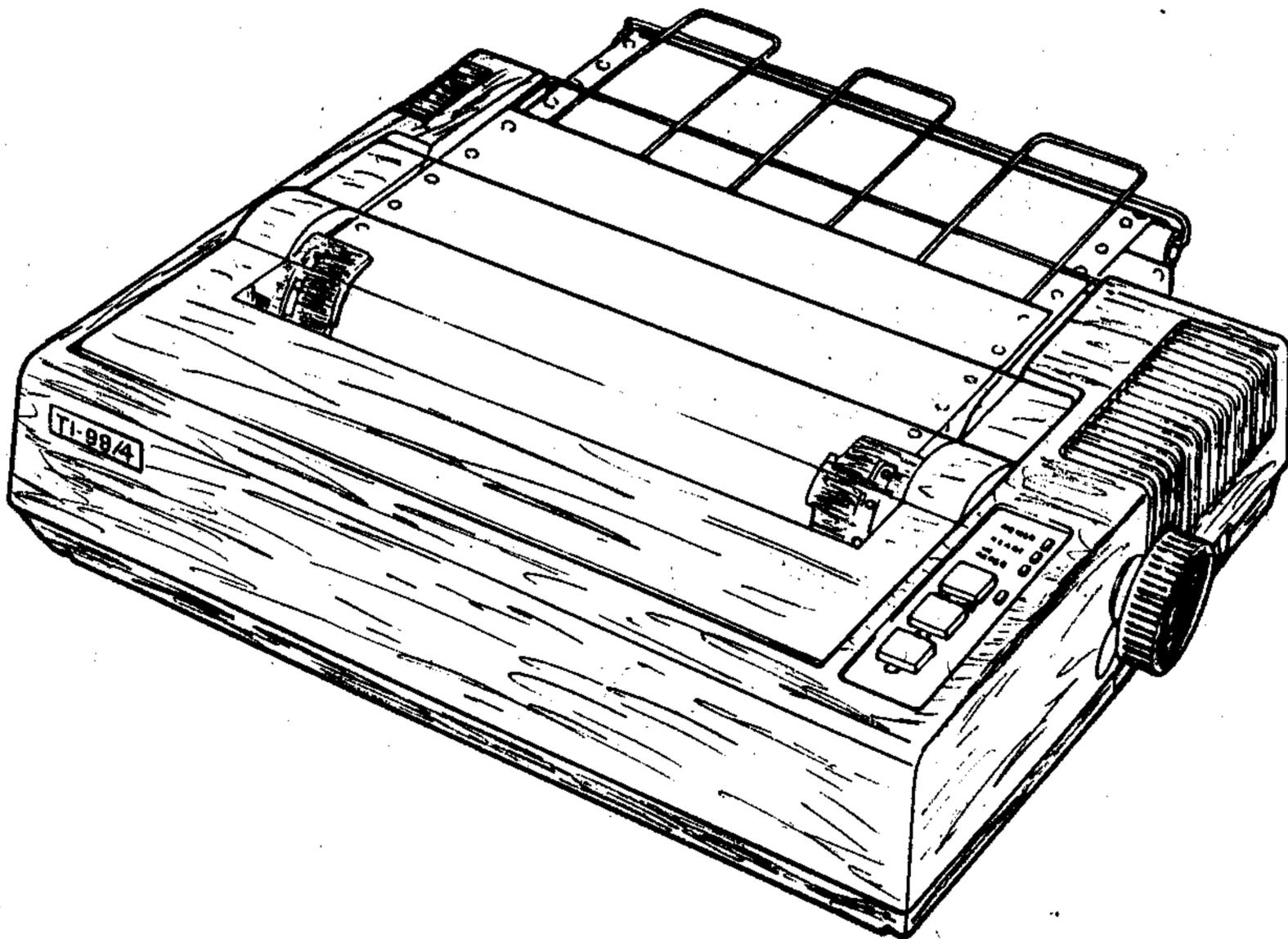




TI-99/4 Printer

Model No. PHP2500



Requires fan-fold paper from 4 to 9½ inches in width (sold separately).

Note: This equipment requires the use of the RS232 Interface unit (sold separately).

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INTRODUCTION

Texas Instruments TI-99/4 Printer is a quiet and smooth-running electronic printing device. It couples innovative design and precision manufacturing with long life, low cost, light weight, and superior performance.

Note: The TI-99/4 Printer must be attached to the computer via the RS232 Interface unit (sold separately).

When it's connected to the Home Computer via the RS232 Interface unit, the TI-99/4 Printer can provide a printed copy of your program and data to aid you in revising long programs or maintaining files of programs and results. The TI-99/4 Printer can print screens or displays from certain *Solid State Software*[™] Command Modules. In addition, the printer can be used in either the Text mode or the Graphic Mode, in which hard copies of illustrations, graphs, charts, and other visuals are produced on the printer under software control.

The TI-99/4 Printer features a speed of 80 characters per second and a 9 x 1 dot-matrix printhead. The printer also offers 40-, 66-, 80-, and 132-column printing widths. Characters can be printed in any desired size — normal, enlarged, condensed, etc. A one-chip microcomputer performs all system control, and the two built-in stepper motors control the carriage movement and paper-feeding functions. Versatile software commands enable you to control a variety of features.

The TI-99/4 Printer:

- Prints text and, in the Graphic Mode, graphic data. In Graphic printing, both normal-density (480 dots/line) and dual-density (960 dots/line) modes are available.
- Prints 40 enlarged characters per line, 66 mixed character widths per line, 80 normal characters per line, or 132 condensed characters per line with programmable column widths.
- Has a top-of-form function for paper lengths of either 11 or 12 inches.
- Can be set to skip over paper perforations automatically.
- Has programmable line spacing, vertical and horizontal tabulation, and a programmable buzzer.
- Prints 80 characters per second bidirectionally with logic-seeking capability.
- Has eight international character sets selectable by software or DIP switch.

OPERATION

The TI-99/4 Printer has three switches and four lighted indicators on its control panel and one power switch on the right side of the case. The printer also contains a buzzer and a paper-end detector. This section discusses these various parts of the printer in order to help you become familiar with the printer and its operation.

Switches and Indicators

Power Switch

This switch, on the right side of the case, controls the primary AC power to the printer. *Note:* Before turning this switch on, check to be sure that the paper is properly set in the printer. Incorrect paper setting may prevent the printer from operating properly.

On-Line Switch

When you turn the power on after loading paper in the printer, the printer automatically enters the ON-LINE mode which allows you to print information sent from the Home Computer. The On-Line indicator light on the right side of the panel comes on.

Pressing down the On-Line switch on the control panel sets the printer in the OFF-LINE mode and causes the On-Line indicator light to go out. This switch does not function if the printer is actively engaged in printing. The printer is automatically placed in the OFF-LINE mode if the paper supply is exhausted or if a mechanical error occurs in the printer. The operations of the Line Feed and Form Feed switches are effective only while the printer is OFF-LINE.

Form Feed Switch

When you press the Form Feed (FF) switch once, the paper advances vertically to the next top-of-form position. You can only use this switch when the printer is OFF-LINE because the form-feed function is not operative while the printer is ON-LINE.

The top-of-form position is set when the power is turned on. Therefore, be sure the paper is set at the desired top-of-form position before turning the power on to start operating the printer.

Line Feed Switch

The Line Feed (LF) switch causes the paper to advance. To advance the paper, hold the switch down; to stop the paper, release the switch. This switch is not operative while the printer is actively engaged in printing.

The spacing for paper advancement is determined by a software code, (described in the "Software Control Codes" section). When you turn the power on, the line spacing is set at 1/6 of an inch.

INDICATORS

The TI-99/4 Printer has four indicators:

POWER	Lights while the printer is receiving AC power.
READY	Lights when the printer is ready to receive data.
PAPER OUT	Lights when the paper supply is near its end.
ON-LINE	Lights when the printer is in the ON-LINE mode.

Buzzer

The buzzer is located inside the printer case and sounds for about one second when the printer receives code 7 (see the "Software Control Codes" section for more information about code 7).

Paper-End Detector

When the paper-end detector (a reed switch located on the paper guide) detects that the paper supply is nearly exhausted, the printer indicates to the Home Computer that an error has occurred and printing stops. To restart the printing, first press the Line Feed switch to take out the remaining paper. Then load the printer with more paper and set its position. Finally, press the On-Line switch and the printer is ready to begin printing. Be careful not to turn the printer off during this procedure; if the printer is turned off, all previously established data such as TAB, line spacing, and so forth, are lost. If the paper-end detector senses that the printer is out of paper and you want to print up to the last line of the paper, you can enter the control codes 27 and 56. The paper-end detecting function is disabled via these software control codes. (For more information on these codes, see "Software Control Codes".)

SET-UP INSTRUCTIONS

To set up the TI-99/4 Printer, first select a location, and then connect the printer to the Home Computer via the RS232 Interface unit, insert the cartridge ribbon, and load the paper. Then set the head gap and test the printer. The steps involved in these procedures are included in this section. Please *read this material completely* before proceeding.

Unpacking the Printer

Before removing the TI-99/4 Printer from the carton, check the box for evidence of shipping damage or mishandling. If you find any evidence of damage, immediately notify the carrier or the store from which you bought the printer.

1. Remove the accessories (RS232 connecting cable, cartridge ribbon, and wire paper separator).
2. Remove the TI-99/4 Printer by holding the bottom of the printer (with the packing material attached) and lifting straight up.
3. Place the printer with the packing material on a table or any other convenient flat surface.
4. Remove the packing material carefully. (Save the packing material for storing or transporting the printer.)
5. Remove the vinyl cover that is fitted over the top of the printer.
6. Check the parts packed with the printer to be sure that they include the
 - wire paper separator
 - RS232 connecting cable
 - cartridge ribbon

If any of these parts are missing or damaged, contact the store where you purchased the TI-99/4 Printer.

WARNING

Do not turn the manual paper-feed knob while the printer is ON. Doing so may damage the paper-feed mechanism.

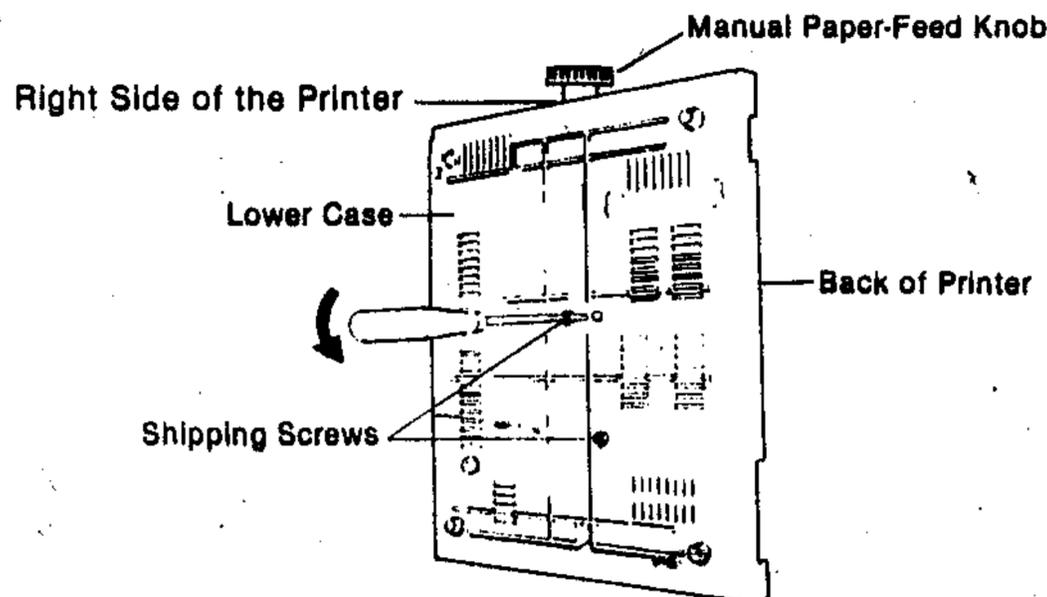
Installing the Printer

1. Place the printer on a bench, tabletop, or any other convenient flat surface with enough room for the paper separator in the back of the printer.

