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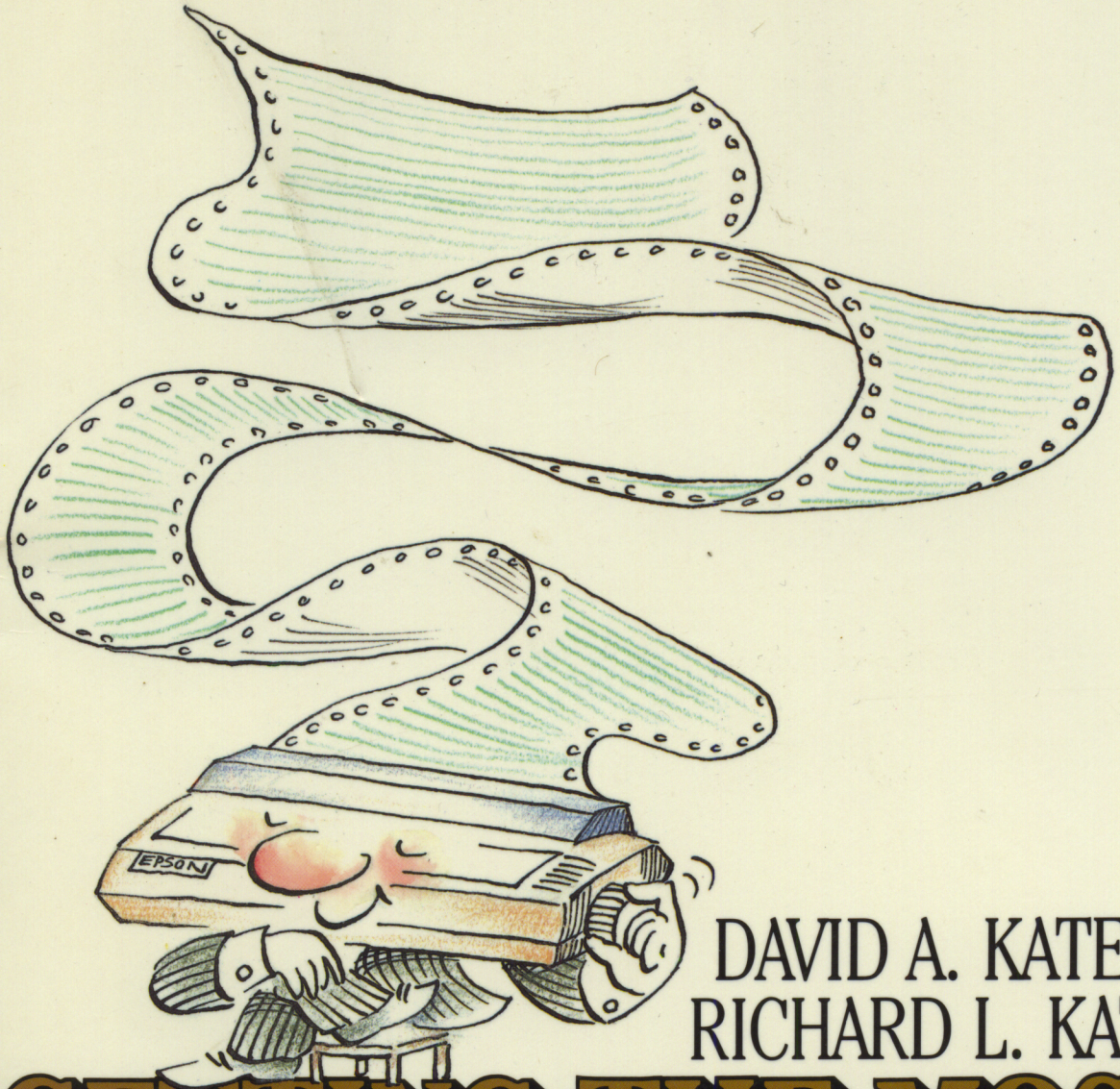

DAVID A. KATER
RICHARD L. KATER

GETTING THE MOST OUT OF YOUR EPSON PRINTER

Getting the Most Out of Your Epson Printer

David A. Kater

and

Richard L. Kater

EduKater

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The editors for this book were Tyler G. Hicks and Susan Killikelly, the designer was Naomi Auerbach, and the production supervisor was Thomas G. Kowalczyk. It was set in Century Schoolbook by University Graphics, Inc. Printed and bound by Halliday Lithograph.

To four people whose enthusiasm and love of life are a constant inspiration:

Gami
G.J.
Poppy
Lee

Our favorite octogenarians

About the Authors

Thank you for joining us in this historic event. You are holding in your hand the first creation of a new writing team, a father-and-son team, a go-for-the-gold team. In this case, the son is the computer pro; the father is the new kid on the block. Together they are a winning team. One supplies technical thoroughness and accuracy; the other, directness with an easy flair. They share an excitement over microtechnology development, empathy with their readers, the joy of working together, and a great sense of humor over just about everything.

Dave Kater is a professional writer devoted to helping people get the most out of their microcomputers. A former college professor in mathematics and computer science, he left the ivory-tower environment to devote his full energies to writing usable documentation. He cofounded the Computer Institute of San Diego and developed EduKater, a writing-consulting firm.

He has that rare ability to make complex ideas easy and fun to learn.

His keyboard has spawned such diverse works as *TRS-80 Graphics—For the Model I and Model III,* three Epson printer manuals (FX-80, RX-80, and FX Series), *TRS-80 Word Processing with SuperSCRIPSIT, The Printed Word, Macintosh Graphics and Sound,* and several magazine articles. These tutorial works encourage you to participate in a step-by-step development of unique examples. This approach enables you to discover in a personal way how to utilize the power of your computer fully.

Dick Kater spent over 30 years in the aerospace industry, first in production management and then in engineering administration. As a father, his experience is even more extensive (by a multiple of 6). His aspirations as a would-be writer date back to junior high school years.

During the past two years, he has contributed significantly to Dave's books, principally the SuperSCRIPSIT book and the RX-80 manual.

After years of polishing his journalistic talents on technical proposals, interoffice documents, letters, graduate course term papers, and essays for special occasions, he has plunged into this new career with collegiate energy, enthusiasm, and mature perspective.

Contents

Acknowledgments

No author is an island. No pair of authors can produce in their own little vacuum. This pair of authors is keenly aware of the efforts and talents that went into this book and the people whom we like to think of as *our team.*

Mike Hunter tested, developed, and documented programs and figures. Mike is always thorough, reliable, and innovative.

Griselda Engelhorn, in her first exposure to a computing machine, struggled with great patience through long, tedious hours of recreating a detailed graphic pattern using unfamiliar software.

Susan Thomas, starting with a rough preliminary, worked with talented dedication to give her beloved lion new, high-density life.

Ramona Garcia made the phone calls, pulled together samples and photos, wrote programs, kept things going in many helpful ways, and ran our socks off in early-morning jogs around the lake—all with eagerness and good humor.

Randy Ozden came through at the end of the schedule, with his graphics talent and programming skill, to contribute some much-needed figures and illustrations.

Kaye Kater patiently kept the home flowers watered while Dick was off on his numerous writing junkets.

Betty Henderson and all the good friends at Lockheed, Burbank, launched a new team of writers with an overflow of love and support.

Introduction

Browsing through a bookstore the other night—yes, it was the computer section—we were impressed with the quality and variety of the selection. Books on Apples and IBMs and Commodores. Lots of books on how to select a personal computer. Books on BASIC and graphics and word processing programs and spreadsheet programs. Printers? No books on printers.

This is a book on printers. The world of microcomputers needs a book about microcomputer printers. *You* need a book about printers. You need some guidelines before you select a printer to print out the good stuff you are feeding into your personal computer. You just can't walk into a computer store and put yourself at the mercy of some salesperson.

If you already have a printer, careful, don't get too smug. How do you know you are getting the last drop of performance out of that little rascal? There is a lot of talent built into the modern microcomputer printer, and we're going to show you just how it works.

So, should we cover the entire printer market or settle on a portion of it? That one is easy to answer. The printer market is so diverse, a comprehensive book would be worth its weight in used printer ribbon. Just too much material to provide thorough coverage.

So what part of the market do we tackle first? That is even easier. The overwhelming popularity of dot-matrix printers makes them the prime candidate. And the most representative line of dot-matrix printers is, of course, Epson.

Since 1964, Epson has led the way in developing the dot-matrix printer and is still the most dominant force in that market. Using Epson's line of printers as a focal point, this book will fill you in on dot-matrix printers, how they work, what they can do, and how to use them.

So that you know what you are getting in this book, let's have a little debriefing on what lies ahead.

What's in the Book

In Part 1, we give you some background on the Epson printer line so that you can understand why we chose Epson as the basis for this book. Then we go through that product line, printer by printer and feature by feature, to put things in perspective historically and in terms of performance and value. This part of the book should be particularly helpful to prospective buyers.

Part 2 is the real guts of the book, oriented to the performance buff—you types who can talk about horsepower, rpm's, and drag coefficients. We explain what dot-matrix printers do and how they do it, with plenty of illustrations.

Of course, we don't forget you potential buyers. Part 2 is where you learn what specific printer features are and how they work. You can also find out which printers have features you want.

In addition to containing a lot of interesting information, this part can help general business users by expanding their understanding of how a printer works. Of course, this means you will be better equipped for problem troubleshooting and for using the printer with your applications programs.

Part 3 is for everyone—what we all want to know about printers. What programs work best with my printer, and vice versa? We concentrate on a word processing program and then examine some of the other popular categories, such as graphics and spreadsheets. We explain how to use system- and user-defined print codes.

OK, you do-it-yourselfers, Part 4 is for you. Here's where we give you a rundown on graphics, with instructions on the major considerations in creating a graphics design. Then you can take your pick from a series of graphics forms design programs, all with keynotes that explain what we did, how we did it, and why we did it the way we did.

Part 5 is geared more for you types who really want to know what's under the hood. In this section, we deal with the interface between printer and computer. We explain how the computer takes the codes that come out of your applications program, translates them into printerese, and transmits them to the printer. We track these codes through printer cards, cables, buffers, and modes and then describe the printer's reaction process.

How to Use the Book

If you have read from the beginning of the introduction through to this point, you are well on your way to one good method for getting good value from this book: Read it cover to cover.

Another method is to browse through the book for familiarization, using

the introduction and table of contents for guides. Then use the index to select the particular sections you want to study.

Those of you who have printers, especially if they are Epsons, will find Part 2 loaded with the complete batch of Epson features and the codes that drive them. We encourage you to experiment with these codes, using any software tools you have at your disposal. Part 3 shows you how to get good mileage out of the printer features, using and even extending selected applications programs.

Well, the preliminaries are over. It's time to get on with the reason you came along for the ride. This is your book on microcomputer printers. It is your chance to learn and appreciate the versatility of dot-matrix printing. We hope you find the subject as interesting as we do and the treatment as rewarding as you deserve.

Part

1

A Look at the Epson Printer Line

Chapter

1

The Epson Phenomenon

It all started with the 1964 Olympics in Tokyo. Although the connection between a computer-driven printing machine and the Olympic games may seem a little vague, don't ever discount the Japanese. Epson invented the world's first small printer just at the time when the eyes of the world were on, and a lot of the world's people were in, Japan.

Subsequent years saw much fine-tuning of the Epson philosophy for success, which was to be the best—best in design, production, and performance, best in innovation, best in documentation, best in marketing. It worked so well that now Epson is able to describe itself as the world's largest manufacturer of print mechanisms.

In 1980, Epson unveiled the MX-80, an 80-column printer that was loaded with innovations. It printed bidirectionally at 80 characters per second; its 9 × 9 dot matrix handled 96 ASCII, 64 graphic, and 64 Katakana characters as well as 9 characters that could be translated into four different languages. It also featured user-selectable print widths of 40, 80, 66, or 132 columns per 8-inch page as well as two types of bold print, *and* it had the world's first disposable print head.

The MX-80 ate up the market. It became the best-selling printer in the world, bar none. Quickly following with new models and innovative features, Epson consolidated its dominant position. Even today, as competition abounds, some estimates put Epson's share at 50 to 60 percent of the microcomputer printer market.

What Makes Epson Run?

In the rest of this chapter, we fill you in on some of the factors that made it all happen. In Chapter 2, we give you a detailed rundown on the entire Epson printer line, starting with the MX-80.

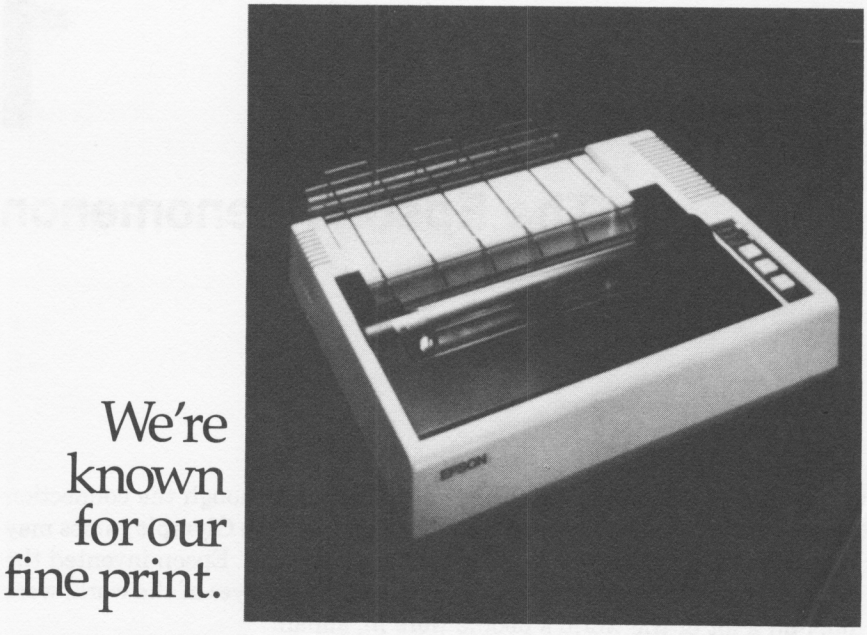


Figure 1-1 MX-80 ad. *(Courtesy of Ripley-Woodbury Advertising, Inc.)*

Foresight in Design

Epson's MX printer series probably made its major impact on the market because of advanced features at a low price, a combination of quality and economy. One factor that made this possible was the firm's employment of the most advanced automatic assembly and machining capability available; this indicates that Epson had the foresight to gear up for high-volume production and price the product accordingly.

The real nugget, however, has to be Epson's painstaking efforts continually to push the state of the art in incorporating improved design features into a machine that cranks along for months and months of trouble-free operation. For example, Epson spent three years developing the MX-80. It was the first printer to sport a disposable print head, which is good for about 50 million characters. *If* the printer head ever fails, you can remove it with your bare hands, throw it away, and replace it for about $30. The MX-80 also prints bidirectionally at 80 characters per second (CPS), with innovative electronics to minimize print-head travel time and maximize throughput.

You will see a lot more printer features when we cover later models in the next chapter. In fact, that printer-by-printer review should give you a

good perspective on the design trends that led to the current flock of printers.

One of the significant influences on microprinter technology is the competition between daisy-wheel and dot-matrix printers. Basically, the struggle is between quality on the one hand and speed and versatility on the other. Daisy-wheel printers sacrifice speed to produce letter-quality documents. Dot-matrix printers are inherently much faster, and the digital nature of the character formation in these printers provides for tremendous variation in character design, pitch, and graphics ability. The major thrusts in dot-matrix design are to achieve much greater speed and to approach the letter-quality output of the daisy wheels.

Timing

Through some fortunate combination of insight, foresight, preparation, and luck, Epson managed to be in the right place at the right time. The microcomputer world was ready, and the MX-80 was exactly what it was ready for. This little machine was the first to hit the market loaded with improvements and with totally new and very usable features.

The clincher was price. Epson had planned for high production and priced the printer accordingly. The price/performance ratio was too good to pass up, and a lot of new users became acquainted with Epson's MX.

Of course, Epson didn't quietly frequent back alleys to peddle this new little wonder. The company launched a sophisticated campaign of very effective full-page ads in leading computer publications. They had the right product at the right price for the right market, and they made sure the right people knew all about it.

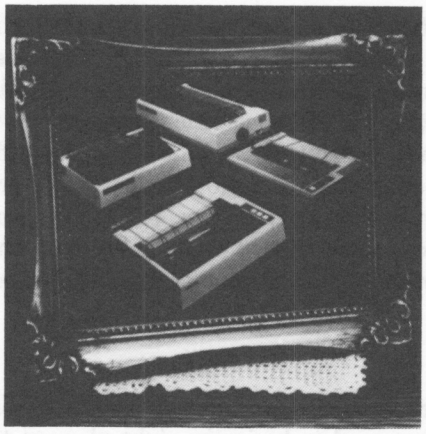
The Class Act

Some of that wisdom also got into the operations act. Epson recognized that the first sale had to be regarded as an opportunity to impress the customer with the quality of both the product and the company.

The Epson printer line has to be its own best promoter because of its sturdy construction and reliable operation. Businesses can't afford downtime, and individuals can't stand downtime. Thus, a record of virtually failure free performance has been a key to Epson's mass sales.

Other manufacturers have jumped on the bandwagon with Epson look-alikes, but unfortunately they are not of Epson quality. The less reliable imitations just aren't selling as well.

Another key to this class act is the user's manual. Before the MX-80, user's manuals were full of specifications and technical jargon. Sensitive to customers' needs, Epson contracted with leading computer writer



The family portrait.

Epson.

We finally got the group together for the family photo. We would have done it sooner, but the family has been growing so fast it just wouldn't hold still.

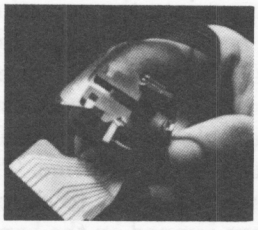
You see, less than a year ago hardly anyone had even heard of Epson. And now we're selling more printers in the U.S. than anyone. Which makes a pretty strong statement about the kind of printers we make. And our dealer network. And our service.

The little printer on the right is our MX-70. Not only is it as reliable as a Boy Scout, it's the lowest-priced 80-column dot matrix printer in America. Out in front, where it belongs, is the MX-80: a full-function, bidirectional printer, with a logical seeking function and a 9x9 matrix for superb correspondence-quality printing. On the left is our versatile MX-80 F/T — all the features of the MX-80, but with both tractor and friction paper feed. So it handles almost any need you'll ever have. And finally, there's the patriarch of the family — the MX-100. It's everything you would expect from an Epson printer, but in a full 136-column format.

Of course, like any family, the Epson MX Series has a few traits in common. Like remarkable Epson reliability. And internal microprocessors. And the famous Micro-Nine disposable dot head: when it wears out, just throw it away, because a new one is a third the price of conventional heads. And you change it yourself in less than a minute.

All in all, we think the Epson MX printers make a pretty impressive family. But when you see this picture again next year, it will probably be a little bigger.

We're expecting.



Meet the whole family at NCC Booth 1634.

EPSON

EPSON AMERICA, INC.

23844 Hawthorne Boulevard • Torrance, California 90505 • (213) 378-2220

Figure 1-2 ***Advertising campaign.*** *(Courtesy of Ripley-Woodbury Advertising, Inc.)*

David A. Lien to produce manuals in an easy-to-read, easy-to-use tutorial style that has established another new standard in the industry.

To maintain customer relations on a long-term basis, Epson established a nationwide network of service centers, which currently are being linked with the Computerland stores. The interface with users provided by these centers has led to many upgrades of existing printers as well as development of new features and new models.

Market Serendipity

Similar to other industries in this technological era, the computer industry supports many specialty companies that build peripheral hardware and interface devices, create software, and distribute computer wares. When the MX-80 opened a new market, support came from many directions.

Many applications programs are written exclusively for Epson printers. Hardware add-ons for Epson printers run the gamut from printer stands to buffer boards. Computer professionals and consultants have developed systems based on Epson capabilities. Now we are writing a book using the Epson line as the best way to present all you need to know about dot-matrix printers.

More of that good fortune? Luck? More likely, Epson's inscrutable wisdom had it mapped out all the way.

Summary

In 1980, Epson unveiled the MX-80, which became the best-selling printer in the world. Epson's subsequent models and emphasis on quality have made it the dominant company in the microprinter market.

Epson has consistently produced reliable quality at low prices by tooling for high-volume production, and Epson design has been a market leader in technical innovation.

Aggressive marketing, usable documentation, and a record of nearly failure free operation have contributed to the Epson success story.

Chapter

2

The Printer Line and How It Grew

Here it is, the whole clan, starting with old Grandad MX, Ma and Pa, and all the little Epsons.

Notice that Figure 2-1, showing our grand old family tree, distinguishes between the MX line, all the members of which are now out of production, and the currently active crop of printers.

Now let's get into printer features so that you can understand what these machines can do as well as get some perspective on their history of development. Note that the explanations in this chapter are brief, just enough to help you understand what the equipment can do and maybe why it can do it. Beginning in Chapter 3, we shall explain most of these features more thoroughly, showing you how they work. And now, starting with . . .

TX-80

The TX-80 was the first Epson printer marketed in the United States, a short-lived precursor to the MX-80.

MX-80

This blockbuster came on the scene in 1980, introduced a slug of features unheard of at its list price of $650,* and became a worldwide best-seller. Its size is about 12 × 15 inches and just over 4 inches high, and it handles paper from 4 to 10 inches wide. Now, for those special features.

*Prices quoted are original list prices.

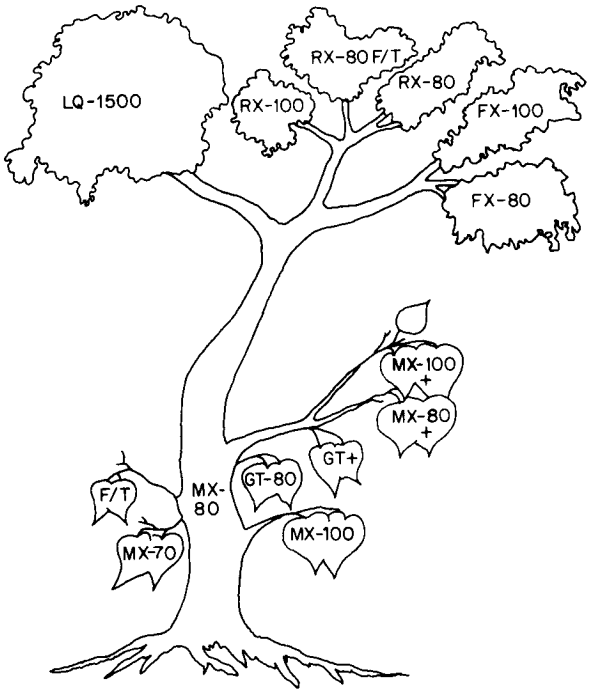


Figure 2-1 Family tree.

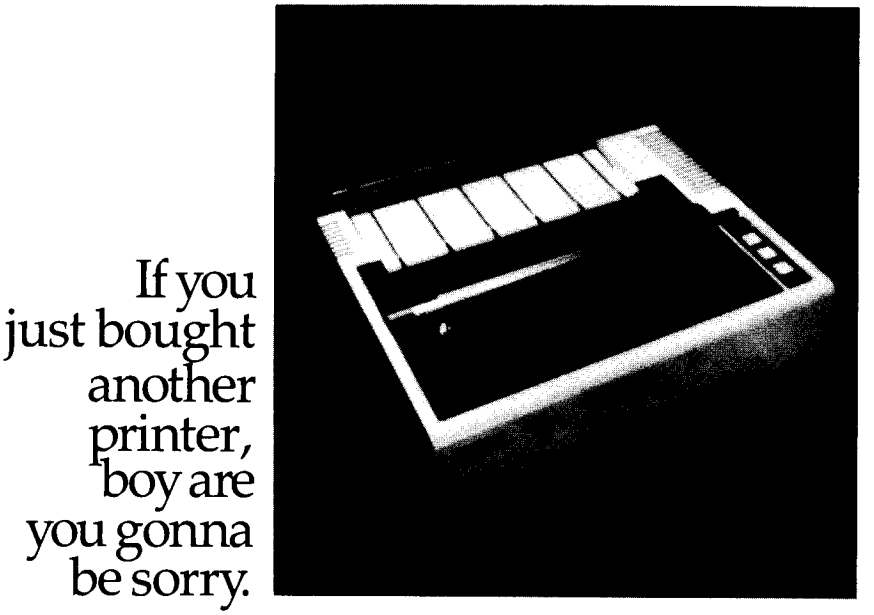


Figure 2-2 MX-80 ad. *(Courtesy of Ripley-Woodbury Advertising, Inc.)*

Bidirectional Printing

The print head doesn't have to return to the left margin to start printing each line; it can print in both directions. To minimize total throughput time, the printer formats each line in the printer's memory (called the buffer) while the print head is still running off the previous line. The printer then calculates which direction and how far it needs to move the print head in order to print the next line. This innovation speeds up the whole printing operation.

Disposable Print Head

A disposable print head means no downtime for print-head repairs. The MX-80 print head is good for about 50 million characters, can be removed without tools, and can be replaced for about $30.

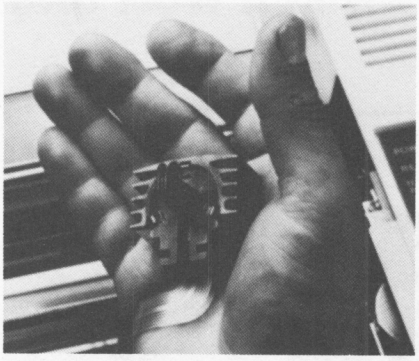


Figure 2-3 MX-80 print head. *(Courtesy of Ripley-Woodbury Advertising, Inc.)*

Speed: 80 CPS

Eighty characters per second is about twice the speed of most daisy-wheel printers. As we continue through this chapter, notice what happens to print speed in later printers.

The 9 × 9 Dot Matrix

The print head contains 9 wires in a vertical column, and combinations of these wires can strike the paper as many as nine times in a horizontal sequence to print 1 character (see Figure 2-4). We shall discuss the mechanics of dot-matrix printing more fully in Chapter 3.

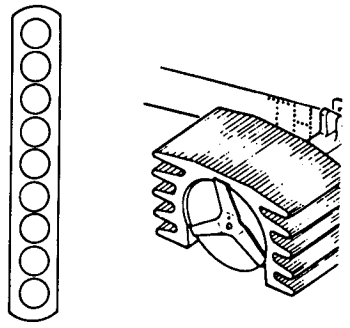


Figure 2-4 The print head in action.

Programmable Form Length and Line Feed

The MX-80 keeps track of where the print head is in relation to the paper at all times. A top-of-form code feeds the paper to align the top of the next page with the print head. At 6 lines to an inch, a standard 8½ × 11 inch sheet holds 66 printed lines, and so the default value for form length is 66. A form length code can change that default value to match a form of virtually any length.

The MX-80 can also change the distance between print lines. The normal line spacing is 6 lines per inch. It can be set to any value from 1/72 inch to 85/72 inch.

Programmable Horizontal and Vertical Tabs

The MX-80 has the ability to store its own horizontal and vertical tabs internally. This capacity is very useful in printing forms of all kinds.

The 95 ASCII Characters

ASCII is the abbreviation for the American Standard Code for Information Interchange. This is the industry standard that makes it possible for equipment from all the different hardware manufacturers to play together. ASCII numbers from 0 through 31 and 127 are reserved for use as control codes. The 95 numbers from 32 through 126 designate printable symbols. Figure 2-5 shows the codes used by the MX-80.

For more on the ASCII standard, see Chapters 4 and 18.

Print Quality

In addition to the ASCII codes listed in Figure 2-5, the MX-80 interprets certain sequences of codes as instructions to change modes of print. Some

Dec.	Char.	Dec.	Char.	Dec.	Char.	Dec.	Char.
0	None	32	b	64	@	96	.
1	None	33	!	65	A	97	a
2	None	34	"	66	B	98	b
3	None	35	#	67	C	99	c
4	None	36	$	68	D	100	d
5	None	37	%	69	E	101	e
6	None	38	&	70	F	102	f
7	BEL	39	'	71	G	103	g
8	None	40	(	72	H	104	h
9	HT	41	)	73	I	105	i
10	LF	42	*	74	J	106	j
11	VT	43	+	75	K	107	k
12	FF	44	,	76	L	108	l
13	CR	45	–	77	M	109	m
14	SO	46	.	78	N	110	n
15	SI	47	/	79	O	111	o
16	None	48	0	80	P	112	p
17	DC1	49	1	81	Q	113	q
18	None	50	2	82	R	114	r
19	DC3	51	3	83	S	115	s
20	DC4	52	4	84	T	116	t
21	None	53	5	85	U	117	u
22	None	54	6	86	V	118	v
23	None	55	7	87	W	119	w
24	CAN	56	8	88	X	120	x
25	None	57	9	89	Y	121	y
26	None	58	:	90	Z	122	z
27	ESC	59	;	91	[	123	{
28	None	60	<	92	\	124	:
29	None	61	=	93	]	125	}
30	None	62	>	94	^	126	~
31	None	63	?	95	-	127	DEL

Source: David A. Kater, *FX Series Printer User's Manual,* Epson America, Inc., 1984.

Figure 2-5 ASCII table for MX-80. *(Courtesy of Epson America, Inc.)*

of these codes direct the printer to select one of two different kinds of bold print. The resulting combinations are shown in Figure 2-6.

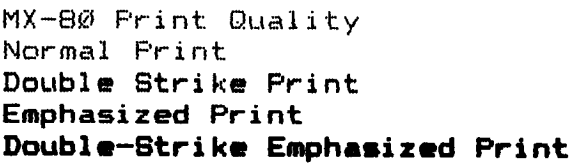


Figure 2-6 MX-80 print quality options.

Character Widths

Additional control codes can change the appearance of the printed text by varying the character widths to look like the ones shown in Figure 2-7.

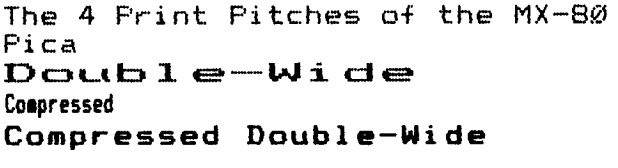


Figure 2-7 MX-80 pitch variations.

Adjustable Tractor Feed

The MX-80 paper-feed tractors can easily accommodate sprocket-feed paper between 4 and 10-inches wide.

Block Graphics

To enable some creative design work, Epson included 64 block graphics characters. These characters are compatible with the screen graphics characters used on the early Radio Shack TRS-80 computers. At the time when the MX-80 was introduced, Radio Shack was at the front of the pack, so this was a good move.

Figure 2-9 shows what can be done using block graphics.

Katakana Characters

With the flick of a switch, the user can trade the graphics characters for the set of 64 Japanese Katakana characters shown in Figure 2-10.

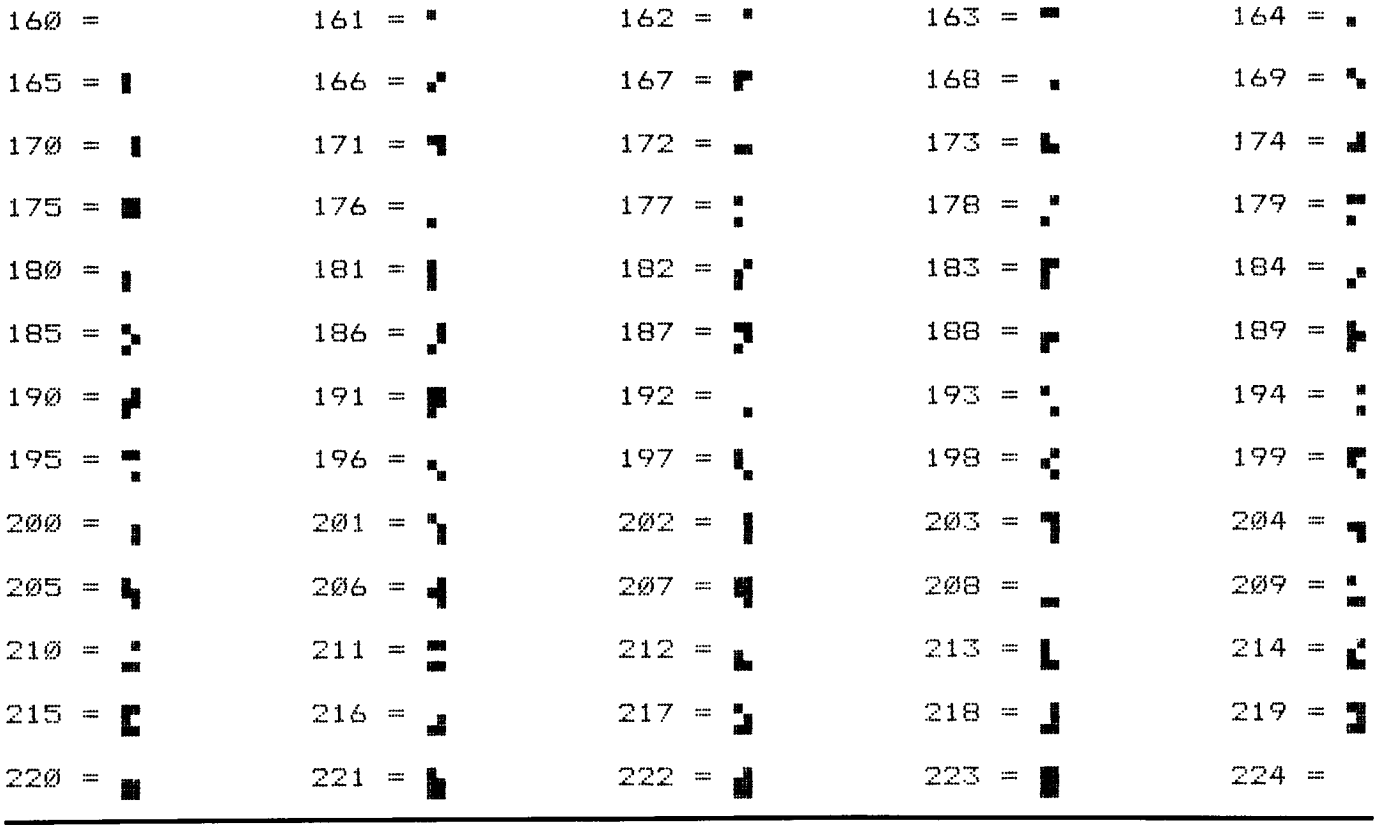


Figure 2-8 MX-80 block graphics.

Figure 2-9 Lion made with block graphics.

International Characters

By changing switches inside the printer, the MX-80 can print characters used in three international languages. The characters are simply switched with the normal ASCII characters. Figure 2-11 shows the characters that can be printed and the countries to which they correspond.

MX-70

Early in 1981 Epson came out with the economy model of the MX line, the MX-70 ($445). It is basically the same printer as the MX-80 with some of the frills removed.

Unidirectional Printing

The MX-70 also has a burst speed of 80 CPS, but its throughput is slower than that of the MX-80 because it can print only from left to right. It has to return to the left margin before printing each new line.

The 5 × 7 Dot Matrix

The MX-70 print isn't as sharp as that of the MX-80 because the MX-70 uses only 5 vertical columns instead of 9. In addition, the lowercase characters do not have descenders. Figure 2-13 shows the difference. Notice that the MX-70 uses no intermediate columns, only the full columns. The grid patterns used here will be explained more fully in Chapter 3.

160 =	161 = ｡	162 = ｢	163 = ｣	164 = ､
165 = ･	166 = ｦ	167 = ｧ	168 = ｨ	169 = ｩ
170 = ｪ	171 = ｫ	172 = ｬ	173 = ｭ	174 = ｮ
175 = ｯ	176 = ｰ	177 = ｱ	178 = ｲ	179 = ｳ
180 = ｴ	181 = ｵ	182 = ｶ	183 = ｷ	184 = ｸ
185 = ｹ	186 = ｺ	187 = ｻ	188 = ｼ	189 = ｽ
190 = ｾ	191 = ｿ	192 = ﾀ	193 = ﾁ	194 = ﾂ
195 = ﾃ	196 = ﾄ	197 = ﾅ	198 = ﾆ	199 = ﾇ
200 = ﾈ	201 = ﾉ	202 = ﾊ	203 = ﾋ	204 = ﾌ
205 = ﾍ	206 = ﾎ	207 = ﾏ	208 = ﾐ	209 = ﾑ
210 = ﾒ	211 = ﾓ	212 = ﾔ	213 = ﾕ	214 = ﾖ
215 = ﾗ	216 = ﾘ	217 = ﾙ	218 = ﾚ	219 = ﾛ
220 = ﾜ	221 = ﾝ	222 = ﾞ	223 = ﾟ	224 =

Figure 2-10 MX-80 Katakana characters.

	35	64	91	92	93	123	124	125	126
U.S.A.	#	@	[	\	]	{	¦	}	~
FRANCE	#	à	°	ç	§	é	ù	è	¨
GERMANY	#	§	Ä	ö	Ü	ä	ö	ü	ß
ENGLAND	£	@	[	\	]	{	¦	}	~

Figure 2-11 MX-80 international characters.

Figure 2-12 MX-70 ad. *(Courtesy of Ripley-Woodbury Advertising, Inc.)*

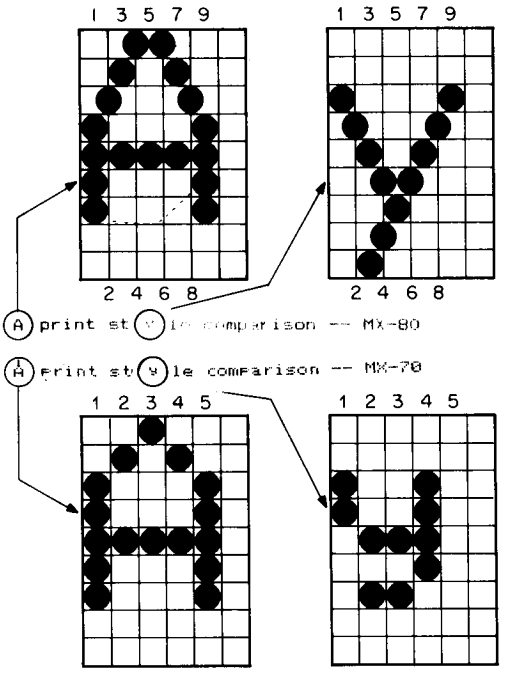


Figure 2-13 MX-70/MX-80 print style comparison.

High-Resolution Graphics

In place of the block graphics available on the MX-80, the MX-70 features a high-resolution graphics package called Graftrax II. It allows the user to control individual pins of the print head. The horizontal print density is 60 dots per inch, or 480 dots across the page. The vertical density is 72 dots per inch. Figure 2-14 shows a sample created with this high-resolution graphics package.

MX-80 F/T

Expanding the versatility of the basic model, the friction tractor (F/T) unit ($745) comes with a friction feed that can handle single sheets, similar to the way a typewriter operates. It also has an attachable, adjustable, removable tractor so that it still has the ability to handle various widths of pin-feed paper.

MX-100

By June 1981, all that Epson inventiveness was in high gear as the firm released the wide-bodied MX-100 ($995). Its obvious major improvement was a wider carriage for printing spreadsheets and the like.

Figure 2-14 Lion made with dot graphics.

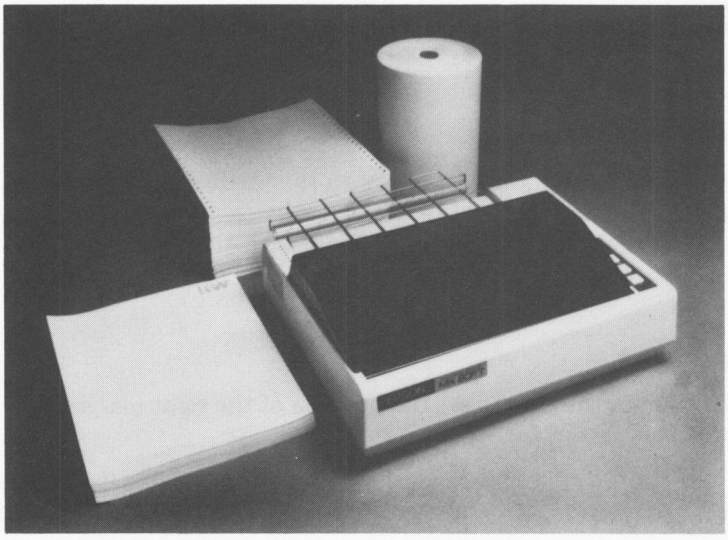


Figure 2-15 MX-80 F/T photo. *(Courtesy of Ripley-Woodbury Advertising, Inc.)*

Wider Carriage

The MX-100 has the ability to print 233 columns of information on 15-inch-wide paper. Like the MX-80 F/T, this printer has both a friction-feed platen and fully adjustable removable tractors. But the software codes are greatly improved. In place of the TRS-80 graphics characters, the MX-100 features high-resolution graphics.

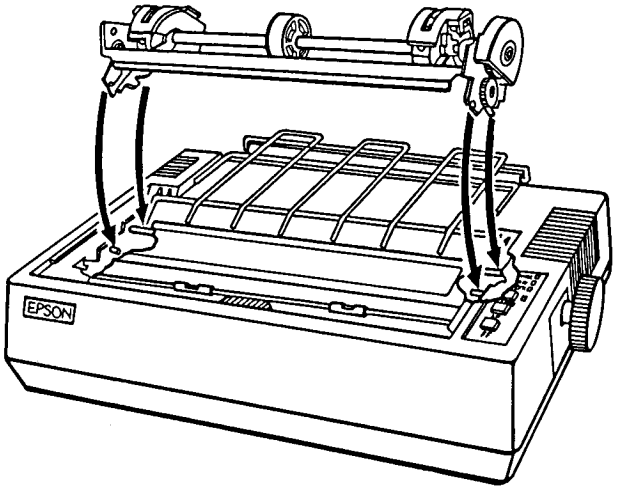


Figure 2-16 Removable tractor unit.

More High-Resolution Graphics

The MX-100 added a new graphics mode to the 60-dots-per-inch (horizontal) mode of the MX-70. This Double-Density mode prints overlapping dots to produce 120 dots per inch. Figure 2-18 compares the two densities.

Adjustable Right Margin

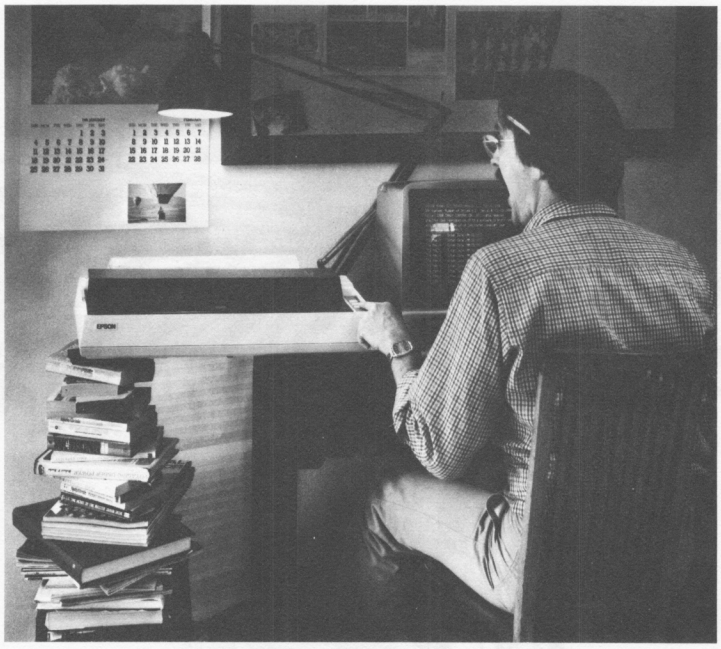
The MX-100 enables the user to set the position of the right margin with software codes.

Skip Over Perforation (SOP)

Without this feature, the printer does not pause for perforations on continuous-feed paper but keeps printing merrily away. With SOP, a special control code or an internal switch tells the printer, "Don't step on the cracks; don't print on them, either."

More International Characters

The MX-100 also added additional international character sets to those of the MX-80, bringing the total to eight countries. Figure 2-19 shows the different characters and countries. These character sets can be selected with software codes or with internal switches.



The MX-100. Not just better. Bigger.

Epson.

Our MX-80 was a pretty tough act to follow. I mean, how do you top the best-selling printer in the world?

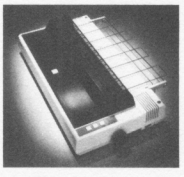
Frankly, it wasn't easy. But the results of all our sleepless nights will knock your socks off.

The MX-100 is a printer that must be seen to be believed. For starters, we built in unmatched correspondence quality printing, and an ultra-high resolution bit image graphics capability. Then we added the ability to print up to 233 columns of information on 15" wide paper to give you the most incredible spread sheets you're ever likely to see. Finally, we topped it all off with *both* a satin-smooth friction feed platen *and* fully adjustable, removable tractors. And the list of standard features goes on and on and on.

Needless to say, the specs on this machine — and especially at under $1000 — are practically unbelievable. But there's something about the MX-100 that goes far beyond just the specs; something about the way it all comes together, the attention to detail, the fit, the feel. Mere words fail us. But when you see an MX-100, you'll know what we mean.

All in all, the MX-100 is the most remarkable printer we've ever built. Which creates rather a large problem for those of us at Epson.

How are we going to top this?



Your next printer.

EPSON

EPSON AMERICA, INC.

3415 Kashiwa Street • Torrance, California 90505 • (213) 539-9140

See the whole incredible Epson MX Series of printers at your Authorized Epson Dealer.

Figure 2-17 MX-100 ad. *(Courtesy of Ripley-Woodbury Advertising, Inc.)*

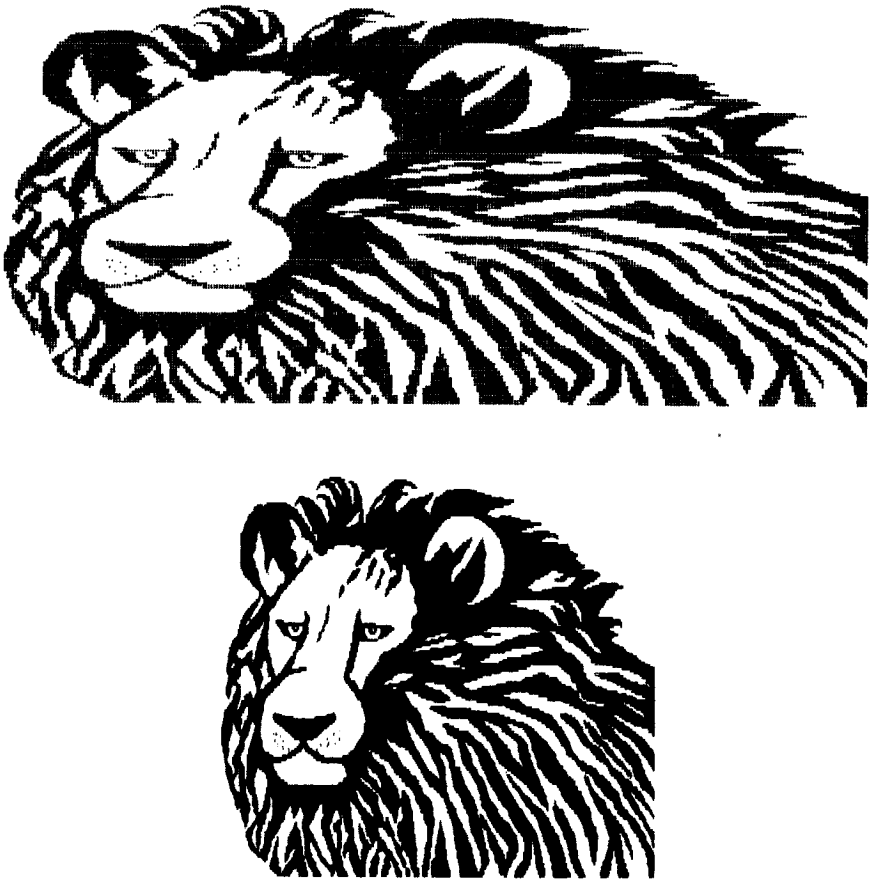


Figure 2-18 Lion: (*a*) single-density and (*b*) double-density.

	35	36	64	91	92	93	94	96	123	124	125	126
U.S.A.	#	$	@	[	\	]	^	`	{	|	}	~
FRANCE	#	$	à	°	ç	§	^	`	é	ù	è	¨
GERMANY	#	$	§	Ä	Ö	Ü	^	`	ä	ö	ü	ß
ENGLAND	£	$	@	[	\	]	^	`	{	|	}	~
DENMARK	#	$	@	Æ	Ø	Å	^	`	æ	ø	å	~
SWEDEN	#	¤	É	Ä	Ö	Å	Ü	é	ä	ö	å	ü
ITALY	#	$	@	°	\	é	^	ù	à	ò	è	ì
SPAIN	₧	$	@	¡	Ñ	¿	^	`	¨	ñ	}	~

Figure 2-19 MX-100 international characters.

Graftrax 80

In the summer of 1981, Epson introduced new programming for the MX-80 and MX-80 F/T printers. This new programming, called Graftrax 80 ($95 for upgrade kit), consisted of three read-only memory (ROM) chips that replaced the logic chips in the machines. Graftrax 80 added a host of new features, but it was only a precursor of what was to come.

Figure 2-20 Graftrax 80 ad. *(Courtesy of Ripley-Woodbury Advertising, Inc.)*

High-Resolution Graphics

Using 120 dots per inch horizontally and 216 dots per inch vertically gives anybody a lot of fine definition at any time. A Graftrax 80 printer can also print double-density graphics at double speed, which is the same speed as

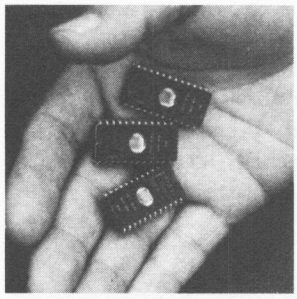


Figure 2-21 Graftrax 80 chips. *(Courtesy of Ripley-Woodbury Advertising, Inc.)*

single-density graphics. The Graftrax 80 chips feature both high-resolution printing and block graphics characters.

Line Spacing to *n*/216

Normal line spacing is ⅙ inch, or $^{36}/_{216}$. To make possible a whole stable of special effects, a new code controls line spacing in increments of $^{1}/_{216}$ inch. That is one-third the distance between the pins in the print head.

Italics

A complete italic character set actually doubles the number of type fonts available, which for the MX-80s is now 24.

ITALICS can be used for *Emphasis*

Figure 2-22 Italics type font.

Printer Control

Graftrax 80 makes it possible to change type style, size, and density at any point in the text, even in the middle of the line. A Reset code cancels all software codes and resets the printer to default modes. Also, a backspace feature is added so that the print head can back up to overprint the previous character.

High-Order Bit

The output on some early computer systems is limited to 7 data lines instead of the normal 8. These computers cannot access codes higher than

127 in the ASCII table. But Epson put in all those block graphics and italic characters, and they mean for you to use them, so the company also put in control codes to turn the high-order bit on or off. With these codes, you can instruct the printer to add 128 to the code number coming from the computer and thus can print block graphics or italic characters no matter what computer you are using.

Redefine Software Codes

Graftrax 80 even includes a code that allows the user to redefine the Escape codes used to access the various modes. This feature can come in handy. For example, if you have a software driver for a daisy-wheel printer but no daisy-wheel printer, you can use your Graftrax 80 printer to emulate the daisy wheel.

Graftrax Plus

Graftrax 80 was superseded early in 1982 by Graftrax Plus ($95 for upgrade kit), which included nearly all the features of its predecessor (block graphics were dropped) plus some added print symbols and modes. Graftrax Plus was available as a retrofit kit, and it became the standard for all factory-produced MX-80s and MX-100s.

Special International Symbols

Although the complete foreign character sets of some of the earlier printers are not included in the Graftrax Plus logic, some special symbols, such as the tilde, umlaut, and franc sign, are available. These symbols can be used to print characters from several foreign languages.

Print Modes

For scientific and word processing use, behold: $_{\text{subscript}}$, $^{\text{superscript}}$, and <u>underline modes</u>.

Line Drawing Graphics

A set of 11 line graphics characters are included in the ASCII table. These characters are extremely useful for preparation of forms, as shown in Figure 2-25.

European Variation

Epson marketed a different version of the MX-80 in Europe. It lacked superscripts and subscripts but had more international characters.

Birth of a legend.

Epson.

A whole new generation of Epson MX printers has just arrived. And while they share the family traits that made Epson famous — like unequalled reliability and ultra-fine printing — they've got a lot more of what it takes to be a legend.

For instance, they've got a few extra type styles. Sixty-six, to be exact, including italics, a handy subscript and superscript for scientific notation, and enough international symbols to print most Western languages.

What's more, on the new-generation MX-80, MX-80 F/T and MX-100, you get GRAFTRAX-Plus dot addressable graphics. Standard. So now you can have precision to rival plotters in a reliable Epson printer. Not to mention true backspace, software printer reset, and programmable form length, horizontal tab and right margin.

All in all, they've got the features that make them destined for stardom. But the best part is that beneath this software bonanza beats the

Figure 2-23 Graftrax Plus ad. *(Courtesy of Ripley-Woodbury Advertising, Inc.)*

Figure 2-26 FX-80 ad. *(Courtesy of Ripley-Woodbury Advertising, Inc.)*

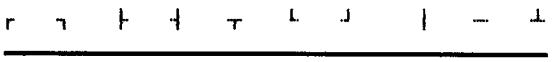


Figure 2-24 Line graphics characters.

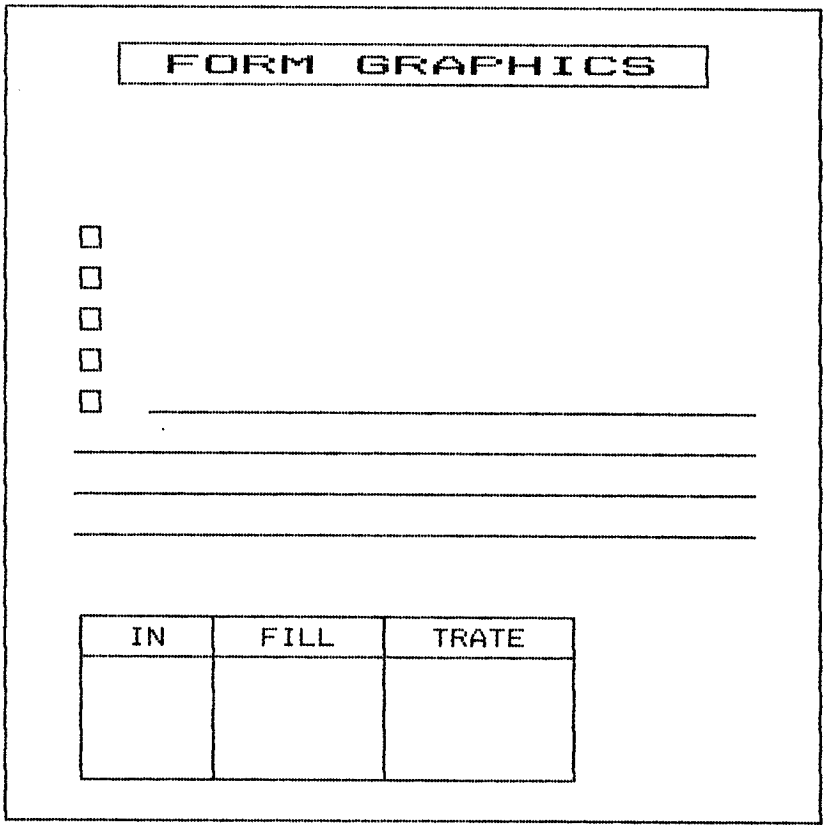


Figure 2-25 Line graphics in action.

