CMT HPIL LCD DISPLAY MANUAL

CONTENTS

CONTENTS

INTRODUCTION

The CMT LCD display interface provides an 8 line by 40 character display for your HPIL controller through the HP-IL interface loop. This manual describes the operation of the CMT LCD.

Generally, there are two types of HPIL controllers: BASIC language and RPN language. Examples of BASIC language controllers are the HP-75C/D and the HP-71B. RPN language controllers are the HP-41C/CV/CX and the CMT MC-II/41M. Since the two different types of controllers have different commands to perform similar operations this manual is split up into two operational sections. The first section describes the functional operation of the CMT LCD and use with various BASIC and RPN controllers. The second section lists its escape sequence control codes. When referring to examples in the text, a BASIC type controller is assumed.

If you have any questions regarding the use of the CMT LCD, please call or write Corvallis MicroTechnology at the address given below:

Corvallis MicroTechnology, Inc.
Grant Plaza
895 NW Grant Ave.
Corvallis, Oregon 97330

Phone: (503) 752-5456
FAX: (503) 752-4117
TWX: (510) 600-5262

SECTION I - FUNCTIONAL OPERATION

INSTALLATION

POWER

CMT recommends the use of a 9 volt alkaline battery or 9 volt lithium battery for your CMT LCD. A carbon-zinc battery will work, however, it will provide significantly less battery life. For a rechargeable battery, CMT recommends our 9 volt NiCad battery. This battery is made exclusively for CMT products. Other NiCad batteries can not be recharged while in the CMT LCD.

Alkaline Battery - This battery is inserted by removing the battery door on the bottom of the CMT LCD. The door is removed by sliding it away from the center of the case. Attach the battery clip wires onto the 9 volt battery and insert the battery into the CMT LCD battery compartment. Re-attach the battery door by sliding it toward the center of the CMT LCD case. The door should latch when closed.

NiCad Battery - This optional battery is inserted by removing the battery door on the bottom of the CMT LCD. The door is removed by sliding it away from the center of the case. Attach the battery clip wires onto the NiCad battery. Attach the wire from the battery to the electrical post in the battery compartment. Re-attach the battery door by sliding it toward the center of the CMT LCD case. The door should latch when closed.

DC Jack - An external power jack has been provided to allow the user to supply power to the CMT LCD from other sources. This may be a wall transformer or a 6-12 volt battery. The DC jack accepts a 2.1 mm DC power plug. The inner tip is positive and the outer sleeve is the negative terminal. The external power supply should be able to supply up to 200ma of current. To recharge the CMT NiCad battery pack properly, the DC external supply should be 12 volts. To prevent the internal battery from draining while using an external 6V battery for the main power source, remove the internal battery from the CMT LCD. The CMT wall adapter acts as an AC/DC convertor for the 9 volt alkaline and also as a recharger for the 9 volt NiCad battery.

INTERFACE CONNECTIONS

Connection to your HPIL loop is provided by the two sets of wires which are near the DC Jack. Familiarity with HPIL is assumed. If you are not familiar with HPIL, consult the owners manual of your HPIL controller. The large connector is "IN" and the small connector is "OUT".

The CMT LCD is a device on the HPIL loop. The CMT LCD can be used as a display device and/or assigned as a printer device. A display device duplicates the HPIL controller display, including all keyboard input and all display output. A printer device is used for all output from the PRINT and PLIST statements. For further detail on display and printer devices, refer to the controller's HPIL interface owner's manual.

RESETTING THE CMT LCD

The CMT LCD does not have a reset switch. Should you wish to reset the CMT LCD send an Esc z sequence to the display. Escape sequences are covered in section II of the manual. If the CMT LCD still does not reset, remove the battery and AC adapter from the device and allow one minute for the internal capacitors to discharge before restoring power. Be careful when connecting the battery or AC adapter that there is not a lot of jiggling going on. This jiggling will cause intermittent power to the CMT LCD and perhaps get it "locked up". It can be recovered from the "locked up" state by removing the power source and making a clean re-connection.

FRONT PANEL OPERATION

SOFTKEYS

The CMT LCD has nine keys. The key on the far left is called the "MODE" key. It's purpose is to turn the CMT LCD on and to toggle through the different softkey modes of the display. The other eight keys are labeled F1 through F8 and are called softkeys. The term softkeys is derived from the fact that the keys are programmable through software to perform different functions. There are three softkey modes. The modes are:

* off mode
* default mode
* user defined mode

If the key is active, pressing the key will cause its programmed function to be performed. Continually holding the key down will cause it to repeat.

In the off mode, no softkey labels are shown on the display and all eight lines of the display are used. The softkeys functions are also inhibited from operating.

In the default mode, the keys are assigned functions which affect the contents on the display. The labels for these functions are shown on the last line on the display. The labels are:

Label:	OFF	CLR	HOME	END	PgUp	PgDn	RlUp	RlDn
Key:	F1	F2	F3	F4	F5	F6	F7	F8

POWER UP/DOWN

The CMT LCD can automatically power up and down with the HPIL controller if the controller supports sending an HPIL command, "LPD", when it turns off. The CMT LCD will automatically turn on whenever it receives a HPIL frame. The CMT LCD will also turn on when the MODE key is pressed. Consult your controller's HPIL owner's manual for determining it's capabilities.

When the CMT LCD is turned off, the contents of the alpha display memory are saved so that when the display is turned on again, the alpha display contents will be the same as before powering down. The graphics data on the display, if any, will be cleared. To clear the display press the CLR softkey.

VIEWING DISPLAY MEMORY

The remaining softkeys allow you to "page" or scroll through the display buffer memory (workspace) to view characters that have rolled off the screen. Since the operation of these softkeys depends upon the dimensions of the display screen, the following terminology differentiates specific areas.

The "display screen" contains 8 rows, each row is 40 columns wide. The display reserves the bottom line for softkey labels if they are enabled.

The "display memory" consists of 2000 bytes. The display memory is organized as 50 lines of up to 40 characters. However, at any one time the CMT LCD displays up to 8 of these lines. The remaining lines may be displayed by scrolling them on the screen. As characters are transmitted to the display, they are stored in the display memory. The display memory only holds the last 50 lines written to the display. All other previous lines are lost.

The "screen window" occupies screen rows 0 to 7, or rows 0 to 6 if softkey labels are enabled. This is your viewing area into "display memory".

The information displayed in the viewing window forms a "page" of data. "Paging" replaces the viewing window with the next or previous set of displayable rows.

You can select which portion of the display memory the CMT LCD displays by pressing the [RlUp] or [RlDn], the [PgUp] or [PgDn], and the [HOME] and [END] softkeys. As the window remains stationary, these escape codes bring different portions of the display memory into view.

[RlUp] rolls (scrolls) the screen up one line. If the last row of the display memory is on the first row of the display screen, no action is performed. [RlDn] rolls the screen down one line. If the first row of the display memory is on the first row of the display screen, no action is performed. [PgUp] displays the next page of display memory. A page consists of 8 lines of display memory, unless the softkeys are enabled, then a page consists of 7 lines. If the last line of display memory is already on the screen when the [PgUp] function is performed, the display is rolled up until the last line of display memory appears on the first display screen row. [PgDn] displays the previous page of display memory. If the first line of display memory is already on the screen when the [PgDn] softkey is pressed, the operation has no effect.