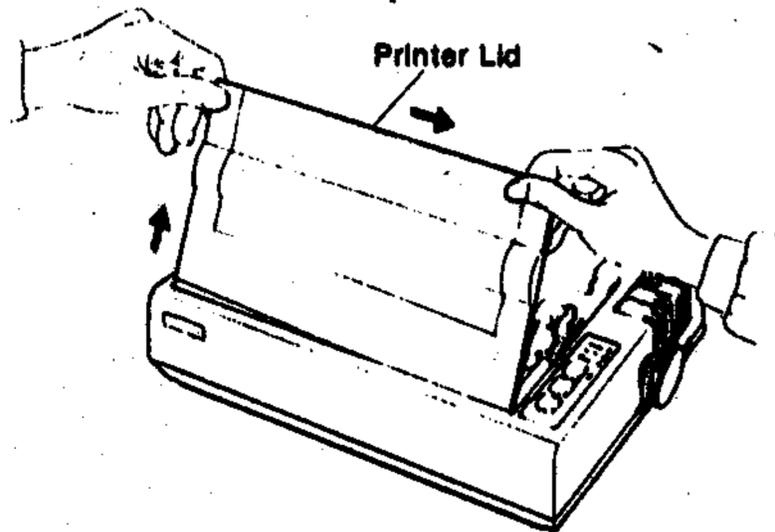
Notes:

- Rubber feet are provided to prevent marring the surface on which you place the printer.
 - Avoid operating the printer in places where it may be exposed to direct sunlight or where greasy dust exists in the air. Direct sunlight may cause it to overheat and malfunction. Greasy dust may cause the printhead to malfunction.
 - Do not subject the printer to temperatures below 5° Centigrade (40°F) or above 35° Centigrade (95°F) during operation, to sudden changes in temperature, or to extreme shock.
 - Avoid use of the printer in humid locations or in the vicinity of heat-generating sources such as a heater.
2. Attach the RS232 Interface unit to the computer console, following the instructions in the RS232 Interface unit owner's manual.
 3. Connect the printer to the RS232 Interface unit by plugging either end of the connecting cable into the back of the printer and the other end into the serial connector on the RS232 Interface unit.
 4. Remove the protective paper from the paper-end detector. This paper is inserted between the inner and outer paper guides to protect the paper-end detector from damage due to shocks and vibrations during transportation. If you reship the printer, remember to return the protective paper to its original position.
 5. Remove the shipping screws from the bottom of the case. The purpose of the screws is to protect the printer from damage that may be caused by shocks or vibration during transportation. To remove these screws, stand the printer on its left side. Then, using a regular screwdriver, remove the two shipping screws visible on the underside of the lower case.

Note: Save the two shipping screws for possible future use.

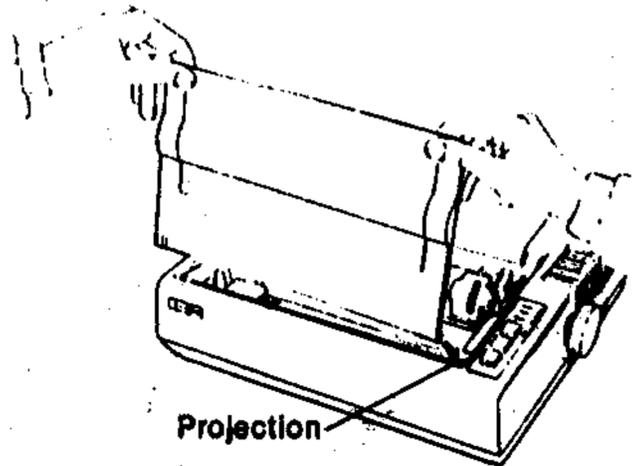


If the printer lid is in your way when you are removing the shipping screws, be sure to remove it since rough or even careless handling may damage or possibly break the hinges. To remove the lid, place the printer on a flat surface, raise the lid to an upright position, and push the lid slightly to the right while pulling up on the left side. When the lid comes off the hinge pin on the left, gently pull the lid up and to the left until it comes off the hinge pin on the right side. **Avoid rotating the lid too far to the right or left since this may cause the hinges to break.**



Removing Printer Lid

To replace the printer lid, fit the right side onto the projection located on the right corner of the printer's upper case. Then fit the left side of the lid onto the left projection and push the printer lid down.



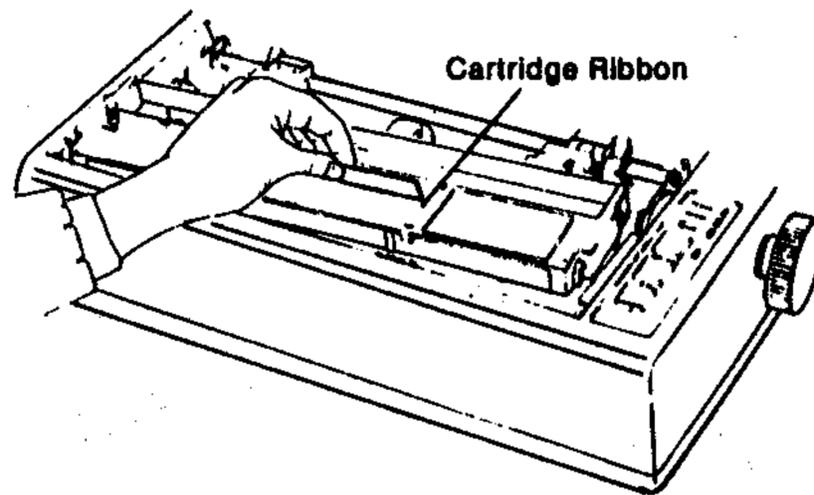
Remounting Printer Lid

Plug the printer into a 115-volt outlet.

Inserting the Cartridge Ribbon

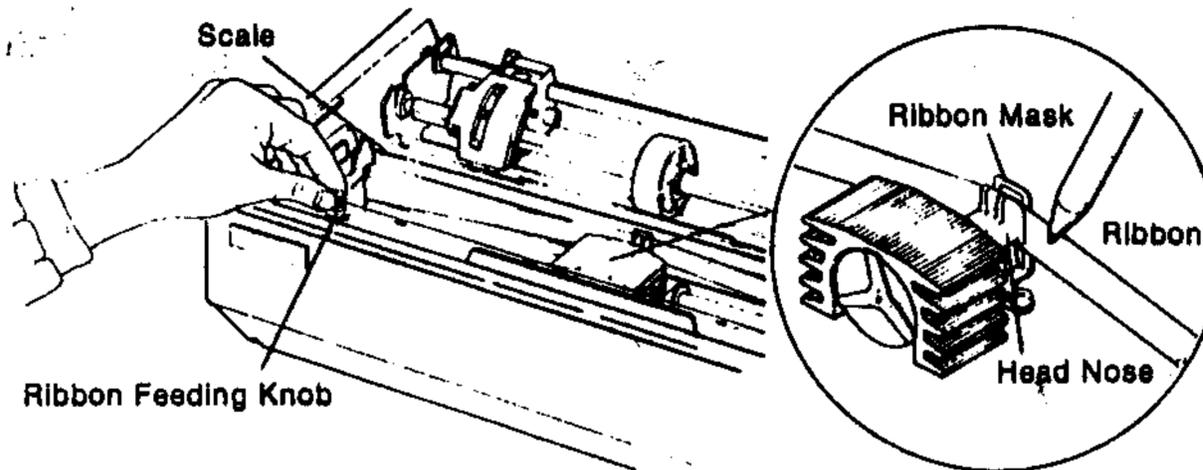
The cartridge ribbon is compact, long-lasting, and very easy to insert and remove. Since you can install the cartridge without touching the ribbon, you can easily avoid getting ink on your fingers.

1. Open the printer lid (or remove it).
2. Make sure that the scale (paper retainer) is turned toward the back of the printer so that it does not interfere with the ribbon.
3. Push the cartridge ribbon down and set it on the printer mechanism. To facilitate the cartridge setting, be sure to hold the projection at the center of the cartridge case when pushing the cartridge ribbon down.



Cartridge Ribbon Setting

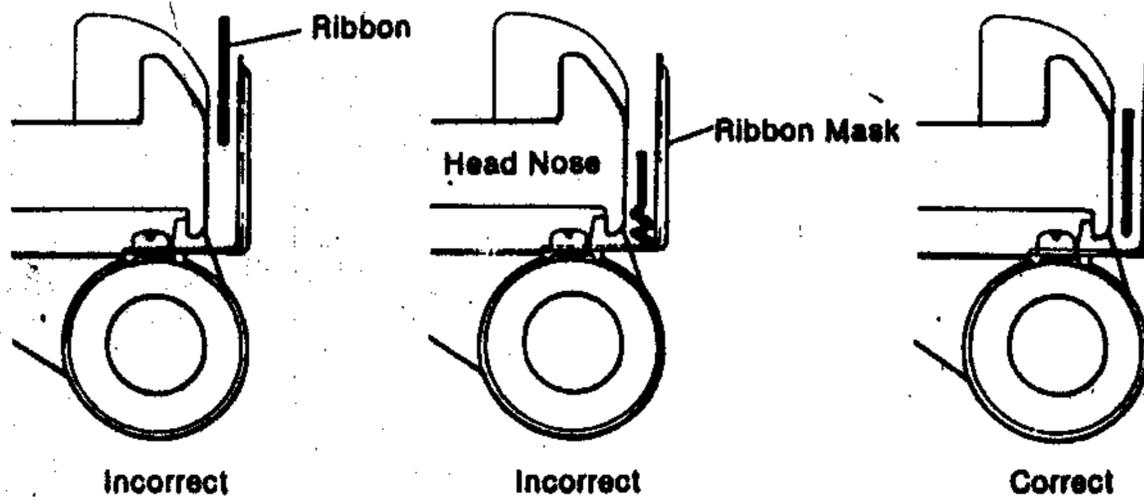
4. Put the ribbon between the head nose and the ribbon mask. In this case, the ribbon can be set easily by hooking it to the edge of the head nose and turning the ribbon-feeding knob on the left end of the cartridge case in the direction of the arrow on the case (i.e., counterclockwise) while pressing down the ribbon with a ball-point pen. Then, take up any slack in the ribbon by again turning the ribbon-feeding knob in the counterclockwise direction.