FX-80

So much for ancient history. When Epson introduced the FX-80 ($699) early in 1983, the entire MX line became obsolete. In spite of all the advanced features on the MX printers, the FX represents many technical breakthroughs. For starters . . .

Wide-Bodied Luxury

The FX is wider than its MX predecessors (16.535 inches), moving the printer cable out of the paper path and allowing easier access to the switches.

Uh...three legends.

heart of an Epson. So you still get a bidirectional, logical seeking, disposable print head, crisp, clean, correspondence quality printing, and the kind of reliability that has made Epson the best-selling printers in the world.

All of which should come as no surprise, especially when you look at the family tree. After all, Epson *invented* digital printers almost seventeen years ago for the 1964 Tokyo Olympics. We were the first to make printers as reliable as the family stereo. And we introduced the computer world to correspondence-quality printing and disposable print heads. And now we've given birth to the finest printers for small computers on the market.

What's next? Wait and see. We're already expecting.

EPSON
EPSON AMERICA, INC.

3415 Kashiwa Street • Torrance, CA 90505 • (213) 539-9140

FEATURE	ORIGINAL MX-80	GRAFTRAX-80*	ORIGINAL MX-100	MX-80 with GRAFTRAX-Plus	MX-80 F/T with GRAFTRAX-Plus	MX-100 with GRAFTRAX-Plus
Bidirectional printing	X	X	X	X	X	X
Logical seeking function	X	X	X	X	X	X
Disposable print head	X	X	X	X	X	X
Speed: 80 CPS	X	X	X	X	X	X
Matrix: 9 x 9	X	X	X	X	X	X
Selectable paper feed			X		X	X
PAPER HANDLING FUNCTIONS						
Line spacing to n/216		X		X	X	X
Programmable form length	X	X	X	X	X	X
Programmable horizontal tabs	X	X	X	X	X	X
Skip over perforation			X	X	X	X
PRINT MODES AND CHARACTER FONTS						
96 ASCII characters	X	X	X	X	X	X
Italics character font		X		X	X	X
Special international symbols				X	X	X
Normal, Emphasized, Double-Strike and Double/Emphasized print modes	X	X	X	X	X	X
Subscript/Superscript print mode				X	X	X
Underline mode				X	X	X
10 CPI	X	X	X	X	X	X
5 CPI	X	X	X	X	X	X
17.16 CPI	X	X	X	X	X	X
8.58 CPI	X	X	X	X	X	X
DOT GRAPHICS MODE						
Line drawing graphics				X	X	X
Bit image 60 D.P.I.		X	X	X	X	X
Bit image 120 D.P.I.		X	X	X	X	X
CONTROL FUNCTIONS						
Software printer reset		X		X	X	X
Adjustable right margin			X	X	X	X
True back space		X		X	X	X
INTERFACES						
Standard — Centronics-style 8-bit parallel	X	X	X	X	X	X
Optional — RS-232C current loop w/2K buffer	X	X	X	X	X	X
RS-232C x-on/x-off w/2K buffer	X	X	X	X	X	X
IEEE-488	X	X	X	X	X	X

*Tandy TRS-80 block graphics only available with GRAFTRAX 80.

Figure 2-23 (*continued*)

Speed: 160 CPS

That's right. This printer's burst speed—160 characters per second—is twice as fast as that of the previous models. You can easily tell the difference when you watch the paper move out of the printer carriage.

User-Defined Characters

This is do-it-yourself alphabet time. If you want a type style different from the standard or italic fonts, you can create up to 256 new characters in a 9 × 11 dot matrix and store them in the printer's memory. Figure 2-27 shows what can be done with a single letter.

Figure 2-27 Variations on the letter F.

A 2K Print Buffer

The FX-80 features a 2K (2048-character) block of random-access memory (RAM) available to the user. This memory can be used either to store user-defined characters or as an additional 2K print buffer. A switch setting selects the preferred usage.

ROM/RAM Downloading

This option makes it possible to copy into the user-defined RAM area the entire set of predefined character patterns that are stored in the printer's ROM. This makes the ROM characters available so that you don't have to reinvent the wheel when you just want to add a few characters to the standard set.

Mixing Modes

Print modes can be selected by typeface, pitch, weight, and spacing. Of the 11 possible mode selections on the FX-80, some are mutually exclusive, but many can be combined, creating an even greater variety of print styles. Figure 2-28 illustrates the possibilities. The FX-80 also has a control code that selects compatible combinations of print modes by number.

Absolute Tabs

The FX-80 can remember up to 32 horizontal tab positions, and tabs can be set to any position on the page. For user convenience, built-in horizontal tabs are set at default increments of 8. Similarly, up to 16 vertical tabs

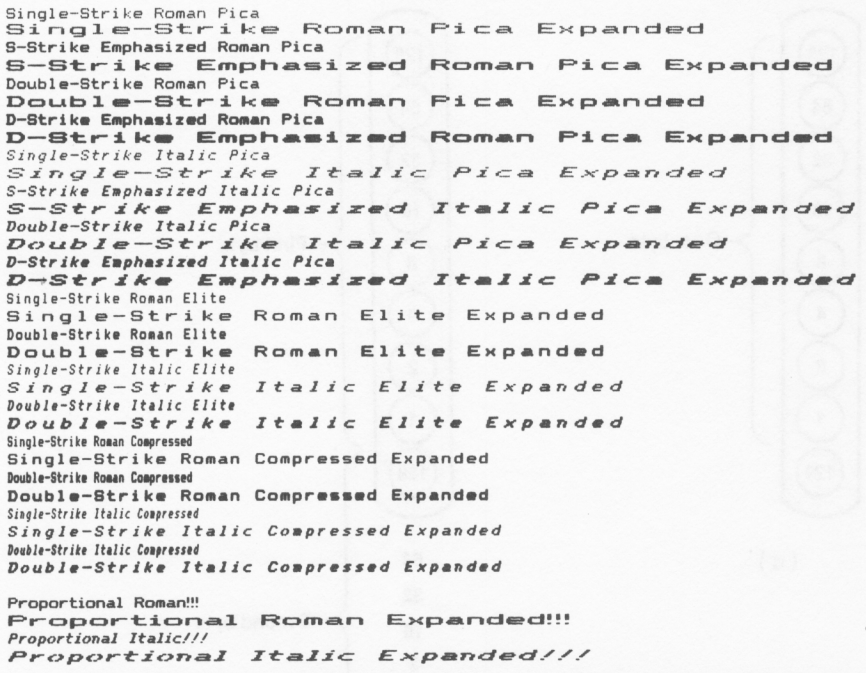


Figure 2-28 FX-80 Print mode combinations.

can be selected. The major contribution of the FX to the Epson tab feature is that once tab stops are defined, they are fixed in place and are not affected by changes in pitch.

Channel Tabs

For use with preprinted forms or multipage forms, another option makes it possible to save sets of vertical tabs, called channels. There are 8 channels available, each with a capacity for 16 tab stops; this enables a user to set up for some serious production tabulating.

The 9-Pin Game

Epson printers are designed to accept data from the computer 8 bits at a time. In the standard graphics modes for 9-wire print heads, each bit fires one of the top 8 pins of the print head, leaving the bottom pin unaccounted for. For graphics-intensive applications, printing 9 pins at a time can speed up the process considerably. The 9-pin Graphics mode code processes data 2 bytes at a time so that you can use all 9 pins on every pass of the print head.

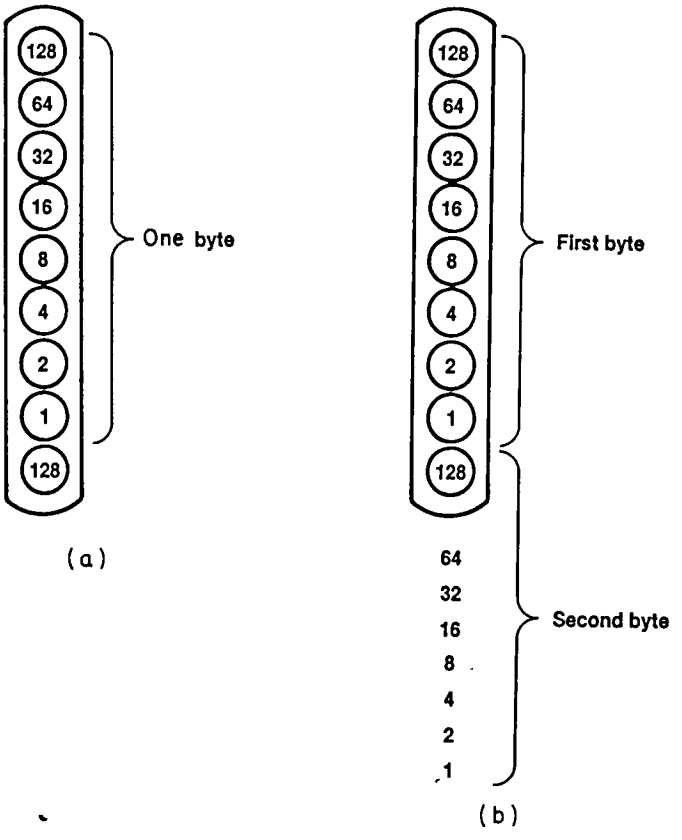


Figure 2-29 (*a*) Normal 8-pin Graphics mode and (*b*) 9-pin Graphics mode. *(From David A. Kater,* FX Series Printer User's Manual, *Epson America, Inc., 1984. Reprinted with permission.)*

Typewriter Emulation Mode

For nostalgia buffs who miss the constant clatter of the old Selectric, there is an immediate print mode. Data are printed as soon as the printer receives them. Then, at the end of each line, good old FX-80 rolls the paper up so that you can read it before it is rolled back into position to print the next line.

Reverse Feed

Did you catch the significance of the paper-rolling action mentioned above? It means that the FX-80 has reverse feed. Not only that, back in the MX days Epson introduced a paper-feed control in increments of $\frac{1}{216}$

inch, or one-third the distance between the pins in the print head. The same fine-tuning is available with reverse feed on the FX-80.

International Characters

With the addition of Japan, the FX supports nine countries with 64 international characters stored in ROM, half of these in italics. They are all available to anyone who knows the proper control code.

Proportional Print

With monospaced pitches, every character, from i to w, takes the same amount of space, similar to the system used in a typewriter. The FX-80 features a proportional print mode in which each letter is given an amount of space proportional to its width. With this feature, the dot-matrix printer takes another step closer to true letter-quality printing.

```
MONOSPACED SAMPLE:
Proportional does it tidier -- from Illinois to Mississippi.

PROPORTIONAL SAMPLE:
Proportional does it tidier -- from Illinois to Mississippi.
```

Figure 2-30 Proportional print sample.

Name Your Own Graphics

We've already worked our way through high- and ultra-high-resolution graphics. The FX-80 includes several new graphics densities, including Quadruple-Density Graphics mode. This machine gives you a selection of seven different graphics densities from 60 to 240 dots per inch.

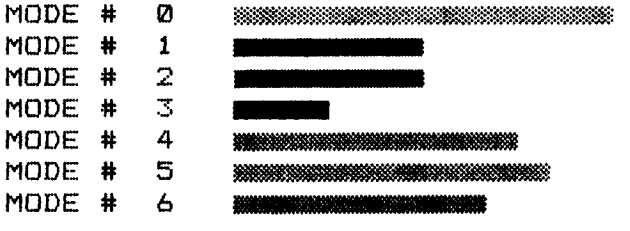


Figure 2-31 Graphics densities compared.

Another graphics code lets you reassign the codes used to access some of the graphics modes. This enables you to change the density of your graphics programs by adding a single program line.

Dual Paper Feed

Is there no end to the new features on this machine? We are going to deal with one more, and that's all you get. The FX-80 has a built-in combination of friction and tractor paper feeds that doesn't require any removing or reattaching. Unfortunately, this clever design makes loading the paper a real chore. For narrow tractor forms such as mailing labels, a separate tractor unit is required. And th-th-that's all, folks.

FX-100

That's all except for the FX-100 ($895), which is the wide-bodied version of the FX-80. Since it uses the feed mechanism from the MX-100, it does not have a built-in tractor, reverse feed, or typewriter emulation modes.

RX-80, RX-80 F/T, and RX-100

What in the world could Epson have done to top the FX-80? Relax. You can take a breather on this one. The RX machines ($494, $599, and $699) are simpler, more econimical models. Actually, Epson packaged most of the FX-80 features into the MX-80 chassis in order to develop new models that are very cost-effective.

Speed: 100 CPS

Burst speed is 100 characters per second: not as fast as the FX but still a respectable speed, certainly faster than the MX printers.

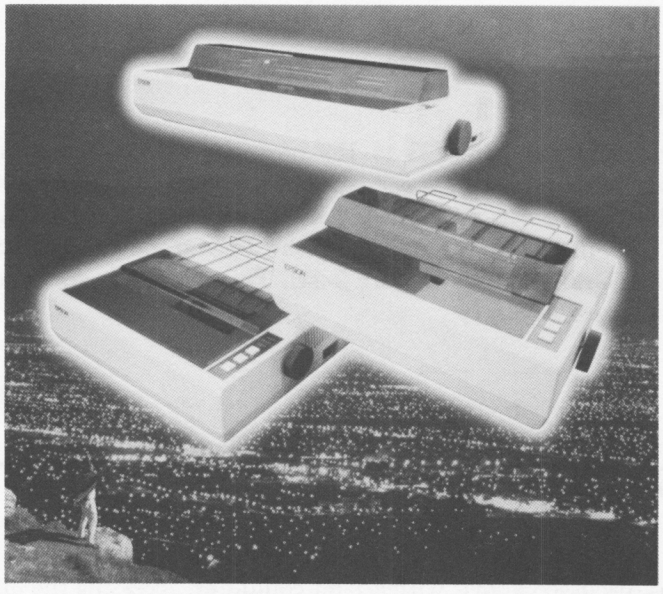
Preset Tabs

The RX machines can still tab both vertically and horizontally but do not have the same all-position capability that the FX has. The default tabs are every eighth column horizontally and every second line vertically. However, a little familiarization with the control codes will give users the ability to reset all tab positions to meet their needs.

International Characters

It seems that more countries are added for each new printer. The RX series can access international symbols for 8 countries by manipulating

Introducing RX Series Printers



They're here.

Epson®.

If you've been waiting for a *real* Epson at a price that's down to earth, wait no more.

A boon to humankind.

The Epson RX Series printers do everything you want a printer to do. They do it reliably, year after year. And they do it at a price you can afford.

The family portrait.

Need a workhorse that prints and keeps on printing? Get the Epson RX-80.™ Want the added versatility of using fanfold, roll or single-sheet paper? The RX-80 F/T gives you the choice. Need a wide printer for spread sheets or general ledgers? The 136-column RX-100 will handle them. With ease.

And every Epson RX Series printer gives you plenty of speed — up to 100 characters per second and 128 different typestyles in print so fine you'll have to look twice to make sure it's dot matrix. Finally, and best of all, you get Epson's legendary reliability.

Let there be hardcopy.

Epson has sold more printers for more personal computers for more years than any other company on earth.

See the RX Series. And find out why.

Number one.
And built like it. EPSON AMERICA, INC.
3415 Kashiwa Street, Torrance, California 90505

Call (800) 421-5426 for the Epson dealer in your area. In California call (213) 539-9140.

Epson is a registered trademark and RX-80 is a trademark of Epson America, Inc.

Figure 2-32 RX Series ad. *(Courtesy of Ripley-Woodbury Advertising, Inc.)*

DIP switches and the symbols for 11 countries by manipulating computer codes. There are now character sets for Norway and for the European version of Denmark. As usual, every character has its italic counterpart.

Special Characters

ASCII decimal numbers 128 to 159 normally store control codes, but Epson has tucked away 32 special graphics characters "beneath" the normal codes. These can be activated by a key code or by setting a DIP switch. The first 11 are similar to the line graphics characters first unveiled in Graftrax Plus (Figure 2-24). The characters speak for themselves in Figure 2-33.

Figure 2-33 RX special character set.

As was discussed above, with a 7-bit computer, accessing the upper part of the ASCII table, where the special graphics set is stored, presents a problem. Since the RX printers don't have the convenient codes of the FX, users of 7-bit computers have to forgo high-order characters on the RX printers.

Sold-Out Features

Other features that were eliminated in the economy move were user-defined codes, 2K buffer, 9-pin graphics mode, proportional print, reverse feed, typewriter emulation mode, selecting mode combinations, and the 1 to 1 graphics mode.

What's Left?

Starting with the MX-80 and proceeding through the FX-80, we have itemized a powerful bundle of features. In this section, we have downgraded or eliminated a few of them. That still leaves the RX printers highly effective, reliable, versatile, and loaded with advanced features. Loading the paper into the RX-80 tractor feed is easier than on the FX-80. Its sister machine, the RX-80 F/T, has a built-in friction platen for individual sheets and forms plus a removable tractor for pin-feed paper.

RX-100 Differences

The RX-100 is the wide-bodied version of the RX-80 F/T. The RX-100 retains a few features of the FX Series printers, including the 9-pin graphics mode and the ability to reassign graphics modes. The most striking difference is that the RX-100 responds to the vertical and horizontal tab codes of the FX printers.

LQ-1500

Epson's latest entry into the dot-matrix printer market is the LQ-1500 ($1395 plus $95 parallel interface). This amazing printer features a 24-wire print head that can generate near-letter-quality (NLQ) characters and spectacular graphics. The code structure is remarkably similar to that of the FX Series printers, but there are a few new features.

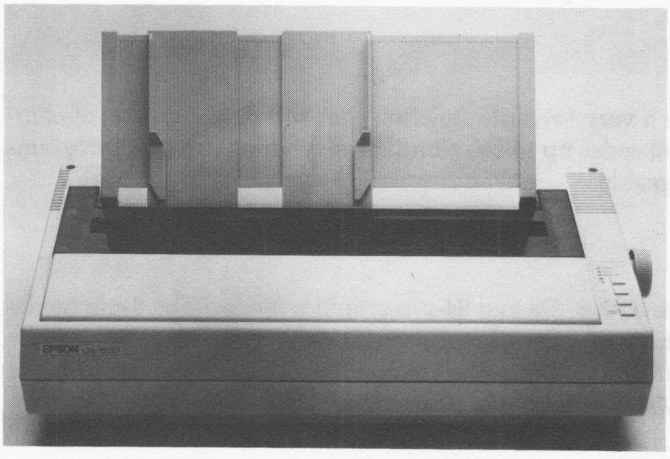


Figure 2-34 LQ-1500. *(Courtesy of Epson America, Inc.)*

Near-Letter-Quality Mode

The Near-Letter-Quality mode brings out the best in the printer. See Figure 2-35.

DRAFT QUALITY PRINTS AT 200 CPS.

NEAR LETTER QUALITY PRINTS AT 67 CPS.

Figure 2-35 Print quality with 24 wires.

Print Speed

Consumers want it faster and faster, and Epson delivers. The LQ-1500 has a burst speed of 200 CPS in its Draft mode and 67 CPS in its Near-Letter-Quality mode. It may not break the sound barrier, but that's fast enough to step out smartly and then some.

Print-Head Control

The LQ-1500 will let you position the print head to any dot column on the line in two ways: relative to the current position or set to an absolute dot position. What control!

Spacing Increment

You can also control the spacing distance between characters in increments of 1/180 inch. What precision!

Repeat Function

The LQ features a very versatile function that will repeat strings of characters and control codes up to 255 times. This function can keep programs short and manageable.

Graphics Modes

The LQ-1500 has both 8-pin and 24-pin graphics modes. The 8-pin modes are similar to those on the other Epson printers. The 24-wire graphics modes allow nearly three times the vertical density of the 9-wire printers. Figure 2-36 shows 24-wire graphics in action.

Figure 2-36 Sample of 24-wire graphics.

Single-Sheet Loader

A convenient feature introduced on the LQ-1500 is a single-sheet loader. Just drop a sheet of paper into position, press the SHEET-LOAD button, and the paper is loaded automatically.

Subtle Differences

The different construction of the print head requires a few subtle differences between the LQ and the rest of the Epson line in terms of the way some of the commands are implemented. For instance, the line-spacing increments have changed from 1/72 and 1/216 to 1/60 and 1/180 inch. The Master Select command includes more modes than the FX printers. The user-defined characters, of course, are defined in a different-size dot grid. All in all, the LQ codes are remarkably consistent with the FX Series codes.

And the Beat Goes On

Technology never stands still. Sometime after this manuscript was past the stage of no return, Epson announced several changes in their product line. The FX series features new Selectype logic that lets you choose the type style that suits your work or mood with the touch of a button. There is also an optional cut sheet feeder and a ROM card that features a specially designed font to approach letter-quality print. The JX-80 is an FX-80 clone that features color. The printer includes a mechanism that moves a four-stripe ribbon up and down to change colors.

The LX-80 and LX-90 replace the RX series in the low end of the printer market. The printers feature sleek new designs and several improvements, including a near-letter-quality font. The LX-90 is a wider version that accepts a modular interface card that makes the printer compatible with one of the popular computers. The Homewriter 10 is a version of the LX printers targeted for sales through department stores.

Epson has diversified into two other printer technologies: ink jet and daisy wheel. They will start with two ink jet printers, one with 9 nozzles and another with 24. The 24-nozzle printer will be similar to the LQ-1500 in features, with speeds of 175 CPS for draft characters and 106 CPS for near-letter-quality characters. The 9-nozzle printer is extremely portable, with speeds of 160 CPS in unidirectional print for draft, and 32 CPS for correspondence quality.

The daisy-wheel printers are Diablo 630 code-compatible. The DX-10 offers a speed of 10 CPS and 82-column print with a parallel interface and optional tractor and cut sheet feed. The DX-20 offers a speed of 20 CPS and 110-column print. It features a single 50-pin connector interface that is switch-selectable to parallel, serial, or IEEE (you supply the cable). It also has an optional typewriter keyboard available.

Summary

We've covered the Epson printer line from A to Z. We've tried to give an overview rather than a detailed analysis. Having a complete picture

should help you understand where your printer fits or which printer to buy.

Part 2 of this book takes a look at how dot-matrix printing works, or at least how Epson does it. We'll look at it feature by feature.

Part

2

Understanding How the Printers Work

Chapter

3

Dot-Matrix Printing

Who Are Those Guys?

This chapter tells you what dot-matrix printing is, and the best place to start is with all the things it isn't. So hang in there and humor us a little; we'll get to the point soon. The background you will gain in the next few pages will give you a better perspective from which to judge the utility of dot-matrix printers in your system.

Daisy-Wheel Printers

Since daisy-wheel printers are very popular in the word processing arena, let's discuss them first. Daisy wheels punch out text in much the same manner as typewriters, particularly the IBM Selectric. The Selectric uses a round ball with raised letters on its surface. The daisy wheel uses a round metal or plastic wheel with raised characters at the end of each spoke. To print, the desired character is pressed against a ribbon that transmits its image to the paper.

Daisy-wheel quality is excellent, comparable to that of the finest business typewriters. Its product is referred to as letter-quality printing.

For this reason, it is the likely choice for installations where word processing is a high priority and quality is essential. What you sacrifice for this quality is speed, versatility, and graphics ability. Price breakthroughs in daisy-wheel printers have made these printers a hot item.

Daisy-wheel print speed is very slow compared with that of dot-matrix printers. Daisy wheels typically plug along at about 10 to 55 CPS, whereas some of the newer dot-matrix printers can get to speeds approaching 200 CPS.

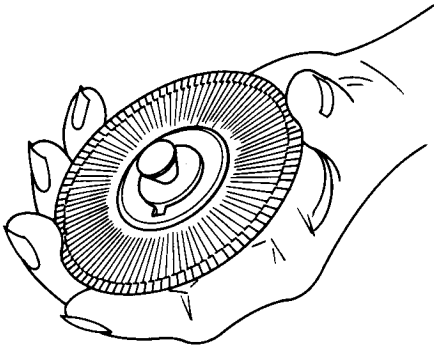


Figure 3-1 Daisy wheel.

Title PS

Taxes are charges levied by a government to pay for the services that are supplied for the good of all. Taxation was inevitable as soon as man began to form into groups for joint endeavor. Stories of taxes can be found in the earliest recorded history of our civilization. Even before money was invented, people paid taxes in the form of work or goods and tools. In fact, the labor tax was the sole tax of man for thousands of years. As society grew more complex and the need for services became greater, taxes become equally greater and more complex.

Figure 3-2 Daisy-wheel print sample. *(Courtesy of Qume Corporation.)*

Variety in typeface styles depends on the particular printer. Some daisy wheels have dozens of typefaces available, and others are limited. See Figure 3-3 for samples.

In any event, to change type styles, you must manually change print wheels, and this can bore you to tears if it happens several times in a document. Dot-matrix printers, on the other hand, have fascinating capacities for switching and combining typefaces without operator intervention.

Electrostatic Printers

Very early in the microcomputer story, printers were horribly expensive, and so there was a need for low-cost hard copy. To meet this need, an inexpensive printing process was developed that burns characters electrostatically onto specially treated aluminum paper. Electrostatic printers have survived today to service the low-price end of the printer market.

DTC 380Z Typestyles Available

Data Terminals &
Communications
590 Division Street
Campbell, CA 95008
Tel. (408) 378-1112
TWX (910) 590-2436

Grande 10 **Pica Pitch 1/10" Pitch**
ABCDEFGHIJKLMNOPQRSTUVWXYZ ABCDEFGHIJKLMNOPQRSTUVWXYZ
1234567890

Pica 10
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz
1234567890

Quadro 1012
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz
1234567890

Script 1012
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz
1234567890

Prestige Italic 1012
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz
1234567890

Prestige 1012
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz
1234567890

Brougham 10
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz
1234567890

OCR-B 10
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz
1234567890

Prestige 1012 **Elite Pitch 1/12" Pitch**
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz
1234567890

Prestige Italic 1012
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz
1234567890

Script 1012
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz
1234567890

Quadro 1012
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz
1234567890

Elite 12
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz
1234567890

Brougham 12
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz
1234567890

Quadro 15 **1/15" Pitch**
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz
1234567890

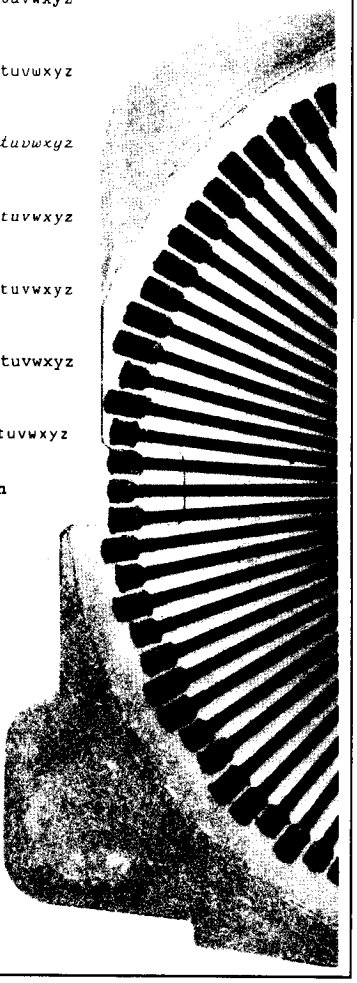


Figure 3-3 Sample daisy-wheel print fonts. *(Courtesy of Data Terminals & Communications.)*

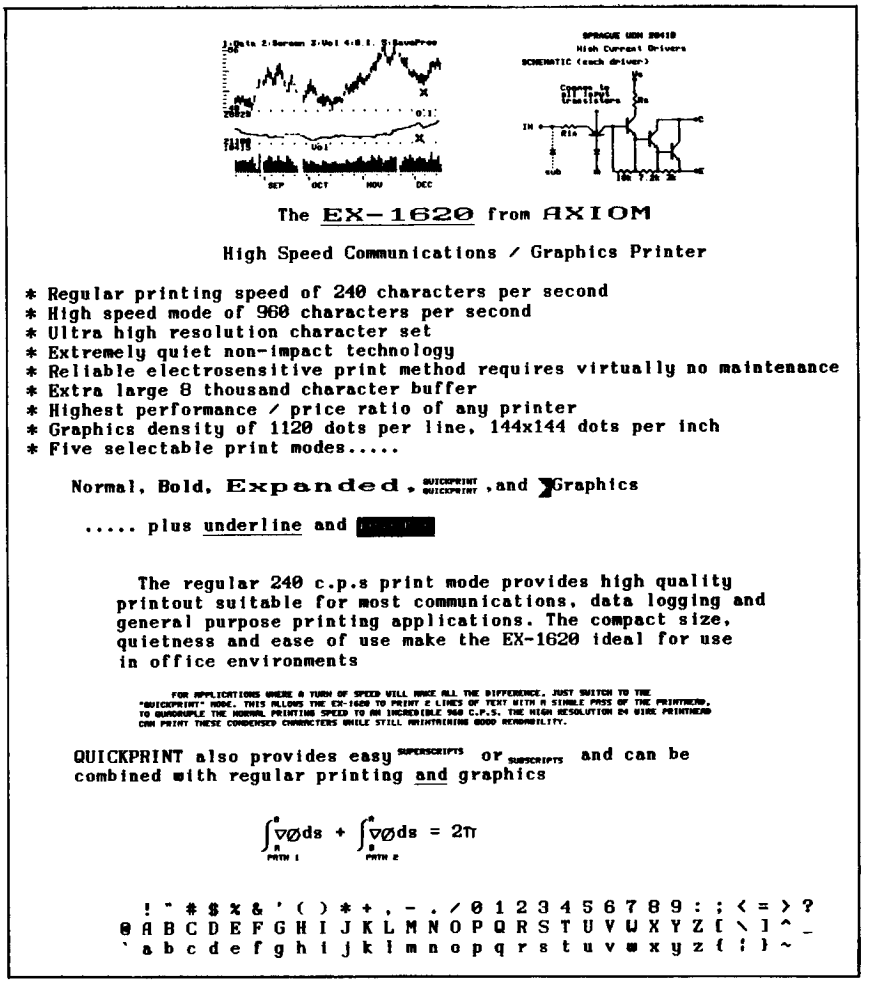


Figure 3-4 Electrostatic print sample. *(Courtesy of AXIOM Corp.)*

Thermal Printers

Thermal printers use heat to transfer images to the paper. They are fast and quiet, but they require a specially treated paper, and the print quality is generally poor. Thermal printers have found favor as narrow-column printers for low-cost hand-held calculators.

Thermal Transfer Printers

Thermal transfer printers use a combination of heat, pressure, and capillary force to transfer ink from a film ribbon to standard paper. Excellent

resolution provides almost near-letter-quality print at high speeds and with quiet operation.

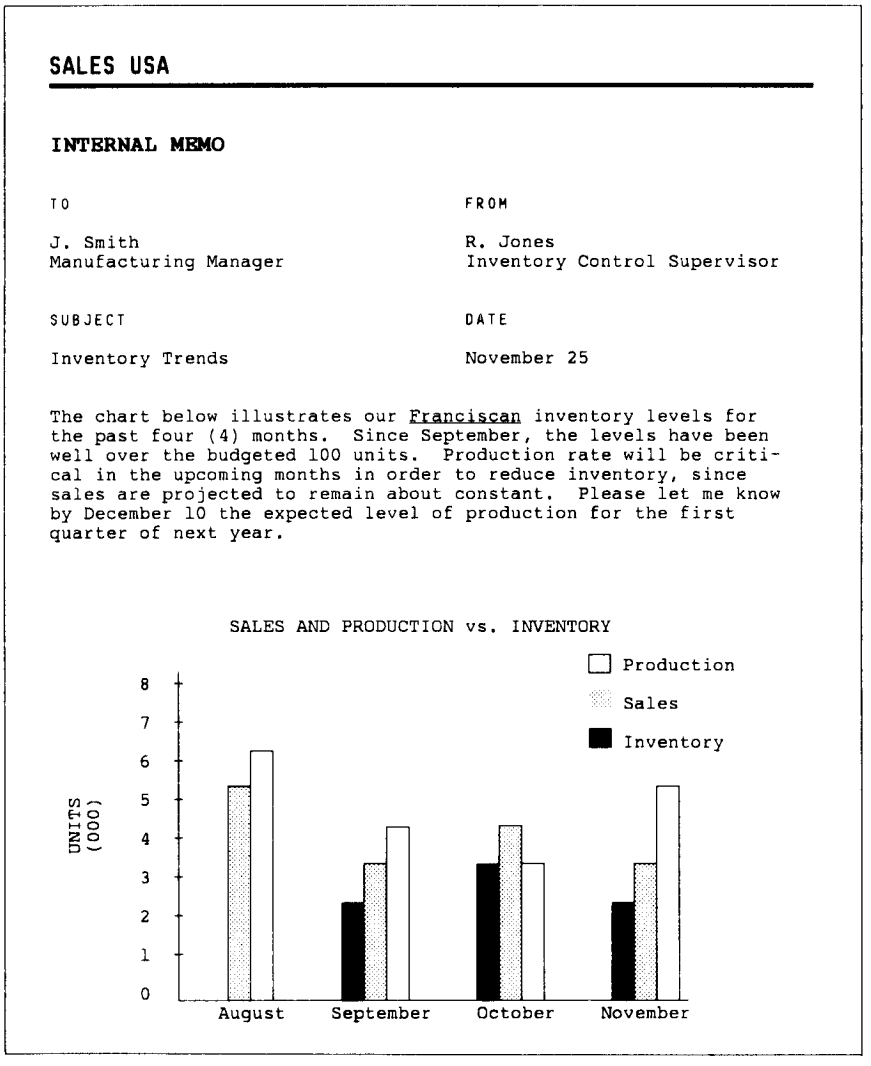


Figure 3-5 Thermal transfer print sample. *(Courtesy of Diablo Systems Incorporated.)*

Laser Printers

Laser printers offer the ultimate in precision, speed, and flexibility. They burn rows of tiny dots into a sensitized drum. The image is then transferred to paper, somewhat as in a photocopier.

The main problem with laser printers is price. Recent advances in technology may bring retail prices down to a tolerable $3000 or $4000 by the time this book is in print. Further reductions in price and the addition of color would certainly threaten the stranglehold on the market currently enjoyed by dot-matrix and daisy-wheel printers.

Please note the vertical line thickness is printed only to reflect the measurements required for your tag – you may have to cut out the tag to get a sufficient quiet zone when reading the bar code.

Figure 3-6 Laser print sample. *(Courtesy of Quality Micro Systems.)*

Color Printers and Plotters

Color printing appears to be the wave of the future. Just how important a factor it will be remains to be seen. We list several types of printers that currently support color output.

Plotters. Plotters trace figures on paper with colored pens. This tracing action allows the plotter to produce smooth curves with great precision. Characters can be expanded and rotated with software control. Although these printers are too slow for standard text use, they fill a specialized market niche.

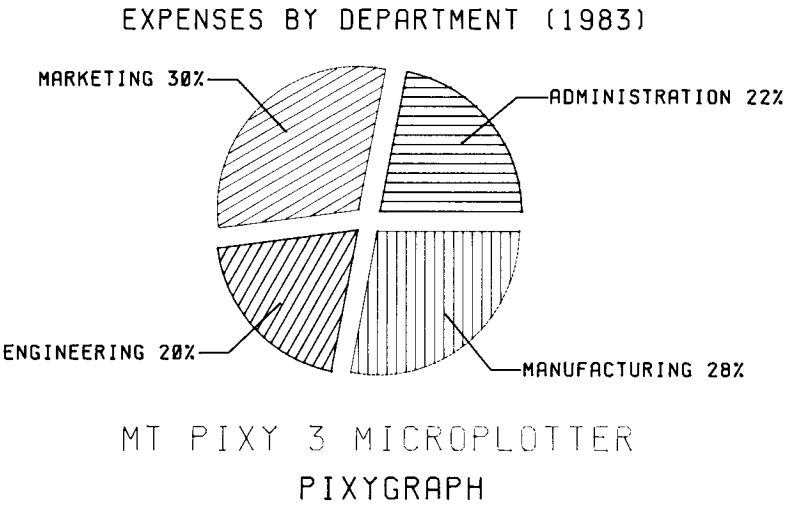


Figure 3-7 Plotter sample. *(Courtesy of Mannesmann Tally Corporation.)*

Ink jet printers. Ink jet printers deposit tiny drops of ink in several different colors at respectable speeds (around 40 CPS). Users of color computers can employ ink jet printers to reproduce their screen displays.

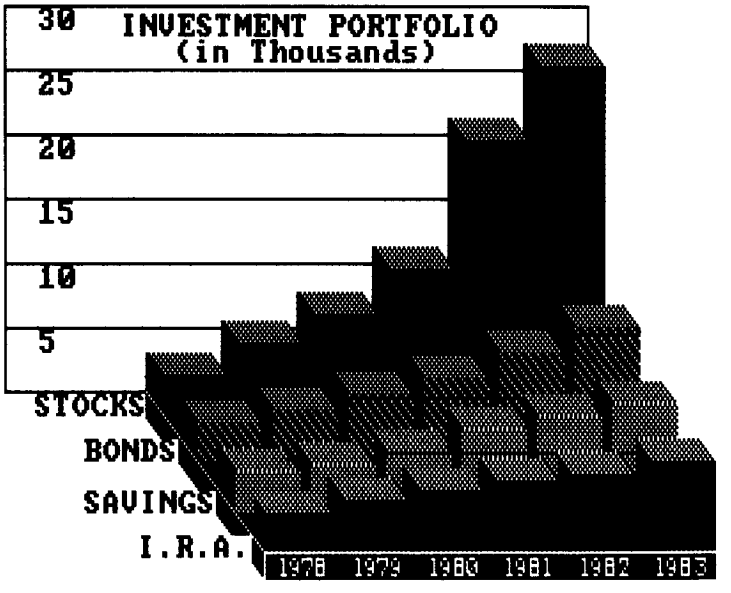


Figure 3-8 Ink jet print sample. *(Courtesy of Diablo Systems Incorporated.)*

Dot-matrix and daisy-wheel printers. Yes, even these traditionally black-and-white printers are getting into the color act. In both cases the color capability is achieved with multicolored ribbons. Some daisy-wheel printers have software to support red-black ribbons as in typewriters. Some dot-matrix printers can use four color ribbons to get up to seven or eight different color combinations.

Thermal transfer printers. Thermal transfer color printers are not available to the public at this writing. Developmental models have demonstrated excellent resolution and color graphics and quiet operation.

A-a-a-nd Still the Champ

The rest of this chapter and the rest of the book deal with dot matrix, the dominant force in microcomputer printers. In this section we take you through a cursory comparison with the rest of the field.

Dot-matrix printers are cheaper, faster, and immensely more versatile than daisy wheels. With the recent advent of 24-wire print heads, dot-matrix printers have closed the gap in print quality significantly and will be acceptable for many more applications.

Laser printers are tremendously faster than dot matrix, produce better quality than even 24-wire machines, have comparable versatility, and are considerably more expensive so far.

Color is a different ball game. Dot-matrix printers can do color, but slowly and with several passes. The color printers that are on the market today tend to be slow or expensive or produce poor print quality. Everybody in the world is working on color. There are even some impact-matrix printers that do beautiful color, like the Epson JX-80.

What's in the Future?

The influx of personal computers in offices across the country means that printers will continue to constitute one of the fastest growing markets in the computer industry. For the short haul, low-cost letter-quality printers will be plugged into computers in droves. Even though dot-matrix printing is becoming more acceptable, even fashionable, most businesses still demand letter-quality print for their correspondence.

As the technology improves, however, the trend will be toward printers that can produce both near-letter-quality print and high-quality graphics rapidly and quietly. Those which also include color printing probably will be the survivors.

We have printers today that almost fit the bill. For example, 24-wire technology produces a beautiful quality of print and steps out at speeds

approaching 200 CPS in Draft mode. The price of these units is continually becoming more attractive. The Epson LQ-1500 costs less than $1500, and Toshiba has a unit (P1340) that breaks the $1000 price barrier. With continued price reductions and color ability, these printers may make major inroads into the market.

Now that we've defined the ideal printer, which technology is likely to take over? As they reduce the price of the 24-wire models, dot-matrix manufacturers have a good shot at maintaining their over 70 percent share of the market. Laser printers already have made a big impact in the business market. These manufacturers will gobble up more and more of the micro market as they reduce the price of their microprinters.

But what about color? Will it become the dominant factor as it did in television? If it does, the dot-matrix and laser folks had better be ready with some good stuff, or ink jet and thermal transfer printers will find themselves the chosen ones.

We are looking at a high-technology industry where technical breakthroughs are the way of life. Surely there are several major advancements being developed right now. We can't be sure how the next generation of printers will operate, but we can be sure they will be faster and more versatile and will produce sharper, cleaner images. We can look for integration of technologies into systems that print out high-quality documentation at remote locations. We can look for more modular design and interface links that will facilitate the assembly of remarkable systems for special applications. We can always look for surprises.

The Dot-Matrix Process: Exposed

Dot-matrix printing is a little more complex than printing with a daisy wheel, but it can be simple if we take it a step at a time. Let's step into some basics to better understand how it works and how it can be used to create a wide variety of print styles. We cover the 9-wire print head first and then delve into the LQ's unique 24-wire dynamo.

Print Head

We shall start at the point of action, where pins meet paper. Actually, it's the ribbon that meets the paper, but the pins are only a ribbon away and pressing hard. The print head contains a vertical column of pins or wires (see Figure 3-9) that are fired at the paper by electrical impulses. These pins are 1/72 inch apart center to center and are fired as many as 8 at a time.

Each pin presses against the ribbon to produce a single dot. As the print head moves across the paper, it fires the pins needed at each position, taking from five to nine positions to print a given character.

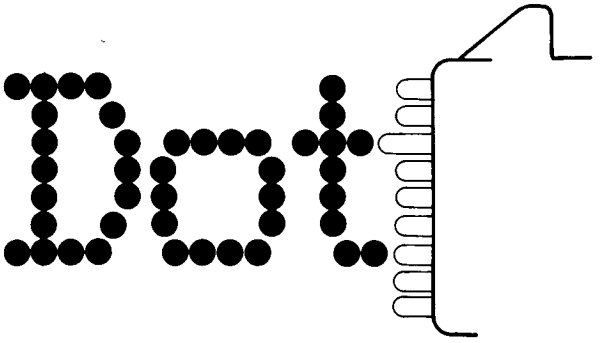


Figure 3-9 Wires in action.

The Grid

The print head can fire from 0 to 8 pins at each print-head position. The print head then moves a short step horizontally to each of the next print positions (step distance depends on the font and pitch). Each character formed by this action is really a matrix of dots, hence the name dot matrix. We can best visualize the matrix pattern of any letter as a grid or graph. Figure 3-10 displays the matrix pattern of a lowercase p and an uppercase H on the 6 × 9 dot grid common to most Epson printers.

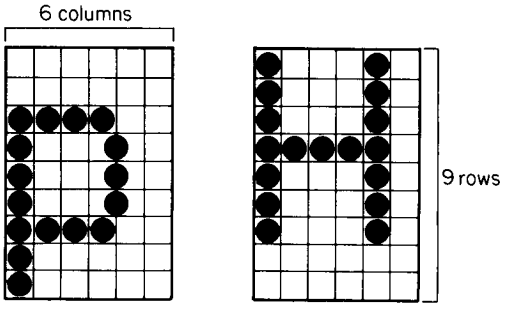


Figure 3-10 Dot-matrix characters.

You can see that the H uses only the upper 7 pins and 5 of the columns, a 5 × 7 dot block of the 6 × 9 dot grid. This arrangement creates 1-dot spacing between the letters and 2 dots for descenders, as demonstrated by the p.

Did you notice that the right-hand column of dots on the p is directly between the fourth and fifth columns? That's right where it should be. To

add the detail necessary for high-quality characters, the print head can move in steps of approximately half a dot to print the intermediate columns. Thus the full character grid for Epson standard dot-matrix characters is 9 dots wide (5 full columns plus 4 intermediate columns) by 9 dots high. Characters using the intermediate column positions are shown in Figure 3-11.

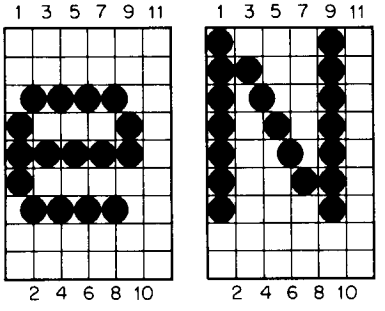


Figure 3-11 Characters using intermediate columns.

Dots printed in these intermediate positions actually overlap with dots in the main columns, yet none of the characters shown in Figure 3-11 use dots in consecutive main and intermediate columns in the same row. Of course, there is a good reason for this. These printers print a complete character in 1/80 second or less. This means the print-head pins are striking as many as nine times in that fraction of a second. At that speed, the print head is simply moving too fast to pull the pins back and forth in time to print an overlapping dot.

Spacing

You have seen that all characters are printed within the 5-full-column limit. The print head skips a sixth full column to create a minimum of 1 dot of space between characters. It follows that narrow characters such as the i end up with lots of white space around them, but wide characters such as the m would butt up against one another were it not for the sixth blank column separating them.

Spacing between rows of text is achieved by automatically setting the line-feed distance to 1/6 inch. This works out to about 12 dots tall. Thus, in each line there are about 9 dots of character (including descenders) and about 3 dots of white space between the lines.

From Figure 3-12 you can see that since most characters come without

descenders, the more apparent ratio is 7 dots per character and 5 dots of white space.

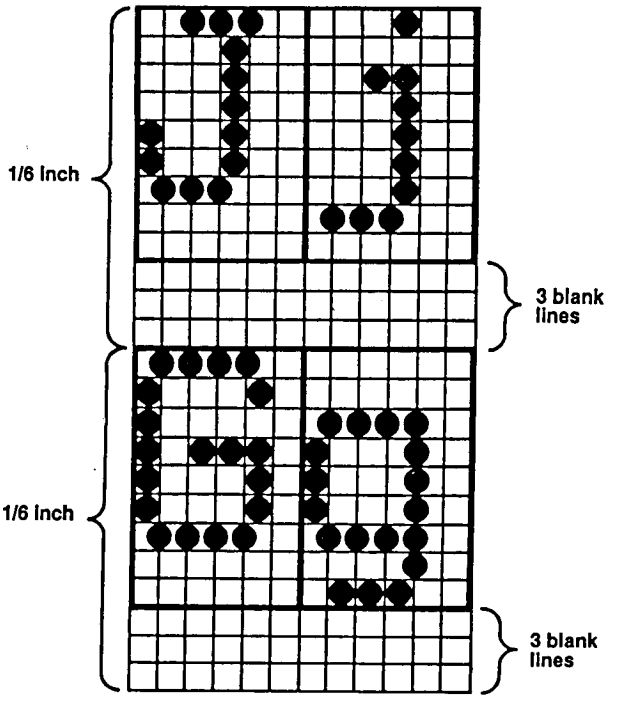


Figure 3-12 Dot grid showing line spacing.

The 24-Wire Differences

The LQ also uses a matrix of dots to form characters, but the numbers and size of the dots and the spacing increments are very different. The source of these differences lies, of course, in the uniqueness of the print head. The LQ print head is arranged in 3 columns of 8 wires. The wires in each column are 1/60 inch apart and just a bit larger than 1/180 inch in diameter. The three columns are offset vertically 1/180 inch, as shown in Figure 3-13.

The LQ operates in three different modes: Draft for speed, Near-Letter-Quality for—come on, take a guess; you got it—quality, and finally Proportional, which is a special mode for textbook-like spacing. As we move through the topics below, we shall identify which mode we are discussing.

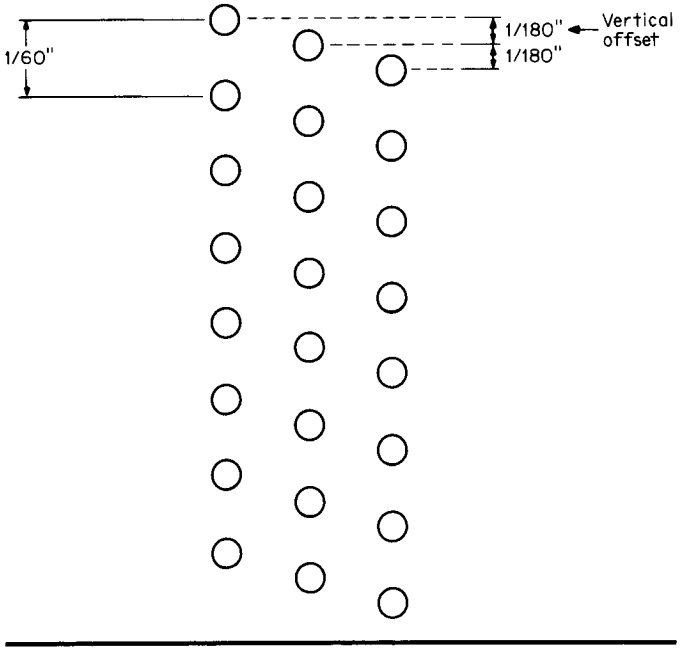


Figure 3-13 A 24-wire print-head arrangement.

The dot patterns used to create characters are different from those of the 9-wire printers. For uppercase Draft characters, the matrix is 9 dots wide × 17 dots tall. The extended matrix, which allows for spaces between letters both vertically and horizontally, is 12 dots wide × 30 dots tall, as shown in Figure 3-14.

For Pica characters, the dots are spaced 1/120 inch apart horizontally. At 12 dots per character, this gives 12/120 or 1/10 inch, which is just right for Pica. The dots are spaced vertically in increments of 1/180 inch. You can see that 30 dots at 1/180 spacing gives 1/6 inch, the standard line spacing.

Near-letter-quality characters command a matrix that is 15 dots wide × 17 dots tall. The extended matrix consists of 18 dots × 30 dots, as shown in Figure 3-15.

In NLQ mode, horizontal spacing between dots in Pica pitch is 1/180 inch, printing characters that are 18/180, or 1/10 inch, wide. Vertical spacing is the same as with Draft characters.

Proportional characters use the same basic font design as NLQ characters except that horizontal spacing of the print head between dots is squeezed to an incredibly precise 1/360 inch.

Figures 3-14 and 3-15 do a good job of illustrating the dot patterns and

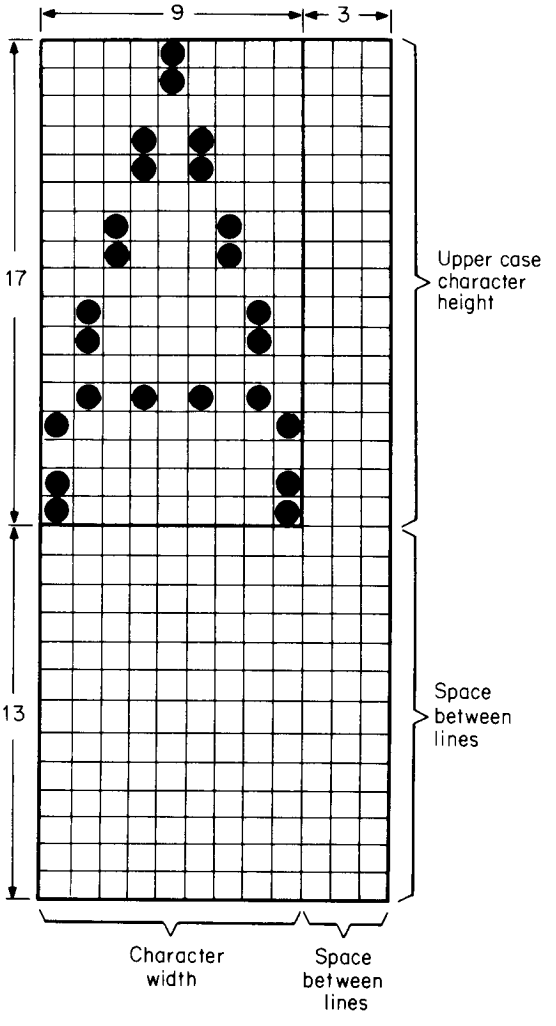


Figure 3-14 Draft mode dot pattern with spacing.

the spacing between characters and lines, but they are a bit misleading in terms of dot sizes and aspect ratio. The dots actually overlap, and on Draft characters, horizontal spacing is greater than vertical spacing. Figure 3-16 shows a "to scale" enlargement of the dot pattern used to print the letter A in Pica pitch and Draft quality.

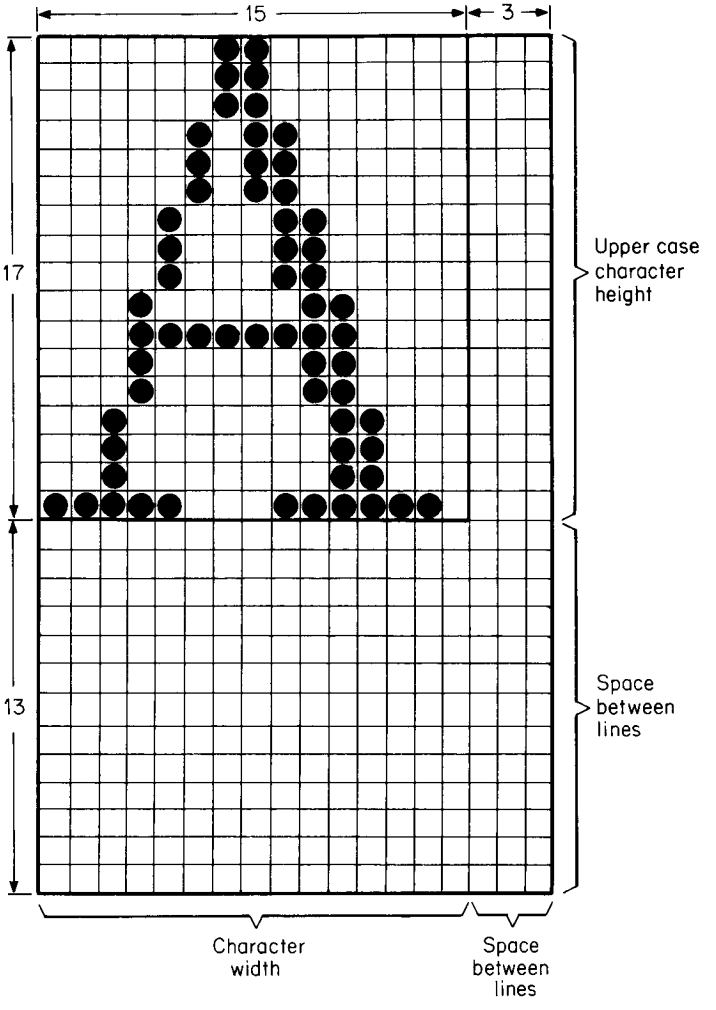


Figure 3-15 Letter-Quality mode dot pattern with spacing.

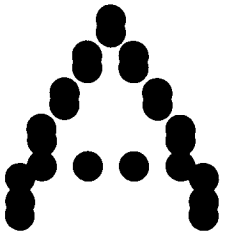


Figure 3-16 Draft character pattern to scale.

Summary

Competing technologies all have their niche in the microprinter market. Daisy wheels are used for letter-quality correspondence. Electrostatic printing serves the low-cost home computer market. Thermal printers are used extensively with hand-held calculators. Thermal transfer printers offer speed, quality, and quiet operation. Lasers are ultra-high-speed and expensive. Plotters are slow and have limited application. Ink jet printers feature flexibility and color graphics. Dot-matrix printers offer the most versatility, speed, and improving quality for the money.