[END] causes the display memory to roll up, so the last line in display memory occupies the next to last row of the display. The cursor moves to the left margin of the next line. If the last row in display memory is already on the screen in a row other than the last row, the display is not rolled up; the cursor moves to the left margin of the row below the last line. [HOME] moves the cursor to the first character position in the display memory. It rolls any text down as far as possible so the first line in the display memory is on the first line of the display screen.

USING THE CMT LCD WITH THE HPIL CONTROLLER

The following examples of operation assume that the CMT LCD is the first device on the HPIL loop.

HP-71B

The HP-71B will try to assign the CMT LCD automatically as the display device when the controller is turned on. If this action is not desired, execute the DISPLAY IS * statement. To assign the CMT LCD as the display device execute DISPLAY IS LCD.

To assign the CMT LCD as the printer device execute the statement, PRINTER IS LCD. To disable printer output from the CMT LCD type the statement PRINTER IS * or PRINTER IS NULL.

The CMT LCD will automatically power up and down with the HP-71B when it is turned on and off. To disable this feature, execute the SFLAG -21 which inhibits sending the power down command. The CMT LCD may be turned off by executing the SEND LPD command. To turn on the CMT LCD type RESET HPIL @ RESTOREIO. To enable the HP-71B to automatically power the CMT LCD on and off execute the CFLAG -21 command.

When the CMT LCD is turned off, the contents of the alpha display memory are saved so that when the display is turned on again, the display contents will be the same as before powering down. The graphics data on the display, if any, will be cleared. To clear the display, execute the CLEAR LCD statement.

HP-75C/D

The HP-75 without the I/O ROM will have to have the loop assigned with the ASSIGNIO statement. To make the loop address the same as the I/O ROM example type ASSIGNIO ':D1'. The I/O ROM will automatically on powerup assign the CMT LCD as ':D1'. To disable the CMT LCD as the display device type DISPLAY IS *.

To enable the CMT LCD as the printer device type PRINTER IS ':D1'. To disable printer output from the CMT LCD type the statement PRINTER IS *.

The CMT LCD will automatically power up and down with the HP-75 with the I/O ROM installed when it is turned on and off. To disable this feature, execute the AUTOLOOP OFF statement which inhibits sending the power down command. To turn on the CMT LCD type RESTOREIO or ASSIGN LOOP. To enable the HP-75 to automatically power the CMT LCD on and off execute the AUTOLOOP ON command.

When the CMT LCD is turned off, the contents of the alpha display memory are saved so that when the display is turned on again, the display contents will be the same as before powering down. The graphics data on the display, if any, will be cleared. To clear the display execute the CLEAR ':D1' statement.

HP-41C/CV/CX

The HP-41 will use the LCD as an output device similar to a printer. To select the LCD execute:

```
MANIO
1
SELECT
```

Use flags 15 and 16 to set how various operations are displayed on the LCD (see HP82160A manual). Programs can be printed with the PRP command and then looked at by scrolling the display contents up and down with the softkeys. The PRPLOT type functions will not work as they are written specifically for the HP82162 HPIL printer only.

The LCD display can be powered down by the HP-41 by executing the PWRDN function. The LCD display will power on with the PWRUP function on when the HP-41 is turned off and then on. The HP 82183A Extended I/O module allows the user to have more control over the HPIL display, but is not required.

CMT MC-II/41M

The CMT LCD can be selected as the printer device by the following key sequence:

```
[ALPHA] PRN:=HPIL:DISPLAY [ALPHA]
[XEQ] [ALPHA] MODE [ALPHA]
[XEQ] [ALPHA] PRON [ALPHA]
```

Use flags 15 and 16 to set how various operations are displayed on the LCD (see CMT-MCII/41M manual). Programs can be printed with the MPRP command and then looked at by scrolling the display contents up and down with the softkeys.

SECTION II - ESCAPE SEQUENCE PROGRAMMING

SOFTKEY ESCAPE CODES

The user can define the softkeys to perform various actions similar to how it is done with computer terminals. The softkeys are controlled by sending escape codes to the display. The escape codes are ASCII character sequences which are used as commands by the LCD. The escape codes all start with the ASCII character 27 (Escape) and followed by one or more characters.

The CMT LCD allows the user to display softkey labels on the LCD screen. This function allows the user to place labels in the LCD on the last line. This line will always remain unless rewritten, turned off, or a hard reset is performed. This capability allows for designing menu driven operations.

There are eight labels available with up to 4 characters for each label. There are two sets of softkey labels. One is defined by the LCD firmware and the other is programmable by the user. Each of the user defined softkeys can have up to a 40 character string associated with it. This string will be placed in the output buffer and the HPIL controller can read the string. If the output buffer is full or nearly full, parts of the string may be not written to the buffer. The default escape string is:

Default:	Esc p	Esc q	Esc r	Esc s	Esc t	Esc u	Esc v	Esc w
Key:	f1	f2	f3	f4	f5	f6	f7	f8

The escape code syntax to define the user labels is:
Esc &f<key>k<string length>l<label length>D <label><string>

The escape codes to enable and disable the labels are:

Esc &jA display pre-defined labels
Esc &jB display user defined labels
Esc &j@ don't display any labels

The pre-defined labels are:

[OFF]	[CLR]	[HOME]	[END]	[PgUp]	[PgDn]	[RlUp]	[RlDn]
f1	f2	f3	f4	f5	f6	f7	f8

The default user defined labels are:

[f1] [f2] [f3] [f4] [f5] [f6] [f7] [f8]

DISPLAY MEMORY ESCAPE CODES

You can select which portion of the display memory the CMT LCD displays by sending the "RlUp" or "RlDn" escape codes, the "PgUp" or "PgDn", and the "HOME" and "END" escape codes. As the window remains stationary, these escape codes bring different portions of the display memory into view.

Esc S (Roll Up, RlUp) rolls the screen up one line. If the last row of the display memory is on the first row of the display screen, no action is performed. Esc T (Roll Down, RlDn) rolls the screen down one line. If the first row of the display memory is on the first row of the display screen, no action is performed. Esc U (Next Page, PgUp) displays the next page of display memory. A page consists of 8 lines of display memory, unless the softkeys are enabled, then a page consists of 7 lines. If the last line of display memory is already on the screen

when the Next page function is performed, the display is rolled up until the last line of display memory appears on the first display screen row. Esc V (Prev Page, PgDn) displays the previous page of display memory. If the first line of display memory is already on the screen when the prev page operation is performed the operation has no effect.

Esc F (Home down) causes the display memory to roll up, so the last line in display memory occupies the next to last row of the display. The cursor moves to the left margin of the next line. If the last row in display memory is already on the screen in a row other than the last row, the display is not rolled up; the cursor moves to the left margin of the row below the last line. Esc h (Home up) moves the cursor to the first character position in the display memory. It rolls any text down as far as possible so the first line in the display memory is on the first line of the display screen.

CURSOR CONTROL ESCAPE CODES

The cursor is used to determine where the next character is placed on the display screen. There are escape codes which allow the user to move the cursor around the display screen, to change the cursor type and to turn the cursor on and off.

