

## **CHAPTER 3**

### **PROGRAMMER'S INFORMATION**

#### **3.1 GENERAL**

The LA120 uses escape sequences standardized by ANSI (American National Standards Institute) to control many of its features. For LA120 features lacking an ANSI standard escape sequence, additional escape sequences are defined within the extensions permitted by the ANSI system.

ANSI has established a flexible and comprehensive system for transmitting format and editing information. It can be used with printing terminals like the LA120 and with video terminals and printers and has the following important advantages.

1. It is well-defined and well-documented. This greatly decreases the chance of incompatible implementation and aids in achieving device independence in output.
2. It has ample provision for future extension without sacrificing compatibility with older programs. The syntax used in ANSI controls allows a large number of new controls to be added easily.
3. It is compatible with all frequently used communication protocols. In contrast, many other systems use control codes that are reserved for communication functions. In these other systems, codes used for line turnaround, disconnect, and synchronization get confused with those used to send parameter values.

Using the escape sequences described in this chapter, the programmer can control the following LA120 features.

- Printer character set
- Active position
- Linefeed-newline mode
- Horizontal pitch
- Horizontal margins
- Horizontal tabs
- Vertical pitch
- Form length
- Vertical margins
- Vertical tabs
- Product identification
- Alternate keypad mode

## 3.2 ESCAPE SEQUENCES

### 3.2.1 Parser Program

An escape sequence is a real-time call to a firmware program that changes an operating parameter of the LA120 printer. The purpose of the escape sequence is to enable control of the terminal's operating parameters from a remote computer or terminal. The remote machine sends a string of characters to the LA120. Upon being parsed (dissected and interpreted), the character string points to a particular firmware routine stored in the microprocessor memory. This routine implements the changes to the printer's operating parameters. Most of the escape sequences deal with forms control (e.g., right and left margins; top and bottom margins). Other sequences select the character set to be used for printing or linefeed-newline mode.

The escape sequence is processed by a master software program called the parser. At each level of the parser program there are choices selected from a look-up table and instructions as to what to do next. To parse the escape sequence ESC[4e (advance active line by 4), the computer program points to a table in which the character [ is found. The entry for [ has the choice of pointing to any of seven tables or of looping in the present table. The logic in the table entries for the [ character knows the next character is a number; therefore, it points to a table that contains numbers. The entry for [ also gives an instruction to parse the next character and perform the search in the number table. Finally, after searching through the tables for the characters [, 4, and e, the pointer points to a terminating routine that instructs the terminal to advance the active line by four lines and reinitialize the parser program.

### 3.2.2 Sequence Descriptions

The LA120 interprets escape sequences sent to it. None of the characters in an escape sequence are printed. When the end of the sequence is found (or an error occurs), the LA120 reverts to its normal printing mode. Control characters (characters with octal codes 000 through 037) may be embedded anywhere in an escape sequence. The control characters perform their normal function and have no effect on the escape sequence. If an escape sequence is received by the LA120 that it does not support, it is ignored.

An escape sequence that has been only partially processed when the operator enters SET-UP mode will complete when the operator leaves SET-UP mode. Escape sequences may also be entered and processed while in local mode and may be used in lieu of SET-UP commands.

In the lists of escape sequences that follow, the escape character (octal code 033) is designated as ESC. Numeric parameters are shown explicitly or designated as  $n$ ,  $n_1$ ,  $n_2$ , etc. The graphic characters in escape sequences are shown using the United States ASCII character set. The characters are spaced apart for clarity only, the space character (octal code 040) never appears in an escape sequence. The case of the characters in escape sequences is significant and must be exactly as documented.

A numeric parameter is a sequence of ASCII decimal digits. That is, octal codes 060 through 071. The parameter is interpreted as an unsigned decimal integer, with the most significant digit transmitted first. Leading zeros are allowed but are not necessary. A missing parameter is interpreted as a value of zero. Plus and minus signs are not allowed in parameters.

#### NOTE

**The space character (octal code 040) never appears in an escape sequence.**

Table 3-1 summarizes LA120 escape sequences. Paragraphs 3.2.2.1 through 3.2.2.12 describe these sequences in more detail.

**Table 3-1 LA120 Escape Sequences**

LA120 Feature	Escape Sequence*	Function/Comments*
Printer Character Sets	ESC ( A	Select character set of Great Britain.
	ESC ( B	Select character set of United States.
	ESC ( C	Select character set of Finland.
	ESC ( E	Select character set of Norway/Denmark.
	ESC ( H	Select character set of Sweden.
	ESC ( K	Select character set of Germany.
	ESC ( R	Select character set of France.
Active Position	ESC [ n'	Set active column to column n (character after n is octal code 140)
	ESC [ n a	Advance advance column by n columns.
	ESC E	Set active column to left margin and increment active line.
	ESC D	Increment active line (active column unchanged).
	ESC [ n d	Set active line to line n.
	ESC [ n e	Advance active line by n lines.
Linefeed-Newline Mode	ESC [ 20 h	Enable linefeed-newline mode.
	ESC [ 20 l	Disable linefeed-newline mode.
Horizontal Pitch	ESC [ w or ESC [ ow	Set horizontal pitch to 10 char/in.
	ESC [ 1 w	Set horizontal pitch to 10 char/in.
	ESC [ 2 w	Set horizontal pitch to 12 char/in.
	ESC [ 3 w	Set horizontal pitch to 13.2 char/in.
	ESC [ 4 w	Set horizontal pitch to 16.5 char/in.
	ESC [ 5 w	Set horizontal pitch to 5 char/in.
	ESC [ 6 w	Set horizontal pitch to 6 char/in.
	ESC [ 7 w	Set horizontal pitch to 6.6 char/in.
	ESC [ 8 w	Set horizontal pitch to 8.25 char/in.