Cartridge Ribbon Setting

Notes:

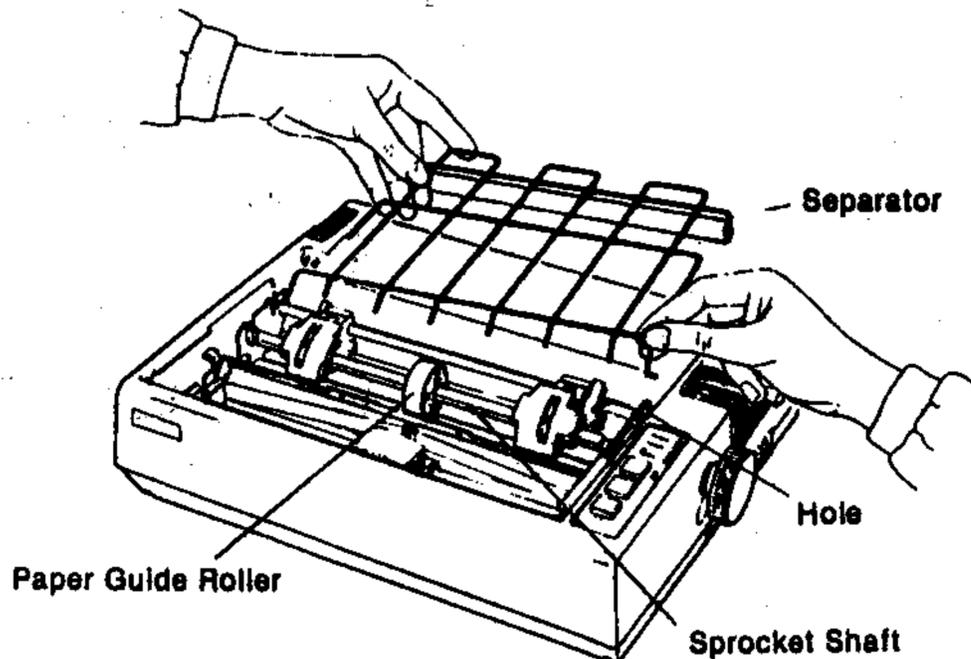
- Incorrect setting of the ribbon may cause it to come off the ribbon mask.
- Be sure that the ribbon is neither twisted nor creased and that the cartridge is set properly.



Examples of Correct and Incorrect Ribbon Setting

Installing the Paper Separator

The paper separator helps ensure smooth paper feeding. To install the paper separator, insert the mounting wires at each edge of the separator into the two holes located at the rear part of the frame of the printer mechanism.

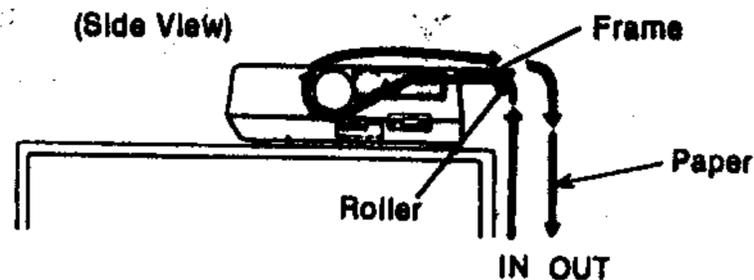
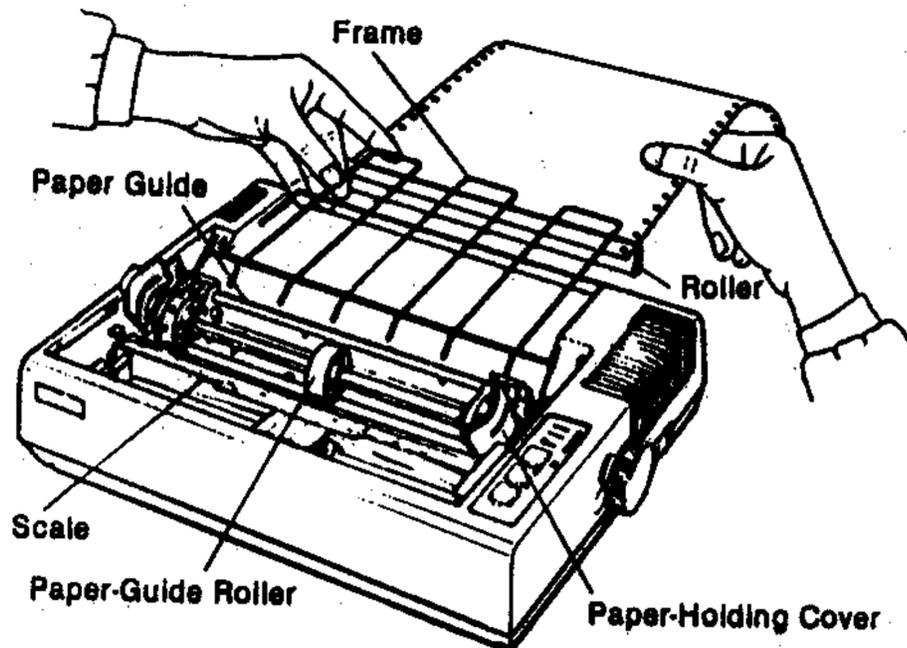


Separator Installation

Loading the Paper

The TI-99/4 Printer accommodates fanfold paper from 4 inches to 9½ inches in width.

1. Make sure the printer is turned OFF.
2. Raise the printer lid.
3. Move the scale that indicates column positions, so that it does not interfere with the feeding of the paper, by turning the scale toward the front of the printer.
4. Check to see if the paper-guide roller is at the center of the sprocket shaft. If it is not, set it at the center of the shaft so that it can facilitate smooth feeding of the paper.
5. Raise the two paper-holding covers, and be sure to insert the fanfold paper between the frame and plastic roller of the paper separator.

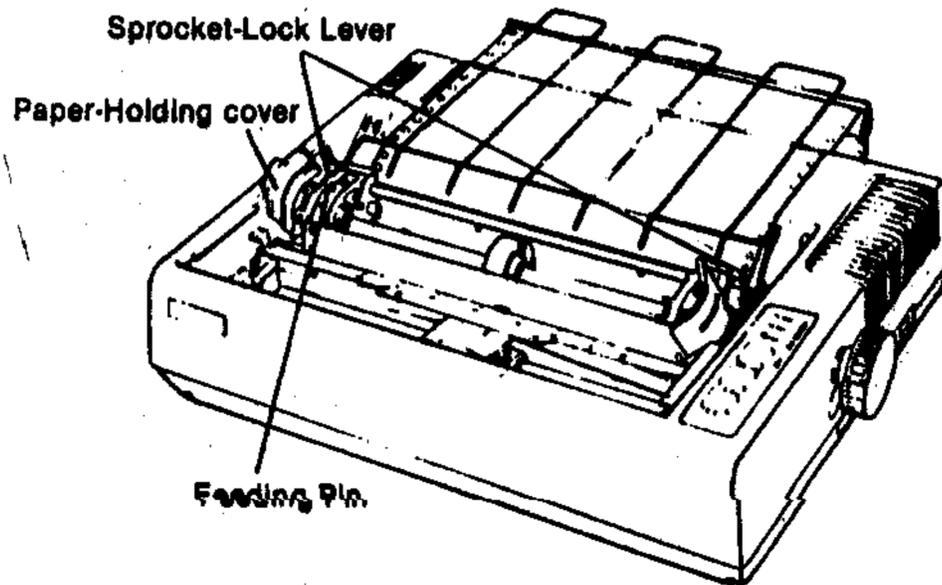


Insertion of Fanfold Paper

Push the paper into the insertion slot between the paper guides at the rear part of the printer mechanism. *Note:* Be sure to pass the paper beneath the upper paper guide.

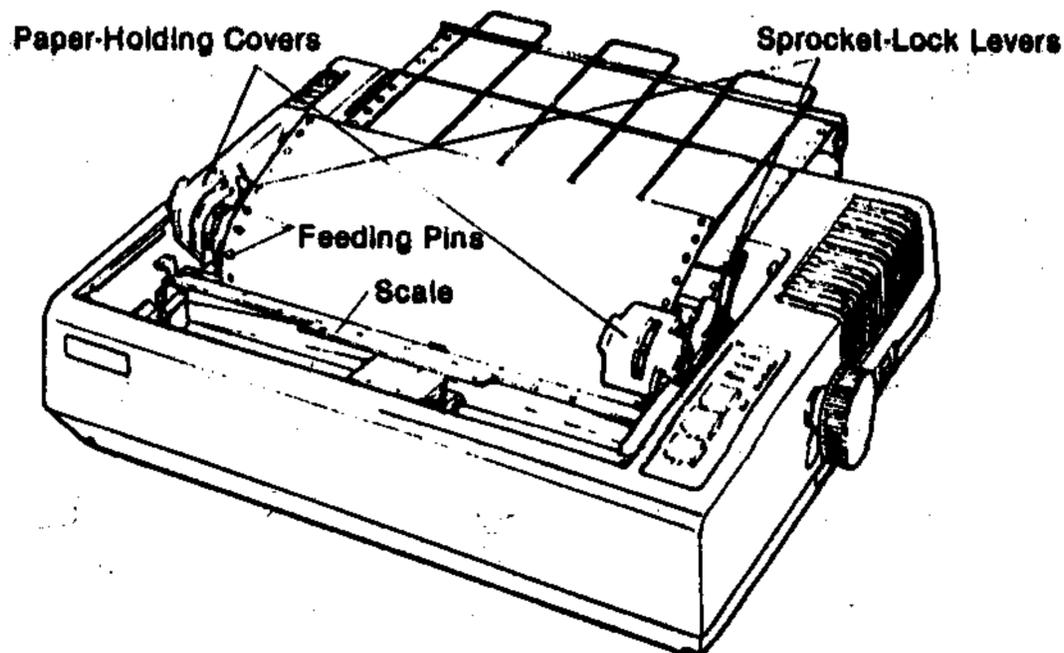
After the leading edge of the paper has emerged from the printer, pull it out gently approximately eight inches.

8. Raise the two sprocket-lock levers to loosen the sprockets. Then adjust the position of the sprockets so that the sprocket pins fit the holes at the edges of the paper.