The big question for the future is, What will the impact of color be?

Epson's original recipe dot-matrix process is based on a 9-pin print head that moves across the page, firing the pins needed at each of nine positions to print a given character. A 6 $\times$ 9 dot grid is used to design, visualize, and explain the various characters and related factors, such as horizontal and vertical spacing.

The extra-crispy 24-wire recipe produces characters that are so finger-licking good that they are referred to as near-letter-quality. This process also uses a dot-matrix pattern to form characters, but all the numbers are different from those of 9-wire printers, from grid sizes to horizontal and vertical line spacing.

Chapter

4

Printer Standards

Can we assume that you let slip with an "Oh yeah!" or "Neat!" or words to that effect a time or two during the last chapter? The dot-matrix scheme is worth at least a grin and a grunt. Dot-matrix printing is a simple concept made operational by some very ingenious electromechanical devices and coding structures.

Does that give you a clue to what comes next? Before getting into specific printer features, let's run through a little grounding in codes and standards. This is a great way to eliminate confusion later. Computer aficionados may prefer to tread lightly through this chapter.

Without dealing with machine language and binary numbers, we can point out that computers and printers don't understand ABC's. They talk to each other in numbers. In order for us human types to get into the act, our words have to be interpreted. This means that every symbol and character we use is represented by a numeric code.

To code all these characters, such as letters of the alphabet, numerals, and keyboard symbols, most manufacturers of computers, printers, and software follow the American Standard Code for Information Interchange, or ASCII (pronounced *ask-ee*).

ASCII and Ye Shall Perceive

The original ASCII standard assigns code numbers from 0 to 127 to typical characters and actions performed by computer-related equipment (i.e., computers, disk drives, and printers). These 128 code numbers can be generated by 7 data lines between different devices. In order to take full advantage of the 8-bit communications typical between microcomputers and printers, Epson modified the standard to include numbers between 0 and 255.

How these numbers are sent to the printer depends on the language or

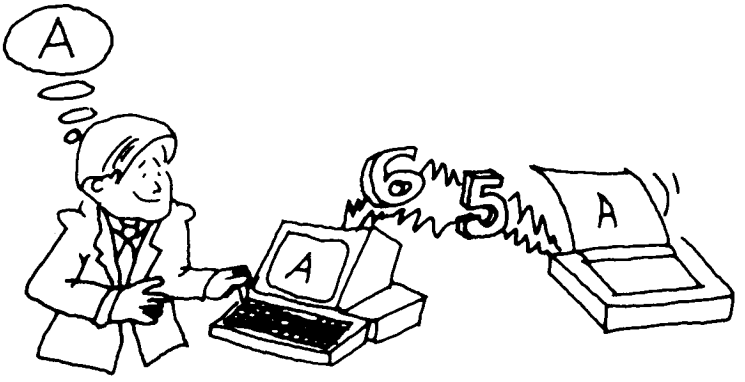


Figure 4-1 Sending an A.

applications program being used. In BASIC, the numbers can be sent via the CHR$ function. They are also sent automatically when you print a string of characters or numbers. For example, printing the string "EPSON" sends the string of numbers 69, 80, 83, 79, 78. The printer receives these numbers and translates them back into the letters "EPSON".

The same translation takes place when you print with a word processing program. The program changes symbols into numbers and sends them to the printer. The printer receives the numbers and translates them back to symbols. As long as the computer and printer agree, there is no problem; unfortunately, that is not always the case. Parts 3, 4, and 5 of this book discuss problems that occur when communicating with the printer, using various types of software.

In order for you to better understand how the computer communicates with the printer, take some time now to get familiar with the ASCII table.

Figure 4-2 shows the symbol table used by the FX Series printers. The table contains three columns labeled "Dec.," "Hex.," and "Char./Func." "Dec." stands for decimal numbers. These are the numeric value of the data sent to the printer. "Hex." is the translation of the decimal number in the hexadecimal numbering system. "Char./Func." stands for the characters, symbols, or control functions that constitute the printer's response to the numbers.

The decimal codes for 0 to 31 are reserved for direct printer commands, such as Backspace, Horizontal Tab, Line Feed, or Form Feed. The numbers from 32 to 47 and 58 to 64 represent keyboard symbols. The numbers from 48 to 57 correspond to the numerals from 0 and 9, and 65 through 90 are the capital, or uppercase, letters of the alphabet. The first half of

Dec.	Hex.	Char./ Func.	Dec.	Hex.	Char./ Func.	Dec.	Hex.	Char./ Func.	Dec.	Hex.	Char./ Func
0	00	None	64	40	@	128	80	None	192	C0	@
1	01	None	65	41	A	129	81	None	193	C1	*A*
2	02	None	66	42	B	130	82	None	194	C2	*B*
3	03	None	67	43	C	131	83	None	195	C3	*C*
4	04	None	68	44	D	132	84	None	196	C4	*D*
5	05	None	69	45	E	133	85	None	197	C5	*E*
6	06	None	70	46	F	134	86	None	198	C6	*F*
7	07	BEL	71	47	G	135	87	BEL	199	C7	*G*
8	08	BS	72	48	H	136	88	BS	200	C8	*H*
9	09	HT	73	49	I	137	89	HT	201	C9	*I*
10	0A	LF	74	4A	J	138	8A	LF	202	CA	*J*
11	0B	VT	75	4B	K	139	8B	VT	203	CB	*K*
12	0C	FF	76	4C	L	140	8C	FF	204	CC	*L*
13	0D	CR	77	4D	M	141	8D	CR	205	CD	*M*
14	0E	SO	78	4E	N	142	8E	SO	206	CE	*N*
15	0F	SI	79	4F	O	143	8F	SI	207	CF	*O*
16	10	None	80	50	P	144	90	None	208	D0	*P*
17	11	DC1	81	51	Q	145	91	DC1	209	D1	*Q*
18	12	DC2	82	52	R	146	92	DC2	210	D2	*R*
19	13	DC3	83	53	S	147	93	DC3	211	D3	*S*
20	14	DC4	84	54	T	148	94	DC4	212	D4	*T*
21	15	None	85	56	U	149	95	None	213	D5	*U*
22	16	None	86	56	V	150	96	None	214	D6	*V*
23	17	None	87	57	W	151	97	None	215	D7	*W*
24	18	CAN	88	58	X	152	98	CAN	216	D8	*X*
25	19	None	89	59	Y	153	99	None	217	D9	*Y*
26	1A	None	90	5A	Z	154	9A	None	218	DA	*Z*
27	1B	ESC	91	5B	[	155	9B	ESC	219	DB	[
28	1C	None	91	5C	\	156	9C	None	220	DC	\
29	1D	None	93	5D	]	157	9D	None	221	DD	]
30	1E	None	94	5E	^	158	9E	None	222	DE	^
31	1F	None	95	5F	-	159	9F	None	223	DF	-
32	20	b	96	60	·	160	A0	b	224	E0	·
33	21	!	97	61	a	161	A1	*!*	225	E1	*a*
34	22	"	98	62	b	162	A2	"	226	E2	*b*
35	23	#	99	63	c	163	A3	#	227	E3	*c*
36	24	$	100	64	d	164	A4	*$*	228	E4	*d*
37	25	%	101	65	e	165	A5	%	229	E5	*e*
38	26	&	102	66	f	166	A6	*&*	230	E6	*f*
39	27	'	103	67	g	167	A7	*&*	231	E7	*g*

Figure 4-2 ASCII table for FX Series printer. *(Courtesy of Epson America, Inc.)* **(continued)**

Dec.	Hex.	Char./ Func.	Dec.	Hex.	Char./ Func.	Dec.	Hex.	Char./ Func.	Dec.	Hex.	Char./ Func
40	28	(	104	68	h	168	A8	*(*	232	E8	*h*
41	29	)	105	69	i	169	A9	*)*	233	E9	*i*
42	2A	*	106	6A	j	170	AA	*	234	EA	*j*
43	2B	+	107	6B	k	171	AB	+	235	EB	*k*
44	2C	,	108	6C	l	172	AC	,	236	EC	*l*
45	2D	-	109	6D	m	173	AD	-	237	ED	*m*
46	2E	.	110	6E	n	174	AE	.	238	EE	*n*
47	2F	/	111	6F	o	175	AF	*/*	239	EF	*o*
48	30	0	112	70	p	176	B0	*0*	240	F0	*p*
49	31	1	113	71	q	177	B1	*1*	241	F1	*q*
50	32	2	114	72	r	178	B2	*2*	242	F2	*r*
51	33	3	115	73	s	179	B3	*3*	243	F3	*s*
52	34	4	116	74	t	180	B4	*4*	244	F4	*t*
53	35	5	117	75	u	181	B5	*5*	245	F5	*u*
54	36	6	118	76	v	182	B6	*6*	246	F6	*v*
55	37	7	119	77	w	183	B7	*7*	247	F7	*w*
56	38	8	120	78	x	184	B8	*8*	248	F8	*x*
57	39	9	121	79	y	185	B9	*9*	249	F9	*y*
58	3A	:	122	7A	z	186	BA	*:*	250	FA	*z*
59	3B	;	123	7B	{	187	BB	*;*	251	FB	{
60	3C	<	124	7C	|	188	BC	<	252	FC	|
61	3D	=	125	7D	}	189	BD	=	253	FD	}
62	3E	>	126	7E	~	190	BE	>	254	FE	~
63	3F	?	127	7F	DEL	191	BF	*?*	255	FF	DEL

Source: David A. Kater, *FX Series Printer User's Manual*, Epson America, Inc., 1984.

Figure 4-2 (*continued*)

the table goes on through the lowercase alphabet and ends with the Delete (DEL) function (127 decimal). The second half of the table is basically a repeat of the first half except that the characters are printed in an italic font instead of roman. Note that the original MX-80, MX-70, and MX-100 printers did not have italic characters.

Figure 4-2 is a good representation of the typical ASCII chart for an Epson printer, but there are some differences between models. For example, some models have graphics characters in the second half of the table. Be sure to refer to the ASCII chart in your user's manual.

How can you use this table? Simply look up the symbol you want to print or the control operation you wish to exercise, find the corresponding

code number, and send it to the printer. For example, if you were to send a 79 and a 75, your printer would give you a big OK, since 79 is the ASCII code for 0 and 75 is the code for K.

The Great Escape!

If you recall your instant course in the world history of Epson dot-matrix printers from Chapter 2, new features and capacities were added in rapid succession. Foreseeing that codes 0 to 255 didn't leave much room for future expansion, Epson designed the logic in its printers to understand special sequences of control codes, which we call Escape (ESC) code sequences.

Escape codes deal with printer features or modes, so essentially they supplement the printer control codes from 0 to 31. Some of these code sequences select printer features such as compressed print, expanded print, subscripted text, international characters, or one of the graphics modes. Others have to do with forms control, paper feed, or formatting.

Each Escape code sequence has two parts: first the ESC code, which your ASCII table lists as decimal number 27, followed by a sequence of one or more codes. For example, ⟨ESC⟩"4" turns on the Italics Print mode. Since the ASCII number for 4 is 52, you would send the printer a 27 followed by 52 to turn on Italics print. All subsequent text is printed in Italics type font.

An alternate way to represent the same code sequence is ⟨ESC⟩(52). In this book, we use quotes (" ") to identify symbols from the Char/Function column of the ASCII table, and parentheses ( ) to identify codes from the Decimal number column.

Sending an Escape code before a character gives it an entirely different meaning. In Figure 4-3, the Escape code completely changes the effect of the dash. The sequence ⟨ESC⟩"-"(1)"X", or 27 45 1 88, prints X in Underline mode. Note that the ASCII code for "-" is 45, and for "X" it is 88.

Troubles in ASCII Land

Now that you have mastered Epson's version of the ASCII and Escape codes, there are some things you should know.

Standards is *not* one of the strong points of the microcomputer industry. Most manufacturers of computers and peripherals modify the original ASCII standard to take advantage of their own special hardware and software features. This practice makes more features available to the customer, but it reduces compatibility with products from other manufacturers and hence locks customers in to a single line of products.

Figure 4-3 Sample Escape sequence.

That's fine for some customers, but there are plenty of folks who buy a computer from one vendor and a printer (say, an Epson) from another. That's where compatibility problems start. For example, the standard printer interface card for the very popular Apple II limits printer output to 7 data lines instead of 8, and this cuts the range of addressable numbers in half (0 to 127); Epson uses the full range 0 to 255. Many versions of the BASIC language do not pass certain numbers faithfully to the printer; to fully use the graphics on the Epson printers requires all numbers, 0 to 255. Applications programs frequently provide a limited list of compatible printers. Even if your printer is on the list, you may have to set up your

own control code sequences to utilize some of the printer's unique features.

In short, the lack of computer-printer standards means that you'll have to learn what limitations are imposed by your operating system, program languages, and applications software as well as how to get around those limitations. Epson printers even include features that compensate for some computer deficiencies. The more you learn about your printer and how it interacts with your computer, the better equipped you will be to get the results you want. And now you are reading this book, which means you are already on the right track.

Summary

The ASCII standard assigns code numbers to all characters and actions performed by computers and related equipment.

Escape codes have been added to include additional printer features and modes.

Manufacturers of computers and peripherals modify ASCII standards to suit their own products. Therefore, the industry has no consistent standards, and compatibility of various pieces of hardware and software is an industry problem. Learning how your printer works will enable you to overcome many compatibility problems and get the most out of your printer.

Chapter

5

Character Sets

Are you ready for a look at the Epson character sets? Sure you are. You know how the printer dots its matrix. You know how the computer tells it what to do. Now you are ready to examine the ways in which dot-matrix printers can manipulate the style of the characters they print.

Our emphasis in Part 2 of this book is on how printers work. We include the code sequences necessary to activate each mode on various printers. In a later section, you will discover how these sequences are sent to the printer by means of the BASIC language and applications programs. So read, enjoy, and learn.

ROM Standards

Ever since the introduction of the Graftrax ROMs, Epson printers have been equipped with two distinct character sets: Roman and Italics. Roman is the default print font. It is what you get if you don't ask for anything special or just call for print. It is a simple typeface, sans serif, which means without serifs. Serifs are the little ticks you see at the tips of letters in some typefaces, such as the one used in this book.

```
Roman characters come in UPPER CASE and lower case.
```

Figure 5-1 Roman characters.

Italics

All other character sets and modes have to be touched off with special code sequences or switches. In Chapter 4, you learned that the special code for the italics set is ⟨ESC⟩"4". That changes the active character set from roman to italic. ⟨ESC⟩"5" returns to the roman character set. Developing the slant that distinguishes italics characters within the standard 9 × 11 character grid requires some ingenuity, as shown in Figure 5-2.

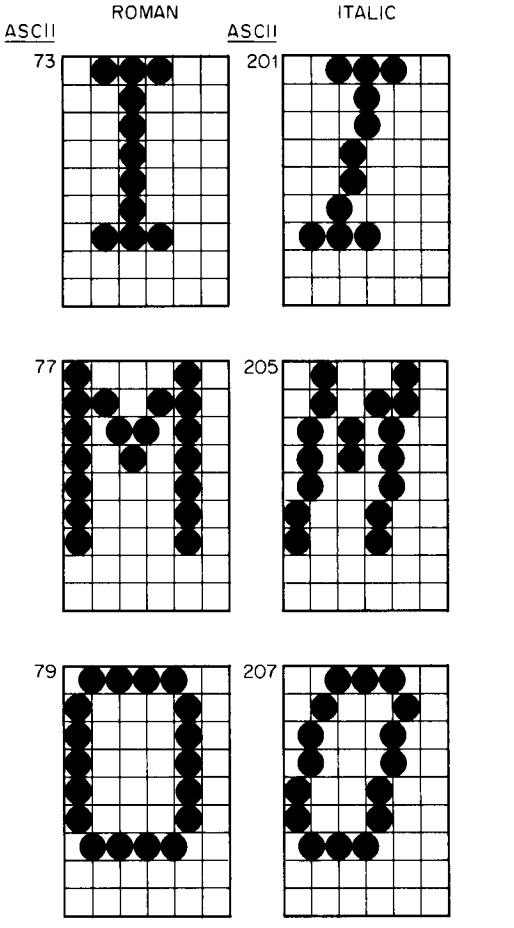


Figure 5-2 Sample roman and italic patterns.

As the figure shows, italics characters are unique and have their own distinct position in the ASCII table. Italics characters are available on all but the original MX series.

Such Characters

We still haven't unveiled all the characters stored in the ASCII table. Along with control codes, alphabet, numerals, and keyboard symbols, it also has tucked away here and there some handy little symbols that you

won't find on some keyboards. Figure 5-3 shows some special characters and their ASCII codes. Of course, adding 128 will get you the italic versions on printers that support the Italics font.

91	[	Left bracket
92	\	Back slash
93	]	Right bracket
94	^	Caret
95	_	Underline
96	`	Accent grave
123	{	Left brace
124	:	Flat colon
125	}	Right brace
126	~	Tilde

Source: David A. Kater, *FX Series Printer User's Manual,* Epson America, Inc., 1984.

Figure 5-3 Some special characters. *(Courtesy of Epson American, Inc.)*

Special Graphics Characters

The RX printers have some unique graphics figures buried "beneath" the symbols in locations 128 through 159 of the ASCII table. These symbols can be used for constructing graphics designs or for dressing up text. They are turned on with ⟨ESC⟩"m"(4) and off with ⟨ESC⟩"m"(0).

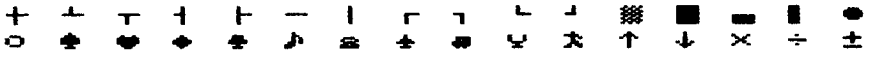


Figure 5-4 RX special graphics characters.

ROM Goes International

That pretty well covers all that meets the eye with ASCII, but we still have to do some probing into your printer's ROM chip. In fact, some of the symbols we have already covered can be translated into several different languages. The characters and the languages into which they translate depend on the printer.

On the origianl MX-80, you could translate 9 characters into four different languages by means of switches. Figure 5-5 shows the possibilities.

The original MX-100 goes international in two different ways in eight languages. It also adds the ability to control international characters by means of software codes.

	35	64	91	92	93	123	124	125	126
U.S.A.	#	@	[	\	]	{	¦	}	~
FRANCE	#	à	°	ç	§	é	ù	è	¨
GERMANY	#	§	Ä	Ö	Ü	ä	ö	ü	ß
ENGLAND	£	@	[	\	]	{	¦	}	~

Figure 5-5 Original MX-80 international characters.

	35	36	64	91	92	93	94	96	123	124	125	126
U.S.A.	#	$	@	[	\	]	^	`	{	¦	}	~
FRANCE	#	$	à	°	ç	§	^	`	é	ù	è	¨
GERMANY	#	$	§	Ä	Ö	Ü	^	`	ä	ö	ü	ß
ENGLAND	£	$	@	[	\	]	^	`	{	¦	}	~
DENMARK	#	$	@	Æ	Ø	Å	^	`	æ	ø	å	~
SWEDEN	#	¤	É	Ä	Ö	Å	Ü	é	ä	ö	å	ü
ITALY	#	$	@	°	\	é	^	ù	à	ò	è	ì
SPAIN	₧	$	@	¡	Ñ	¿	^	`	¨	ñ	}	~

Figure 5-6 Original MX-100 international characters.

The current Epson printers can change 12 characters into even more tongues: 9 on the FX and 11 on the RX and LQ printers. The code sequence used to get into an international mode is ⟨ESC⟩"R" followed by a number to select one of the countries from the list below.

0 USA
1 France
2 Germany
3 England
4 Denmark
5 Sweden
6 Italy
7 Spain
8 Japan
9 Norway (RX, LQ only)
10 Denmark European (RX, LQ only)

Figure 5-7 reveals the new worlds that a simple ⟨ESC⟩"R" opens to you. Of course, by adding ⟨ESC⟩"4" you can have any of these symbols printed in italics.

FX:

	35	36	64	91	92	93	94	96	123	124	125	126
JAPAN	#	$	@	[	¥	]	^	`	{	¦	}	~

RX & LQ:

	35	36	64	91	92	93	94	96	123	124	125	126
NORWAY	#	¤	É	Æ	Ø	Å	Ü	é	æ	ø	à	ü
DENMARK (EUROPEAN)	#	$	É	Æ	Ø	Å	Ü	é	æ	ø	à	ü

Figure 5-7 Additional international characters for current printers.

Extending the Character Sets

That just about takes care of the basic characters listed on the printer's ASCII chart. But that's just the beginning. There are many ways to stretch, compress, manipulate, and otherwise rearrange ROM characters. The next several chapters will open your eyes to the many variations you can get by activating different print modes.

In this section, we shall consider two ways to change the basic dot patterns of the printer. One method is to compress the characters vertically with the Superscript and Subscript modes. Another method is to overprint two characters on top of each other.

The Script Double Shuffle

Many printers create script modes by rolling the carriage up or down half a line, using full-size characters. Epson prints true-script characters that are about half the normal height.

In fact, at first glance it looks like script characters have their own unique character grids, but that is not the case. So how did the clever Epson engineers create such distinct characters in a pint-sized space with only 9 wires to work with? They printed the dot patterns for each character in a unique order in two passes with a short line feed in between. Very scrutable!

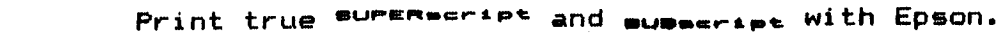


Figure 5-8 Superscript and Subscript.

In the first pass, the odd rows (1,3,5,7) of the character matrix are printed with the top 4 pins of the print head. After a short line feed of 1/216 inch, the even rows (2,4,6,8) are printed with the same 4 pins on the second pass. Figure 5-9 shows how it's done.

And a little sleight of hand on the paper roller neatly separates the two passes to illustrate the point, as shown in Figure 5-10.

Thus, Script characters are created by a clever manipulation of standard ROM characters.

On the LQ printer, superscript and subscript characters can be printed with a single pass because there are 24 wires to work with. As a result, the script characters are not automatically printed in Double-Strike mode unless you request it.

Script characters, both superscript and subscript, are available on all Epson printers except the original MX Series and Graftrax 80. The format for bringing them to life is ⟨ESC⟩"S"(n), where n = 0 selects super-

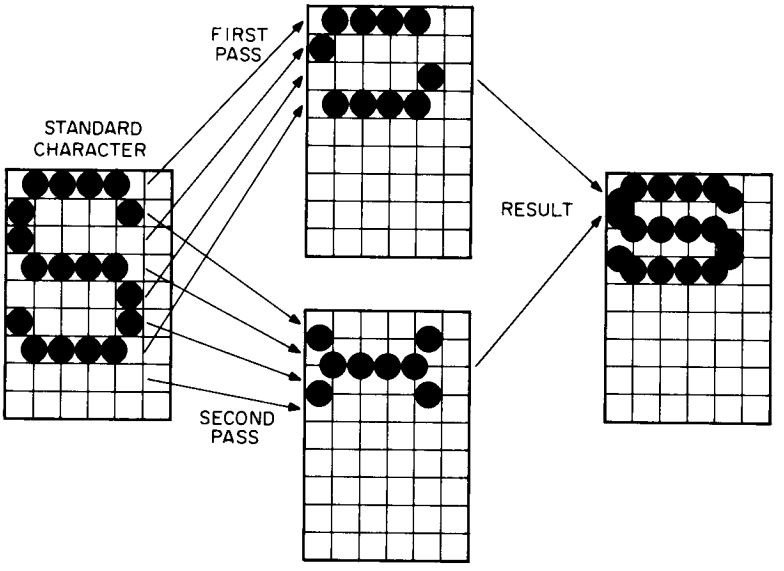


Figure 5-9 Script character creation.

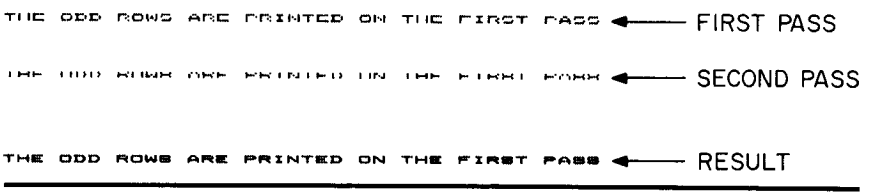


Figure 5-10 Two-pass process exposed.

script and $n = 1$ selects subscript. Both modes are turned off with ⟨ESC⟩"T". As with all codes that turn off with 1 and 0, you can optionally use the symbols 1 (decimal 49) and 0 (decimal 48) on the latest Epson printers: RX, FX, and LQ.

To reiterate the explanation in Chapter 4, we use parentheses in Escape sequences to indicate ASCII code numbers from 0 through 255. The corresponding ASCII symbols are displayed in quotes. For example, the sequence 27 83 48 will be displayed as ⟨ESC⟩"S"(48) or ⟨ESC⟩"S0".

Overprinting

Sometimes called strikeover, overprinting is the process of printing two or more characters in the same print position. Overprinting can be done in

several ways. You can print a line in two passes with a carriage return and no line feed or use a very slight line feed for a subtle vertical offset. A widely used method is to simply backspace to reprint a character.

Backspace. The backspace function, available on all Epson printers except the original MX series, moves the print head backward 1 space so that you can print 2 characters in the same space. Figure 5-11 shows the words "BACKSPACE" and "backspace" printed right on top of each other using the backspace function after each letter.

Figure 5-11 Backspace in action.

The simple ASCII control code, 8, causes the printer to backspace. With it you can do single-character overstrikes and create any number of new and wonderful symbols. For example, you can combine = and / to get ≠ (not equal to) or + and − to get ± (plus or minus). Did you figure that one out? We used superscript and subscript to make it work. On printers such as Graftrax Plus that do not have foreign characters built into the ROM, you can use backspacing to create a few international characters.

Graftrax Plus users should be aware of one abnormality in using the backspace function. Expanded mode, which is discussed later in this chapter, doubles the width of each character. In Expanded mode, one code 8 causes a full double-width backspace. Hold the applause, please. When you try several, or more than one, in succession, the first still does a good old double backtrack, but each of the rest just moves the print head one single-width space to the left.

The LQ adds an interesting wrinkle to the Backspace code. It eliminates physical backspacing of the print head. Instead, characters that would overlap because of a backspace are actually combined in the print buffer. This speeds up printing but has a few limitations. The LQ backspace will not combine dot graphics or an HT code, among others. See the LQ user's manual for details.

What's the Pitch?

Another way to vary the dot patterns on Epson printers is to change the horizontal spacing between dots. The standard spacing between columns of dots on the 9-wire printers is 1/60 inch (1/120 inch for half-dot spacing). This results in characters spaced 1/10 inch apart. On typewriters, this is known as Pica pitch. Using the proper control codes, you can either compress or expand the dot patterns to alter the pitch.

Monospaced Pitches

Pitch refers to the width of printed characters. The standard default character that we discussed above prints 10 characters per inch (CPI). This is the same as a typewriter's Pica character set.

Elite. With the code ⟨ESC⟩"M" and an RX, FX, or LQ printer, you can change pitch to Elite, or 12 CPI. This doesn't change the pattern of the letters; it simply tells the print head to move horizontally in smaller increments, and this brings each column of dots closer together. To see how this works in grid format, compare the Pica and Elite M's in Figure 5-12.

Note that although the LQ's dot patterns differ, the method used to achieve Elite characters is identical.

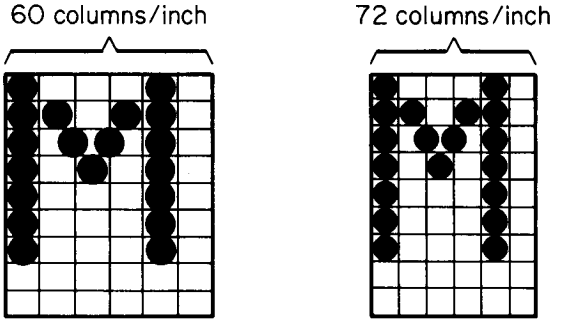


Figure 5-12 "M" in Pica and Elite.

Since the Elite mode, which produces Elite pitch, shortens print-head movements, it compresses spaces as well as characters. The result is 96 characters per 8-inch line for Elite compared with 80 characters per 8-inch line for Pica.

Elite mode is turned off with ⟨ESC⟩"P".

```
You can see the difference between ELITE pitch here
And PICA, the normal print pitch.
```

Figure 5-13 Pica and Elite print samples.

Compressed. You can squeeze even more words into a line with Compressed characters, which stack up 17.16 characters per inch. You turn on Compressed mode with ASCII control code 15 and turn it off with 18. On the LQ, FX, and RX printers, you can also use ⟨ESC⟩(15) and ⟨ESC⟩(18)

to turn Compressed mode on and off. The Graftrax 80 ROMs used a non-standard (for Epson) pair of control codes for Compressed mode: ⟨ESC⟩"P" to turn it on and ⟨ESC⟩"Q" to turn it off.

Compressed mode is typically used in situations where it is important to squeeze as many characters on a horizontal line as possible. Compressed characters will fit 136 to an 8-inch line and 233 to a 13.6-inch line.

Of course, the three pitches—Pica, Elite, and Compressed—are mutually exclusive. Only one pitch can be in effect at a time. However, all three can be used in any given text, even in the same line, except with the early printers such as the original MX-80.

```
COMPRESSED stays on until cancelled
PICA again
```

Figure 5-14 Pica and Compressed print samples.

Compressed-Elite. There is one exception to the incompatibility of the three pitches. The LQ, because of its narrow pins and precise print-head control, added another pitch to the Epson printer line: Compressed-Elite. It is even narrower than Compressed pitch at 20 CPI and 272 characters per 13.6-inch line.

To activate this pitch, just turn on Compressed, ⟨ESC⟩(15), and Elite, ⟨ESC⟩"M", at the same time. Figure 5-15 shows a print sample.

```
PICA
COMPRESSED
COMPRESSED ELITE
```

Figure 5-15 Compressed-Elite print sample.

Expanded. Now we come to a pitch mode that can be used with any of the other pitches. In fact, it can't be used by itself. It must be used with another pitch. Expanded mode doubles the width of the current pitch. Since it can be combined with all three pitches (four on the LQ), it also doubles the number of available print pitches. Figure 5-16 shows what kind of variety this gives you.

To print an Expanded character, the printer in essence extends the dot matrix by spreading the dots horizontally to twice their normal distance apart and adding a duplicate of each dot to the next full-dot position (see Figure 5-17).

```
PICA, the Great Default     EXPANDED PRINT is no PICA
ELITE is Neat               EXPANDED ELITE is Discrete
COMPRESSED is packed        EXPANDED COMPRESSED is unpacked
COMPRESSED ELITE is slight  EXPANDED COMPRESSED ELITE is just right
```

Figure 5-16 Expanded print sample.

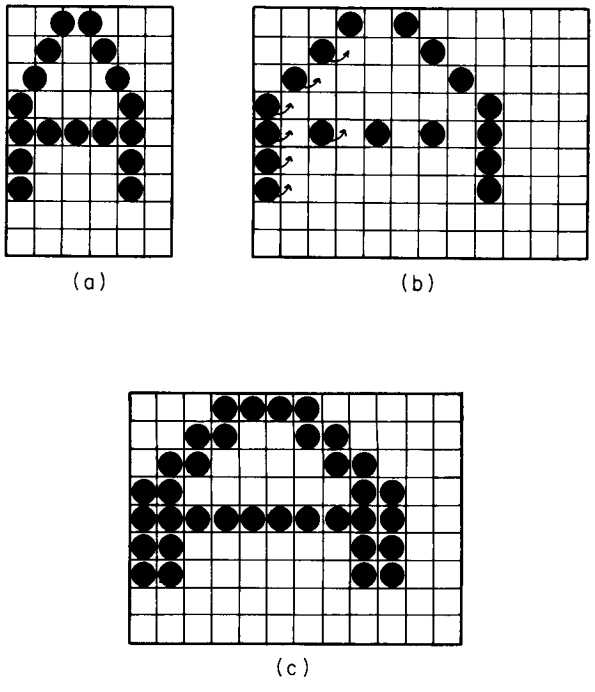


Figure 5-17 Expanding a character: (*a*) Pica A, (*b*) dots spread twice Pica distance, and (*c*) expanded A.

The dot patterns on the LQ differ from those in Figure 5-17, but the technique for expanding a character is the same.

Starting with Graftrax Plus and subsequent printers, you can turn on Expanded mode with ⟨ESC⟩"W"(1), but it will stay on until it gets ⟨ESC⟩"W"(0). On the current printers (RX, FX, and LQ), you can also use ⟨ESC⟩"W1" and ⟨ESC⟩"W0" to turn Expanded mode on and off.

Expanded for 1 line. An alternate version of the Expanded mode stays active only until the end of the current line; then it shuts off automatically. ASCII code 14 turns on this 1-line Expanded mode until the end of the current line or ASCII code 20 shuts it off. All Epson printers (even the

MX-70) can use this version of Expanded mode. RX, FX, and LQ printers can also use ⟨ESC⟩(14) and ⟨ESC⟩(20). Graftrax 80 printers use a non-standard ⟨ESC⟩"S" and ⟨ESC⟩"T" to turn 1-line Expanded mode on and off.

Proportional Pitch (FX and LQ only)

The pitches we have discussed so far are all monospaced. Each character takes the same amount of space, as you saw in Figure 5-2, where a skinny, little I is patterned on the same size grid as the M. This is our way of illustrating that the print head moves the same distance to print each character, regardless of its inherent width.

In a step toward letter-quality print, Epson has added Proportional mode on the FX and LQ printers. In Proportional mode, characters are printed with a uniform amount of blank space between them; this produces a more readable text, more like the typeset print in this book. You can see the difference in Figure 5-18.

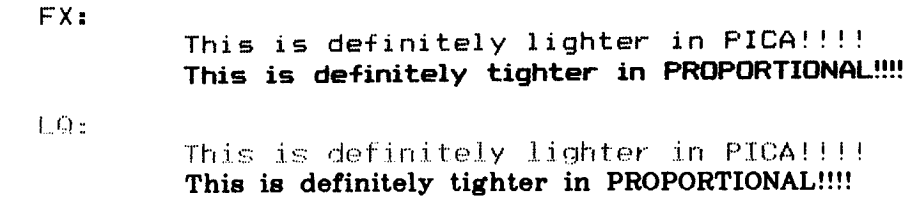


Figure 5-18 Pica and Proportional compared.

The two obvious differences are spacing and print boldness. Spacing is different because in Proportional mode the printer isn't constrained to fill the gaps between characters with blank space to make them all the same width. The exclamation marks, being only a few dots wide, clearly show the difference between monospaced and proportional printing. The FX and LQ user's manuals list the width of each character in an appendix.

The second difference is in character density or boldness. Proportional characters are printed in bold print modes on both printers. FX Proportional characters are printed in Emphasized mode (see Chapter 6). LQ Proportional characters have their own unique design, very similar to the Near-Letter-Quality font. Proportional characters are generally wider than their NLQ equivalents, and the characters are a bit sharper since the horizontal print-head movement is in increments of $\frac{1}{360}$ inch compared with the normal $\frac{1}{180}$ inch for NLQ mode. Using this tiny horizontal spac-

ing, the Proportional character matrix is an astounding 37 dots wide × 17 dots tall, compared with 15 × 17 for NLQ characters.

You turn on Proportional mode with ⟨ESC⟩"p1" and turn it off with ⟨ESC⟩"p0". The optional ⟨ESC⟩"p"(1) and ⟨ESC⟩"p"(0) work fine too. That puts the printer back into the mode it was in before Proportional was switched on. For example, if you entered Proportional from Compressed mode, ⟨ESC⟩"p0" would switch off Proportional and return the printer not to Pica, the default, but to Compressed mode.

Proportional Justification

One of the disappointments of the FX printer is that there is no easy way to right justify Proportional text. Sure, you can use Graphics mode to add little slivers of space between words, but that is cumbersome. In fact, you'll see very few word processing programs that support Proportional justification on the FX for just that reason.

Pitch control. The LQ has a command that may be of some help. The format is ⟨ESC⟩"b"(n), or ⟨ESC⟩(32)(n), where *b* stands for the ⟨SPACE⟩ character (ASCII 32) and *n* varies between 0 and 127. This command increases the spacing between characters by *n* "dots," as shown in Figure 5-19.

Spacing increments are in units of the dot spacing of the current mode:

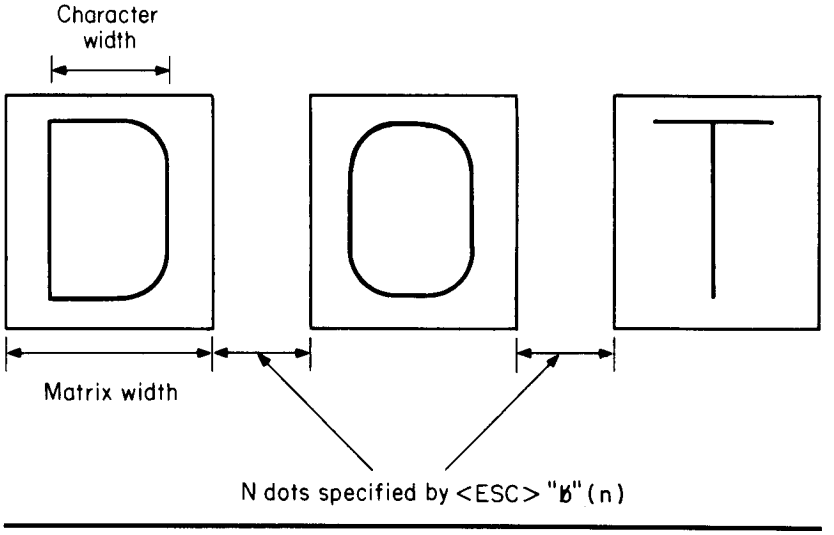


Figure 5-19 Variable spacing feature.

1/120 inch in Pica Draft, 1/180 inch in NLQ, and 1/360 inch in Proportional print. Software designers can use this command to stretch out short lines and achieve a justified right margin, as shown in Figure 5-20.

```
SAMPLE PRINT LINE TO DEMONSTRATE RIGHT JUSTIFICATION IN PROPORTIONAL PITCH.
WE WILL RIGHT JUSTIFY THIS LINE WITH THE FIRST LINE USING <ESC> <SPACE>.
WE WILL RIGHT JUSTIFY THIS LINE WITH THE FIRST LINE USING <ESC> <SPACE>.
```

Figure 5-20 Proportional justification.

The first two lines of Figure 5-20 are printed in Proportional pitch. Line 3 has been adjusted with a combination of ⟨ESC⟩"b"(1) and ⟨ESC⟩"b"(2) spacings to line up with line 1.

The line spacing can be turned off with ⟨ESC⟩"b"(0).

Summary

⟨ESC⟩"4" switches the active character set from the default Roman to Italics. ⟨ESC⟩"5" switches back to Roman mode.

Figure 5-3 displays 10 special characters that are stored in the ASCII table, including brackets, caret, reverse slash, and tilde.

On RX printers only, ⟨ESC⟩"m"(4) turns on and ⟨ESC⟩"m"(0) turns off special graphics codes buried in ASCII 128 to 159.

⟨ESC⟩"R" unlocks the door to special international codes that enable you to print text in several languages.

Script mode is turned on with ⟨ESC⟩"S", followed by a 0 for superscript or a 1 for subscript. Both Script modes are turned off by ⟨ESC⟩"T".

Epson Script characters are unique because they are actually reduced in height. To accomplish this, they are printed in two passes, using only 4 of the 9 print-head wires.

For every ASCII code, 8, you get a backspace, which you can use to overstrike and create new symbols.

⟨ESC⟩"M" changes pitch from the default, 10 CPI, Pica, to 12 CPI, Elite. ⟨ESC⟩"P" turns off Elite.

Codes for Compressed mode, 17.16 CPI, vary with the printer.

Model	*On*	*Off*
MX-80,100	15	18
Graftrax Plus, FX, RX, LQ	15 or ⟨ESC⟩(15)	18 or ⟨ESC⟩(18)
Graftrax 80	⟨ESC⟩"P"	⟨ESC⟩"Q"

Elite and Compressed modes can be combined only on the LQ by turning on ⟨ESC⟩"15" and ⟨ESC⟩"M" at the same time.

Codes for Expanded mode also vary with the printer.

Model	*On*	*Off*
Graftrax Plus	⟨ESC⟩"W"(1)	⟨ESC⟩"W"(0)
FX, RX, LQ	⟨ESC⟩"W1" (or one line only)	⟨ESC⟩"W0"
All models	ASCII 14	End of line
Graftrax 80	⟨ESC⟩"S"	⟨ESC⟩"T"

ASCII code 14 turns on a 1-line Expanded mode that turns off at the end of the line or after ASCII code 20. RX, FX, and LQ printers can also use ⟨ESC⟩(14) and ⟨ESC⟩(20). Graftrax 80 printers use ⟨ESC⟩"S" and ⟨ESC⟩"T".

On the FX and LQ printers only, Proportional mode is turned on with ⟨ESC⟩"p1" and off with ⟨ESC⟩"p0". On the LQ, ⟨ESC⟩"b"(n) varies the spacing between characters to aid in justifying text. This mode is turned off by ⟨ESC⟩"b"(0).

Chapter

6

Variations

"You mean there's more?" That's right! You ain't seen nuthin yet! You have seen the standard character matrix compressed both horizontally and vertically, slanted, and expanded, and there's more. Your little ol' Epson printer does everything to the character matrix except fold, spindle, or mutilate.

Emphasized Mode

One of the most rewarding things the printer can do for you is print darker characters. In Chapter 5, you made a brief acquaintance with Expanded print, where each column of each character is printed twice, a full column apart. In a similar way, Emphasized mode prints a duplicate set of dots to the right of the initial set, but this time only half a column over. Figure 6-1 shows how this spacing works to create a much denser character.

Did all those overlapping dots set off an alarm? Remember, Chapter 3 pointed out that print-head speed precludes overlapping dots in the same flow. Emphasized mode gets around this by printing at half speed. All printers except the MX-70 can use Emphasized mode.

For 9-wire printers, half speed does the trick in Pica pitch, but the dots in Elite and Compressed pitch are already so close that the print head just can't manipulate those pins fast enough. Thus Emphasized mixes with Pica but not with Elite or Compressed. Proportional pitch, of course, can be used only in Emphasized mode. As you will see in Figure 6-6, the pecking order gives Elite priority over Emphasized, but Compressed has lower priority.

Things are not so constricted on the LQ model. In the Draft style, Emphasized can mix with Elite, with Compressed (also known as Condensed), or with the new combination, Compressed-Elite. Emphasized mode can also be mixed with Proportional print and NLQ print. We go into mixing of modes more thoroughly later in this chapter.

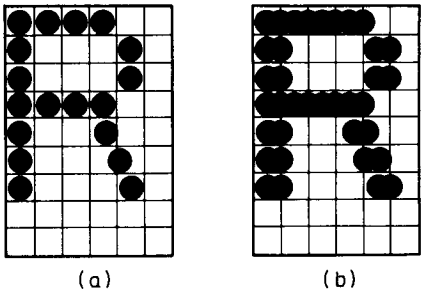


Figure 6-1 (*a*) Single-Strike and (*b*) Emphasized letters.

Once again you must remember that what gets turned on must be turned off. ⟨ESC⟩"E" is the on switch for Emphasized, and ⟨ESC⟩"F" shuts it off.

Double-Strike Mode

Another mode that produces darker characters by overlapping dots, thus affecting the quality (rather than the width) of print, is Double-Strike mode, which is available on all printers except the MX-70. The difference is that Double-Strike overlaps vertically instead of horizontally as Emphasized does.

As the name indicates, Double-Strike takes two passes. At the end of each line it shifts the paper up about 1/216 inch (1/180 inch on the LQ) and prints the entire line again. Of course, the printer can step along at top speed, but with two passes the throughput of Double-Strike is still cut in half. Figure 6-2 shows how Double-Strike fills in a character.

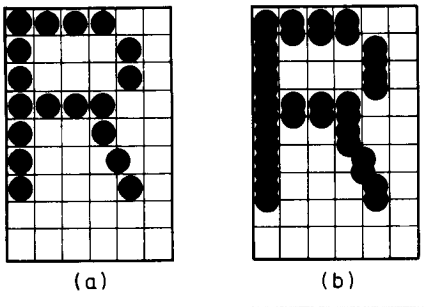


Figure 6-2 (*a*) Single-Strike and (*b*) Double-Strike letters.

Once you turn on Double-Strike mode with ⟨ESC⟩"G", it stays on until you turn it off with ⟨ESC⟩"H". And it does stay on and on. Like Expanded, Double-Strike is a good mixer and can be used with any other mode except Proportional on the FX. You will find Double-Strike a useful alternative to Emphasized print on printers where Emphasized cannot be mixed with Elite or Compressed pitch.

In Figure 6-3, you can see how Emphasized and Double-Strike compare and how they combine.

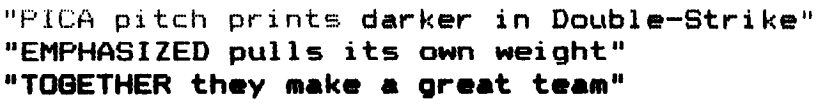


Figure 6-3 Bold modes compared and combined.

There is a cost to using a lot of these high-density modes. Printing is slower, and there is more wear on the ribbon. For most uses, however, that is a negligible price for the capabilities you gain.

Underline Mode

They just keep making things so easy! In the olden days, underlining characters with dot-matrix printers was something of a challenge. It took combinations of underscores (_) and backspacing or hyphens (-) and line-spacing changes. Then, with the introduction of the Graftrax Plus printers, Epson came up with the idea of an Underline mode. Using ⟨ESC⟩"-"(1) for on and ⟨ESC⟩"-"(0) for off, you can underline anything you want, even blank spaces. With the RX, FX, and LQ printers, you can also use ⟨ESC⟩"-1" and ⟨ESC⟩"-0" to turn Underline mode on and off.

There is a very minor price to pay for this feature. For 9-wire printers, Underline mode prints by firing the bottom pin of the print head so that it overlaps the bottom row of dots on those lowercase letters which have descenders—cuts off their tails, so to speak. There are two exceptions to this rule. With its reverse feed, the FX-80 can print underlines in the tenth row of dots and then realign itself with the current text line. The LQ makes good use of its many-wired print head to slip underlines in just below the lowercase descenders.

There is also a small problem with the Underline mode as it first appeared on Graftrax Plus printers. Graftrax Plus printers refuse to underline leading or trailing spaces on a print line. You can correct for

this by starting or ending such a line with the underline character (ASCII 95), as shown in Chapter 17. The problem was corrected on subsequent printers.

Figure 6-4 shows how Underline looks combined with other modes on the FX-80.

Figure 6-4 Underline mode.

LQ Print Quality Selection

As was mentioned in Chapter 3, the LQ printer has three different styles of operation, each with a unique pattern of dots and two distinct fonts: Roman and Italics.

Draft is the default print quality, with a 9 × 17 dot character matrix (9 wide by 17 tall), 1/120 inch horizontal spacing between dots, and a print speed of 200 CPS.

NLQ mode has a 15 × 17 dot character matrix, 1/180 inch dot spacing, and a print speed of 67 CPS. ⟨ESC⟩"x"(1) or ⟨ESC⟩ "x1" selects NLQ print; to get back to Draft, use ⟨ESC⟩"x"(0) or ⟨ESC⟩"x0".

We considered Proportional in the last chapter under the category of pitch, contrasting it with monospaced printing. However, on the LQ, Proportional is more than just another pretty pitch. Proportional mode has its own 37 × 17 dot character matrix, 1/360-inch dot spacing, and a burst speed of unadvertised CPS (a reliable source assures us that its average burst rate is around 57 CPS). We consider Proportional to be one of the three basic print qualities of the LQ printer. You turn it on with ⟨ESC⟩"p"(1) and off with ⟨ESC⟩"p"(0) (or the option ⟨ESC⟩"p1" and ⟨ESC⟩"p0").

Mixed-Up Modes

So far, we have covered several categories of print: several different pitches (Pica, Elite, etc.), two bold print modes (Emphasized and Double-Strike), two print fonts (Roman and Italics), some print variations (Underline, Expanded, Script), and even three print qualities on the LQ (Draft, Proportional, and NLQ). Many of these features can be combined to create dazzling effects, but there are some limitations. The rest of this

chapter will help you get a firm grip on this mixed-up mode-mixing methodology.

We'll start with 9-wire printers and in particular four print modes (Single-Strike, Double-Strike, Expanded, and Emphasized) common to all Epson printers except the MX-70. These four modes can be combined eight different ways in Pica pitch. Of the four modes, only Emphasized does not combine with the other two pitches: Compressed and Elite. Figure 6-5 shows the 16 unique combinations possible with these modes (note that the MX printers do not support Elite pitch). The FX has a Proportional pitch with its own peculiarities; it is always Emphasized, and it can't be mixed with Double-Strike. This adds two additional possibilities for the FX (again, see Figure 6-5).

On the LQ printer, there are three basic character designs: Draft, Proportional, and NLQ. There are also four pitches: Pica, Elite, Compressed, and Compressed-Elite. The higher-density character designs can't be mixed with each other or with the higher-density pitches. In particular, Proportional print can be used only in Pica pitch; NLQ print can be used only in Pica and Elite. The resulting seven combinations can be combined quite well with the eight combinations of Single-Strike, Double-Strike, Emphasized, and Expanded shown in Figure 6-5 to give 56 unique mode combinations.

Even with the incompatibilities between some of the modes, we still have access to a lot of combinations. In fact, there are more yet! Remember Italics and Underline modes? They combine with everything including each other, and so you can multiply the number of unique combinations shown above by 4 (normal, Italics, Underline, and Italics/Underline). If you are counting, this brings the total of unique combinations to 48 for MX Graftrax Plus, 64 for RX, 72 for FX, and 224 for LQ.

Then there are the Script modes: Superscript and Subscript. In Chapter 5 we learned that although Script characters are printed in two passes on 9-wire printers, they are still Single-Strike characters. That is, the second pass does not merely repeat the patterns printed on the first pass with overlapping dots as is the case with Double-Strike characters. Thus, Script characters combine with all modes except Double-Strike (also Proportional on the FX). This means you can combine both Superscript and Subscript with all the monospaced Single-Strike modes, which multiplies only the Single-Strike modes by 3 (non-Script, Superscript, and Subscript). Adding in the Double-Strike modes brings the 9-wire totals to 96 for the MX Graftrax Plus, 128 for the RX, and 136 for the FX (including Proportional print).

Of course, with a 24-wire print head, the LQ can print Script characters in one pass. As a result, these modes combine beautifully with everything. Thus, the number of unique print modes on the LQ triples to a whopping 672.

	PICA	ELITE (FX, RX)	COMPRESSED	PROPORTIONAL (FX ONLY)
SINGLE-STRIKE	ABCDEFGHIJKL	ABCDEFGHIJKLMN	ABCDEFGHIJKLMNOPQRST	////////////
S-S EMPHASIZED	ABCDEFGHIJKL	////////////	////////////	ABCDEFGHIJKL
S-S EXPANDED	ABCDEF	ABCDEFG	ABCDEFGHIJ	////////////
S-S EMPHASIZED EXPANDED	ABCDEF	////////////	////////////	ABCDEF
DOUBLE-STRIKE	ABCDEFGHIJKL	ABCDEFGHIJKLMN	ABCDEFGHIJKLMNOPQRST	////////////
D-S EMPHASIZED	ABCDEFGHIJKL	////////////	////////////	////////////
D-S EXPANDED	ABCDEF	ABCDEFG	ABCDEFGHIJ	////////////
D-S EMPHASIZED EXPANDED	ABCDEF	////////////	////////////	////////////

NOTES:

1) Italics and Underline can be mixed with all modes.
2) Script characters can be combined with all Single-Strike characters. They are formed with a two pass process, but are not Double-Strike characters.
3) Proportional characters are Emphasized Pica only.

Figure 6-5 Print mode combinations: (*a*) FX and (*b*) LQ. *(continued)*

	PICA			ELITE			COMPRESSED			COMPRESSED ELITE		
	DRAFT	NLQ	PROP	DRAFT	NLQ	PROP	DRAFT	NLQ	PROP	DRAFT	NLQ	PROP
SINGLE-STRIKE	ABCD	ABCD	ABCD	ABCDE	ABCDE	////	ABCDEFG	////	////	ABCDEFGH	////	////
S-S EMPHASIZED	ABCD	ABCD	ABCD	ABCDE	ABCDE	////	ABCDEFG	////	////	ABCDEFGH	////	////
S-S EXPANDED	AB	AB	AB	AB	AB	////	ABC	////	////	ABCD	////	////
S-S EMPHASIZED EXPANDED	AB	AB	AB	AB	AB	////	ABC	////	////	ABCD	////	////
DOUBLE-STRIKE	ABCD	ABCD	ABCD	ABCDE	ABCDE	////	ABCDEFG	////	////	ABCDEFGH	////	////
D-S EMPHASIZED	ABCD	ABCD	ABCD	ABCDE	ABCDE	////	ABCDEFG	////	////	ABCDEFGH	////	////
D-S EXPANDED	AB	AB	AB	AB	AB	////	ABC	////	////	ABCD	////	////
D-S EMPHASIZED EXPANDED	AB	AB	AB	AB	AB	////	ABC	////	////	ABCD	////	////

NOTE:
Italics, Underline, and Script modes can be combined with all modes.

Figure 6-5 (*continued*)

Modes with Priorities

Now that you have some perspective on the impressive variety of print combinations available on Epson printers, let's consider what the printer does when it receives instructions to turn on two conflicting modes.

What it does is just what you instruct it to do. It turns on both modes internally. However, the Epson engineers gave their printers a built-in set of priorities so that when a printer receives requests for two conflicting modes, only the highest-priority one is activated. When that one gets switched off, the other mode steps right up and takes over. This means, for example, that if you activate both Elite and Proportional on FX and LQ printers, the FX will print out Elite, and the LQ will print out Proportional. See Figure 6-6, which shows the mode priorities for FX and LQ printers.

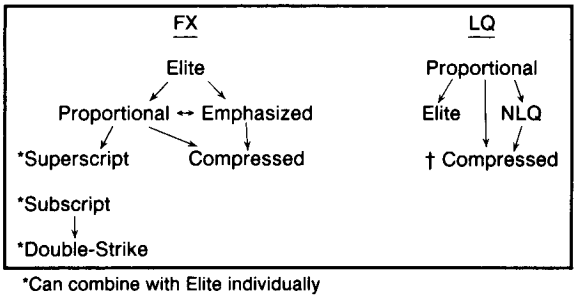


Figure 6-6 Print mode priorities.

Elite mode on the FX has priority over all the modes below it in the chain (except those noted with asterisks). Pica, of course, as the default, doesn't even make the list. It takes over when all other modes are turned off. Proportional is always combined with Emphasized and takes priority over all incompatible modes except Elite.

The LQ is much more accommodating in the area of mixing modes. The LQ allows previously unheard of (in the Epson world) mode combinations such as Emphasized-Compressed, Compressed-Elite, and Proportional-Superscript. The primary thing to watch out for is printing Proportional or NLQ characters in narrow pitch modes. More specifically, Proportional has priority over NLQ as well as Elite and Compressed pitches. NLQ has priority over Compressed pitch but gets along fine with Elite.