**Table 3-1 LA120 Escape Sequences (Cont)**

LA120 Feature	Escape Sequence*	Function/Comments*
Horizontal Margins	ESC [ ns or ESC [n; os	Set left margin to column n.
	ESC [; ns or ESC [o; ns	Set right margin to column n.
	ESC [ n <sub>1</sub> ;n <sub>2</sub> s	Set left margin to column n <sub>1</sub> and set right margin to column n <sub>2</sub> .
Horizontal Tabs	ESC H	Set horizontal tab stop at active column.
	ESC I	Set horizontal tab stop at active column.†
	ESC [ g or ESC o g	Clear horizontal tab stop at active column.
	ESC [ 2 g	Clear all horizontal tab stops.
	ESC [ 3 g	Clear all horizontal tab stops.
	ESC 2	Clear all horizontal tab stops.†
	ESC [ n u	Set horizontal tab stop at column n.
	ESC [ n <sub>1</sub> ;n <sub>2</sub> u	Set horizontal tab stops at column n <sub>1</sub> and at column n <sub>2</sub> .
ESC [ n <sub>1</sub> ;n <sub>2</sub> ; ...n <sub>x</sub> u	Set horizontal tab stops at columns n <sub>1</sub> , n <sub>2</sub> , ... n <sub>x</sub> (x ≤ 16).	
Vertical Pitch	ESC [ z or ESC [ o z	Set vertical pitch to 6 lines/in.
	ESC [ 1 z	Set vertical pitch to 6 lines/in.
	ESC [ 2 z	Set vertical pitch to 8 lines/in.
	ESC [ 3 z	Set vertical pitch to 12 lines/in.
	ESC [ 4 z	Set vertical pitch to 2 lines/in.
	ESC [ 5 z	Set vertical pitch to 3 lines/in.
	ESC [ 6 z	Set vertical pitch to 4 lines/in.

**Table 3-1 LA120 Escape Sequences (Cont)**

LA120 Feature	Escape Sequence*	Function/Comments*
Form Length	ESC [ n t	Set form length to n lines. Set top margin to line 1. Set bottom margin to line n. Set active line to line 1.
Vertical Margins	ESC [ n r ESC [ ; n r ESC [ n <sub>1</sub> ;n <sub>2</sub> r	Set top margin to line n. Set bottom margin to line n. Set top margin to line n <sub>1</sub> and set bottom margin to line n <sub>2</sub> .
Vertical Tabs	ESC J ESC 3 ESC [ l g ESC [ 4 g ESC 4 ESC [ n v ESC [ n <sub>1</sub> ;n <sub>2</sub> v ESC[ n <sub>1</sub> ;n <sub>2</sub> ; ... n <sub>x</sub> v	Set vertical tab stop at active line. Set vertical tab stop at active line.† Clear vertical tab stop at active line. Clear all vertical tab stops. Clear all vertical tab stops.† Set vertical tab stop at line n. Set vertical tab stops at line n <sub>1</sub> and at line n <sub>2</sub> . Set vertical tab stops at lines n <sub>1</sub> , n <sub>2</sub> , ... n <sub>x</sub> (x ≤ 16).
Product Identification	ESC [ C or ESC [ o c	LA120 transmits ESC [ ? 2 c
Alternate Keypad Mode	ESC = ESC >	Enable alternate keypad mode. Disable alternate keypad mode.

\* n represents a numeric parameter.

† This escape sequence is available for compatability with the LA36.

### 3.2.2.1 Printer Character Sets

**United States and British Character Sets** – The LA120 is capable of receiving and printing both the United States ASCII character set and the British version in which the character “#” is replaced by the character “£”. The United States ASCII character set is shown in Table 3-2. Refer to Table 3-1 for the escape sequences that select the printer character sets of the United States and Great Britain.

**Table 3-2 United States ASCII Character Set**

Code	Char	Code	Char	Code	Char
040	space	100	@	140	'
041	!	101	A	141	a
042	"	102	B	142	b
043	#	103	C	142	c
044	\$	104	D	144	d
045	%	105	E	145	e
046	&	106	F	146	f
047	'	107	G	147	g
050	(	110	H	150	h
051	)	111	I	151	i
052	*	112	J	152	j
053	+	113	K	153	k
054	,	114	L	154	l
055	-	115	M	155	m
056	.	116	N	156	n
057	/	117	O	157	o
060	0	120	P	160	p
061	1	121	Q	161	q
062	2	122	R	162	r
063	3	123	S	163	s
064	4	124	T	164	t
065	5	125	U	165	u
066	6	126	V	166	v
067	7	127	W	167	w
070	8	130	X	170	x
071	9	131	Y	171	y
072	:	132	Z	172	z
073	;	133	[	173	{
074	<	134	\	174	
075	=	135	]	175	}
076	>	136	^	176	~
077	?	137	-		

**Optional Character Sets** – Five additional national character sets and an APL character set are available as an option. The national character sets are selected by the operator, using SET-UP commands, or by the programmer using escape sequences. The national character sets differ from United States ASCII in only a limited number of code positions.

