The pen draws successive lines between the points defined by the pairs of parameters.

The parameters must be in the range −16383 to 16383.

This command references points as absolute positions relative to the coordinate origin.

The type of line used is determined by the line type (L) command.

Examples:

Both examples below assume that the current position is the origin (point 0,0).

D 400,500

This command draws a line from the current position to the point 400,500. See Figure 12-2.

D 300,600, 500,700

This command draws a line from the current position to the point 300,600 and then draws a line from the point 300,600 to the point 500,700. See Figure 12-3.

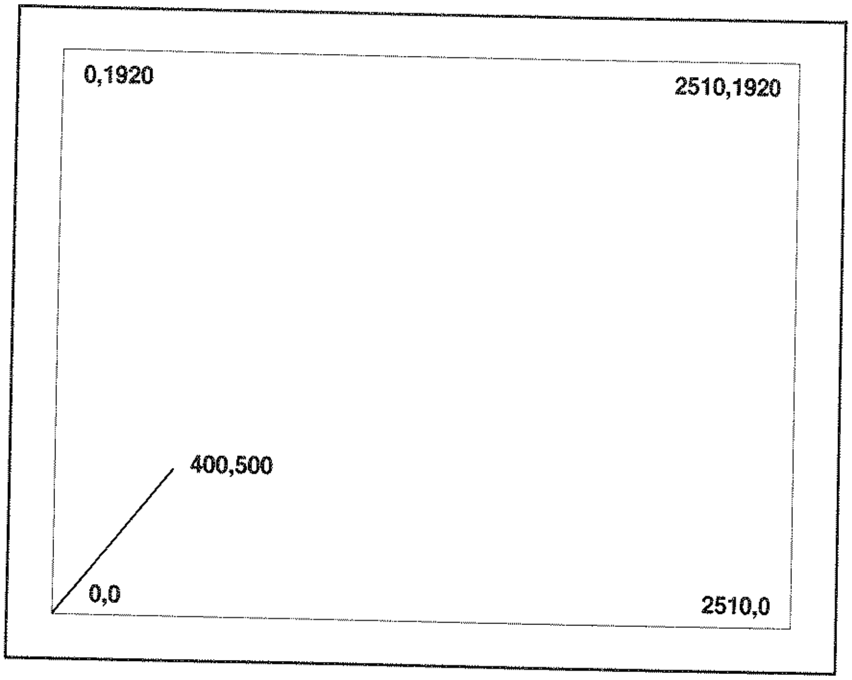


Figure 12-2. Draw absolute (D) command

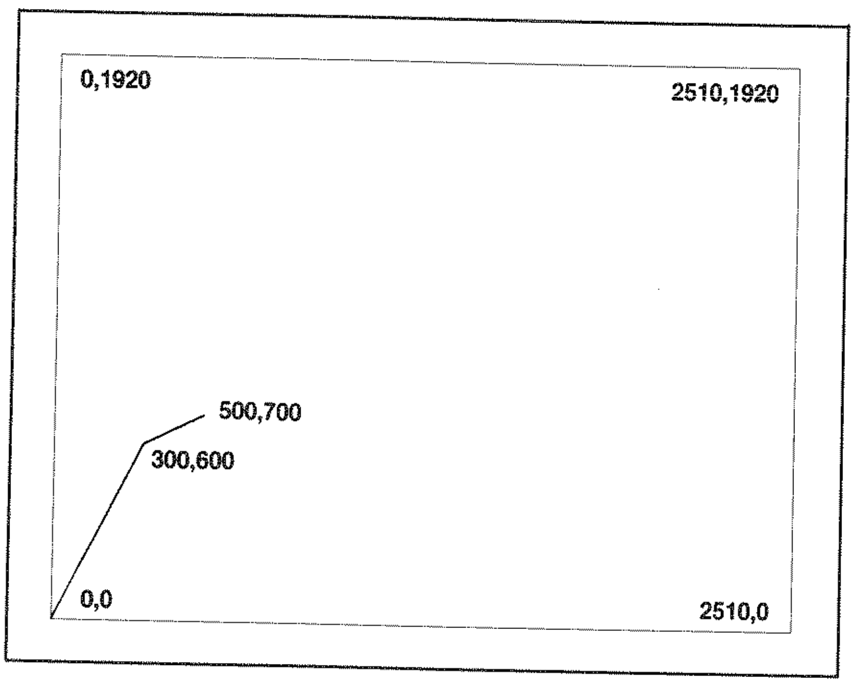


Figure 12-3. Draw absolute (D) command

Move relative

Function:

Moves without drawing to the relative coordinate *dx,dy*.

Format:

R *dx,dy*

Parameters:

The parameters *dx* and *dy* define the distance to the point that the pen moves to, measured from the current position.

Remarks:

The point is defined relative to the current position. The *dx* value defines a distance from the current position in the X direction. The *dy* value defines a distance from the current position in the Y direction.

The parameters must be in the range −16383 to 16383.

If the absolute coordinate of the point is outside the range −32768 to 32767, an error will result.

Examples:

R 300,600

This command moves the pen to the point that is 30.0 mm away in the X direction and 60.0 mm away in the Y direction. See Figure 12-4.

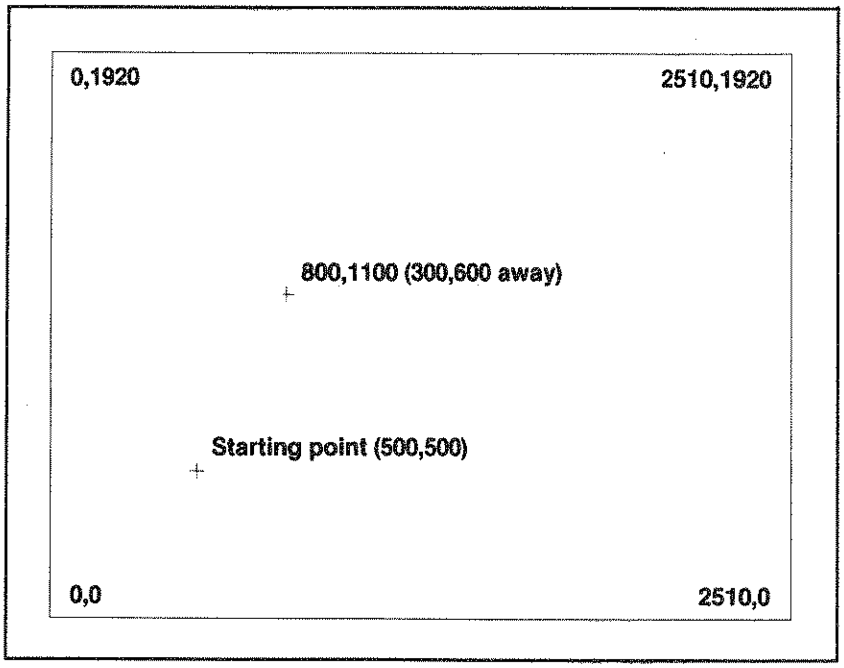


Figure 12-4. Move relative (R) command

Draw relative

Function:

Draws a line from the current position to a point that is a distance *dx1,dy1* from the current position, and then on to a point that is a distance *dx2,dy2* from the first point, etc.

Format:

I *dx1,dy1 [, dx2,dy2 ... , dxn,dyn]*

Parameters:

The parameters *dx1* and *dy1* define the distance to the point at the end of the first line segment, measured from the current position.

The parameters *dx2* and *dy2* define the distance to the point at the end of the second line segment, measured from the current position.

The parameters *dxn* and *dyn* define the distance to the point at the end of the nth line segment, measured from the current position.

Remarks:

Parameters must be included in pairs consisting of a *dx* value and a *dy* value, which together specify a distance to a point.

You can include as many pairs of parameters as you like with this command. The pen draws successive lines between the points defined by the pairs of parameters.

The parameters must be in the range −16383 to 16383.

The points are defined relative to the current position (or the position of the previous point). The *dx* value defines a distance from the current position in the X direction. The *dy* value defines a distance from the current position in the Y direction.

The type of line used is determined by the line type (L) command.

If the absolute coordinate of any point is outside the range −32768 to 32767, an error will result.

To draw just a dot at the current position, use I 0,0 (or I,).

Examples:

I 300,200

This command draws a line from the current position to a point that is 30.0 mm away in the X direction and 20.0 mm away in the Y direction. See Figure 12-5.

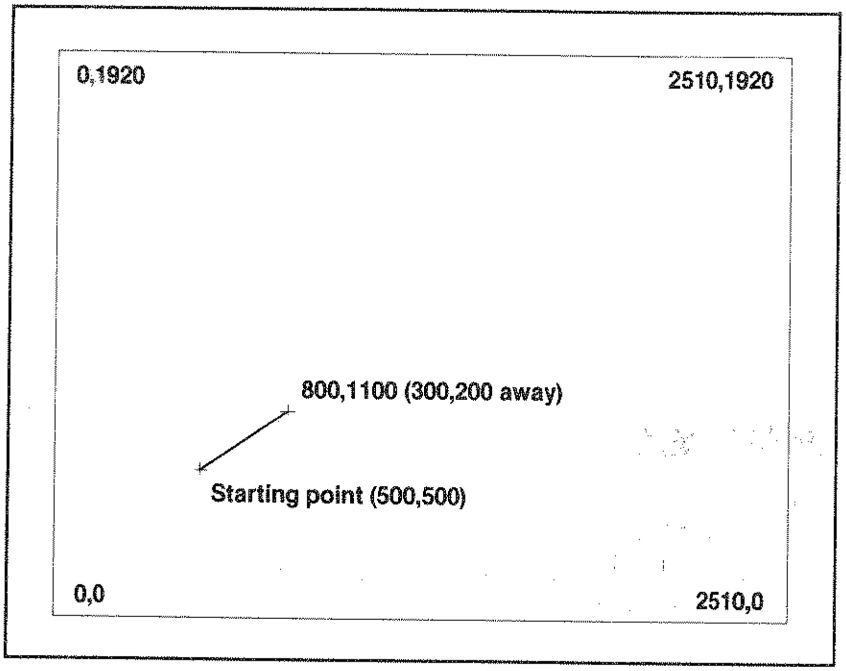


Figure 12-5. Draw relative (I) command

I 400,0, 0,400, −400,0, 0,−400

This command draws a square, with sides 40.0 mm long, starting at the current location. See Figure 12-6.

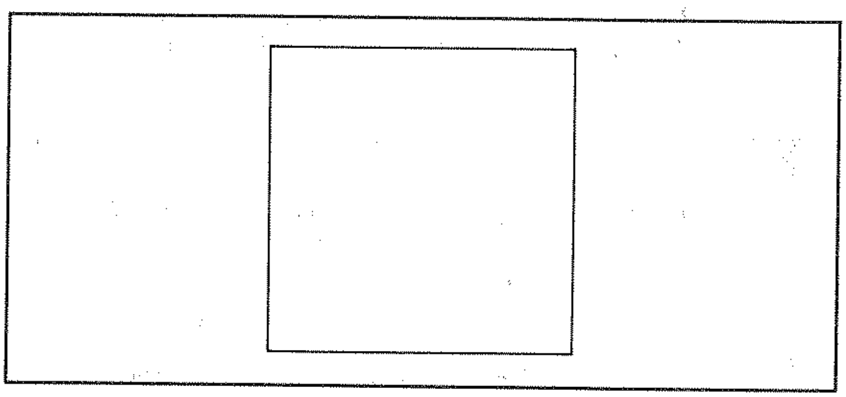


Figure 12-6. Draw relative (I) command

Miscellaneous Commands

Clear interface

Function:

Clears error conditions.

Format:

;

Parameters:

No parameters are required.

Remarks:

This command resets error conditions. It turns off the ERROR indicator and allows the plotter to continue normal operations.

If the plotter is set to stop on error conditions, any commands between the one that caused the error, and the clear interface (;) command are ignored.

No plotting parameters are reset by this command.

Examples:

;

Home pen

Function:
Moves the pen to the coordinate origin.

Format:
H

Parameters:
No parameters are required.

Remarks:
This command is the equivalent of the command M 0,0.

This command resets an error condition.

The origin cannot be moved from the lower left (default) position in this command set.

Examples:
H

This command moves the pen to the origin.

Default values

Function:

Sets all values to the default state and returns the pen to the coordinate origin.

Format:

:

Parameters:

No parameters are required.

Remarks:

This command resets all the plotting parameters to the default settings as shown in Table 12-1.

Table 12-1. Default plotting parameters

Command		Default value
Character size	S	24 x 24
Character direction	Q	0°
Line type	L	0 (solid)
Line pitch	B	60
Pen speed	T	0 (high speed)
Select pen	J	1

This command does not change command sets (regardless of the DIP switch settings).

Examples:

:

Select pen

Function:

Selects a pen, or stows and caps the pens.

Format:

J *pen-num*

Parameters:

The parameter *pen-num* specifies the pen (*pen-num* = 1 through 8), or the pen-capped option (*pen-num* = −1 or 0).

Remarks:

The pen positions are marked on the pen cassette as shown in Figure 12-7.

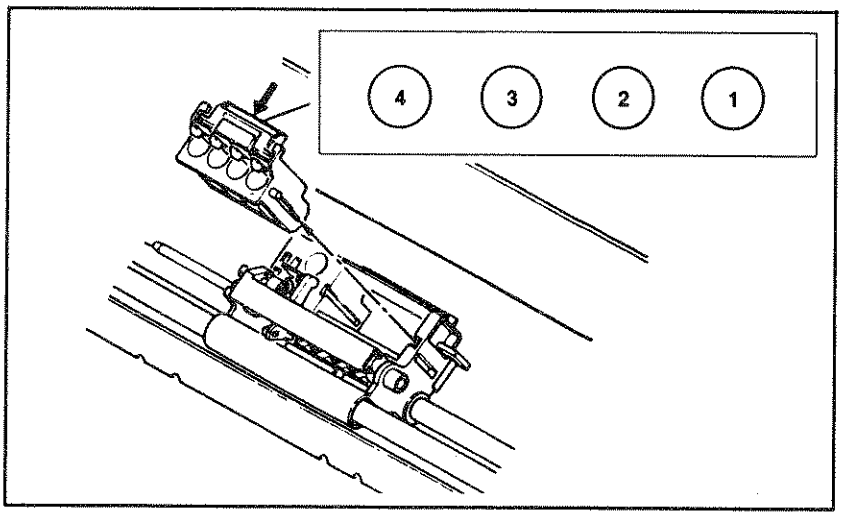


Figure 12-7. Pen numbers

The parameter *pen-num* can be any integer value from −1 through 8.

When *pen-num* is −1, the carriage moves to the extreme right, pen-capped position. When the next command (or even just a carriage return) is received, the pen returns to its position prior to the J −1 command.

When *pen-num* is 0, the carriage moves to the extreme right, pen-capped position. You must press the CAP/OFF key for the HC100 to resume operation.

When *pen-num* is 1 through 4, the respective pen is selected.

When *pen-num* is 5 through 8, the sequence of pens is repeated (J 5 selects pen 1, J 6 selects pen 2, etc.).

After the new pen is selected, it returns to the point prior to the J command.

The default pen number is 1.

The default (:) command resets this to the default value.

Examples:

J 2

This command selects pen number 2.

J 7

This command selects pen number 3.

Pen speed

Function:

Sets the drawing speed of the pen.

Format:

T *speed*

Parameters:

The parameter *speed* specifies how fast the pen is to move. The parameter *speed* can be 0 (fast) or 1 (slow).

Remarks:

The fast pen speed (*speed* = 0) is 230 mm/sec, the slow pen speed (*speed* = 1) is 100 mm/sec.

The fast pen speed is the default.

When the pen is moving diagonally, the actual pen speed is the result of the velocity in both the X and Y directions. For example, when the pen is moving at 45°, the pen speed is 1.414 times the specified velocity.