Raising Sprocket-Lock Levers

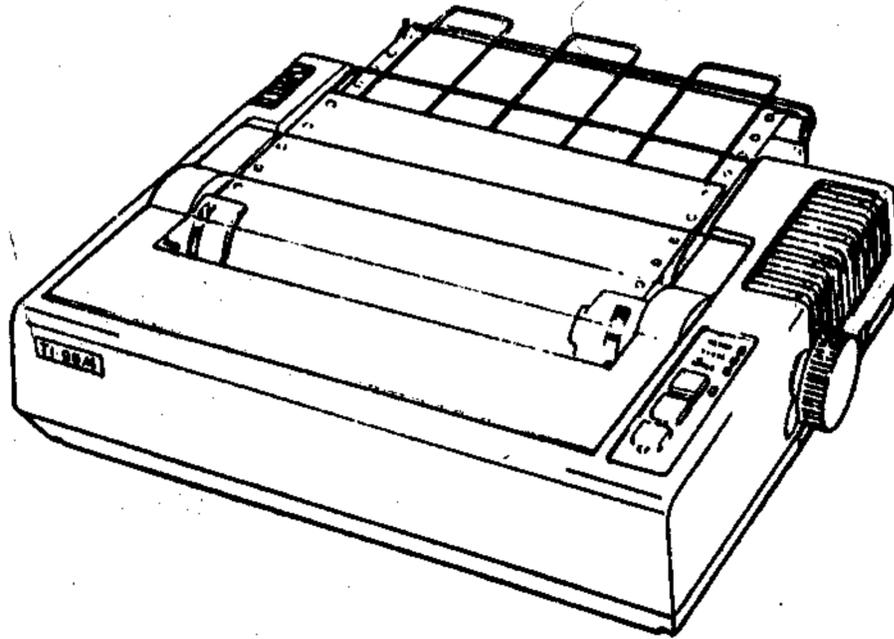
9. Place the paper-feed holes of the paper on the feeding pins, push the scale back into position against the paper, and adjust the paper tension. Then push the paper-holding covers and the two sprocket-lock levers down. *Note: Be sure that the feeding pins are centered in their respective feed holes in the paper.*



Engagement of Paper Feed-Holes on Feeding Pins

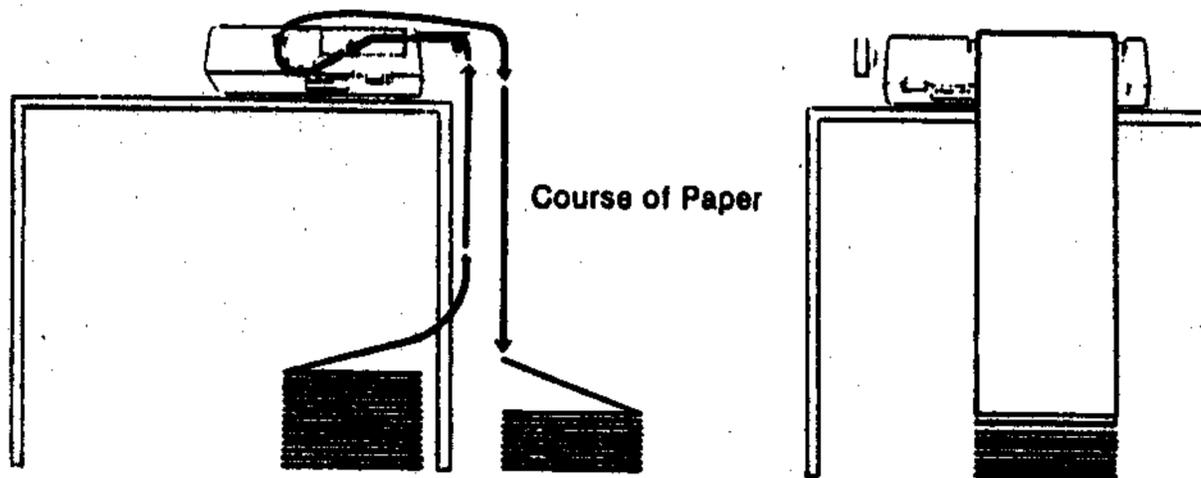
10. Push the paper scale back against the paper.

11. Replace the lid on the printer.



Printer with Fanfold Paper Completely Set

When the TI-99/4 Printer is to be used on a desk or table, you can arrange the paper in line with the printer so that it can be unfolded and folded in an accordion style.



Example of Paper Arrangement

Removing Paper from the Printer

To remove the fanfold paper, turn the power off and pull the paper forward out of the printer, or feed the paper out of the printer by turning the power on and pressing the Line Feed (LF) or Form Feed (FF) button. **CAUTION:** Do not turn the manual paper-feed knob while the power is on, as this may cause damage to the printer.

GETTING STARTED

A common application of your TI-99/4 Printer involves printing a listing of a TI BASIC program. For example, enter this program.

```
10 OPEN #1:"RS232"  
20 FOR K = 1 TO 10  
30 PRINT #1:"THIS IS A TEST"  
40 NEXT K  
50 CLOSE #1  
60 END
```

Line 10 opens the output to the printer. In lines 20 through 40, the computer is instructed to print "THIS IS A TEST" ten times. Line 50 closes the output to the printer, and line 60 indicates the end of the program.

Now enter this command:

```
LIST "RS232"
```

The program in the computer's memory is listed by the printer. To print "THIS IS A TEST," type RUN and press ENTER, and the printer prints THIS IS A TEST ten times.

Text Examples

Shown below is a simple program which you can use to print information that you have entered on your Home Computer console and displayed on the video screen. This program enables you to use your printer much like a typewriter. To see how it works, first enter the program.

```
100 OPEN #1:"RS232"  
120 PRINT  
140 PRINT "PRESS '9999' TO STOP."  
160 PRINT "INPUT LINE";  
180 INPUT A$  
200 IF A$ = "9999" THEN 260  
220 PRINT #1:A$  
240 GO TO 160  
260 CLOSE #1  
280 END
```

type RUN and press ENTER. The message "PRESS '9999' TO STOP." appears followed by the prompt "INPUT LINE." Now you can type any information you want to print on your printer. When you press ENTER, the printer prints whatever you have entered, and the prompt "INPUT LINE" again appears on the video screen. When you are finished, type 9999 and press ENTER; the program stops.

Your TI-99/4 Printer has different type faces which you can select by specifying different character designations. The printer can print condensed, enlarged, emphasized, condensed-enlarged, and double-printed characters. To see a demonstration of some of these types of printing, enter the following program.

```

100 OPEN #1:"RS232.LF"
110 PRINT #1:CHR$(10)
120 PRINT #1:CHR$(15);TAB(10);"With CONDENSED PRINTING,";
130 PRINT #1:" you can have up to 132 characters per line."
140 PRINT #1:CHR$(10);CHR$(10)
150 PRINT #1:CHR$(14);"With CONDENSED-ENLARGED printing,";
160 PRINT #1:CHR$(20);" you can have up to 66 characters per line."
170 PRINT #1:CHR$(10);CHR$(10);CHR$(18);CHR$(27);"E"
180 PRINT #1:CHR$(14);"With ENLARGED PRINTING,";CHR$(10)
190 PRINT #1:CHR$(20);TAB(25);" you can have up to 40 characters per line."
200 PRINT #1:CHR$(10);CHR$(10);CHR$(27);"F"
210 PRINT #1:"The previous line was";CHR$(13);
220 PRINT #1:CHR$(27);"E";TAB(24);"EMPHASIZED."
230 PRINT #1:CHR$(27);"F"
240 CLOSE #1
250 END

```

Line 100 opens a file for the printer. Lines 110 through 130 tell the printer to print "With CONDENSED PRINTING, you can have up to 132 characters per line." in condensed characters. Line 140 provides line spacing. Lines 150 and 160 print a sample of condensed-enlarged printing. Line 170 provides line spacing and designates emphasized printing. Lines 180 and 190 print a sample of enlarged printing with emphasized characters. Line 200 provides line spacing and turns off emphasized printing. Line 210 prints a sample of normal printing, while line 220 demonstrates how emphasized printing can be done on the same line with normal printing. Line 230 turns off emphasized printing. Line 240 closes the file that was opened for the printer, and line 250 indicates the end of the program. For a complete discussion of the codes used in this program to designate different types of characters, see the "Software Control Codes" section.

When you type RUN and press ENTER, the printer prints the following samples.

With CONDENSED PRINTING, you can have up to 132 characters per line.

With CONDENSED-ENLARGED printing, you can have up to 66 characters per line.

With ENLARGED PRINTING,
you can have up to 40 characters per line.

The previous line was EMPHASIZED.

works

Mixing Text and Graphics

The printer can combine text and graphics on one line. To see a demonstration of mixed text and graphics, enter the following program.

```
100 OPEN #1:"RS232.CR" — OR — "PIO" OPEN FILE To Printer
110 PRINT #1:CHR$(27);"E"
120 PRINT #1:CHR$(14);"GRAPHICS";CHR$(20)
130 PRINT #1:" MAY BE EMBEDDED ";
140 PRINT #1:CHR$(27);"L";CHR$(42);CHR$(0)
150 FOR J=1 TO 6
160 PRINT #1:CHR$(255);
170 NEXT J
180 FOR K=1 TO 3
190 FOR J=1 TO 6
200 PRINT #1:CHR$(195);
210 NEXT J
220 PRINT #1:CHR$(219);CHR$(219);
230 NEXT K
240 FOR J=1 TO 6
250 PRINT #1:CHR$(195);
260 NEXT J
270 FOR J=1 TO 6
280 PRINT #1:CHR$(255);
290 NEXT J
300 PRINT #1:" WITHIN A STRING OF TEXT"
310 PRINT #1:CHR$(13);CHR$(10);CHR$(27);"F"
320 CLOSE #1 CARR. RET.
330 END
```

Line 100 opens a file for the printer. Lines 110 through 130 tell the printer to print "GRAPHICS MAY BE EMBEDDED" with emphasized characters. Lines 140 through 290 print a sample of a graphic pattern on the same line. Line 300 prints " WITHIN A STRING OF TEXT." Line 310 provides a carriage return and line feed and turns off emphasized printing. Line 320 closes the file for the printer, and line 330 indicates the end of the program. For a complete discussion of the printing codes used in this program, see the "Software Control Codes" and "Graphic Mode" sections.

When you type RUN and press ENTER, the printer prints the following line.

GRAPHICS MAY BE EMBEDDED  WITHIN A STRING OF TEXT

WORKS

Another program which combines text and graphics on the same line is shown below. To see a demonstration, first enter the program.

```

100 OPEN #1:"RS232.CR"
110 FOR L=1 TO 3
120 FOR J=1 TO 3
130 PRINT #1:CHR$(15);CHR$(14);"HELLO"
140 PRINT #1:CHR$(27);"K";CHR$(80);CHR$(0) Graphics Mode
150 FOR K=1 TO 79
160 PRINT #1:CHR$(255);
170 NEXT K
180 PRINT #1:CHR$(0);
190 NEXT J
200 PRINT #1:CHR$(13);CHR$(10) Carriage Return, line feed
210 NEXT L
220 PRINT #1:CHR$(18);CHR$(20) - Turns off enlarged Condensed & enlarged. Chr.
230 PRINT #1:"DONE";CHR$(13);CHR$(10) Carriage Return, Line Feed
240 CLOSE #1
250 END
    
```

Line 100 opens a file for the printer. Lines 110 through 210 compose a FOR-NEXT loop which tells the printer to print the combined text and graphics on three lines. Another FOR-NEXT loop in lines 120 through 190 tell the printer to print the same information three times on each line. Line 130 prints "HELLO" in condensed-enlarged characters. Line 140 puts the printer in the graphics mode. Lines 150 through 170 print a solid bar. Line 180 provides space between the bar and the next "HELLO". Line 220 turns off condensed-enlarged printing. Line 230 prints "DONE" and provides a carriage return and line feed. Line 240 closes the file for the printer, and line 250 indicates the end of the program. For a complete discussion of the printing codes used in this program, see the "Software Control Codes" and "Graphic Mode" sections.

When you type RUN and press ENTER, the printer prints the following lines.

```

HELLO ██████████ HELLO ██████████ HELLO ██████████
HELLO ██████████ HELLO ██████████ HELLO ██████████
HELLO ██████████ HELLO ██████████ HELLO ██████████
DONE
    
```

↑ ENLARGED Chr.