The code differences among the national character sets are shown in Table 3-3. Refer to Table 3-1 for the escape sequences that select the optional printer character sets.

**3.2.2.2 Active Position** – Active position may be either active column or active line. Active column is defined as the column where the next character will normally be printed. Active line is defined as the line where the next character will normally be printed. Column and line numbers begin with one, not zero. Printable characters normally increment active column. Line feeds normally increment active line. Active column and active line are collectively known as active position.

**Table 3-3 Code Differences Among National Character Sets**

Character Set	Code										
	043	100	133	134	135	136	140	173	174	175	176
United States	#	@	[	\	]	^	`	{		}	~
Great Britain	£	@	[	\	]	^	`	{		}	~
Finland	#	@	Å	Ö	Ä	Ü	é	ä	ö	ä	ü
Sweden	#	é	Å	Ö	Ä	Ü	é	ä	ö	ä	ü
Norway/Denmark	#	À	Æ	Ø	Å	Ü	ä	æ	ø	ä	ü
Germany	#	§	À	Ö	Ü	^	`	ä	ö	ü	ß
France	£	è	°	ç	§	^	`	é	ù	è	

Active position is only loosely linked to the physical position of the LA120 print head and paper mechanism. In general, active column is only recorded when a character is actually printed. Any previous history of active column values is not significant. Active line is different because it may only be advanced, since backward paper motion is not allowed. When the LA120 is idle, active and physical positions are identical.

In the LA120, bell characters have only an active line attribute. They are not guaranteed to be sounded at any particular column within a line.

In addition to the normal position control characters (space, backspace, carriage return, line feed, horizontal tab, vertical tab, and form feed), active position escape sequences listed in Table 3-1 also modify active position.

**3.2.2.3 Linefeed-Newline Mode** – Linefeed-newline mode is controllable both by the operator and the programmer. If linefeed-newline mode is enabled, the characters line feed, vertical tab, and form feed each return the active column to the left margin in addition to their normal functions. Linefeed-newline mode may be enabled by the operator selecting choice 2 (line feed) in the printer new line character SET-UP command. The mode is disabled any time the operator selects choice 1 (none) or choice 3 (carriage return) in the printer new line character SET-UP command.

Table 3-1 contains the escape sequences that control linefeed-newline mode.

**3.2.2.4 Horizontal Pitch** – Horizontal pitch determines the width of printed characters as well as their spacing. The LA120 has eight different horizontal pitches. Any combination of pitches may be used on a single print line. Changing horizontal pitch modifies the active column. The resulting new active column is that of the first column boundary at or to the right of the physical position of the previous active column in the old pitch. It is calculated as:

$$\text{Newcol} = \frac{1 + (\text{Oldcol} - 1) * \text{Oldpitch}}{\text{Newpitch}}$$

where: Newcol = new active column  
 Newpitch = new pitch in chars/in  
 Oldcol = old active column  
 Oldpitch = old pitch in chars/in

The division performed above is integer division. Any remainder or fractional part of the quotient is discarded.

The escape sequences that set horizontal pitch are listed in Table 3-1.

**3.2.2.5 Horizontal Margins** – Printing is permitted only within the inclusive left and right margins. A carriage return character sets the active column to the left margin. Attempting to move the active column left of the left margin sets the active column equal to the left margin. Attempting to move the active column more than one column right of the right margin executes an auto newline if auto newline is enabled. If auto newline is disabled, an error bell sounds and the character or command that attempted the motion is discarded.

Horizontal margins may be set so long as the following is true.

$$1 \leq \text{left margin} \leq \text{right margin} \leq \text{max column}$$

Note that maximum column is a function of horizontal pitch.

$$\text{maximum column} = 13.2 \text{ inches} * \text{horizontal pitch}$$

where the product is rounded down to the nearest column.

The horizontal margin escape sequences listed in Table 3-1 set the left and right horizontal margins.

**3.2.2.6 Horizontal Tabs** – The LA120 has 217 possible horizontal tab stops, one for each column. Tab stops are associated with column numbers, not physical positions on the paper. Thus, changing horizontal pitch will also change the physical position of tab stops. Each stop may be set or cleared independently. Setting a stop already set has no effect; the same is true for clearing a stop already cleared. Tab stops may be set or cleared without regard to margins or horizontal pitch.

The horizontal tab escape sequences used to set and clear horizontal tab stops are listed in Table 3-1.

**3.2.2.7 Vertical Pitch** – Vertical pitch determines the spacing between lines, not the height of printed characters. Changing vertical pitch does not affect active line number; but it does clear vertical margins. The escape sequences that set vertical pitch are listed in Table 3-1.

**3.2.2.8 Form Length** – Form length is defined in lines, not physical units. Therefore, changing vertical pitch will alter the physical form length. Forms may be from 1 to 168 lines in length. Changing form length clears vertical margins and defines the current line as line one. The escape sequence that sets form length is listed in Table 3-1.

**3.2.2.9 Vertical Margins** – Printing is permitted only on lines within the inclusive top and bottom margins. When vertical pitch or form length are changed, these margins are cleared; that is, the top margin is set to line one and the bottom margin is set to the form length. The following must be true to successfully set new vertical margins.

$$1 \leq \text{top margin} \leq \text{bottom margin} \leq \text{form length}$$

Whenever active line < top margin or active line > bottom margin, the active line is set to the top margin. For example, a line feed performed at the bottom margin will execute a form feed.