Esc A (Cursor Up) moves the cursor up one line, the cursor does not move past the top line. Esc B (Cursor Down) moves the cursor down one line, the cursor does not move past the bottom line. Esc C (Cursor Right) moves the cursor right one position, if activated at column 39, the cursor moves to column 0 of the next line. If activated at column 39, row 7 (row 6 if softkey labels are enabled), the cursor moves to column 0, row 0. Esc D (Cursor Left) moves the cursor left one position. If activated at column 0, it moves the cursor to column 39 of previous line, the cursor doesn't move past column 0, row 0.

Esc G (Cursor Return) moves the cursor to col 0 on the current line. Esc H (Cursor Home) moves the cursor to col 0, row 0 but does not affect the display memory contents.

Esc Q (Insert Cursor) displays the cursor as an underscore. Esc R (Replace Cursor) displays the current character in inverse video. Esc < (Cursor Off) will not display the cursor but the cursor functions normally. Esc > (Cursor On) will display the cursor. Esc %cr (Cursor Move) will move the cursor to a display address of the form (COL,ROW) where c and r are code numbers for characters c and r. The column address is interpreted as "c modulo 40" and the row address as "r modulo 8" ("r modulo 7" if softkey labels are enabled).

EDIT ESCAPE CODES

Esc J (Clear Display) will clear the display from the cursor position to the bottom of the screen. Esc K (Clear Line) will clear the display from the cursor position to the end of the line. Esc L (Insert Line) will insert a blank line above the line the cursor is on, moving all remaining text down. The last line in the display buffer may be lost if the buffer is full. Esc M (Delete Line) will remove the line the cursor is on and moves all lines below the cursor up. Esc P (Delete Char) will remove the character at the cursor position from the display and adjusts the remaining characters on the line to the left filling the right side with a space.

RESETTING THE DISPLAY

The display can be reset by different methods. There are two different reset states, soft and hard. A soft reset is performed when a "device clear" or "selected device clear" message is received on HPIL. This message is sent when the "CLEAR" or "CLEAR LCD" command is executed. A soft reset is also performed when the escape code Esc E is sent to the CMT LCD. A hard reset is performed when the escape code Esc e is sent to the CMT LCD.

A soft reset performs the following functions:

* clear the HPIL input, output and status buffers
* turn off monitor and function modes
* turns off graphics mode
* set the cursor to location 0,0
* set the replace cursor on
* clear the display buffer and display screen

A hard reset performs the following functions:

* clear the HPIL input, output and status buffers
* turn off monitor and function modes
* turns off graphics mode
* set the cursor to location 0,0
* set the replace cursor on
* clear the display buffer and display screen
* turn on the default softkey labels
* reset the character font

DISPLAY MODES

The display has three different modes which deal with what characters are written to the LCD screen. The modes are called Normal, Function, and Monitor.

NORMAL MODE

The Normal mode is the mode of the display when the device is first powered on or after a hard reset. This mode only allows the characters with the ASCII character codes 32 to 127 and 160 to 255 to be displayed on the LCD. The characters with codes 8, 10, 13, 27 perform special functions. Character code 8 will perform the backspace function. Character code 10 will perform the line feed function. Character code 13 will perform a carriage return. Character code 27 begins an escape code sequence. All other character codes not mentioned are ignored by the display.

FUNCTION MODE

The Function mode is entered by sending the escape code Esc y. It is exited by sending the escape code Esc Z. The function mode allows more characters to be displayed on the LCD screen than the normal mode does. This mode emulates the HP-71B LCD more closely. The characters with ASCII codes 0-255, except for codes 8, 10, 13, and 27, are displayed on the LCD screen. Character code 8 performs a backspace. Character code 10 performs a line feed. Character 13 performs a carriage return. Character code 27 begins an escape code sequence.

MONITOR MODE

The Monitor mode is entered by sending the escape code Esc Y. It is exited by sending the escape code Esc Z. The monitor mode will display all ASCII characters sent to the LCD screen. It will display the carriage return and linefeed characters but it will also perform those operations. It also will monitor escape sequences to determine if the exit sequence Esc Z is sent. All other escape sequences will not be performed.

CHANGING THE CHARACTER FONTS

When the LCD is turned on for the first time or a hard reset is performed the character font set is determined by the internal firmware. This character font is the same as that of the HP-71B. A table of the characters is listed in the appendix. Any of the characters may be changed by an escape code sequence.

Esc *f ABCDEFGH (Set Font) will modify a character font of ASCII code "A". The top row of the font will be filled with the binary data represented by "B", the second row by the data represented by "C" and so on. An example is best here. To change the character "0" to be a "1", the escape code would be:

Note: "0" = ASCII 48

```
A$=chr$(48)&chr$(4)&chr$(6)&chr$(4)&chr$(4)&chr$(4)&chr$(4)&chr$(14)&chr$(0);
OUTPUT LCD; chr$(27)&"*f"&A$;
```

binary data of new font:

	1	2	4	8	16	
line 1				*		4
line 2			*	*		4+2 = 6
line 3				*		4
line 4				*		4
line 5				*		4
line 6				*		4
line 7			*	*	*	2+4+8 = 14
line 8						0

The escape code must always include all 8 bytes of the character definition.

READING THE DISPLAY

The contents of the display buffer can be read back by sending the Esc ? xyz escape code. The "x" and "y" bytes represent the starting position in the buffer where "x" is the column address and "y" is the row address of the starting character in the display window. "z" is the number of bytes to send and is a number between 1 and 255. If the display buffer's end is reached before the requested number of characters are sent then the operation is stopped after the last byte in the buffer is sent. If there is room in the HPIL output buffer a carriage return and line feed will be tagged onto the end of the data sent. This is to allow normal termination of most HPIL controller's input ENTER statements. If 255 bytes are requested or there is not enough room in the output buffer, the ENTER statement may not terminate. Consult with your owners manual for proper terminating without CR, LF.

RASTER GRAPHICS

The CMT LCD emulates the HP graphics mode of the Thinkjet printer. This allows the user to add graphics to the LCD combined with text. The escape codes are:

Esc *b #W where # is the number of bytes to receive
Esc *rA - begin raster graphics on next line.

When the LCD screen is scrolled, the graphics will be deleted from the screen. The maximum value for # is 30 (240 dots/8 bits). Due to the way that data must be written to the LCD, the number of bytes of graphics data written to the LCD should be a multiple of 3 in order for all bits to be displayed.

Graphics data is sent to the LCD one byte at a time. Each bit specifies one dot position. If a bit is zero, the corresponding dot position is left blank. If a bit is one, a dot is printed at the corresponding position. The graphics data is sent to the LCD in groups, where each group contains the graphics data for one horizontal row (1 pixel high). The first (most significant) bit of graphics data byte specifies the leftmost dot, the last (least significant) bit specifies the rightmost dot.

The escape code to transfer the data for one dot row is Esc *b#W. The value field #, specifies the number of graphic data bytes which follow the escape code.

EXAMPLE:

```
OUTPUT :LCD; chr$(27)&"b20W";
```

The next twenty bytes of data are interpreted as specifying 160 dots of the current dot row. The cursor will automatically advance to the next pixel row. Sending a linefeed after the graphics sequence will turn off the graphics mode.

When the raster dot row escape sequence is received by the LCD, a carriage return is perform and graphics data is accepted and written onto the screen over the previous text.

To avoid printing over previous text, send the escape code ESC *rA before sending any graphics data. This escape code will perform a carriage return and a line feed.

It is best to turn off the alpha cursor before starting graphics mode. The cursor can be positioned by writing the Esc %xyz escape code. Whenever the alpha screen data causes a display scroll, the graphics data on the LCD will be lost.