Graphics

Your TI-99/4 printer can also be used strictly in the graphics mode. To see a demonstration of some simple graphics printing, enter the following program.

```

100 OPEN #1:"RS232.CR"
110 FOR L=1 TO 4
120 FOR M=1 TO 2
130 PRINT #1:CHR$(27);"K";CHR$(120);CHR$(0) Printer into Graphic Mode
140 FOR J=1 TO 10
150 FOR K=1 TO 12
160 READ A
170 PRINT #1:CHR$(A);
180 NEXT K
190 RESTORE
200 NEXT J
210 NEXT M
220 PRINT #1:CHR$(13);CHR$(10) CR + LF
230 NEXT L
240 CLOSE #1
250 END
260 DATA 1,2,4,8,16,32,64,32,16,8,4,2

```

Line 100 opens a file for the printer. Lines 110 through 230 form a FOR-NEXT loop which tells the printer to print the graphic pattern on four lines. Another FOR-NEXT loop in lines 120 through 210 tell the printer to repeat the graphic pattern so that it is printed twice on the same line. Line 130 puts the printer in the graphics mode. Lines 140 through 200 form a FOR-NEXT loop which prints ten of the characters generated by the data in line 260. The FOR-NEXT loop in lines 150 through 180 design a character consisting of 12 dots, one for each piece of data in line 260. Line 190 enables the computer to read the data in line 260 more than once. Line 220 provides a carriage return and line feed at the end of the line. Line 240 closes the file for the printer, line 250 indicates the end of the program, and line 260 contains the graphic data. For a complete discussion of the printing codes used in this program, see the "Software Control Codes" and "Graphic Mode" sections.

When you type RUN and press ENTER, the printer prints the following graphic pattern.



THE TI-99/4 PRINTER AND COMMAND MODULES

The TI-99/4 Printer can be controlled from some Command Modules. Activating the printer when you are using these modules usually requires a single keystroke. Follow the instructions shown on the display or printed in the module owner's manual.

THE TI-99/4 PRINTER AND TI BASIC

The OPEN, PRINT, CLOSE, and LIST statements and commands are used in TI BASIC to control and output data to the printer. The OPEN, PRINT, and CLOSE statements in your program produce printed copy when the program is run. The LIST command instructs the computer to print a copy of the program currently in memory.

To activate the printer, you must include a file name for it in the OPEN statement or LIST command. You can also specify certain software switch options and software control codes to control print-action codes such as carriage return (CR) and line feed (LF), paper formatting codes such as horizontal and vertical tabulation, the type of characters printed, and graphic codes.

File Names

TI BASIC and certain Command Modules recognize the string expression "RS232" as the file name for the printer. Whenever an OPEN statement or a LIST command is performed with the file name "RS232", all output goes to the TI-99/4 Printer via the RS232 Interface unit. Note: If the printer is connected to serial I/O port 1 on the RS232 Interface unit, use the file name "RS232" or "RS232/1"; if the printer is connected to serial I/O port 2, use "RS232/2".

Examples: LIST "RS232/2"
100 OPEN #1:"RS232"

If you reference the printer when it is not attached to the Home Computer, the program stops, and the display shows an error message.

Software Switch Options

Computer accessories often require switches to give instructions to the computer. These switches are sometimes a physical part of the product and are set by hand. However, in the TI-99/4 Printer, some of these switches can be programmed into an integrated circuit contained in the unit. Since these switches are part of the printer's "software," they are referred to as *software switch options*. There are also other switches which can only be set manually.

The OPEN statement and LIST command control the software switch options that affect the operation of the printer. When they are used in TI BASIC, these switch options turn the printer features on or off. To use the software switch options, you must observe certain procedures:

- Software switch options must follow the file name, RS232, in the TI BASIC OPEN statement or LIST command.
- Each software switch option must be preceded by a period (with no space between the period and the switch option).
- Software switch options can be listed in any order.

Examples: OPEN #1:"RS232.BA = 1200"
OPEN #2:"RS232/2.TW.BA = 4800"

In the first example, the printer is connected to serial I/O port 1 of the RS232 Interface unit and the baud rate is set at 1200 bits per second. In the second example, the printer is connected to serial I/O port 2, two stop bits are transmitted, and the baud rate is set to 4800 bits per second.

Note: Many of the software switch options have a corresponding hardware switch on a circuit board inside the printer. These switches are set at the factory to the default value for the RS232 Interface unit so that you do not need to change any of the switch settings in order to operate your printer. If you change the software switch option in the OPEN statement, you must also make sure that the corresponding hardware switch is set properly. For more information on software switch options and their default values, refer to the *RS232 Interface owner's manual*. For a description of how to change the hardware switch settings, see Appendix D.

TI BASIC Statements and Commands

This section discusses the TI BASIC statements and commands, OPEN, CLOSE, PRINT, and LIST, which are used with the printer. For a more detailed explanation, see the "BASIC Reference Section" of the *User's Reference Guide*.

OPEN #file-number:"file-name[.software switch options]"[file-attributes]

The OPEN statement links the printer to a *file-number* and sets the software switch options that control its function. Any combination of the software switch options can be listed in the OPEN statement.

- *File-number* is a numeric expression that evaluates to an integer between 1 and 255, inclusive.
- *File-name* is a string expression containing the device name, RS232, and any combination of the software switch options.
- *File-attributes* are string expressions, separated by commas, which specify file structure, data format, file processing, and record length. The TI-99/4 Printer assumes certain *file-attributes*. These assumed specifications are called default values. You only have to specify those attributes you need to change from the default values. The four *file-attribute* categories, their valid specifications, and the default values for the printer are:

Entry	Default
<i>file-organization</i> : SEQUENTIAL only (<u>RELATIVE files cannot be used</u>)	SEQUENTIAL
<i>file-type</i> : DISPLAY or INTERNAL	DISPLAY
<i>open-mode</i> : INPUT, OUTPUT, UPDATE, or APPEND	UPDATE
<i>record-type</i> : FIXED or VARIABLE [record length]	VARIABLE 80

Examples: 100 OPEN #1:"RS232"
 100 OPEN #2:"RS232/1.BA = 9600.EC.CH"
 100 OPEN #3:"RS232/2,^{2 stop Bits}TW,BA = 110",FIXED 32

In the first example, all default values are assumed on port 1 of the RS232 Interface unit. In the second example, file #2 on port 1 has a baud rate of 9600 bits per second, the echo feature is turned off, and parity checking does occur. In the last example, the printer is connected to port 2 of the RS232 Interface unit, two stop bits are transmitted, the baud rate is 110, and the record type is set to FIXED 32 characters in length.

When you list a *record-type*, specify a length not exceeding 132, the maximum length used by the printer, if you want the output printed in columns. INTERNAL file-type prints the 9-byte internal representation of each character, and DISPLAY prints the ASCII character set. *File-attributes* and file processing are explained further in the "BASIC Reference Section" of the *User's Reference Guide*.

CLOSE #file-number

The CLOSE statement "closes" or discontinues the association between the file specified by the *file-number* and a program. A file must be closed before any pending outputs are printed.

Example: 130 CLOSE #1

PRINT #file-number[:print-list]

This form of the PRINT statement outputs data to the TI-99/4 Printer. If a file has previously been opened for the printer, you must use the same *file-number* in the PRINT statement. If a file has not been opened, one must be opened and assigned to the printer before the PRINT statement can be used to output to the printer.

In general, the computer performs and sends a PRINT statement to the printer the same way it does to the display screen. However, data are not printed until the computer encounters a PRINT statement with an ending comma or semicolon, until the file is closed, or until the record exceeds the length specified in the OPEN statement.

For more information on the *print-list* clause, see the "BASIC Reference Section" of the *User's Reference Guide*.

Example: 100 OPEN #1:"RS232"
200 PRINT #1:"THIS IS A PRINT STATEMENT"
300 CLOSE #1
400 END

LIST file-name[:line-list]

When the LIST command is entered, the computer prints the entire program or the lines specified in the *line-list*.

Examples: *Print the entire program:*
LIST "RS232"

Print program lines 100-300:
LIST "RS232":100-300

Software Control Codes — Text Mode

The TI-99/4 Printer has two standard operation modes. One is the Text Mode, which prints corresponding characters on normal ASCII (American Standard Code for Information Interchange) coded inputs. The other is the Graphic Mode which permits printing of pictures and images in dot configurations. The Text Mode is described in this section, while the Graphic Mode is presented in a following section.

The TI-99/4 Printer has been designed as a terminal unit capable of various software controls. When software control codes are transferred to the printer, respective operations governed by these codes, such as form feed, line feed, etc., are executed immediately. In order to obtain the maximum benefit from the use of these functions, fully read the following information on software control codes. In this section, the control codes are presented in four groups: print action codes, paper formatting codes, character designation codes, and other codes.

Each of the following software control codes is sent to the printer as the binary equivalent of an ASCII code. In your program, you use the character string function, CHR\$(n), where "n" is the ASCII software control code. For example, to sound the buzzer, you send ASCII code 7 to the printer in the form shown below.

```
100 OPEN #1:"RS232"
200 PRINT #1:CHR$(7)
300 CLOSE #1
400 END
```

Software Control Codes

Print Action Codes	Page Reference
Carriage Return (CR)	26
Line Feed (LF)	26
Vertical Tabulation (VT)	26
Form Feed (FF)	26
Paper Formatting Codes	
<i>Horizontal:</i>	
Tabulation	26
Column Width	27
<i>Vertical:</i>	
Line Spacing	27
Tabulation	28
Form Feed	28
Form Length	29
Skip-over Perforation	29
Character Designation Codes	
Enlarged Printing	30
Condensed Printing	30
Emphasized Printing	31
Double Printing	31
International Character Set	32
Other Codes	
Selection or Disabling of the Printer	32
Selection or Disabling of the Paper-End Detector	32
Bell (Sound the Buzzer)	32
Back Space	32
Termination of Tabulation	32
Access to Graphic Mode	32

Note: Appendix C is a complete listing of software control codes and their functions.

Print Action Codes

CHR\$(13) — ASCII code 13 is the carriage return code. When code 13 is transmitted to the print buffer, all data stored in the print buffer is printed and the paper is advanced one line.

CHR\$(10) — ASCII code 10 is the line feed code. When code 10 is received by the printer, all data in the print buffer is printed and the paper is advanced one line.

CHR\$(11) — ASCII code 11 is the vertical tabulation code. When code 11 is sent to the printer, all data preceding this code are printed and the vertical tabulation is made to a predetermined line position, which is set by codes 27 and 66 (up to eight positions). If no vertical tab position is set by codes 27 and 66, code 11 performs the same function as the line feed code, code 10, and the paper is advanced one line after printing stops.

80

20 positions

CHR\$(12) — ASCII code 12 is the form feed code. Code 12 causes the printer to print all data stored in the print buffer and advances the paper to the next predetermined top-of-form position.

Paper Formatting Codes

Some of the previous codes, such as ASCII code 13 for carriage return, are cancelled at the end of each line and must be set for each new line. Other codes, such as those for horizontal or vertical tabulation, are held in the printer's memory and need only be entered once. These codes can be cancelled by using other software control codes or by turning the printer off.

CHR\$(9) — ASCII code 9 is the horizontal tabulation code. Code 9 causes the printer to perform horizontal tabulation to a predetermined position, which is set by codes 27 and 68 (up to 12 positions). Any tab settings exceeding the predetermined column width are ignored. In the enlarged character mode, the tab setting is not effective and is ignored.