The escape sequences that set the top and bottom margins are listed in Table 3-1.

**3.2.2.10 Vertical Tabs** – The LA120 has 168 vertical tab stops set and cleared similar to horizontal tab stops. Vertical tab stops are associated with specific line numbers, not physical positions on the paper. Thus, changing vertical pitch changes the printing position of vertical tabs.

The escape sequences that set or clear vertical tab stops are listed in Table 3-1.

**3.2.2.11 Product Identification** – The LA120 terminal automatically transmits an answer to the ANSI standard request for a device attributes escape sequence.

The escape sequence that causes the LA120 to transmit its product identification escape sequence is listed in Table 3-1.

**3.2.2.12 Alternate Keypad Mode** – Alternate keypad mode allows application programs to differentiate between keystrokes performed on the optional numeric pad and those performed on the main keyboard so that the numeric pad may be used for commands or special functions.

Alternate keypad mode is controllable by the operator using the alternate keypad mode SET-UP command, or by the programmer. If alternate keypad mode is disabled, the keys on the optional numeric keypad transmit the codes that correspond to the keycap legends. If alternate keypad mode is enabled, each of these keys transmits the escape sequence specified in Table 3-4.

**Table 3-4 Escape Sequences Transmitted in Alternate Keypad Mode**

Key	Code Transmitted	
	Normally	Alternate Keypad Mode
PF1	ESC O P	ESC O P
PF2	ESC O Q	ESC O Q
PF3	ESC O R	ESC O R
PF4	ESC O S	ESC O S
ENTER	Same as RETURN key	ESC O M
,	,	ESC O l
-	-	ESC O m
.	.	ESC O n
0 (number)	0 (number)	ESC O p
1	1	ESC O q
2	2	ESC O r
3	3	ESC O s
4	4	ESC O t
5	5	ESC O u
6	6	ESC O v
7	7	ESC O w
8	8	ESC O x
9	9	ESC O y

The escape sequences that control alternate keypad mode are listed in Table 3-1.

### 3.3 CONTROL CHARACTERS

The LA120 receives the control characters listed in Table 3-5 and responds accordingly.

**Table 3-5 LA120 Control Characters**

Code	Mnemonic	Name
000	NUL	Null
003	ETX	End of Text
004	EOT	End of Transmission
005	ENQ	Enquiry
007	BEL	Bell
010	BS	Backspace
011	HT	Horizontal Tabulation
012	LF	Line Feed
013	VT	Vertical Tabulation
014	FF	Form Feed
015	CR	Carriage Return
016	SO	Shift Out
017	SI	Shift In
020	DLE	Data Link Escape
030	CAN	Cancel
032	SUB	Substitute
033	ESC	Escape
177	DEL	Delete

Control characters not listed in Table 3-5 are always ignored when received by the LA120. Paragraphs 3.3.1 through 3.3.17 describe each character.

#### 3.3.1 Null or Delete (NUL or DEL)

Null and delete characters cause no operation. But they are different from ignored characters in that they are disposed of without occupying space in the input buffer. Thus, they are fill characters and truly equivalent to idle marking time.

#### 3.3.2 End of Text (ETX)

If the LA120 is operating in half duplex with ETX turnaround, the end of text character is recognized as the turnaround character. If the LA120 is operating in any other full- or half- duplex mode, the ETX character has no effect.

#### 3.3.3 End of Transmission (EOT)

If the LA120 is operating in half duplex with EOT turnaround, the end of transmission character is recognized as the turnaround character. If the LA120 is operating in any other full- or half- duplex mode, the EOT character is recognized as a disconnect request, unless the auto disconnect feature is turned off. For disconnect request in half duplex with EOT turnaround, see Data Link Escape (DLE) (Paragraph 3.3.14).

#### 3.3.4 Enquiry (ENQ)

The LA120 automatically transmits its answerback message upon receipt of ENQ.

### **3.3.5 Bell (BEL)**

The bell character sounds a momentary 2400 Hz tone. No more than eight bells can be pending at any one time.

### **3.3.6 Backspace (BS)**

The backspace character decrements the active column, unless the active column is at the left margin, in which case the backspace character is ignored.

### **3.3.7 Horizontal Tab (HT)**

The horizontal tab character advances the active column to the next horizontal tab stop greater than the current active column, but no greater than the right margin. If there is no such tab stop, the active column is advanced to the column after the right margin.

### **3.3.8 Line Feed (LF)**

The line feed character increments the active line, unless the active line is at the bottom margin, in which case it sets the active line to the top margin of the next page. If linefeed-newline mode is enabled, the active column is set to the left margin.

### **3.3.9 Vertical Tab (VT)**

The vertical tab character advances the active line to the next vertical tab stop greater than the current active line but no greater than the bottom margin. If there is no such tab stop, the active line is set to the top margin (on the next page). If linefeed-newline mode is enabled, the active column is set to the left margin.

### **3.3.10 Form Feed (FF)**

The form feed character advances the active line to the top margin of the next page which may or may not be the physical top of the form. If linefeed-newline mode is enabled, the active column is set to the left margin.

### **3.3.11 Carriage Return (CR)**

The carriage return character returns the active column to the left margin. If carriage return is selected as the printer new line character, the active line is incremented.