Master Select Mode

In order to simplify the process of activating combinations of print modes on the FX and LQ printers, Epson includes a Master Select code

sequence—⟨ESC⟩"!"(n)—which makes certain combinations of print modes accessible by number. The number may range from 0 to 255. It is selected by using the bit structure shown in Figure 6-7.

Bit Number	Bit Value	FX Mode	LQ Mode
0	1	Elite	Elite
1	2	—	Proportional
2	4	Compressed	Compressed
3	8	Emphasized	Emphasized
4	16	Double-Strike	Double-Strike
5	32	Expanded	Expanded
6	64	—	Italics
7	128	—	Underline

Figure 6-7 Master Select bit values.

To derive the correct number, you first select the combination of modes you want. To illustrate the concept, let's pick Expanded, Double-Strike, and Elite. Next, total up the bit values for the selected modes, in this case 32 + 16 + 1, for a total of 49. All that remains is to send the printer an instruction that reads like this, ⟨ESC⟩"!"(49), with the message "EXPANDED DOUBLE-STRIKE ELITE" and the printer will give you what is shown in Figure 6-8.

EXPANDED DOUBLE-STRIKE ELITE

Figure 6-8 Sample mode combination.

When you are ready to change to another combination of modes, turn on a new combination with Master Select, and the previous modes will be turned off automatically. ⟨ESC⟩"!"(0) turns off all modes and returns to Pica.

Later versions of the FX printers let you select type styles at the touch of a button. What will they think of next?

There you have it, the full book on variations to print characters available on dot-matrix printers. In the next chapter, you will learn something of the versatility of paper-feed mechanisms and the kinds of variations that can be generated by paper-feed control.

Summary

Emphasized mode is turned on by ⟨ESC⟩"E" and off by ⟨ESC⟩"F". It

prints duplicate sets of dots just half a column apart but has to slow to half speed to print the overlapping dots.

Double-Strike mode is turned on by ⟨ESC⟩"G" and off by ⟨ESC⟩"H". It reprints the entire character with a vertical separation of 1/216 inch (about one-third of a dot).

Underline mode is turned on by ⟨ESC⟩"-"(1) and turned off by ⟨ESC⟩"-"(0). Later printers also accept ⟨ESC⟩"-1" and ⟨ESC⟩"-0". Underlining is done in the ninth row of the character matrix, except on the FX-80 and LQ-1500 printers, where it's done below the bottom row of dots.

The LQ printer has three basic print qualities: Draft, NLQ, and Proportional. ⟨ESC⟩"x1" selects NLQ and ⟨ESC⟩"x0" switches back to the default, Draft.

Although the number of possible print mode combinations is impressive, it is possible to send control codes to the printer for a mode combination that the printer can't print. In that case, you will get something other than what you ordered. Figure 6-5 is included in this chapter to help you avoid this problem.

In the event that conflicting modes are ordered, the printer will pick the mode with highest priority. Figure 6-6 shows the mode selection priorities.

Master Select print mode on the FX or LQ printers allows us to select a combination of print modes by number with ⟨ESC⟩"!"(n).

Chapter

7

Paper Feed

The last four chapters dealt primarily with features related to the print head. Dot matrix may be the name of this game, but the print head is not the only interesting facet of Epson printers. In this chapter, we look at the many options you can control in connection with moving the paper.

Friction or Tractor Drive

There are three types of paper-feed drives available on Epson printers. Some printers come with a tractor drive, as on the MX-80 and RX-80. Some printers have a removable tractor feed mechanism along with a built-in friction drive, as on the MX-80 F/T and RX-80 F/T. The FX-80 has three different paper-feed mechanisms: a friction drive, a pin-feed mechanism that can accommodate standard 9-inch or 9½-inch pin-hole paper, and a removable tractor for narrow continuous-feed forms such as mailing labels.

The friction drive is similar to a typewriter roller mechanism. You feed a single sheet of paper through, as you would in a typewriter, until it is in position to print and then lower the bail to hold it in place. The LQ printer makes this single-sheet feed operation semiautomatic. Just pop a sheet of paper into the opening, press the sheet-load button, and the paper is fed right into position.

The tractor feed drive has wheels with pins that pick up the holes along the edges of pin-feed paper. Loading the paper is a little more involved than with the friction feed. The printer tractors must be adjusted to the right width for the paper, and the holes in the paper must be exactly aligned with the tractor pins. Also, your stack of paper must be located with respect to the printer so that the paper can feed, without binding, from the source stack through the printer to the printout stack.

Figure 7-1 compares the feed mechanisms of the various Epson printers.

Feed Type	Printers
Adjustable tractor drive	MX-80, MX-70, RX-80
Friction drive with removable tractor	MX-80 F/T, RX-80 F/T
Wide-carriage friction drive with removable tractor	MX-100, FX-100, RX-100
Dual feed: built-in friction and tractor, with removable narrow form tractor	FX-80
Friction drive with single-sheet loader; removable tractor adjustable from 4 to 16 inches	LQ-1500

Figure 7-1 Paper-feed mechanisms.

The various paper-feed features discussed in the remainder of this chapter apply equally to all the drives mentioned in the previous paragraphs. You just tell the printer how you want the paper moved, and it will move it, no matter what kind of paper drive it is using.

Standard Line-Spacing Options

Of course, there is a default setting, which produces line spacing of ⅙ inch, or 6 lines of print per inch. This standard line spacing on 9-wire printers is equivalent to 12 rows of dots in the character matrix (see Figure 7-2).

The line spacing on the LQ works out to 17 dots for uppercase characters and 13 dots between the lines.

As you have come to expect, there are options on the standard line spacing. The first convenient option available on all printers except the MX-70 reduces line spacing to ⅛ inch (8 printed lines per inch). For 9-wire printers, this is equivalent to 9 dots; for the LQ, it comes to about 22½ dots. This ⅛ inch spacing is turned on by ⟨ESC⟩"0" (27 48) and back to the default by ⟨ESC⟩"2" (27 50). This spacing makes for a snug fit, as you can see in Figure 7-3.

Note that the position of these line-feed codes in a line of text is not significant since they don't take effect until a line feed is activated at the end of the line. They stay in effect until a subsequent line-feed command changes the line spacing.

On all 9-wire printers except the MX-70 and MX-100, 7-dot spacing (7/72 inch) can be turned on by ⟨ESC⟩"1" and turned back to the default by

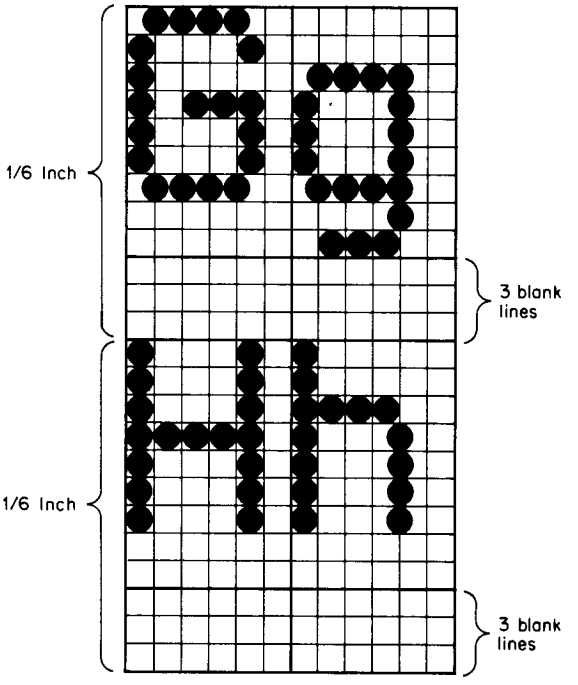


Figure 7-2 Default line spacing (⅙ inch).

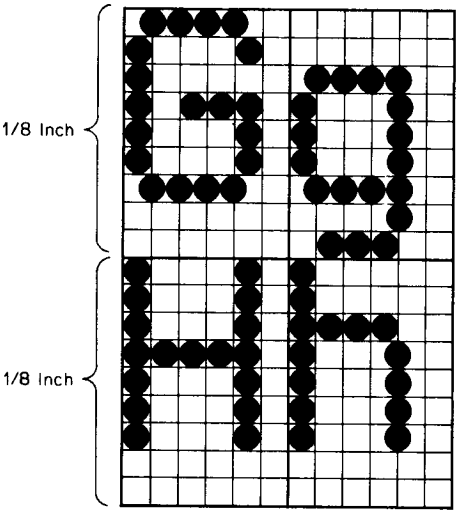


Figure 7-3 Graphic showing 9-dot spacing on 9-wire printer with ⅛ inch line spacing.

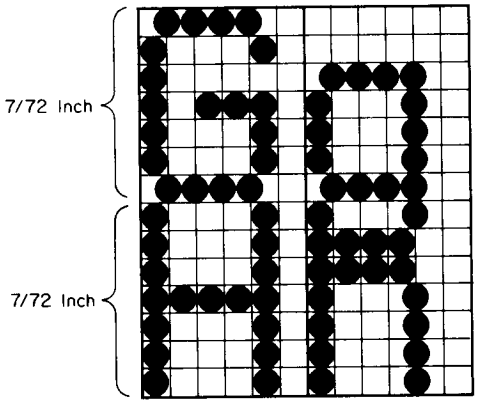


Figure 7-4 Graphic showing 7-dot spacing on 9-wire printer.

⟨ESC⟩"2". This mode is particularly useful for applications involving graphics.

Figure 7-5 gives you a chance to compare these three standard spacing modes in actual print.

```
DEFAULT spacing
DEFAULT spacing
                    NINE-dot spacing
                    NINE-dot spacing
                    NINE-dot spacing
                                        SEVEN-DOT spacing
                                        SEVEN-DOT spacing
                                        SEVEN-DOT spacing
                                        SEVEN-DOT spacing
                                        SEVEN-DOT spacing
```

Figure 7-5 Comparison of standard spacing modes.

Variable Line-Spacing Options

The standard line-spacing modes we have just discussed are preset to provide some useful and convenient options. A far more flexible mode allows you to call for line feeds in increments the same as the pin spacing in the print head: 1/72 inch for 9-wire printers and 1/60 inch for the LQ. You can vary line spacing from 0 to 85 dots worth (0/72 to 85/72, or 0/60 to 85/60) by using ⟨ESC⟩"A"(n). This opens a new door to seemingly endless possibilities, and that door is closed by our friend ⟨ESC⟩"2". All Epson printers (even the MX-70) can use this mode.

The original MX-80 uses ⟨ESC⟩"A" differently from all the others. You first set the line spacing with ⟨ESC⟩"A"as above, but the new line spacing isn't activated until you send an ⟨ESC⟩"2".

Figure 7-6 shows what happens when you print a line several times using 2-dot spacing, ⟨ESC⟩"A"(2).

Figure 7-6 Illustration of 2-dot (2/72 inch) vertical spacing.

The ultimate in line-feed control, available on all but the original MX Series printers, is turned on by ⟨ESC⟩"3"(n). This gives you the same spacing that is used in printing Double-Strike mode—one-third the ⟨ESC⟩"A" spacing. For 9-wire printers, this distance is 1/216 inch; for the LQ, the distance is 1/180 inch.

For 9-wire printers, the ⟨ESC⟩"3" spacing is one-third the distance between pins in the print head, center to center. This means the printer can position a line of print one-third of a dot lower than the previous line, or two-thirds, or anywhere from 0 to 255 thirds. However, considering the delicacy of this fine setting, don't expect total accuracy.

If double-strike is not striking enough for you, try making your own triple-strike or more. For example, Figure 7-7 shows the density you get with five passes on an FX printer.

With 10 passes, you get something similar to what is shown in Figure 7-8.

Figure 7-7 Illustration of 1/216 inch spacing, five passes.

Figure 7-8 Illustration of 1/216 inch spacing, 10 passes.

Immediate Line Feed

You can really have fun with this one. With a Graftrax Plus, FX, RX, or LQ printer and ⟨ESC⟩"J"(n), you get the same 0 to 255/216 inch (*n*/180 inch on the LQ) as with the previous delicate spacing option. However, ⟨ESC⟩"J" executes immediately instead of at the end of the text line. If the command is placed in the middle of a line of text, the line feed is executed immediately without a carriage return, and then the rest of the line is printed as if nothing sneaky had happened. At the end of the text line, the spacing reverts back to the currently active line-feed distance. This means you don't need a code to turn it off. ⟨ESC⟩"J" activates immediately and is not stored in memory.

In order for you to see clearly how this feature works and maybe stim-

ulate your imagination to other possibilities, let's do a series of five samples on the FX, increasing each one by 2/16 inch.

A word of caution here. While you are thinking up strange and wonderful ways to use tiptoe-type line feeds, remember that ⟨ESC⟩"J" works only in one direction. You can't dip below the line and then come back to the original print line. All you can do is tell the paper drive to move *now* a designated increment and then continue printing as before ... well, maybe there is an exception. If you have an FX-80, let's see what it will do.

```
LINEFEED
LINEFEED
LINEFEED
LINEFEED
LINEFEED
```

Figure 7-9 Immediate line feed, 2/16 inch, five passes.

Reverse Feed

The FX-80 (not the FX-100) does have reverse feed. This printer uses reverse feed ability to do underlining and to correct for the paper creep caused by Double-Strike mode (see below). Reverse feed is also available to you as a new print mode similar to ⟨ESC⟩"J", an immediate, one-time-only line feed without a carriage return. The difference is that you activate it with ⟨ESC⟩"j"(n), and the paper feeds in the opposite direction. Figure 7-10 shows how reverse feed can be used to compensate for immediate forward line feed.

```
Immediate LINEFEED with reverse LINEFEED
Immediate LINEFEED with reverse LINEFEED
Immediate LINEFEED with reverse LINEFEED
Immediate LINEFEED with reverse LINEFEED
Immediate LINEFEED with reverse LINEFEED
```

Figure 7-10 Immediate line feed: forward and reverse.

Using reverse feed does require a little care. For example, never use reverse feed with mailing labels loaded into the printer. They tend to peel off and jam the paper-feed mechanism. *Always* feed labels forward.

With continuous forms, use reverse only in small increments. The paper tends to bunch up in reverse, and the print head can get caught in the perforation.

Reverse the Creep

Reverse feed was added to the FX-80 to correct for a few minor inconveniences such as the Double-Strike creep. Every time Double-Strike mode is turned on, the paper is rolled forward 1/216 inch. If it is turned on and off several times in the same line, the line of print will take on a noticeable sag. Figure 7-11 demonstrates that sag on an RX printer.

Figure 7-11 Double-Strike creep.

By slipping in a reverse feed after every Double-Strike entry, the FX-80 prevents this sad sag (see Figure 7-12).

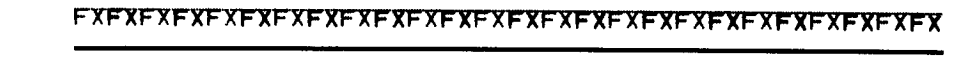


Figure 7-12 Double-Strike creep reversed.

Underline and Reverse Feed

As was mentioned in Chapter 6, underlining on most Epson printers interferes with the bottom row of lowercase letters with descenders. Figure 7-13 illustrates the problem.

With its reverse feed, the FX-80 drops down 1 dot to print the underline and then executes a reverse feed back to the normal print line. Figure 7-14 shows the result.

Of course, the LQ doesn't have this problem with its many-wired print head.

Figure 7-13 Underline cuts off descenders.

Figure 7-14 FX-80 Underline clears descenders.

Immediate Print Mode

You don't get an electric typewriter built in to any Epson printer, but the FX-80 does a fair imitation. Normally, data coming from the computer

feed into the printer buffer and don't print out until the buffer is full. If you are watching, you can't see what it is printing because the paper bail is in the way.

In the FX-80's Immediate mode, all data are printed as soon as the printer receives them, right from your keyboard. Then the current line being printed is rolled up so that you can read it and then is rolled back for more data, thanks to reverse feed. You turn on this typewriter mode with ⟨ESC⟩"i1" and turn it off with ⟨ESC⟩"i0".

Summary

Epson printers come with a tractor drive or with some combination of friction and tractor drive. The friction drive handles single sheets of paper, similar to the operation of a typewriter roller feed. The tractor drive operates wheels with pins that engage the holes in pin-feed paper.

The line-spacing default is 6 lines per inch (1/72 inch on 9-wire printers and 3/180 inch on the LQ).

The 1/8 inch spacing is turned on by ⟨ESC⟩"0" and off by ⟨ESC⟩"2". It prints 8 lines per inch on most printers.

The 7-dot spacing is turned on by ⟨ESC⟩"1" and off by ⟨ESC⟩"2". It prints 10 or more lines per inch on most 9-wire printers.

⟨ESC⟩"A"(n) establishes a new line-spacing distance in increments of 1/72 inch for 9-wire printers (the center-to-center distance between pins in the print head) and 1/60 inch on the LQ. *n* can range from 0 to 85.

⟨ESC⟩"3"(n) establishes an even finer line spacing in increments of 1/216 inch for 9-wire printers and 1/180 inch for the LQ. All these line-spacing modes are activated with carriage return and remain in effect until turned off by ⟨ESC⟩"2" on the later printers.

An immediate line feed is activated by ⟨ESC⟩"J"(n) on the FX, RX, and LQ printers, where *n* ranges from 0 to 255. The line-spacing increments are identical to the ⟨ESC⟩"3" mode, but the line feed is activated immediately and returns to the currently active line-feed distance at the end of the print line.

Reverse feed, only on the FX-80, turns on with ⟨ESC⟩"j"(n) and works the same as ⟨ESC⟩"J" except that it rolls the paper backwards.

Chapter

8

Forms Control

Many of you have found your niche and are settled comfortably into a routine with your printer. The paper is loaded into the printer; each page is 11 inches long; and there is a whole box waiting to be printed.

Others are a little more diversified. You will be using various sizes of forms, labels, and notes. You will want your printer with you all the way in this matter. You especially want your printer to know where the paper begins and where it ends.

Never fear. Your printer knows exactly how to handle the paper-pushing particulars. When you have finished with this chapter, you will know, too.

Setting Form Length

The best way to start this discussion is with turning on the printer. When the printer is turned on, it records the current position of the print head with respect to the paper as the top of form. If you press the ON LINE button so that the light goes off and then press the FF (form-feed) button, the paper advances 11 inches (the default form length). If you are using standard 11-inch paper, this motion positions the print head at the same spot on the next sheet.

To set the top of form, line up the paper perforation with the top of the ribbon (see Figure 8-1). Turn the printer off and then back on. With this setting, the first line of print will be directly below the perforation. Normally, that will be your preferred top-of-form position.

So far, so good. The printer knows where the top of form is, and it knows that the top of the next form is 11 inches away. That is its default length of form. It will keep track of the number of lines printed and skip to the top of the next page when it receives a form-feed code.

However, all pieces of paper are not created equal. If the length of your forms is anything other than 11 inches, you must inform the printer. Typ-

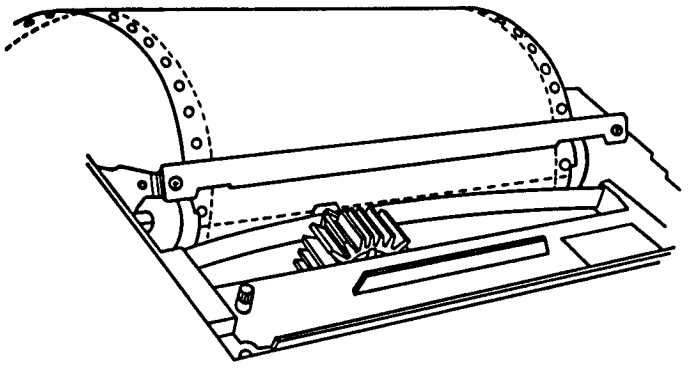


Figure 8-1 Setting the top of form.

ically, the form length is selected with software codes. But the original MX-100, RX, and LQ printers have a special switch setting for 12-inch forms, the standard page size in Europe.

For any other form length, shorter or longer, ⟨ESC⟩"C" is the key. It resets both top of page and form length. ⟨ESC⟩"C"(n) sets form length to *n lines.*

With the introduction of the MX-100, Epson added an optional way to set the form length. ⟨ESC⟩"C"(0)(n) sets form length to *n inches.*

Both options are available on current printers. The only difference between the options is the 0; its presence or absence tells the printer whether you want to set the form length in inches or in lines. Figure 8-2 shows the form length set to 2 lines with ⟨ESC⟩"C"(2).

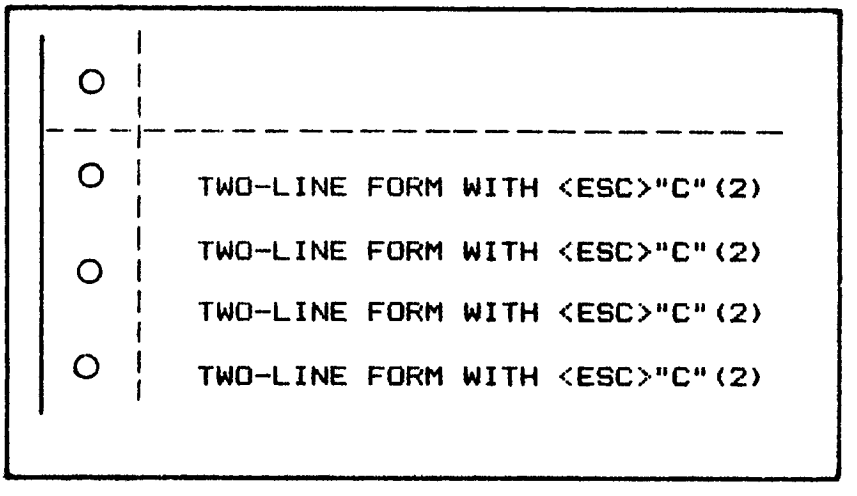


Figure 8-2 Two-line form length.

Adding the 0 to the control code sequence, ⟨ESC⟩"C"(0)(2), changes the meaning entirely. The result is a 2-inch form length, as shown in Figure 8-3.

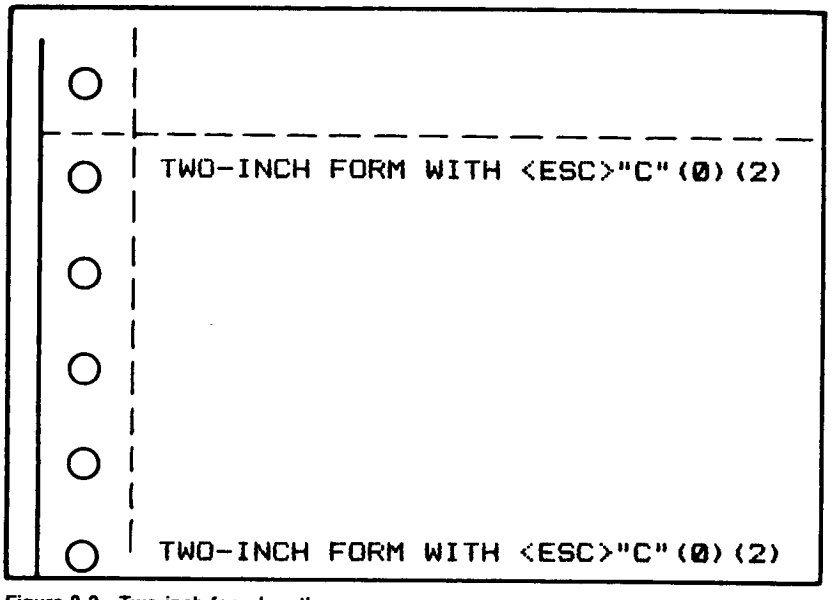


Figure 8-3 Two-inch form length.

That's nice, but why do we need two methods? Actually, we don't. This is just one of those extra conveniences built into the code structure to indulge some of us more indolent types. If you know the form length in inches, use ⟨ESC⟩"C"(0)(n); if you know the length in lines, use ⟨ESC⟩"C"(n).

The only other difference between the two options is the maximum form length. The ⟨ESC⟩"C"(0)(n) option allows a maximum form length of 22 inches, certainly long enough for most forms. If you absolutely need a longer form length, the number of lines option gives you almost unlimited form length. Its maximum is 127 lines, and you already know that you can set line spacing to a maximum of $^{85}/_{72}$ inch ($^{85}/_{60}$ inch on the LQ). That combination will take you to a form length of 150 inches (well, all right, 149.9 inches) and nearly 180 inches on the LQ.

The neat part about these maximum settings is that once you have set form length, you can go back to a more usable line spacing without affecting form length. That is true of both options with ⟨ESC⟩"C". Form length is set absolutely and is not affected by subsequent changes in line spacing.

Form Feed

It is probably most appropriate at this point to remind you that, like so much book information, the whole business of form length is a lot easier to do than to explain. For many of you, it will soon be as automatic as shifting gears in a car.

Once top of form and form length have been established, all that remains is to place a form-feed code at the end of text for each page or form. This code causes the paper to feed quickly to the top of the next form. It also saves you from counting lines and manually feeding line-feed codes to the printer in order to move the paper. ASCII numbers 12 and 140 activate the form-feed function; use the one most convenient on your system.

Skipping the Paper Perforation

If you get everything right that we have discussed so far in this chapter, you will not encounter the problem of printing right on the paper perforation. It will be skipped over as the paper rolls up to the next top of page. However, there may be situations, such as listing a BASIC program, where it is not convenient or possible to insert form-feed codes at the bottom of every page.

Enter, stage left, ⟨ESC⟩"N"(n), known far and wide as the skip over perforation (SOP) command. ⟨ESC⟩"N" was introduced in the MX-100 and is available on all printers since the Graftrax Plus ROMs. This handy labor-saving code sequence simply inserts *n* blank lines immediately ahead of the next top of form. You can plug in any number of blank lines from 1 to 127. However, if the number is greater than the current form length, according to ⟨ESC⟩"C" or the default (66 lines), then ⟨ESC⟩"N" is ignored. That is for the record only; certainly *you* would never try that.

A common practice is to set the SOP distance to 1 inch with ⟨ESC⟩"N"(6). With the normal top-of-form setting, as shown in Figure 8-1, printed text would start just below the perforation at the top and stop with an inch of blank space (6 lines) at the bottom.

To equalize the blank space at the top and bottom of the page, you can reset your top of form about ½ inch (3 lines) below the perforation, as shown in Figure 8-4. That is the final step in setting up to print many, many pages of text with equal half-inch margins, top and bottom. When you are ready to change forms or modes, you can turn off the SOP feature with ⟨ESC⟩"O" (the letter O, not zero) or by setting a new form length with ⟨ESC⟩"C".

Those who find this 6-inch SOP feature a must can select it as the default condition for their printers by setting a switch. Only the original MX-80, Graftrax 80, and the MX-70 machines do not have this switch

option. Don't be bashful about changing the switch setting. You can always turn off the SOP feature with ⟨ESC⟩"O" or change the skip distance with ⟨ESC⟩"N"(n).

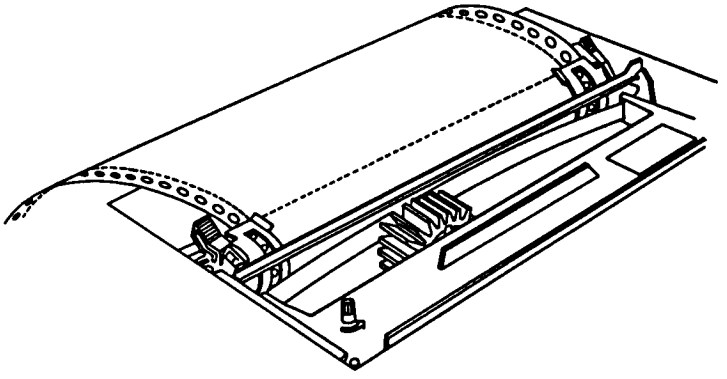


Figure 8-4 Top of form for the standard skip.

Paper-Out Sensor

If you are printing on single-sheet paper, using a friction-feed printer, the printer will sound a warning before you reach the end of the paper and will automatically shut down the printing until you load another sheet and continue. This prevents the printer from printing on its platen. It also prevents you from printing on the last quarter of the page.

If you need to print on the lower quarter of the page, most Epson printers let you override the paper-out sensor with a switch setting. The only printers without this ability are the original MX-80, MX-70, and Graftrax 80 printers. Another way is to feed an ⟨ESC⟩"8" code to the printer. In either case, you have taken on a responsibility for the well-being of the platen, so proceed with caution. When you want the sensor back, ⟨ESC⟩"9" will restore it to full power. Note that ⟨ESC⟩"8" and ⟨ESC⟩ "9" are not available on the original MX-80 or MX-70.

Note that computers that monitor line 12 of the parallel connector may not be able to utilize ⟨ESC⟩"8" and ⟨ESC⟩"9" if line 12 is connected. Epson supplies a special cable (No. 8222) that eliminates this problem for TRS-80s.

Summary

The process of form control starts with establishing the top of form. With the printer off, locate the paper perforation so that it lines up with the top of the ribbon. Then turn on the printer.

⟨ESC⟩"C"(n) sets the form length to *n* lines, and ⟨ESC⟩"C"(0)(n) sets the form length to *n* inches. Both reset the top-of-form mark to the current print line.

ASCII 12 is the form-feed code. It rolls the paper down to the next top-of-page position.

⟨ESC⟩"N"(n) inserts *n* blank lines at the end of each page to accomplish skip over perforation.

Using single-sheet paper on friction-feed printers, ⟨ESC⟩"8" overrides the paper-out sensor, and ⟨ESC⟩"9" restores it.

Chapter

9

Positioning the Print Head

Our fine-wired friend the print head is responsive to still more control codes. You can position it on the paper both horizontally and vertically, using tabs and margins, and you can set tabs in either evenly spaced or variable patterns.

Don't let us mislead you on terminology. We have been using the terms "column" and "row" to discuss the positioning of dots within a character matrix. In this chapter, we use the same terms to refer to the positioning of characters on a page.

Setting the Margins

There is nothing like a good left margin followed by a sound right margin to put the print head in its proper place. The defaults are set for a full 80 Pica characters on the standard printers and 136 Pica characters on their wide-bodied counterparts. Most word processing programs have codes for resetting margins to suit your format requirements. Epson printers have margin control codes, too.

Left Margins

The latest printers from Epson (including RX, FX, and LQ) start margin control with a left margin command in the format ⟨ESC⟩"l"(n). The l is a lowercase letter "el," and *n* is the column number you want for your new left margin. If your system has trouble with lowercase letters, you can use decimal 108 in place of the l.

Simple enough! That's all there is to it. Well, almost all. There are some ground rules. The values allowed for *n* on standard-size printers range from 0 to 78 for Pica, 0 to 93 for Elite, and 0 to 133 for Compressed mode. The values allowed for *n* on wide-carriage RX-100 and FX-100 printers

range from 0 to 134 for Pica, 0 to 160 for Elite, and 0 to 229 for Compressed. The LQ range is the same for Pica but is limited to 160 for the denser pitches, including Compressed-Elite. Epson had to impose some limit on the LQ left margin command since you can cram 272 Compressed-Elite characters per line, but the largest single number possible with an 8-bit computer is 255.

The printer ignores all invalid settings, such as those greater than the current page width. New margin settings go into effect when a carriage return is received, and they stay in effect until you change them or turn off the printer.

There is one more ground rule. As the ranges we have listed suggest, the actual position of a margin setting on the page depends on the print mode in effect when you give the command. However, once margins are set, they are not affected by changes in print mode. Sounds like a good lead-in for a sample figure, right? Let's see what happens if we set the left margin at column 15 with the command ⟨ESC⟩"l"(15), then change from Pica to Compressed Mode, and then reset the margin at 15 while still in Compressed mode.

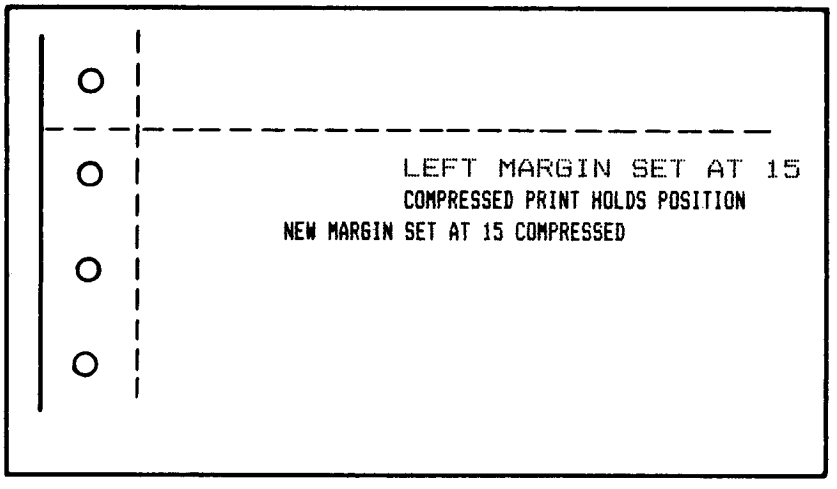


Figure 9-1 Effect of pitch on setting margins.

Just as the ground rules claimed. The left margin of 15 is set 1½ inches from the edge of the page in Pica mode. Changing to Compressed mode doesn't change the margin. But when we reset the margin to 15 while in Compressed mode, it moves to less than an inch from the edge of the page, more precisely, 0.874 inch. There are 17.16 Compressed spaces to an inch (15/17.16 = 0.874).

Right Margins

Similar conditions apply to setting right margins. The command code is ⟨ESC⟩"Q"(n), where *n* ranges from 2 to 80 in Pica, 3 to 96 in Elite, and 4 to 137 in Compressed mode. For the wide-bodied RX-100 and FX-100, the range is 2 to 136 in Pica, 3 to 163 in Elite, and 4 to 233 in Compressed. The LQ has its own unique right margin limits: 1 to 80 in Pica, 1 to 96 in Elite, 1 to 137 in Compressed, and 1 to 255 in Compressed-Elite. Again, note that the right margin goes all the way to 272 in Compressed-Elite, but the largest 1-byte number that can enter the printer is 255. The moral is: Don't set large right margins in Compressed-Elite pitch; use another pitch.

The right margin command is very helpful when you are using 80-column paper on a wide-bodied printer. Just send ⟨ESC⟩"Q"(80) to the printer before printing anything that may print wider than the paper.

Once more, your printer gets a little uppity if you don't do it right. If you try to set your right margin with a lower number than the left, which would put it on the wrong side of the left margin, you will be ignored. Your right margin will still be at the default.

Actually, it is a little more complicated than that. The left margin command starts counting the columns with 0, but the right margin command starts with 1. Furthermore, the RX and FX printers aren't satisfied (the LQ couldn't care less) with a right margin location just because it is to the right of the left margin. No, they insist on enough room for at least 1 Expanded Pica character between margins.

Let's see how this RX and FX rule would work out if you wanted your margins as close together as possible. In Pica, an Expanded Pica character would require 2 spaces. With your left margin at 20, it would require columns 20 and 21. However, since the left margin command starts counting columns with 0, its column 21 is column 22 to the right margin command. In Elite pitch, an Expanded Pica character would require 3 spaces, so its minimum right margin setting would be 23. In Compressed mode, the minimum setting would be 24.

To test these ground rules, we will use ⟨ESC⟩"l"(20) to set the left margin at 20 and ⟨ESC⟩"Q"(21) to set the right margin at 21. What do you suppose that will do?

You are right! The FX and RX printers are just as smart as they claim to be. They ignore the right margin command, because we didn't leave enough space for an Expanded Pica character (see Figure 9-2). Well, we can sure fix that just by changing the right margin command to 22 (see Figure 9-3). That narrows the field, doesn't it? Again, the LQ doesn't demand any minimum distance between margins.

There are two more factors to bear in mind when using margin commands. First, since both of these commands delete all characters currently

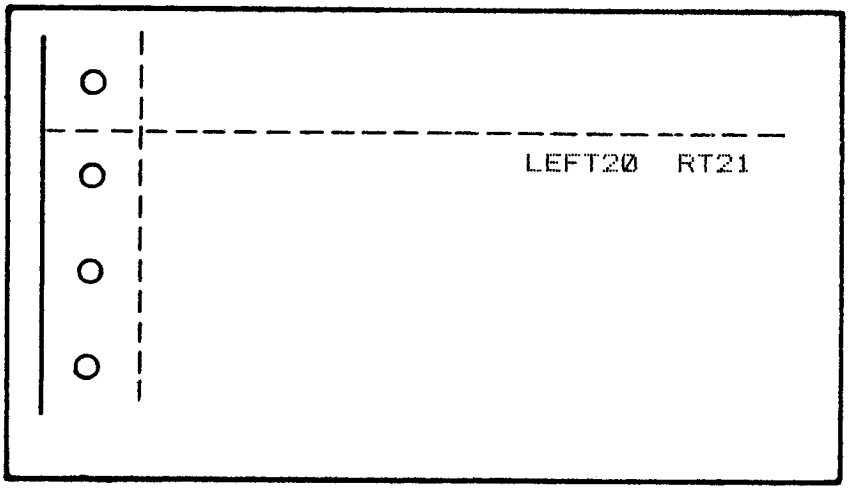


Figure 9-2 Illegal right margin command ignored.

in the print buffer, you should avoid using them at the end of a program line or lines that produce print. It is a good rule to send the new margin command ahead of the print line.

Second, the left margin is the zero point for all horizontal tabs. Changing the left margin causes all horizontal tab settings to shift accordingly. You will learn how tabs work in the next section.

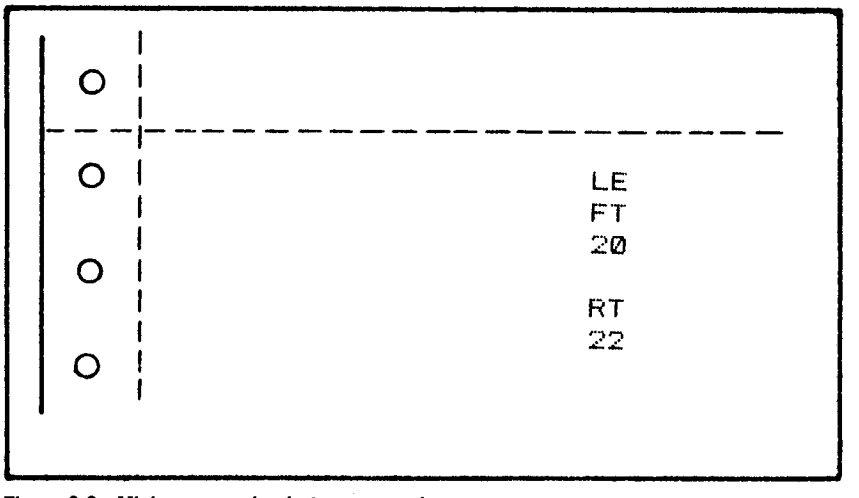


Figure 9-3 Minimum spacing between margins.

Horizontal Tabs

The first thing you need to know about tabulating the print head of Epson printers is the decimal code number 9. That is the horizontal tab trigger, and it is appropriately labeled in the ASCII table as HT. If your system won't send a 9, decimal 137 will do nicely (9 + 128 = 137). The horizontal tab code triggers the print head to move from any position on a print line to the next tab stop (no, it won't move backwards).

Standard Stops

If you were to send your printer a string of words here and there interspersed with code 9s, you would get something that looks like Figure 9-4. The top line of numbers, from 0 to 29, is just a little something we added so that you can quickly locate the tabs. In this case it shows you that the default tabs in your printer are in multiples of 8, i.e., 8, 16, 24, 32, 40, etc. Note that the first column is not number 1 but 0.

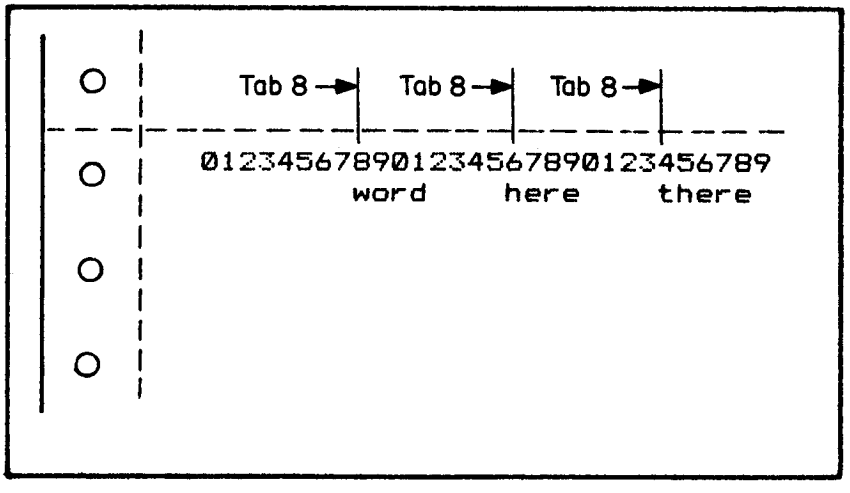


Figure 9-4 Default horizontal tabs.

Of course, even using the defaults, you have some flexibility in that you don't have to use every stop. You can skip any stops just by adding an extra decimal 9. If you want to start printing at the left margin and then tab to column 16 for your first stop, you send the printer the first nomenclature without a control code and then send two code 9s with the next word.

Since the BASIC language is commonly used to send codes to the

printer, it is well to point out here that some BASICs add a space ahead of any numbers that are being tabbed. This tends to offset columns of numbers under their respective text headings. Knowing this, you can add extra spaces as needed to line up columns of numbers with headings as you see fit. If you were to send tabbed numbers to the printer for the example in Figure 9-5 without adding extra spaces, you could get the result shown in Figure 9-6.

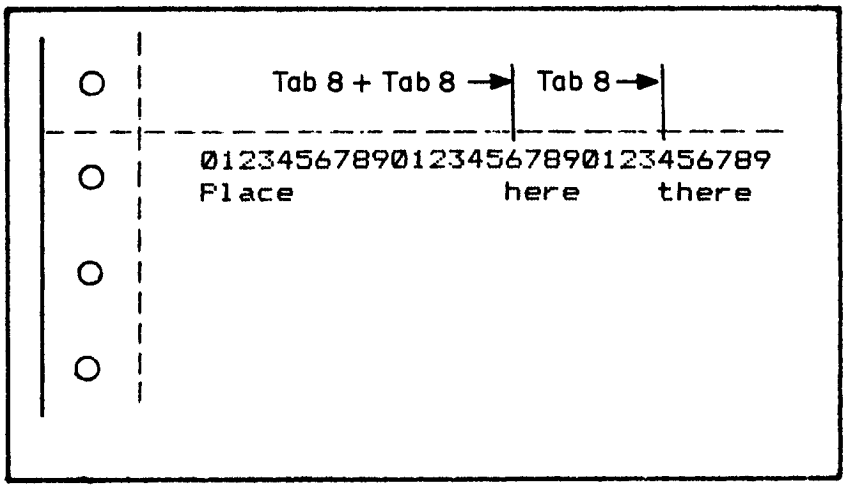


Figure 9-5 Selected default tabs.

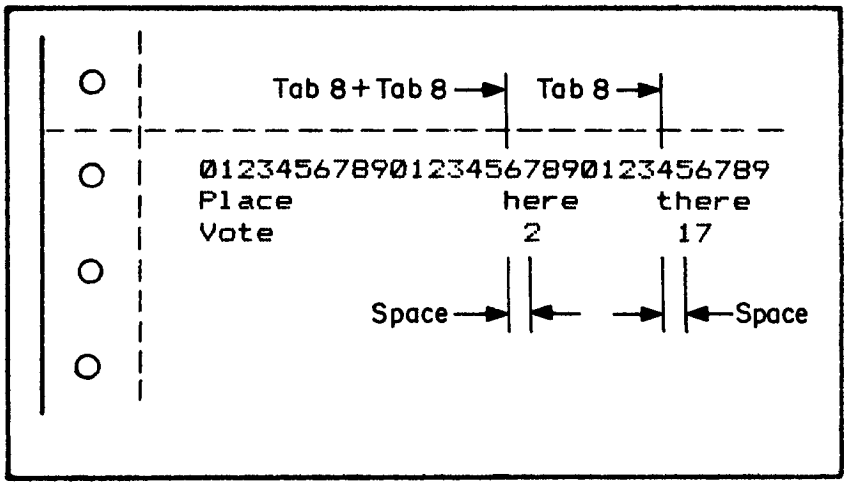


Figure 9-6 Tab placement with letters and numbers.

If the default tabs don't give you quite the flexibility you need, Epson's printers also provide a do-it-yourself tab feature.

Variable Stops

The most variable aspect of the do-it-yourself tab stops feature is that it varies according to the printer you are using. Most Epson printers (except the MX-70 and RX-80) use ⟨ESC⟩"D" to set horizontal tab stops. With the format ⟨ESC⟩"D"(n_1)(n_2).....(n_{32})(0), you can place up to 32 tab stops in any position you wish. In this case, 0 terminates the sequence. Actually, current printers will accept any number (including 0) lower than your last tab setting to terminate the tab sequence.

Your new tab sequence will remain in effect until you turn off the printer or define another tab sequence. In fact, just like margin settings, tab stops on the current printers do not change with subsequent changes in pitch. Once set, they are fixed in place until a new tab sequence is issued.

No matter what tab stops you are using, tabbing is activated by decimal number 9 (or its high-order counterpart, 137), which is listed on the ASCII charts as HT for horizontal tabulation.

Setting tabs to 7, 11, and 17 and initiating action with 9 gives the results shown in Figure 9-7.

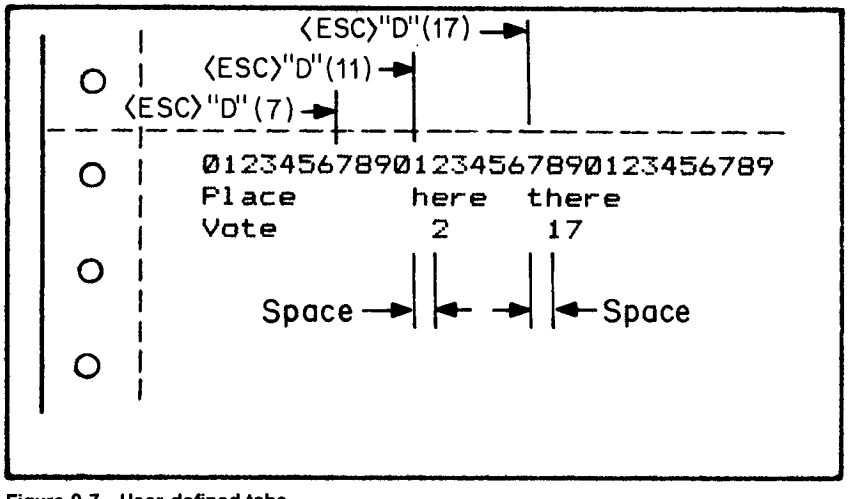


Figure 9-7 User-defined tabs.

You can see that ⟨ESC⟩"D" gives you virtually unlimited flexibility for setting tabs. Each section of a document may require different tabs. You

can locate a tab in any column. You can even change tab sequences from one line to another.

The RX-80 does it differently.

RX-80 Variations

The RX-80 (not the RX-100) has its own unique way of setting tabs. It is not as straightforward as the ⟨ESC⟩"D" tab scheme, but with just a touch of ingenuity you can tab over to any position you want.

Control over the RX-80 tabs is achieved through a combination of fixed-interval tabbing and a special spacing command. The fixed-interval tabs are simply a variation on the default tabs. The default tabulates in increments of 8. You can use ⟨ESC⟩"e0"(n) to change the increment from 8 to some other number. The sequence ⟨ESC⟩"e0"(20), for example, would set tabs at positions 20, 40, 60, 80, etc.

There are limits to the values you can use for *n*, but they are a function of the current print pitch. You can go from 0 to 21 in Pica, 0 to 25 in Elite, and 0 to 36 in Compressed. But watch out for this one. Once the tabs are set, they do not change when you change print pitch, similar to the margins and the ⟨ESC⟩"D" tabs.

Let's see what happens to our example in Figure 9-6 when we change the default tab from 8 to 10 and change the bottom line to Compressed pitch.

Remember, the new tabs are 10, 20, and 30, and the space in front of each number is compressed, just like the characters. Thus, changing the

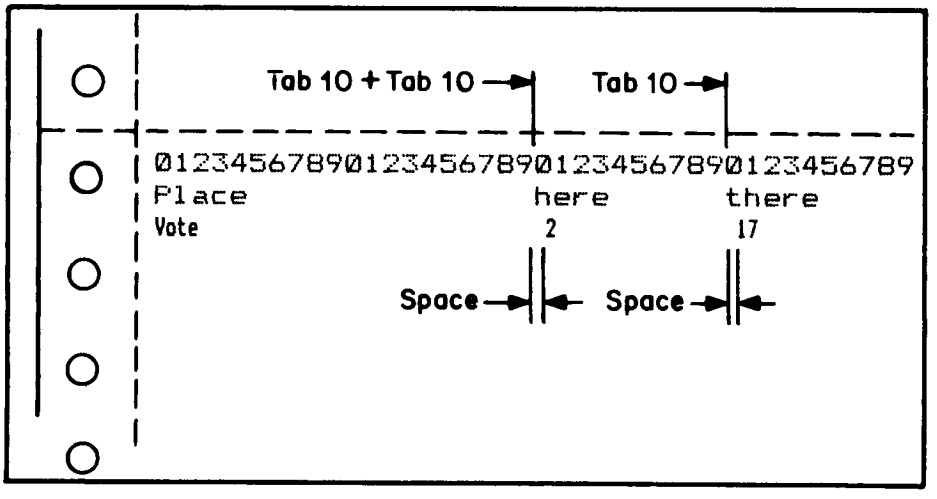


Figure 9-8 RX regulated tabs.

pitch has no effect on tab locations. They stick to their home positions on the page.

Clearly, setting a tab increment is not as powerful as the ⟨ESC⟩"D" command used on the other printers. But the RX has a unique way of handling irregular horizontal tabs. The code is ⟨ESC⟩"f0"(n), and it is a versatile one, indeed. It tells the print head to jump *n* spaces to the right of its current position.

Let's say the print head is at the left margin with the default tabs intact and you want to move it to column 12. One way to get there is with a code 9 to get to column 8; then ⟨ESC⟩"f0"(4) gets you all the way to 12. Or . . .

If the tab increment is set to 10 (⟨ESC⟩"e0"(10)), then code 9 would take you to column 10, and you would need an ⟨ESC⟩"f0"(2) to go to column 12. Or . . .

You can tab directly to column 12 with ⟨ESC⟩"f0"(12).

⟨ESC⟩"f0"(n) can be used to move as many as 127 spaces. You must be careful, however, to be sure you know its starting location. See if you can follow this example. With the default tabs intact, if you start with a code 9 followed by ⟨ESC⟩"f0"(2) and print "TEN", where would ⟨ESC⟩"f0"(7) put you? The "TEN", which starts in column 10, puts the print head in column 13, and a 7-space tab moves it to column 20.

Changing the initial tab increment to 10 (⟨ESC⟩"e0"(10)) in Figure 9-9 would move everything 2 columns to the right.

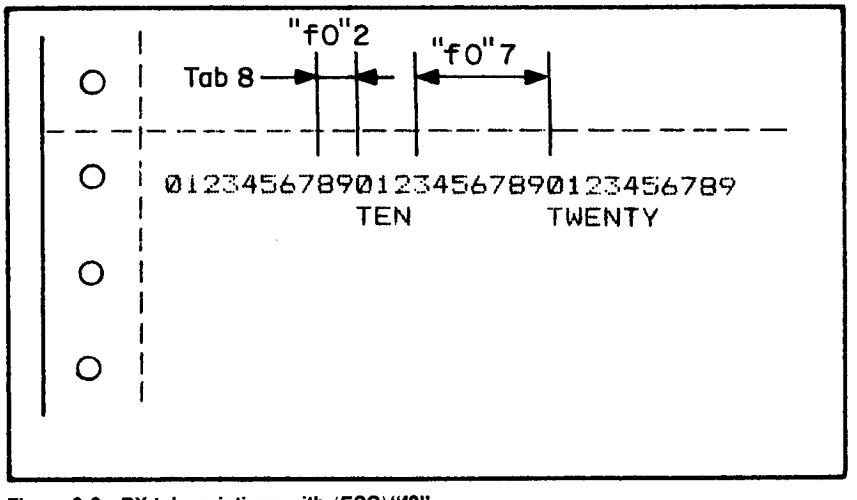


Figure 9-9 RX tab variations with ⟨ESC⟩"f0".

We have used simple examples to demonstrate the various features of horizontal tabbing and have shown that you can locate tab stops at any

point on a line. The ⟨ESC⟩"D" tab scheme is simpler and more direct than the RX-80 plan, but both are completely versatile and usable with a little practice.

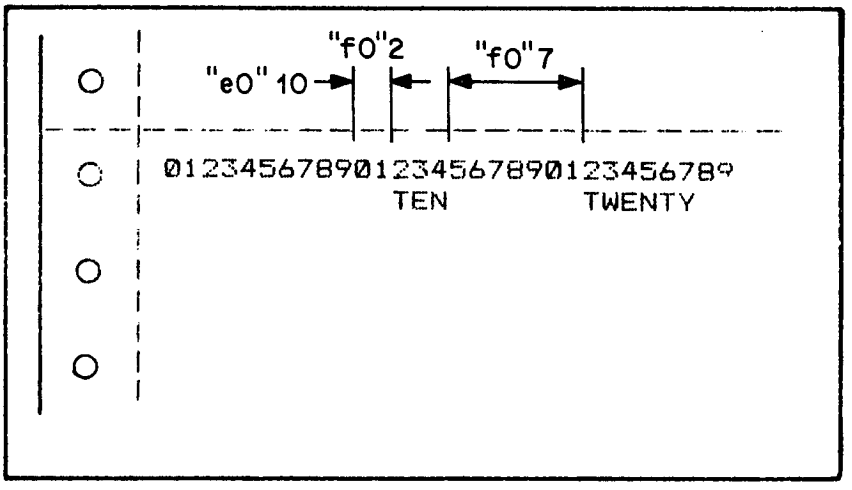


Figure 9-10 RX regulated and variable tabs combined.

Relative Positioning

The LQ-1500 has two additional ways to get just the right horizontal positioning. The first one, ⟨ESC⟩(92)(n_1)(n_2), moves the print head n dots in either direction from its current position. The maximum number of dots *(n)* is derived from n_1 and n_2 by $n = n_2 \times 256 + n_1$.

This command moves the print head with the accuracy of the current print mode: 1/120 inch for Draft, 1/180 inch for NLQ, and 1/360 inch for Proportional. Given that the wide LQ carriage leaves room for 136 Pica characters, these print styles give a total dot count per line of 1632 for Draft, 2448 for NLQ, and 4896 for Proportional. Accordingly, the limits on n are

$$-4894 \leq n \leq +4895$$

To reach the maximum number 4895, n_2 must be 19 and n_1 must be 31, since $19 \times 256 + 31 = 4895$. Thus n_2 does not need to be larger than 19. To move the print head left of the current position, you select a number between 0 and −4894. For this purpose, the LQ looks to the seventh bit of n_2. If this bit is 0, n is positive; if this bit is 1, n is negative. Since the place value of this bit is 64, the bottom line is that you simply add 64 to n_2 to make the number n negative and therefore move the print head to the left.

Let's see how to calculate n_1 and n_2 for 400 dots. We can see that

400 = 1 × 256 + 144, so n_2 = 1 and n_1 = 144. Figure 9-11 shows how the sequence ⟨ESC⟩(92)(144)(1) looks with the three different print quality modes.

```
⟨ESC⟩"\"(144)(1) MOVES THE PRINTHEAD:

      ⟩                                    400 DRAFT DOTS RIGHT
      ⟩                          400 NLQ DOTS RIGHT
      ⟩              400 PROPORTIONAL DOTS RIGHT
```

Figure 9-11 Relative dot positioning right.

