

# High Performance, Low Cost New Printer

By Owen F. Thomas

An electric discharge printer is being offered for sale to the OEM market for \$257 assembled. This could be the output device that the hobby and small systems users have been wishing for. The printer will produce 44 characters in half a second in a 5x7 dot matrix format on paper 6 cm. wide; and it will do that continuously. Software control will produce larger characters for emphasis and will allow graphics to be printed. The low cost is achieved by a simple printing mechanism, limited number of components on the interface board, and software to provide all of the logic control to the printer.

There is no distributor to the hobby market at the present, but the manufacturer will deliver single units from the factory. You must write to Electronic Products Associates, Inc., 1157 Vega Street, San Diego, CA 92110 if you want one at once. Perhaps someone will advertise soon as a distributor to the hobby and small system users.

The printer mechanism comes from a distributor in Germany. Those who wish to try assembling their own system can contact Datamega KA, 8011 Putzbrunn, Munich, Germany. Their catalog lists the printer mechanism only as MP 310/21L for 160 German Marks. I do not know of a source for single units in this country, but anyone wishing to build their own interface from information in this article can try offering the equivalent of 160 German Marks to EPA. A cash offer would probably not be refused. Printed circuit board layout, or wire wrapping, must be done carefully in a homebrew system to keep noise out of the low level signal from a magnetic pickup; the other circuitry is straightforward.

All good things have their problems, right? This printer requires a special aluminum coated paper which is available from EPA at 95¢ per 90 foot roll. One roll will hold about 6,000 lines, or about 250,000 characters. This is not ex-