### **3.3.12 Shift In (SI)**

The shift in character shifts the printer to the primary character set. If no secondary character set (such as APL) is installed, this character has no effect.

### **3.3.13 Shift Out (SO)**

The shift out character shifts the printer to the secondary character set. If no secondary character set (such as APL) is installed, or if alternate character set is disabled, this character has no effect.

### **3.3.14 Data Link Escape (DLE)**

If the LA120 is operating in half duplex with EOT turnaround, the data link escape character, when received or transmitted immediately prior to an EOT, causes the EOT to be interpreted as a disconnect request. If the LA120 is operating in any other full- or half-duplex mode, the DLE character has no effect.

### **3.3.15 Cancel (CAN)**

The cancel character terminates any pending escape sequence and causes the sequence to be ignored.

### **3.3.16 Substitute (SUB)**

The substitute character is interpreted as being in place of a character received in error. Characters received with parity errors are converted to the SUB character. If characters are ever lost due to input

buffer overflow, a SUB character is placed in the input buffer at that point. The SUB character is printed as the following graphic symbol:

⌘

The SUB character also has the effect of a cancel character.

### 3.3.17 Escape (ESC)

The escape character is interpreted as introducing an escape sequence. Escape sequences are described in detail in Paragraph 3.2.

## 3.4 APL CHARACTER SET

If the alternate character set SET-UP feature is enabled, the optional APL character set can be selected by the SO control character, independent of the national character set in use. The SI control character returns the printer to the previously selected national character set.

For the APL keyboard to work properly, the keyboard character set must have been set by the operator to United States or Great Britain. The APL character set is shown in Table 3-6.

Table 3-6 APL Character Set

Code	Char	Code	Char	Code	Char
040	space	100	--	140	
041	"	101	α	141	A
042	)	102	⊥	142	B
043	<	103	∩	143	C
044	≤	104	L	144	D
045	=	105	ε	145	E
046	>	106	--	146	F
047	]	107	∇	147	G
050	√	110	Δ	150	H
051	^	111	∖	151	I
052	≠	112	∘	152	J
053	÷	113	⋅	153	K
054	,	114	□	154	L
055	+	115		155	M
056	.	116	τ	156	N
057	/	117	⊖	157	O
060	0	120	*	160	P
061	1	121	?	161	Q
062	2	122	ƒ	162	R
063	3	123	Γ	163	S
064	4	124	~	164	T
065	5	125	↓	165	U
066	6	126	u	166	V
067	7	127	w	167	W
070	8	130	∩	170	X
071	9	131	↑	171	Y
072	(	132	c	172	Z
073	[	133	←	173	{
074	;	134	⊢	174	+
075	X	135	→	175	}
076	:	136	⋆	176	\$
077	\	137	+		

### 3.5 SAMPLE FORM SETUP USING ESCAPE SEQUENCES

All form control features available to the operator in SET-UP mode can also be transmitted to the LA120 using escape sequences. The sample form illustrated in Figure 3-1 could be set up using the escape sequences in Table 3-7.

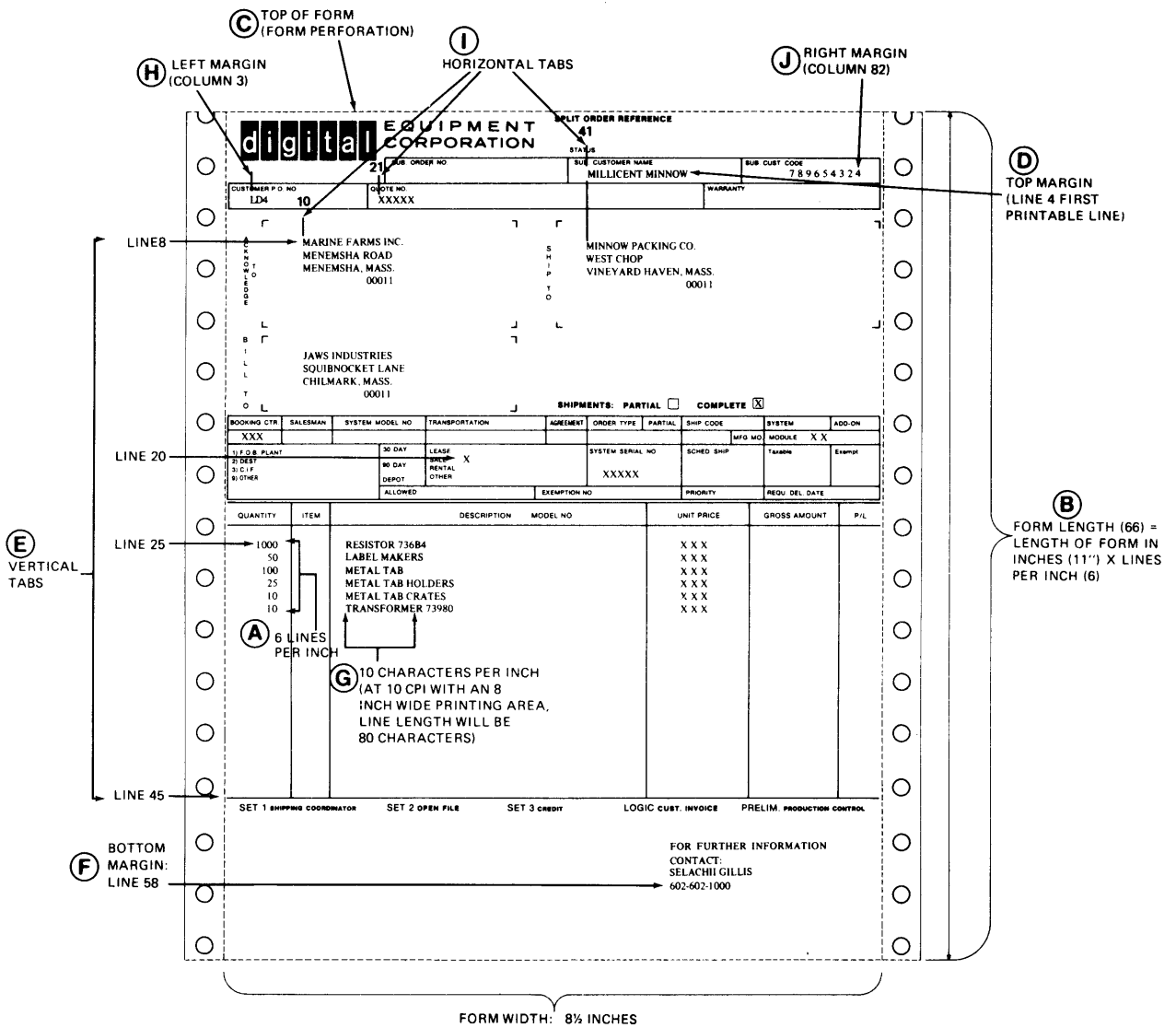
**Table 3-7 Escape Sequences for Sample Form**