The slow pen speed may produce better quality drawings on some materials.

The default (:) command resets this to the default value.

Examples:

T 1

This command sets the pen speed to 100 mm/sec.

Plotting Commands

Axis

Function:

Draws an axis line and graduates it.

Format:

X *dir, len, div*

Parameters:

The parameter *dir* specifies whether the axis is an X-axis (*dir* = 0 or 2) or a Y-axis (*dir* = 1 or 3). Also specifies whether *len* is interpreted as the length of one scale division (*dir* = 0 or 1) or the overall length of the axis line (*dir* = 2 or 3).

The parameter *len* specifies the length of one scale division (*dir* = 0 or 1) or the overall length of the axis line (*dir* = 2 or 3).

The parameter *div* specifies the number of scale divisions (maximum of 255).

Remarks:

The parameter *len* must be in the range −16383 to 16383.

Table 12-2 shows the interrelation of the parameters in the axis command.

Table 12-2. Interrelation of the axis command parameters

dir	Axis	*len*
0	Y	division
1	X	length
2	Y	overall
3	X	length

The axis line starts at the current position.

Both the axis line and the ticks are drawn as solid lines, regardless of the setting of the line type (L) command.

When *dir* is 2 or 3, *len* is divided by *div* to find the length of a division. If the result of this division is not an integer, then the remainder is discarded. This results in a slightly shorter line than would be expected. For example, if *len* = 1000, and *div* = 13, then the unit length is 76, since $^{1000}/_{13}$ = 76.9231. This results in an axis line 12 shorter than expected (76 x 13 = 988).

To draw an axis in the negative direction, make *len* negative.

Examples:

M 500,500

X 1, 100, 6

M 500,500

X 2, 1000, 10

This example draws the axes shown in Figure 12-8. In the first axis command *dir* has a value of 1 so the other parameters (*len, div*) are given in terms of one division. In the second axis command *dir* has a value of 2 so the other parameters (*len, div*) are given in terms of the entire axis.

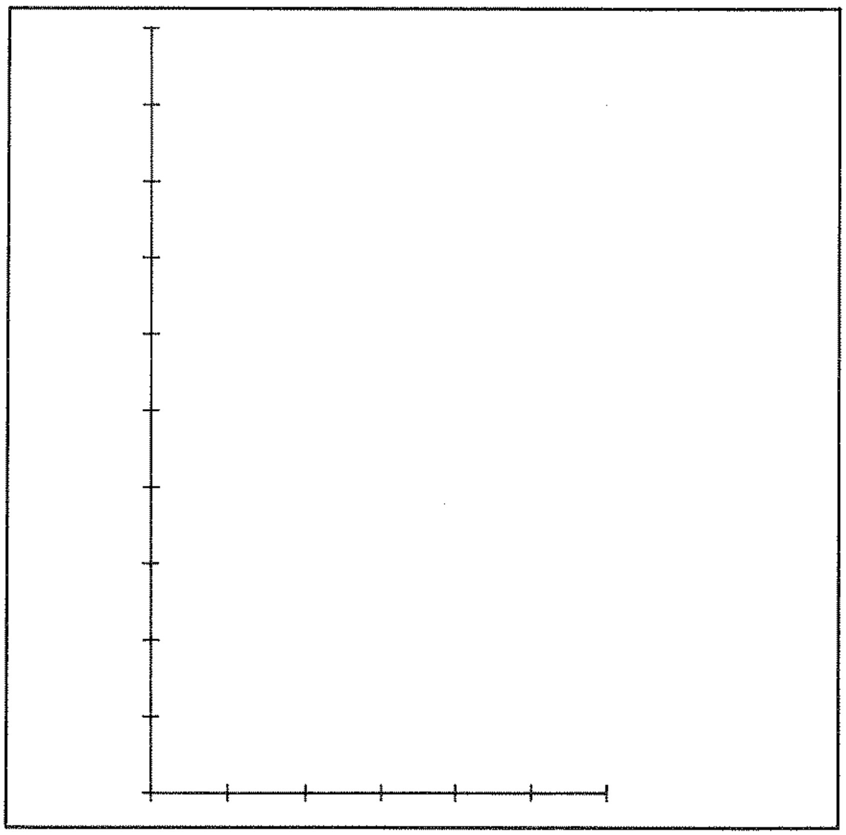


Figure 12-8. Axis (A) command

Function:

Draws a mark at the current position.

Format:

N *style*

Parameters:

The parameter *style* defines the type of mark made; *style* can range from 0 to 15.

Remarks:

The types of marks are shown in Figure 12-9.

The size and rotation of the marks is changed by the character size (S) and character direction (Q) commands.

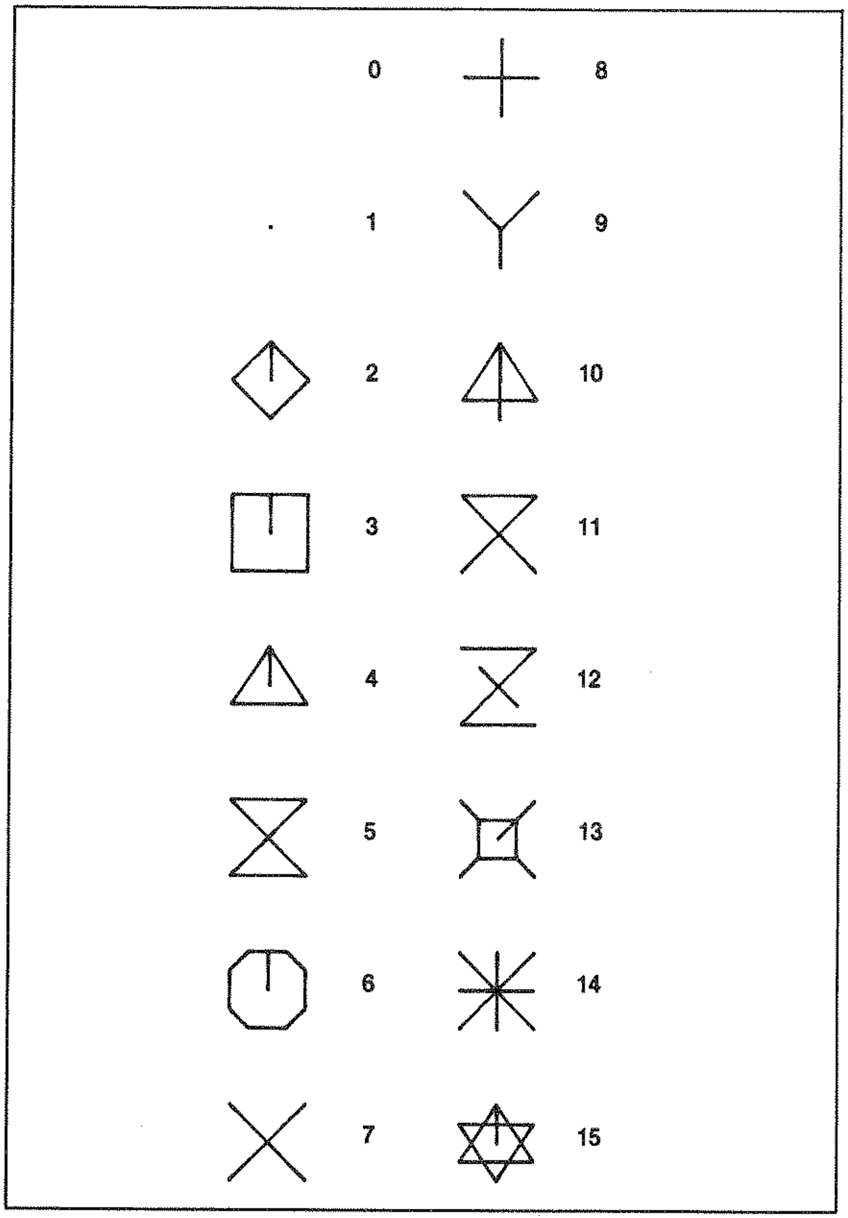


Figure 12-9. Mark types

Examples:

M 600,750
N 14

D 700,680
N 14

D 800,1050
N 14

D 900,1380
N 14

D 1000,1430
N 14

This example creates Figure 12-10. The marks are type 14.

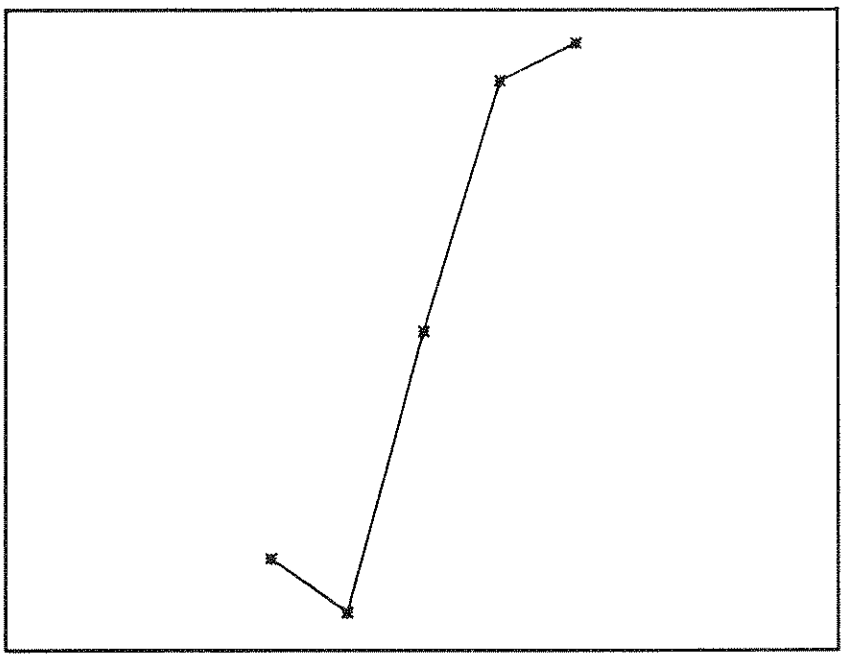


Figure 12-10. Mark (N) command

Labels

Label

Function:

Prints a text string starting at the current position.

Format:

P *text-string*

Parameters:

The parameter *text-string* is a string of ASCII characters to be printed.

Remarks:

The characters in *text-string* must have ASCII codes between 32 and 255.

Some codes in the range do not have characters assigned. If no character is assigned, then none are printed.

Each character is drawn inside of an imaginary box whose default dimensions are 2.4 mm x 2.4 mm. The character is drawn in the box as shown in Figure 12-11. The bottom left corner of the box is the current position, and the lower right corner of the box is the pen position when the character has been drawn. Note that the box includes space on the right side of the character so that the characters do not run together.

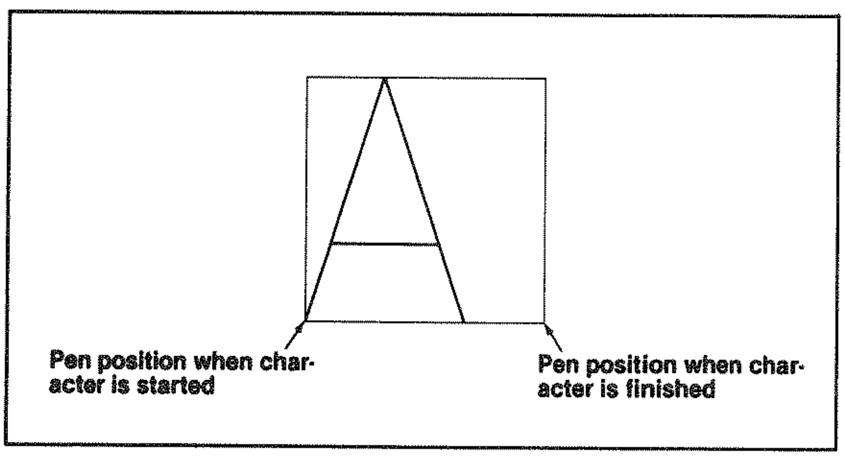


Figure 12-11. Character format

When all the characters in *text-string* are printed, the pen is left at the ending position of the last character. The carriage return at the end of the command does not move the pen to a new line, it only terminates the command. You must move the pen to the beginning of the next line with a separate command: move absolute (M) or move relative (R).

If a character would be drawn outside of the effective drawing area, it is clipped in the same way as any other plotting would be.

The following commands affect the way characters are drawn:

character size	S
character direction	Q
reset characters	A

If a space is inserted between the command "P" and the first character printed, the space is printed as a space.

Examples:

PAlways read the manual

P before you have a problem.

This example prints one line as shown in Figure 12-12. Note that the space before the word "before" is printed.

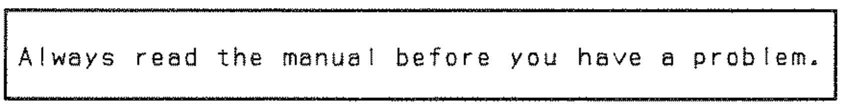


Figure 12-12. Label (P) command

Character size

Function:

Sets the size of characters and marks.

Format:

S *size*

Parameters:

The parameter *size* specifies the size of the characters.

Remarks:

This command adjusts the size of the characters printed by the label (P) command and the marks created by the mark (N) command.

The parameter, *size*, must be in the range 0 to 254.

The sizes of characters and marks are calculated by the following formulas:

Character height = 0.7 x (*size* + 1) mm

Mark size = 0.4 x (*size* + 1) mm

(For *size* = 0 or 1, the size of the mark is the same.)

The actual character width of the normal ASCII characters is $2/3$ of the height. The space on the right side of each character is $1/3$ of the height. Therefore, the total space from the starting position of one character to the starting position of an adjacent character is equal to the height.

The default character size is 2.4 mm x 2.4 mm.

The reset character (A) command, and the default (:) command reset this to the default value.

Examples:

S 8

PChanging the size

This example prints with characters 6.3 mm high as shown in Figure 12-13.

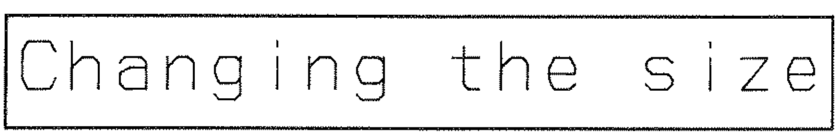


Figure 12-13. Character size (S) command

Character direction

Function:

Sets the direction that labels are printed.

Format:

Q *dir*

Parameters:

The parameter *dir* specifies the direction that labels are printed. The parameter *dir* can range from 0 to 3.

Remarks:

The value of *dir* specifies the angle of rotation, measured from the positive X-axis, as shown in Table 12-3.

Table 12-3. Label direction

Value of *dir*	Angle of rotation
0	0°
1	90°
2	180°
3	270°

Positive values of *dir* cause rotation in the counterclockwise direction.

The default *dir* is 0 (parallel to the X-axis).

The reset character (A) command, and the default (:) command reset this to the default value.

Examples:

Q 1

PThis is printed at 90 degrees

This example prints Figure 12-14.