EXAMPLE:

Fill 7 rows of the LCD with alternate ones and zeros.

```
5 printer is * @ display is *
10 dim a$[30]
20 for i=1 to 30 @ a$[i,i]=chr$(170)@ next i
30 clear lcd
40 OUTPUT LCD; chr$(27)&"<";
50 for i=1 to 56
60 OUTPUT LCD; chr$(27)&"*b30W";
70 OUTPUT LCD; a$;
80 next i
```

SELF TEST ESCAPE CODE

The CMT LCD will perform a selftest, if possible, when the escape code Esc z is received. After the selftest the LCD will display all of the default character set on the LCD.

ANSI COMPATIBILITY

The CMT LCD display also performs a subset of the escape codes defined in the display driver interface of the ANSI 3.64-1977 terminal interface standard. This is the same standard by which the MS-DOS terminal driver and many terminals are modeled on (the DEC VT100, VT220 and HP2392 for example). This feature set was implemented so that the CMT LCD will work with the CMT MC-II family of calculators and computers.

Please notice that the character set of the CMT LCD follows the HP-71B and not the IBM PC character set used by the MC-II.

The following function list is implemented:

NAME	Sequence	Function
BS	CTRL-H	Backspace
HT	CTRL-I	Horizontal Tab
LF	CTRL-J	Linefeed
CR	CTRL-M	Carriage return
ESC	CTRL-[	Escape
CUU	ESC [A	Cursor up one line
CUD	ESC [B	Cursor down one line
CUF	ESC [C	Cursor forward
CUB	ESC [D	Cursor backward
CUP	ESC Pn ; Pn H	Cursor Position
ED	ESC [Pn J	Erase to end of display
EL	ESC [K	Erase to end of line
IL	ESC [L	Insert line
DL	ESC [M	Delete line
DCH	ESC [P	Delete character at cursor
RIS	ESC c	Reset
SM	ESC [Pn h	Set mode (CRM or IRM)
RM	ESC [Pn l	Reset mode
SGR	ESC [Pn m	Set Graphics Rendition (Inverse only)

non - ANSI but MC-II compatible

SCUR	ESC [: char	Set cursor character

Many character sequences can supply an ASCII unsigned decimal numeric parameter (Pn). The parameter will assume its default value of '1'. A value of '0' or no parameter is the same as specifying the default value. Parameters are separated from each other by the ';' character. Spaces are not permitted between parameters.

For ANSI Mode, the origin is in the upper left corner of the window which is (1,1). The screen is 40 chars by 8 lines. All row/column designations for CUP are relative to this window memory.

Tab stops are not setable; tab stops are at each 8 column positions.

The display is a window into a large buffer of characters. This buffer is simply a logical display within which the physical display is showing a portion. The cursor displays the location IN THE BUFFER where the next visible character will be stored. When the cursor moves beyond the last column of the display buffer, it will move to the first position of the next line of the buffer. When the cursor moves beyond the last line of the buffer, it will: delete the first line of the buffer, move to the first column of the last row (now blank) line of the buffer.

APPENDIX A SUMMARY OF ESCAPE CODE INSTRUCTIONS

Esc A	27 65	Cursor Up	Moves the cursor up one line; cursor does not move past top line.
Esc B	27 66	Cursor Down	Moves the cursor down one line; cursor does not move past bottom line.
Esc C	27 67	Cursor Right	Moves the cursor right one position; if activated at column 39, cursor moves to column 0 of the next line; if activated at column 39, row 8, cursor moves to column 0, row 0.
Esc D	27 68	Cursor Left	Moves the cursor left one position; if activated at column 0, moves cursor to column 39 of previous line; cursor doesn't move past column 0, row 0.
Esc E	27 69	Soft Reset	Clears the display memory, moves the cursor to col 0, row 0 and displays the replace cursor.
Esc F	27 70	Home down	Causes display memory to roll up, so the last line in display memory occupies the next to last row of the display. The cursor moves to the left margin of the next line. If the last row in display memory is already on the screen in a row other than the last row, the display is not rolled up; the cursor moves to the left margin of the row below the last line.
Esc G	27 71	Cursor Return	Moves the cursor to col 0.
Esc H	27 72	Cursor Home	Moves the cursor to col 0, row 0 but does not affect the display.
Esc J	27 74	Clear Display	Clears the display from the Cursor position to the bottom of the screen.
Esc K	27 75	Clear Display	Clears the display from the cursor to End of Line position to the end of the line.
Esc L	27 76	Insert Line	Inserts a blank line above cursor, moving all remaining text down.
Esc M	27 77	Delete Line	Removes the line the cursor is on and moves all lines below cursor up.
Esc P	27 80	Delete Char	Removes the character at the cursor position from the display and adjusts the remaining characters on the line to the left filling the right side with a space.
Esc Q	27 81	Insert Cursor	Displays cursor as an underscore.
Esc R	27 82	Replace Cursor	Displays character in inverse video.
Esc S	27 83	Roll Up	Rolls screen up one line.
Esc T	27 84	Roll Down	Rolls screen down one line.
Esc U	27 85	Next Page	Displays the next page of display memory. A page consists of 8 lines of display memory, unless the softkeys are enabled, then a page consists of 7 lines. If the last line of display memory is already on the screen when the Next page function is performed, the display is rolled up until the last line of display memory appears on the last visible row.
Esc V	27 86	Prev Page	Displays the previous page of display memory. If the first line of display memory is already on the screen when the prev page operation is performed the operation has no effect.
Esc Y	27 89	Monitor Mode	Displays control characters.
Esc Z	27 90	Monitor Mode	Returns to Normal Mode with Function Mode off.
Esc <	27 60	Cursor Off	Cursor is not displayed but functions normally.
Esc >	27 62	Cursor On	Displays Cursor.
Esc %cr	27 37 cr	Move cursor	Moves the cursor to a display address of the form (col,row). The column address is interpreted as (c modulo 40) and the row address as (r modulo 8 or 7).
Esc e	27 101	Hard Reset	The display resets as if from a power up condition.

Esc h	27 104	Home Up	Moves cursor to first location in buffer and roll screen so the first line in buffer is first line on screen.
Esc y	27 121	Function Mode	Displays control characters.
Esc z	27 122	Self Test	Performs self test of display.
Esc &	27 38	USER KEYS	Defines user softkeys.
Esc *b#W			Graphics dump # of bytes.
Esc *f	27 42	Set Font	Modifies a character font.
Esc *rA		Begin Graphics	Begins raster graphics on next line.
Esc ?	27 63	Send Display Data	Outputs the contents of the display from the requested position to the end of the requested # of bytes to the HPIL output buffer.

APPENDIX B HPIL TECHNICAL DETAILS

HPIL DEVICE CODES

The response to the HP-71B command DEVID$(':lcd') will be "LCD8x40G" for a good battery and "LCD8x40B" for a bad battery. A carriage return and line feed will always be added to the string. The response to the HP-71B command DEVAID("LCD") will be 48.