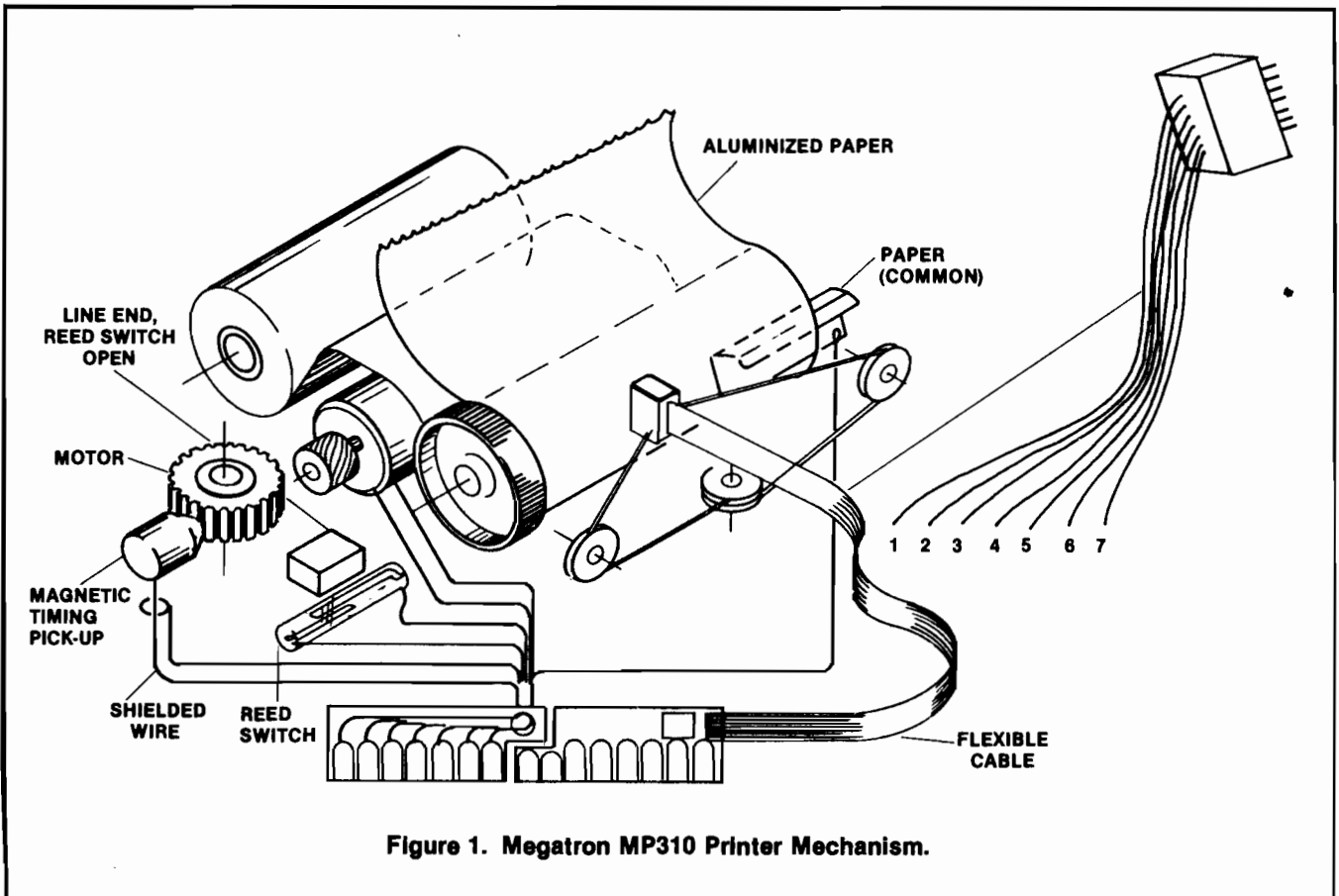


Figure 1. Megatron MP310 Printer Mechanism.

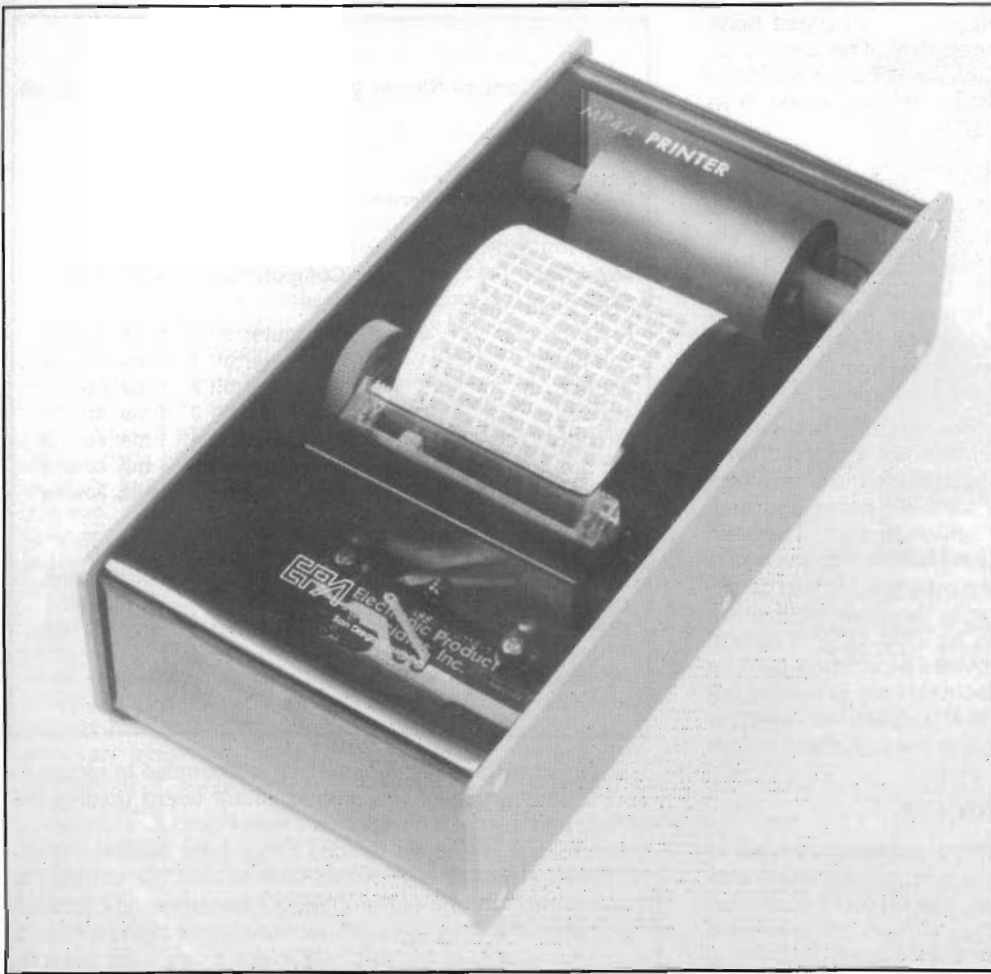


PHOTO 1



PHOTO 2

pensive for systems with video displays which need occasional permanent copies from the screen. The copy is archival, it never fades, and copy machines will work well from the original. So there is some bad news and good news about paper!