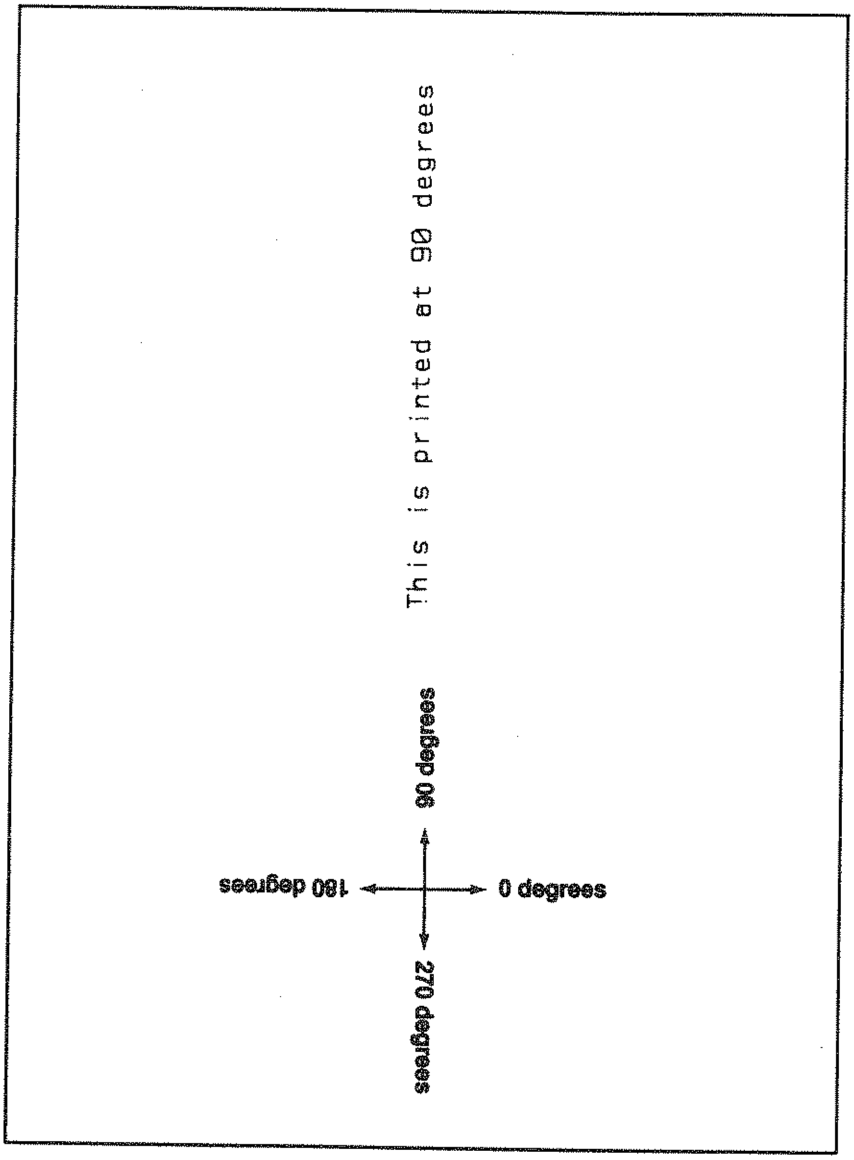


Figure 12-14. Character direction (Q) command

Reset characters

Function:

Resets the character style and size to the default parameters.

Format:

A

Parameters:

No parameters are required.

Remarks:

Resets the character attributes set by the commands shown in Table 12-4 to their default values.

Table 12-4. Character reset default values

Command		Default value
Character size	S	24 x 24
Character direction	Q	0°

Examples:

S 8

Q 1

PLarge letters, 90 degrees

A

PReset to regular letters, 0 degrees

This example prints some large letters going straight up, then resets the character attributes and prints some default-sized characters. The results are shown in Figure 12-15.

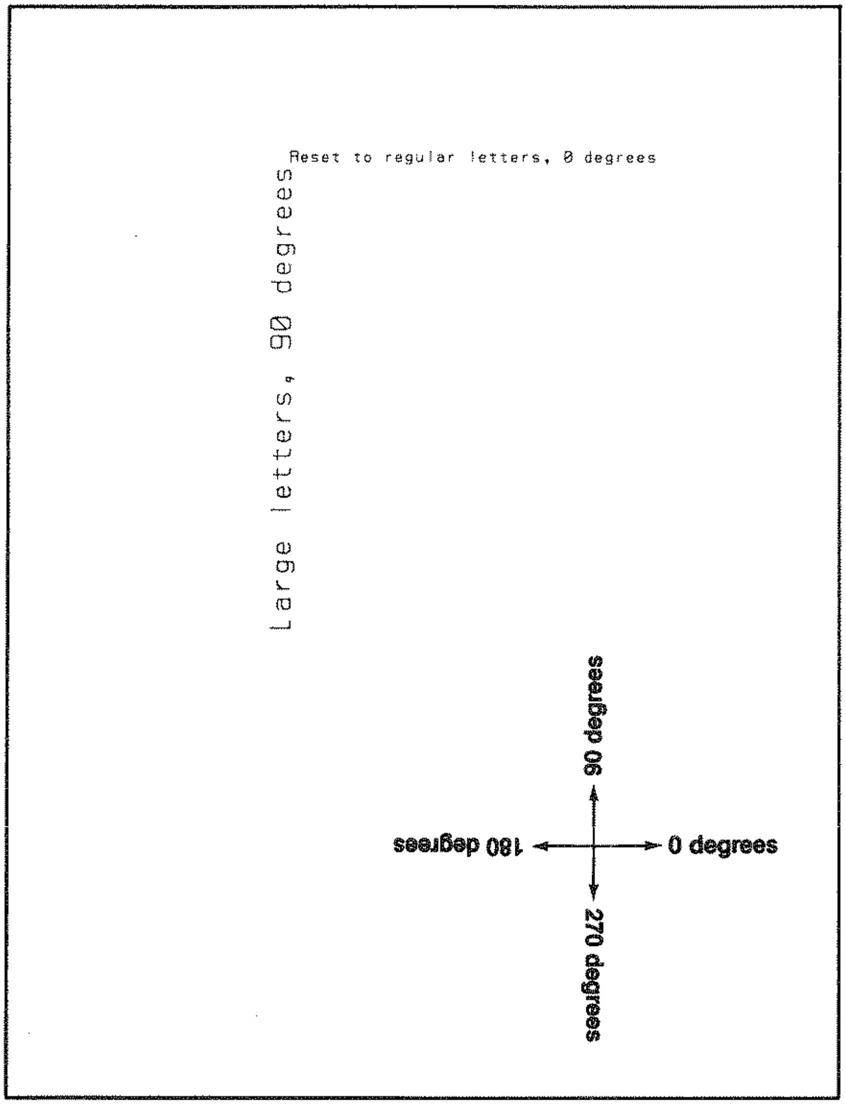


Figure 12-15. Reset characters (A) command

Line Types

Line type

Function:

Specifies the type of line to be printed.

Format:

L *style*

Parameters:

The parameter *style* specifies the type of line to be used; *style* can range from 0 (normal, solid line) to 8.

Remarks:

The line types that can be drawn are shown in Figure 12-16.

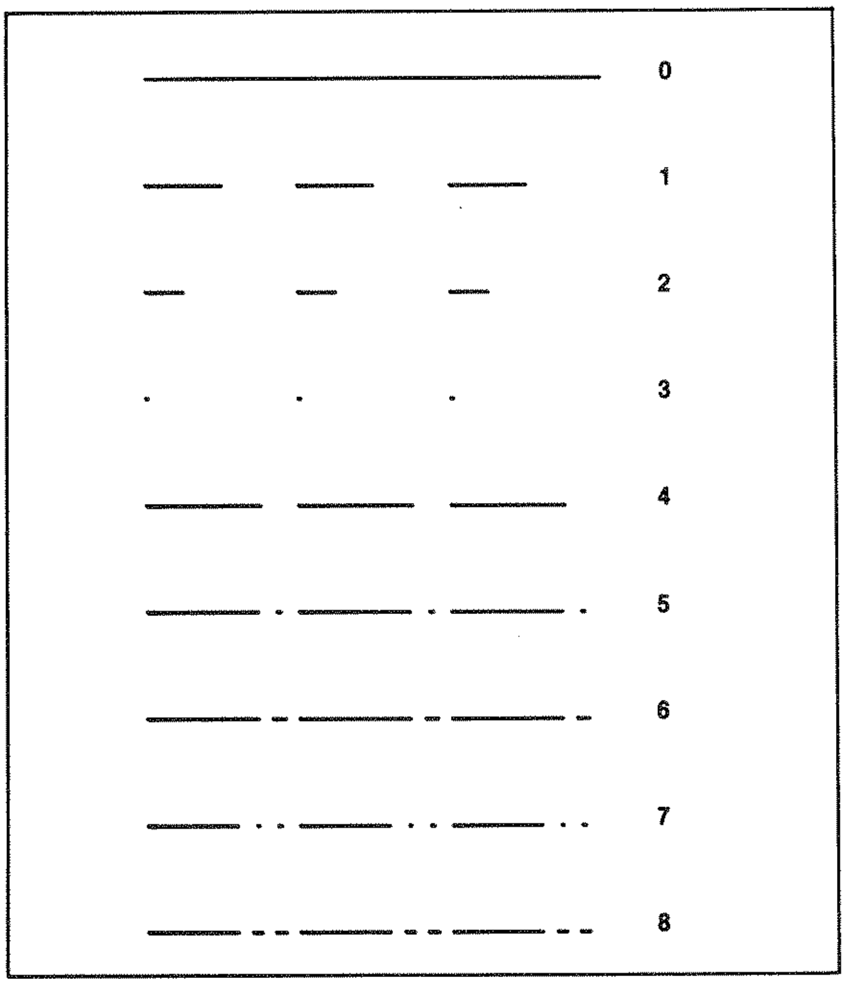


Figure 12-16. Line types

This command affects the type of line drawn with the following commands:

draw absolute	(D)
draw relative	(I)

The pitch of the various types of line can be set with the line pitch (B) command. The pitch of each line type is shown in Figure 12-17.

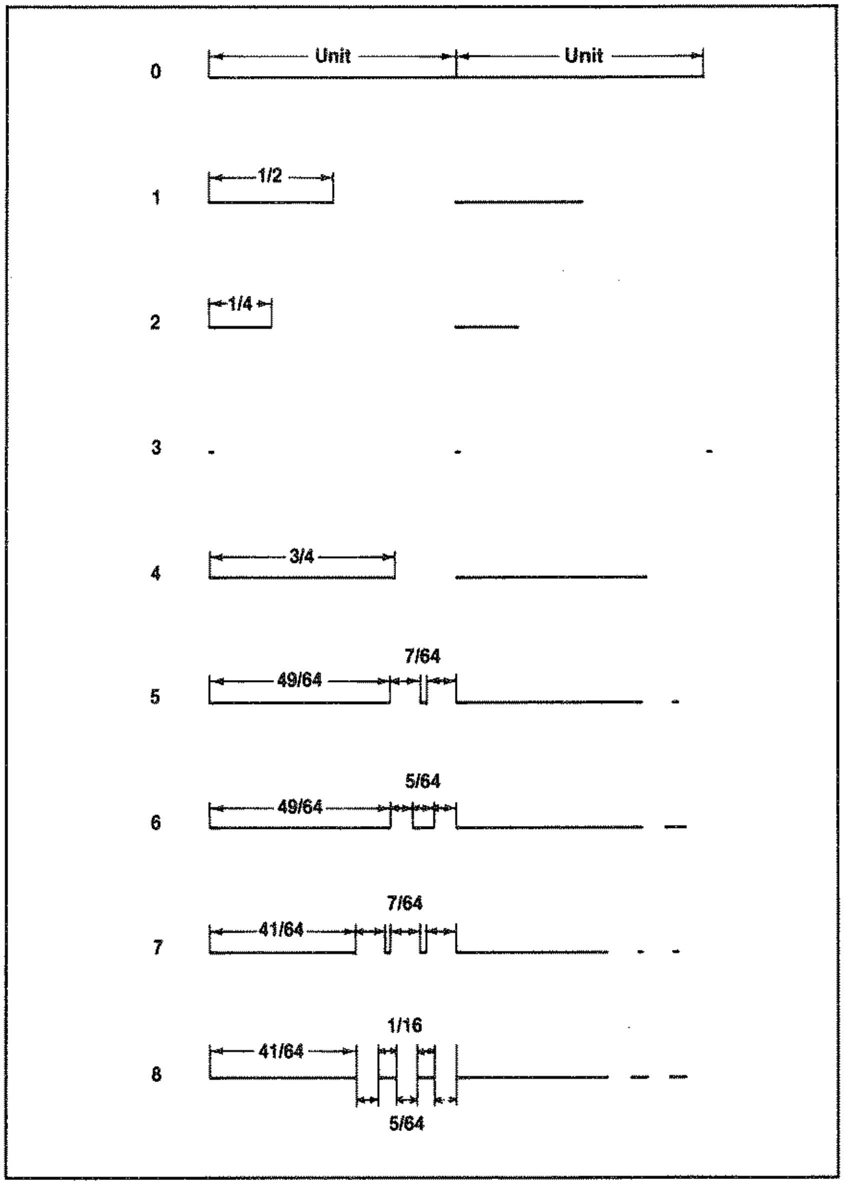


Figure 12-17. Pitch of the types of lines

The default line type is 0 (solid line).

The reset character (A) command, and the default (:) command reset this to the default value.

Examples:

L 8

This command selects a dashed line as shown in Figure 12-18.

Figure 12-18. Line type (L) command

Line pitch

Function:

Specifies the pitch of the line style determined by the line type (L) command.

Format:

B *pitch*

Parameters:

The parameter *pitch* sets the length of one-half pitch of the current line type.

Remarks:

The parameter *pitch* must be in the range 1 to 16383.

The parameter *pitch* is one half of the length of the repeating unit.

The line pitch does not have any effect on a solid line (line type 0).

The default value of *pitch* is 30, which gives a pitch length of 6.0 mm.

The default (:) command resets this to the default value.

Examples:

```
M 300,1000
L 8
I 1000,0

M 300,800
B 60
I 1000,0
```

The results of this example are shown in Figure 12-19. The pitch of the line is doubled, from the default of 6.0 mm to a new value of 12.0 mm.

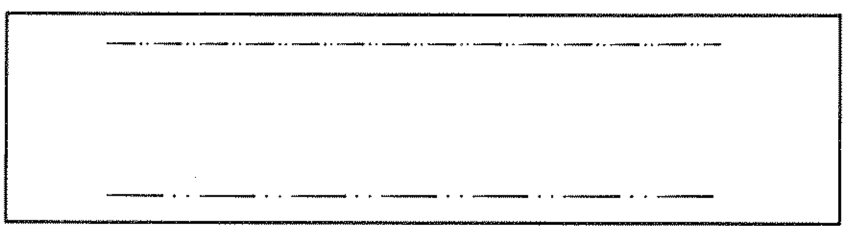


Figure 12-19. Line pitch (B) command

Changing Command Sets

Alternate command set

Function:

Selects one of the command sets.

Format:

AC *set*

Parameters:

The parameter *set* specifies the command set.

Remarks:

This command switches between the plotting command sets: Epson (*set* = 0) and Graphtec emulator (*set* = 1).

Additional optional command sets may be added in the future. Check the manual for your optional command set for the proper value of *set*.

Plotting parameters are not changed when you change command sets.

This is the only two letter command in this command set.

Examples:

AC 0

This command selects the Epson plotter command set.

Chapter 13

Printer Emulator Command Reference

This chapter is a summary of the printer commands used when the printer emulator command set is selected. In the printer command set, the HC100 acts like an Epson RX-80 printer to format and print text. Although it does not have all the flexibility of an Epson dot-matrix printer (such as dot graphics capability), it does handle most of the printer functions.

To select the printer command set:

1. Send the code 〈DC2〉 (which is ASCII 18 decimal) or,
2. Hold the CAP/OFF button down and turn ON the power switch.

The printer commands are organized into five logical groups:

- Vertical Spacing Commands
- Horizontal Spacing Commands
- Print Style Commands
- Character Set Commands
- Miscellaneous Commands

The following format is used to describe each command:

Format:
The correct syntax for the ASCII code that the plotter understands. When *n* (or another italic letter) is used as a variable, it stands for a numerical value.

Description:
How the plotter performs the command and what variable values are used (if any).