HPIL STATUS BYTES

The CMT LCD will respond to the HP-IL send status command with 6 bytes. The first byte is the HPIL system status byte. The remaining bytes represent the internal state and status of the CMT LCD. The bytes are defined as follows:

byte 1: system status
byte 2: Flags
byte 3: low byte cursor
byte 4: high byte cursor
byte 5: low byte buffer offset
byte 6: high byte buffer offset

The system status byte is defined by the HPIL protocol and the CMT LCD will respond with one of the following (in order of priority)

service not requested	service requested	Meaning
133	197	Input buffer is full
129	193	Low battery
162	226	Data in output buffer
161	225	Ready to receive data
163	227	Not ready to send or receive data

The flag register is defined as:

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
0	0	graphics mode	function mode = 1	monitor mode = 1	0	cursor on = 1	type = 1

The cursor is a number between 0 and 319. The buffer offset is a pointer into the display buffer where the display screen begins. It is always a multiple of 40 and ranges from 0 to 1720.

HPIL MESSAGES

COMMAND GROUP

Interface clear	Removes talker or listener status.
Device clear	Performs a soft reset.
Selected device clear	If listener, device cleared as with device clear.
Go to local	No response.
Local lockout	No response.
Remote enable	No response.
Not Remote enable	No response.
Parallel poll Enable	No response.
Parallel poll disable	No response.
Group execute trigger	No response.
Loop power down	Device turns off.
Enable asynchronous requests	No response.
Auto Address unconfigure	Address set to 2
Listen address 0-31	If address matches, device is removed from talker status and becomes a listener. If message address is 31, device removed from listener status.
Unlisten	Device is removed from listener status.
Device Dependent listener 0-31	No response.
Talk Address 0-31	If address matches, device removed from listener status and becomes a talker. If address does not match, device is removed from talker status.
Untalk	Device is removed from talker status.
Device Dependent talker 0-31	No response.
Secondary Address 0-30	No response.
Null	No response.

READY GROUP

Take control	No response.
Ready for command	Passes message to next device in the loop after responding to previous message.
Send Data	If talker, data in output buffer is transmitted.
Send Status	If talker, sends six bytes of status.
Send device ID	If talker, send the string 'LCD8x40G' of 'LCD8x40B' with CR,LF terminator.
Send accessory ID	If a talker, sends one byte with the value of 48.
Not Ready for Data	If talker, makes previous data byte the last byte sent.
End of Transmission - OK	No response.
End of Transmission - ERROR	No response.
Auto Address 0-31	If device has earlier auto address, no response if message address is 31, no response if message address is less than 31 and device does not have an earlier auto address, sets device address to message address, increments message address by one and passes the revised message to the next device.
Auto extended primary 0-31	No response.
Auto extended secondary 0-31	No response.
Auto multiple primary 0-31	No response.

IDENTIFY GROUP

Identify (no service request)	No response.
Identify (service request)	If service request enabled and data is in output buffer the SRQ. bit in the frame will be set.

DATA GROUP

Data Byte (no service request)	If listener, accepts data byte and passes to next device.
Data Byte (service request)	If listener, accepts data byte and passes to next device.
End Byte (no service request)	If listener, accepts data byte and passes to next device.
End Byte (service request)	If listener, accepts data byte and passes to next device.

APPENDIX C Service, Warranty, Care, & Specifications

Service Information

Should your LCD Display require service, please do the following:

1. Call CMT for a Return Authorization Number.
2. Write a detailed description of the problem and include your name and address.
3. Ship the product and problem description to CMT, prepaid, in a protective package to avoid damage. (Use the original shipping container and cushioning material.) In-transit damage is not covered by the warranty.

Address all correspondence and packages to:

CMT
895 N.W. Grant Ave.
Corvallis, OR 97330
USA

Our phone number is:

(503)752-5456

CMT does not accept any returns without a Return Authorization Number.

For warranty service or repair, return the sales receipt with the unit.

Warranty Information

CMT provides a limited 90 day warranty on the LCD DISPLAY. The warranty period starts from the time the product is shipped to you from our facility or an authorized CMT distributor.

The warranty covers defects in materials and workmanship during the warranty period. During this period, Corvallis Microtechnology, Inc. will, at its option, repair or replace, free of charge, any unit which proves to be defective. The warranty does not cover damage to the unit caused by batteries, abuse, accident, misuse, buyer-supplied interface equipment or service or modification performed by other than CMT technical personnel.

CMT does not warrant that the operation of this device and the firmware and software installed in it will be error free.

No other warranty is expressed or implied. Corvallis Microtechnology, Inc. specifically disclaims the implied warranties of fitness for a particular purpose.

Basic LCD Display care

To maximize the life of your LCD Display, please take note of the following suggestions:

Do not drop the unit onto a hard surface.

Do not allow water to get inside the case.

Do not rub the display surface with abrasive materials or harsh chemicals.

Also, care should be taken to see that the LCD Display remains inside the temperature range specified in the specifications.

Radio/Television Interference Potential

The CMT HPIL LCD Display generates and uses radio frequency energy and, if not installed and used properly - that is, in strict accordance with the instructions in this manual - may cause interference with radio and television reception. It has been 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 the 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. In the unlikely event that the unit does cause interference to radio or television reception (which can be determined by removing all power to the LCD Display and then reconnecting the power and then turning it on) you are encouraged to try to correct the interference using one or more of the following measures:

Re-orient the receiving antenna.

Relocate the LCD Display with respect to the receiver.

Move the LCD Display away from the receiver.

Plug the AC adapter into a different AC outlet so the LCD Display and receiver are on different branch circuits.

If necessary, contact an experienced radio/television technician for additional suggestions. You 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 number 004-000-00345-4.

Specifications

The following specifications apply to the **HPIL LCD Display:**

Interface:

Type: HP-IL (Hewlett-Packard Interface Loop)
default address: 2

Power Requirements:

Primary source: 9V Alkaline or NiCad battery pack
Typical recharge time (NiCad's): 6 hours

Current Drain:

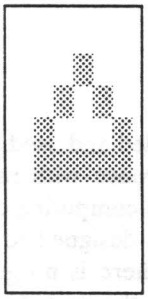
ON: 65 mA
STANDBY: 16 mA
OFF: 0.11 mA

Temperature Limits:

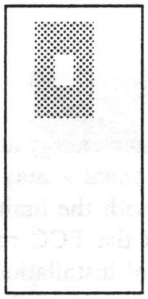
Operating: 0 to 55 degrees C
Charging: 0 to 55 degrees C
Storage: -40 to 75 degrees C