Escape Sequence	Function/Comments
ESC [ 1 z	Selects 6 lines/in.
ESC [ 6 6 t	Sets form length to 66 lines and sets top-of-form at current line.
ESC [ 4; 5 8 r	Sets top margin at line 4 and bottom margin at line 58.
ESC [ 4 g	Clears all vertical tabs.
ESC [ 8; 2 0; 2 5; 4 5 v	Sets vertical tabs at lines 8, 20, 25, and 45.
ESC [ 1 w	Sets horizontal pitch to 10 char/in.
ESC [ 3; 8 2 s	Sets left margin to column 3 and right margin to column 82.
ESC [ 2 g	Clears all horizontal tabs.
ESC [ 1 0; 2 1; 4 1 u	Sets horizontal tabs at columns 10, 21, and 41.

### 3.6 SYNCHRONIZATION

When the LA120 receives a character (other than the fill characters, NUL and DEL), it stores it in its 1000 character input buffer. When the printer is ready, characters are fetched from the input buffer and printed. If the printer falls behind by more than about 1000 characters, the input buffer overflows and data is lost. There are three ways to avoid buffer overflows.

1. Send data only as fast as it can be printed. When receiving data at 1200 baud or less, the LA120 can keep up with normal character sequences. Very short lines and multiple form feeds cannot be printed this fast. Fill characters may be used to slow the effective data transmission speed in these cases. Fill time formulas are given in Paragraph 3.6.2.
2. Limit the length of your message to the LA120's input buffer size. If the buffer is empty at the beginning of your transmission, you can send a message of about 1000 characters without worrying about buffer overflow.
3. Use a terminal synchronization protocol, such as XON/XOFF or restraint mode. Using a synchronization protocol, the LA120 can tell the data source when to pause in sending data and when to resume. Synchronization allows maximum throughput and eliminates the need for fill character calculations and message size limits.



\* FORM LENGTH (66); LENGTH OF FORM IN INCHES (11) TIMES LINES PER INCH (6)

MA 2322

Figure 3-1 Sample Form SET-UP

When synchronization is used, the LA120 constantly monitors the number of characters stored in its input buffer. When the number of characters exceeds a "high water mark," the LA120 signals the data source to pause temporarily. Meanwhile, the printer continues to take characters out of the input buffer. When the number of characters remaining is less than a "low water mark," the LA120 signals that transmission may resume. The values used for the high and low water marks are selected by the buffer control SET-UP command.

The LA120 also sends a pause signal when the printer is not ready due to error conditions or operator actions. Running out of paper or detecting a print head jam can cause a pause request to be sent. The operator can induce a pause request by opening the cover or entering SET-UP mode.

The pause and resume signals to the data source are sent in either or both of two ways:

1. Using the control characters XON (octal code 021) and XOFF (octal code 023),
2. Using the EIA signal SRTS in restraint mode.

Restraint mode operation is suited for local, hard-wired installations, especially when the LA120 is used as a serial line printer replacement. Restraint mode is selected using SET-UP commands: "S" (secondary channel) must be "1" (enabled) and "M" (modern/protocol) must be "1" (full duplex, no EIA controls).

XON/XOFF is suitable for either local or remote operation so long as the connection is full duplex. To select XON/XOFF operation, the "X" set-up must be set to "1" (enabled). The XON/XOFF protocol is complicated by the fact that the synchronization characters may be interspersed between the characters typed at the LA120 keyboard. The operator can tell the data source to pause by typing XOFF (CTRL-S) and to resume by typing XON (CTRL-Q). To make sure that neither the buffer controller's nor the operator's pause requests are lost, typed characters may be transmitted with an XOFF character immediately following.

If XON/XOFF is enabled, the LA120 will transmit XON when first powered up and transmit enabled.