Command Syntax Used in this Chapter

There are a wide variety of ways to send printer control codes to the HC100 plotter. In this chapter, the commands are shown as in this example:

⟨ESC⟩ W 1

This is the command to turn on expanded print. ⟨ESC⟩ is the escape code, which is ASCII code 27. The letter (or number) is the character that is sent to the printer. In the example above, a capital "W" is sent following the escape code.

In BASIC, you could do this in a couple of ways: by sending the character itself (e.g. LPRINT "W";), or by using the CHR$ function to send the ASCII code for the character (e.g. LPRINT CHR$(87);).

Many of HC100's commands end with a 1 or a 0. When shown without quotes or CHR$, you can use either ASCII code 1 [i.e. CHR$(1)] or the character "1" [which is ASCII code 49, or CHR$(49)]. The same rules apply to commands ending with 0.

For the example above, any of these BASIC statements has the same result:

LPRINT CHR$(27) "W" CHR$(1)

LPRINT CHR$(27) "W" CHR$(49)

LPRINT CHR$(27) "W1"

There are three commands that require the use of ASCII code 0; the character "0" (ASCII code 48) cannot be substituted. In these cases, CHR$(0) is shown each time these commands are referenced. The commands are ⟨ESC⟩ "C" CHR$(0) *n* (set page length to *n* inches), ⟨ESC⟩ "e" CHR$(0) *n* (set horizontal tabs), and ⟨ESC⟩ "f" CHR$(0) *n* (absolute horizontal tab).

There are two commands that require the use of ASCII code 1; the character "1" (ASCII code 49) cannot be substituted. These commands are referenced as CHR$(1). The commands are ⟨ESC⟩ "e" CHR$(1) *n* (set vertical tabs), and ⟨ESC⟩ "f" CHR$(1) *n* (absolute vertical tab).

The plotter command set also uses commands that are unique to the HC100plotter. These commands begin with ⟨GS⟩ which is ASCII code 29. For example, the command ⟨GS⟩ "C" selects the pen, and the command ⟨GS⟩ "G" selects the Epson plotter command set.

Vertical Spacing Commands

Line feed

Format:

⟨LF⟩

Description:

Returns the print head to the left margin and advances the paper one line.

One-time *n*/216-inch line feed

Format:

⟨ESC⟩ J *n*

Description:

Advances the paper *n*/216-inches (*n* can range from 0 to 255). It does not execute a carriage return.

Set 1/8-inch line spacing

Format:

⟨ESC⟩ 0

Description:

Sets the line spacing for subsequent line feed commands to 1/8-inch.

Set 7/72-inch line spacing

Format:

⟨ESC⟩ 1

Description:

Sets the line spacing for subsequent line feed commands to 7/72-inch.

Set 1/6-inch line spacing

Format:

⟨ESC⟩ 2

Description:

Sets the line spacing for subsequent line feed commands to 1/6-inch.

Set *n*/216-inch line spacing

Format:

⟨ESC⟩ 3 *n*

Description:

Sets the line spacing for subsequent line feed commands to *n*/216-inch (*n* can range from 0 to 255).

Set *n*/72-inch line spacing

Format:

⟨ESC⟩ A *n*

Description:

Sets the line spacing for subsequent line feed commands to *n*/72-inches (*n* can range from 0 to 127).

Auto line spacing for extended height characters

Format:

⟨GS⟩ F

Description:

Sets automatic line spacing to 7/4 the height of the characters on the previous line. This command is used to prevent overlapping characters of one line with characters of the next line when the ⟨GS⟩ H command is used to change the character height.

Automatic line spacing is the default condition so that changing the height of the characters automatically adjusts the line spacing.

If this setting were not possible, the extended height characters would print on top of one another because the line spacing would only be appropriate to the normal characters. A separate command would be required to set the line spacing for the particular character height chosen.

Because auto line spacing is based on the last line, the increased line spacing doesn't take effect until after a carriage return (⟨CR⟩) is executed. If you print a line, increase the character height and print the next line, the second line will overlap the first. To overcome this, add a ⟨CR⟩ after changing the character height to adjust the line spacing before you print the second line.

The commands ⟨ESC⟩ 0, ⟨ESC⟩ 1, ⟨ESC⟩ 2, ⟨ESC⟩ 3 (*n*), ⟨ESC⟩ A (*n*), and ⟨ESC⟩ 3 (*n*) all disable automatic line spacing.

Form feed

Format:

⟨FF⟩

Description:

Ejects the paper, caps the pens, and flashes the ON LINE indicator for paper changing.

Set page length by lines

Format:

<ESC> C *n*

Description:

Sets the length of the page to *n* lines (*n* can range from 1 to 127). The page length must not exceed the effective drawing area.

Set page length by inches

Format:

<ESC> C CHR$(0) *n*

Description:

Sets the page length to *n* inches (*n* can range from 1 to 22). The page length must not exceed the effective drawing area.

Set bottom margin

Format:

<ESC> N *n*

Description:

Sets a bottom margin of *n* lines (*n* can range from 1 to 127). When the bottom margin is reached a form feed (<FF>) is automatically sent.

Cancel bottom margin

Format:

<ESC> O

Description:

Sets the bottom margin to 0 lines. The command uses the letter "O", not the number zero.

Vertical tab

Format:

⟨VT⟩

Description:

Advances the paper to the next vertical tab position. If no vertical tabs have been set, this code advances the paper one line. This command also cancels one-line expanded width print set by ⟨SO⟩ or ⟨ESC⟩ ⟨SO⟩.

Absolute vertical tab

Format:

⟨ESC⟩ f CHR$(1) *n*

Description:

Moves the paper to line *n*. If the value of *n* is greater than the number of lines on the page, the command is ignored.

Set vertical tabs

Format:

⟨ESC⟩ e CHR$(1) *n*

Description:

Sets relative vertical tabs at every *n* position. If the value of *n* is greater than the number of lines on the page, the command is ignored. If the line spacing is changed, vertical tab settings remain at the old line spacing. If the height of the characters is increased, line spacing is based on the new character height.

Horizontal Spacing Commands

Carriage return

Format:

⟨CR⟩

Description:

Returns the print head to the left margin. If *auto-line feed* is on, then the paper is also advanced one line.

Set right margin

Format:

⟨ESC⟩ Q *n*

Description:

Sets a right margin at *n* character columns of the current character width (*n* can range from 1 to 255). This command must be sent at the beginning of a line. If a line to be printed exceeds the right margin, a carriage return and line feed is inserted to keep the line from exceeding the right margin.

Set left margin

Format:

⟨ESC⟩ l *n*

Description:

Sets the left margin at *n* character positions of the current character width (*n* can range from 1 to 160). If the value of *n* results in a left margin greater than 8 inches, the command is ignored. This command should be placed at the beginning of a line and uses the lowercase letter "l", not the number one.

Horizontal tab

Format:

⟨HT⟩

Description:

Advances the print head to the next horizontal tab position. The default tab settings are every 8 characters.

Absolute horizontal tab

Format:

⟨ESC⟩ f CHR$(0) *n*

Description:

Moves the pen to column *n*, counting from the left margin and using the current character width (*n* can range from 1 to 137).

Set horizontal tabs

Format:

⟨ESC⟩ e CHR$(0) *n*

Description:

Sets horizontal tabs at every *n* character position of the current character width (*n* can range from 1 to 255).

Print Style Commands

Select elite width print

Format:
⟨ESC⟩ M

Description:
Selects elite width printing. Characters are printed with a height of 2.4 mm, a width of 1.5 mm, and a pitch of 2.0 mm. This command does not cancel condensed and expanded width printing. It does, however, cancel character size set by the ⟨GS⟩ H (set character height) and ⟨GS⟩ W (set character width) commands.

Cancel elite width print

Format:
⟨ESC⟩ P

Description:
Cancels elite width printing and returns to (normal) pica width printing. Characters are printed with a height of 2.4 mm, a width of 1.6 mm, and a pitch of 2.4 mm. This command does not cancel condensed and expanded width printing. It does, however, cancel character size set by the ⟨GS⟩ H (set character height) and ⟨GS⟩ W (set character width) commands.

Select one-line expanded width print

Format:
⟨SO⟩

Description:
Selects expanded (double-width) printing for the remainder of the current line (unless explicitly cancelled sooner). Characters are printed at twice the current width or twice the character size specified by the ⟨GS⟩ H (set character height) and ⟨GS⟩ W (set character width) commands.

Select one-line expanded width print

Format:

⟨ESC⟩ ⟨SO⟩

Description:

Selects expanded (double-width) printing for the remainder of the current line (unless explicitly cancelled sooner). This command is the same as ⟨SO⟩.

Cancel one-line expanded width print

Format:

⟨DC4⟩

Description:

Cancels one-line expanded (double-width) printing before the end of the line.

Expanded width print on/off

Format:

⟨ESC⟩ W *n*

Description:

Turns expanded (double width) printing on ($n = 1$) or turns expanded width printing off ($n = 0$). Characters are printed at twice the current width or twice the character size specified by the ⟨GS⟩ H (set character height) and ⟨GS⟩ W (set character width) commands.

Select compressed width print

Format:

⟨SI⟩

Description:

Selects compressed width printing. The characters printed are reduced to 7/12 of the current character width or the character size specified by the ⟨GS⟩ H (set character height) and ⟨GS⟩ W (set character width) commands.

Select compressed width print

Format:

⟨ESC⟩ ⟨SI⟩

Description:

Selects compressed width printing. This command is the same as ⟨SI⟩.

Cancel compressed width print

Format:

⟨DC2⟩

Description:

Cancels compressed width printing but does not cancel the commands ⟨GS⟩ H (set character height) and ⟨GS⟩ W (set character width).

Set character height

Format:

⟨GS⟩ H *n1* *n2*

Description:

Sets the character height. This command lets you set the character height in 0.1 mm units. The minimum height is 4 units and the maximum is the current height of the page.

When the character height is less than the minimum or greater than the maximum height, the command is ignored and the previous setting remains.

The value of the height in this command is stated as two ASCII codes ($n1$ and $n2$). The values, $n1$ and $n2$, are determined by the following formulas:

$$n1 = \text{INT}(n/256)$$
$$n2 = n \text{ MOD } 256$$

where n is the character height in 0.1 mm units.

Character height is determined from the values of $n1$ and $n2$ by the following formula:

$$\text{character height} = 0.1 \times (n1 \times 256 + n2) \text{ mm}$$

The maximum height values for *n1* and *n2* according to the size of the paper is shown in Table 13-1.

Table 13-1. Maximum height values of n1 *and* n2

Paper size	Portrait	*n1*	*n2*	Landscape	*n1*	*n2*
A4	2670	10	110	1920	7	128
US letter	2510	9	206	1920	7	128
B5	2270	8	222	1640	6	104

When the character height is selected, the pen moves down the paper to the character baseline. If the height is not specified correctly, rather than clipping the part of the character outside the effective drawing area, the HC100 will attempt to change the paper with a form feed. The following instances will cause this to happen:

1. The character height specified is greater than the height of the paper.
2. The printing direction is changed from the portrait to landscape position and the character height is too great to fit on the paper.
3. The character height is changed and the baseline position for the enlarged character is outside the effective drawing area because the pen was positioned part of the way down the paper.

In all these cases, you must reset the height of the characters.

This command does not change the character width and is not affected by the commands to select expanded width print, condensed width print or emphasized print.

Set character width

Format:

⟨GS⟩ W *n1* *n2*

Description:

Sets the character width. The minimum width is 4 units and the maximum is the width of the current margins.

When the character width is less than the minimum or greater than the maximum width, the command is ignored and the previous setting remains.

The value of the width in this command is stated as two ASCII codes ($n1$ and $n2$). The values, $n1$ and $n2$, are determined by the following formulas:

$$n1 = \text{INT}\ (n/256)$$
$$n2 = n\ \text{MOD}\ 256$$

where n is the character width in 0.1 mm units.

Character width is determined from the values of $n1$ and $n2$ by the following formula:

$$\text{character width} = 0.1 \times (n1 \times 256 + n2)\ \text{mm}$$

The maximum width values for $n1$ and $n2$ according to the size of the paper is shown in Table 13-2.

Table 13-2. Maximum width values of n1 and n2

Paper size	Portrait	*n1*	*n2*	Landscape	*n1*	*n2*
A4	1920	7	128	2670	10	110
US letter	1920	7	128	2510	9	206
B5	1640	6	104	2270	8	222

If the character width is not specified correctly, rather than clipping the part of the character outside the effective drawing area, the HC100 will attempt to change the paper with a form feed. The following instances cause this to happen:

1. The character width specified is greater than the width of the paper or of the current margins.
2. The margins are changed resulting in a character width that is greater than the margins set.
3. The printing direction is changed from the portrait to landscape position and the character width is too great to fit on the paper.

In all these cases, you must reset the width of the characters.

This command does not change the character width and is not affected by the commands to select expanded width print, condensed width print or emphasized print.

Select emphasized print

Format:

⟨ESC⟩ E

Description:

Selects emphasized printing. Characters are printed twice with a horizontal offset. This command does not affect character width or size.

Cancel emphasized print

Format:

⟨ESC⟩ F

Description:

Cancels emphasized printing.

Select double-strike print

Format:

⟨ESC⟩ G

Description:

Selects double-strike printing. Characters are printed twice with a vertical offset. This command does not affect character width or size.

Cancel double-strike print

Format:

⟨ESC⟩ H

Description:

Cancels double-strike printing.

Select italic print

Format:

<ESC> 4

Description:

Selects the italic character set and prints characters at a slant of 9 degrees. This command adds 9 degrees to a slant specified by the <GS> I command.

Cancel italic print

Format:

<ESC> 5

Description:

Cancels italic printing and returns printing to the normal character set.

Select italic print and define slant

Format:

<GS> I *n1* *n2*

Description:

Selects italic printing and defines the degree of slant that the characters will be printed. The angle of slant is calculated by:

$$\text{TAN}(angle) = n1 + n2/256$$

n1 and *n2* are determined by the following formulas:

$$n1 = \text{INT}(\text{TAN}(angle))$$
$$n2 = 256 * \text{TAN}(angle) \text{ MOD } 256$$

If $n1*256 + n2$ is greater than 512, the command is ignored.

This command adds to the slant produced by the <ESC> 4 command. This command is cancelled by setting *n1* and *n2* to 0.

Underline on/off

Format:

⟨ESC⟩ — n

Description:

Turns underlining on ($n = 1$) or turns underlining off ($n = 0$).

Select superscripts or subscripts

Format:

⟨ESC⟩ S n

Description:

Selects superscripts ($n = 0$) or selects subscripts ($n = 1$). Superscript and subscript characters are printed at half their normal height in either the upper half (superscript) or lower half (subscript) of the line.

Cancel superscripts and subscripts

Format:

⟨ESC⟩ T

Description:

Cancels superscripts and subscripts.

Character Set Commands

Select international character set

Format:

⟨ESC⟩ R *n*

Description:

Selects one of the 11 international character sets. Table 13-3 shows the valid values of *n* and the character sets selected for each. You must use the ASCII codes for 0 to 10, not the characters. Appendix A shows the characters that change in the international character sets.

Table 13-3. International character sets

n	Country
0	USA
1	France
2	Germany
3	England
4	Denmark
5	Sweden
6	Italy
7	Spain
8	Japan
9	Norway
10	Denmark II

Miscellaneous Commands

Backspace

Format:

⟨BS⟩

Description:

Moves the pen one character to the left. This allows you to overstrike characters.

Delete

Format:

⟨DEL⟩

Description:

Deletes the character immediately preceding it, unless the character has already been printed.

Initialize printer

Format:

⟨ESC⟩ @

Description:

Resets the printer to the power-on state but remains in the printer emulator command set.

Return pen to home position

Format:

⟨ESC⟩ ⟨

Description:

Returns the pen to the left margin of the same line.