APPENDIX D LCD DISPLAY FONT

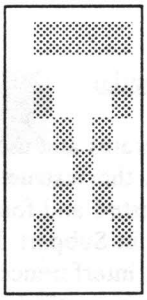
Character 0



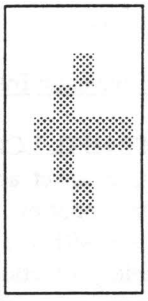
Character 1



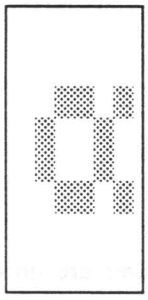
Character 2



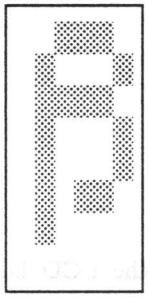
Character 3



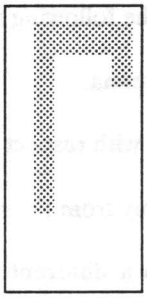
Character 4



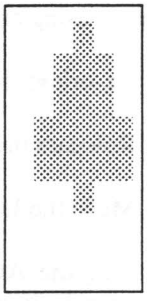
Character 5



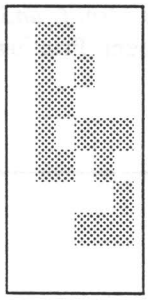
Character 6



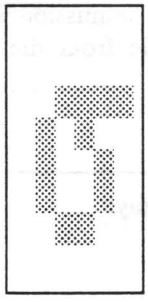
Character 7



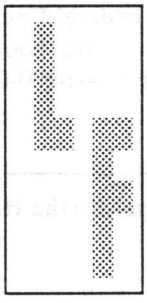
Character 8



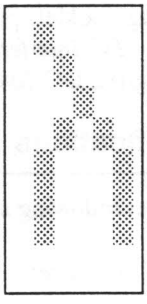
Character 9



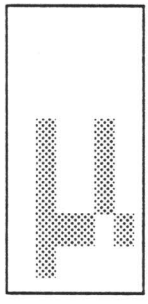
Character 10



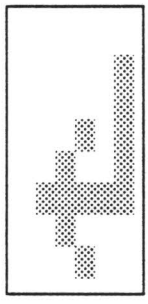
Character 11



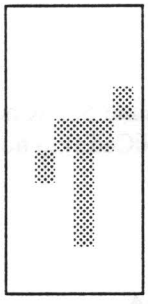
Character 12



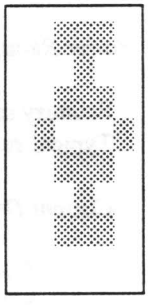
Character 13



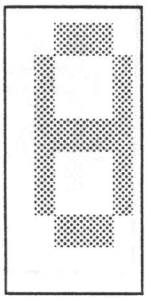
Character 14



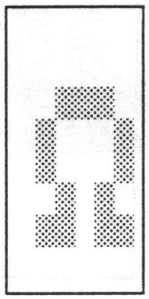
Character 15



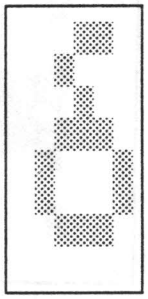
Character 16



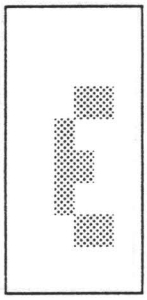
Character 17



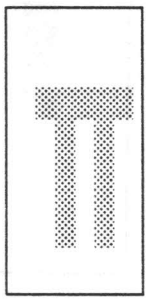
Character 18



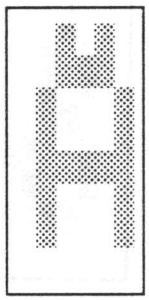
Character 19



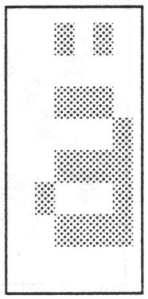
Character 20



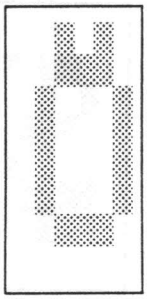
Character 21



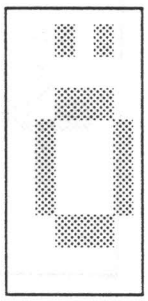
Character 22



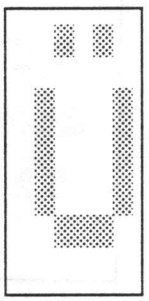
Character 23



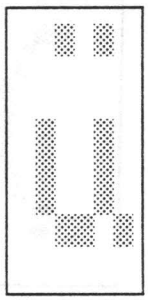
Character 24



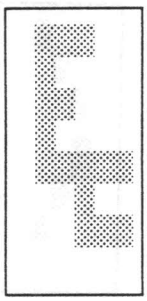
Character 25



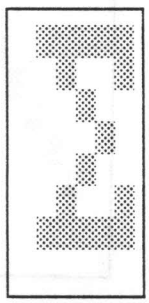
Character 26



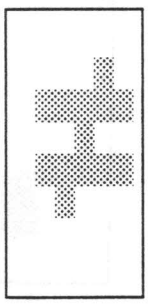
Character 27



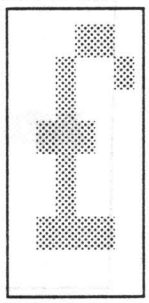
Character 28



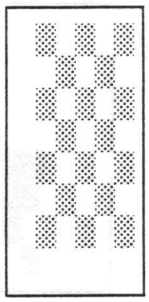
Character 29



Character 30

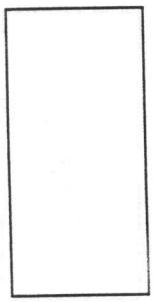


Character 31

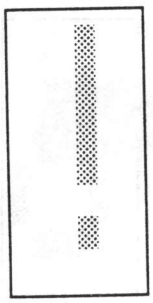


APPENDIX D LCD DISPLAY FONT

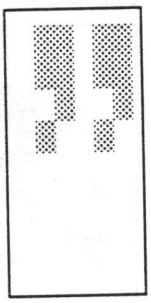
Character 32



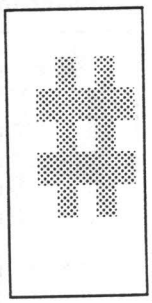
Character 33



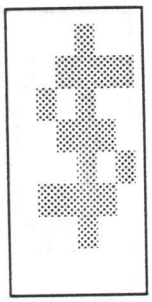
Character 34



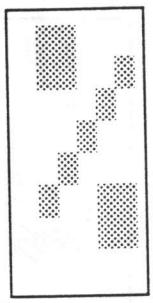
Character 35



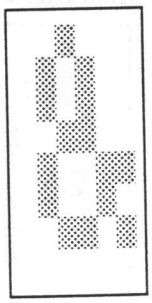
Character 36



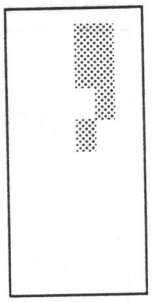
Character 37



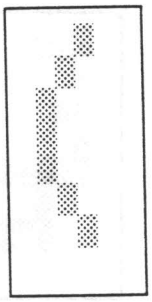
Character 38



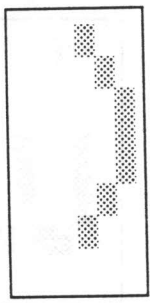
Character 39



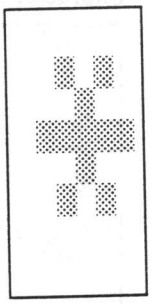
Character 40