CHR\$(27);CHR\$(68) — When used in conjunction with the horizontal tabulation code (code 9), ASCII codes 27 and 68 specify the horizontal tab stop positions. The format for using this code is:

```
CHR$(27);CHR$(68);CHR$(n1);CHR$(n2); . . . ;CHR$(nk);CHR$(0)
```

where codes 27 and 68 are the horizontal tab codes, "n" denotes the column position where the printhead stops, and code 0 indicates the ending of the tab sequence. The 12 tab stops per line are recognized by the printer, and subsequent tab stops are ignored. The tab stop positions can be specified up to 80 columns in the normal character mode and 132 columns in the condensed character mode. In the enlarged character mode, tabulation is not effective.

Print the first nine letters of the alphabet in three columns with the first beginning in column position 1, the second in position 10, and the third in position 15. The format is:

```
OPEN #1:"RS232"  
PRINT #1:CHR$(27);CHR$(68);CHR$(10);CHR$(15);CHR$(0);"ABC";  
CHR$(9);"DEF";CHR$(9);"GHI"
```

Code 68 is the ASCII code for the letter "D", which can be inserted directly in the program. The program in TI BASIC is as follows.

```

100 OPEN #1:"RS232"
200 PRINT #1:CHR$(27);"D";CHR$(10);CHR$(15);CHR$(0);"ABC";
CHR$(9);"DEF";CHR$(9);"GHI"   Col   Col   Col
300 CLOSE #1                   (1)
400 END
    
```

When you run this program, the printer prints:

ABC DEF GHI

CHR\$(27);CHR\$(81) — ASCII codes 27 and 81 control the print column width. The format for using these codes is:

```
CHR$(27);CHR$(81);CHR$(n)                      OK
```

where codes 27 and 81 are the column width codes, and "n" is the print column width you select. The maximum column width has certain limits depending on the type of characters you want to print. For normal characters, the maximum value for n is 80; for condensed characters, 132; for enlarged characters, 40; and for condensed-enlarged characters, 66.

CHR\$(27);CHR\$(65) — ASCII codes 27 and 65 specify the amount of line spacing in the line feed function. The format for using this code is:

```
CHR$(27);CHR$(65);CHR$(n)
```

where codes 27 and 65 are the line spacing codes, and "n" is a decimal number between 1 and 85, inclusive. Each integer value of n increases the paper advancement by 1/72 inch. Since the distance between any two dot wires of the printhead is 1/72 inch, any line spacing in increments proportional to the distance between the dot wires can be established.

Example: Print the word HELLO on two lines with 7/72 inch spacing between lines. The format is:

```

OPEN #1:"RS232"
PRINT #1:CHR$(27);CHR$(65);CHR$(7);"HELLO";CHR$(13);CHR$(10);"HELLO"
    
```

where code 65 is the ASCII code for the letter "A", which can be inserted directly in the program. Code 13 indicates a carriage return, and code 10 is for the line feed. The program to print these two lines is as follows.

```

100 OPEN #1:"RS232"
200 PRINT #1:CHR$(27);"A";CHR$(7);"HELLO";CHR$(13);CHR$(10);"HELLO"
300 CLOSE #1
400 END
    
```



CHR\$(27);CHR\$(48) — When you send ASCII codes 27 and 48 to the printer, the subsequent spacing between lines is set to 1/8-inch.

CHRS(27);CHRS(50) — When the printer receives ASCII codes 27 and 50, the spacing between lines is set to either 1/6 or 1/8 inch depending on the initial condition of an internal DIP switch. (See Appendix D for more information on the setting of DIP switches.)

CHRS(11) — ASCII code 11 is used to advance the paper to predetermined vertical tabulation positions. (See codes 27 and 66 below.)

CHRS(27);CHRS(66) — ASCII codes 27 and 66 specify up to ²⁰eight vertical tab stop positions. If the form length is set to 66 lines when power is initially applied, the last tab stop should be less than 66 to avoid printing on the next page. If you use more than one tab stop, you must arrange them in incremental numerical order. To set vertical tabs, use code 11. After the vertical tab stops are established, they remain set until new stops are specified. If you do not set any stops, ~~code 11 behaves like the line feed code and the paper advances one line after printing.~~ The format for using this code is:

(10x see Note CHRS(11))

```
CHRS(27);CHRS(66);CHRS(n1);CHRS(n2); . . . ;CHRS(nn);CHRS(0)
```

where codes 27 and 66 are the vertical tab code, "n" is the line number, and code 0 indicates the end of the vertical tab sequence.

Example: Set vertical tabs for the fourth, sixth, and tenth lines from the first print line. Print ABC on the first line, DEF on the fourth line, GHI on the sixth line, and JKL on the tenth line. The format is:

```
OPEN #1:"RS232"
PRINT #1:CHRS(27);CHRS(66);CHRS(4);CHRS(6);CHRS(10);CHRS(0);"ABC";
CHRS(11);"DEF";CHRS(11);"GHI";CHRS(11);"JKL"
```

where code 66 is the ASCII code for the letter 'B', which can be inserted directly in the program, and code 11 is the vertical tab code.

The TI BASIC program is as follows. Notice that line 200 sets the vertical tab stops and line 300 outputs the text and tab commands to the printer.

```
100 OPEN #1:"RS232"
200 PRINT #1:CHRS(27);"B";CHRS(4);CHRS(6);CHRS(10);CHRS(0)
300 PRINT #1:"ABC";CHRS(11);"DEF";CHRS(11);"GHI";CHRS(11);"JKL"
400 CLOSE #1
500 END
```

CHRS(12) — ASCII code 12 is the software control code for the form feed function. See "Print Action Codes" section for more information.

CHR\$(27);CHR\$(67) — ASCII codes 27 and 67 specify the form length which is determined by the number of lines on the paper. The maximum form length is 127 lines with the line spacing specified by codes 27 and 65. When the form length is not programmed by codes 27 and 67, one page is designated as having either 66 or 72 lines depending on the setting on an internal DIP switch. (See Appendix D for information on setting DIP switches.) The format for using these codes is:

Same CHR\$(27);CHR\$(67);CHR\$(n) (27) (67) ~~65~~ (72)

where codes 27 and 67 control the form length, and "n" is the number of lines.

Example: Set the form length at 75 lines. Code 67 is the ASCII code for the letter "C", which can be inserted directly in the program. The TI BASIC program is as follows.

```
100 OPEN #1:"RS232"
200 PRINT #1:CHR$(27);"C";CHR$(75)
300 CLOSE #1
400 END
```

ASCII codes 27 and 67 can also be used to specify the form length in inches instead of lines. The format when specifying form length in inches is:

CHR\$(27);CHR\$(67);CHR\$(0);CHR\$(m)

where codes 27 and 67 are the form length code, code 0 indicates that the length is to be specified in inches, and "m" is the number of inches. The maximum length that can be specified is 22 inches.

CHR\$(27);CHR\$(78) — ASCII codes 27 and 78 set the skip-over perforation function and determine the number of lines to be skipped. The format for using these codes is:

Same CHR\$(27);CHR\$(78);CHR\$(n)

where codes 27 and 78 are the skip-over perforation codes, and "n" is the number of lines to be skipped at the bottom of the page. Notice that the value of n cannot be set greater than the form length specified by codes 27 and 67.

When the current form length is changed with codes 27 and 67, the number of lines previously set for skipping over the perforation is cancelled. When this happens, you must use codes 27 and 78 to reset the number of lines to be skipped over. If the number of lines to be skipped over is not set using these codes or the internal DIP switch for this function is off (see Appendix D), the amount of skip-over is automatically set to one inch.

CHR\$(27);CHR\$(79) — When you send ASCII codes 27 and 79 to the printer, the amount of skip over the perforation set by codes 27 and 78 is cancelled.

Same

Character Designation Codes

Character designation codes can be used to emphasize, condense, and enlarge characters. Once these codes are entered, they remain in effect until a carriage return (CR) or line feed (LF) is received by the printer. Thus, to combine two types of character designations on one line, you need to disable the automatic addition of a carriage return at the end of each line by adding ".CR" to the OPEN statement (i.e., OPEN #1:"RS232.CR"). Then use the TAB command to move the printhead to the proper position for the second type of character designation (see the second example in the "Getting Started" section). When you are finished, send the printer a CR and LF (ASCII codes 13 and 10).

CHRS(14) — ASCII code 14 activates the printing of enlarged characters. When you send code 14 to the printer, all data that follows it in the same line is printed out in enlarged (double width) characters. This code is in effect until cancelled by sending the printer code 20. Since this code can be used at any column position on a line, normal and enlarged characters can be mixed on the same line.

Example: Print the first nine letters of the alphabet with the middle three printed as enlarged characters. The TI BASIC program is as follows.

```
100 OPEN #1:"RS232"  
200 PRINT #1:"ABC";CHRS(14);"DEF";CHRS(20);"GHI"  
300 CLOSE #1  
400 END
```

CHRS(15) — ASCII code 15 activates the printing of condensed characters. When you send the printer code 15, all data that follows it are printed in condensed characters. Code 15 can be used at any column position on the line, but all characters or symbols on the line are printed in condensed form; normal and condensed characters cannot be mixed on the same line. This code is in effect until cancelled by sending the printer code 18.

When printing condensed characters, the capacity of the print buffer becomes 132 columns per line. When code 14 is received after code 15, condensed-enlarged characters (double the width of condensed characters) are printed. Condensed-enlarged printing is cancelled by code 20 or by a line feed, code 10.

Example: Print the first five letters of the alphabet in condensed form and the next five in condensed-enlarged form. The TI BASIC program is as follows.

```
100 OPEN #1:"RS232"  
200 PRINT #1:CHRS(15);"ABCDE";CHRS(14);"FGHIJ";CHRS(20)  
300 CLOSE #1  
400 END
```

CHRS(17);CHRS(14) — These ASCII codes function the same as code 14.

CHRS(17);CHRS(15) — These ASCII codes function the same as code 15.

CHRS(20) — ASCII code 20 cancels code 14 (stops printing enlarged characters and returns to normal characters).

CHR\$(18) — ASCII code 18 cancels code 15 (stops printing condensed characters and returns to normal characters).

CHR\$(27);CHR\$(69) — ASCII codes 27 and 69 activate the printing of emphasized characters. Emphasized printing gives the vertical lines in each character a stronger impression on the paper. This code can be used in any column position on a line, but all characters on the line containing codes 27 and 69 are printed as emphasized characters. The printing of emphasized characters is in effect until cancelled by sending the printer codes 27 and 70. The speed of the printhead reduces to 40 characters per second while it is printing emphasized characters.

Example: Print the first five characters of the alphabet as emphasized characters. Code 69 is the ASCII code for the letter E, which can be inserted directly in the program. The TI BASIC program is as follows.

```
100 OPEN #1:"RS232"
200 PRINT #1:CHR$(27);"E";"ABCDE";CHR$(27);CHR$(70)
300 CLOSE #1
400 END
```

CHR\$(27);CHR\$(70) — ASCII codes 27 and 70 cancel the emphasized printing mode. Note that 70 is the ASCII code for the letter F, which can be inserted directly in your program.