Select printing direction

Format:

⟨GS⟩ D *n*

Description:

Sets the printing direction either across or down the paper.

If $n = 0$, the lines are printed as they normally would be in a document (in portrait position along the Y-axis with line feeds in the X direction).

If $n = 1$, lines are printed the long way as they would be on a normal graph (in landscape position along the X-axis with line feeds in the Y direction).

When the HC100 receives the command ⟨GS⟩ D 1, the paper is ejected and you are prompted (by a flashing ON LINE lamp) to insert a new sheet. Reload the paper, press the ON LINE switch, and the paper is moved showing the printing area. The pen position is then set at the top left hand corner for the landscape position.

Whenever this command is sent, all format commands are cleared to the default values for that direction of printing. Printing is done according to the window size. If a character would be printed outside the window, a carriage return is sent (to prevent clipping) and the character is printed on the next line.

Pen speed

Format:

⟨ESC⟩ s *n*

Description:

Sets the drawing speed of the pen to 230 mm/sec (n=0) or 100 mm/sec ($n = 1$).

Select pen

Format:

⟨GS⟩ C *n*

Description:

Selects a pen. When $n = 1, 2, 3$, or 4 the pen is selected according to the pen numbers marked on the pen cartridge.

If $n = 0$, the pens are stowed and capped. The value of n can also be 5, 6, 7, or 8 which are the same as 1, 2, 3, and 4, respectively. You must use the ASCII codes 0 to 8, not the characters.

If $n = 0$, the pens are capped which is the same as pressing the CAP/OFF key except that the ON LINE switch becomes inactive. Pressing the CAP/OFF key causes pen 1 to be selected and returned to the previous pen position.

If $n = 255$, the pens are also capped but any subsequent commands cause the pen to return to the previous pen position and continue. The CAP/OFF key does not have to be pressed.

Select plotter command set

Format:

⟨GS⟩ G

Description:

Selects one of the plotter command sets. If you used the CAP/OFF and POWER ON switches to select the printer command set, then the plotter command set is set according to DIP switches 4 and 5. If you used ⟨DC2⟩ (ASCII 18) to select the printer command set, the plotter command set is set to 0, regardless of the DIP switch settings.

The character print style and pen selection are not changed when the new command set is selected but all page formats (i.e. margins, line spacing, etc.) are cleared. The pen position is not changed. When printing a character, the pen position is left at the bottom right hand corner of the character.

Appendix A
HC100 Character Set

Standard Character Set

	8	P	h
!	9	Q	i
"	:	R	j
#	;	S	k
$	<	T	l
%	=	U	m
&	>	V	n
'	?	W	o
(	@	X	p
)	A	Y	q
*	B	Z	r
+	C	[	s
,	D	\	t
-	E	]	u
.	F	^	v
/	G	_	w
0	H	`	x
1	I	a	y
2	J	b	z
3	K	c	{
4	L	d	|
5	M	e	}
6	N	f	~
7	O	g	

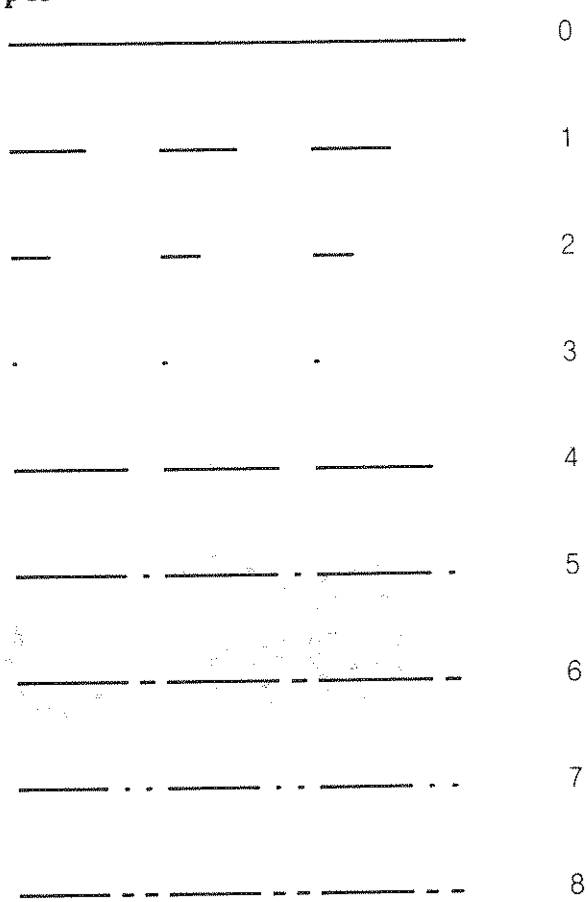
International Character Set

	ASCII CODE (decimal)											
	35	36	64	91	92	93	94	96	123	124	125	126
0 USA	#	$	@	[	\	]	^	`	{	¦	}	~
1 France	#	$	à	°	ç	§	^	`	é	ù	è	¨
2 Germany	#	$	§	Ä	Ö	Ü	^	`	ä	ö	ü	ß
3 England	£	$	@	[	\	]	^	`	{	¦	}	~
4 Denmark	#	$	@	Æ	Ø	Å	^	`	æ	ø	å	~
5 Sweden	#	¤	É	Ä	Ö	Å	Ü	é	ä	ö	å	ü
6 Italy	#	$	@	°	\	é	^	ù	à	ò	è	ì
7 Spain	₧	$	@	¡	Ñ	¿	^	`	¨	ñ	}	~
8 Japan	#	$	@	[	¥	]	^	`	{	¦	}	~
9 Norway	#	¤	É	Æ	Ø	Å	Ü	é	æ	ø	å	ü
10 Denmark II	#	$	É	Æ	Ø	Å	Ü	é	æ	ø	å	ü

Appendix B
Symbols and Line Styles

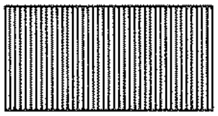
This appendix shows the various line types, symbols and types of hatching possible with the HC100.

Line Types

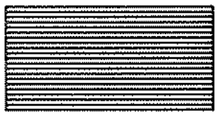


Hatch Types

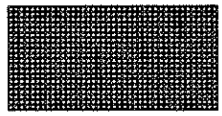
Hatch *type* 0



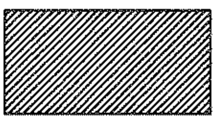
Hatch *type* 1



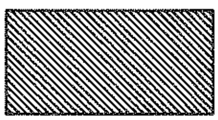
Hatch *type* 2



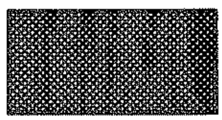
Hatch *type* 3



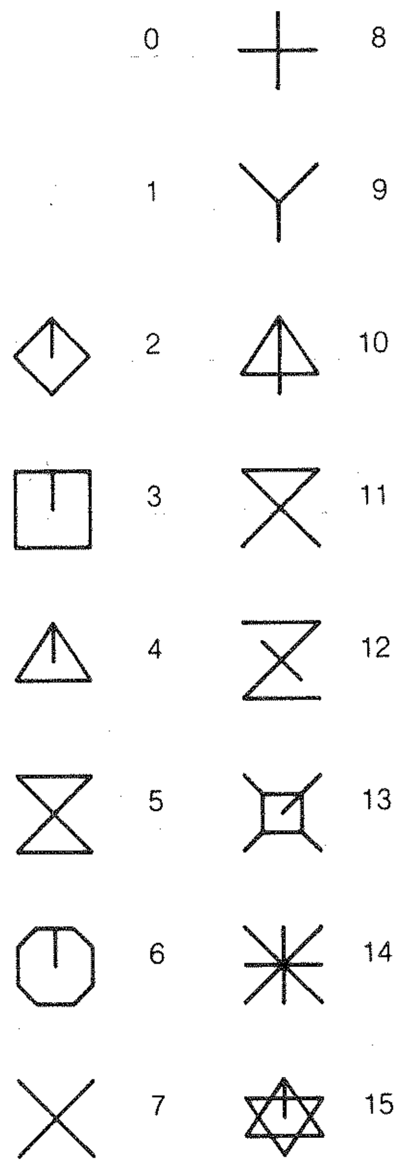
Hatch *type* 4



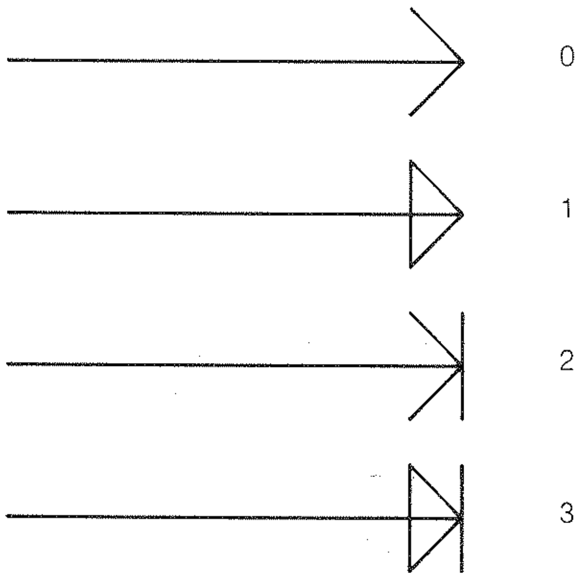
Hatch *type* 5



Mark Types



Arrow Types



Appendix C
Alphabetical List of Commands

Epson Plotting Commands

Command	Name	Page
AC	Alternate command set	158
AM	Absolute line and mark	101
AR	Arrow	146
AX	Axis	98
CA	Circle absolute	76
CH	Change paper	94
CI	Clear interface	88
CR	Circle relative	85
CS	Character set	132
DA	Draw absolute	73
DF	Default values	90
DI	Character direction	125
DR	Draw relative	82
EM	Character emphasis	128
GR	Grid	118
HB	Hatched bar	111
HO	Home pen	89
HP	Hatched pie	114
IF	Input factor	154
IM	Error control	162
IN	Initialize plotter	91
IW	Input window	152
LA	Label	122
LP	Line pitch	143
LT	Line type	140

MA	Move absolute	72
MR	Move relative	80
OR	Origin	150
RC	Reset characters	136
RM	Relative line and mark	104
SI	Character size	124
SL	Character slant	130
SP	Select pen	92
TL	Tick length	144
VA	Curve absolute	106
VO	Vertical offset	134
VR	Curve relative	108
VS	Pen speed	95
⟨DC2⟩ (ASCII 18)	Printer emulator	159

Graphtec Command Set

Command	Name	Page
A	Reset characters	195
AC	Alternate command set	204
B	Line pitch	201
D	Draw absolute	169
H	Home pen	177
I	Draw relative	173
J	Select pen	179
L	Line type	198
M	Move absolute	168
N	Mark	186
P	Label	190
Q	Character direction	193
R	Move relative	171
S	Character size	192
T	Pen speed	181
X	Axis	184
;	Clear interface	176
:	Default values	178

Appendix D
Epson Plotting Commands by Function

Absolute and Relative Commands

MA *x,y*	Move absolute
DA *x1,y1 [, x2,y2 ... , xn,yn]*	Draw absolute
CA *x,y, rad, start-angle, end-angle*	Circle absolute
MR *dx,dy*	Move relative
DR *dx1,dy1 [, dx2,dy2 ... , dxn,dyn]*	Draw relative
CR *rad, start-angle, end-angle*	Circle relative

Miscellaneous Commands

CI	Clear interface
HO	Home pen
DF	Default values
IN	Initialize plotter
SP *pen-num*	Select pen
CH	Change paper
VS *speed*	Pen speed

Plotting Commands

AX *dir, len, div, scale-mark [, start-num, end-num, num-space, num-dir]*	Axis
AM *style, x1,y1 [, x2,y2, ... , xn,yn]*	Absolute line and mark
RM *style, dx1,dy1 [, dx2,dy2, ... , dxn,dyn]*	Relative line and mark
VA *type, x1,y1, x2,y2 , x3,y3 [, ... , xn,yn]*	Curve absolute
VR *type, dx1,dy1, dx2,dy2 , x3,y3 [, ... , dxn,dyn]*	Curve relative
HB *type, x-len, y-len, pitch, style*	Hatched bar
HP *type, x,y, rad, start-angle, end-angle, pitch, style [, inner-rad]*	Hatched pie
GR *x-unit, x-num, y-unit, y-num*	Grid

Labels

LA *text-string*	Label
SI *height, width*	Character size
DI *angle* -or- DI *run, rise*	Character direction
EM *style*	Character emphasis
SL *value*	Character slant
CS *set-num*	Character set
VO *offset*	Vertical offset
RC	Reset characters

Formats and Line Types

LT *style*	Line type
LP *pitch*	Line pitch
TL *pos-len, neg-len*	Tick length
AR *style, head-len, head-ang, dx,dy, dir*	Arrow

Positioning and Scaling

OR	Origin
IW *size* - or - IW *x-min,y-min, x-max,y-max*	Input window
IF *numerator, denominator*	Input factor

Changing Command Sets

AC *set*	Alternate command set
⟨DC2⟩ (which is ASCII 18)	Printer emulator

Error Handling

IM *type, action*	Error control

Appendix E
Default Parameter Settings

The default parameters for the Epson plotter command set are shown in Table E-1.

Table E-1. Epson plotter default parameters

Command		Default value
Character set	CS	Set 0 (USA)
Character size	SI	24 x 24
Vertical offset	VO	0
Character direction	DI	0°
Character slant	SL	0
Character emphasis	EM	0 (no emphasis)
Line type	LT	0 (solid)
Line pitch	LP	60
Input window	IW	max size
Input factor	IF	1:1
Pen speed	VS	0 (high speed)
Tick length	TL	10 x 10
Select pen	SP	1
Error control	IM	31,1 (stop on all errors)

The default parameters for the Graphtec plotter command set are shown in Table E-2.

Table E-2. Graphtec plotter default parameters

Command		Default value
Character size	S	2.4 mm x 2.4 mm
Character direction	Q	0°
Line type	L	0 (solid)
Line pitch	B	6.0 mm
Pen speed	T	0 (high speed)
Select pen	J	1

The default parameters for the printer emulator command set are shown in Table E-3.

Table E-3. Printer emulator default parameters

Parameter	Default value
Print direction	+ Y (portrait)
Starting print position	24,0
Line spacing	4.2 mm in X direction (set automatically by character height)
Page length	A4 — 267 mm (64 lines) US — 251 mm (60 lines) B5 — 227 mm (54 lines)
Print columns	A4 — 192 mm (80 columns) US — 192 mm (80 columns) B5 — 164 mm (68 columns)
Character size	2.4 mm x 2.4 mm (normal)
Select pen	1

Appendix F
Parameters Affecting Other Commands

There are some plotter commands that affect the parameters and attributes of other commands within the two plotter command sets.

Table F-1 shows the commands affected in the Epson plotter command set.

Table F-1. Epson plotter command set

Command	Commands Affected
CS	LA
SI	LA, AM, AX, RM
VO	LA
DI	LA, AM, RM
SL	LA
EM	LA, AX
RC	LA, AX, AM, RM
LT	DA, DR, CA, CR, VA, VR, GR, HB, HP, AM, RM
LP	DA, DR, CA, CR, VA, VR, GR, AM, RM, HB, HP
IF	DA, DR, MA, MR, LA, AM, CA, CR, VA, VR, AX, GR, HB, HP, AR
OR	DA, MA, CA, VA, HP, AM
VS	DA, DR, LA, CA, CR, VA, VR, AX, GR, HB, HP, AM, AR
TL	AX
SP	DA, DR, LA, CA, CR, VA, VR, AX, GR, HB, HP, AM, RM, AR

Table F-2 shows the commands affected in the Graphtec plotter command set.