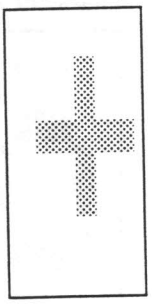
Character 41



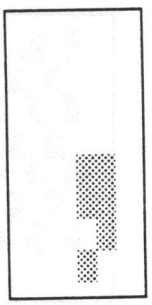
Character 42



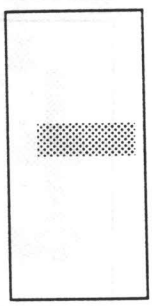
Character 43



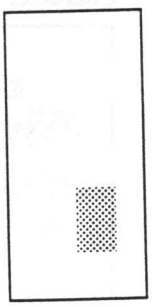
Character 44



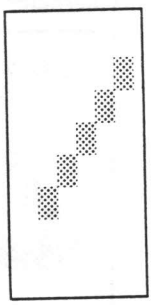
Character 45



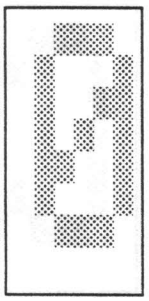
Character 46



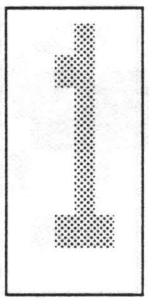
Character 47



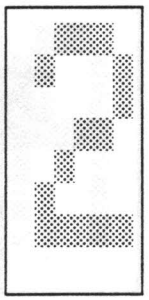
Character 48



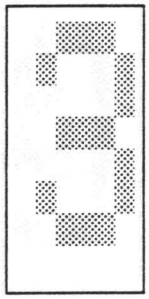
Character 49



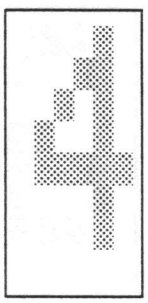
Character 50



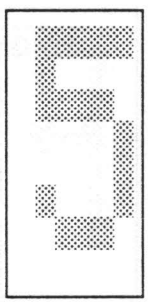
Character 51



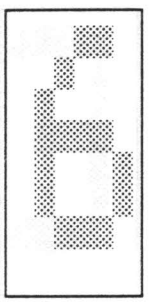
Character 52



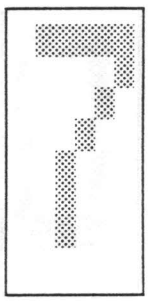
Character 53



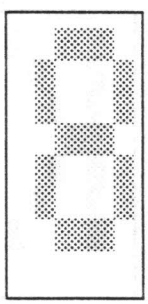
Character 54



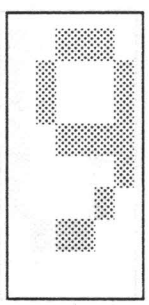
Character 55



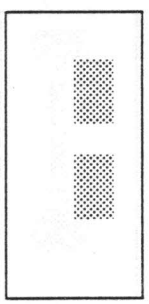
Character 56



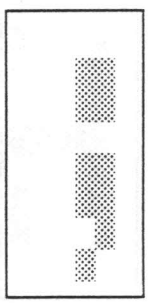
Character 57



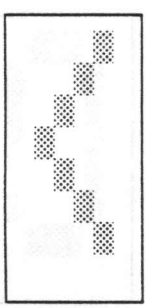
Character 58



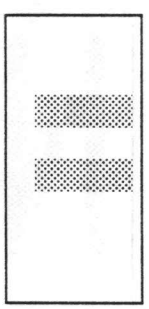
Character 59



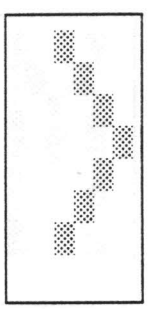
Character 60



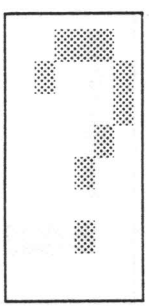
Character 61



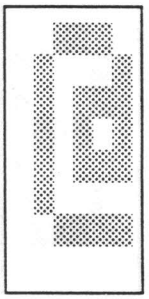
Character 62



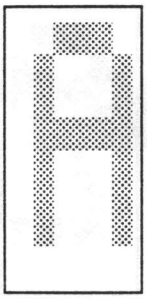
Character 63



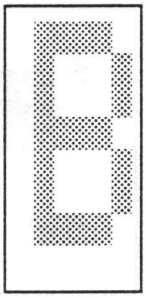
Character 64



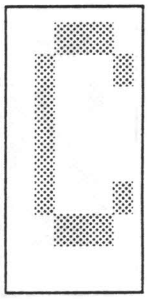
Character 65



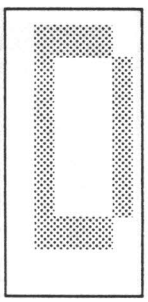
Character 66



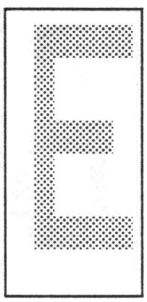
Character 67



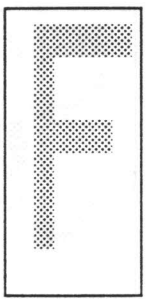
Character 68



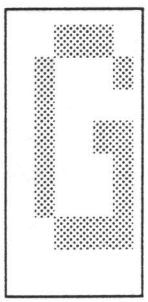
Character 69



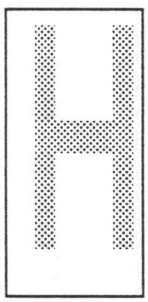
Character 70



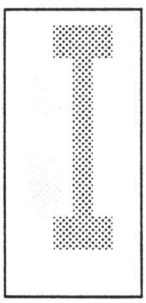
Character 71



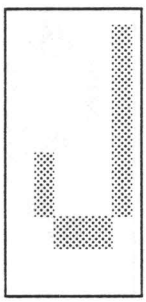
Character 72



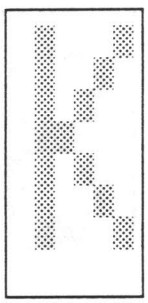
Character 73



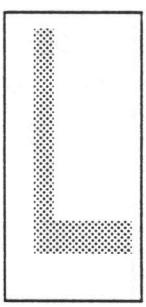
Character 74



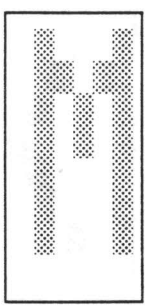
Character 75



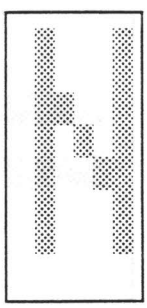
Character 76



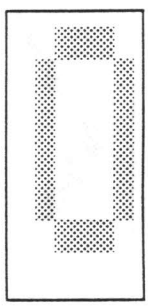
Character 77



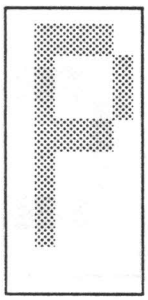
Character 78



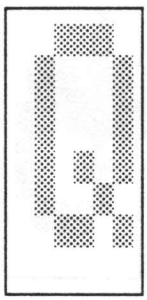
Character 79



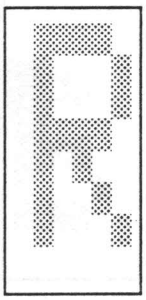
Character 80



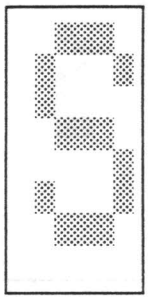
Character 81



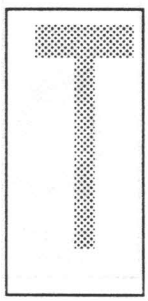
Character 82



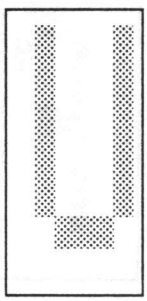