## HARDWARE DESCRIPTION

The print mechanism from Megatron is a box full of pulleys, cables, gears, motor, reed switch, and magnetic pickup coil for timing pulses. There are fourteen wires from the box to two small paddle boards. One paddle board connects to the motor, reed switch, timing pickup, and paper common electrode. The other paddle board connects via a flexible printed circuit to the seven electrodes on the print head. This makes the print head easy to replace.

A conceptual layout of the functioning parts is shown in Figure 1. The seven printing electrodes are mounted vertically in a small plastic block which is moved in a racetrack path from left to right in contact with the paper and then moved away from the paper for return to start. The reed switch is open for a short space just before the electrodes touch the left edge of the paper. The magnetic pickup generates a periodic voltage from a gear in the drive mechanism while the motor is turning (driven by 24V DC). A carbon roller in contact with the paper provides a common path for the print current when the print electrodes are grounded but limits the current. An automatic line feed ratchet, which is not illustrated, advances the paper one line just after the print head leaves the paper.

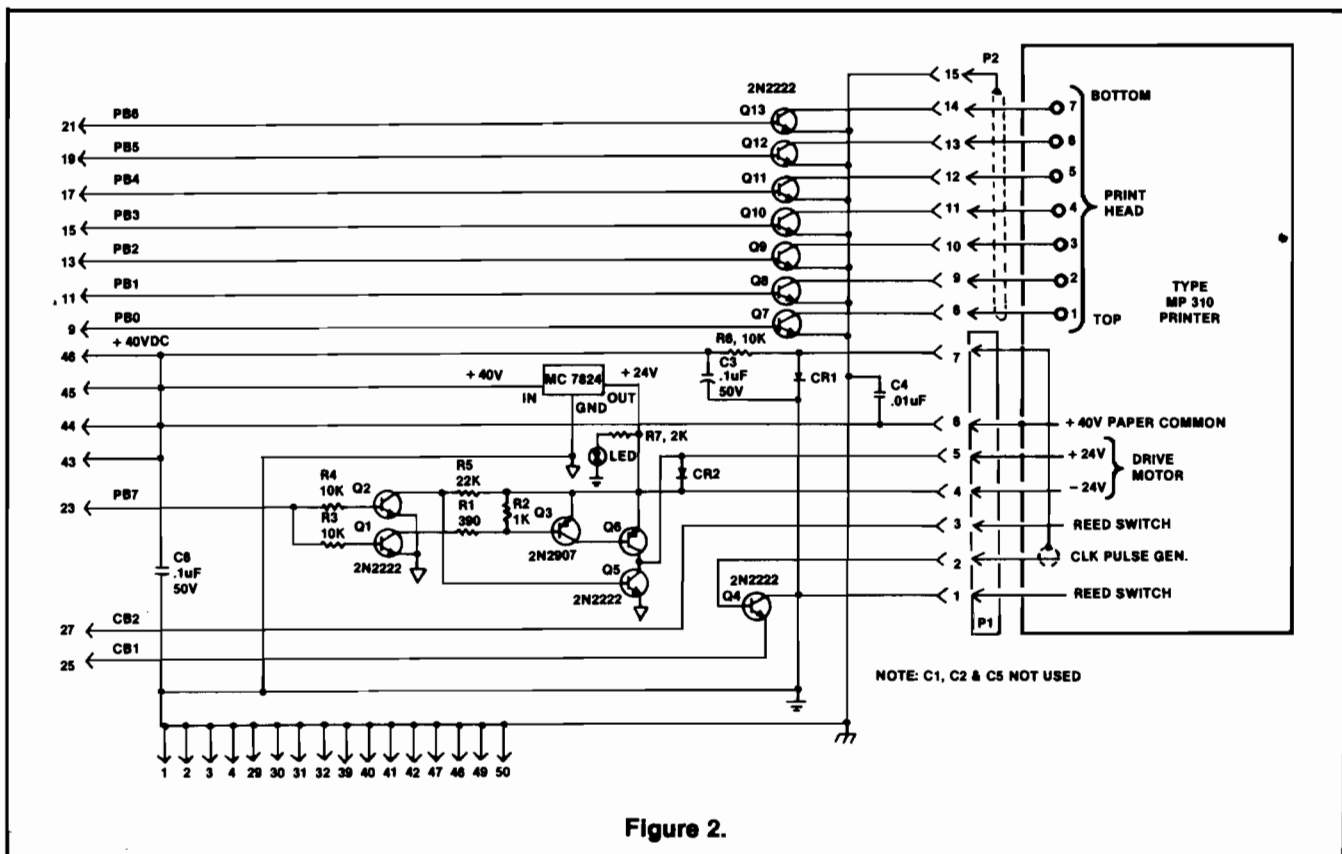
## COMPUTER INTERFACE CIRCUIT

A minimum of extra components has been provided to allow computer control of motor and print current and to provide timing marks to the computer. The motor is controlled with one output bit, and the print electrodes are controlled with the other seven bits of an 8-bit output word. The timing marks are provided to the computer as low impedance to ground; they can be used to ground pullup resistors on two computer input lines.

**Table 1. Control Signal and Power Supply Description**

Signal Description	Pin Number	Signal Source	Active Signal
Motor Run	23	Computer bit 7	+5v., 1 ma.
Print Electrodes:			
Print top dot	9	Computer bit 0	1 ma. source
2nd dot	11	Computer bit 1	1 ma. source
3rd dot	13	Computer bit 2	1 ma. source
4th dot	15	Computer bit 3	1 ma. source
5th dot	17	Computer bit 4	1 ma. source
6th dot	19	Computer bit 5	1 ma. source
Bottom dot	21	Computer bit 6	1 ma. source
-----			
Line end	27	Printer	current sink
Character timing	25	Printer	current sink
Power	43,44, 45,46		40v. ¼ amp.
Power ground	1,2,3,4		