Table F-2. Graphtec plotter command set

Command	Commands Affected
S	P, N
Q	P, N
L	D, I
B	D, I
T	D, I, P, N, X
J	D, I, P, N, X

Appendix G
Switching Command Sets and Parameter Changes

Most parameters are not changed when the HC100 is switched between plotter and printer command sets under software control. Thus it is possible to switch back and forth without changing the parameters. Some parameters can be changed in both command sets. When changing from plotter to printer command sets, however, the printer format commands (tabs, margins, etc.) are all reset and previously defined values are lost.

Table G-1 shows which parameters are changed when the command set is changed in the printer and plotter command sets.

Table G-1. Commands and parameters changed

Command	Plotter to printer	Printer to plotter	Changeable in printer mode	Changeable in plotter mode
CS	No	No	Yes	Yes
SI	No	No	Yes	Yes
VO	0	No	Yes	Yes
DI	0 or 900	No	Yes	Yes
SL	No	No	Yes	Yes
EM	No	No	Yes	Yes
LT	No	No	No	Yes
LP	No	No	No	Yes
IW	No	No	No	Yes
IF	1:1	No	No	Yes
VS	No	No	Yes	Yes
TL	No	No	No	Yes
SP	No	No	Yes	Yes
IM	No	No	No	Yes

The parameter for the direction (DI) command is 0 in the portrait position, and 900 in the landscape position.

Appendix H
Error Handling Procedures

When the HC100 encounters an error in a command, it stops and lights the ERROR indicator. This can make it difficult to find the error in your programs because it is not always clear which command is in error. You can make the HC100 report which command caused an error and also how to make it continue plotting after the error occurs.

Types of Plotting Errors

Command error:

You have used a command that the HC100 does not recognize. Check the two-letter command to be sure it is correct. For example, using CD for character direction results in this error because the proper command is DI.

Parameter range error:

You have used a parameter that is outside the allowable range. For example, the command DA 500, 25000 results in this error because 25000 is greater than the allowable range of 16383.

Missing parameter error:

You have not supplied enough parameters for the command. For example, the command CR 200, 90 results in this error because the parameter for the *end-angle* is missing.

Delimiter error:

You have used the wrong delimiter between parameters. Delimiters can only be commas and spaces. A delimiter error may occur as the result of the BASIC language outputting a number in scientific notation, such as 3.45678E04. The "E" causes this error (and the number is misinterpreted by the HC100). You can use a PRINT USING statement to be sure that BASIC outputs numbers in the proper format.

Overflow error:

The results of a calculation have exceeded the allowable range (−32768 to +32767). This is usually the result of using relative commands that would move the pen outside of the allowable range. It also occurs if you attempt to divide by zero in a command like IF 1, 0.

Locating Plotting Errors

There are two methods for finding errors with the HC100:

1. Use the error reporting facilities of the HC100.
2. Switch the HC100 into the printer command set and read what the plotter is receiving from the computer.

Method 1: Using the HC100 Error Control (IM) Command

HC100 can report errors with the *error control* (IM) command which selects the kinds of errors to report and how to report them. The format is:

IM *type, action*

The parameter *type* specifies which of the five error types are to be reported. Each of the five error types has a value as shown in Table H-1. The parameter *type* is the sum of the values of all the error types that you want to include. The most common value for *type* is 31, which is the sum of all five error types.

Table H-1. Error type values

Error	type
Command error	1
Parameter range error	2
Missing parameter error	4
Delimiter error	8
Overflow error	16

Error types not included in the parameter *type* are ignored. That is, the command that contains the error is not executed, and the plotter moves on to the following command.

The parameter *action* specifies what kind of action the HC100 is to take when it encounters an error. Table H-2 lists the possible values of *action*.

Table H-2. Error actions with values of action

action	Error description
0 or 8	The ERROR indicator is lit. The command containing the error is skipped and execution continues with the next command. The ERROR indicator remains lit until cleared by an error releasing command.
1 or 9	The ERROR indicator is lit, execution halts, and all commands are ignored until an error releasing command is received. (This is the default state.)
2 or 10	The ERROR indicator is lit. The error type and first ten characters of the command containing the error are printed in the lower left of the drawing area. The command containing the error is skipped and execution continues with the next command. The ERROR indicator remains lit until cleared by an error releasing command.
3 or 11	The ERROR indicator is lit. The error type and first ten characters of the command containing the error are printed in the lower left of the drawing area. Execution halts, and all commands are ignored until an error releasing command is received.

If you use a value of *action* between 8 and 11, then the error signal on the parallel interface is also set to LOW when an error is encountered. Nothing happens if a serial interface is used.

Figure H-1 shows how the HC100 prints errors in the lower left of the drawing area. If you have more than one error, the error messages print on top of each other.

```
PARAMETER INSUFFICIENT ERROR!! CMD:hb 0, 200,
```

Figure H-1. A typical error message

Method 2: Using the printer command set

Many errors are caused by the plotter not receiving the same thing that (you think) your program sends. For example, if you are trying to send a command to the plotter that is more than 80 characters long, then most BASICs insert a carriage return and a line feed after the first 80 characters.

This looks like two commands to the HC100; and the second one is probably not a valid command since it doesn't start with a two letter command. The plotter, therefore, tries to execute the first part of the command, and may in fact succeed. Then it encounters the second part of the original command, the ERROR indicator lights, and the plotter freezes.

By switching the plotter to the printer command set, HC100 prints out all the plotting commands in text. This lets you compare what the plotter is receiving to what you expect your program to send. To switch to the printer command set, turn the plotter on while you hold down the CAP/OFF switch. The plotter stays in the printer command set until you turn it off and back on again (unless you give it the software command to change to the plotter command set).

Figure H-2 shows an example of plotter commands that have been printed on the plotter using the printer command set.

With most versions of BASIC you can use a statement like the one below to prevent BASIC from inserting a carriage return and a line feed every 80 characters.

```
100 WIDTH "LPT1:", 255
```

or

```
100 WIDTH LPRINT 255
```

Check the BASIC manual for your computer to see which form of this command you should use.

```
CI
MA 1255, 960
OR
IF 2, 3
HB 2, 400, 200, 9, 3
DF
CH
```

Figure H-2. Plotting commands printed on the plotter

Appendix I
Specifications of the Tektronix HC100

Drawing

Effective drawing area	10.50 in (267 mm) along X-axis 7.56 in (192 mm) along Y-axis
Maximum drawing speed	9 in (230 mm)/sec along pen axis
Maximum resolution	0.004 in (0.1 mm)
Pen response speed	15 times/sec
Pen movement precision	Better than 0.012 in (0.3 mm) for a single pen Better than 0.020 in (0.5 mm) for different pens
Pen change precision	Within 0.012 in (0.3 mm)
Pen-up time	2 seconds during operation
Drawing modes	Self test Epson plotter Graphtec emulator Epson RX-80 printer mode
Character Types	96 ASCII characters 32 International characters (for 11 countries)

Pen Selection

Pen types	Water-based ball-point (10 colors) Water-based fiber-tipped (10 colors) Oil-based fiber-tipped (10 colors)
Pen colors	Standard: black, red, green, and blue Optional: yellow, cyan, magenta, brown, purple, and orange

Paper Selection

Paper sizes	US letter (8½ x 11 in) (279 mm x 216 mm) ISO A4 (11⅝ x 8¼ in) (297 mm x 210 mm) B5 (10⅛ x 7$^{3}/_{16}$ in) (257 mm x 182 mm)
Paper types	Standard paper Clear acetate film Adhesive drafting film

Plotter

Dimensions	Height: 3.19 in (81 mm) Width: 16.34 in (415 mm) Depth: 10.71 in (272 mm)
Weight	9.9 lb (4.5 kg)
Number of pens	4 (in removable cassette)
Power required	Voltage: 108 to 132 VAC Frequency: 49.5 to 60.5 Hz Power Consumption: 30 VA maximum
Temperature ranges	5° to 35°C, operating −30° to 70°C, stored
Humidity	10 to 80%, non-condensing
Plotter MTBF	1000 hours (50% duty ratio), pens excluded

Pen drawing life	Approx. 650 ft (200 mm) (water-based fiber-tipped) Approx. 1300 ft (400 mm) (oil-based fiber-tipped) Approx. 1300 ft (400 mm) (water-based ballpoint)

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Options and Replaceable Parts

Options

The HC100 may be purchased configured in any of the following options:

Option 01	HC100 with 1-meter GPIB cable.
Option 02	HC100 with 9-ft sub-miniature D to Centronix cable.

Power Cord Options

Standard	North American 120V
Option A1	Universal Euro 240V
Option A2	United Kingdom 240V
Option A3	Australian 240V
Option A4	North American 240V
Option A5	Switzerland 220V

Standard Accessories

Tek Part No.	Description
070-6441-00	Instruction Manual

Optional Accessories

The following optional accessories may be ordered separately:

Tek Part No.	Description
012-0991-01	1-meter GPIB cable (same as in Option 01 above)
012-1250-00	9-ft sub-miniature D to Centronix cable (same as in Option 02 above)
161-0066-09	Universal Euro 240V power cord (same as in Option A1 above)
161-0210-00	United Kingdom 240V power cord (same as in Option A2 above)
161-0066-11	Australian 240V power cord (same as in Option A3 above)
161-0066-12	North American 240V power cord (same as in Option A4 above)
161-0154-00	Switzerland 220V power cord (same as in Option A5 above)

Supplies

The following supplies are available from Tektronix:

Tek Part No.	Description
016-0876-00	HC100 PEN CASSETTE
016-0877-00	HC100 BALL POINT PENS (PKG OF 4 COLORS: BLACK, RED, GREEN, BLUE)
016-0878-00	HC100 OIL BASE PENS (PKG OF 4 COLORS: BLACK, RED, GREEN, BLUE)
016-0879-00	HC100 WATER BASE PENS (PKG OF 4 COLORS: BLACK, RED, GREEN, BLUE)

Replaceable Parts

At this time, Tektronix does not recommend or support component-level replacement of parts on the HC100. If your HC100 requires service, contact your local Tektronix Field Office for maintenance or exchange.

The following parts may be subject to wear and tear and are offered as customer replaceable parts:

Tek Part No.	Description
118-6681-00	Smoked plastic cover (see Figure 1-2 in the User's Section).
118-6685-00	Paper support (see Figure 1-4 in the User's Section).

Contents

APPENDIXES

The HP-GL Emulation Command Set

The HC100 comes standard with an HP-GL (Hewlett-Packard Graphics Language) emulation command set. This gives the user a forth complete command set in addition to the other three described earlier in this manual. The HP-GL emulation command set makes the HC100 operational characteristics compatible with the HP plotter (HP 7470). Applications software containing drivers for these plotters can be used with the HC100 when it is in this mode.

NOTE: When in the HP-GL mode, the self-test (as described in Chapter 2 in the Users's Section) will generate a different plot than the one pictured in Chapter 2. The HP-GL self-test plot will have a different diagram and will include the heading, "HP-GL Emulation ROM" with the installed version number.

Setting The Command Set

To put the HC100 into HP-GL mode, refer to Appendix C in the User's Section of this manual. The emulation command set resides in the "ROM Option" selection (DIP Switch 4 located on the main board) given in Table C-1, DIP Switch Settings. Switch 4 must be in the ON position to be in HP-GL mode. When the HC100 is shipped from Tektronix, it is set in the HP-GL mode (Switch 4 ON).

NOTE: When changing switch settings, make sure to turn the plotter off. The changes to the settings come into effect only when the plotter is next turned on.

The GPIB Interface

Ten of the HP-GL commands (the Output commands, OA through OW) require answering codes from the plotter. Although most of the HP-GL command set can be used with the parallel interface, these particular commands cannot be used. The HC100 comes with an additional bidirectional interface, the GPIB interface, which allows the use of these output commands. The GPIB interface also allows the HC100 to be connected to devices, such as oscilloscopes and spectrum analyzers, which have a GPIB port.

The GPIB port has its own set of DIP switches to control its configuration. These switches are located next to the GPIB port on the back panel and are easily accessed without opening the plotter case.

The first two switches control the port and command mode selection, switch 3 is used in special configurations, and the last five switches (4 through 8) control the GPIB address for the plotter. Refer to Tables 1 and 2.

Table 1. GPIB Interface Board Switches

Switch	Function	When OFF	When ON	As Shipped
1	Interface	Parallel Port	GPIB	ON
2	Command mode	Other	HP-GL	ON
3	Special config	Standard	Special	OFF
4	Address	0	16	OFF
5	Address	0	8	OFF
6	Address	0	4	OFF
7	Address	0	2	OFF
8	Address	0	1	OFF

Table 2. Address Assignments (Switches 4 Through 8)

Address Characters		Address Switch Settings	Address Codes	
Listen	**Talk**	**16 8 4 2 1**	**Decimal**	**Octal**
SP	@	0 0 0 0 0	0	0
!	A	0 0 0 0 1	1	1
"	B	0 0 0 1 0	2	2
#	C	0 0 0 1 1	3	3
$	D	0 0 1 0 0	4	4
%	E	0 0 1 0 1	5	5
&	F	0 0 1 1 0	6	6
'	G	0 0 1 1 1	7	7
(	H	0 1 0 0 0	8	10
)	I	0 1 0 0 1	9	11
*	J	0 1 0 1 0	10	12
+	K	0 1 0 1 1	11	13
,	L	0 1 1 0 0	12	14
-	M	0 1 1 0 1	13	15
.	N	0 1 1 1 0	14	16
/	O	0 1 1 1 1	15	17
0	P	1 0 0 0 0	16	20
1	Q	1 0 0 0 1	17	21
2	R	1 0 0 1 0	18	22
3	S	1 0 0 1 1	19	23
4	T	1 0 1 0 0	20	24
5	U	1 0 1 0 1	21	25
6	V	1 0 1 1 0	22	26
7	W	1 0 1 1 1	23	27
8	X	1 1 0 0 0	24	30
9	Y	1 1 0 0 1	25	31
:	Z	1 1 0 1 0	26	32
;	[	1 1 0 1 1	27	33
<	\	1 1 1 0 0	28	34
=	]	1 1 1 0 1	29	35
>		1 1 1 1 0	30	36
?	_	1 1 1 1 1	31	37

Connecting To The Host Machine

When connecting the HC100 to a host machine such as a computer, use a properly shielded GPIB cable. Use of a non-shielded cable may produce unpredictable results.

Differences Of Features

Due to the differences between the HP 7470 plotter and the HC100, there are several important differences between the HP-GL command set and the HP-GL emulation as implemented on this plotter.

Functional Precision

Because the mechanical precision of the HP 7470 is 0.025 mm and that of the HC100 is 0.1 mm, drawings produced on the HC100 are not quite as precise. Coordinate values, however, are calculated using 0.025-mm units. The HC100 then uses these calculations to draw in 0.1-mm increments with the result that little or no noticeable plotting inaccuracies accumulate.

The HC100's control panel switches which manually control pen movement also move in 0.1-mm increments. When the digitizing function is used to read coordinates from a graphic design, these coordinate values are converted to 0.1-mm units. Thus, the digitizing accuracy will also be slightly less than that of the HP 7470.

Number of Pens

The HP 7470 plotter is designed to draw with pens selected from two carriage holders via the Pen Select command. Using any even-numbered value (except 0) designates the right pen, and any odd-numbered value selects the left pen. The 0-value returns the pens to their storage position. With the HC100, numbers 1 through 4 are used with the Pen Select command to designate which of the four pens is desired. As with the HP 7470, a value of 0 returns the pens to storage.

Pen Velocity

The HP 7470 has a Velocity Select command which is used with the following values to set the pen speed:

0	0.38 cm/sec
1 to 38.1	Specified value (cm/sec)
38.1 to 127.9999	38.1 cm/sec

The HC100 has two different pen speeds that are selected by the following velocity select parameters:

0 to 19.9999	low speed (10 cm/sec)
20 to 127.9999	high speed (23 cm/sec)

Control Panel Switches

When using the HC100 in its HP-GL emulation mode, the switch functions on the control panel are different than normal to more closely match the HP 7470.