Character 83



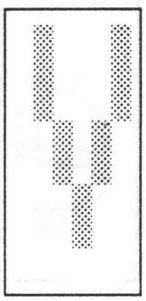
Character 84



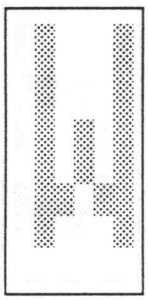
Character 85



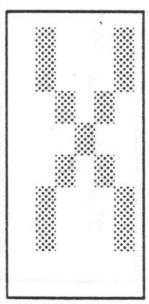
Character 86



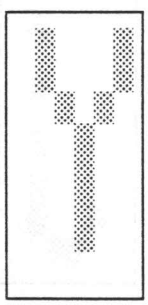
Character 87



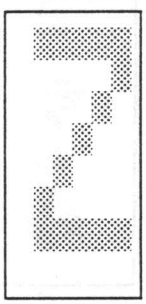
Character 88



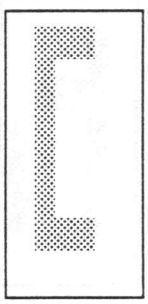
Character 89



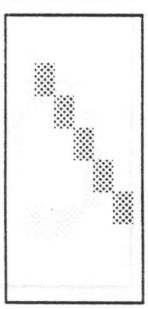
Character 90



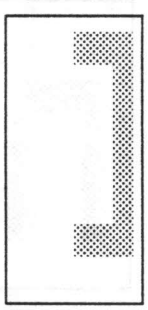
Character 91



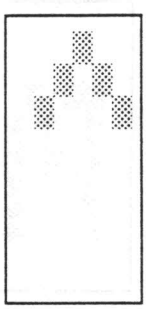
Character 92



Character 93

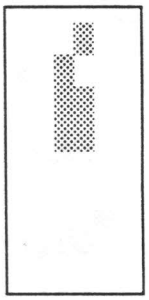


Character 94

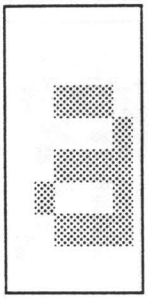


Character 95

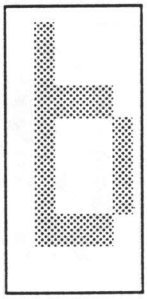
Character 96



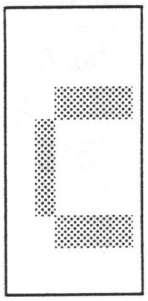
Character 97



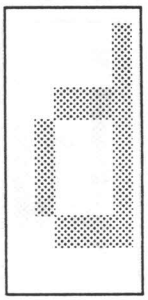
Character 98



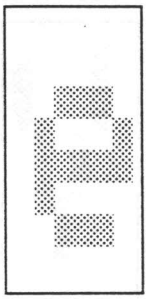
Character 99



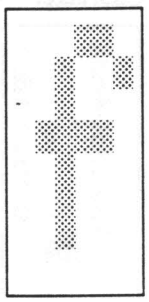
Character 100



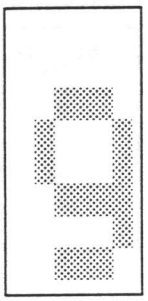
Character 101



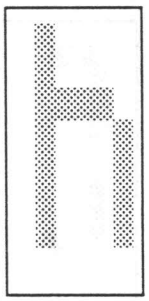
Character 102



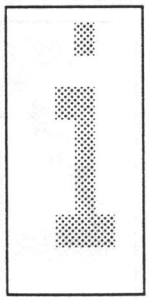
Character 103



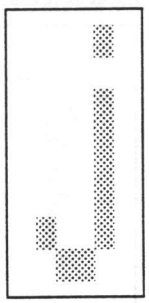
Character 104



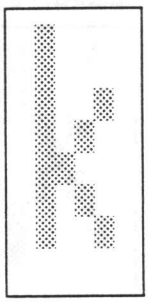
Character 105



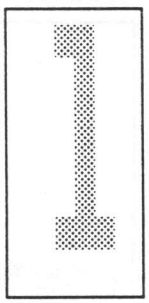
Character 106



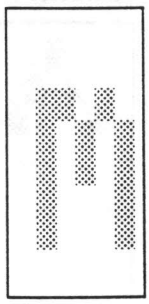
Character 107



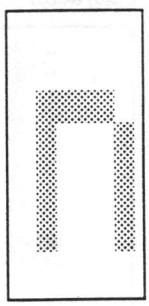
Character 108



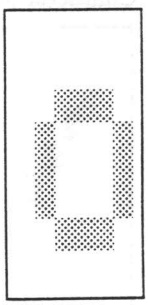
Character 109



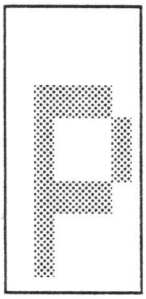
Character 110



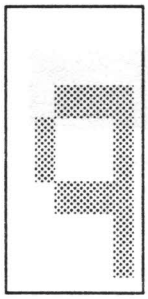
Character 111



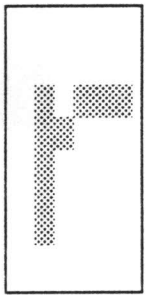
Character 112



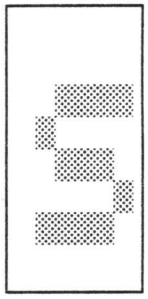
Character 113



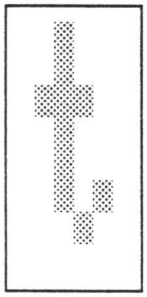
Character 114



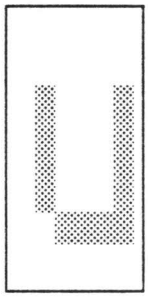
Character 115



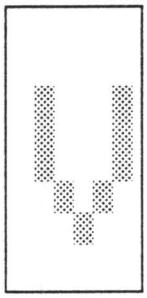
Character 116



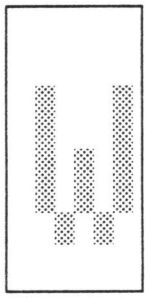
Character 117



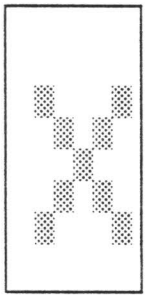
Character 118



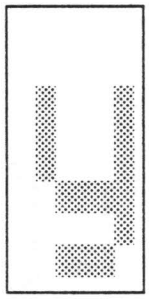
Character 119



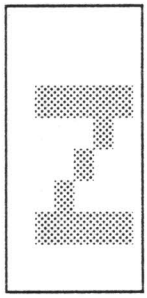
Character 120



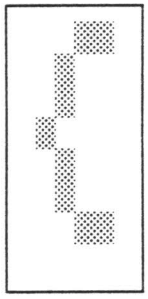
Character 121



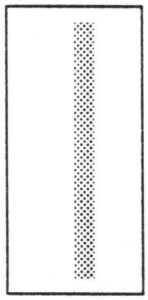
Character 122



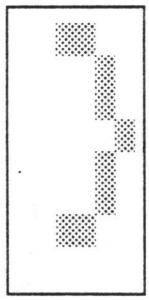
Character 123



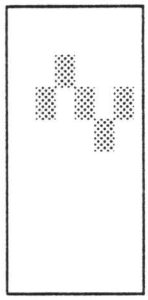
Character 124



Character 125



Character 126



Character 127