To move the print head to the left of the mark, add 64 to n_2.

Note that Figure 9-12 is a simulation because the ⟨ESC⟩(92) command was not fully implemented on our test unit by press time.

```
⟨ESC⟩"\"(144)(65) MOVES THE PRINTHEAD:

 400 DRAFT DOTS LEFT                    ⟨
             400 NLQ DOTS LEFT          ⟨
                          400 PROPORTIONAL DOTS LEFT
```

Figure 9-12 Relative dot positioning left.

Absolute Positioning

Another horizontal positioning command available on the LQ positions dots directly to any of 816 locations on the print line. The format is ⟨ESC⟩"$"($n_1$)($n_2$), where $n = 256 \times n_2 + n_1$ determines the number of dots to the right of the left margin. Dot spacing is ⅙₀ inch regardless of print pitch. The print head can move left and right depending on the order in which you send the commands. Figure 9-13 shows the results of selecting three positions in the order 100, 50, 150.

```
DOT POSITIONING WITH ⟨ESC⟩"$" TO POSITIONS 100, 50, THEN 150:

PICA:       SECOND   FIRST    THIRD
COMPRESSED: SECOND   FIRST    THIRD
```

Figure 9-13 Absolute dot positioning.

Now let's look at a unique feature that can improve the quality of your printouts.

Unidirectional Printing

Bidirectional printing is one of the features that contribute to the high-speed printing rates of the Epson printers. As the print head moves back and forth across the paper, it prints in both directions, providing high-quality printouts as well as high speed. However, there are situations in which vertical columns, printed in Elite mode or Compressed mode, get slightly misaligned. For most applications, the misalignment is not only acceptable, it isn't even detectable. However, some high-quality graphics displays may require better alignment.

Epson printers, starting with Graftrax Plus, have a Unidirectional mode to effect more precise registration in such cases. The difference is very subtle, especially since Epson keeps improving its printers, so we will set up a unique condition to emphasize any misalignment. Figure 9-14 prints 10 repetitions of a special character (decimal 134) from the RX-80's special character set.

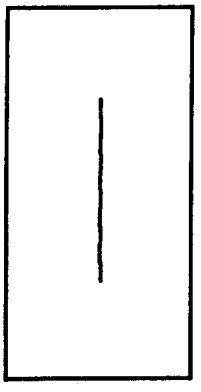


Figure 9-14 Bidirectional misalignment.

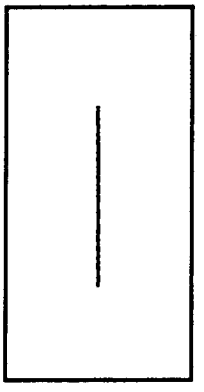


Figure 9-15 Undirectional alignment.

Not bad, but when you look closely, you can see that the right-to-left pass of the print head offsets the character very slightly from the left-to-right pass. To see the difference unidirectional printing makes, use the code ⟨ESC⟩"U1" to turn it on and ⟨ESC⟩"U0" to turn it off.

Another way to get the same result is with the command ⟨ESC⟩"<", which was introduced with the Graftrax 80 ROMs. It activates unidirectional printing for a single line and then reverts to bidirectional printing.

Vertical Tabs

In many respects, vertical tabbing on Epson printers parallels the processes for horizontal tabbing. Similar to the decimal 9 trigger for horizon-

tal tabs, vertical tabs are activated by decimal 11, which is labeled as VT in the ASCII table.

Standard Stops

One way to find out what the defaults are is to initiate a little test with a series of decimal 11 codes. Figure 9-16 shows that the default simply skips 1 line, so we could use a code 11 with each line to print out double spacing.

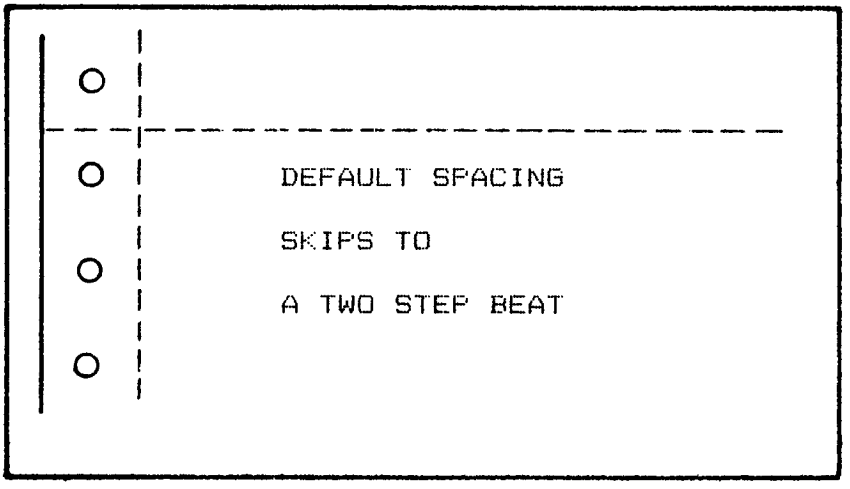


Figure 9-16 Default vertical spacing: 2 lines.

If that doesn't seem very exciting or suitable for your application, you can slip into the do-it-yourself mode and name your own stops. You can, that is, if you have one of the following printers: MX-80, MX-100, Graftrax 80, FX Series, RX-100, or LQ-1500. With one of these printers, ⟨ESC⟩"B"(n) tells the printer to get ready for some plain or fancy vertical tab setting, and *n* represents the line number of the first tab stop. You can append from 1 to 16 vertical tab stops to the ⟨ESC⟩"B" sequence. Then you terminate the tab-setting process by entering a code number that is less than the last tab stop, 0, or 255, depending on your printer.

Figure 9-17 is a form that might be sent out by an educational institution to be filled in by a potential candidate for graduate student status. The form uses the tab code sequence ⟨ESC⟩"B"(6)(8)(11)(17)(20)(28)(0). Of course, each vertical tab is activated by a decimal code 11.

Just as with horizontal tabs, your vertical tabs will remain in effect until you replace them or turn off the printer. We should point out also that the *n* numbers trailing ⟨ESC⟩"B" are counted in numbers of lines. Thus

each tab location is a multiple of the current line spacing. On the current printers, subsequent changes in line spacing do not affect the tab positions.

```
Professional Institute of Lifelong Learning

CANDIDATE DECLARATION

Name:
Address:

Telephone:


Degree Status:


Statement of Purpose:




Resume:
```

Figure 9-17 Form with user-defined vertical tabs.

Normal line spacing gives 66 lines to an 11-inch page. These are numbered as tab stops 0 through 65. However, if you were using 7-dot line spacing, you could count 113 lines to an 11-inch form. For most applications, those numbers would be your maximum tab settings. The largest permissible tab setting is 254, so you can range pretty far if you have that requirement.

Vertical Channels

For users who require repeated use of several different sets of vertical tab stops, some of the printers (including FX, RX-100, and LQ) can store up to eight unique series or channels of tab settings. This feature can be invaluable when you are filling out preprinted forms that use different vertical spacings for each category or want to create a multipage report with different vertical tab settings on each page.

The format you should use to establish a vertical tab channel is ⟨ESC⟩"b"(N)(n_1)...(n_{16})(0). *N* is the reference number, from 0 to 7, where this channel or set of tabs will be stored. When your tab channels are stored, you recall, or load, any particular set with ⟨ESC⟩"/"(n), where *n* selects channels 0 through 7. Channel 0 is the same as the ⟨ESC⟩"B" setting.

As with horizontal tabs, the RX-80 has its own unique way of tabbing.

The RX-80 Variation

Those who read the first parts of this chapter can probably make a fair guess at the way the RX-80 handles vertical tabs. Sure enough, the RX-80 does it with regulated vertical tabs and a vertical spacing command, just as it handles horizontal tabbing. The default is good old skip a line, like the other printers, and tabbing is activated by decimal code 11.

The code for regulated vertical tabs is the same ⟨ESC⟩"e" that is used for the Horizontal mode except that it is followed by a 1 instead of a 0.

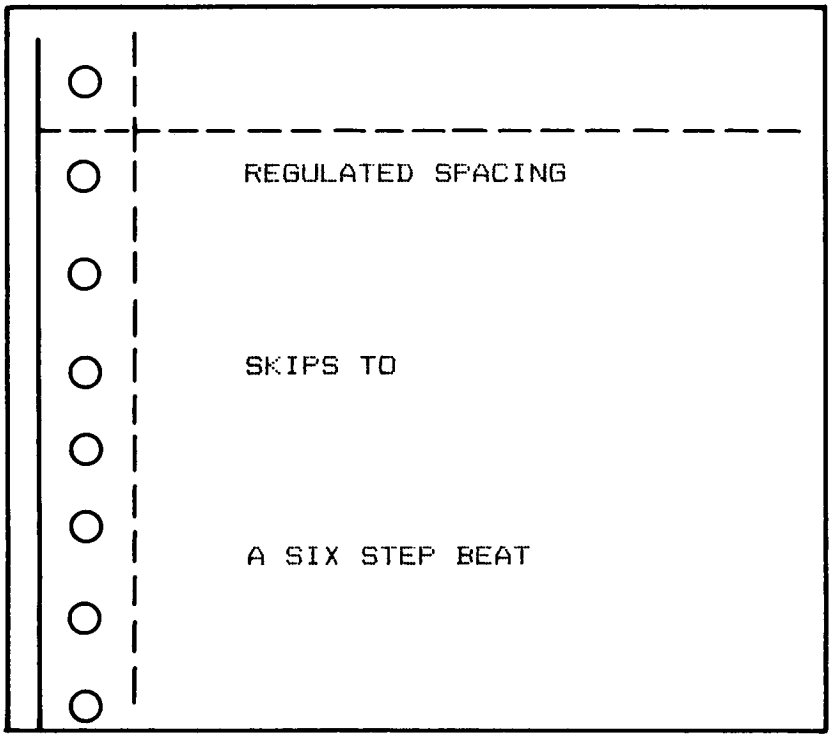


Figure 9-18 RX regulated vertical tabs change the default.

So let's see how well it works. Figure 9-16 prints out the same on the RX using default tabs. Then we can change the wording a bit and add ⟨ESC⟩"e1"(6) to get the result shown in Figure 9-18.

As you might suspect, the lines on your page are numbered from 0 to 65, so the first line of Figure 9-18 is at 0, the next is at 6, and the last is at 12, exactly 1 inch apart. And that is very close to the maximum allowable.

The maximum vertical tab value depends on the current line spacing, and it must be expressed as a whole number. For spacing of $n/216$ inch, the maximum value is 255 divided by n. For spacing of $n/72$, the maximum value is $85/n$.

Our sample figure uses the default 12-dot spacing, or $^{12}/_{72}$ inch, so the calculation is $^{85}/_{12}$ = 7. 083333, which rounds to the integer 7. This means you can set your regulated tab increment to a maximum value of 7, which allows you 7 lines of $^{12}/_{72}$ or 0.166667 inch each. That gives you a maximum tab spacing of 1.166667 inches. If you work out the tab increment for any other line spacing, it comes to approximately the same, varying only for rounding differences.

Remember that vertical tab stops are fixed at absolute positions on the

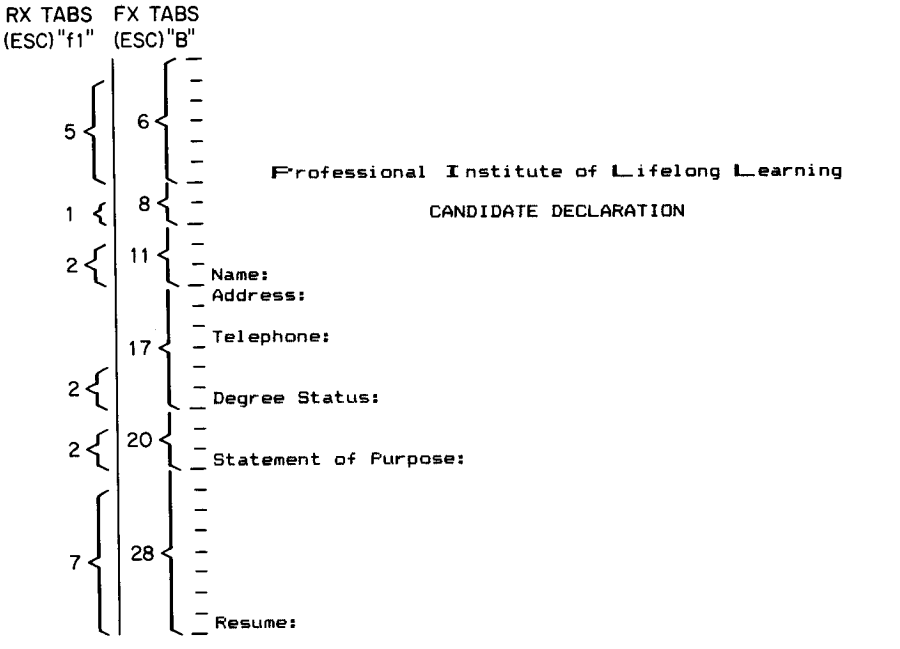


Figure 9-19 Vertical tabs: FX versus RX.

page. Subsequent changes in line spacing do not change tab stop positions.

The RX printer also has a vertical spacing function for fine-tuning of vertical tabs: ⟨ESC⟩"f1"(n). The *n* specifies the number of line feeds, from 0 to 127. Note that these are line feeds without carriage returns, and so the print head stays in the current horizontal position as the paper feeds. Note also that ⟨ESC⟩"f", just as in horizontal tabbing, starts at the current position of the print head.

If you refer back to Figure 9-17, we used ⟨ESC⟩"B" to set tab stops at lines 6, 8, 11, 17, 20, and 28 and triggered the tab action for each step with code 11. We can get exactly the same result on the RX by removing the ⟨ESC⟩"B" sequence and by replacing each code 11 with ⟨ESC⟩"f1" followed by the number that is appropriate for that position. You can examine Figure 9-19 to see how it all relates.

Summary

The print head on Epson printers can be controlled by setting left and right margins and by tab stops, both horizontal and vertical and regular or variable.

⟨ESC⟩"l"(n) (lower case "el") sets the left margin at *n*. The available range for *n* varies with the carriage width and pitch.

⟨ESC⟩"Q"(n) sets the right margin at *n*. The available range for *n* varies with the carriage width and pitch.

Decimal 9 (or 137) activates horizontal tabbing.

⟨ESC⟩"D"(n_1).....(n_{32})(0) sets variable tab stops on most Epson printers.

⟨ESC⟩"e0"(n) replaces the default with a new horizontal regulated tab increment on the RX-80 only. Its ranges are Pica, 0 to 21; Elite, 0 to 25; and Compressed, 0 to 36.

⟨ESC⟩"f0"(n) activates a one-time-only horizontal movement *n* spaces to the right on the RX-80 printer.

⟨ESC⟩(92)(n_1)(n_2) moves the LQ-1500 print head left or right relative to its current position. The distance moved is determined by n_1 and n_2 in increments of the current print style.

⟨ESC⟩"$"($n_1$)($n_2$) positions the LQ-1500 print head anywhere on the current print line in increments of ⅙₀ inch regardless of the current print style.

⟨ESC⟩"U1" turns on continuous unidirectional printing.

⟨ESC⟩"U0" turns off continuous unidirectional printing.

⟨ESC⟩"<" turns on 1-line unidirectional printing.

Decimal 11 (or 139) activates vertical tabbing.

⟨ESC⟩"B"(n_1)...(n_{16})(0) sets variable vertical tabs on selected printers.

⟨ESC⟩"b"(N)(n_1)....(n_{16})(0) sets and stores a vertical tab channel on the FX, RX-100, and LQ printers.

⟨ESC⟩"/"(n) selects or loads one of the ⟨ESC⟩"b" vertical tab channels.

⟨ESC⟩"e1"(n) sets a regulated vertical tab increment on the RX-80.

⟨ESC⟩"f1"(n) performs *n* line feeds without carriage returns on the RX-80.

Chapter

10

Miscellaneous Features

If all those print-head positioning possibilities left you a bit dazed, be not dismayed. This chapter will be a breeze. This is where we pause for breath and gather up a few loose ends.

Hear Those Bells Ringing

In Chapter 8, we dealt with the paper-out sensor that sounds a beeper when the printer nears the bottom of the page on single-sheet printing. That beeper is a feature of all Epson printers except the MX-70. You can use it to give audible notice of many kinds of events. For example, it can let you know the printer has come to the end of a long document, or to the end of a page in single-sheet printing. With a little ingenuity, it can be useful for many applications. In fact, since most computers have real-time clocks, it can be used as a time-is-up alarm.

Ringing the bell takes two conditions. First, it is controlled by a DIP switch that must be in the default position for the alarm to sound. On the MX-100, it is a fixed feature that can't be turned off by a DIP switch. Second, it is activated by decimal code (7).

Code (7) works for all Epson printers, but the DIP switch arrangement and ON-OFF positions vary from printer to printer. Switch settings and defaults will be covered in Chapter 11. Another variable is elapsed time, which varies from a 0.1-second beep on some printers to a 3-second buzz on others.

Changing Print Speed

When you made the acquaintance of Emphasized mode in Chapter 6, you learned that it has to run at half speed. Epson made that half-speed capa-

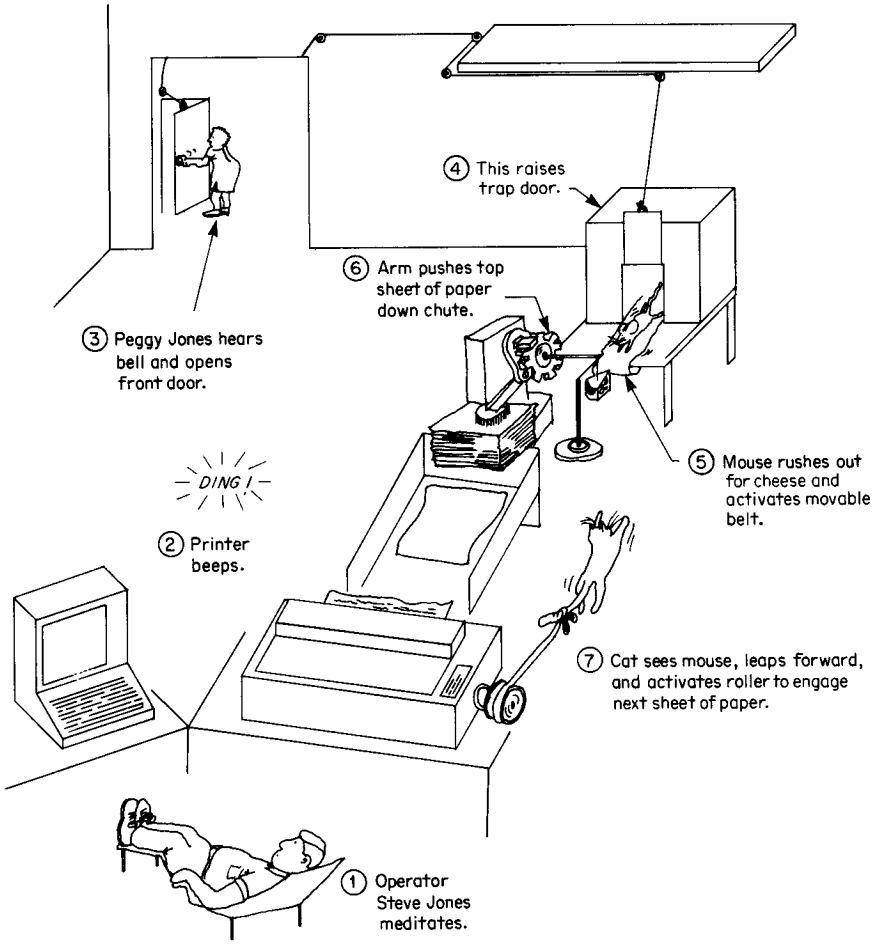


Figure 10-1 A beeper application.

bility available as an option when it introduced the FX-80 printer. You can call for it with ⟨ESC⟩"s"(n). The (n) toggles it on with (1) and off with (0).

On the FX printers, then, you set the speed at 80 CPS with ⟨ESC⟩"s"(1) and back to 160 CPS with ⟨ESC⟩"s"(0). The RX and LQ printers can slow to half speed as well.

Printing at half speed doesn't slow throughput by 50 percent. Line feeds and carriage returns operate at normal speeds so that it only takes about a third longer to print a document at half speed. The most notice-

able difference is in the noise pitch; higher speed gives off a higher-frequency sound, so you may find half speed more acceptable for late night sessions. You will have to decide for yourself whether you prefer zzziipp or zzzuuuuupppp.

The 2K Buffer

FX Series printers introduced a print buffer capability that is controlled by DIP switch 1-4. Epson has built in a 2K RAM memory, which is about enough capacity to accommodate a one-page business letter. There are two ways to utilize this feature, so it is worth some time for experimenting by the user.

With the DIP switch in the ON position, the RAM is used as a buffer. If you are printing less than 2K of text, the buffer loads immediately, freeing your computer for the next task. This means that *you* don't have to wait for the printer. When you are rolling, you don't have to lose your momentum.

With the DIP switch in the OFF position, the RAM can be used to store user-defined characters. This can greatly expand the utility of your system. Chapter 13 explains how it's done.

The LQ-1500 has the same 2K buffer ability except that it does not exclude user-defined characters. The buffer *must* be active in order for the repeat function (⟨ESC⟩"V") to work. Switch 1-1 controls this function on the LQ.

Harnessing the High-Order Bit

Although we are discussing an 8-bit printer line, some computers are capable of sending only 7 bits to the printer, probably reminiscent of the original ASCII table that topped off at 128 codes. (Of course you know, but we'll just remind you that $2^7 = 128$ whereas $2^8 = 256$.) This just means that these computers use an interface of 7 channels instead of 8. And that means that they cannot access the high order-section of the ASCII table where the Epson printers typically store italics and other interesting special symbols.

However, all the Epson printers since Graftrax Plus have software codes that control the high-order (eighth) bit. When this bit is turned on, the printer adds 128 to every code received from the computer. There are three instructions that enable a 7-bit computer to control its high-order bit:

⟨ESC⟩"⟩" turns the high-order bit on. This is the one that does it. Plus 128 every time.

⟨ESC⟩"=" turns it off. When your printer says off, it means leave it *off!* Send it a code higher than 128, and the printer subtracts 128 every time.

⟨ESC⟩"#" returns it to normal. Good old steady Epson. It just processes whatever you send it, just the way you send it.

Printer Select

In normal operation, the printer responds to any instruction it receives. On the FX and LQ printers, with DIP switches 2-1 and 2-8 turned off, the printers can be activated or deactivated by software codes. Decimal code 19 (DC3) deactivates the printer, and code 17 (DC1) activates it again. Some of the other printers have a similar DIP switch but do not recognize codes 17 and 19.

Master Reset

Ever since it was initiated on Graftrax Plus, all Epson printers provide a neat code that is particularly helpful in controlling print modes. Regardless of what instruction codes you have sent to the printer, the Master Reset code, ⟨ESC⟩"@", returns everything to the default condition. It is good practice to use ⟨ESC⟩"@" at the end of each file to avoid picking up stray print modes left over from the previous exercise.

The Master Reset code also deletes the contents of the print buffer, so don't use it at the end of a text line unless you intend to delete that line. Just in case you underestimate the power of this command, here is a list of what it does on the LQ printer:

1. Returns the print head to the left margin.
2. Goes online.
3. Clears the print buffer.
4. Reads the DIP switch settings.
5. Clears download characters.
6. Sets line-feed spacing to ⅛ inch.
7. Resets vertical and horizontal tabs to the defaults.
8. Enters normal print mode.
9. One-line buffer is set to 136 characters for Pica and 233 for Compressed.
10. Sets vertical tab channel number to 0.
11. Sets the top of form.

And that's a mouthful.

Repeat Function

The LQ printer has a repeat function available with ⟨ESC⟩"V". The format is ⟨ESC⟩"V"(N)(n_1) ... (n_m)⟨ESC⟩"V"(0) where N is the number of repetitions (up to 255), (n_1) ... (n_m) is the data to be repeated, and ⟨ESC⟩"V"(0) marks the end of the repeat loop. This function can handle a string of characters up to 2K, and the string data can even contain other repeat strings.

The repeat function is not intended to replace the looping ability of languages like BASIC or Pascal. In fact, this function is limited to strictly repeating strings; no variation is allowed. The real power of the repeat function is in situations where the ability of your applications program is limited. For example, some word processing programs allow the user to embed limited amounts of graphics data in the text. Using the repeat function, you can get a lot more graphics for very little data.

For example, Figure 10-2 shows a graphics symbol (see Chapter 12) and the word "REPEAT."

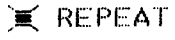


Figure 10-2 Symbol and text.

Using only enough data for one copy of each along with three nested repeats, we created Figure 10-3.

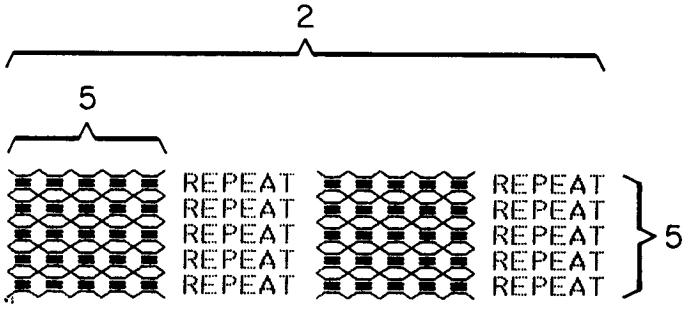


Figure 10-3 Nested repeats.

Summary

ASCII 7 rings an audible alarm or bell. On most printers, the bell can be deactivated with a DIP switch.

The RX, FX, and LQ printers can run at half speed for quieter operation with ⟨ESC⟩"s"(1). ⟨ESC⟩"s"(0) resets the print speed to normal.

The FX printer has a 2K buffer to speed up printing. It cannot be active at the same time as user-defined characters. The LQ also has a 2K input buffer. It is totally independent of user-defined characters, but it *must* be active in order to use the repeat function (⟨ESC⟩"V").

⟨ESC⟩"⟩" turns the high-order bit on.

⟨ESC⟩"=" fixes the high-order bit off.

⟨ESC⟩"#" returns the high-order bit to normal.

Most Epson printers can be set with switches to ignore all data from the computer. The FX and LQ can be controlled with codes 17 and 19.

The current Epson printers have a Master Reset code (⟨ESC⟩"@") that clears out the buffer and resets all modes to their default values.

The LQ printers can repeat strings of characters up to 255 times with ⟨ESC⟩"V".

Chapter

11

Setting Defaults with Switches

How about a custom-styled printer? Just your style! That's right, do-it-yourself customizing. All the Epson printers except the MX-70 have switches that enable you to customize your printer for different applications. Before turning on the printer, you select your own default settings. For example, you can select Compressed pitch for spreadsheet printouts or Emphasized print for correspondence.

It is important to understand that switch settings only affect the start-up or default condition of the printer. In fact, the switches have no effect if they are changed when the printer is on. The only time the printer recognizes the switch settings is when it is first turned on. So set all switches with the printer off.

Another important concept is that switches don't override software codes. Regardless of the switch settings, you can still change print modes by sending the proper codes to the printer.

In the FX and LQ printers, the switches are easily accessible. For the other printers, you must either remove the cover of the entire printer or change the switches through an access hatch at the back of the lid.

The functions set by these switches vary from printer to printer. Even changing the ROM chips in a printer may change the functions associated with each switch. Switch assignments and factory default settings are listed in Figure 11-1.

Whew, what a lot of switches! And we look at every one of them and explain every feature they control in this chapter. That's not as bad as it sounds. You can concentrate on the printer you own or would like to own.

	MX-80		MX-100		Graftrax 80		Graftrax Plus		FX-80/FX-100		RX-80/RX-80 F/T		LQ-1500*	
1-8	*Printer on*	Remote select	*Printer on*	Remote select	*Printer on*	Remote select	*Printer on*	Remote select	International character set		International character set		*Printer on*	Remote select
1-7	Katakana	*Block graphics*	International character set		Slashed zero	*Regular zero*	Slashed zero	*Regular zero*	International character set		International character set		NLQ	*draft*
1-6	*Bell on*	Bell off	Paper sensor off	*Paper sensor on*	*Bell on*	Bell off	*Bell on*	Bell off	International character set		International character set		Bell off	*Bell on*
1-5	*Delete inactive*	Delete active	Unused	*Unused*	Emphasized	*Normal*	Emphasized	*Normal*	Emphasized	*Normal*	Paper sensor off	*Paper sensor on*	Skip over perf.	*Normal*
1-4	Cancel inactive	*Cancel active*	Print quality with SW 1-3		Italic	*Normal*	Italic	*Normal*	2K buffer	*User character*	12-inch form	*11-inch form*	12-inch form	*11-inch form*
1-3	*NO LF*	Auto LF	Print quality with SW 1-4		*No LF*	Auto LF	Paper sensor off	*Paper sensor on*	Paper sensor off	*Paper sensor on*	Alarm mute	*Alarm sounds*	International character set	
1-2	*NO LF*	Auto LF	12-inch form	*11-inch* form	*No LF*	Auto LF	Unused	*Unused*	Slashed zero	*Normal zero*	Graphic chars	*Control codes*	International character set	
1-1	*Unused*	Unused	8 lines/ inch	*6 lines/* inch	Compressed	*Normal*	Compressed	*Normal*	Compressed	*Normal*	Compressed	*Normal*	International character set	
2-4	TRS-80 mode	*Normal*	*Normal*	Skip over perf.	TRS-80 mode	*Normal*	Skip over perf.	*Normal*	CR + LF	*CR only*	Skip over perf.	*Normal*	Always off	
2-3	*CR + LF*	CR only	CR + LF	*CR only*	CR + LF	*CR only*	CR + LF	*CR only*	Skip over perf.	*Normal*	CR + LF	*CR only*	CR + LF	*CR only*
2-2	International characters		International character set		Unused	*Unused*	Unused	*Unused*	*Bell on*	Bell off	*Printer on*	Remote select	Paper sensor off	*Paper sensor on*
2-1	International characters		International character set		Unused	*Unused*	Unused	*Unused*	*Printer on*	Remote select	Slashed zero	*Normal zero*	No buffer	*2K buffer*

*LQ-1500 Manual labels 8 switch DIP as switch 2, and 4 switch DIP as switch 1.

Notes:

1. Default settings are shown in italics.
2. On the MX-100, switches 1-3 and 1-4 have the following functions:

Switch 1-3	Switch 1-4	Print Quality
ON	ON	Emphasized
OFF	ON	Compressed
ON	OFF	12 pitch
OFF	OFF	Normal

Figure 11-1 The complete directory of DIP switches.

We group features into three basic categories:

1. Features common to several printers
2. Features unique to a single printer or printer series
3. Features that are selected by a combination of switches

Just refer to Figure 11-1 for the features available on your printer.

Features Commonly Controlled by Switches

Select Printer

This switch is found on all printers. It sets the printer in an active state or inactive state on power up. It is intended for external control of the printer. For example, you may have several peripheral devices linked to a central processor, and you want only one active at a given time. Although all the printers have this switch, only the FX and LQ printers recognize the software codes. These printers can be activated by 17 decimal and deactivated by 19 decimal.

Zero Font

This switch is found on all printers except original MX Series and LQ. It gives you a selection of either a normal zero or a slashed zero. This function cannot be controlled by software codes on any printer.

Bell

The bell is found on all printers. In one position, the internal bell sounds when the printer receives a 7 decimal or when an error condition, such as paper out, occurs. In the other position, the bell does not sound except for internal errors.

Emphasized/Normal

This switch is found on all printers except original MX-80, RX-80, and LQ. It can be used to establish Emphasized print as the default mode on start-up instead of normal print. ⟨ESC⟩"E" and ⟨ESC⟩"F" still activate and deactivate Emphasized print.

Italics/Normal

This switch is found on Graftrax Plus and Graftrax 80. With this switch on, the italics type font becomes the default on start-up. Still, it can be activated and deactivated with ⟨ESC⟩"4" and ⟨ESC⟩"5".

Compressed/Normal

This switch is found on all printers except original MX-80 and LQ. It selects either Compressed pitch (17.16 CPI) or Pica pitch (10 CPI) on printer start-up. Software codes can be used to override the switch setting.

Paper-Out Sensor

This switch is found on all printers except original MX-80 and Graftrax 80. In one position, it deactivates the paper-out sensor so that you can print on the lower portion of single sheets. The printer stays online.

In the other position, printing stops when the sensor no longer senses the paper. If the alarm bell is active, it will sound when paper is out.

Auto Line Feed

This is found on all printers. In one position, the printer does an automatic line feed with every carriage return. In the other position, no line feed is added by the printer. This enables you to adjust your printer to accommodate the computer. Some computers send a line feed with each carriage return; others do not.

Skip Over Perforation

This is found on all printers except original MX-80 and Graftrax 80. In one position, a 1-inch paper feed is performed at the bottom of every form. Make sure the top of form is properly set at start-up. This automatic skip feature is used to avoid the paper perforation for program listings and other programs that may not provide printer formatting.

In the other position, the printer does not skip over the perforation.

The 12-Inch Form and 11-Inch Form

These are found on the RX-80, MX-100, and LQ. Users can select as the default form length either 11 inches (American) or 12 inches (European).

TRS-80 Mode/Normal

This is found on the original MX-80 and Graftrax 80. Switch 2-4 enables TRS-80 users to access the graphics characters on the printer with the same numbers used for the video display. That is, it shifts the range from 160 to 223 down to 128 to 191. When this TRS-80 mode is active, all other printer features are severely limited.

The 2K Buffer/User-Defined Characters

This switch is found on the FX and LQ. It lets you determine how to use the 2K RAM area inside the printer. It can be used as a buffer area to hold up to 2048 characters of text, just enough for a short letter of memo. This way, you can continue using your word processing program while the text is being printed.

The other option depends on the printer. On the FX, the 2K buffer can be used for user-defined characters. You can define a completely different set of characters or symbols in place of the standard ROM characters. On the LQ, user-defined characters can be employed regardless of the status of the 2K input buffer, but the buffer must be active in order for the repeat command (⟨ESC⟩"V") to work. Since a printer buffer can sometimes be a mixed blessing, the switch is still available on the LQ, so that you can turn the buffer on or off.

Unique Features Controlled by Switches

Katakana/TRS-80 Block Graphics

These are found on the original MX-80 only. Switch 1-7 determines which special character set is active for ASCII codes 160 to 223. ON gives a set of Japanese Katakana characters, and OFF gives the set of standard TRS-80 screen graphics blocks used on Models I, III, and 4. Note that switch 2-4 drops these sets down to the range 128 to 191, making the characters correspond directly with the actual ASCII values used internally on the TRS-80 computers.

Delete Code

This is found on the original MX-80 only. It allows the printer to ignore or accept the Delete code (127 and 255) from the computer.

Cancel Code

This is found on the original MX-80 only. It allows the printer to ignore or accept the Cancel code (24 and 152) from the computer. Delete and Cancel will be explained in Chapter 18.

Special Characters/Control Codes

This is found on the RX only. It allows RX users to print special graphics characters instead of control codes for ASCII numbers 128 to 159. See Chapter 5.

Line Spacing

This switch is found on the MX-100 only. It allows MX-100 users to change the line spacing from the normal 6 lines per inch to 8 lines per inch.

Special LF and CR Switches

These are found on the original MX-80 only. The original MX-80 has very precise control of the line feed. A line feed can be sent when the buffer is full, or when a CR (carriage return = 13 decimal) code is received. Switch 2-3 is the master switch. It works like the corresponding switch on most of the other Epson printers. When 2-3 is on, a line feed is done with each carriage return. If 2-3 is off, switches 1-3 and 1-2 control the action. Switch 1-3 can be set to either activate or deactivate the line feed when the buffer fills. Switch 1-2 can be set to either activate or deactivate the line feed when the printer receives a CR code.

Near Letter Quality/Draft

This switch is found on the LQ only. It selects between Draft characters (the default) and Near-Letter-Quality characters on the LQ printers.

Features Controlled by Several Switches in Combination

International Characters

These are found on all printers except Graftrax Plus and Graftrax 80. Some printers are able to reproduce characters from several foreign coun-

Country	Switch 1-6	Switch 1-7	Switch 1-8
USA	On	On	On
France	On	On	Off
Germany	On	Off	On
England	On	Off	Off
Denmark	Off	On	On
Sweden	Off	On	Off
Italy	Off	Off	On
Spain	Off	Off	Off

Source: David A. Kater, *FX Series Printer User's Manual,* Epson America Inc., 1984.

Figure 11-2 International switch settings: FX and RX. *(Courtesy of Epson America, Inc.)*

tries. The country can be selected by function codes, or the printer can be set to a specific country on start-up with a combination of several switches. The switch settings for the RX and FX-80 printers are shown in Figure 11-2. The FX-100 and LQ printers access the same eight countries with different switch numbers.

The switch settings for the MX-80 and MX-100 are shown in Figure 11-3. Note that switch 1-7 (not shown) on the MX-80 selects Japanese Kana characters in place of the default block graphics characters.

	U.S.A.	France	England	Germany
Switch 2-1	ON	ON	OFF	OFF
Switch 2-2	ON	OFF	OFF	ON

Figure 11-3 International switch settings: MX-80 and MX-100.

Summary

All Epson printers except the MX-70 have switches that allow the user to adjust several start-up conditions of the printer.

Features controlled by DIP switches in some or all Epson printers are as follows:

Select printer

Zero font

Bell

Emphasized/normal

Italics/normal

Compressed/normal

Paper-out sensor

Auto line feed

Skip over perforation

12-inch form/11-inch form

TRS-80 mode/normal

2K buffer/user-defined characters

Features that are controlled by switches and are unique to one model are as follows:

Katakana/TRS-80 block graphics (MX-80)

Delete code (MX-80)

Cancel code (MX-80)

Special characters/control codes (RX)

Line spacing (MX-100)

Line feed/carriage return control (MX-80)

Near Letter Quality/Draft (LQ-1500)

Features that are controlled by several switches in combination are as follows:

International characters—country selection

Chapter

12

Graphics Modes on the Epson Printers

You have just passed a major milestone in this book. You have discovered all the ways of Epson with text. If you like the way Epson handles words, you'll love the way it handles pictures. Epson graphics can add an entirely new dimension to your documents and computer creativity.

In this chapter, you will look at the graphics features of all Epson printers: the different dot densities and speeds available as well as some of the extra graphics modes available on FX and LQ printers.

Standard Graphics Mode

The natural place to start is with the standard Epson Graphics mode that was first introduced on the MX-70 printer. This mode enables you to print dots 1/60 inch apart horizontally and 1/72 inch apart vertically. It was not available on the original MX-80 but has been part of every subsequent Epson printer, even the 24-wire LQ model.

Standard Graphics mode accesses the top 8 pins of the 9-pin print head. The LQ acts like an 8-pin printer by using only one of its three 8-pin columns. By sending the correct numbers to the printer, you direct the print head to fire any of the 256 possible combinations of these 8 pins. You can print graphics patterns right in the middle of a text line or consecutive patterns extending the full width of the page. You are limited only by the width of your printer and the extent of your patience.

Once you master the intricacies of one-pass graphics, the next step is to combine consecutive rows of graphics to portray complex figures and symbols. The more complex your figures, the more planning this step will require. Detailed graphics should be laid out on a grid that is proportional

to the final printed design and marked off in rows 8 dots high. This design can then be converted to the language of graphics dot patterns.

Entering Graphics Mode

The printer boots up in Text mode. To enter Graphics mode, you send a special Escape sequence of four codes followed by the numbers corresponding to the patterns you want to print. It sounds complicated, but it's not too bad if you take it one step at a time.

First you send the Escape code (27) to let the printer know it is about to change modes. This is followed by "K", or decimal (75), signifying the standard Graphics mode. The next two numbers combine to tell the printer how many patterns you want to print according to the formula

$$N = n_1 + 256 \times n_2$$

As we have mentioned, standard Graphics mode gives you 60 horizontal dot patterns per inch. On 8-inch-wide paper, that amounts to 480 dot patterns per line. Since the largest single number that can traverse the 8-bit computer-printer interface is 255, it requires more than one number to select more than 255 dot patterns in a line. Thus Epson's Graphics mode requires two numbers, n_1 and n_2, to specify the number of dot patterns. The whole sequence starts out like this:

⟨ESC⟩"K"(n_1)(n_2) . . .

The second number (n_2) is multiplied by 256 and then added to the first number (n_1) to determine the total number of patterns. With that set up, in order to tell the printer to print 480 patterns, you would set $n_2 = 1$ and $n_1 = 224$:

⟨ESC⟩"K"(224)(1)

But that's not all. Entering Graphics mode is like signing a contract. Once you agree to send a certain number of codes, you better deliver, or the printer will retaliate according to the law. Only in this case, the printer makes the rules.

Sending Graphics Data

So how do you determine what numbers to send? That's next on the agenda. In Graphics mode, each pin corresponds to 1 bit of the computer word (a byte) that carries the information from the computer to the printer. Since the place value (pardon the brief lapse into binary math) of each bit is a power of 2, the pins on the print head respond to the assignments shown in Figure 12-1.

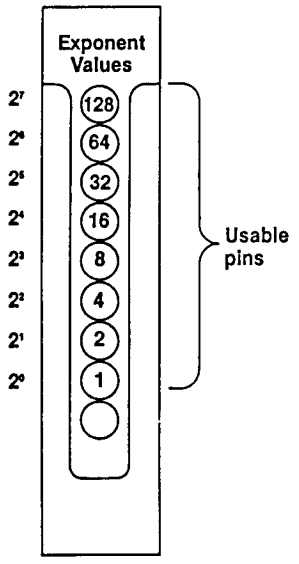


Figure 12-1 Print-head pin values. *(From David A. Kater,* FX Series Printer User's Manual, *Epson America, Inc., 1984. Reprinted with permission.)*

Once you accept this labeling system, the rest is easy. You just select the pins you want and add up their values to get the total number for that pattern. For example, to fire pins 1, 8, and 64, the computer must send the number 1 + 8 + 64, or 73, to the printer. To fire no pins, you send the number 0; to fire them all, you send 255 (1 + 2 + 4 + . . . + 128).

So, you know how to enter Graphics mode and how to determine the pin patterns. Now you have to put it all together. The printer expects everything in a continuous sequence: the four codes to enter the Graphics mode followed by the specified number of pin patterns.

```
ESC SEQUENCE: ESC "K" n1 n2 DATA.............
               27 75  27 0  0,0,255,126,133,133,137,181,165,
                             149,149,149,149,149,214,168,160,160,
                             160,160,160,160,160,160,160,160,64

RESULT: ☞
```

Figure 12-2 Graphics mode data sequence.

There, you have completed the full cycle for generating 1 row, 8 dots high. Once the printer receives all the data promised by n_1 and n_2, it returns to the normal text mode.

Creating multiple-line graphics is a matter of repeating the cycle for each 8-dot line, starting with entering Graphics mode. So, back to ⟨ESC⟩"K", and away we go. All the way to the first hurdle.

Line Feed and Graphics

Line feeds can be a problem with graphics until you understand one thing: The standard line-feed distance is set for single-spaced text. It allows room for the characters as well as space between lines of text. This total distance is ⅙ inch.

In Graphics mode, we usually don't want to leave gaps between rows of graphics. Epson enables the user to control line feeds so that you can produce continuous graphics images. And boy oh boy, does Epson give you line-feed control! With the ⟨ESC⟩"A" command, you can control line feeds in increments from $\frac{0}{72}$ inch to $\frac{85}{72}$ inch ($\frac{0}{60}$ to $\frac{85}{60}$ on the LQ). Not only that, the ⟨ESC⟩"J" command lets you control line feeds in increments of $\frac{1}{216}$ inch ($\frac{1}{180}$ inch on the LQ). Talk about fine control!

Figure 12-3 uses several consecutive lines of graphics to demonstrate the difference between ⅙ inch spacing and $\frac{8}{72}$ inch spacing on the FX-80.

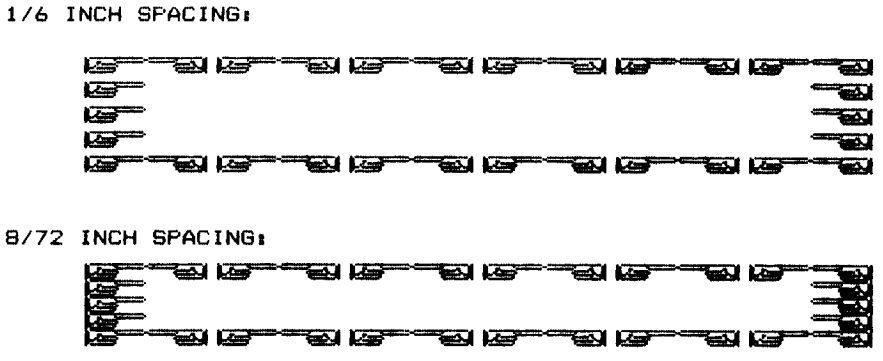


Figure 12-3 Line-feed control of graphics.

So, when you want to produce multiline graphics, you need to change from the default ⅙ inch spacing to a shorter line feed. And when you mix graphics and text, you may have to use several combinations of line feeds to make everything come out right. See Chapter 17 for examples using special line feeds for multiline graphics and for mixing graphics and text.

One last thought on line feeds. The FX-80 only (not the FX-100) has the ability to feed paper in reverse. This feature enables you to do things such as producing 2-column brochures and newsletters, *and* it may be a help in creating special graphics effects.

Changing Density

The standard Graphics mode (⟨ESC⟩"K") was introduced on the MX-70 and MX-100 printers. For the Graftrax ROMs, Epson added a double-density mode ⟨ESC⟩"L". This mode packed the pin patterns together horizontally to twice the standard density. Thus you could print 120 dots per inch horizontally instead of the usual 60. Notice that the vertical distance of the dots is established by the wire spacing in the print head and can't be varied. For 9-wire print heads, the distance is fixed at 72 dots per inch. For 24-wire print heads in any of the 8-wire modes, the vertical distance is 60 dots per inch.

With a horizontal density of 120 dots per inch, the dot columns actually overlap in Double-Density Graphics mode. See Figure 12-4. This double-density action is handy but slow. In this mode, the print head slows down to half speed so that it can fire consecutive pins in the same row. With the print head moving at its top speed, there simply isn't enough time for the pin to retract and then fire again.

For those who want the best of both worlds, Epson introduced ⟨ESC⟩"Y", a high-speed, double-density graphics mode. With this mode, the user can get both high speed and double density, with the only drawback being that the printer can't print two consecutive dots in the same row. See Figure 12-5.

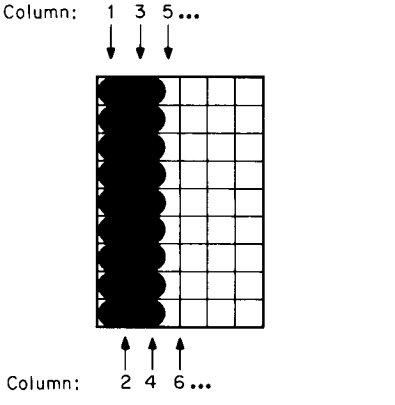


Figure 12-4 Double-Density dot pattern, half speed.

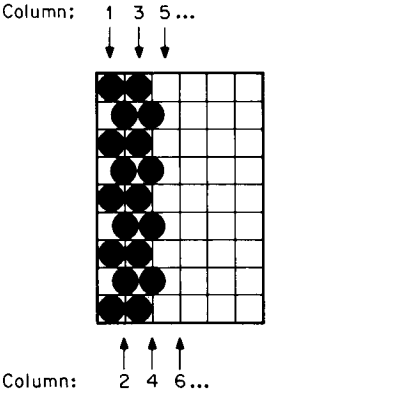


Figure 12-5 Double-Density dot pattern, high speed.

Current printers are also gifted with a quadruple-density graphics mode: ⟨ESC⟩"Z". It prints 240 dots per inch. Caramba! Again, in this mode the print head will not print 2 consecutive dots in the same row. But with that kind of density, who cares.

And there's more. The RX, FX, and LQ printers have a mode ⟨ESC⟩"*"(n) that lets you select one of seven (six on the RX and LQ) graphics modes. Figure 12-6 shows the different modes.

Mode	Density	Alternate Code	Description	Head Speed (In./Sec.)
0	Single	⟨ESC⟩"K"	60 dots per inch; 480 dots per 8-inch line	16
1	Low-speed double	⟨ESC⟩"L"	120 dots per inch; 960 dots per 8-inch line	8
2	High-speed double	⟨ESC⟩"Y"	Same density as Mode 1, but faster. The printer does not print consecutive dots in any one row.	16
3	Quadruple	⟨ESC⟩"Z"	240 dots per inch; 1920 dots per 8-inch line. The printer does not print consecutive dots in any one row.	8
4	QX-10		Matches the screen density of Epson's QX-10: 80 dots per inch; 640 dots per 8-inch line. (This makes it easy to do screen dumps.)	8
5	One-to-one (Plotter)		72 dots per inch; 576 dots per 8-inch line. Produces the same density horizontally as vertically, which makes circles look round.	12
6	CRT screens		90 dots per inch; 720 dots per 8-inch line. Matches the Corvus CONCEPT and the DEC screens.	8

Note: The RX and LQ cannot access mode 5.
Source: David A. Kater, *FX-80 Printer User's Manual,* Epson America, Inc., 1983.

Figure 12-6 Graphics density mode options. *(Courtesy of Epson America, Inc.)*

Modes 0, 1, 2, and 3 are the same as ⟨ESC⟩"K", ⟨ESC⟩"L", ⟨ESC⟩"Y", and ⟨ESC⟩"Z". Including them in the ⟨ESC⟩"*" command is a convenience that allows you to use a numeric variable to select graphics modes in your programs.

Modes 4 and 6 have horizontal densities of 80 dots per inch and 90 dots per inch, respectively. Mode 4 matches the screen density of Epson's QX-10 computer. Mode 6 matches the screen density of the Corvus CONCEPT and the DEC computers. This makes it possible to accurately duplicate the screens of these computers with screen dump programs. If your computer differs, try the different densities (by number!) to see which best matches your display.

Mode 5 is not implemented on the RX or the LQ. This mode spreads the dots horizontally 72 dots per inch to match the vertical distance between pins on the print head. Thus the dots have a 1 to 1 aspect ratio, which is good for plotting circles that look like circles instead of ovals. Think of it as a plotter mode.

Figure 12-7 uses the dot pattern from Figure 12-5 to compare the dot densities of the different modes.

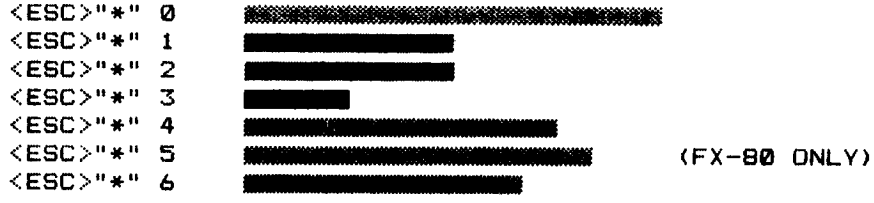


Figure 12-7 Graphics density mode comparison.

The LQ can also access four 24-wire print modes with the ⟨ESC⟩"*" command, as we shall see shortly.

Special Graphics Modes

The FX and LQ printers feature some additional graphics abilities.

The 9-Pin Graphics Mode

FX printers have a 9-pin graphics mode, ⟨ESC⟩"^", that lets you control all 9 pins on each sweep of the print head. One additional pin may not seem like a lot, but if you are doing data-intensive operations such as screen dumps, this is the fastest way to go.

Since each number (byte) we send to the printer can hold only 8 bits (1 for each pin), we have to send a second byte to complete each 9-dot pattern. The second byte controls the bottom pin of the print head. If the number is greater than 127 (128 to 255), the bottom pin is fired. If the number is less than 128 (0 to 127), the bottom pin is not fired.

The general format for 9-pin graphics mode goes something like this:

⟨ESC⟩"^"(d)(n_1)(n_2)

where $d = 0$ selects Single-Density mode (⟨ESC⟩"K"), and $d = 1$ selects Double-Density mode (⟨ESC⟩"L"). n_1 and n_2 determine the number of data bytes to follow in the usual way, but remember that each pattern requires 2 bytes in this mode. So, for example, if you want to print 50 patterns, you need to reserve 50 columns of graphics data. Then send 50 *pairs* of bytes to complete the contract.

Reassigning Graphics Modes

FX and LQ printers allow you to redefine one of the graphics modes—⟨ESC⟩"K", ⟨ESC⟩"L", ⟨ESC⟩"Y", or ⟨ESC⟩"Z"—as one of the seven graphics modes available through the ⟨ESC⟩"*" command. With this command, you can change the density of a program's output without having to change the codes in the program. Suppose you have a program that has ⟨ESC⟩"K"s scattered liberally throughout. With one simple command, you can have the ⟨ESC⟩"K" act like any of the other densities from ⟨ESC⟩"*"(1) to ⟨ESC⟩"*"(6) without the necessity of changing each ⟨ESC⟩"K".

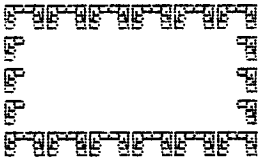
The format is

⟨ESC⟩"?""s"(n)

where *s* is the mode, *K*, *L*, *Y*, or *Z*, used in the program being redefined, and *n* is a number, 0 to 6, that selects the new density from the ⟨ESC⟩"*" command.

For example, the single command ⟨ESC⟩"?K"(3) converts all ⟨ESC⟩"K" entries in Figure 12-3 into quadruple-density graphics, as shown in Figure 12-8. Compare the two figures.

1/6 INCH SPACING:



8/72 INCH SPACING:

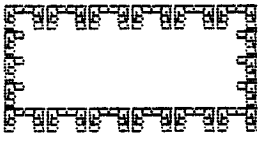


Figure 12-8 Quadruple-Density handwork.

The ⟨ESC⟩"?" command means that you can easily take advantage of the many new FX and LQ graphics modes with programs written for MX printers.

The 24-Wire Graphics!

The outstanding feature of the LQ printer is of course its 24-wire print head. Up to this point, we've only considered its ability to mimic the 9-wire print heads and their various print modes. But the LQ-1500 printer also has the ability to print a column of 24 dots in one pass of the print head. In these modes, the vertical distance between dots, center to center, is $\frac{1}{180}$ inch.

The Epson 24-wire graphics modes come in four different densities, as shown in Figure 12-9.

	m	Dots per Inch	Dots per Line
Normal density	32	60	816
Double density	33	120	1632
CRT graphics	38	90	1224
Triple density	39	180	2448

Figure 12-9 LX 24-wire densities.