ON/OFF: This is equivalent to the HP 7470 ENTER key. This switch is used for scale point setting and digitizing. Also, this switch is used as a "shift" key to change the function of the position keys. When this key is held down, pressing the up position key will toggle the pen up and down, pressing the left position key will change the pen in a 1,2,3,4,1,... sequence, pressing the right position key will toggle between draft and letter quality, and pressing the down position key will initialize the plotter.

UP/DOWN: This is equivalent to the HP 7470 P1 key. When this switch is pressed, the pen rises to shift to P1 coordinates on a form. The P1 coordinates can be set to the current position by pressing this switch and the ON/OFF switch at the same time.

CAP/OFF: This is equivalent to the HP 7470 P2 key. When this switch is pressed, the pen rises to shift to P2 coordinates on a form. The P2 coordinates can be set to the current position by pressing this switch and the ON/OFF switch at the same time.

POSITION KEYS: These keys move the pen in the direction indicated. Pushing two adjoining keys will move the pen along the diagonal. The pen will move in 0.1-mm steps if a direction key is pressed once. If the key is held down for more than about 1 second, the pen will move along at about 100 mm/sec. The position keys are also used in conjunction with the ON/OFF key (as explained above).

Command Summary

The following is a brief description of the complete list of HP-GL commands as they are implemented in the HC100 emulation. For a complete description, refer to the section following this one.

Instruction	Description
AA X, Y, arc angle (,chord angle)	Arc absolute
AR X, Y, arc angle (,chord angle)	Arc relative
CA n	Designate an alternate set n
CI radius (,chord angle)	Circle
CP space, lines	Character plot
CS m	Designate standard set m
DC	Digitize clear
DF	Set default value
DI run, rise	Absolute direction
DP	Digitize point
DR run, rise	Relative direction
DT c	Define label terminator
IM e (,s (,p))	Input e, s and p masks
IN	Initialize
IP P1x, P1y (,P2x, P2y)	Input P1 and P2
IW Xlo, Ylo, Xhi, Yhi	Input window
LB c.....c	Label ASCII string
LT t(,1)	Designate line type and length
OA	Output actual position and pen status
OC	Output commanded position and pen status
OD	Output digitized point and pen status
OE	Output error
OF	Output factors
OI	Output identification
OO	Output options
OP	Output P1 and P2
OS	Output status
OW	Output window
PA x,y (,x,y(,..))	Plot absolute
PD (x,y(,..))	Pen down
PR x,y (,x,y(,..))	Plot relative
PU (x,y(,..))	Pen up
SA	Select alternate character set
SC Xmin, Xmax, Ymin, Ymax	Scale
SI width, height	Absolute character size
SL tan	Absolute character slant from vertical
SM c	Symbol mode c
SP n	Select pen
SR width, height	Relative character size
SS	Select standard character set
TL tp (,tn)	Tick length
UC (pen,)x,y,pen(,...)	User defined character
VS v	Select velocity v
XT	X-axis tick
YT	Y-axis tick

HP-GL Emulation Commands

Arc Absolute

Function:

Draws an arc of a specified number of degrees with a specified smoothness. Using the current pen status (either up or down), the arc is centered at the x,y coordinate.

Format:

AA *x-coordinate,y-coordinate,arc angle[,chord angle][terminator]*

Parameters:

The parameters *x-coordinate* and *y-coordinate* specify plotter units in integer, unless scaling is in effect; then in user units.

The parameter *arc angle* (integer) specifies degrees. A negative value specifies clockwise, a positive value specifies counterclockwise (anticlockwise).

The parameter *chord angle* (integer) defines the arc smoothness in degrees. The default is 5 degrees.

Arc Relative

Function:

Draws an arc of a specified number of degrees with a specified smoothness. Using the current pen status (either up or down), the arc is centered relative to the current pen position.

Format:

AR *x-increment,y-increment,arc angle[,chord angle][terminator]*

Parameters:

The parameters *x-increment* and *y-increment* specify plotter units in integer, unless scaling is in effect; then in user units.

The parameter *arc angle* (integer) specifies degrees. A negative value specifies clockwise, a positive value specifies counterclockwise (anticlockwise).

The parameter *chord angle* (integer) defines the arc smoothness in degrees. The default is 5 degrees.

Designate Alternative Character Set

Function:

Designates one of the five character sets (0 to 4) as the alternate character set.

Format:

CA *character set number[terminator]*

or

CA*[terminator]*

Parameter:

The parameter *character set number* is an integer from 0 to 4, inclusive.

Circle

Function:

Draws a circle of the specified radius centered at the current pen position.

Format:

CI *radius[,chord angle][terminator]*

Parameters:

The parameter *radius* (integer) specifies the radius in plotter units unless scaling is in effect, otherwise in user units. The starting point is 0 degrees with a positive parameter and 180 degrees with a negative parameter.

The parameter *chord angle* (integer) defines the circle smoothness in degrees. The default is 5 degrees.

Character Plot

Function:

Moves the pen a specified number of character-space fields.

Format:

CP *spaces,lines[terminator]*

or

CP*[terminator]*

Parameters:

The parameters are given as decimal numbers in the range –128 to 127.9999.

Designate Standard Character Set

Function:

Designates one of the five character sets (0 to 4) as the standard character set.

Format:

CS *character set number[terminator]*

or

CS*[terminator]*

Parameter:

The parameter *character set number* is an integer from 0 to 4, inclusive.

Digitize Clear

Function:

Terminates digitize mode.

Format:

DC*[terminator]*

Parameters:

No parameters are required.

Default Values

Function:

Returns the plotter to its default conditions. (For these conditions, refer to Appendix A.)

Format:

DF*[terminator]*

Parameters:

No parameters are required.

Absolute Direction

Function:

Specifies the direction in which characters are printed. The rise/run ratio specifies the tangent of the angle of inclination of the character.

Format:

DI *run,rise[terminator]*

Parameters:

The parameters *run* and *rise* are given as decimal numbers in the range of –127.9999 to 127.9999.

Digitize Character Point

Function:
Sets the plotter to digitize mode.

Format:
DP*[terminator]*

Parameters:
No parameters are required.

Relative Direction

Function:

Specifies the direction in which characters are printed relative to the P1, P2 settings.

Format:

DR *run,rise[terminator]*

or

DR*[terminator]*

Parameters:

The parameters *run* and *rise* are specified as decimal numbers in the range –127.9999 to 127.9999. The *run* parameter is the percentage of the difference between P1 and P2 in the x-coordinate direction and the *rise* parameter is the percentage in the y-coordinate direction.

Define Terminator

Function:

Specifies the character to be used as the label terminator.

Format:

DT *t[terminator]*

Parameters:

The parameter *t* is the character to be used as the label terminator, given as an ASCII code from 1 to 127.

Input Mask

Function:

Sets the mask to specify which errors will cause the error LED to light up and bit 5 of the status byte to be set.

Format:

IM *E-mask value[terminator]*

or

IM*[terminator]*

Parameters:

The parameter *E-mask value* is given as an integer in the range 0 to 255. If no parameter is given, the mask is set to the default value of 233.

The E-mask bit-values and their meanings are as follows:

Table 3. E-mask bit values and meanings.

E-mask Bit Value	Bit	Error No.	Meaning
1	0	1	Command not recognized.
2	1	2	Wrong number of parameters.
4	2	3	Out-of-bounds parameters, illegal character.
8	3	4	Not used.
16	4	5	Unknown character set.
32	5	6	Position overflow.
64	6	7	Not used.
128	7	8	Not used.

Initialize

Function:

Sets the plotter to its default conditions (See Appendix B) in addition to raising the pen, setting the scaling points to P1 = 250,279 and P2 = 10250,7479, clearing all errors, setting bit 3 of the output status (to "1"), and reading the setting of the paper size switch.

Format:

IN*[terminator]*

Parameters:

No parameters are required.

Input P1 and P2

Function:

Sets scaling points P1 and P2.

Format:

IP *$P1_x$,$P1_y$,$P2_x$,$P2_y$[terminator]*

or

IP*[terminator]*

Parameters:

The coordinates are given as integers in plotter units within a range of –32768 to 32767. If the parameters are omitted, P1 and P2 are set to the default values (see *Initialize*). Negative P1 and P2 values will cause the scaling points to be set to 0.

Input Window

Function:

Restricts the programmed pen motion to a rectangular area of the plotting surface known as a "window."

Format:

IW $x_{lower\ left}, y_{lower\ left}, x_{upper\ right}, y_{upper\ right}$ *[terminator]*

or

IW*[terminator]*

Parameters:

The coordinates are given as integers in plotter units from –32768 to 32767.

Label

Function:
Prints text, expressions, or string variables using the currently defined character set.

Format:
LB *c. . .c t*

Parameters:
No parameters are required. "*t*" is the designated label terminator.

Line Type

Function:
Specifies the type of line (solid, broken, etc.) to be used with the PA and PR commands.

Format:
LT *pattern number [,pattern length][terminator]*

Parameters:
The parameter *pattern number* is a number from 0 to 6. The parameter *pattern length* is a number from 0 to 127.999.

Output Actual Position and Pen Status

Function:

Outputs the x and y coordinates and pen up/down status associated with the actual pen position.

Format:

OA*[terminator]*

Output:

X,Y,P[TERM]

where:
X is the x-coordinate of the digitized point
Y is the y-coordinate of the digitized point
P is the pen up/down status (1 = up; 0 = down)
[TERM] is the output terminator

Output Command Position and Pen Status

Function:

Outputs the *x* and *y* coordinates and pen up/down status associated with the last pen position command.

Format:

OC*[terminator]*

Output:

X,Y,P[TERM]

where:
X is the x-coordinate in plotter or user units
Y is the y-coordinate in plotter or user units
P is the pen up/down status (1 = up; 0 = down)
[TERM] is the output terminator

Output Digitized Point

Function:

Outputs the x and y coordinates and pen up/down status associated with the last point digitized using the DP command.

Format:

OD*[terminator]*

Output:

X,Y,P[TERM]

where:
X is the x-coordinate of the digitized point
Y is the y-coordinate of the digitized point
P is the pen up/down status (1 = up; 0 = down)
[TERM] is the output terminator

Output Error

Function:
Outputs the decimal equivalent of the last error (if any).

Format:
OE*[terminator]*

Output:
Error number[TERM]

The error number is defined as follows:

Table 4. Error number definitions.

Error No.	Meaning
0	No error.
1	Command not recognized.
2	Wrong number of parameters.
3	Out-of-bounds parameter, illegal character.
4	Not used.
5	Unknown character set.
6	Position overflow.
7	Not used.
8	Not used.

Output Factors

Function:

Outputs the number of plotter units per millimeter.

Format:

OF*[terminator]*

Output:

40,40[TERM]

Output Identification

Function:
Outputs a plotter identifier (ID code).

Format:
OI*[terminator]*

Output:
7470 A[TERM]

Output Options

Function:
Outputs eight option parameters.

Format:
OO*[terminator]*

Output:
0,1,0,0,1,0,0,0[TERM]

where:
The first "1" indicates that pen select capability is included in the plotter and the second "1" indicates that the circle and arc plotting capability is included.

Output P1, P2

Function:

Outputs the plotter unit coordinates of scaling points P1 and P2.

Format:

OP*[terminator]*

Output:

$P1_x, P1_y, P2_x, P2_y$[TERM]—four integers in ASCII code.

Output Status

Function:

Outputs the value of the plotter status byte.

Format:

OS*[terminator]*

Output:

Status[TERM]

This output is in ASCII and represents the following:

Table 5. Status byte definitions.

Bit Value	Bit No.	Meaning
1	0	Pen down.
2	1	P1 or P2 changed.
4	2	Digitized point available.
8	3	Initialized.
16	4	Ready for data.
32	5	Error.
64	6	Not used.
128	7	Not used.

Output Window

Function:

Outputs the *x* and *y* coordinates of the lower-left and upper-right corners of the area in which plotting can currently take place.

Format:

OW*[terminator]*

Output:

The output is in plotter units in the form of four integers in ASCII code in the following form: $x_{lower\ left}, y_{lower\ left}, x_{upper\ right}, y_{upper\ right}$*[TERM]*

Plot Absolute

Function:

Moves the pen to the point or points specified by the x and y coordinates.

Format:

PA x_1,y_1*[, . . . ,*x_n,y_n*][terminator]*

or

PA*[terminator]*

Parameters:

The coordinates are numbers in a range of –32768.0000 to 32767.9999. When scaling is off, parameters are truncated to integers.

Pen Down

Function:
Lowers the pen and moves it to a new position if coordinates are given.

Format:
PD*[terminator]*

or

PD $x_1y_1[x_2,y_2 \ldots x_n,y_n]$*[terminator]*

Parameters:
The coordinates are numbers in a range of –32768.0000 to 32767.9999.

Plot Relative

Function:

Moves the pen relative to its current location by the number of units specified by the *x*- and *y*-increment parameters.

Format:

PR x_1,y_1*[, . . . ,*x_n,y_n*][terminator]*

or

PR*[terminator]*

Parameters:

The coordinates are numbers in a range of –32768.0000 to 32767.9999.

Pen Up

Function:

Raises the pen and moves it to a new position if coordinates are given.

Format:

PU $x_1,y_1[x_2,y_2, \ldots ,x_n,y_n]$*[terminator]*

or

PU*[terminator]*

Parameters:

The coordinates are numbers in a range of –32768.0000 to 32767.9999.

Select Alternative Character Set

Function:

Selects the alternate set designated by the most recent CA command in order to print non-standard characters.

Format:

SA*[terminator]*

Parameters:

No parameters are required.

Scale

Function:

Scales the plotting area into user units.

Format:

SC x_{min},x_{max},y_{min},y_{max}*[terminator]*

or

SC*[terminator]*

Parameters:

The coordinates are numbers from –32768.000 to 32767.999.

Absolute Character Size

Function:

Specifies the size of characters and symbols in centimeters.

Format:

SI *width,height[terminator]*

or

SI*[terminator]*

Parameters:

The parameters *width* and *height* are given as decimal numbers in the range of –128 to 127.9999.

Slant Character

Function:

Specifies the slant used for character lettering.

Format:

SL *tanθ[terminator]*

or

SL*[terminator]*

Parameters:

The parameter *tanθ* is given as a decimal number in the range of –128 to 127.9999.

Symbol Mode

Function:

When used with the PA or PR command, this command makes it possible to draw a single character centered at the end of each vector.

Format:

SM *c[terminator]*

or

SM*[terminator]*

Parameters:

The parameter *c* is given as an ASCII character code (decimal) in the range 33 to 127 except for semicolon (;).

Select Pen

Function:
Selects one of the four plotting pens.

Format:
SP *pen number[terminator]*

or

SP*[terminator]*

Parameters:
The parameter *pen number* should be an integer from 0 to 4. No parameter is also possible. A parameter of 0 returns the pens to their storage position.

Relative Character Size

Function:

Specifies the size of characters and symbols as a percentage of the distance between scaling points P1 and P2.

Format:

SR *width,height[terminator]*

or

SR*[terminator]*

Parameters:

The parameters *width* and *height* are given as decimal numbers in the range –128 to 127.9999.

Select Standard Character Set

Function:

Selects the standard set designated by the most recent CS instruction as the character set to be used for labeling.

Format:

SS*[terminator]*

Parameters:

No parameters are required.

Tick Length

Function:

Specifies the length of tick marks drawn on the *x* and *y* axes expressed as a percentage of the horizontal or vertical distance between P1 and P2. The parameter *tp* denotes the positive direction and *tn* the negative direction.