CHR\$(27);CHR\$(71) — ASCII codes 27 and 71 activate double printing. Double printing gives the horizontal lines in each characters a stronger impression on the paper. This code can be used in any column position on a line, but all characters on the line containing codes 27 and 71 are printed with double printing. Double printing of characters is in effect until cancelled by sending the printer codes 27 and 72. The speed of the printhead reduces to 40 characters per second during double printing.

Example: Print the first five characters of the alphabet using double printing. Code 71 is the ASCII code for the letter G, which can be inserted directly in the program. The TI BASIC program is as follows.

```
100 OPEN #1:"RS232"
200 PRINT #1:CHR$(27);"G";"ABCDE"
300 PRINT #1:CHR$(27);CHR$(72)
400 CLOSE #1
500 END
```

CHR\$(27);CHR\$(72) — ASCII codes 27 and 72 cancel the double printing mode. Note that 72 is the ASCII code for the letter H, which can be inserted directly in your program.

CHRS(27);CHRS(82) — ASCII codes 27 and 82 specify one of eight possible international character sets contained in the TI-99/4 Printer. The format for using this code is:

CHRS(27);CHRS(82);CHRS(n)

where codes 27 and 82 are the character set codes, and "n" represents one of the following countries.

n	Country
0	U.S.A.
1	France
2	Germany
3	England
4	Denmark
5	Sweden
6	Italy
7	Spain

Other Codes

CHRS(17) — ASCII code 17 enables the printer to receive data. If the printer receives this code while it is active, all data stored prior to the receipt of code 17 is ignored.

CHRS(19) — ASCII code 19 disables the printer so that it cannot receive data. Once the printer is placed in this state, it does not receive data unless it first receives code 17.

CHRS(27);CHRS(56) — ASCII codes 27 and 56 invalidate the paper-end detector function, making it possible to transmit data even if there is no paper in the printer. You can use these codes to print information down to the last line of the last page.

CHRS(27);CHRS(57) — ASCII codes 27 and 57 cancel the condition set by codes 27 and 56 and reactivate the paper-end detector. If the paper-end detector is operational and there is no paper, the printer cannot receive data.

CHRS(7) — When you send the printer ASCII code 7, the buzzer sounds for about one second.

CHRS(8) — ASCII code 8 is a back space code; it cancels the data immediately preceding this code, so that one byte of data stored prior to code 8 is cleared from the print buffer as though that data had not been transferred from the Home Computer. Note that this code is valid only in the Text Mode.

CHRS(0) — ASCII code 0 terminates a tabulation sequence. The lack of code 0 causes incorrect data printout.

CHRS(27);CHRS(75) — When entered in the Text Mode, ASCII codes 27 and 75 cause the printer to switch to normal-density graphic printing.

CHRS(27);CHRS(76) — When entered in the Text Mode, ASCII codes 27 and 76 cause the printer to switch to dual-density graphic printing.

Graphic Mode

Most of the software control codes discussed in the previous sections are normally used in the Text Mode. The software control codes for the Graphic Mode are discussed in this section. The TI-99/4 Printer allows you to control each of eight wires in the printhead independently by programming them in the Graphic Mode. To switch the printer from the Text Mode to the Graphic Mode, send one of two control codes to the printer, as explained in the following sections.

IMPORTANT NOTE

To use the full capabilities of the Graphics Mode, you must set an internal switch, SW2-1, to the OFF position. See *Appendix D, Table D2*, for details.

Normal-Density Graphic Printing

To switch the printer from the Text Mode to the normal-density Graphic Mode, use ASCII codes 27 and 75. The format for using these codes is:

```
CHR$(27);CHR$(75);CHR$(n1);CHR$(n2)
```

where codes 27 and 75 are the software control codes, and "n₁" and "n₂" define the amount of graphic data to be transferred. The n₁ value represents two low-order digits of a decimal code, while the n₂ value represents two high-order digits. In normal-density Graphic Mode processing, the maximum number of dot positions that can be printed per line is 480. Any values of n₁ and n₂ specified in excess of 480 dot positions are ignored.

Example: Check the normal-density graphic printing of the TI-99/4 Printer. Use 80 for n₁ and 0 for n₂. To print a solid bar, use ASCII code 255 for the graphic data.

The format is:

```
OPEN #1:"RS232.CR.DA=8"
PRINT #1:CHR$(27);CHR$(75);CHR$(80);CHR$(0)
PRINT #1:CHR$(255)
```

where code 75 is the ASCII code for the letter "K", which can be inserted directly in the program. The TI BASIC program is as follows.

```
100 REM NORMAL-DENSITY GRAPHIC PRINTING
110 OPEN #1:"RS232.CR.DA=8"
120 FOR J=1 TO 3
130 PRINT #1:CHR$(27);"K";CHR$(80);CHR$(0)
140 FOR N=1 TO 80
150 PRINT #1:CHR$(255);
160 NEXT N
170 NEXT J
180 CLOSE #1
190 END
```

Mixing of text data and graphic data on the same line is possible.

Text (20 Characters)	Code 27	K	n = 480 Graphic Mode Data	Next Data
----------------------	---------	---	---------------------------	-----------

When text and graphics are mixed on the same line, text uses six columns of dots per character. Thus, in the diagram above, 20 characters in the Text Mode correspond to 120 graphic positions ($20 \times 6 = 120$). The result is that 360 ($480 - 120 = 360$) bit positions remain in the Graphic Mode. If 480 data values are entered as Graphic Mode characters, the first 360 can be printed, but the remaining 120 data are ignored and are therefore not printed.

Dual-Density Graphic Printing

To switch the printer from the Text Mode to the dual-density Graphic Mode, use software control codes 27 and 76. The format for using these codes is:

```
CHR$(27);CHR$(76);CHR$(n1);CHR$(n2)
```

where codes 27 and 76 are the software control codes, and "n₁" and "n₂" define the amount of graphic data to be transferred. Data is transferred to the printer in the same sequence as in the normal-density Graphic Mode, but graphic printing is performed with twice the dot density in the horizontal direction. Thus, in the dual-density Graphic Mode, 960 dot positions can be printed per line, which produces denser graphics.

Example: Check the dual-density graphic printing of the TI-99/4 Printer. Use 80 for n₁ and 0 for n₂. To print a solid bar, use ASCII code 255 for the graphic data.

The format is:

```
OPEN #1:"RS232"
PRINT #1:CHR$(27);CHR$(76);CHR$(80);CHR$(0)
PRINT #1:CHR$(255)
```

Code 76 is the ASCII code for the letter "L", which can be inserted directly into the program. The TI BASIC program is as follows.

```
100 REM DUAL-DENSITY GRAPHIC PRINTING
110 OPEN #1:"RS232.CR"
120 FOR J = 1 TO 6
130 PRINT #1:CHR$(27);"L";CHR$(80);CHR$(0)
140 FOR N = 1 TO 80
150 PRINT #1:CHR$(255);
160 NEXT N
170 NEXT J
180 CLOSE #1
190 END
```

One of the default conditions for the RS232 Interface unit automatically adds a carriage return (CR) and a line feed (LF) at the end of each variable length DISPLAY type record (see "TI BASIC Statements and Commands" and the "Software Switch Options" section of the RS232 Interface owner's manual). To print up to 480 dot positions per line in the normal-density Graphic Mode or up to 960 dot positions in the dual-density Graphic Mode, the automatic addition of the CR and LF must be suppressed. To do this, add ".CR" to the OPEN statement (i.e., OPEN #1:"RS232.CR").

Obtaining n_1 and n_2

When using the TI-99/4 Printer in the Graphic Mode, you must send the number of data (n_1 and n_2) to the printer in decimal form immediately following the codes for the Graphic Mode, codes 27 and 75 or codes 27 and 76. If, for example, the number of Graphic Mode data is 200, then n_1 and n_2 are derived as follows:

$$\begin{aligned}n_1 &= (\text{Number of data}) \text{ MOD } 128 \text{ (for } .DA = 7; \text{ for} \\ &\quad .DA = 8, \text{ use MOD } 256.) \\ &= 200 \text{ MOD } 128 \\ &= \text{Remainder of } (200/128) \\ &= 72\end{aligned}$$

$$\begin{aligned}n_2 &= \text{INT} (\text{Number of data}/256) \\ &= \text{INT} (200/128) \\ &= \text{INT} (1.5625) \\ &= 1\end{aligned}$$

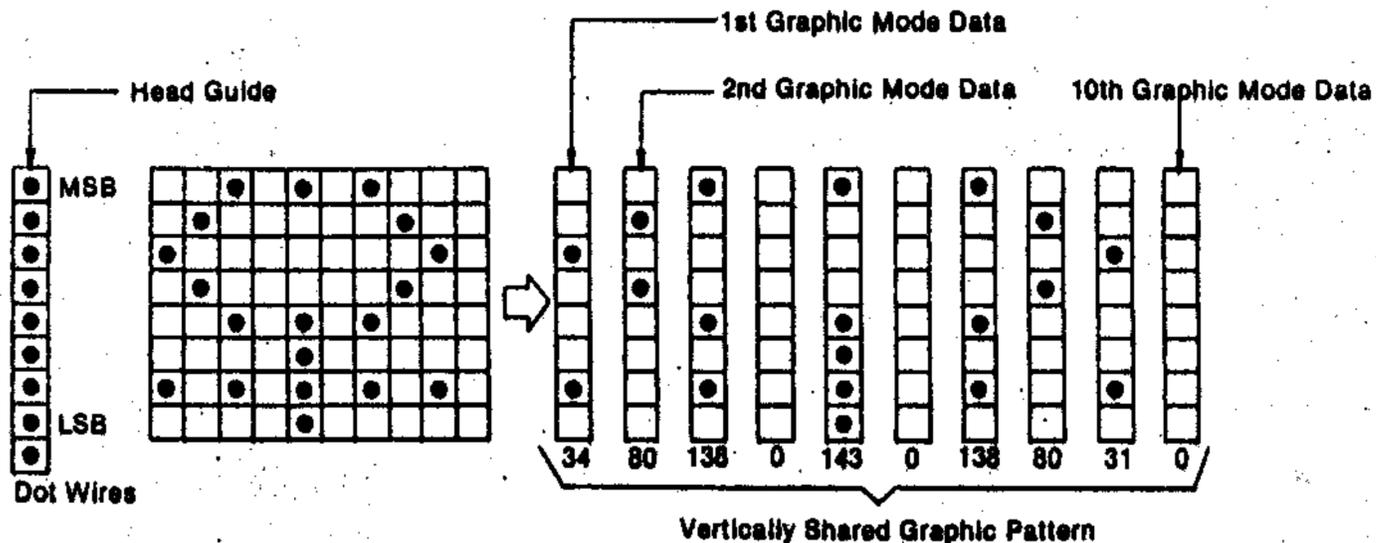
Note: When $.DA = 7$, the number of graphics mode data can only be within the ranges 1 through 127 and 256 through 383 for normal-density graphics. For dual-density graphics, the number of graphics mode data can only be within the ranges 1 through 127, 256 through 383, 512 through 639, and 768 through 895. If it is necessary to have graphics mode data outside of these ranges, you can set an internal switch, SW2-1, to the OFF position. See Appendix D, Table D2, for details.

In determining n_1 , MOD refers to a modulo calculation in which you use the remainder of the division of one number into another. In this case, 128 divides into 200 one time with a remainder of 72. In determining n_2 , you want the integer value of the number of data divided by 128. In this case, 200 divided by 128 yields one and a decimal fraction. The integer value of the result is 1.