### 3.6.1 Synchronization Limits

Synchronization limits are given in Table 3-8.

**Table 3-8 Synchronization Limits**

"B" SET-UP Choice	Low Limit	High Limit
0 (small)	50 char	60 char
1 (large)	256 char	576 char

### 3.6.2 Fill Time Formulas

**3.6.2.1 Horizontal Movement** – Includes horizontal tabs and horizontal positioning escape sequences. First, convert to actual number of columns moved, then allow 15 ms for each of the first ten columns (30 ms in double-width pitches) and 5.5 ms for each additional column (11 ms in double-width pitches).

**3.6.2.2 Vertical Movement** – Includes line feeds, vertical tabs, form feeds, and vertical positioning escape sequences. First, convert to actual number of lines moved, then allow 33 ms for the first line moved up to 1/6 inch and 135 ms for each additional inch.

### 3.7 KEYBOARD OPERATION

The LA120 operator's console contains a typewriter-style keyboard resembling an office typewriter in key size, shape, and location. The keyboard also contains a 4-digit numeric display and eight binary indicators. There is provision for an optional, field installable numeric keypad.

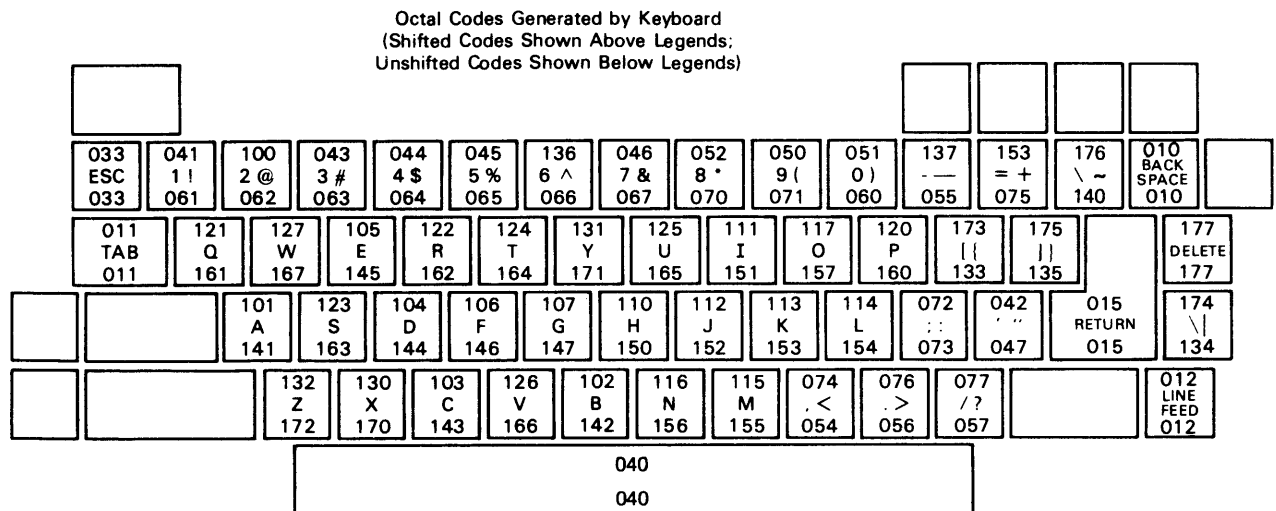
The operator uses the keyboard to transmit codes. If the LA120 is transmit-enabled, codes are transmitted as each key is pressed except during auto repeat activity or with certain combinations of three or more keys held down which cannot occur in normal touch typing. If the LA120 is not transmit-enabled, keystrokes are stored in a 16-character buffer for future transmission. If more than 12 keystrokes are in the buffer, each keystroke generates a 400 Hz tone to indicate that the buffer is full or nearly full. The buffer will be cleared without transmission any time SET-UP mode is entered or exited, line/local status is toggled, or a break is transmitted.

#### 3.7.1 Auto Repeat

If auto repeat is enabled and a key that generates the space, backspace, or delete code or any printable character code is held down for more than 0.6 second, the code for that key is transmitted repeatedly at 7.5 char/sec per second, gradually increasing to 25 char/sec, or at a rate determined by the baud rate, whichever is slower. If auto repeat is in process, all keystrokes are ignored until the repeating key is released. If more than one key is held down prior to the start of auto repeat, only the last key pressed is subject to auto repeat.

#### 3.7.2 Printable Character Keys

There are 47 keys that generate printable character codes. The relationship between these keys and the SHIFT and CAPS LOCK keys is such that each of the 26 alphabetic keys transmits the lowercase code unless either or both of the SHIFT keys are down, or unless the CAPS LOCK key is down. Each nonalphabetic key generates two different codes. One code is generated if neither SHIFT key is down. The other code is generated if either or both of the SHIFT keys are down. Unlike the SHIFT LOCK key of a typewriter, the CAPS LOCK key does not affect the nonalphabetic keys. The codes generated by each code generating key are shown in Figure 3-2.



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Figure 3-2 Octal Codes Generated by Keyboard

### 3.7.3 Control Character Keys

There are seven keys that generate control character codes. The codes generated by these keys are independent of the SHIFT and CAPS LOCK keys. The control character keys and their functions are listed in Table 3-9.

In coded control half duplex, the RETURN key transmits the turnaround character automatically after transmitting its normal code or codes.