Format:

TL *tp,[,tn][terminator]*

or

TL*[terminator]*

Parameters:

The parameters *tp* and *tn* are given as decimal numbers in the range –128.000 to 127.999.

User Defined Character

Function:

Draws characters and symbols designed by the user.

Format:

UC *[pen control,] x1, y2, . . . ,[terminator]*

or

UC*[terminator]*

Parameters:

The parameter *pen control* is set to –99 for pen up or 99 for pen down.

The parameters *x1* and *y1* are coordinates on a grid of a range of ±98 units. To produce a character the same size as a normal character, the user-defined character should be within a range of 0 to 4 (width) and 0 to 8 (height).

Velocity Select

Function:

Specifies the speed at which plotting and labeling operations will take place. This command is used to change the pen-down plotting speed velocity from a default setting of 23 cm/s.

A parameter <20 will set the pen speed to 10 cm/s. A parameter ≥20 will set the pen speed to 23 cm/s.

Format:

VS *pen velocity[terminator]*

or

VS*[terminator]*

Parameters:

The parameter *pen velocity* is given as a number in the range 0 to 127.999.

X Tick

Function:
Draws a vertical X-tick at the current location.

Format:
XT*[terminator]*

Parameters:
No parameters are required.

Y Tick

Function:
Draws a horizontal Y-tick at the current location.

Format:
YT*[terminator]*

Parameters:
No parameters are required.

Appendix A
HP-GL Default Values

The default parameters for the HP-GL command set are shown in Table A-1.

Table A-1. HP-GL plotter default parameters.

Function	Command	Default Condition
Drawing mode	PA;	Absolute coordinates (PA)
Angle of rotation	DR1,0;	Horizontal (DR1,0)
Line Type	LT;	Solid line
Line pattern	LT;	4% of distance between P1 and P2
Window	IW;	Clipped by hardware
Character size	SR;	Width = 0.75% of $\lvert P2_x - P1_x \rvert$ Height = 1.5% of $\lvert P2_y - P1_y \rvert$
Symbol Mode	SM;	Off
Scale length	TL;	tp = tn = 0.5% of $\lvert P2_x - P1_x \rvert$ Y axis scale tp = tn = 0.5% of $\lvert P2_y - P1_y \rvert$ X axis scale
Standard char. set	CS0;	Set 0
Alternate char. set	CA0;	Set 0
Select char. set	SS;	Standard character set
Char. inclination	SL0;	0°
Mask value	IM233,0,0;	233,0,0
Digitize clear	DC;	ON
Scaling	SC;	OFF
Pen speed	VS;	Fast speed (23 cm/s)
Label terminator	DT ext;	EXT(3)

Appendix B
HP-GL Character Sets*

*These characters differ according to the set. All others are standard ASCII characters as shown in the User's Section of this manual.

Table B-1. HP-GL International Character Sets.

Decimal Value	Standard ASCII (Set 0)	9825 (Set 1)	French/ German (Set 2)	Scandi- navian (Set 3)	Spanish/ Latin American (Set 4)
35	#	#	£	£	¿
39	'	'	´	'	´
91	[	[	[	Ø	[
92	\	√	Ç	Æ	¡
93	]	]	]	ø	]
94	^	↑	^	æ	^
95	_	_	_	_	_
96	`	`	`	`	`
123	{	π	¨	¨	~
124	¦	⊢	°	°	~
125	}	→	¨	¨	~
126	~	~	'	°	~

Applications Information

Introduction

The following examples describe procedures for using the HC100 with various Tektronix instruments. These examples are not intended to be all-inclusive and only describe the procedures that are known to work at the time of publication of this manual. Alternate procedures may also achieve the same results. For further information on Tektronix instruments that are compatible with the HC100 consult your Tektronix Product Catalog or your local Tektronix representative. *Since updates to the firmware may have occurred in the instruments described here, the instrument manual should be checked for the most up-to-date plot procedure.*

NOTE: The examples are not intended to include the basic operation of the instruments covered. For instrument setups consult the instrument operator's manual. The procedures given below start after the oscilloscope has been configured as desired and the waveform that you wish to plot is displayed on the crt.

The presence of other printers or plotters on the the GPIB can cause buss contention and should be avoided.

Recommended GPIB switch settings for both the HC100 and the instrument are included in the examples. The "ON" position of the switch is indicated by a black dot. The absence of a dot indicates "DON'T CARE." Refer to the HP-GL section of this manual for more information on switch settings.

NOTE: After changing the GPIB switch settings on either the instrument or the HC100, the device must be turned off and then on again for the new settings to be recognized.

Instruments Covered

336-01
370
468-02
490P Series
2220/2221
2230
2430/2430A
2750 Series
7854
7D20
RTD710

Additional pages covering other instruments may also be added to this section of the manual. For complete and current information regarding the use of the HC100 with Tektronix instruments or systems, contact your local Tektronix representative.

Instrument: 336-01

HC100 GPIB Switch Settings:

	1	2	3	4	5	6	7	8
OFF		●	●	●	●	●	●	●
ON	●							

Procedure:

NOTE: Acquire ground level before storing any waveforms, or the ground mark (+) will not be included in the plot.

1. Press the ON/OFF Button of the MENU section. Menu selections 1 through 5 should be displayed on the screen.

2. Press Button 2 (DATAOUT) of the MENU section. Menu selections 1 and 2 should appear on the screen.

3. Press Button 2 (GPIB) of the menu section. Menu selections 1 through 4 should appear on the screen.

4. If portion A is ADRS=XX (not TALK ONLY), press either Button 1 (INCR) or Button 2 (DECR) of the MENU section untill ADRS=XX changes to TALK ONLY.

5. Press Button 3 (TRANSMIT) of the MENU section. This should start the HC100 plotting.

Instrument: 370

GPIB Switch Settings:

HC100

	1	2	3	4	5	6	7	8
OFF				●	●	●	●	●
ON	●	●	●					

370

	1	2	3	4	5	6
OFF		●	●	●	●	●
ON	●					

For or GPIB operation, both the 370 and the HC100 must be set to Address #31.

Parallel Port Switch Settings:

HC100

	1	2	3	4	5	6	7	8
OFF	●							●
ON		●	●	●	●	●	●	

370

	1	2	3	4	5	6
OFF						●
ON	●	●	●	●	●	

For parallel port operation, both the 370 and the HC100 can be set to to any address except Address #31.

Procedure:

After the initial setup and obtaining the desired display, all that is necessary to obtain a plot is to press the PLOT button on the front panel of the 370. If PLOT/CURVE and FAST/SHIFT are pressed simultaneously, the graticule, cursor, and crt readout will not be included in the plot.

Instrument: 468-02

GPIB Switch Settings

	1	2	3	4	5	6	7	8
OFF		●	●	●	●	●	●	●
ON	●							

HC100

	1 (TALK ONLY)	2	3	4	5	6
ON	●					
OFF						

468-02

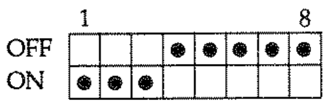
Procedure:

NOTE: Acquire ground level before storing any waveforms, or the ground mark (+) will not be included in the plot.

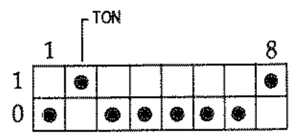
After the initial setup and obtaining the desired display, all that is necessary to obtain a plot is to press the TRANSMIT button on the left side panel of the 468-02. The 468-02 should enter the Save Storage Mode and the HC100 should begin plotting. (The 468-02 may also be put into Save Storage Mode by pressing the SAVE button in the STORAGE MODE section.)

Instrument: 490P Series

GPIB Switch Settings:



HC100



490P Series

Procedure:

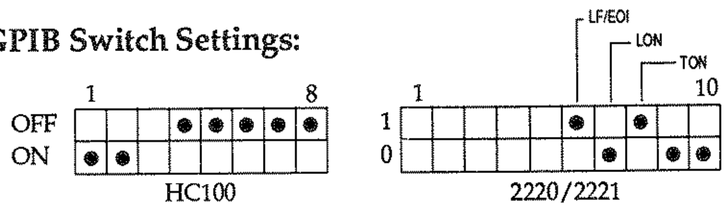
1. Press <SHIFT> SAVE A on the instrument. The plotter selection menu should appear.

2. Select item 3 (for the HP7475A plotter).

3. Press <SHIFT> PLOT. The HC100 should begin plotting.

Instruments: 2220/2221

GPIB Switch Settings:

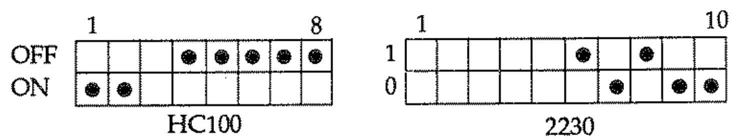


Procedure:

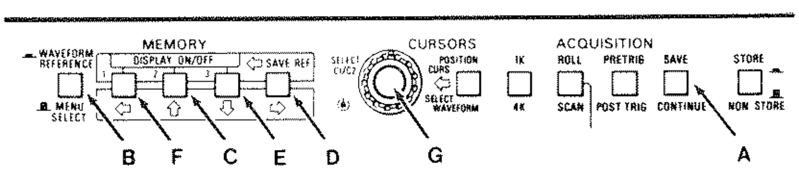
After the initial setup and obtaining the desired display, all that is necessary to obtain a plot is to press the SAVE button and then the PLOT button on the 2220/2221. The HC100 should begin plotting. If it is desired to include the graticule in the plot, press AUTOPLOT instead of PLOT.

Instrument: 2230

GPIB Switch Settings:



Procedure:



2230 Front Panel.

NOTE: The procedure given is for the first time through, starting from the beginning. Subsequent operations may return you to various points in the menu. The entire procedure needn't be repeated every time—only that part which follows from your position in the menu.

1. Press SAVE (Button A).

2. Select MENU SELECT (Button B OFF).

3. Press the up arrow (Button C) two times. This will select PLOT mode from the menu.

4. Press the right arrow (Button D) one time. (Select SPEED mode.)

5. Press the down arrow (Button E). (Select GRATICULE mode.)

6. Press the right arrow (Button D). (Select OFF mode.)

7. Press the down arrow (Button E). (Select ON mode.)

8. Press the left arrow (Button F). (Select GRATICULE mode.)

9. Press the up arrow (Button C). (Select START mode.)

10. Press CURSOR (Button G). The HC100 should start plotting.

2432 NEXT PAGE!

Instruments: 2430/2430A

GPIB Switch Settings:

	1							8
OFF		●	●	●	●	●	●	●
ON	●							

HC100

Procedure:

NOTE: The procedure given is for the first time through, starting from the beginning. Subsequent operations may return you to various points in the menu. The entire procedure needn't be repeated every time—only that part which follows from your position in the menu.

1. Press the OUTPUT button. The screen menu will be displayed on the lower part of the crt.

2. Press menu SETUP.

3. Press menu MODE.

4. Press menu T/ONLY.

5. Press menu WFMPRE/CURVE. (press W/WFMPRE)

6. Press the front panel OUTPUT button.

7. Press menu SETUP.

8. Press menu TERM.

9. Press menu LF/EOI.

10. Press the front panel OUTPUT button.

11. Press menu SETUP.

12. Press menu ENCDG.

13. Press menu RP. (RP B,W)

14. Press the front panel OUTPUT button.

15. Press menu TRANSMIT. The HC100 should begin plotting.

2430A Alternate GPIB Switch Settings:

USE FOR 2432!!

	1	2	3	4	5	6	7	8
OFF				●	●	●	●	●
ON	●	●	●					

HC100

Alternate Procedure (2430A Only):

1. Press the OUTPUT button. The screen menu will be displayed on the lower part of the crt.

2. Press menu SETUP.

3. Press menu MODE.

4. Press menu DEVICES.

5. Press menu HPGL PLOTTER.

6. Press menu SETUP.

7. Press the front panel OUTPUT button.

8. Press menu PLOT. The HC100 should begin plotting.

NOTE: The above procedure may not work on 2430As with firmware versions earlier than 1.8.

Instrument: 2750 Series

GPIB Switch Settings:

	1	2	3	4	5	6	7	8
OFF				●	●	●	●	●
ON	●	●	●					

HC100

	1	TON						8
1		●						●
0	●		●	●	●	●	●	

2750 Series

Procedure:

1. Press <SHIFT> SAVE A on the instrument. The plotter selection menu should appear.

2. Select item 3 (for the HP7475A plotter).

3. Press <SHIFT> PLOT. The HC100 should begin plotting.

Instrument: 7854

GPIB Switch Settings:

HC100

	1	2	3	4	5	6	7	8
OFF		●	●	●	●	●	●	●
ON	●							

7854

	1	2	3	4	5	6	7	8
1	●	●						
0			●					

The 7854 must be put in TALK ONLY Mode before the power is turned on.

Procedure:

NOTE: This oscilloscope requires a calculator keyboard to plot a waveform. There are two plotting methods: Immediate Mode and Program Mode. An example is given for each. The examples given are for plotting two waveforms and would be changed accordingly for different situations.

NOTE: Acquire ground level before storing any waveforms, otherwise value VZR at power on will be used as the ground level.

Immediate Mode:

In this mode, the desired waveforms can be selected for plotting manually. In this example, assume that waveforms are stored in waveform memories, #0, #1, and #2, and that plots are wanted for waveforms W0 and W1. The following commands should be entered from the keyboard.

1. 0 ENTER f SENDX

2. 0 WFM f SENDX (The plotter will plot W0.)

3. 1 ENTER f SENDX

4. 1 WFM f SENDX (The plotter will plot W1.)

5. 99 ENTER f SENDX (The plotter will plot the grids and complete the operation.)

Program Mode:

In this mode, up to six preset waveforms can be plotted in order. In the following example, it is assumed that waveforms are stored in waveform memories, #0, #2, and #3, and that plots are wanted for waveforms W0 and W2.

1. Press PROGRAM ENTRY (EXECUTE).

2. Enter the following program:

   2 ENTER f SENDx 2 WFM f SENDx NEXT
   0 ENTER f SENDx 0 WFM f SENDx NEXT
   99 ENTER f SENDx NEXT
   STOP NEXT

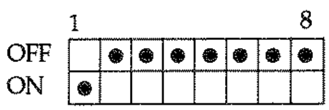
3. Press PROGRAM ENTRY (EXECUTE).

4. Press f (START).

5. The program will, in order, send the data for W2 (line 1), then W0 (line 2), then the grid (line 3).

Instrument: 7D20

GPIB Switch Settings:



HC100

Procedure:

The 7D20 outputs only the CSW X waveform on which the cursor is set when the TALK ONLY mode is selected. To plot two or more waveforms, change CSW X each time. The grid is plotted by sending CSW 1.

NOTE: Acquire ground level before storing any waveforms, otherwise value VZR at power on will be used as the ground

1. Press ID on the front panel of the 7D20. The menu will be displayed on the screen.

2. Press button 4 of the MEMORY DISPLAY section. MODE=XX will be displayed on the screen.

3. Continue pressing button 4 until MODE=XX changes to read MODE=T.

4. Press button 5 of the MEMORY DISPLAY section. TERM=XX will be displayed on the screen.

5. Continue pressing button 5 until TERM=XX changes to read TERM=LF/EOI.

6. Set the cursor on the waveform to be plotted. The selected waveform will be displayed as CSW X at the lower left corner of the screen.

7. Press MENU TEST. Either the MASTER MENU or the UTILITIES MENU will appear on the screen. If the MASTER MENU appears, press button 4 to change to the UTILITIES MENU.

8. If the HOLD lamp is not lit, press the HOLD button.

9. Press either MENU SELECT 1 or 2 (SEND CSW ASCII or SEND CSW BINARY).

10. The HC100 will plot the waveform selected in step 6.