Note: When you are using the full graphics capability (all 8 dot wires) of the printer, you must use MOD 256 instead of MOD 128. Remember, you must also specify eight bits in the OPEN statement (i.e., OPEN #1: "RS232.DA = 8"), and you must set the appropriate DIP switch inside the printer (see Appendix D).

Graphics Programming Examples

You can generate your own graphic pattern or characters by translating the dot wire positions to decimal form and using this information to write a TI BASIC program. In the example shown below, the character to be generated is divided into 10 vertical columns with each position in the column corresponding to one of the wires in the printhead. Each vertical column then has an equivalent binary value which is translated to decimal form (see Appendix B). These decimal numbers become the data in the TI BASIC program.



Example of Graphic Pattern Formation

In the diagram above, the top dot wire is not activated when the printer is set to the default condition for the RS232 Interface unit in which only seven bits are used to transmit data. Unless you specify eight bits in the OPEN statement and set the appropriate DIP switch in the printer as described in Appendix D, only the lower seven dot wires are activated.

Codes 27 and 76 are the ASCII codes for dual-density graphic printing. Code 76 is the ASCII code for the letter "L", which can be inserted directly in the program. The value for n_1 is 10 and for n_2 is 0, and the data in lines 170 and 180 are the decimal equivalents of the binary representation of each column for the character to be generated. The TI BASIC program is as follows.

```

100 REM GRAPHIC MODE PRINTING (DUAL-DENSITY)
110 OPEN #1:"RS232"
120 PRINT #1:CHR$(27);"L";CHR$(10);CHR$(0);
130 FOR N= 1 TO 10
140 READ A
150 PRINT #1:CHR$(A);
160 NEXT N
170 DATA 34,80,138,0,143
180 DATA 0,138,80,34,0
190 CLOSE #1
200 END
    
```

When you run this program, notice that the top dots in the center of the character are not printed because the top dot wire is not activated.

EXAMPLE PROGRAM FOR THE TI-99/4 PRINTER

The preceding sections on Software Control Codes contain several examples of TI BASIC programs which you can use in the Text or Graphic Mode. This section contains one additional example. The program prints the TI BASIC character set shown on the Home Computer's display screen. This character set is divided into four columns. The decimal code and its corresponding character are printed for the entire set.

Each TI BASIC character is printed in a 5x6 dot matrix. The character codes range from 32 through 95. All of the characters and character codes 96 through 159 may be redefined as explained in *Beginner's BASIC* and the *User's Reference Guide*.

```

100 REM-99/4 TI BASIC CHARACTER SET
110 OPEN #1:"RS232"
120 FOR K = 32 TO 47
130 PRINT #1:K;CHR$(K);"   ";
140 PRINT #1:K + 16;CHR$(K + 16);"   ";
150 PRINT #1:K + 32;CHR$(K + 32);"   ";
160 PRINT #1:K + 48;CHR$(K + 48)
170 NEXT K
180 CLOSE #1
190 END

```

Line 110 opens a file for the printer via the RS232 Interface unit. The FOR-NEXT loop in lines 120 through 170 instructs the printer to print 16 lines beginning with character code 32. Lines 130 through 160 cause the characters to be printed in four columns: the first column contains characters 32 through 47 (line 130); the second, characters 48 through 63 (line 140); the third, characters 64 through 79 (line 150); and the fourth, characters 80 through 95 (line 160). Notice that you need to leave three spaces between the quotation marks in lines 130, 140, and 150 in order to provide spacing between the columns. Line 180 closes the file for the printer.

Printed output from the program for the TI BASIC character set:

32		48	0	64	o	80	P
33	!	49	1	65	A	81	Q
34	"	50	2	66	B	82	R
35	#	51	3	67	C	83	S
36	\$	52	4	68	D	84	T
37	%	53	5	69	E	85	U
38	&	54	6	70	F	86	V
39	?	55	7	71	G	87	W
40	(	56	8	72	H	88	X
41	)	57	9	73	I	89	Y
42	*	58	:	74	J	90	Z
43	+	59	;	75	K	91	[
44	,	60	<	76	L	92	\
45	-	61	=	77	M	93]
46	.	62	>	78	N	94	^
47	/	63	?	79	O	95	_

An example of a program used to generate a character in the normal-density Graphic Mode is shown below.

```
100 REM GRAPHIC MODE PRINTING (NORMAL-DENSITY)
110 OPEN #1:"RS232"
120 PRINT #1:CHR$(27)&"K";CHR$(12);CHR$(0);
130 FOR I=1 TO 12
140 READ A
150 PRINT #1:CHR$(A);
160 NEXT I
170 DATA 4,10,26,58,103,231
180 DATA 231,103,58,26,10,4
190 CLOSE #1
200 END
```

The character printed by this program appears below.

APPENDIX B — ASCII Code Table

To make a conversion from binary to decimal form, the first four bits are defined from the column heading and the second four bits are defined from the row heading. For example, break the binary number 01010000 into two equal parts (0101 and 0000), find 0101 at the top of the table and 0000 on the left side. The intersection of this column and row is the decimal number 80.

Most Significant Bits

		Most Significant Bits																	
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F		
Hex. No.	Binary No.	00000	00001	00010	00011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111		
0	0000	NUL	SP	0	@	P	p	NUL	SP	0	@	P	p	NUL	SP	0	@	P	p
1	0001	DC1	!	1	A	Q	a	DC1	!	1	A	Q	a	DC1	!	1	A	Q	a
2	0010	DC2	"	2	B	R	b	DC2	"	2	B	R	b	DC2	"	2	B	R	b
3	0011	DC3	#	3	C	S	c	DC3	#	3	C	S	c	DC3	#	3	C	S	c
4	0100	DC4	\$	4	D	T	d	DC4	\$	4	D	T	d	DC4	\$	4	D	T	d
5	0101		%	5	E	U	e		%	5	E	U	e		%	5	E	U	e
6	0110		&	6	F	V	f		&	6	F	V	f		&	6	F	V	f
7	0111	BEL		7	G	W	g	BEL		7	G	W	g	BEL		7	G	W	g
8	1000	BS	(	8	H	X	h	BS	(	8	H	X	h	BS	(	8	H	X	h
9	1001	HT	)	9	I	Y	i	HT	)	9	I	Y	i	HT	)	9	I	Y	i
A	1010	LF	.		J	Z	j	LF	.		J	Z	j	LF	.		J	Z	j
B	1011	VT	ESC	+	:	K	k	VT	ESC	+	:	K	k	VT	ESC	+	:	K	k
C	1100	FF		<	L	\	l	FF		>	L	\	l	FF		>	L	\	l
D	1101	CR	-	=	M	]	m	CR	-	=	M	]	m	CR	-	=	M	]	m
E	1110	SO		>	N	^	n	SO		>	N	^	n	SO		>	N	^	n
F	1111	SI	/	?	O	-	o	SI	/	?	O	-	o	SI	/	?	O	-	o

Least Significant Bits

APPENDIX C — Software Control Codes

Note: Codes preceded by ASCII code 27 can be entered as equivalent characters in quotation marks without using the CHR\$(n) format.

Function	ASCII Code(s)	Format	Page Reference
Terminate tabulation	0	CHR\$(0)	32
Sound the buzzer	S 7	CHR\$(7)	32
Back space	S 8	CHR\$(8)	32
Horizontal tabulation	S 9	CHR\$(9)	26
Line feed	S 10	CHR\$(10)	26
Vertical tabulation	S 11	CHR\$(11)	26
Form feed	S 12	CHR\$(12)	26
Carriage return	S 13	CHR\$(13)	26
Print enlarged characters -	S 14	CHR\$(14)	30
Print condensed characters-	S 15	CHR\$(15)	30
Select printer	S 17	CHR\$(17)	32
Turn off condensed printing	18	CHR\$(18)	31
Disable printer	S 19	CHR\$(19)	32
Turn off enlarged printing	S 20	CHR\$(20)	30
Prefix for the following codes	S 27	CHR\$(27)	
Set line spacing to 8 per inch	S 27; 48	CHR\$(27);"0"	27
Set line spacing to 6 per inch	S 27; 50	CHR\$(27);"2"	28
Disable paper-end detector	S 27; 56	CHR\$(27);"8"	32
Select paper-end detector	S 27; 57	CHR\$(27);"9"	32
Set line spacing from 1/72 to 85/72 inch	A S 27; 65	CHR\$(27);"A"	27
Set up to 8 vertical tab positions	27; 66 - 80	CHR\$(27);"B" - P	28
Set form length up to 127 lines or 22 in.	A S 27; 67	CHR\$(27);"C"	29
Set up to <u>12</u> horizontal tab positions	S 27; 68 -	CHR\$(27);"D"	26
Turn on emphasized character printing	S 27; 69	CHR\$(27);"E"	31
Turn off emphasized character printing	S 27; 70	CHR\$(27);"F"	31
Turn on double printing	S 27; 71	CHR\$(27);"G"	31
Turn off double printing	S 27; 72	CHR\$(27);"H"	31
Turn on normal-density graphic printing	A S 27; 75	CHR\$(27);"K"	32
Turn on dual-density graphic printing	A S 27; 76	CHR\$(27);"L"	32
Set skip-over perforation	S 27; 78	CHR\$(27);"N"	29
Release skip-over perforation	S 27; 79	CHR\$(27);"O"	29
Set a column width	A S 27; 81	CHR\$(27);"Q"	27
Select 1 of 8 international character sets	27; 82 - 55	CHR\$(27);"R" 7	32

64	45,1	42	-	97	a
	45,0	36,1	-	98	b
	83,0	36,0		77	m
	83,1	43,30		82	R
	84	33		52	
	85,1	62		86,1	B 1
	85,0	71		66,2	B 2
	49	35		66,3	B 3
	51	127		18	
	74	89,0		87,1	
	121	89,1		87,0	
	122				

APPENDIX F — Error Codes

Listed below are the error codes related to the operation of TI BASIC programs that use the TI-99/4 Printer.

- OPEN:** CODE 00 — Device named in the statement or command cannot be opened.
CODE 02 — A software switch option entry is in error, such as incorrect first two characters of an option, invalid BAUD rate, or incorrect number of data bits, or the RELATIVE record type is specified in the OPEN statement.
CODE 06 — A hardware error occurred and the device cannot be opened.
- INPUT:** CODE 24 — INTERNAL data-type record is too large to be read into the buffer space allocated.
CODE 26 — Some type of hardware error occurred. Also caused by pressing CLEAR to stop the reception of a pending or in progress operation.
- PRINT:** CODE 36 — See INPUT code 26.
- OLD:** CODE 50 — Program cannot be loaded from the specified device.
CODE 52 — Attempting to use .EC, .CR, .LF, .NU, or .DA switch with OLD statement. Also see OPEN code 02.
CODE 54 — The program is too large to be loaded.
CODE 56 — See INPUT code 26.
- SAVE:** CODE 60 — Program cannot be saved to the specified device.
CODE 62 — Attempting to use .EC, .CR, .LF, .NU, or .DA switch with SAVE statement. Also see OPEN code 02.
CODE 66 — See INPUT code 26.
- MISC. ERROR CODES:**
CODE 43,73,83,93 — Executing an illegal command.