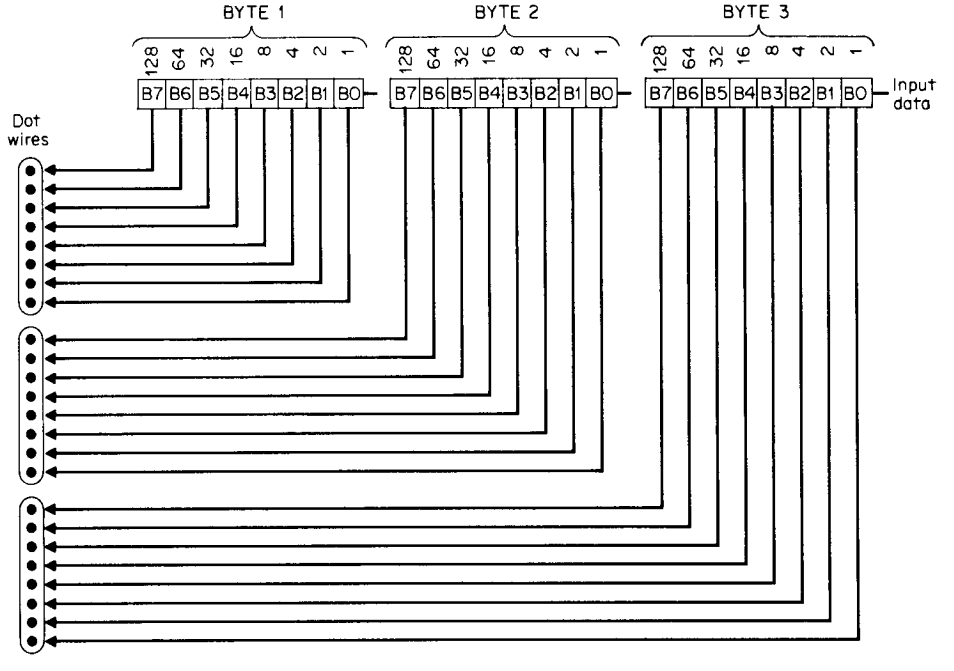


Figure 12-10 Map of 24-pin graphics. *(From* LQ-1500 Printer Programmer's Manual, *Epson America, Inc., 1984. Reprinted with permission.)*

m selects the desired mode from the sequence

⟨ESC⟩"*"(m)(n_1)(n_2) . . .

n_1 and n_2 combine to determine the number of graphics columns to be printed in the usual way:

$$N = n_1 + 256 \times n_2$$

But each column requires 3 bytes of data, with each byte controlling 8 pins of the print head. Figure 12-10 shows the relation between the 3 bytes and the 24 dots in each column.

Figure 12-11 illustrates how much more detail is possible with 24 wires at your disposal.

24-WIRE HAND:

9-WIRE HAND:

Figure 12-11 Comparison of 24-wire and 9-wire heads. Note the detail achieved with 24 wires.

Summary

In Standard Graphics mode, the dots are 1/60 inch apart horizontally. Vertical distance between dots is 1/72 inch for 9-wire printers and 1/60 inch for the LQ in the 9-wire graphics modes.

Standard Graphics mode is entered with ⟨ESC⟩"K"(n_1)(n_2), where $n_1 + n_2 \times 256$ equals the number of dot patterns to be printed on that line.

The ⟨ESC⟩"K" sequence is followed by a number for each dot pattern. This number is the total value of the dots for that pattern.

Line feeds can be controlled in increments of 1/72 (1/60 on the LQ) with ⟨ESC⟩"A" or increments of 1/216 (1/180 on the LQ) with ⟨ESC⟩"J".

High-density modes include ⟨ESC⟩"L", double-density, 120 dots per inch; ⟨ESC⟩"Y", high-speed double-density; and ⟨ESC⟩"Z", quadruple-density, 240 dots per inch. Other special modes selected by ⟨ESC⟩"*"(N) match the screen densities of selected computers, and the FX has a graphics mode with a 1 to 1 aspect ratio, 72 dots per inch, both vertically and horizontally.

On the FX printers, ⟨ESC⟩"^" can be used to print with 9 pins instead of 8.

Also on the FX and LQ printers, ⟨ESC⟩"?" will let you change the density of any of the graphics modes entered with ⟨ESC⟩"K", L, Y, or Z to match one of the modes available with ⟨ESC⟩"*".

The LQ has 24-wire graphics modes in four different densities, all activated with ⟨ESC⟩"*". Each column of graphics dots requires 3 bytes of data.

Chapter

13

User-Defined Character Sets

Now! What's all this business about user-defined characters that we mentioned in Chapter 10? Read on, because it is exactly true, and here is where you learn how to do it. With the FX and LQ printers you can modify existing characters or design your own complete, new character sets. To stimulate your imagination, there are books and books full of different and unusual typefaces. Since it can't store them all, the printer gives you a way to create and use your own design.

The printer, of course, already has a bunch of dot patterns stored in its internal memory for standard characters: numbers, letters, foreign letters, punctuation symbols, etc. Each character is assigned a number between 0 and 255 in the ASCII table (see Chapter 4). The patterns are stored in an area of memory called ROM, which stands for read-only memory. "Read-only" means that you cannot alter this memory.

So how do you alter these character patterns for your own nefarious purposes? You don't. But the FX and LQ printers have a special section of RAM (random-access memory) set aside for this very purpose. In this area of memory, you can assign a dot pattern to any number from 0 to 255 (0 to 127 on the LQ). Would you like to define a completely new character set? Go to it! Then you tell the computer which character set to use during printing: the factory-defined ROM or your own RAM set.

And the story is even better yet. Suppose you are happy with the original ROM set but want to gently rewicker a few characters? Aha! Epson to the rescue. The company included a command that copies all the dot patterns from the ROM set into RAM. That way, you don't have to reinvent the wheel. You just copy the ROM to RAM, pop in the few changes you want, designate your RAM set as the active one, and print happily ever after!

Now comes the crucial question: How do you go about using this feature? Well, you can send the character patterns via your own program

(machine language, BASIC, or other language) or use commercially available software. Either way, once the codes are set in the printer's memory, they stay there until the printer is turned off.

Now for the relevant printer codes.

Defining Characters—FX

The process of defining your own characters differs enough on the FX and LQ that we will cover them separately, starting with the FX. The first step in defining your own characters on the FX printers is to set switch 1-4 to the OFF position (remember to set all switches with the power off). This switch controls the use of the internal 2K buffer area. If the switch is in the wrong position, the buffer area will not be available for storing user-defined characters.

Next we pick a number or range of numbers to define. All the numbers from 0 through 255 are fair game except the ranges used for control codes: 0 to 31, 127, 128 to 159, and 255. Even some of these numbers may be used (with caution) if you use the ⟨ESC⟩"I" and ⟨ESC⟩"6" functions (see below).

Defining characters is similar to Graphics mode in that you tell the computer how many bytes to expect and use the same pin values (1, 2, 4, 8, 16, 32, 64, and 128), but there the similarity ends. The format for defining characters starts with

Symbols: ⟨ESC⟩"&"(r)(c_1)(c_2)

Numbers: 27 38

where r is 0, and c_1 and c_2 specify the starting and ending numbers to be defined. For example, setting $c_1 = 77$ and $c_2 = 84$ selects the code numbers normally assigned to the letters M and T. Just as in Graphics mode, you are contracting with the printer to send a specific number of bytes. In this case, we are proposing to redefine the characters M, N, O, P, Q, R, S, and T.

For each of these 8 characters, the printer expects 12 bytes of information: 1 byte to determine the attributes of the character and 11 bytes defining the dot pattern to be used. These 8 sets of 12 bytes must be sent directly after the initial sequence of codes (⟨ESC⟩"&"(0)(77)(84)).

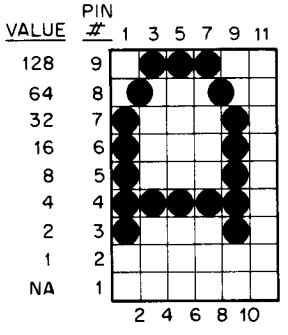
Remember, in Figure 3-11 you learned that standard characters use up to 9 columns, leaving 2 columns or 1 full dot of spacing between characters. For the most part, you'll want to adhere to this rule when defining your own characters. Only for characters that should be connected will you use the full 11 columns.

To define only one code, use the same number for c_1 and c_2, followed by 12 data numbers. Figure 13-1 shows a sample character and the codes

required to assign this symbol to character number 65 (normally the letter A).

Of course, the number sequence 27 38, or ⟨ESC⟩"&", tells the printer to stand by to take on some new characters. Zero means use the standard RAM area (at present, this is the only option for this number). The starting and ending code numbers are both 65 for A, and 139 is the attribute byte, which we explain in the next section. The number 62 is the sum of pin values 2 + 4 + 8 + 16 + 32. The number 64 is the place value of pin 8. The number 132 is the sum of place values 128 + 4. Zero indicates no dot in column 4, and the rest of the codes are repeats to complete our cleverly designed letter A.

Notice that there are never 2 dots from the same row in adjacent columns. This rule should be observed in defining all characters. In Figure 13-1, row 4 has dots in columns 1 and 3 but not in column 2. The only column 2 dot is in row 8, with nothing on either side.



NUMBERS: 27, 38, 0, 65, 65, 139, 62, 64, 132, 0, 132, 0, 132, 64, 62
SYMBOLS: ESC,"&", , "A", "A", ...

Figure 13-1 Process for user-defined A.

Attribute Byte

Perhaps the only difficult concept to follow in defining characters on the FX printers is the attribute byte. We'll take it one step at a time. This byte determines three things about the character being defined:

1. Which pins of the print head are used to print it
2. The starting column number of the matrix to print
3. The ending column number of the matrix to print

Unfortunately, we have to assemble this byte 1 bit at a time. Each byte is composed of 8 ON-OFF switches (called bits). We use 1 to represent on and 0 to represent off. So each byte is simply a sequence of eight 1s or 0s.

The attribute byte is partitioned into three sections: 1 bit for the pins of the print head to use, the next 3 bits for the starting column, and the last 4 bits for the ending column, as shown in Figure 13-2.

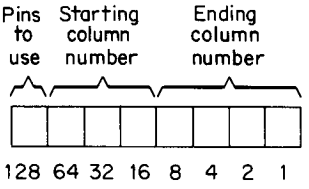


Figure 13-2 Three segments for the attribute byte.

The rule for the first (leftmost) bit is simple. If this bit is 1, the character will be printed with the top 8 pins; if it is 0, the character will be printed with the bottom 8 pins. This is Epson's way of controlling the bottom pin for characters with descenders despite the 8-bit limitation of the system. For most characters, the bottom pin is not used.

The next three bits select the starting column number. The numbering system used by the printer for the 11 available columns is 0 to 10, so the typical starting column is 0.

The last 4 bits select the ending column number. From the 0 to 10 numbering system, you might deduce that 10 is the largest ending column possible. Well, it is actually 11, and here's why.

The starting and ending column numbers have significance only when printing in Proportional mode. And Proportional characters are always Emphasized, which means that each column in the original character design is duplicated one-half column over. Thus, the column 10 dots are copied into column 11. In order to make room for this extra column, you must always add a 1 to the ending column number. Thus, the largest possible ending column number is 11.

Once you have pondered the three parts of the attribute byte, you have to put it all together. Let's suppose you have chosen the numbers 1 for using the top 8 pins, 1 for the starting column, and 11 for the ending column. Each number must be expressed as a sequence of 1s and 0s using the place values shown in Figure 13-3.

To get the 11, for example, you select the numbers that add up to 11 from the place values, 1, 2, 4, and 8, that is, $1 + 2 + 8 = 11$. So each of these place values is selected with a 1, and the 4 is ignored with a 0. Thus, the desired string of 1s and 0s is 10011011. To translate this to a decimal number, add the corresponding place values to get 155, as shown in Figure 13-4.

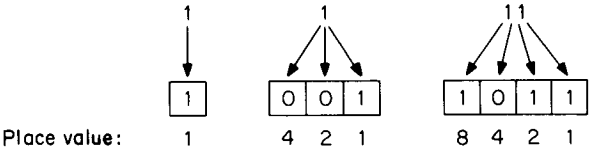


Figure 13-3 Attribute byte place values.

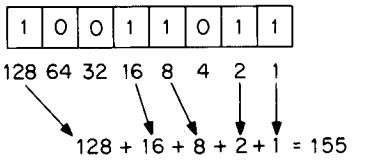


Figure 13-4 Attribute byte total.

Selecting the correct attribute for each character is perhaps the most confusing part of defining your own characters. However, there is a reliable pattern that simplifies the process. In Figure 13-4, we calculated 155, but for most characters, you can use 139: top 8 pins, starting column 0, ending column 11.

When you are designing your character patterns, keep in mind that the printer will not print 2 consecutive dots in the same row. Also, the attribute byte must be followed by a sequence of 11 data numbers specifying the pin patterns.

If you are familiar with any of the typography books we mentioned at the beginning of this chapter, we have to confess that a 6 × 9 dot matrix offers very limited capacity to accommodate rampant artistry. But it is far from hopeless. You can move dots around within that framework in order to develop some unique and fitting type styles.

```
You can build up one "■■■■■" at a time, or
Round them into "OOQC" shapes, or
Just do it with a "FLAIR"
```

Figure 13-5 User-defined type fonts.

So much for the basic stuff. Once you get the creative juices flowing, you can devise other ways of employing your user-defined characters. For example, you can put 2 characters together, either side by side or stacked, one on top of the other. Or you can do both. Figure 13-6 shows an example

of a letter A that was put together from four separate user-defined characters.

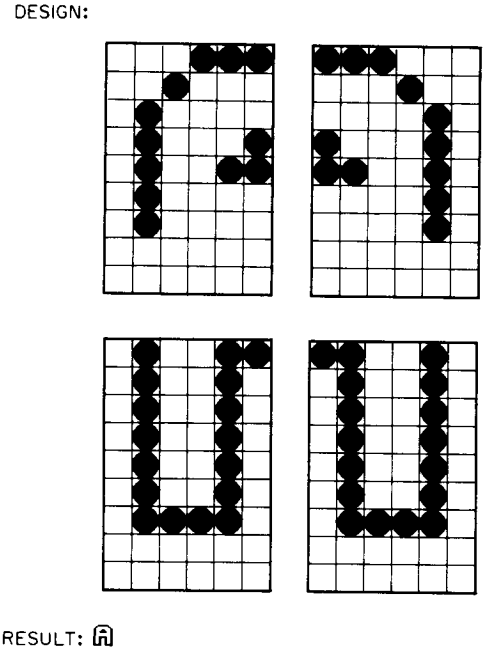


Figure 13-6 The letter A side by side and stacked.

And that still isn't all. If you can design a character in four separate sections, why not design 8 or 10 graphic symbols or building blocks and use them to develop many kinds of finished graphics? The line graphics symbols on the RX are a good example. Figure 13-7 shows another good example.

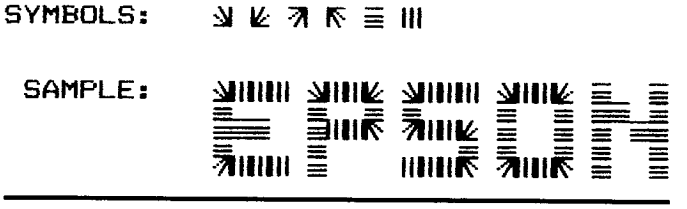


Figure 13-7 User-defined building blocks.

Defining Characters—LQ

Defining characters on the LQ uses the same sequence as the FX:

Symbols: ⟨ESC⟩"&"(r)(c_1)(c_2) . . .

Numbers: 27 38

where r = 0 and c_1 and c_2 select the range of characters to be defined. But there are some differences. For one thing, c_1 and c_2 can range only from 0 to 127. For another, the 24-wire print head means that the characters can be up to 24 dots tall in one pass. With the 8-bit limitation per byte, 1 column of dots requires 3 bytes of data, just as in 24-wire Graphics mode (see Figure 12-10).

Another difference is that there are three basic character types on the LQ: Draft, NLQ, and Proportional. Only one of these three modes can be active at any time. The one active when you issue the ⟨ESC⟩"&" command determines the type of character being defined. The maximum width of the character matrix varies with the type since each one has a different density. Recall that Draft density is 120 dots per inch (Pica pitch), NLQ density is 180 dots per inch, and Proportional density is 360 dots per inch. The maximum dot widths (not including spacing between characters) are 9 for Draft, 15 for NLQ, and 37 for Proportional.

A third difference between the LQ and the FX is that the LQ requires 3 "attribute bytes" per character. The first byte specifies how many blank dot columns should be allowed to the left of the character. The second byte specifies the number of columns for the character itself (see maximum values above). The third byte specifies the number of blank columns allowed for the right side of the character. The sum of these three numbers is limited to 12 for Draft, 18 for NLQ, and no limit for Proportional. This means, for example, that if you use 9 columns to define a character in Draft mode (byte 2 equals 9), the maximum number of columns for the left and right margins will be 3.

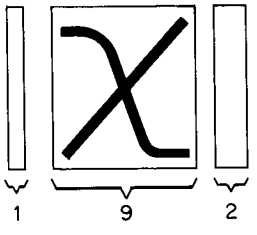


Figure 13-8 Three attribute bytes: left margin, character, and right margin.

For all these differences, the 24-wire capability of the LQ greatly expands the matrix available for defining your own characters. Figure 13-9 shows the flexibility this larger matrix allows. Compare it with Figure 13-5.

Figure 13-9 The LQ difference.

Activating the RAM Area

On both printers, FX and LQ, the character definitions you send to the printer are stored in a special area of RAM memory (FX users must set switch 1-4 off). But when you print, only the standard ROM character set prints unless you "activate" the RAM area with

⟨ESC⟩"%"(1)(0) (⟨ESC⟩"%"(1) on LQ)

This command changes the active set from ROM to RAM. To change back to ROM characters, use

⟨ESC⟩"%"(0)(0) (⟨ESC⟩"%"(0) on LQ)

Note that if your LQ characters are defined in Near-Letter-Quality mode, for example, and you switch to Draft or Proportional for printing, the printer will automatically revert to ROM characters.

Copying the ROM Set to RAM

Once you activate the RAM set, you may be in for a big surprise. Only those characters which you define with ⟨ESC⟩"&" will print; everything else prints as a blank space. In other words, you are responsible for defining the complete RAM set.

To make things a little easier, Epson provides a command that copies the entire set of ROM characters over to the RAM area:

⟨ESC⟩":"(0)(0)(0)

Unless you prefer to define all 256 (128 on the LQ) characters yourself, your sequence of commands may look something like the following:

1. Copy the ROM to the RAM area with ⟨ESC⟩":"(0)(0)(0)
2. Define characters with ⟨ESC⟩"&"(0)(c_1)(c_2) . . .
3. Activate RAM area for printing with ⟨ESC⟩"%"(1)(0)

And should you decide to use the original ROM characters, they can be reactivated with ⟨ESC⟩"%"(0)(0). However, the RAM character set is

still in memory, so you can switch back and forth between the ROM and RAM character sets.

Using Control Ranges

In defining your own characters on the FX, you can use any number from 0 through 255. However, printing the codes stored in locations 0 to 31, 127, 128 to 159, and 255 requires special commands.

Why this added difficulty? Because these numbers are normally reserved for control codes. Remember, printing an 8 causes a backspace, printing a 10 causes a line feed, and so on.

Using the codes 128 to 159 and 255 is fairly straightforward. These codes are merely mirror images of the codes 0 to 31 and 127 and therefore are not essential as control codes. By issuing the command ⟨ESC⟩"6", you are able to print the characters stored in these locations. ⟨ESC⟩"7" changes them back into control codes.

You may find it interesting to note that these codes in the original ROM are used to store the italic foreign characters.

Now, what about the codes 0 to 31 and 127? Well, you *never* want to disable the control codes. Can you imagine accidentally deactivating the ESC code, for instance? But there is a command that lets you print the characters stored in the numbers that are not assigned to control codes, namely, 0 to 6, 16, 21 to 23, 25, 26, and 28 to 31. The command is ⟨ESC⟩"I1". Just as with the upper control code area, you'll find that the roman versions of the international characters are stored in the lower control code area. To change the codes back to their normal status, use ⟨ESC⟩"I0".

And what about the symbols stored in the actual control code locations? Well, you can print these characters, but it isn't easy. You have to use the ⟨ESC⟩"R" command. If you are really that interested, see your FX-80 or FX Series user's manual. It has all the gory details.

Summary

The FX and LQ printers enable you to define and store your own characters. FX users must have switch 1-4 off.

⟨ESC⟩"&"(0)(c_1)(c_2) starts the process of defining your own characters. c_1 and c_2 define the range and can vary from 0 to 255 on the FX and 0 to 127 on the LQ.

⟨ESC⟩"%" activates the ROM and RAM areas for printing.

⟨ESC⟩":" copies the ROM characters into the RAM area.

Part

3

Controlling the Printer from Applications Programs

Chapter

14

Word Processing with WordStar

Epson printer manuals do an excellent job of showing how to control the printers with BASIC. (If you think our participation in writing the manuals has in any way influenced this point of view, you are correct!) BASIC is a natural choice to explore the features of any printer. The language is relatively easy to use, is an integral part of nearly every microcomputer produced, and allows the user to send most codes from 0 through 255. Thus, you can activate nearly all the features of your printer with BASIC.

Application programs for the most part do not allow nearly as much freedom. They usually deal only with a small subset of the printer features. For example, most word processing programs have provisions for activating superscript, subscript, bold characters, and underline, but they may not let you activate italic characters or foreign characters, and they typically provide little or no capacity for graphics.

Spreadsheet programs, on the other hand, have an entirely different orientation. They use the printer in two ways: to print out the spreadsheet and to create graphs from selected bits of data. In printing the spreadsheet, they make little use of standard word processing features—superscripts, subscripts, bold characters, and underline modes—and in printing graphs, they use the graphics modes of the printer.

Even though applications programs don't attempt to be all things to all people, they can greatly increase your power over the printer. Programs that are well matched to your printer and application can give you access to many features without requiring that you have a master's degree in printerology. And for those who want to access features not typically addressed by a program, there sometimes are ways of achieving this goal.

That's what these next two chapters are about—getting the most out of the printer with applications programs. And now, ladies and gentlemen, meet . . .

WordStar

Why start with word processing and WordStar? Because word processing is the most popular computer activity, and WordStar is still the most popular word processing program on the market.

WordStar's interaction with the printer is typical of many of the newer word processing programs. The program definitely utilizes the capabilities of the printer. It has options for changing printer modes interactively by embedding control codes right in the text. Some of the standard features are listed below, along with their codes.

^PB: Boldface

^PS: Underscore

^PD: Double-Strike

^PX: Strikethrough

^PV: Subscript

^PT: Superscript

^PY: Change ribbon color

We use the caret (^) here to represent the control key.

Since WordStar is not designed to display printer modes such as Bold and Underlined on the screen, you must insert control codes at appropriate points in the text to activate the corresponding modes on the printer.

For example, the ^B codes embedded in the following sentence cause the word "You" to be printed in Bold mode.

^BYou^B are the greatest miracle in the world.

In WordStar, printer control codes are inserted by pressing ^P to get the Print Menu and then selecting the appropriate letter, in this case B. When this line is printed, the program sees the first ^B and sends a code sequence out to the printer to *activate* Bold mode. The second ^B causes the program to send the code sequence required to *shut off* Bold mode. Hence, ^B is called a "toggle code," as explained below. The output is shown in Figure 14-1.

```
You are the greatest miracle in the world
```

Figure 14-1 A bold "You" by WordStar.

Note that printer codes take up space on the screen but not on the printed result. WordStar understands this quite well. To demonstrate it

for yourself, move the cursor across the embedded codes and watch the column numbers in the status line. They do not change while the cursor moves across the embedded codes.

All the codes listed above are toggle codes. That is, they switch the designated mode alternately on or off each time they are encountered by the program. Other print codes can signal only the same action each time they are encountered. Examples of single-action codes include the following:

^PH: Overprint character

^PO: Nonbreak space

^PF: Phantom space

^PG: Phantom rubout

^PRET: Overprint line

^PA: Alternate pitch

^PN: Standard pitch

^PC: Printing pause

User-Definable Codes

WordStar even provides four codes you can define yourself with the WINSTALL program (see below):

^Q

^W

^E

^R

Again, all these codes are inserted into the text by pressing ⟨CTRL⟩P and then selecting the correct letter.

Dot Commands

Before we dig deeper into embedded codes, you should be aware of another series of codes that are inserted into text on lines that begin with a dot. In WordStar, a dot (or period) at the beginning of a line signifies that the line is not to be printed but contains only a command and/or comments. Dot commands control such features as line spacing, margins, page length, page numbering, and headers and footers. The dot command, .CW, which is used below, controls character width in 120-inch increments.

Examining the Codes

Here is a brief look at the purpose of each code.

^H: Overprint can be used to print a foreign character that requires an accent or for striking out a character with X or a slash.

^O: Nonbreak spaces are used to keep names together (e.g., RX-80^OF/T).

^F and ^G let you print 2 additional special characters on daisy-wheel printers. Which symbols are printed depends on the print wheel. Typically, ^F prints as a cent sign or pound sign, and ^G prints as double underline or a graphic symbol. Unfortunately, these two codes can't be used with dot-matrix printers. Too bad.

^⟨RETURN⟩: Overprints lines so that you can overlay characters in wholesale fashion.

^A: Switches from Pica to an alternate pitch, usually 12 pitch. The alternate pitch can be specified with the .CW command.

^N switches from the alternate pitch to the standard pitch (default is pica). Standard pitch can also be specified with a .CW command.

^C causes the printing operation to pause for changing print elements, paper, or ribbons. P (or ^KP) resumes printing.

And now for the toggle codes:

^B prints boldface characters by moving the print head half a dot ($\frac{1}{120}$ inch) and reprinting the boldface portion. This is the same as Emphasized mode.

^S underlines characters using the Underline character instead of the continuous Underline mode Epson owners have come to expect.

^D prints darker characters by backspacing after each character and reprinting the character.

^X overprints each character with a dash to strike out the character.

^V and ^T enable subscript and superscript, respectively. They are designed to alternately use forward feed and reverse feed to achieve this effect. On printers that do not have reverse feed, users would do well to use other codes for superscript and subscript. See our discussion below.

^Y is set up to select a different ribbon color on two-color ribbons. Only the JX-80 can take advantage of this feature, so we use ^Y for another purpose.

^Q, ^W, ^E, and ^R (note that they are all in one row on the keyboard) can be used to activate four additional print functions. Each code can

send a sequence of up to 4 numbers to the printer. The code sequences can be defined when installing WordStar or modifying the installation. A sample use would be changing type fonts or activating the sheet feeder. These commands will do nothing until installed.

So, how do you assure that embedding these codes in the text will get the correct code numbers to the printer? For some printers the answer is very simple. You select the printer's name from the menu of available printers when installing WordStar, and the program automatically sends the correct codes to the printer.

Well, now, isn't that nice? And which Epson printers does WordStar support? The original MX-80 and MX-100. That's all. Not Graftrax 80, not Graftrax Plus, not the FX, the RX, or the LQ printers. Of course, even that doesn't utilize the full capabilities of those original printers. And the last word we had from MicroPro is that they have no plans to update their list of printers.

There you have it. The most popular word processing program does a regrettably poor job of supporting the most popular line of dot-matrix printers. The only thing left to do is pick up our wounded spirits and devise our own driver to control the printer. WordStar does provide that option.

Installation Procedure

Some of the control code sequences sent to the printer can be modified by running a program called WINSTALL that is supplied with WordStar. This program creates a completely new copy of WordStar based on your instructions. The Installation Menu includes installation of terminals, printers, and several WordStar features. We shall concentrate on changing the printer driver option.

Once the WINSTALL program is done, you have a new version of WordStar with a file name of your choice. If you have several different printers, you can create separate versions of WordStar for each printer.

To run the installation program, get to the system level (A⟩) and type

```
WINSTALL
```

This is the installation program. Answer all questions with Y (yes) or ⟨RETURN⟩ until it asks for product. Select WS for WordStar. Then select disk drive (press ⟨RETURN⟩ for the default drive A). Press ⟨RETURN⟩ for the standard printer driver WSU.COM. Use WSE for the name of your new version (E for Epson). The installation program will automatically add the extension .COM.

Finally, you are at the Installation Menu. There are several things you can install. The two we are interested in are options C and D. Press C. It

shows that the default is an IBM parallel printer. If you are fortunate to own one of the printers on this menu, you simply press the appropriate letter, and that's the end of it.

Unfortunately, the only Epson representatives are the old MX-80 and MX-100 before Graftrax Plus hit the streets. Using this gives satisfactory results on most Epson printers, but it doesn't handle superscripts and subscripts correctly. And it doesn't let you use modes such as Compressed, Italics, Emphasized, and Expanded. So we have to set up our own codes. Press 2 if you want to see the rest of the printers supported. Press ⟨RETURN⟩ several times to get back to the Installation Menu.

Now select D for custom installation of printers. Press ⟨ENTER⟩ to get to the Printer Installation Menu. Don't worry about specialty printers versus standard printers (options A and B). WordStar considers daisy-wheel printers to be specialty printers. Since options A or B simply take you through selected portions of options C through M, you can go directly to option C.

Here we do a setup for the FX-80 printer. You can modify it for your printer, but it should work on most Epsons. Select each option by its letter and make the changes suggested below.

C Printer name:
Use FX-80.

D Initialization:
Select C to change the initialization code sequence. The code sequence you enter here will be sent to the printer each time you start to print a file, so choose it carefully. A good one to start with is ⟨ESC⟩"@" (Master Reset).

There are several ways to enter the correct string. If you like decimal numbers, use #27 #64 and then ⟨.⟩⟨RETURN⟩ to end. If you like hexadecimal numbers, use ,1B ,40 and then ⟨.⟩⟨RETURN⟩ to end. You can even substitute the ASCII symbol @ for its numeric equivalent with the sequence #27 :@. No matter how you enter the string, WordStar displays the result in hexadecimal format: 1Bh 40h.

For better-quality output from your word processing effort, you might want to tack on the Epson Bold or Emphasized modes. LQ users may want to use Near-Letter-Quality mode. Keep in mind that bold modes run at half speed and that Emphasized does not combine with Compressed except in LQ Draft quality. Of course, another option is to embed in each text file a code for WordStar Bold or Double-Strike.

If you were to initialize with Master Reset followed by Epson's Double-Strike, the decimal sequence would become #27 #64 #27 #71; hexadecimal would be ,1B, 40 ,1B ,47; and the numeric

equivalents would be #27 :@ #27 :G. So you have options not only in determining what your default condition will be but also in sending control codes to the printer. If all is well, press ⟨RETURN⟩.

For the de-initialization code, you can use #27 #64, the Master Reset code.

E Overprinting

Select B for backspacing standard printer. Then select #8 for backspacing control sequence.

I Ribbon selection

Most Epson printers have no use for a code that changes ribbon color, but we can use it to activate and deactivate Italics characters or some other Epson print mode. Use ⟨ESC⟩"4" (#27 :4 or #27 #52) for alternate ribbon selection and ⟨ESC⟩"5" (#27 :5) for standard ribbon selection. The program will alternate between these codes each time a ^Y is sent.

O User-defined functions

These four codes are yours to modify to your heart's content. Each code is limited to four numbers, which is enough to get us into trouble. Set them to

Q: ⟨ESC⟩"S0" or #27 :S :0 for Superscript on

W: ⟨ESC⟩"S1" or #27 :S :1 for Subscript on

E: ⟨ESC⟩"T" or #27 :T for cancel Superscript and Subscript modes

R: ⟨SO⟩, or #14 for 1-line Expanded mode on

P Carriage roll

Option P lets you define the codes used for forward and reverse paper feed. These codes are traditionally used by the program to print superscripts and subscripts for printers that can feed paper in both directions. ^T alternately activates reverse feed and forward feed to create superscripts, as shown in Figure 14-2.

```
Screen:
   Our ^Tsuper^Tprogram does ^Tsuper^Tscript

Printout:
   Our SUPER PROGRAM DOES SUPER SCRIPT
```

Figure 14-2 Superscript by paper-rolling process.

The first ^T sends the Roll-Up command; the second sends the Roll-Down command. Subsequent ^T commands continue that pattern. ^V activates the line-feed codes in the opposite order to create subscripts, as shown in Figure 14-3.

```
Screen:
   Our ^Vsub^Vtle program does ^Vsub^Vscript

Printout:
   Our sub tle program does sub script
```

Figure 14-3 Subscript by paper-rolling process.

Unfortunately, none of the Epson printers have reverse feed ability except the FX-80. Epson printers create superscript and subscript characters in a completely different way. The Script characters are made by printing a vertically compressed font in the upper or lower portions of the line. The characters are shorter than normal and look better in mathematical equations than full-sized characters.

And to add insult to injury, the Epson script codes don't fit neatly into the WordStar ^T/^V toggle scheme. One Epson code turns on superscript, another code turns on subscript, and a third one shuts them both off.

So, our best bet is to use the carriage roll codes for some other purpose and handle the script modes with WordStar's user-defined codes—Q, W, E, and R—as shown in Figure 14-4.

```
Epson superscript and subscript
```

Figure 14-4 Epson's special Compressed script.

Let's use the codes ^T and ^V for Expanded mode. Select the P option and enter the codes as follows:

Roll-Up: ⟨ESC⟩"W1" or #27 :W :1 for Expanded mode on

Roll-Down: ⟨ESC⟩"W0" or #27 :W :0 for Expanded mode off

When you use these in the text, remember that they are toggle codes. You can control Expanded mode effectively and avoid confusion by using only ^T. Figure 14-5 shows how ^Twill function.

SCREEN:

```
SINGLE ^TDOUBLE^T SINGLE ^TDOUBLE^T
```

PRINTOUT:

SINGLE **DOUBLE** SINGLE **DOUBLE**

Figure 14-5 ^T code toggles Expanded mode.

Q Character pitch
This command is straightforward. Set Alternate pitch (^A) to #15 for Compressed. Set Standard pitch (^N) to #18 to cancel Compressed print. Those who prefer Elite pitch can use #27 :M (⟨ESC⟩"M") for Alternate pitch and #27 :P (⟨ESC⟩"P") for Standard pitch.

Options to Skip

The rest of the Print Menu items shouldn't need changing.

F Boldfacing
This just does a double strike; leave it alone.

G Protocol menu
Users with parallel printer cards leave it set to option A. No communications protocol is required.

H Driver menu
Leave at parallel driver.

J Vertical motion
Not for dot-matrix printers.

K Horizontal motion
Not for dot-matrix printers.

L Print modes
These codes access the forward and reverse printing directions available on daisy-wheel printers. They cannot be activated by embedded print codes, so we can ignore them.

M Phantom characters
Phantom Space (^F) and Phantom Rubout (^G) are also designed to be used with daisy-wheel printers. Even if you enter

numbers for these codes, WordStar will not faithfully send them to the printer when it encounters ^F and ^G.

N Return/line feed
Skip this one as it can't be used to our advantage.

Running Your Customized WordStar

When you have finished changing all the parameters, gracefully exit the installation program (clumsily will get it done, but gracefully is better). Your new version of Wordstar should be safely saved on disk. To execute the new program, type in the name (WSE if you followed our lead) and try it out with your printer.

A word of caution. Be careful about using this new program with old files, especially files with lots of superscripting and subscripting. In defining the new version of WordStar, we changed the function of some print codes. Codes embedded in your old files will now activate the new functions we assigned.

Also be careful about getting too fancy with your code choices. Keep in mind that WordStar thinks we still are using ^T for superscripts and ^Y for changing ribbon color.

Helpful Hint

WordStar automatically underlines (^S) by printing the Underline character. Unfortunately, it doesn't underline spaces between words. If you want these spaces underlined, you'll have to change them to an Underline character one at a time with the Hyphen character. If this is too much bother, you can use Epson's Underline mode in place of one of the other modes in the installation program. Epson's Underline mode doesn't have that problem with spaces.

In the installation above, we don't assign codes for Emphasized mode, but that is easily fixed. For example, it can be used in place of Expanded or Compressed. The bottom line here seems to be that although wonderful WINSTALL allows us to customize our own word processors, it does have limits, and we do have to make choices.

If you don't like the way you installed the program, don't worry. You can always revise the current version by redoing the installation. Use the current driver as source and use a new name as destination.

Here's a short summary of the changes suggested above.

C Printer name
FX-80

D Initialization
  Initialize: ⟨ESC⟩"@" or #27 :@ (Master Reset)
  De-initialize: ⟨ESC⟩"@" or #27 :@ (Master Reset)

E Overprinting
  ^H Backspace: BS, #8 (backspace)

I Ribbon selection
  ^Y Alternate selection: ⟨ESC⟩"4" or #27 :4 (Italics on)
  ^Y Standard selection: ⟨ESC⟩"5" or #27 :5 (Italics off)

O User-defined functions
  ^Q ⟨ESC⟩"S0" or #27 :S :0 (Superscript on)
  ^W ⟨ESC⟩"S1" or #27 :S :1 (Subscript on)
  ^E ⟨ESC⟩"T" or #27 :T (Script modes off)
  ^R SO, #14 (1-line Expanded on)

P Carriage roll
  Roll-Up ⟨ESC⟩"W1" or #27 :W :1 (Expanded on)
  Roll-Down ⟨ESC⟩"W0" or #27 :W :0 (Expanded off)
  (codes toggle, ^T starts with on, ^V starts with off)

Q Character pitch
  ^A alternate pitch: SI, #15 (Compressed on)
  ^N Standard pitch: DC2, #18 (Compressed off)

By the way, the folks at MicroPro were *extremely* helpful while we were learning how WordStar interacts with printers. It's easy to see why their program has maintained its number one status for so long.

Summary

WordStar supports only the original MX printers. With the WINSTALL utility program supplied with WordStar, you can modify the program to take advantage of other Epson printer features.

Chapter

15

Other Applications

One chapter for WordStar; one chapter for others. We're trying to be helpful. But comprehensive? Maybe another book. Just send your requests and petitions to . . .

In this chapter, we look at the way some other applications programs interface with Epson printers and how you can use them to get the most out of your printer. We start with Lotus 1-2-3 and work our way through GEAP/DotWriter and PowerDOT.

If you are disappointed at this selection, our apologies. We made no attempt to cover the field. There are simply too many programs out there. We tried to pick a few programs that are either popular or unique, with the expectation that our experience with these may be helpful to you in getting maximum use out of your favorite software.

Lotus 1-2-3

Lotus 1-2-3 is a spreadsheet program that features attributes of a data base manager and supports the printing of charts and graphs. Using Lotus with an Epson printer is both a disappointment and a pleasant surprise. It is a disappointment because it won't let you highlight individual cells with underlining, bold print, italic print, superscript, or subscript when printing a spreadsheet. These abilities are not essential, but they can certainly help dress up some dry reports.

Printing a Spreadsheet

On the other hand, Lotus has some compensating features. It lets you send a setup string of up to 39 ASCII codes to the printer before printing the spreadsheet. This may be used to kick the printer into Italics or Emphasized print or to set the print pitch to Compressed or Elite.

The actual printing is a piece of cake. Here's a brief overview of the steps:

1. /P selects the print option.
2. Select P for printer.
3. Define the range of cells to be printed. The other settings such as margin and page-length adjustments are optional (defaults will be used if you don't specify them). Default settings can be changed with the Worksheet Global Default command.

   Note: If no printer is currently available, you can store the output in a print file for printing at a later time.
4. Select GO to start printing

When the printer is finished, you get a printout such as the one shown in Figure 15-1.

1-2-3 Exports: March 1989

		Monthly Total	Previous Total	Current Total
Revenues				
	Services	1254.56	2550.70	3805.26
	Sales	15838.92	32477.82	48316.74
	Misc	0.00	546.66	546.66
	Total:	17093.48	35575.18	52668.66
Expenses				
	Utilities	372.23	738.86	1111.09
	Rent	1250.00	2500.00	3750.00
	Supplies	254.86	472.24	727.10
	Merchandise	3775.99	8848.61	12624.6
	Payroll	5373.55	8209.60	13583.15
	Depreciation	433.03	622.87	1055.90
	Travel	0.00	286.32	286.32
	Insurance	140.8	302.51	443.31
	Total:	11600.46	21981.01	33581.47
Net Income		5493.02	13594.17	19087.19

Figure 15-1 Lotus spreadsheet.

Printing Charts and Graphs

Even better, the program can take spreadsheet data and produce graphs, using the Graphics mode of your printer. And the best news is that you don't have to understand the printer to make it work.

You create a spreadsheet with 1-2-3. We'll leave that up to you. Next,

you select the Graph option to create a print file. This gives you several more options: type of graph (line, bar, XY, stacked bar, or pie), an X range and up to 6 Y ranges, Reset (cancel the current graph settings), View (preview the current graph), Save (save the current graph to disk to be printed later), Options (legend, format, titles, grid, scale, color, black and white, data labels), Name (use, create, delete, or reset named graphs), and Quit (return to the spreadsheet).

To create a graph, you select a type, specify your variable ranges (see the manual for help here), specify any desired options, name the graph, and save it to disk. To preview the graph, select the Graph View sequence. To print the graph, you must run the PrintGraph program.

With the graph saved to disk, quit the worksheet and select PrintGraph from the Lotus Menu. With the PrintGraph disk installed, the options are Select, Options, Go, Configure, Align, Page, and Quit. First, pick the graph you want to print with Select. Then select the correct printer and density with Configure, Device. For Epson, the available printer modes are as follows:

FX-80 printer: Single-Density mode
FX-80 printer: Double-Density mode
FX-80 printer: Triple-Density mode
FX-80 printer: Quadruple-Density mode

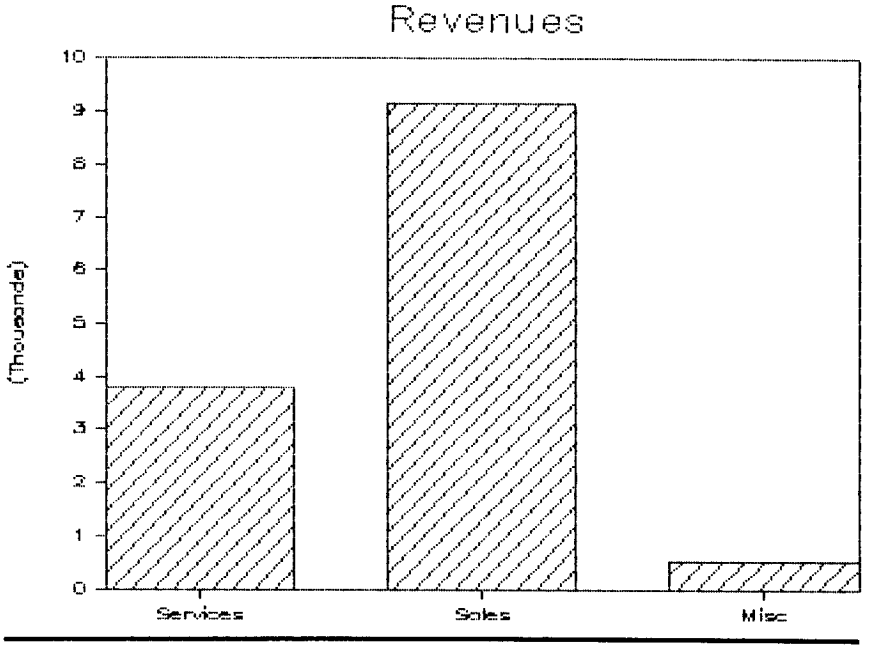
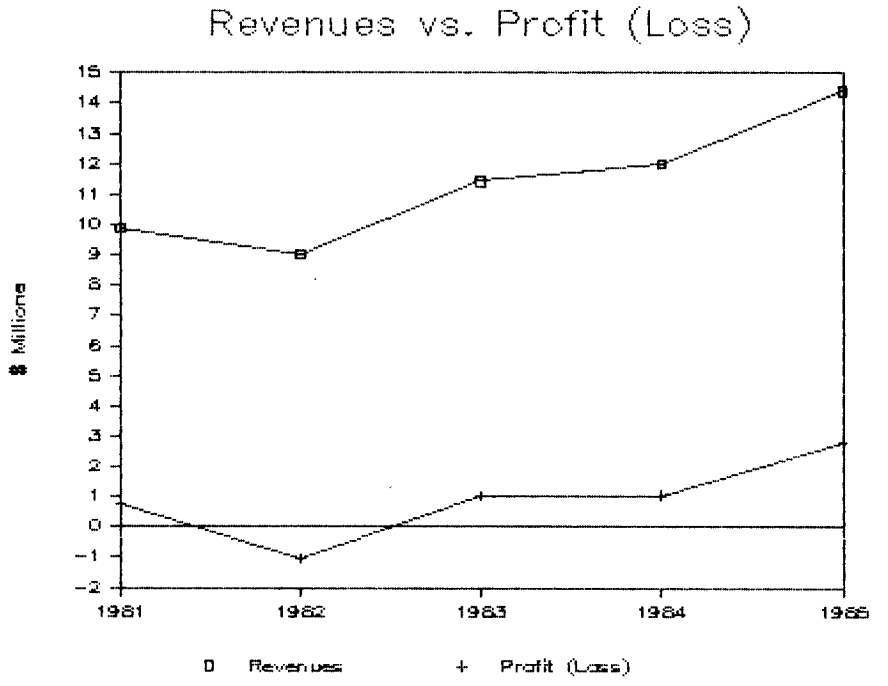


Figure 15-2 Three examples of Lotus graphics.



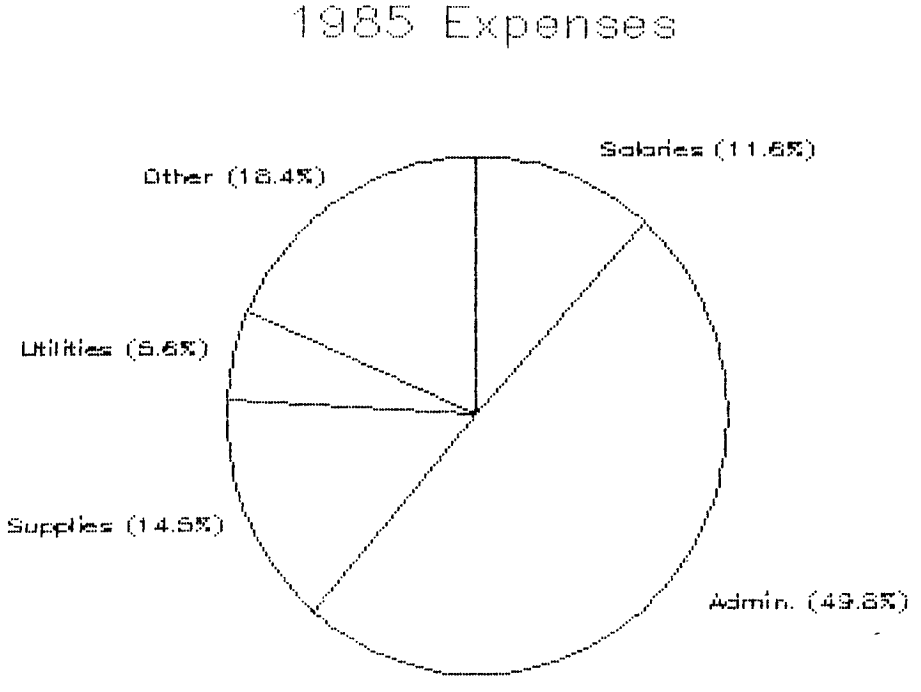


Figure 15-2 (*continued*)

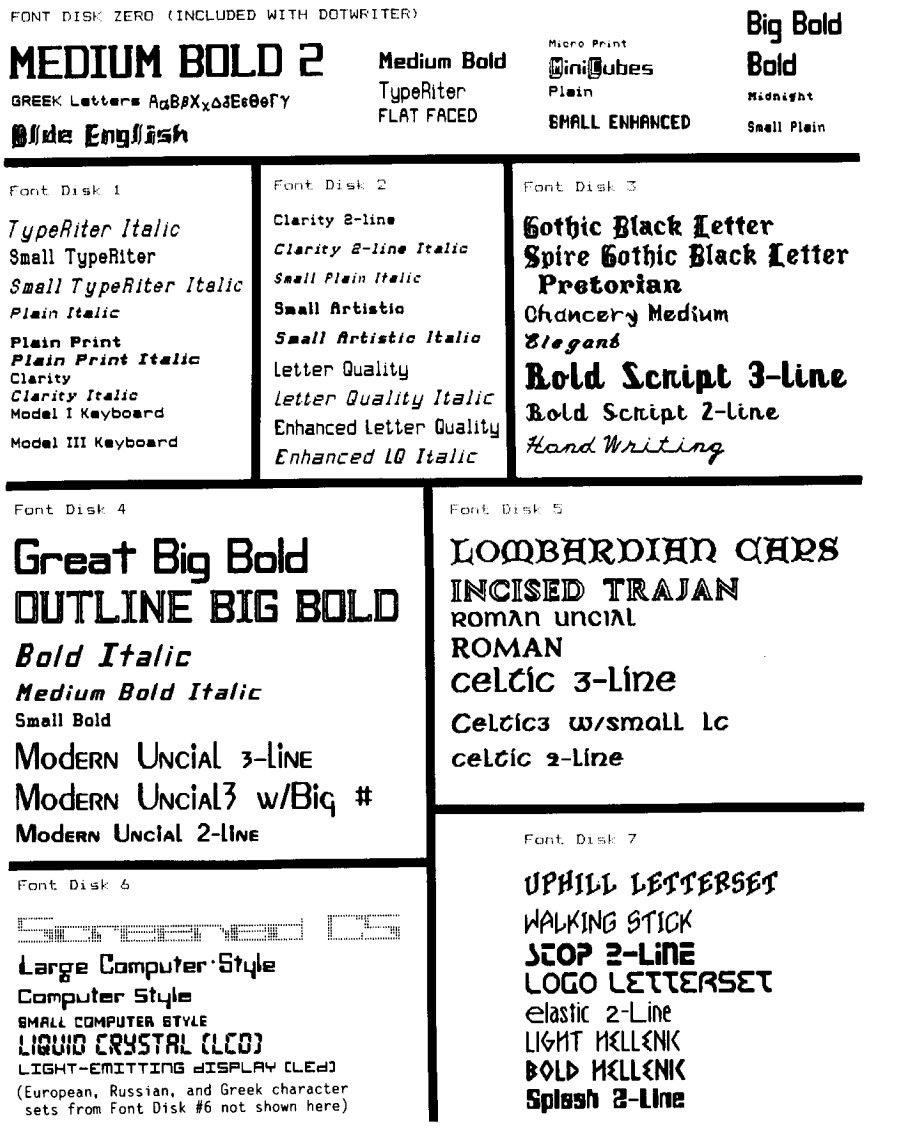


Figure 15-3 DotWriter font samples. *(Courtesy of PROSOFT, a division of The Tesler Software Corporation.)*

MX-80/MX-100: Single-Density mode

MX-80/MX-100: Double-Density mode

MX-80/MX-100: Triple-Density mode

Select any options with Options, and finally choose GO to print the graph.

Figure 15-3 (*continued*)

There are all kinds of things to learn before you become adept at it, but the point is that you simply specify what you want, and the program produces the output on the printer for you. You don't have to know a thing about the Epson printer; the PrintGraph program takes care of the whole enchilada. Figure 15-2 shows some sample graphs.

Lotus has expanded its original version of 1-2-3 and called it Sym-

phony. This new package includes the standard 1-2-3 applications as well as word processing and telecommunications. Current plans are to continue marketing Lotus 1-2-3 as a separate package.

PowerDot and GEAP/DotWriter

Next, we look at a couple of programs that translate low-resolution screen graphics to the high-resolution graphics of the Epson printer. The interesting thing is the difference in their orientation. GEAP/DotWriter is more oriented toward printing text with different fonts and styles and integrating graphics with text. PowerDot is oriented toward producing large graphics. Both products are designed to run on TRS-80 computers. Similar products may be available for other computer systems.

GEAP/DotWriter

GEAP is two products in one. The Graphics Editor and Programmer lets you create graphics on the screen using the TRS-80 rectangles and dump them to the printer as graphics blocks. GEAP is limited to one screen at a time. A utility program lets you join screenfuls to make larger drawings.

DotWriter is an extension of GEAP which lets you create graphics on the screen and dump them to the printer as high-resolution graphics dots. Each screenful is stored on disk in association with a particular keyboard symbol. This correspondence makes it easy to design your own character sets. Each character set is stored in a separate file. Even graphics must be stored as characters. To print the results, you simply print the keyboard characters and tell the program which character set to get the dot pattern from. Figure 15-3 (see previous page) shows some of the character fonts available on disk for DotWriter.

PowerDot

This program makes it easier to draw screen-sized graphics than is the case with GEAP, but it lacks the text-processing ability of DotWriter. PowerDOT has two types of print modes. The character graphics modes will reproduce both TRS-80 block graphics and text. It even supports Model III special characters. See Figure 15-4.

PowerDOT also sports four dot graphics modes. In these modes, the

Figure 15-4 TRS-80 Model III special characters.

program translates each block on the screen into 1 dot on the paper. Since the program allows you to scroll continuously through several screens in any direction, it is easy to create large dot-by-dot graphics figures. In this dot graphics print mode, text characters on the screen are ignored. Figure 15-5 shows an example created with PowerDOT.

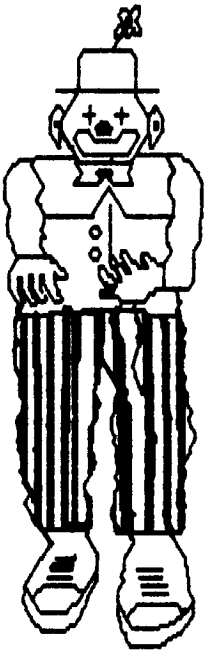


Figure 15-5 PowerDOT graphics.

Product Information

For more information, contact:

Lotus 1-2-3	Lotus Development Corporation 161 First Street Cambridge, MA 02142
DotWriter	RCM Computers 221 Hirschfield Drive Williamsville, NY 14221
PowerDOT	Powersoft 11500 Stemmons Fwy., Suite 125 Dallas, TX 75229

Part

4

Do-It-Yourself Applications with BASIC

Chapter

16

Graphic Design Considerations

From WordStar to PowerDOT, with print modes and graphics codes, utility programs get a lot of mileage out of our printers. Yet each program has its limitations. Software is designed to do a particular job, and it uses only those printer features which support that job. So, inevitably, it seems, the time comes when none of your trusty programs seem to have the right tools for the job *you* want to do. Wouldn't it be great if you could just sit right down and . . . do it yourself?

In the next two chapters, we shall look at just that: do-it-yourself graphics on the Epson using the BASIC programming language. This chapter will kick it off with general layout and design considerations. Chapter 17 will put those principles to use with a sample program that has been translated into four different printer languages: Graftrax Plus, RX-80, FX Series, and LQ 1500.

Working with BASIC

No, we won't try to teach you BASIC. There are plenty of books and manuals on that subject already. We have to assume that you have at least a rudimentary grasp of how to send BASIC commands with your computer. What we do here is demonstrate the use of BASIC codes to set up special printer modes that your applications software may not provide. If the codes we use seem slightly different from the ones you know, it's because we use TRS-80 Disk BASIC (similar to Microsoft BASIC) and you are familiar with another form of BASIC.

The Character String (CHR$)

CHR$(n) is a BASIC language function, called Character String, that sends decimal numbers from 0 to 255. These numbers can be sent to the printer with LPRINT to control any of the printer's functions.

That's it! Now we know how simple it is to control printers with BASIC, right? Sure, you print text with LPRINT and quotes:

```
LPRINT "Look out printer, here comes some text"
```

and you send numeric code sequences with the CHR$ function:

```
LPRINT "HERE COME DE CODES:";CHR$(27)CHR$(48)
```

The BASIC Issue

But working with the BASIC that is programmed into your computer is not always pure joy. Many BASICs have a habit of intercepting certain codes and altering them on their way to the printer. This can play havoc with graphics when you want the computer to send all numbers from 0 to 255 directly to the printer without interpretation.