**Table 3-9 Control Character Keys**

Key	Octal Code	Function
RETURN	015 or 015 012	CR or NL
LINE FEED	012	LF or NL
BACK SPACE	010	BS
TAB	011	HT
Space Bar	040	SP
DELETE	177	DEL
ESC	033	ESC

### 3.7.4 CTRL (Control) Key

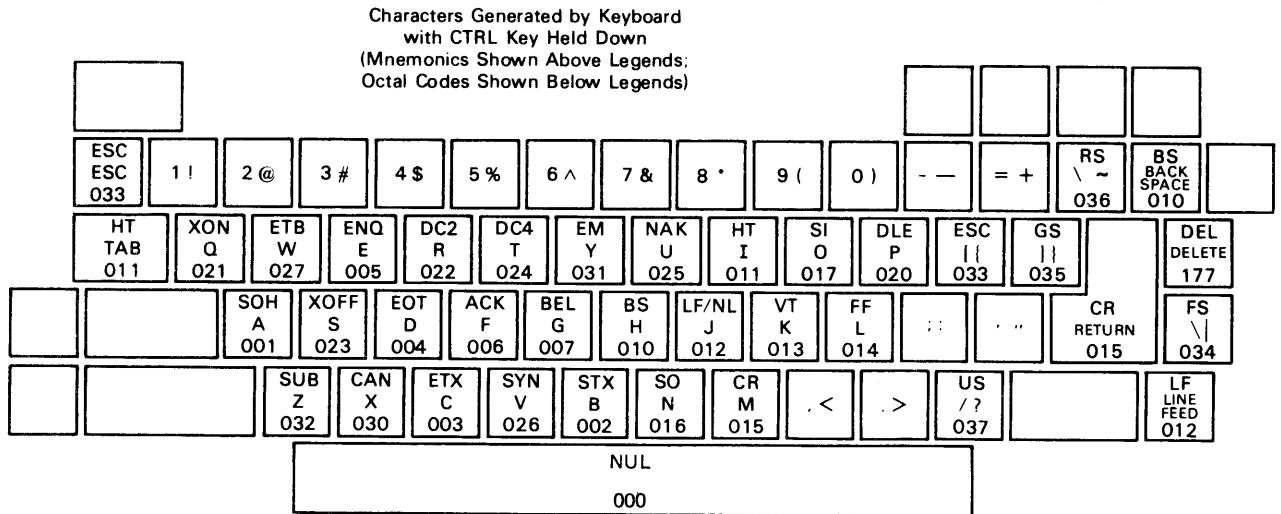
The CTRL key is used in conjunction with certain other keys on the keyboard to generate control character codes. The CTRL key is also used in conjunction with the SET-UP key to enter SET-UP mode.

The codes generated and keys affected by the CTRL key are independent of SHIFT and CAPS LOCK keys. It is never necessary to hold both the CTRL key and the SHIFT key down in combination with another key to generate control character codes. Also, there is only one CTRL key combination for each of the 32 control characters. Because of these requirements, there are three control characters whose locations on the LA120 may differ from other terminals. These characters and their locations on the LA120 and other terminals are shown in Table 3-10.

**Table 3-10 Variations in Control Character Locations**

Code	LA120	Other Terminals
NUL (000)	CTRL - <span style="border: 1px solid black; padding: 2px;">Space Bar</span>	CTRL-SHIFT - <span style="border: 1px solid black; padding: 2px;">@ 2</span>
RS (036)	CTRL - <span style="border: 1px solid black; padding: 2px;">~ \</span>	CTRL-SHIFT - <span style="border: 1px solid black; padding: 2px;">^ 6</span>
US (037)	CTRL - <span style="border: 1px solid black; padding: 2px;">? /</span>	CTRL-SHIFT - <span style="border: 1px solid black; padding: 2px;">- -</span>

The characters and codes generated by each key when the CTRL key is held down are shown in Figure 3-3.



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Figure 3-3 Characters Generated by Keyboard with CTRL Key Held Down

### 3.7.5 Optional Auxiliary Keypad

The optional auxiliary keypad contains 18 keys that transmit the codes for the characters or escape sequences specified in the escape sequences section of this chapter (Paragraph 3.2).

### 3.7.6 BREAK Key

Pressing the BREAK key causes the LA120 to transmit a short break signal of 233 ms duration.

Holding one or both SHIFT keys down and pressing the BREAK key causes the LA120 to transmit a long break disconnect signal of 3.5 seconds duration.

The interface leads involved in transmitting break signals are described in Chapter 4 of the *LA120 User Guide*.

### 3.7.7 VIEW Key

If automatic view is in use and the printer has been idle but has not yet timed out the automatic view delay time, pressing the VIEW key causes the view operation to be performed.

If automatic view is not in use, pressing and holding the VIEW key causes the print head to idle at the viewing position. With the VIEW key released, the print head idles at the ready to print position.

Where there is no character to print, the carriage moves to the print cell immediately to the left of the cell designated by the active position (ready to print position). If the printer remains idle longer than the automatic view delay time, the carriage moves to the right to facilitate viewing of the last character printed (viewing position).

The automatic view delay time is a function of keyboard activity. If characters are being typed at a touch typing rate or faster, the time is set long enough to prevent erratic carriage motion. Otherwise, it is set to provide instant visibility of single typed or received characters. The automatic view operation may be disabled by the operator using a SET-UP command (SET-UP Z).