Since this is not the usual case, you have two options. One, find out how to correct the signal. There are sometimes hardware or software corrections available for specific computers. Two, design around it. For example, if your computer refuses to send a 10 to the printer, you design your graphics patterns so that they avoid the number 10.

To discover what tricks your computer is playing, use the Hex Dump mode on the RX, FX, and LQ printers. In this mode, the printer prints each number (in hexadecimal) that it receives. Just send it every number from 0 to 255 to see what your computer is actually transmitting. Make a note of the codes that are not working correctly so that you can avoid them until you find out how to correct them. Your local user's group or computer manufacturer may be able to help.

Programming Tips

Another helpful technique in working with BASIC is to write your programs in modules. Once you get part of your program printing correctly, use temporary GOTOs to skip that part while you work on the next section. Work with one section at a time until each part is thoroughly tested; then put it all back together.

Also, be conscious of what modes you leave on at the end of a program run. Unless you send the Master Reset code (⟨ESC⟩"@") or turn the printer off between runs, the modes you leave on will still be active at the start of the next run.

Forms Design in a Graphics Mode

One area in which BASIC can be very useful is designing your own custom forms. But beware. There are several pitfalls that can trap you after you are deep into the program. The key is to plan ahead. This chapter deals with several typical problem areas and how to cope with them.

The more you rely on programming your own solutions, the more important it is that you understand how your printer works and how your computer communicates with the printer. The more you know about the limitations of your printer and computer, the easier it will be to design effective routines within those constraints.

Pitch Changes

Many forms require a border on both the right and left edges of the page, as shown in Figure 16-1. And, of course, you must make sure that these borders line up all the way down the page. The natural inclination is to place tabs where you want the borders and use them to align the border characters or graphics. This is fine and dandy if you have only one kind of text between the borders. But what if you have occasion to switch between several different pitches on the same line?

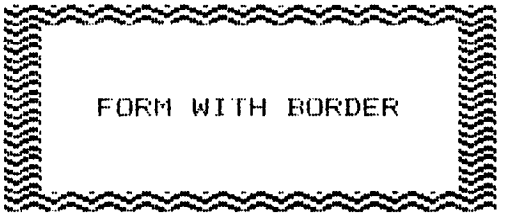


Figure 16-1 Form with border.

The answer is: It depends on your printer. FX, RX, and LQ Series printers all have absolute tab settings. That is, tabs are set in the current pitch, and subsequent changes of pitch *do not* affect tab positions! This terrific feature guarantees uniform tab settings. Unfortunately, users of earlier printers must adjust for pitch switches. Figure 16-2 illustrates what

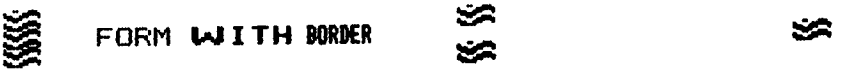


Figure 16-2 Misalignment on Graftrax Plus.

effect changing pitch can have with ⟨ESC⟩"D" tabs on Graftrax Plus printers.

One way to compensate for this little quirk is to place your tabs as close as possible to the right edge border (Figure 16-3) and then make final adjustments by printing slivers of space with Graphics mode (Figure 16-4).

Figure 16-3 Adjustment with tab.

Figure 16-4 Adjustment with Graphics mode.

The slivers are added in this program with

```
LPRINT CHR$(27)"K"CHR$(2)CHR$(0)CHR$(0)CHR$(0);
```

which prints 2 blank columns of graphics to line up the right borders.

Another trick to keeping borders lined up is to use the Unidirectional Print mode (⟨ESC⟩"U"). Bidirectional printing can cause vertical lines to be slightly out of alignment. If you experience this problem, give the Unidirectional Print mode a try. It will slow down the throughput but may improve the look of your form.

Line-Spacing Considerations

Mixing text with a graphics pattern that continues unbroken down the page requires some judicious handling of line spacing. For example, suppose you are using a special character to create a graphics border down the page. In order to get a continuous border, you have to set line spacing to the height of this character. For a typical 9-wire printer, line spacing would be 7 or 8 dots tall, depending on the height of your character. For the LQ, line spacing would be $\frac{8}{60}$ inch (or $\frac{24}{180}$ in 24-wire mode), the distance between the top and bottom pins of the print head.

Now what about printing text with these narrow line spacings? Since 9-wire text characters are 7 dots tall (9 for lowercase with descenders), you won't want to print text on consecutive lines; it would get too crowded. So skip a line between lines of text. With 7-dot line spacing, two line feeds gives a distance of 14 dots, which is only slightly larger than the default line spacing of 12 dots. On the LQ, you can design your characters

to be 17 dots tall to match the height of text characters. With the line spacing set to $^{17}/_{180}$ inch, two line feeds gives a spacing of 34 dots, which is comparable to the default of 30.

Figure 16-5 uses 7-dot line spacing on an FX for a continuous border and illustrates text on alternating lines.

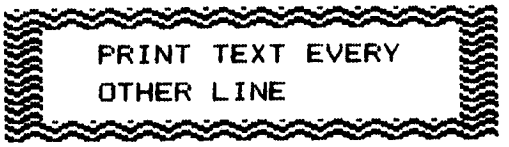


Figure 16-5 Continuous graphics and alternating lines of text.

Even if your border character is 8 dots tall, you may be able to use 7-dot line spacing, overlapping the bottom and top dots of adjacent lines. We use this spacing in Figure 17-4 with no ill effects.

Dot Pattern Design

Before starting your own dot pattern design, consider what print density you intend to use. If you use quadruple density or high-speed double density, the printer will not print consecutive dots in the same row, even if you put them in your design.

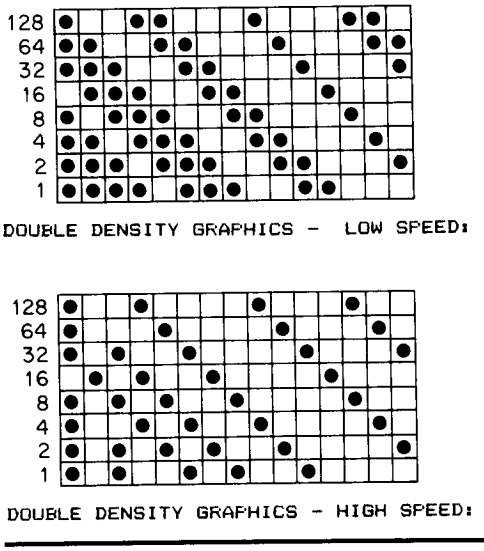


Figure 16-6 Consecutive dot conflict.

Layout and Design

Even if you are creating a simple graphics figure, the first step is to decide how big you want the figure to be. Do you want it 1 inch square or large enough to fill a complete 8½ × 11 inch sheet of paper? Why not go for the gusto and fill the whole sheet.

Fine. The next thing to consider is which density of graphics to use. Densities range from 60 dots per inch to 240 dots per inch in the horizontal direction. Only one density is available in the vertical direction on 9-wire printers: 72 dots per inch (the distance between the pins of the print head). The LQ uses either 60 dots per inch in the 8-pin mode or 180 dots per inch in the 24-wire mode.

At the least dense setting on a 9-wire printer, a 1-inch square requires 60 × 72 dots, or a total of 4320 dot positions that you will have to define in your layout and then send to the printer. How about that, sports fans! At the densest setting, we are talking four times that much, or 17,280 dots for a little ol' 1-inch square, and over twice that amount for a 24-wire printer. Good grief, Charley Brown! I'll leave it to your imaginations and calculators to figure out how many dots you would manipulate for a full-page design.

Now, let's try that first step again. How large do you want your graphic to be? Just as I suspected, suddenly a lot more people are willing to settle for 1 square inch. That's fine. For your first few attempts at graphics, it's best to keep it small and manageable.

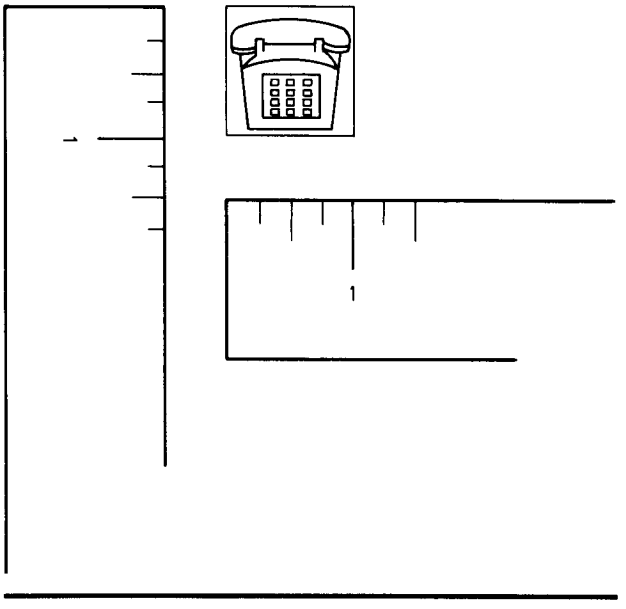
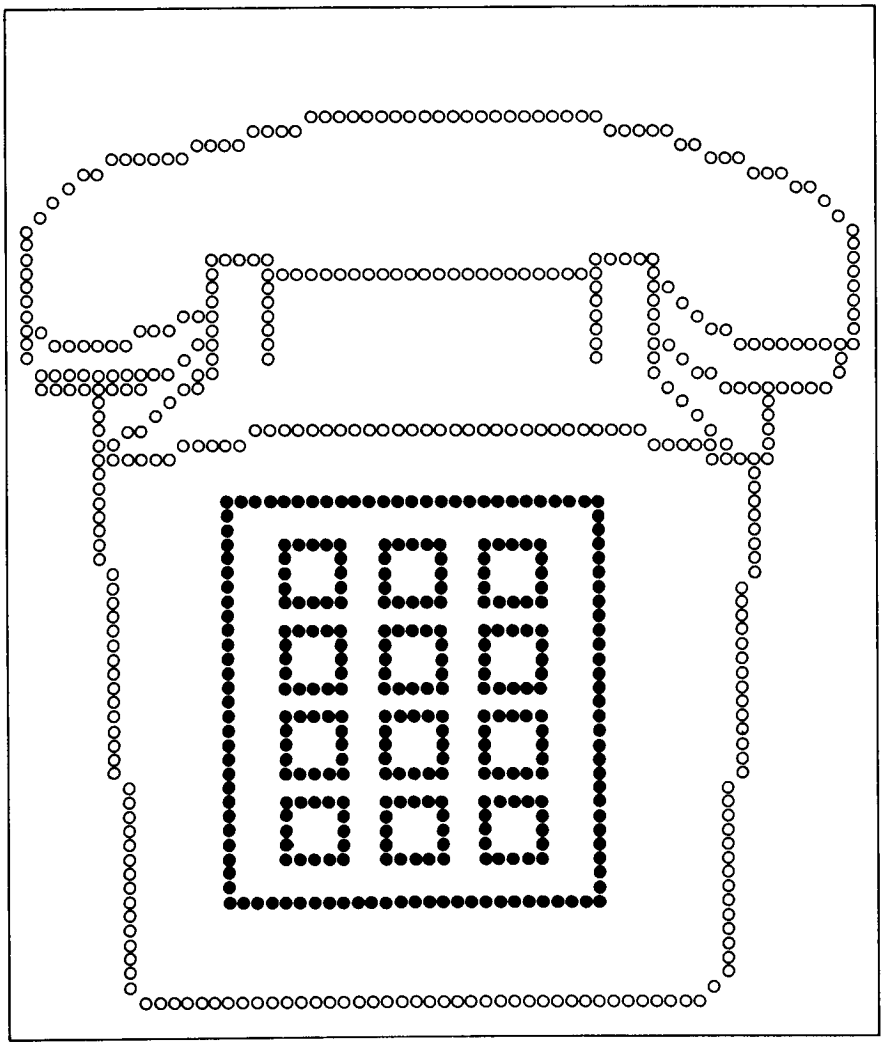


Figure 16-7 Rough sketch to size.

Next, draw a rough sketch the size you want it.

Select a density (single density for this example) and calculate how many dots are needed, both vertically and horizontally (72 vertically and 60 horizontally per inch). Then mark off a grid on your graph paper with these dimensions. Draw heavy horizontal lines every 8 rows to help you calculate pin patterns.

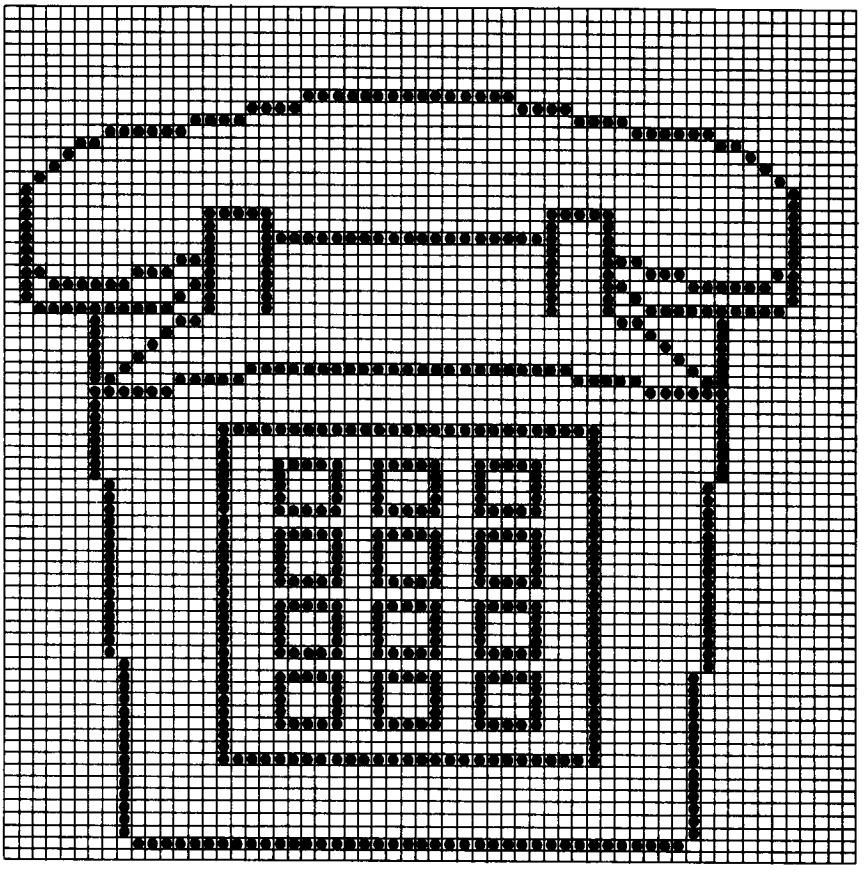


(a)

Figure 16-8 Digitized figures in two proportions: (*a*) 1 to 1 ratio and (*b*) 60 to 72 ratio.

It is very important at this point to keep in mind that the squares on graph paper are the same distance horizontally and vertically. The ratio of horizontal density to vertical density (called the aspect ratio) in your printout will depend on the print mode you select. In Figure 16-8, the figure is laid out on two grids. The first is standard graph paper in a 1 to 1 ratio, and the second is a modified grid to simulate the 60 to 72 ratio of the Single-Density Graphics mode. So your digitized figure will be stretched and scrunched to fit the graphics density you choose.

Another good example of the effect of graphics density was discussed way back in Chapter 2. Figure 2-18 clearly demonstrates the effect of changing graphics density on our illustration of a lion's head. With this in



(b)

Figure 16-8 ***(continued)***

mind, translate your rough sketch to the grid, dot by dot. It may help to have your original sketch enlarged at the local copy center.

Next, you have to go through and calculate the pin patterns for graphics, as shown in Chapter 12. With that time-consuming process out of the way, sending the data to the printer is fairly straightforward.

Another thing to consider in selecting a graphics density is overlapping dots. The ⟨ESC⟩"Y" and ⟨ESC⟩"Z" graphics modes will not fire consecutive pins in the same row. It's better to know what density you intend to use *before* you start placing dots in a grid.

Summary

Many of the BASIC language protocols that are programmed into computers interpret certain ASCII code numbers before sending them to the printer. When programming graphics, it is essential to either correct or work around these aberrations.

It is helpful to write and test BASIC programs by modules.

In the MX Series Epson printers, absolute tab positions vary with changings of pitch. These can be adjusted by adding tiny slivers of space in Graphics mode.

When you are using graphics with text, line spacing must be coordinated between the two. If graphics requires a 7-dot line spacing, text can use two line feeds per text line.

In designing a graphics figure, consider what print density you will use. In quadruple density or high-speed double density, the printer will not print consecutive dots in the same row.

In designing a graphics figure, consider printout size. A 1-inch square can contain as many as 17,820 dots to be defined and transmitted to the printer.

In designing a graphics figure, make allowance for aspect ratio. It will be stretched vertically or horizontally depending on the graphics mode used to print it. Changing print densities can seriously distort a printed figure.

Chapter

17

BASIC Examples

In the last chapter, we majored in BASIC pitfalls and how to avoid them. In this chapter, we put some of these tidbits to use.

Just one more time, let's consider why anyone would want to agonize over a finicky computer in order to write a program for a printer in BASIC when there are scads of programs out there for all kinds of applications. Certainly, if you are happy with the reports and forms your programs generate, you don't need this headache. However, we usually find ourselves wanting just one more thing from even the most sophisticated programs. More universal are needs for forms that are totally unique to particular business or home uses. Here is where you get some guidance in do-it-yourself forms programming.

In this chapter, we create a customized form for a company called EduKater (oh, you've heard of them?). We have purposely developed a form that has very limited application in order to typify the kind of thing you would do for yourself: forms, customized for your needs, that you are not likely to find in the local stationery store.

We show you four examples of this form, one for each of the major Epson printer lines: MX with Graftrax Plus, RX, FX, and LW. For each form, we include a printout and the listing, followed by a brief discussion of the unique printer features used to create that particular version.

This will give you a chance to see how the four printer lines compare when set to the same task. It will also give you some useful programming tools for writing your own forms. Finally, it will demonstrate how some of the graphics considerations mentioned in Chapter 16 can be put to use.

About the Form

Called Chapter Management Record, this form is designed to accompany each chapter of a book as it goes from person to person throughout the

production cycle. It contains just about everything a new person would want to know about the current status of the chapter: what is enclosed in the package (diskettes, files, printouts, etc.), state of chapter development, room for comments, and a checklist of the final pass procedures.

Again, the form is customized for the unique needs of a single company. You can adapt the techniques used here for your own custom forms.

MX Graftrax Plus

The first of the printer lines is the MX with the up-to-date Graftrax Plus ROM chips installed. The printout and program listing are shown in Figure 17-1.

Program Discussion: Some Important Points

Straight lines are used extensively in forms. With Epson printers, you can print a continuous straight line using the Underline mode. A simple routine for right justification is discussed below in the explanation for lines 1060 to 1100.

The boxes for number of figures, files, etc., are created with special line graphics characters stored in the MX character ROM (see Figure 2-24). Boxes are printed in three passes, using a 7-dot line feed, as shown in Figure 17-2.

Line-by-Line Explanation

Lines 110 to 130 define strings that we use repeatedly in the program. The strings in lines 120 to 130 turn on Underline mode and then print an Underline character (CHR$(95)). We have to do this because Graftrax Plus printers won't underline the trailing or leading spaces on a line of print. You will find the Underline character again in lines 11030 and 11050.

The Z5$ code uses the BASIC command, STRING, to put together a string of 5 zeros. Developing a form often requires the use of multiple zeros, and this code is used frequently as a convenient building block.

Section 1. Section 1, beginning at line 1000, develops the upper quarter of the form with its five boxes.

Setting up to print the boxes, line 1010 turns on 7-dot line spacing and, for clean vertical registration, unidirectional print.

Line 1020 turns on Double-Strike, Emphasized, and Expanded Print modes and then tabs over 16 spaces and prints the title.

Line 1040 turns off Double-Strike mode and sets 2 horizontal tabs. Expanded mode was turned on by CHR$(14), so it turned off automati-

CHAPTER MANAGEMENT RECORD

ENCLOSURES FOR CHAPTER: _____

- [ ] FIGURES: _____
- [ ] MISC FILES: _____
- [ ] PRINTOUTS: _____
- [ ] DISKETTES: _____
- [ ] ONE TIME ITEMS: _____

CIRCLE ITEMS THAT ARE *NOT* TO BE MODIFIED ON DISK.
CROSS OFF ONE-TIME-ONLY ITEMS WHEN RECEIVED.

CHAPTER DEVELOPMENT

ASSIGNED	COMPLETED	INIT.	
/ /	/ /		1. RESEARCH TOPIC; DEVELOP EXAMPLES.
/ /	/ /		2. USE EXAMPLES TO PRODUCE FIRST DRAFT.
/ /	/ /		3. EDIT AND POLISH FIRST DRAFT.
/ /	/ /		4. TECHNICAL CHECK.
/ /	/ /		5. MORE POLISHING AND RESOLVE PROBLEMS.
/ /	/ /		6. CHAPTER CHECK LIST.
/ /	/ /		7. FIELD TESTING.
/ /	/ /		8. REVISIONS BASED ON TESTING.
/ /	/ /		9. SUBMISSION

FINAL PASS (☑)

- ☐ TRANSFER HARDCOPY CHANGES TO DISK.
- ☐ CHECK FIGURES.
- ☐ CHECK CAPTIONS.
- ☐ EDIT FOR FLOW.
- ☐ CHECK CHAPTER SUMMARIES.
- ☐ VERIFY REFERENCES TO OTHER PARTS OF BOOK.
- ☐ DELETE IN HOUSE NOTES.
- ☐ CHECK INDEX ENTRIES.
- ☐ CHECK CHAPTER HEADINGS AGAINST TABLE OF CONTENTS.
- ☐ CHECK SPELLING.
- ☐ PRINT CHAPTERS AND FIGURES FOR MAILING.

RESOLUTION	PROBLEM	SOLUTION	PROGRESS
/ /			
/ /			
/ /			

Figure 17-1 Graftrax Plus form and listing.

```
100       *** DEFINE STRINGS ***
110 E$=CHR$(27): Z$=CHR$(0): H$=CHR$(9): Z5$=STRING$(5,0)
120 D1$ = E$+"-"+CHR$(1)+CHR$(95)+"   /    /    "+CHR$(95)+E$+"-"+Z$
130 D2$ = E$+"-"+CHR$(1)+CHR$(95)+"    "+CHR$(95)+E$+"-"+Z$
1000 '
     '     <<< SECTION 1 >>>
     '
1010 LPRINT E$"1";E$"U"CHR$(1);
1020 LPRINT H$;H$;E$"G";E$"E";CHR$(14);"CHAPTER MANAGEMENT RECORD"
```

```
1030 LPRINT: LPRINT
1040 LPRINT E$"H";E$"D"CHR$(4)CHR$(19)Z$
1050 LPRINT H$;"ENCLOSURES FOR CHAPTER: ";D2$: LPRINT
1060 T$="FIGURES": GOSUB 11000
1070 T$="MISC FILES": GOSUB 11000
1080 T$="PRINTOUTS": GOSUB 11000
1090 T$="DISKETTES": GOSUB 11000
1100 T$="ONE TIME ITEMS": GOSUB 11000
1110 LPRINT E$"F";E$"2"
1120 LPRINT H$;"CIRCLE ITEMS THAT ARE ";E$"4";"NOT";E$"5";
1130 LPRINT " TO BE MODIFIED ON DISK."
1140 LPRINT H$;"CROSS OFF ONE-TIME-ONLY ITEMS WHEN RECEIVED."
1150 LPRINT: LPRINT
2000 '
     '      <<< SECTION 2 >>>
     '
2010 LPRINT H$;E$"G";CHR$(15);CHR$(14);"CHAPTER DEVELOPMENT"
2020 LPRINT E$"H";E$"4";CHR$(18)
2030 LPRINT E$"S"Z$;" SCHEDULED          DATE       INIT.";
2040 LPRINT E$"A"CHR$(5): LPRINT E$"2";
2050 LPRINT " COMPLETION     COMPLETED";E$"T"
2060 LPRINT E$"5"
2070 GOSUB 13010:LPRINT "    1. RESEARCH TOPIC; DEVELOP EXAMPLES."
2080 GOSUB 13010:LPRINT "    2. USE EXAMPLES TO PRODUCE FIRST DRAFT."
2090 GOSUB 13010:LPRINT "    3. EDIT AND POLISH FIRST DRAFT."
2100 GOSUB 13010:LPRINT "    4. TECHNICAL CHECK."
2110 GOSUB 13010:LPRINT "    5. MORE POLISHING AND RESOLVE PROBLEMS."
2120 GOSUB 13010:LPRINT "    6. CHAPTER CHECK LIST."
2130 GOSUB 13010:LPRINT "    7. FIELD TESTING."
2140 GOSUB 13010:LPRINT "    8. REVISIONS BASED ON TESTING."
2150 GOSUB 13010:LPRINT "    9. SUBMISSION"
2160 LPRINT: LPRINT
3000 '
     '      <<< SECTION 3 >>>
     '
3010 LPRINT E$"1";H$;H$;" ";E$"L"CHR$(14)Z$;Z5$;
3020 LPRINT Z$;Z$;Z$;CHR$(3);CHR$(6);CHR$(12);
3030 LPRINT CHR$(24);CHR$(48);CHR$(96)
3040 LPRINT E$"3"CHR$(1);H$;H$;
3050 LPRINT E$"L"CHR$(20)Z$;Z5$;Z5$;
3060 LPRINT CHR$(48);CHR$(24);CHR$(12);
3070 LPRINT CHR$(6);CHR$(6);CHR$(12);
3080 LPRINT CHR$(24);CHR$(48);CHR$(96);CHR$(192)
3090 LPRINT E$"1";H$;CHR$(15);CHR$(14);E$"G";
3100 LPRINT "FINAL PASS ( ";
3110 LPRINT CHR$(18);"O";CHR$(15);" )"
3120 LPRINT E$"H";CHR$(18);E$"2"
3130 LPRINT
3140 X$=" "+CHR$(14)+"O"+CHR$(20)+H$
3150 LPRINT X$;"TRANSFER HARDCOPY CHANGES TO DISK."
3160 LPRINT X$;"CHECK FIGURES."
3170 LPRINT X$;"CHECK CAPTIONS."
3180 LPRINT X$;"EDIT FOR FLOW."
3190 LPRINT X$;"CHECK CHAPTER SUMMARIES."
3200 LPRINT X$;"VERIFY REFERENCES TO OTHER PARTS OF BOOK."
3210 LPRINT X$;"DELETE IN HOUSE NOTES."
3220 LPRINT X$;"CHECK INDEX ENTRIES."
3230 LPRINT X$;"CHECK CHAPTER HEADINGS AGAINST TABLE OF CONTENTS."
3240 LPRINT X$;"CHECK SPELLING."
3250 LPRINT X$;"PRINT CHAPTERS AND FIGURES FOR MAILING."
3260 LPRINT: LPRINT
4000 '
     '      <<< SECTION 4 >>>
     '
4010 LPRINT E$"G";E$"U1"
4020 C=4: H=4
4030 FOR K=1 TO 5: READ L(K),M(K),N(K),R(K): NEXT K
4040 FOR K=1 TO C: READ W(K): NEXT K
4050 FOR L=1 TO 5: IF L=4 THEN FOR G=1 TO H
4060   IF L=2 THEN LPRINT E$"3"CHR$(1);
4070   IF L=4 AND G=3 THEN LPRINT E$"3"CHR$(1);" ";D1$
4080   LPRINT CHR$(L(L));: FOR K = 1 TO C-1
4090   N=W(K): A$=CHR$(M(L)): GOSUB 12010
```

```
4100   LPRINT CHR$(N(L));: NEXT K
4110   N=W(C): A$ = CHR$(M(L)): GOSUB 12010: LPRINT CHR$(R(L));
4120   IF L<>2 THEN 4200
4130   LPRINT E$"E";E$"H"
4140   FOR Q=1 TO C: READ T$: D = (W(Q)-LEN(T$)+1)/2
4150    N=D: A$=" ": GOSUB 12010
4160    LPRINT T$;
4170    N=D+1: A$=" ": GOSUB 12010
4180   NEXT Q: LPRINT E$"G";E$"F";
4190   LPRINT E$"3"CHR$(15): GOTO 4210
4200   LPRINT E$"1"
4210   IF L=4 THEN NEXT G: NR=NR+1: IF NR<3 THEN L=2
4220 NEXT L: LPRINT
4230 LPRINT E$"F";E$"H"
4240 LPRINT
4500 '      *** COPYRIGHT MESSAGE ***
4510 LPRINT E$"L"CHR$(10)Z$;
4520 LPRINT Z$;CHR$(60);CHR$(66);CHR$(153);CHR$(165);CHR$(165);
4530 LPRINT CHR$(165);CHR$(129);CHR$(66);CHR$(60);
4540 LPRINT   " 1984.  EduKater"
4550 LPRINT CHR$(27)"@"
4560 END
10000 '
      '      <<< SUBROUTINES >>>
      '
11000 '      *** PRINT SQUARES ***
11010 LPRINT CHR$(134)CHR$(157)CHR$(149)
11020 LPRINT CHR$(156)CHR$(160)CHR$(156);
11030 LPRINT H$;T$;": ";E$"-"CHR$(1);CHR$(95);
11040 N=70-LEN(T$): A$=" ": GOSUB 12010
11050 LPRINT CHR$(95);E$"-"Z$
11060 LPRINT CHR$(153)CHR$(157)CHR$(154)
11070 RETURN
12000 '      *** STRING$ ROUTINE ***
12010 FOR J = 1 TO N: LPRINT A$;: NEXT J: RETURN
13000 '      *** DATE ROUTINE ***
13010 LPRINT " ";D1$;"    ";D1$;"    ";D2$;
13020 RETURN
20000 '
      '      <<< DATA >>>
      '
21000 '      *** BOX DATA ***
21010 DATA 134,157,152,149,156,160,156,156,150,157
21020 DATA 159,151,156,160,156,156,153,157,158,154
21030 DATA 12,20,20,20,"RESOLUTION","PROBLEM","SOLUTION","PROGRESS"
```

Figure 17-1 ***(Continued)***

Figure 17-2 Box in three passes.

cally at the end of the line. That leaves Emphasized for the current print mode.

Line 1050 tabs over and prints a subheading and the predefined D2$ underline.

Lines 1060 to 1100 each print a square and some text and then fill out the line with underlines, using the subroutine at line 11000. Note that line 11040 of the subroutine establishes right justification for the horizontal lines. Since the length of T$ in lines 1060 to 1100 varies, line 11040 sets

the length of the underline, *N*, equal to 70 minus the length of T$, so all five underlines end in a dead heat at 70.

Line 1110 turns off Emphasized mode and returns to normal 12-dot line spacing.

Lines 1120 to 1140 print a message in normal print mode with the word *NOT* in italics.

Section 2. Section 2 begins at line 2000 and develops the second quarter of the form on Chapter Development.

Line 2010 turns on Double-Strike, Compressed, and Expanded modes to print the major heading.

Line 2020 turns off Double-Strike and Compressed modes and turns on Italics mode (Expanded mode shuts off by itself).

Line 2030 turns on Superscript mode to print the first line of subheadings.

Line 2040 adds a 5-dot line feed at the end of that printed line and then returns to the Default line-spacing mode for the rest of this section.

Line 2050 prints the rest of the heading, still in italicized Superscript, and line 2060 turns off Italics mode.

Lines 2070 to 2150 use the subroutine at line 13010 to print three sections of underlining, using previously defined strings. Then each line adds appropriate text.

Section 3. Section 3 begins at line 3000 and develops the third major part of the form, under the heading "FINAL PASS."

It starts by printing a check mark at the end of the title. The check mark is printed in two passes, as shown in Figure 17-3.

Figure 17-3 Check mark passes.

First, lines 3010 to 3030 enter Double-Density Graphics mode, tab out to the vicinity of the check, using several blank columns to position the check correctly, and print the top part of the check. Then they issue a 7-dot line feed to ensure a continuous check mark.

Actually, the Graftrax Plus seems sensitive about where you place the line-spacing command ⟨ESC⟩"1". It worked best as the first code in the program for this line of print. The program also worked better when we

printed both sections of the check mark first, followed by the rest of the line. The other programs follow a different sequence.

Lines 3040 to 3080 print the bottom portion of the check mark, followed by a 1/216 inch line feed, the closest thing Graftrax Plus has to no line feed. Again, the line-feed code is entered at the beginning of the line.

Lines 3090 to 3120 print the text characters in several exotic modes to finish the line.

Line 3090 sets the stage with a line-feed command, a tab, and activation of three print modes: Compressed, Expanded, and Double-Strike.

Line 3110 prints a 0 in Expanded mode.

Line 3120 turns off Double-Strike and Compressed print modes and returns to normal 12-dot line spacing.

Line 3140 defines X$ as our stretched circle plus a tab, and then each of the lines 3150 to 3250 prints this circle with the corresponding pass description.

Section 4. Section 4 begins at line 4000 and develops the big box at the bottom of the form.

We turn on Double-Strike and Undirectional print modes in line 4010. Line 4020 sets the number of cells to 4 and the height of each cell to 4. The special characters for each pass are read into the arrays L, M, N, and R. The width of each cell is read into the array W in line 4040.

The boxes are printed in a loop from lines 4050 to 4210. L varies from 1 to 5. In the first pass, the top row is printed with special characters.

Things get a little more exciting with L = 2. A short line feed is set in line 4060, and the headings are printed in the segment from lines 4130 to 4190. Line 4140 calculates the number of spaces needed to center the headings in their respective cells. Lines 4150 and 4170 print the blank spaces using the subroutine at line 12010. Users whose BASIC has the STRING$ function can use that function instead of this routine. The headings are printed in line 4160, and the line spacing is set at the end in line 4190.

The rest of the passes are done with L = 3 and 4. The second IF in line 4210 resets L back to 2 in order to print rows for several comments. The IF in line 4050 and the NEXT in line 4220 repeat the L = 4 pass several times. This controls the height of the boxes.

When NR mercifully reaches 4, control passes to line 4220 to start the last pass with L = 5.

Line 4230 resets the bold print modes.

Lines 4510 to 4530 print a copyright symbol in double-density graphics, and line 4540 prints the copyright message. Then we send the printer a Master Reset code to end the program. Line 4560 declares END for the printing portion of the program.

Subroutines. Line 10000 marks the beginning of the subroutines.

The first subroutine, lines 11000 to 11070, interacts with the coding in section 1 to print the 5 lines that begin with squares at the top of the form.

Lines 11010, 11020, and 11060 utilize MX line graphics characters to define those squares.

Lines 11030 to 11050 use the T$ strings in 1060 to 1100 and the subroutine in 12010 to extend those lines from the squares.

Line 12010 contains the subroutine to repeat A$ *N* number of times. This subroutine is used several times in the program. The BASIC function STRING$ can be used instead.

Lines 13000 to 13020 constitute the subroutine to print previously defined underline strings.

The DATA start at line 20000. Lines 22010 to 22030 hold the data for the box routine.

RX Series Printer Differences

RX Series printers have some unique features that require special techniques and other features that simplify the programming task. Figure 17-4 displays the RX printout and program listing.

Printers after Graftrax Plus *do* underline leading and trailing spaces, so lines 120 to 130 are slightly different. Also, the ESC codes that use a CHR$(1) or CHR$(0) for a toggle, such as Underline mode, can now use 1 or 0. This simplifies lines 120 to 130, 1010, 2030, 11030, and 11050.

We add another string definition in line 140 for RX printers only. Since RX printers don't have normal internal tabs, this string makes it easier to print blank spaces.

In line 1010, we add an ⟨ESC⟩"m"(4) to turn on the RX special character set. These RX line graphics characters fill out the complete character matrix with dots, unlike the Graftrax Plus characters, so the squares on this form fill in solidly with no gaps.

In line 1040, we set the horizontal tab increment with ⟨ESC⟩"e0" instead of setting horizontal tabs with ⟨ESC⟩"D".

In lines 4060 and 4120, we use a 0-dot line spacing to prevent a line feed when printing the column headings of the box.

In lines 4140 and 4160, instead of the STRING$ subroutine, we use S$, defined as ⟨ESC⟩"f0", to print blank spaces.

We print the copyright symbol in high-speed double-density graphics with ⟨ESC⟩"Y" in line 4510.

The numbers in lines 11010 to 11020 and 22010 to 22020 are different because RX line graphics characters have different ASCII codes than their MX counterparts.

CHAPTER MANAGEMENT RECORD

ENCLOSURES FOR CHAPTER: ____

☐ FIGURES: _____

☐ MISC FILES: _____

☐ PRINTOUTS: _____

☐ DISKETTES: _____

☐ ONE TIME ITEMS: _____

CIRCLE ITEMS THAT ARE *NOT* TO BE MODIFIED ON DISK.
CROSS OFF ONE-TIME-ONLY ITEMS WHEN RECEIVED.

CHAPTER DEVELOPMENT

SCHEDULED COMPLETION	DATE COMPLETED	INIT.	
__/__/__	__/__/__	____	1. RESEARCH TOPIC; DEVELOP EXAMPLES.
__/__/__	__/__/__	____	2. USE EXAMPLES TO PRODUCE FIRST DRAFT.
__/__/__	__/__/__	____	3. EDIT AND POLISH FIRST DRAFT.
__/__/__	__/__/__	____	4. TECHNICAL CHECK.
__/__/__	__/__/__	____	5. MORE POLISHING AND RESOLVE PROBLEMS.
__/__/__	__/__/__	____	6. CHAPTER CHECK LIST.
__/__/__	__/__/__	____	7. FIELD TESTING.
__/__/__	__/__/__	____	8. REVISIONS BASED ON TESTING.
__/__/__	__/__/__	____	9. SUBMISSION

FINAL PASS (☑)

☐ TRANSFER HARDCOPY CHANGES TO DISK.
☐ CHECK FIGURES.
☐ CHECK CAPTIONS.
☐ EDIT FOR FLOW.
☐ CHECK CHAPTER SUMMARIES.
☐ VERIFY REFERENCES TO OTHER PARTS OF BOOK.
☐ DELETE IN HOUSE NOTES.
☐ CHECK INDEX ENTRIES.
☐ CHECK CHAPTER HEADINGS AGAINST TABLE OF CONTENTS.
☐ CHECK SPELLING.
☐ PRINT CHAPTERS AND FIGURES FOR MAILING.

RESOLUTION	PROBLEM	SOLUTION	PROGRESS
__/__/__			
__/__/__			
__/__/__			

Figure 17-4 RX-80 form and listing.

```
100        *** DEFINE STRINGS ***
110 E$=CHR$(27): Z$=CHR$(0): H$=CHR$(9): Z5$=STRING$(5,0)
120 D1$ = E$+"-1    /    /    "+E$+"-0"
130 D2$ = E$+"-1     "+E$+"-0"
```

```
140 S$=E$+"f0"
1000 '
     '      <<< SECTION 1 >>>
     '
1010 LPRINT E$"1";E$"U1";E$"m"CHR$(4);
1020 LPRINT H$;H$;E$"G";E$"E";CHR$(14);"CHAPTER MANAGEMENT RECORD"
1030 LPRINT: LPRINT
1040 LPRINT E$"H";E$"e0"CHR$(4)
1050 LPRINT H$;"ENCLOSURES FOR CHAPTER: ";D2$: LPRINT
1060 T$="FIGURES": GOSUB 11000
1070 T$="MISC FILES": GOSUB 11000
1080 T$="PRINTOUTS": GOSUB 11000
1090 T$="DISKETTES": GOSUB 11000
1100 T$="ONE TIME ITEMS": GOSUB 11000
1110 LPRINT E$"F";E$"2"
1120 LPRINT H$;"CIRCLE ITEMS THAT ARE ";E$"4";"NOT";E$"5";
1130 LPRINT " TO BE MODIFIED ON DISK."
1140 LPRINT H$;"CROSS OFF ONE-TIME-ONLY ITEMS WHEN RECEIVED."
1150 LPRINT: LPRINT
2000 '
     '      <<< SECTION 2 >>>
     '
2010 LPRINT H$;E$"G";CHR$(15);CHR$(14);"CHAPTER DEVELOPMENT"
2020 LPRINT E$"F";E$"4";CHR$(18)
2030 LPRINT E$"S0";" SCHEDULED          DATE       INIT.";
2040 LPRINT E$"A"CHR$(5): LPRINT E$"2";
2050 LPRINT " COMPLETION     COMPLETED";E$"T"
2060 LPRINT E$"5"
2070 GOSUB 13010:LPRINT "    1. RESEARCH TOPIC; DEVELOP EXAMPLES."
2080 GOSUB 13010:LPRINT "    2. USE EXAMPLES TO PRODUCE FIRST DRAFT."
2090 GOSUB 13010:LPRINT "    3. EDIT AND POLISH FIRST DRAFT."
2100 GOSUB 13010:LPRINT "    4. TECHNICAL CHECK."
2110 GOSUB 13010:LPRINT "    5. MORE POLISHING AND RESOLVE PROBLEMS."
2120 GOSUB 13010:LPRINT "    6. CHAPTER CHECK LIST."
2130 GOSUB 13010:LPRINT "    7. FIELD TESTING."
2140 GOSUB 13010:LPRINT "    8. REVISIONS BASED ON TESTING."
2150 GOSUB 13010:LPRINT "    9. SUBMISSION"
2160 LPRINT: LPRINT
3000 '
     '      <<< SECTION 3 >>>
     '
3010 LPRINT E$"1";S$;CHR$(20);E$"L"CHR$(13)Z$;Z5$;Z$;Z$;
3020 LPRINT CHR$(3);CHR$(6);CHR$(12);
3030 LPRINT CHR$(24);CHR$(48);CHR$(96)
3040 LPRINT H$;CHR$(15);CHR$(14);E$"G";
3050 LPRINT "FINAL PASS ( ";
3060 LPRINT CHR$(18);"O";CHR$(15);" )";
3070 N=4: A$=CHR$(8): GOSUB 12010
3080 LPRINT E$"L"CHR$(20)Z$;
3090 LPRINT Z5$;Z5$;
3100 LPRINT CHR$(48);CHR$(24);CHR$(12);
3110 LPRINT CHR$(6);CHR$(6);CHR$(12);
3120 LPRINT CHR$(24);CHR$(48);CHR$(96);CHR$(192)
3130 LPRINT E$"H";CHR$(18);E$"2"
3140 LPRINT
3150 X$=" "+CHR$(14)+"O"+CHR$(20)+H$
3160 LPRINT X$;"TRANSFER HARDCOPY CHANGES TO DISK."
3170 LPRINT X$;"CHECK FIGURES."
3180 LPRINT X$;"CHECK CAPTIONS."
3190 LPRINT X$;"EDIT FOR FLOW."
3200 LPRINT X$;"CHECK CHAPTER SUMMARIES."
3210 LPRINT X$;"VERIFY REFERENCES TO OTHER PARTS OF BOOK."
3220 LPRINT X$;"DELETE IN HOUSE NOTES."
3230 LPRINT X$;"CHECK INDEX ENTRIES."
3240 LPRINT X$;"CHECK CHAPTER HEADINGS AGAINST TABLE OF CONTENTS."
3250 LPRINT X$;"CHECK SPELLING."
3260 LPRINT X$;"PRINT CHAPTERS AND FIGURES FOR MAILING."
3270 LPRINT: LPRINT
4000 '
     '      <<< SECTION 4 >>>
     '
4010 LPRINT E$"G"
4020 C=4: H=4
```

```
4030 FOR K=1 TO 5: READ L(K),M(K),N(K),R(K): NEXT K
4040 FOR K=1 TO C: READ W(K): NEXT K
4050 FOR L=1 TO 5: IF L=4 THEN FOR G=1 TO H
4060   IF L=4 AND G=3 THEN LPRINT " ";D1$; E$"A"Z$
4070   LPRINT CHR$(L(L));: FOR K = 1 TO C-1
4080   N=W(K): A$ = CHR$(M(L)): GOSUB 12010
4090   LPRINT CHR$(N(L));: NEXT K
4100   N=W(C): A$ = CHR$(M(L)): GOSUB 12010: LPRINT CHR$(R(L));
4110   IF L<>2 THEN 4190
4120   LPRINT E$"E";E$"H";E$"A"Z$
4130   FOR G=1 TO C: READ T$: D=(W(G)-LEN(T$)+1)/2
4140    LPRINT S$;CHR$(D);
4150    LPRINT T$;
4160    LPRINT S$;CHR$(D+1);
4170   NEXT G
4180   LPRINT E$;"G";E$"F";
4190   IF L<5 THEN LPRINT E$"1"
4200   IF L=4 THEN NEXT G: NR=NR+1: IF NR<3 THEN L=2
4210 NEXT L: LPRINT
4220 LPRINT E$"F";E$"H"
4230 LPRINT
4500 '      *** COPYRIGHT MESSAGE ***
4510 LPRINT E$"Y"CHR$(10)Z$;
4520 LPRINT Z$;CHR$(60);CHR$(66);CHR$(153);CHR$(165);CHR$(165);
4530 LPRINT CHR$(165);CHR$(129);CHR$(66);CHR$(60);
4540 LPRINT  " 1984.  EduKater"
4550 LPRINT E$"@"
4560 END
10000 '
      '      <<< SUBROUTINES >>>
      '
11000 '      *** PRINT SQUARES ROUTINE ***
11010 LPRINT CHR$(135)CHR$(133)CHR$(136)
11020 LPRINT CHR$(134)CHR$(160)CHR$(134);
11030 LPRINT H$;T$;": ";E$"-1";
11040 N=70-LEN(T$): A$=" ": GOSUB 12010
11050 LPRINT E$"-0"
11060 LPRINT CHR$(137)CHR$(133)CHR$(138)
11070 RETURN
12000 '      *** STRING$ ROUTINE ***
12010 FOR J = 1 TO N: LPRINT A$;: NEXT J: RETURN
13000 '      *** ? ROUTINE ***
13010 LPRINT " ";D1$;"    ";D1$;"    ";D2$;
13020 RETURN
20000 '
      '      <<< DATA >>>
      '
22000 '      *** BOX DATA ***
22010 DATA 135,133,130,136,134,160,134,134,132,133
22020 DATA 128,131,134,160,134,134,137,133,129,138
22030 DATA 12,20,20,20,"RESOLUTION","PROBLEM","SOLUTION","PROGRESS"
```

Figure 17-4 ***(Continued)***

FX Series Printer Differences

Once again, each printer is unique. FX printers add powerful capabilities but are missing some of the features of the RX and MX. Let's look at a printout of the FX form and a listing of the program in Figure 17-5.

Expanded graphics capability gives the FX seven graphic densities but does not include line graphics characters. To be consistent in our method of developing the squares for section 1 of the form, we defined a set of line graphics characters for this application. The user-defined character commands are entered in lines 21010 to 21110.

CHAPTER MANAGEMENT RECORD

ENCLOSURES FOR CHAPTER: ____

☐ FIGURES: _____

☐ MISC FILES: _____

☐ PRINTOUTS: _____

☐ DISKETTES: _____

☐ ONE TIME ITEMS: _____

CIRCLE ITEMS THAT ARE *NOT* TO BE MODIFIED ON DISK.
CROSS OFF ONE-TIME-ONLY ITEMS WHEN RECEIVED.

CHAPTER DEVELOPMENT

SCHEDULED COMPLETION	DATE COMPLETED	INIT.	
/ /	/ /	____	1. RESEARCH TOPIC; DEVELOP EXAMPLES.
/ /	/ /	____	2. USE EXAMPLES TO PRODUCE FIRST DRAFT.
/ /	/ /	____	3. EDIT AND POLISH FIRST DRAFT.
/ /	/ /	____	4. TECHNICAL CHECK.
/ /	/ /	____	5. MORE POLISHING AND RESOLVE PROBLEMS.
/ /	/ /	____	6. CHAPTER CHECK LIST.
/ /	/ /	____	7. FIELD TESTING.
/ /	/ /	____	8. REVISIONS BASED ON TESTING.
/ /	/ /	____	9. SUBMISSION

FINAL PASS (☑)

- ☐ TRANSFER HARDCOPY CHANGES TO DISK.
- ☐ CHECK FIGURES.
- ☐ CHECK CAPTIONS.
- ☐ EDIT FOR FLOW.
- ☐ CHECK CHAPTER SUMMARIES.
- ☐ VERIFY REFERENCES TO OTHER PARTS OF BOOK.
- ☐ DELETE IN HOUSE NOTES.
- ☐ CHECK INDEX ENTRIES.
- ☐ CHECK CHAPTER HEADINGS AGAINST TABLE OF CONTENTS.
- ☐ CHECK SPELLING.
- ☐ PRINT CHAPTERS AND FIGURES FOR MAILING.

RESOLUTION	PROBLEM	SOLUTION	PROGRESS
/ /			
/ /			
/ /			

Figure 17-5 FX-80 form and listing.

```
100       *** DEFINE STRINGS ***
110 E$=CHR$(27): Z$=CHR$(0): H$=CHR$(9): Z5$=STRING$(5,0)
120 D1$ = E$+"-1    /    /    "+E$+"-0"
130 D2$ = E$+"-1     "+E$+"-0"
200       *** DEFINE LINE GRAPHICS CHARACTERS ***
```

```
220 LPRINT E$":"Z$Z$Z$;
230 LPRINT E$"%"CHR$(1)Z$;
240 LPRINT E$"&"Z$"ak";
250 FOR Y=1 TO 11: LPRINT CHR$(139);
260 FOR X=1 TO 11: READ C: LPRINT CHR$(C);: NEXT X
270 NEXT Y
1000 '
     '      <<< SECTION 1 >>>
     '
1010 LPRINT E$"1";E$"U1";
1020 LPRINT H$;H$;E$"!8";"CHAPTER MANAGEMENT RECORD"
1030 LPRINT: LPRINT
1040 LPRINT E$"!"CHR$(8);E$"D"CHR$(4)CHR$(20)Z$
1050 LPRINT H$;"ENCLOSURES FOR CHAPTER: ";D2$: LPRINT
1060 T$="FIGURES": GOSUB 11000
1070 T$="MISC FILES": GOSUB 11000
1080 T$="PRINTOUTS": GOSUB 11000
1090 T$="DISKETTES": GOSUB 11000
1100 T$="ONE TIME ITEMS": GOSUB 11000
1110 LPRINT E$"!@";E$"2"
1120 LPRINT H$;"CIRCLE ITEMS THAT ARE ";E$"4";"NOT";E$"5";
1130 LPRINT " TO BE MODIFIED ON DISK."
1140 LPRINT H$;"CROSS OFF ONE-TIME-ONLY ITEMS WHEN RECEIVED."
1150 LPRINT: LPRINT
2000 '
     '      <<< SECTION 2 >>>
     '
2010 LPRINT H$;E$"!4";"CHAPTER DEVELOPMENT"
2020 LPRINT E$"!@";E$"4"
2030 LPRINT E$"SO";" SCHEDULED          DATE       INIT.";
2040 LPRINT E$"A"CHR$(5); LPRINT E$"2";
2050 LPRINT " COMPLETION      COMPLETED";E$"T"
2060 LPRINT E$"5"
2070 GOSUB 13010:LPRINT "    1. RESEARCH TOPIC; DEVELOP EXAMPLES."
2080 GOSUB 13010:LPRINT "    2. USE EXAMPLES TO PRODUCE FIRST DRAFT."
2090 GOSUB 13010:LPRINT "    3. EDIT AND POLISH FIRST DRAFT."
2100 GOSUB 13010:LPRINT "    4. TECHNICAL CHECK."
2110 GOSUB 13010:LPRINT "    5. MORE POLISHING AND RESOLVE PROBLEMS."
2120 GOSUB 13010:LPRINT "    6. CHAPTER CHECK LIST."
2130 GOSUB 13010:LPRINT "    7. FIELD TESTING."
2140 GOSUB 13010:LPRINT "    8. REVISIONS BASED ON TESTING."
2150 GOSUB 13010:LPRINT "    9. SUBMISSION"
2160 LPRINT: LPRINT
3000 '
     '      <<< SECTION 3 >>>
     '
3010 LPRINT E$"1";H$;H$;E$"L"CHR$(13)Z$;Z5$;Z$;Z$;
3020 LPRINT CHR$(3);CHR$(6);CHR$(12);
3030 LPRINT CHR$(24);CHR$(48);CHR$(96)
3040 LPRINT H$;E$"!4";
3050 LPRINT "FINAL PASS ( ";
3060 LPRINT CHR$(18);"O";CHR$(15);" )";
3070 N=4: A$=CHR$(8): GOSUB 12010
3080 LPRINT E$"L"CHR$(20)Z$;
3090 LPRINT Z5$;Z5$;
3100 LPRINT CHR$(48);CHR$(24);CHR$(12);
3110 LPRINT CHR$(6);CHR$(6);CHR$(12);
3120 LPRINT CHR$(24);CHR$(48);CHR$(96);CHR$(192)
3130 LPRINT E$"!@";E$"2"
3140 LPRINT
3150 X$=" "+CHR$(14)+"O"+CHR$(20)+H$
3160 LPRINT X$;"TRANSFER HARDCOPY CHANGES TO DISK."
3170 LPRINT X$;"CHECK FIGURES."
3180 LPRINT X$;"CHECK CAPTIONS."
3190 LPRINT X$;"EDIT FOR FLOW."
3200 LPRINT X$;"CHECK CHAPTER SUMMARIES."
3210 LPRINT X$;"VERIFY REFERENCES TO OTHER PARTS OF BOOK."
3220 LPRINT X$;"DELETE IN HOUSE NOTES."
3230 LPRINT X$;"CHECK INDEX ENTRIES."
3240 LPRINT X$;"CHECK CHAPTER HEADINGS AGAINST TABLE OF CONTENTS."
3250 LPRINT X$;"CHECK SPELLING."
3260 LPRINT X$;"PRINT CHAPTERS AND FIGURES FOR MAILING."
3270 LPRINT: LPRINT
4000 '
     '      <<< SECTION 4 >>>
     '
```

```
4010 LPRINT E$"G"
4020 C=4: H=4
4030 FOR K=1 TO 5: READ L$(K),M$(K),N$(K),R$(K): NEXT K
4040 FOR K=1 TO C: READ W(K): NEXT K
4050 FOR L=1 TO 5: IF L=4 THEN FOR G=1 TO H
4060 IF L=4 AND G=3 THEN LPRINT " ";D1$; E$"A"Z$
4070   LPRINT L$(L);: FOR K=1 TO C-1
4080   N=W(K): A$=M$(L): GOSUB 12010
4090   LPRINT N$(L);: NEXT K
4100   N=W(C): A$=M$(L): GOSUB 12010: LPRINT R$(L);
4110   IF L<>2 THEN 4190
4120   LPRINT E$"!"CHR$(8);E$"3"CHR$(3)
4130   FOR Q=1 TO C: READ T$: D = (W(Q)-LEN(T$)+1)/2
4140    N=D: A$=" ": GOSUB 12010
4150    LPRINT T$;
4160    N=D+1: A$=" ": GOSUB 12010
4170   NEXT Q
4180   LPRINT E$"!"CHR$(16);E$"j"CHR$(3);
4190   IF L<5 THEN LPRINT E$"1"
4200   IF L=4 THEN NEXT G: NR=NR+1: IF NR<3 THEN L=2
4210 NEXT L: LPRINT
4220 LPRINT E$"!@"
4230 LPRINT
4500 '      *** COPYRIGHT MESSAGE ***
4510 LPRINT E$"Y"CHR$(10)Z$;
4520 LPRINT Z$;CHR$(60);CHR$(66);CHR$(153);CHR$(165);CHR$(165);
4530 LPRINT CHR$(165);CHR$(129);CHR$(66);CHR$(60);
4540 LPRINT E$"%"Z$Z$; " 1984.  EduKater"
4550 LPRINT E$"@"
4560 END
10000 '
      '      <<< SUBROUTINES >>>
      '
11000 '      *** PRINT SQUARES ROUTINE ***
11010 LPRINT "ajb"
11020 LPRINT "k k";
11030 LPRINT H$;T$;": ";E$"-1";
11040 N=70-LEN(T$): A$=" ": GOSUB 12010
11050 LPRINT E$"-0"
11060 LPRINT "djc"
11070 RETURN
12000 '      *** STRING$ ROUTINE ***
12010 FOR J=1 TO N: LPRINT A$;: NEXT J: RETURN
13000 '      *** DATE ROUTINE ***
13010 LPRINT " ";D1$;"    ";D1$;"    ";D2$;
13020 RETURN
20000 '
      '      <<< DATA >>>
      '
21000 '      *** LINE GRAPHICS ***
21010 DATA 0,0,0,0,15,0,8,0,8,0,8:'a
21020 DATA 8,0,8,0,15,0,0,0,0,0,0:'b
21030 DATA 8,0,8,0,120,0,0,0,0,0,0:'c
21040 DATA 0,0,0,0,120,0,8,0,8,0,8:'d
21050 DATA 8,0,8,0,120,0,8,0,8,0,8:'e
21060 DATA 8,0,8,0,15,0,8,0,8,0,8:'f
21070 DATA 0,0,0,0,127,0,8,0,8,0,8:'g
21080 DATA 8,0,8,0,127,0,0,0,0,0,0:'h
21090 DATA 8,0,8,0,127,0,8,0,8,0,8:'i
21100 DATA 8,0,8,0,8,0,8,0,8,0,8:'j
21110 DATA 0,0,0,0,127,0,0,0,0,0,0:'k
22000 '      *** BOX DATA ***
22010 DATA a,j,f,b,k," ",k,k,g,j,i,h,k," ",k,k,d,j,e,c
22020 DATA 12,20,20,20,"RESOLUTION","PROBLEM","SOLUTION","PROGRESS"
```

Figure 17-5 ***(Continued)***

FX printers have the Master Print Mode Select command, ⟨ESC⟩"!". This allows us to turn on any combination of Elite, Compressed, Emphasized, Double-Strike, and Expanded modes. We use this command in line

CHAPTER MANAGEMENT RECORD

ENCLOSURES FOR CHAPTER: ____

☐ FIGURES: _____

☐ MISC FILES: _____

☐ PRINTOUTS: _____

☐ DISKETTES: _____

☐ ONE TIME ITEMS: _____

CIRCLE ITEMS THAT ARE *NOT* TO BE MODIFIED ON DISK.
CROSS OFF ONE-TIME-ONLY ITEMS WHEN RECEIVED.

CHAPTER DEVELOPMENT

SCHEDULED COMPLETION	DATE COMPLETED	INIT.	
__/__/__	__/__/__	____	1. RESEARCH TOPIC; DEVELOP EXAMPLES.
__/__/__	__/__/__	____	2. USE EXAMPLES TO PRODUCE FIRST DRAFT.
__/__/__	__/__/__	____	3. EDIT AND POLISH FIRST DRAFT.
__/__/__	__/__/__	____	4. TECHNICAL CHECK.
__/__/__	__/__/__	____	5. MORE POLISHING AND RESOLVE PROBLEMS.
__/__/__	__/__/__	____	6. CHAPTER CHECK LIST.
__/__/__	__/__/__	____	7. FIELD TESTING.
__/__/__	__/__/__	____	8. REVISIONS BASED ON TESTING.
__/__/__	__/__/__	____	9. SUBMISSION

FINAL PASS (✓)

- ☐ TRANSFER HARDCOPY CHANGES TO DISK.
- ☐ CHECK FIGURES.
- ☐ CHECK CAPTIONS.
- ☐ EDIT FOR FLOW.
- ☐ CHECK CHAPTER SUMMARIES.
- ☐ VERIFY REFERENCES TO OTHER PARTS OF BOOK.
- ☐ DELETE IN HOUSE NOTES.
- ☐ CHECK INDEX ENTRIES.
- ☐ CHECK CHAPTER HEADINGS AGAINST TABLE OF CONTENTS.
- ☐ CHECK SPELLING.
- ☐ PRINT CHAPTERS AND FIGURES FOR MAILING.

RESOLUTION	PROBLEM	SOLUTION	PROGRESS
__/__/__			
__/__/__			
__/__/__			

Figure 17-6 LQ-1500 form and listing.

```
100        *** DEFINE STRINGS ***
110 E$=CHR$(27): Z$=CHR$(0): H$=CHR$(9): Z5$=STRING$(5,0)
120 D1$ = E$+"-1    /    /    "+E$+"-0"
```

```
130 D2$ = E$+"-1     "+E$+"-0"
200 '     *** DEFINE LINE GRAPHIC CHARACTERS ***"
210 LPRINT E$"x0";
220 LPRINT E$";"Z$Z$Z$;
230 LPRINT E$"%"CHR$(1);
240 LPRINT E$"&"Z$"al";
250 FOR Y=1 TO 12: LPRINT Z$;CHR$(9);Z$;
260 FOR X=1 TO 27: READ C: LPRINT CHR$(C);: NEXT X
270 NEXT Y
1000 '
     '      <<< SECTION 1 >>>
     '
1010 LPRINT E$"A";CHR$(6);E$"U1";
1020 LPRINT H$;H$;E$"x1";CHR$(14);"CHAPTER MANAGEMENT RECORD"
1030 LPRINT: LPRINT E$"x0"
1040 LPRINT E$"!";CHR$(8);E$;"D"CHR$(4)CHR$(20)Z$
1050 LPRINT H$;"ENCLOSURES FOR CHAPTER: ";D2$: LPRINT
1060 T$="FIGURES": GOSUB 11000
1070 T$="MISC FILES": GOSUB 11000
1080 T$="PRINTOUTS": GOSUB 11000
1090 T$="DISKETTES": GOSUB 11000
1100 T$ = "ONE TIME ITEMS": GOSUB 11000
1110 LPRINT E$"!"Z$;E$"2"
1120 LPRINT H$;"CIRCLE ITEMS THAT ARE ";E$"4";"NOT";E$"5";
1130 LPRINT "  TO BE MODIFIED ON DISK."
1140 LPRINT H$;"CROSS OFF ONE-TIME-ONLY ITEMS WHEN RECEIVED."
1150 LPRINT: LPRINT
2000 '
     '      <<< SECTION 2 >>>
     '
2010 LPRINT H$;E$"!4";"CHAPTER DEVELOPMENT"
2020 LPRINT E$"!"Z$;E$"4"
2030 LPRINT E$"SO";" SCHEDULED          DATE       INIT.";
2040 LPRINT E$"A"CHR$(5): LPRINT E$"2";
2050 LPRINT" COMPLETION     COMPLETED";E$"T"
2060 LPRINT E$"5"
2070 GOSUB 13010:LPRINT "    1. RESEARCH TOPIC; DEVELOP EXAMPLES."
2080 GOSUB 13010:LPRINT "    2. USE EXAMPLES TO PRODUCE FIRST DRAFT."
2090 GOSUB 13010:LPRINT "    3. EDIT AND POLISH FIRST DRAFT."
2100 GOSUB 13010:LPRINT "    4. TECHNICAL CHECK."
2110 GOSUB 13010:LPRINT "    5. MORE POLISHING AND RESOLVE PROBLEMS."
2120 GOSUB 13010:LPRINT "    6. CHAPTER CHECK LIST."
2130 GOSUB 13010:LPRINT "    7. FIELD TESTING."
2140 GOSUB 13010:LPRINT "    8. REVISIONS BASED ON TESTING."
2150 GOSUB 13010:LPRINT "    9. SUBMISSION"
2160 LPRINT : LPRINT
3000 '
     '      <<< SECTION 3 >>>
     '
3010 LPRINT E$"A"CHR$(7);H$;H$;E$"L"CHR$(11)Z$;Z5$;
3020 LPRINT CHR$(3);CHR$(6);CHR$(12);
3030 LPRINT CHR$(24);CHR$(48);CHR$(96)
3040 LPRINT H$;E$"!4";
3050 LPRINT "FINAL PASS ( ";
3060 LPRINT CHR$(18);"0";CHR$(15);" )";
3070 LPRINT E$"$"CHR$(113)Z$;
3080 LPRINT E$"L"CHR$(20)Z$;
3090 LPRINT Z5$;Z5$;
3100 LPRINT CHR$(48);CHR$(24);CHR$(12);
3110 LPRINT CHR$(6);CHR$(6);CHR$(12);
3120 LPRINT CHR$(24);CHR$(48);CHR$(96);CHR$(192)
3130 LPRINT E$"!"Z$;E$"2"
3140 LPRINT
3150 X$=" "+CHR$(14)+"0"+CHR$(20)+H$
3160 LPRINT X$;"TRANSFER HARDCOPY CHANGES TO DISK."
3170 LPRINT X$;"CHECK FIGURES."
3180 LPRINT X$;"CHECK CAPTIONS."
3190 LPRINT X$;"EDIT FOR FLOW."
3200 LPRINT X$;"CHECK CHAPTER SUMMARIES."
3210 LPRINT X$;"VERIFY REFERENCES TO OTHER PARTS OF BOOK."
3220 LPRINT X$;"DELETE IN HOUSE NOTES."
3230 LPRINT X$;"CHECK INDEX ENTRIES."
3240 LPRINT X$;"CHECK CHAPTER HEADINGS AGAINST TABLE OF CONTENTS."
3250 LPRINT X$;"CHECK SPELLING."
3260 LPRINT X$;"PRINT CHAPTERS AND FIGURES FOR MAILING."
```

```
3970 LPRINT : LPRINT
4000 '
     '      <<< SECTION 4 >>>
     '
4010 LPRINT E$"G";E$"D"CHR$(2)CHR$(20)CHR$(40)CHR$(61)Z$
4020 C=4: H=4
4030 FOR K=1 TO 5: READ L$(K),M$(K),N$(K),R$(K): NEXT K
4040 FOR K=1 TO C: READ W(K): NEXT K
4050 FOR L=1 TO 5: IF L=4 THEN FOR G=1 TO H
4060 IF L=4 AND G=3 THEN LPRINT " ";D1$; E$"A"Z$
4070   LPRINT L$(L);: FOR K=1 TO C-1
4080   N=W(K): A$=M$(L): GOSUB 12010
4090   LPRINT N$(L);: NEXT K
4100   N=W(C): A$=M$(L): GOSUB 12010: LPRINT R$(L);
4110   IF L<>2 THEN 4190
4120   LPRINT E$"E";E$"A"CHR$(0)
4130   FOR Q=1 TO C: READ T$
4150    LPRINT H$;T$;
4170   NEXT Q
4180   LPRINT E$"I"CHR$(16);
4190   IF L<5 THEN LPRINT E$"A";CHR$(6)
4200   IF L=4 THEN NEXT G: NR=NR+1: IF NR<3 THEN L=2
4210 NEXT L: LPRINT
4220 LPRINT E$"I"Z$
4230 LPRINT
4500 '      *** COPYRIGHT MESSAGE ***
4510 LPRINT E$"Y"CHR$(10)Z$;
4520 LPRINT Z$;CHR$(60);CHR$(66);CHR$(153);CHR$(165);CHR$(165);
4530 LPRINT CHR$(165);CHR$(129);CHR$(66);CHR$(60);
4540 LPRINT E$"%"Z$Z$; " 1984.  EduKater"
4550 LPRINT E$"@"
4560 END
10000 '
     '      <<< SUBROUTINES >>>
     '
11000 '      *** PRINT SQUARES ROUTINE ***
11010 LPRINT "ajjb"
11020 LPRINT "kllk";
11030 LPRINT H$;T$;": ";E$"-1";
11040 N=70-LEN(T$): A$=" ": GOSUB 12010
11050 LPRINT E$"-0"
11060 LPRINT "djjc"
11070 RETURN
12000 '      *** STRING$ ROUTINE ***
12010 FOR J=1 TO N: LPRINT A$;: NEXT J: RETURN
13000 '      *** DATE ROUTINE ***
13010 LPRINT " ";D1$;"    ";D1$;"    ";D2$;
13020 RETURN
20000 '
     '      <<< DATA >>>
     '
21000 '      *** LINE GRAPHICS ***
21010 DATA 0,0,0,0,0,0,0,0,0,0,0,0,255,192,0,0,0,0,128,0,0,0,0,0,128,0:'a
21020 DATA 0,128,0,0,0,0,0,128,0,0,0,0,0,255,192,0,0,0,0,0,0,0,0,0,0,0:'b
21030 DATA 0,128,0,0,0,0,0,128,0,0,0,0,255,128,0,0,0,0,0,0,0,0,0,0,0:'c
21040 DATA 0,0,0,0,0,0,0,0,0,0,0,0,255,128,0,0,0,0,0,128,0,0,0,0,0,128,0:'d
21050 DATA 0,128,0,0,0,0,0,128,0,0,0,0,255,128,0,0,0,0,0,128,0,0,0,0,0,128,0:'e
21060 DATA 0,128,0,0,0,0,0,128,0,0,0,0,0,255,192,0,0,0,0,128,0,0,0,0,0,128,0:'f
21070 DATA 0,0,0,0,0,0,0,0,0,0,0,0,255,255,192,0,0,0,0,128,0,0,0,0,0,128,0:'g
21080 DATA 0,128,0,0,0,0,0,128,0,0,16,0,255,255,192,0,0,0,0,0,0,0,0,0,0,0:'h
21090 DATA 0,128,0,0,0,0,0,128,0,0,0,0,255,255,192,0,0,0,0,128,0,0,0,0,0,128,0:'i
21100 DATA 0,128,0,0,0,0,0,128,0,0,0,0,0,128,0,0,0,0,0,128,0,0,0,0,0,128,0:'j
21110 DATA 0,0,0,0,0,0,0,0,0,0,0,0,255,255,192,0,0,0,0,0,0,0,0,0,0,0:'k
21120 DATA 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0:'l
22000 '      *** BOX DATA ***
22010 DATA a,j,f,b,k,l,k,k,g,j,i,h,k,l,k,k,d,j,e,c
22020 DATA 16,26,27,27,"RESOLUTION","PROBLEM","SOLUTION","PROGRESS"
```

Figure 17-6 ***(Continued)***

1020 to turn on Expanded, Double-Strike, and Emphasized modes. We also use it in lines 1040, 1110, 2010, 2020, 3040, 3130, 4120, 4180, and 4220.

The FX-80 has a reverse line feed, which we use in line 4180. It vertically centers the column headings in the box after a forward line feed of 3/216 inch in line 4120. For the FX-100, since it doesn't have reverse line feed, change the end of line 4120 to E$"3"CHR$(0).

Data in lines 21010 to 21110 contain the pin patterns for the user-defined line graphics characters.

Data in line 22010 are different since the line graphics characters are defined as characters a through k.

LQ-1500 Printer Differences

The LQ printer brings a flock of new options and features to any programming activity. However, for comparative purposes we keep our forms program consistent with the previous examples, as you can see in Figure 17-6.

However, we do indulge ourselves with one new feature of the 24-wire printer; line 1020 prints the title in Expanded Near-Letter-Quality mode.

Since LQ printers don't have the ⟨ESC⟩"1" command, line 3010 sets a comparable line spacing with ⟨ESC⟩"A"(7) to print the check mark in 2 lines of graphics.

As with the FX, we define line graphics characters for the LQ, but with an added character, 1, for a blank space.

We define the line graphics characters to be 18 dots high, which works out to 9/60 inch, so in lines 1010 and 4200 we use ⟨ESC⟩"A"(6) line spacing.

The data in lines 21010 to 21120 are different because each user-defined character requires 27 bytes of data.

The line graphic characters defined by this data are printed in two different modes: Emphasized in section 1 and normal in section 2. Even though we used the full 9 columns allowed in defining draft characters and set the left and right margins to 0, the characters are not continuous. See the section 4 printout. But in section 1, Emphasized mode adds just enough to fill in the horizontal lines.

The LQ logic features a one-pass backspace function. To accomplish this task, the printer simulates a backspace by overlaying dot patterns of characters in memory and then prints the line in one pass. This speeds up printing but has some drawbacks. For one thing, it doesn't work so well with graphics, so we can't use the backspace in section 3 as in the FX and RX programs. In line 3070, we move the print head backward with the Absolute Dot Positioning command, ⟨ESC⟩"$".

The Master Select command differs on the FX and LQ printer lines. ⟨ESC⟩"!@" returns to default on the FX; ⟨ESC⟩"!"(0) does it on the LQ.

The routine used on the other printers to center the headings in section 4 does not work on the LQ, because the line graphics characters are not the same width as text characters. So we set new tabs in line 4010 and use them in line 4150 to position the headings.

Summary

This chapter presents four versions of the BASIC language program and the printout of a form called Chapter Management Record. This form and the accompanying discussion are used to highlight differences in programming necessary for the four leading Epson printers: MX Graftrax Plus, RX, FX, and LQ-1500.

Part

5

Communicating with the Printer

Chapter

18

The Printer-Computer Link

Giving Orders

One of the attractive aspects of working with a computer is the way it instantly obeys your every command. No back talk, not even the slightest hesitation. Only in order to communicate your desires, you have to learn to speak its language. Sure, that part is getting easier all the time, but there is still a lot to learn.

Writing a BASIC program requires learning one set of commands, and using DBASE II requires another. And the list goes on.

Communicating with a printer demands mastery of the printer's code structure. Each printer responds only to its own unique list of commands. To further complicate matters, there is a long chain of intermediates that handle the message from your fingertips until it actually plops down on the paper as pearls of wisdom.

Think about it. You type data into the computer. The data are accepted by a software program (perhaps a word processing program, programming language, or graphing program). This program interprets your data according to its own rules and then sends the data to the printer.

The next stopping point is the printer interface logic, which is located inside the computer. It handles the communications protocols with the printer. This logic is sometimes designed to intercept control codes you may have intended for the printer and then use them internally. Otherwise, it simply does its job and sends the data along a cable.

At the end of the cable is . . . the printer! But that's not the end of the story. Data are collected by the printer logic 1 byte at a time and then interpreted. Control codes are processed immediately, while data are sent to a special holding area of memory called the buffer.

Buffer sizes range from 1 line to 2K on Epson printers. Characters pile into the buffer one at a time until the buffer fills or a buffer printing ESC

code is received. Then the printer sends a message to the computer telling it to stop sending codes. When the contents of the buffer are printed, the printer transmits a message to resume sending data.

And if everything goes according to plan, the end result is a happy end user.

Clearly, there is a lot going on between the time you tell the computer program to print your data and the time it hits the paper. And all it takes is one out-of-sorts cook to spoil the broth.

We examine all links in this chain, starting with the software.

Software Programs

In terms of our chain of communications, the job of the software program is to accept data from your fingers, compile the data, and send the data, in the proper format, to the printer. In order to do this, the program has to know what printer is connected to it and what codes are required. Applications programs that make heavy use of the printer often store information that is unique to each printer in separate files called printer drivers. With this arrangement, a change in printers entails only a change in printer drivers, not a new applications program.

From the user's point of view, the problem starts when you try to use a software program that has no printer driver for your printer. Then you have to create your own, if possible, or pick one that is close to yours. Even if your printer is supported, you may want to use functions that the printer driver does not implement.

Computer languages are subject to some of the same problems as applications programs. In most cases, a language is stuck with some fixed printer driver and has to live with the limitations. These drivers may have their own ways of doing things. For instance, Radio Shack printers are not expected to keep track of the top-of-form position; the computer handles all the top-of-form details. When a user sends a form-feed code (12 decimal), the printer driver program intercepts it, calculates the number of lines to the next top of form, and sends out that number of line feeds (10 decimal). This is fine for printing text, but can you imagine the surprise awaiting unsuspecting users the first time they use a 12 in the middle of a graphics data string and get thirty-five 10s instead?

Horror stories like this abound. Each computer and program has its limitations and surprises. The best thing for a user to do is stay informed. Attend user's groups and keep up with the periodicals for solutions. The Radio Shack problem was resolved for some of us alert users when someone published a magazine article with a simple BASIC program that fixed this and other problems. So keep your eyes peeled for solutions.

On many computers, the printer interface logic is contained on a removable circuit card. These cards can swallow codes as easily as internal

printer drivers do. The original Apple II interface card used to swallow 9s along with the next number or two. In addition, it deactivated the top data bit, limiting all numbers to the range 0 to 127 instead of 0 to 255. There are other cards on the market that eliminate some of these problems. Again, it is important to stay informed by reading the trade journals and your user's manuals for solutions to computer idiosyncrasies.

Cable Connection

The simplest part of the link between printer and computer is the cable. It is simply a series of wires through which all data pass. But the simplicity is deceptive. Both computer and printer have software which regulates the flow of data through the printer cable. The primary purpose of this software is to compensate for the fundamental difference in speed between the rate at which data can be transmitted through the cable and the rate at which the printer can print. Whereas a microcomputer can send over 100,000 characters per second, microcomputer printers are usually limited to a range of 10 to 200 characters per second. Obviously, something has to regulate the flow of information, or much of it will get lost in translation if not in transmission.

Epson printers handle this rapid influx of data with an input buffer. All data received from the computer are stored in this buffer. Control codes are separated out, and printable data are converted to dot patterns. Finally, the data are printed in the format determined by the currently active control codes. Meanwhile, the computer and printer are in constant communication. The printer tells the computer to wait while it prints each line. When a line is printed, the printer signals the computer for more data, and the cycle starts again. Several of the wires in the cable are used for this feedback system.

There are two principal ways of transmitting data to printers: serial and parallel. In both cases, the computer is connected to the printer with a cable consisting of several wires. These wires are used to send high and low pulses (bits) to the printer. The printer interprets each collection of 8 bits as a character (byte).

In a *serial* connection, the pulses are sent one at a time over a single wire (in serial). The printer collects these pulses as they come in, bundles them in groups of 8, and then sends them on to other parts of the printer's logic. Figure 18-1 shows the pin assignments for Epson 8143 serial interface board.

Data are received on line 3; the other lines are used primarily to monitor the flow of data.

In a *parallel* connection, 8 wires are reserved for sending data, with each wire representing 1 bit. The computer sends all 8 bits simultaneously (in parallel). Epson printers support the parallel standard established by

Pin No.	Signal	Direction	Description
1	Protective GND		Printer chassis ground
2	Transmitted data (TXD)	To printer	This signal is normally at "MARK"
3	Received data (RXD)	To computer	Serial input data
6	Data set ready (DSR)	To computer	This signal must be at the space level (the positive EIA) for the printer to receive data
7	Signal ground		Return path for data and control signals
8	Data carrier detect (DCD)	To computer	This signal must be at the space level for the printer to receive data.
11 20	Reverse channel (= 2nd RTS) Data terminal ready (DTR)	To printer To printer	These signals show the printer is at the busy level. These signals are at the space level (the positive EIA) when the printer is ready to accept data entry. Operator can invert the polarity of these signals by using an internal jumper.
17 24	TTY-TXD TTY-TXD Return	To printer	Low impedance ("MARK") between Pin nos. 17 and 24 when the printer is busy; high impedance when the printer is ready to accept data Operator can invert the polarity of these signals by using an internal jumper.
25	TTY-RXD		Input data of serial current loop
23	TTY-RXD Return		

Note: All signals except TTY-TXD and TTY-RXD are based on EIA RS-232C level.
Source: "FX-80 Specifications Bulleting for U.S.A. and Europe," September 23, 1982, P8294008, rev. C, pp. 24–25, unpublished work.

Figure 18-1 Serial pin assignments. Interface connector: EIA Standard 25-pin Cannon type. *(Courtesy of Epson America, Inc.)*

Centronics Corporation. Figure 18-2 shows the pin assignments for this interface.

Now, which kind of interface is right for you? Well, parallel is faster by far; thus, it is the preferred interface. And because of its popularity, parallel is the default port used for printer output on most microcomputers. On the IBM PC, for example, the LPT1: (or parallel printer #1) is the default printer for most software applications. Therefore, parallel is a good choice for ease of installation and integration of "canned software."

But parallel does have one limitation. The parallel interface signal deteriorates at distances over 20 feet. For one computer-one printer setups, this is rarely a problem. But many large businesses use a single printer to

Signal Pin No.	Return Pin No.	Signal	Direction	Description
1	19	STROBE	In	STROBE pulse to read data in. Pulse width must be more than 0.5 μs at receiving terminal
2	20	DATA 1	In	These signals represent information of the 1st to 8th bits of parallel data, respectively. Each signal is at "HIGH" level when data is logical "1" and "LOW" when logical "0"
3	21	DATA 2	In	
4	22	DATA 3	In	
5	23	DATA 4	In	
6	24	DATA 5	In	
7	25	DATA 6	In	
8	26	DATA 7	In	
9	27	DATA 8	In	
10	28	ACKNLG	Out	Approx. 9 μs pulse. "LOW" indicates that data have been received and that the printer is ready to accept other data.
11	29	BUSY	Out	A "HIGH" signal indicates that the printer cannot receive data. The signal becomes "HIGH" in the following cases: 1. During data enty 2. During printing operation 3. In OFF-LINE state 4. During printer error status
12	30	PE	Out	A "HIGH" signal indicates that the printer is out of paper.
13	—	—	—	Pulled up to +5V through 3.3 kΩ resistance
14	—	AUTO FEED XT	In	With this signal at "LOW" level, the paper is automatically fed one line after printing. (The signal level can be fixed to "LOW" with DIP 1-3 provided on the interface circuit board.)
15	—	NC	—	Not used.
16	—	OV	—	Logic GND level.
17	—	CHASSIS GND.	—	Printer chassis GND. In the printer, the chassis GND and the logic GND are isolated from each other.
18	—	NC	—	Not used.
19 to 30	—	GND	—	TWISTED-PAIR RETURN signal GND level.
31	—	$\overline{\text{INIT}}$	In	When the level of this signal becomes "LOW", the printer controller is reset to its initial state and the print buffer is cleared. This signal is normally at "HIGH" level, and its pulse width must be more than 50 μs at the receiving terminal.

Figure 18-2 Parallel pin assignments. Connector: 57-30360 (Amphenol). *(Courtesy of Epson America, Inc.)*

Signal Pin No.	Return Pin No.	Signal	Direction	Description
32	—	$\overline{\text{ERROR}}$	Out	The level of this signal becomes "LOW" when the printer is in 1. PAPER END state 2. OFF-LINE state 3. Error state
33	—	GND	—	Same as with Pin nos. 19 to 30.
34	—	NC	—	Not used.
35	—	—	—	Pulled up to +5V through 3.3 kΩ resistance.
36	—	$\overline{\text{SLCT IN}}$	In	The DC1/DC3 code is only valid when this signal is "HIGH" level. (Internal fixing can be carried out with DIP 2-8. The level of this signal is factory-set to "LOW".)

Notes:

1. "Direction" refers to the direction of signal flow as viewed from the printer.
2. "Return" denotes "TWISTED PAIR RETURN" and is to be connected at signal ground level.

As to the wiring for the interface, be sure to use a twisted-pair cable for each signal and never fail to complete connection on the Return side. To prevent noise effectively, these cables should be shielded and connected to the chassis of the host computer and the printer, respectively.

3. All interface conditions are based on TTL level. Both the rise and fall times of each signal must be less than 0.2 μs.
4. Data transfer must not be carried out by ignoring the $\overline{\text{ACKNLG}}$ or BUSY signal. (Data transfer to this printer can be carried out only after confirming the $\overline{\text{ACKNLG}}$ signal or when the level of the BUSY signal is "LOW".)
5. Under normal conditions, printer cable pins 11, 12 and 32 are activated when out of paper is detected.

ESC 8 code disable pins 11 and 32 from the PE(PaPer-End)signal, but it does not disable pin 12.

Although most computers do not monitor pin 12, those which do (e.g., TRS-80) will halt printing when the paper is out. Therefore, ESC 8 code is ineffective with these computers unless pin 12 is disconnected.

Source: Epson Parallel Interface Unit #7171 Use Manual, Epson America, Inc., 1983.

Figure 18-2 ***(Continued)***

service several remotely located terminals. That's where serial comes in handy. The serial signals are reliable up to about 400 feet or so. So schools, large businesses, and other groups that require communications over distances are typically wired exclusively for serial.

Epson printers use a standard parallel interface, but all can be converted to serial with the purchase of an additional serial card. Only folks who already have serial cards in their computers or who need printers at remote locations must use serial connections.

Printer Buffer

The next stop in the journey of data from the computer across the cable is the input buffer of the printer. For Epson printers, the capacity of this

buffer ranges from 1 line to 2K (2048 bytes), depending on the printer. The LQ has two additional 15K internal buffers, but that's a story for another time.

The job of the input buffer is to collect a stream of data from the computer, separate the text from the control codes, assemble a line of print following the direction of the embedded commands, and send the complete text to the print head for printing.

The 1-line buffers are designed to automatically send their contents to be printed when they fill up. There are also commands that activate the printing process. The line-feed (LF, 10 decimal) and carriage-return (CR, 13 decimal) codes naturally cause buffer contents to be printed. Computers automatically send a line feed or both line-feed and carriage-return codes at the end of every text line.

There are other codes that cause the buffer to print its contents before the print line is completely assembled. Any of the Graphics mode commands, ⟨ESC⟩"K", ⟨ESC⟩"*", etc., immediately cause the buffer to empty its contents. In fact, the majority of control codes activate the printing of the latest segment of the print line.

Now why would anyone care whether a line is printed in short bursts or printed all at once? If your program uses any of the codes CAN (24), DEL (127), or ⟨ESC⟩"@" (27, 64), you'll want to be aware of what is currently in the buffer and what is safely printed on the paper.

These three codes all delete portions of the printer buffer. The Delete code cancels the last text character placed in the buffer. The Cancel code deletes all the data stored in the buffer for the current print line. The Master Reset code (⟨ESC⟩"@") deletes the entire contents of the current print line and resets all print modes to their defaults. Even the left and right margin commands (⟨ESC⟩"l" and ⟨ESC⟩"Q") erase the current print line. So you can see that it is important to handle these codes with care when valuable data are still stored in the buffer. A safe rule is to use all buffer deleting commands *only at the beginning* of a print line.

External Printer Buffers

One final thought on buffers. Several companies produce separate buffers that can store from 8 to 64K of data. Some are external boxes; others are designed to fit right inside the Epson printers. These devices intercept the message from the computer on its way to the printer. The buffer then doles out data to the printer as the printer can handle the data, freeing the computer for other duties. This is particularly useful in sites where large volumes of data, such as text files or accounting reports, would otherwise tie up the computer.

The Printer Responds

What happens to the data once they successfully traverse the cable into the printer buffer? It depends on the data and the printer. The result of all the sophisticated interface logic boils down to one simple fact: Your computer can send numbers from 0 through 255 to the printer. Now, what the printer does with these numbers depends on the printer. Each printer has an internal table that translates those numbers into symbols to be printed or into actions. See Figure 18-3.

Notice that not all the numbers are associated with symbols. Some

Dec.	Hex.	Char./ Func.	Dec.	Hex.	Char./ Func.	Dec.	Hex.	Char./ Func.	Dec.	Hex.	Char./ Func.
0	00	None	64	40	@	128	80	None	192	C0	@
1	01	None	65	41	A	129	81	None	193	C1	*A*
2	02	None	66	42	B	130	82	None	194	C2	*B*
3	03	None	67	43	C	131	83	None	195	C3	*C*
4	04	None	68	44	D	132	84	None	196	C4	*D*
5	05	None	69	45	E	133	85	None	197	C5	*E*
6	06	None	70	46	F	134	86	None	198	C6	*F*
7	07	BEL	71	47	G	135	87	BEL	199	C7	*G*
8	08	BS	72	48	H	136	88	BS	200	C8	*H*
9	09	HT	73	49	I	137	89	HT	201	C9	*I*
10	0A	LF	74	4A	J	138	8A	LF	202	CA	*J*
11	0B	VT	75	4B	K	139	8B	VT	203	CB	*K*
12	0C	FF	76	4C	L	140	8C	FF	204	CC	*L*
13	0D	CR	77	4D	M	141	8D	CR	205	CD	*M*
14	0E	SO	78	4E	N	142	8E	SO	206	CE	*N*
15	0F	SI	79	4F	O	143	8F	SI	207	CF	*O*
16	10	None	80	50	P	144	90	None	208	D0	*P*
17	11	DC1	81	51	Q	145	91	DC1	209	D1	*Q*
18	12	DC2	82	52	R	146	92	DC2	210	D2	*R*
19	13	DC3	83	53	S	147	93	DC3	211	D3	*S*
20	14	DC4	84	54	T	148	94	DC4	212	D4	*T*
21	15	None	85	55	U	149	95	None	213	D5	*U*
22	16	None	86	56	V	150	96	None	214	D6	*V*
23	17	None	87	57	W	151	97	None	215	D7	*W*
24	18	CAN	88	58	X	152	98	CAN	216	D8	*X*
25	19	None	89	59	Y	153	99	None	217	D9	*Y*
26	1A	None	90	5A	Z	154	9A	None	218	DA	*Z*
27	1B	ESC	91	5B	[	155	9B	ESC	219	DB	[
28	1C	None	92	5C	\	156	9C	None	220	DC	\
29	1D	None	93	5D	]	157	9D	None	221	DD	]
30	1E	None	94	5E	^	158	9E	None	222	DE	^

Figure 18-3 Typical ASCII table. *(Courtesy of Epson America, Inc.)*

Dec.	Hex.	Char./ Func.	Dec.	Hex.	Char./ Func.	Dec.	Hex.	Char./ Func.	Dec.	Hex.	Char./ Func.
31	1F	None	95	5F	-	159	9F	None	223	DF	-
32	20	b	96	60	'	160	A0	b	224	E0	'
33	21	!	97	61	a	161	A1	!	225	E1	a
34	22	"	98	62	b	162	A2	"	226	E2	b
35	23	#	99	63	c	163	A3	#	227	E3	c
36	24	$	100	64	d	164	A4	$	228	E4	d
37	25	%	101	65	e	165	A5	%	229	E5	e
38	26	&	102	66	f	166	A6	&	230	E6	f
39	27	'	103	67	g	167	A7	'	231	E7	g
40	28	(	104	68	h	168	A8	(	232	E8	h
41	29	)	105	69	i	169	A9	)	233	E9	i
42	2A	*	106	6A	j	170	AA	*	234	EA	j
43	2B	+	107	6B	k	171	AB	+	235	EB	k
44	2C	,	108	6C	l	172	AC	,	236	EC	l
45	2D	-	109	6D	m	173	AD	-	237	ED	m
46	2E	.	110	6E	n	174	AE	.	238	EE	n
47	2F	/	111	6F	o	175	AF	/	239	EF	o
48	30	0	112	70	p	176	B0	0	240	F0	p
49	31	1	113	71	q	177	B1	1	241	F1	q
50	32	2	114	72	r	178	B2	2	242	F2	r
51	33	3	115	73	s	179	B3	3	243	F3	s
52	34	4	116	74	t	180	B4	4	244	F4	t
53	35	5	117	75	u	181	B5	5	245	F5	u
54	36	6	118	76	v	182	B6	6	246	F6	v
55	37	7	119	77	w	183	B7	7	247	F7	w
56	38	8	120	78	x	184	B8	8	248	F8	x
57	39	9	121	79	y	185	B9	9	249	F9	y
58	3A	:	122	7A	z	186	BA	:	250	FA	z
59	3B	;	123	7B	{	187	BB	;	251	FB	{
60	3C	<	124	7C	:	188	BC	<	252	FC	:
61	3D	=	125	7D	}	189	BD	=	253	FD	}
62	3E	>	126	7E	~	190	BE	>	254	FE	~
63	3F	?	127	7F	DEL	191	BF	?	255	FF	DEL

Source: David A. Kater, *FX Series Printer User's Manual,* Espon America, Inc., 1984.

numbers cause the printer to do actions such as a carriage return or to ring a bell. But that is only half the story. Printers also have the ability to change their mood or mode. Epson printers are chock-full of features, including underline, italics, superscript, subscript, and a variety of different pitches. These features are activated by, you guessed it, numbers. Actually, most are activated by sequences of numbers starting with 27, the Escape code. Control codes for the LQ printer are listed in Figure 18-4.

	Code			
	Dec.	Hex.	Symbol	Name
	7	07	BEL	Bell
	8	08	BS	Backspace
	9	09	HT	Horizontal tab
	10	0A	LF	Line feed
	11	0B	VT	Vertical tab
	12	0C	FF	Form feed
	13	0D	CR	Carriage return
	14	0E	SO	Set enlarged mode with auto-reset
	15	0F	SI	Set condensed mode
	17	11	DC1	Select printer
	18	12	DC2	Cancel condensed mode
	19	13	DC3	Deselect printer
	20	14	DC4	Cancel enlarged mode with auto-reset
	24	18	CAN	Cancel
	27	1B	ESC	Escape
⟨ESC⟩	14	0E	SO	Set enlarged mode with auto-rest
⟨ESC⟩	15	0F	SI	Set condensed mode
⟨ESC⟩	32	20	(space)	Set character space
⟨ESC⟩	33	21	!	Select print mode
⟨ESC⟩	35	23	#	Cancel MSB control
⟨ESC⟩	36	24	$	Set absolute dot position
⟨ESC⟩	37	25	%	Select/deselect download character
⟨ESC⟩	38	26	&	Define download characters
⟨ESC⟩	42	2A	*	Select a bit image mode
⟨ESC⟩	45	2D	-	Set/cancel underline mode
⟨ESC⟩	47	2F	/	Select a VFU channel
⟨ESC⟩	48	30	0	Set 1/8 inch line space
⟨ESC⟩	50	32	2	Set 1/6 inch line space
⟨ESC⟩	51	33	3	Set *n*/180 inch line space
⟨ESC⟩	52	34	4	Set Italics character mode
⟨ESC⟩	53	35	5	Cancel Italics character mode
⟨ESC⟩	56	38	8	Disable paper-end detection
⟨ESC⟩	57	39	9	Enable paper-end detection
⟨ESC⟩	58	3A	:0	Copy ROM character set
⟨ESC⟩	60	3C	⟨	Home printer head
⟨ESC⟩	61	3D	=	Reset MSB
⟨ESC⟩	62	3E	⟩	Set MSB
⟨ESC⟩	63	3F	?	Assign bit image mode
⟨ESC⟩	64	40	@	Initialize printer

Figure 18-4 LQ control codes. *(Courtesy of Epson America, Inc.)*

	Code			
	Dec.	Hex	Symbol	Name
⟨ESC⟩	65	41	A	Set *n*/60 inch line space
⟨ESC⟩	66	42	B	Set vertical tab positions
⟨ESC⟩	67	43	C	Set form length in lines
⟨ESC⟩			C 0	Set form length in inches
⟨ESC⟩	68	44	D	Set horizontal tab positions
⟨ESC⟩	69	45	E	Set Emphasized mode
⟨ESC⟩	70	46	F	Cancel Emphasized mode
⟨ESC⟩	71	47	G	Set Double-Strike mode
⟨ESC⟩	72	48	H	Cancel Double-Strike mode
⟨ESC⟩	74	4A	J	*n*/180 inch line feed
⟨ESC⟩	75	4B	K	Set Normal-Density bit image mode
⟨ESC⟩	76	4C	L	Set Dual-Density bit image mode
⟨ESC⟩	77	4D	M	Set Elite-size mode
⟨ESC⟩	78	4E	N	Set skip over perforation
⟨ESC⟩	79	4F	O	Cancel skip over perforation
⟨ESC⟩	80	50	P	Cancel Elite-size mode
⟨ESC⟩	81	51	Q	Set right margin
⟨ESC⟩	82	52	R	Select international character set
⟨ESC⟩	83	53	S O	Set Superscript mode
			S 1	Set Subscript mode
⟨ESC⟩	84	54	T	Cancel Superscript/Subscript mode
⟨ESC⟩	85	55	U	Select print direction
⟨ESC⟩	86	56	V	Set repetitive print data
⟨ESC⟩	87	57	W	Set/cancel Enlarged mode
⟨ESC⟩	89	59	Y	Set double-speed, dual-density bit image mode
⟨ESC⟩	90	5A	Z	Set Quadruple-Density bit image mode
⟨ESC⟩	92	5C	\	Set relative dot position
⟨ESC⟩	98	62	b	Set VFU position
⟨ESC⟩	108	6C	l	Set left margin
⟨ESC⟩	112	70	p	Set/cancel Proportional mode
⟨ESC⟩	115	73	s	Set/cancel half-speed printing
⟨ESC⟩	120	78	x	Select Draft/NLQ
	127	7F	DEL	Delete

Source: LQ-1500 Operating Manual, Epson America, Inc. 1983.

Figure 18-4 ***(Continued)***

Do you need to understand all these functions and the code sequences used to activate them? That depends. If your applications programs do everything you want them to do, every time, with no malfunctions and no surprises, then congratulations! You haven't a care in the world. You are the exception!

More typically, you will want to do something with the printer that your programs don't normally handle or use a printer that is not supported by a particular program. Most typically, you can't get the old program to run with a different printer or a new program with the old printer.

The more you know about your printer and about the chain of interfaces that this chapter discusses, the better prepared you will be to quickly resolve these downtime situations and get on with productive output and the creative stuff.

We sincerely hope this book has opened some new doors for you and has contributed to a happier relationship between you and your printer.

Summary

The communications chain between user and printed hard copy includes computer keyboard, software, interface logic, cable, printer interface, and printer buffer.

Software programs must be used with a printer driver that is compatible with the printer being used.

Epson printers are set for parallel interface but can be used in serial interface with the proper cable and a special serial card. Users should select their preferred interface modes and set up accordingly.

Printer buffers collect data coming from the computer and control both the rate of input from the computer and the output to the paper. Certain commands—Delete, Cancel, Master Reset (⟨ESC⟩"@"), and the left and right margin commands (⟨ESC⟩"l" and ⟨ESC⟩"Q")—erase all or a portion of the data in the buffer.

Every printer has its own unique set of responses to ASCII codes and control codes that are received from the computer. Familiarity with all the characteristics of a printer helps a user maximize the utility of the printer and more effectively resolve problem situations.

Appendix A

TABLE A-1 ASCII Code Summary

Dec.	Hex.	Char./ Func.	Dec.	Hex.	Char./ Func.	Dec.	Hex.	Char./ Func.	Dec.	Hex.	Char./ Func.
0	00	None	64	40	@	128	80	None	192	C0	@
1	01	None	65	41	A	129	81	None	193	C1	*A*
2	02	None	66	42	B	130	82	None	194	C2	*B*
3	03	None	67	43	C	131	83	None	195	C3	*C*
4	04	None	68	44	D	132	84	None	196	C4	*D*
5	05	None	69	45	E	133	85	None	197	C5	*E*
6	06	None	70	46	F	134	86	None	198	C6	*F*
7	07	BEL	71	47	G	135	87	BEL	199	C7	*G*
8	08	BS	72	48	H	136	88	BS	200	C8	*H*
9	09	HT	73	49	I	137	89	HT	201	C9	*I*
10	0A	LF	74	4A	J	138	8A	LF	202	CA	*J*
11	0B	VT	75	4B	K	139	8B	VT	203	CB	*K*
12	0C	FF	76	4C	L	140	8C	FF	204	CC	*L*
13	0D	CR	77	4D	M	141	8D	CR	205	CD	*M*
14	0E	SO	78	4E	N	142	8E	SO	206	CE	*N*
15	0F	SI	79	4F	O	143	8F	SI	207	CF	*O*
16	10	None	80	50	P	144	90	None	208	D0	*P*
17	11	DC1	81	51	Q	145	91	DC1	209	D1	*Q*
18	12	DC2	82	52	R	146	92	DC2	210	D2	*R*
19	13	DC3	83	53	S	147	93	DC3	211	D3	*S*
20	14	DC4	84	54	T	148	94	DC4	212	D4	*T*
21	15	None	85	55	U	149	95	None	213	D5	*U*
22	16	None	86	56	V	150	96	None	214	D6	*V*
23	17	None	87	57	W	151	97	None	215	D7	*W*
24	18	CAN	88	58	X	152	98	CAN	216	D8	*X*
25	19	None	89	59	Y	153	99	None	217	D9	*Y*
26	1A	None	90	5A	Z	154	9A	None	218	DA	*Z*
27	1B	ESC	91	5B	[	155	9B	ESC	219	DB	[
28	1C	None	92	5C	\	156	9C	None	220	DC	\
29	1D	None	93	5D	]	157	9D	None	221	DD	]
30	1E	None	94	5E	^	158	9E	None	222	DE	^
31	1F	None	95	5F	-	159	9F	None	223	DF	-
32	20	b	96	60	‘	160	A0	b	224	E0	‘
33	21	!	97	61	a	161	A1	!	225	E1	*a*
34	22	“	98	62	b	162	A2	“	226	E2	*b*
35	23	#	99	63	c	163	A3	#	227	E3	*c*

TABLE A-1 ASCII Code Summary (*continued*)

Dec.	Hex.	Char./ Func.	Dec.	Hex.	Char./ Func.	Dec.	Hex.	Char./ Func.	Dec.	Hex.	Char./ Func.
36	24	$	100	64	d	164	A4	*$*	228	E4	*d*
37	25	%	101	65	e	165	A5	%	229	E5	*e*
38	26	&	102	66	f	166	A6	*&*	230	E6	*f*
39	27	'	103	67	g	167	A7	'	231	E7	*g*
40	28	(	104	68	h	168	A8	*(*	232	E8	*h*
41	29	)	105	69	i	169	A9	*)*	233	E9	*i*
42	2A	*	106	6A	j	170	AA	*	234	EA	*j*
43	2B	+	107	6B	k	171	AB	+	235	EB	*k*
44	2C	,	108	6C	l	172	AC	,	236	EC	*l*
45	2D	-	109	6D	m	173	AD	-	237	ED	*m*
46	2E	.	110	6E	n	174	AE	.	238	EE	*n*
47	2F	/	111	6F	o	175	AF	/	239	EF	*o*
48	30	0	112	70	p	176	B0	*0*	240	F0	*p*
49	31	1	113	71	q	177	B1	*1*	241	F1	*q*
50	32	2	114	72	r	178	B2	*2*	242	F2	*r*
51	33	3	115	73	s	179	B3	*3*	243	F3	*s*
52	34	4	116	74	t	180	B4	*4*	244	F4	*t*
53	35	5	117	75	u	181	B5	*5*	245	F5	*u*
54	36	6	118	76	v	182	B6	*6*	246	F6	*v*
55	37	7	119	77	w	183	B7	*7*	247	F7	*w*
56	38	8	120	78	x	184	B8	*8*	248	F8	*x*
57	39	9	121	79	y	185	B9	*9*	249	F9	*y*
58	3A	:	122	7A	z	186	BA	*:*	250	FA	*z*
59	3B	;	123	7B	{	187	BB	*;*	251	FB	{
60	3C	⟨	124	7C	;	188	BC	⟨	252	FC	;
61	3D	=	125	7D	}	189	BD	=	253	FD	}
62	3E	⟩	126	7E	~	190	BE	⟩	254	FE	~
63	3F	?	127	7F	DEL	191	BF	*?*	255	FF	DEL

Source: David A. Kater, *FX Series Printer User's Manual,* Epson America, Inc., 1984. Reprinted with permission.

Appendix

B

TABLE B-1 Printer Code and Feature Comparison

Sym.	Function	MX-80	MX-70	MX-80F/T	MX-100	GT-80	GT PLUS	FX-80	RX-80	FX-100	RX-100	LQ-1500
BEL	Sounds beeper	*		*	*	*	*	*	*	*	*	*
BS	Backspace		*			*	*	*	*	*	*	*
HT	Horizontal tabulation				*	*	*	*	*	*	*	*
LF	Line feed	*	*	*	*	*	*	*	*	*	*	*
VT	Vertical tabulation	*		*	*	*		*	*	*	*	*
FF	Form feed		*		*	*	*	*	*	*	*	*
CR	Carriage return	*	*	*	*	*	*	*	*	*	*	*
SO	S O Expanded (1-line) on	*	*	*	*	*	*	*	*	*	*	*
SI	SI: Compressed on	*		*	*	*	*	*	*	*	*	*
DC1	Activates the printer	*		*	*	*		*		*		*
DC2	Compressed mode off	*		*	*	*	*	*	*	*	*	*
DC3	Deactivates the printer	*		*	*	*		*		*		*
DC4	Expanded mode (1-line) off	*	*	*	*	*	*	*	*	*	*	*
CAN	CAN.text in print buffer	*		*				*		*	*	*
ESC	Escape code	*	*	*	*	*	*	*	*	*	*	*
DEL	Deletes last character	*		*	*	*	*	*	*	*	*	*
ESC SO	Same as SO							*	*	*	*	*
ESC SI	Same as SI							*	*	*	*	*
ESC !	Selects mode combinations							*		*		*

TABLE B-1 Printer Code and Feature Comparison (*continued*)

Sym.	Function	MX-80	MX-70	MX-80F/T	MX-100	GT-80	GT PLUS	FX-80	RX-80	FX-100	RX-100	LQ-1500
ESC #	Cancels MSB function						*	*		*		*
ESC %	Selects active character set							*		*		*
ESC :	Copies from ROM to RAM					†		*		*		
ESC &	Defines user characters							*		*		*
ESC *	Selects dot graphics modes							*	*	*	*	*
ESC /	Selects active vertical tab channel							*		*	*	*
ESC -	Underline mode						*	*	*	*	*	*
ESC ^	9-Pin Graphics mode							*		*	*	
ESC 0	1/8 inch line spacing	*		*	*	*	*	*	*	*	*	*
ESC 1	7/72 inch line spacing	*		*		*	*	*	*	*	*	*
ESC 2	1/6 inch line spacing	*	*	*	*	*	*	*	*	*	*	*
ESC 3	*n*/216 inch line spacing					*	*	*	*	*	*	
ESC 4	Italic mode on					*	*	*	*	*	*	*
ESC 5	Italic mode off					*	*	*	*	*	*	*
ESC 6	Deact. high-order ctrl.							*		*		
ESC 7	Restores high-order ctrl.							*		*		
ESC 8	Paper end detector off				*	*	*	*	*	*	*	*

ESC 9	Paper end detector on				*	*	*	*	*	*	*	*
ESC ⟨	One-line Uni-dir mode					*	*	*	*	*	*	*
ESC ⟩	Sets MSB function					*	*	*		*		*
ESC =	Resets MSB function					*	*	*		*		*
ESC @	Master Reset					*	*	*	*	*	*	*
ESC A	*n*/72 inch line spacing	*	*	*	*	*	*	*	*	*	*	
ESC B	Vertical tab setting	*		*	*	*		*		*	*	*
ESC C	Page length	*	*	*	*	*	*	*	*	*	*	*
ESC D	Horizontal tab setting	*		*	*	*	*	*		*	*	*
ESC E	Emphasized mode on	*		*	*	*	*	*	*	*	*	*
ESC F	Emphasized mode off	*		*	*	*	*	*	*	*	*	*
ESC G	Double-Strike mode on	*		*	*	*	*	*	*	*	*	*
ESC H	Double-Strike mode off	*		*	*	*	*	*	*	*	*	*
ESC I	Control code select							*		*		
ESC J	Immediate tem. line feed					†	*	*	*	*	*	*
ESC K	Sgl-Density Gph. mode		*		*	*	*	*	*	*	*	*
ESC L	Dbl-Density Gph. mode				*	*	*	*	*	*	*	*
ESC M	Elite mode on							*	*	*	*	*
ESC N	Skip over perforation on				*		*	*	*	*	*	*
ESC O	Skip over perforation off				*		*	*	*	*	*	*
ESC P	Elite mode off					†		*	*	*	*	*

TABLE B-1 Printer Code and Feature Comparison (*continued*)

Sym.	Function	GT PLUS	FX-80	RX-80	FX-100	RX-100	LQ-1500	MX-80	MX-70	MX-80F/T	MX-100	GT-80
ESC Q	Sets right margin				*	†	*	*	*	*	*	*
ESC R	International characters				*			*	*	*	*	*
ESC S	Super/subscript mode on					†	*	*	*	*	*	*
ESC T	Super/subscript mode off					†	*	*	*	*	*	*
ESC U	Uni-Dir. printing on/off						*	*	*	*	*	*
ESC W	Expanded mode (cont) on/off						*	*	*	*	*	*
ESC Y	Dbl-Speed Dbl-Density Graphics mode							*	*	*	*	*
ESC Z	Quad.-Density Gph. mode							*	*	*	*	*
ESC b	Sets vertical tab channel							*		*	*	*
ESC e	Sets horizontal/vertical tab increments								*	*		
ESC f	Sets horizontal/vertical								*			
ESC i	Imm. print (typewriter mode)							*				
ESC j	Imm. temp. reverse paper feed							*				
ESC l	Sets left margin							*	*	*	*	*

ESC m	Selects gph, char. set								*		*	
ESC p	Proportional mode on/ off		*		*							
ESC s	Half-Speed on/off		*	*	*	*	*					
ESC (space)	Sets character space						*					
ESC $	Sets absolute dot position						*					
ESC 3	Sets *n*/180-inch line space						*					
ESC ?	Assigns bit image mode				*		*					†
ESC A	Sets *n*/60-inch line space						*					
ESC x	Selects Draft/NLQ						*					
ESC V	Sets repetitive print data						*					
ESC \	Relative dot position						*					
ESC ;	Cancels TRS mode											†
	Bidirectional print	*	*	*	*	*	*	*		*	*	*
	Disposable print head	*	*	*	*	*	*	*	*	*	*	*
	Hex dump		*	*	*	*	*					
	Logic seeking	*	*	*	*	*	*	*		*	*	*
	Matrix	9 × 9	9 × 9	9 × 9	9 × 9	9 × 9	24 × 37	9 × 9	9 × 6	9 × 9	9 × 9	9 × 9
	Paper feed	—	F/T	Tractor	F/T	F/T	F/T	Tractor	Tractor	F/T	F/T	—
	Print buffer	1 line	2K	1 line	2K	1 line	2K+	1 line	1 line	1 line	1 line	1 line

TABLE B-1 Printer Code and Feature Comparison (*continued*)

Sym.	Function	GT PLUS	FX-80	RX-80	FX-100	RX-100	LQ-1500	MX-80	MX-70	MX-80F/T	MX-100	GT-80
	Switches	*	*	*	*	*	*	*		*	*	*
	Top print speed (CPS)	80	160	100	80	100	200	80	80	80	80	80

†Unique function.

Index

GETTING THE MOST OUT OF YOUR EPSON PRINTER

Learn how to *control* and *customize* your Epson printer. Make it do everything you want it to do. Produce professional, good-looking documents quickly and easily. This complete guide will show you how. And if you're a first-time buyer, it will help you choose the Epson dot-matrix printer that's exactly right *for your microcomputer and your kind of work.*

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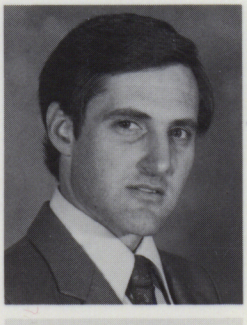

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