A circuit diagram of the interface is illustrated in Figure 2, and a photograph of the printed circuit board holding the printer and interface components is in Photo 2. The positive input voltage is applied directly to the print head common, and each electrode is provided with its own current path to ground through one of the 2N2222 transistors Q7 through Q13 when the base current is turned on by a high bit output. A printer supply of 40 volts will make a very dark mark on the paper; 30 volts will make an acceptable mark. The paper common is also connected to the printer case, so it must not be grounded or connected to metallic parts of the system.



**Figure 2.**

The other computer output bit drives the five transistors Q2 through Q6. This complicated circuit is required to provide dynamic braking to the motor when the output bit is high as well as to pass current to the motor when the bit is low. A voltage regulator is provided to produce the specified 24-volt motor drive regardless of what printing voltage is used.

The reed switch is grounded on one side, and the other side goes direct to the pullup resistor on the computer input line. When the reed switch opens, the bit goes high, and the computer can stop the motor before the next line begins.

The periodic timing marks are only about 0.6 volts peak to peak and require special conditioning for computer input. The pickup coil shield is biased up from ground by one diode drop across CR2, making the base of Q1 the same potential as the emitter when the motor is off. When the motor runs, it will cause the pickup coil to turn Q1 on for a part of each timing period and therefore provide a low impedance to ground for a pullup resistor on the computer input line. This will cause the collector of Q1 to be at a low voltage during part of each timing period to generate a timing signal for use by the computer in determining when to activate the print electrode bits.

No more interface components are required to allow the computer software to print a 44-column line as the printer head crosses the paper in half a second. The subroutine which controls this interface will be explained in detail in the context of a software package to print a line of characters which are input from an ASCII keyboard. The printer control software is a single subroutine called LINPTR described under software.

### SOFTWARE DESCRIPTION

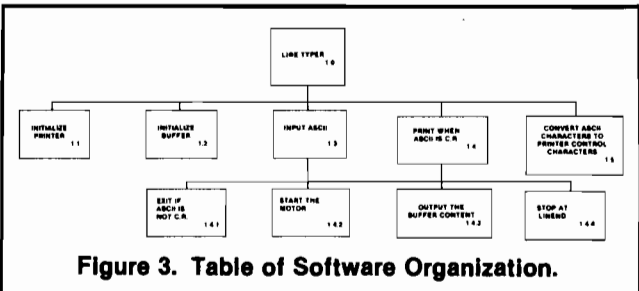


Figure 3. Table of Software Organization.

This description uses a set of visual aids to enhance the introduction of data and control concepts before presenting program listings.\* Figure 3 shows the organization of software modules to accomplish a line typer task. Each module of the figure has a key number in the lower right corner of its box as a key to the following descriptions.

### Overview

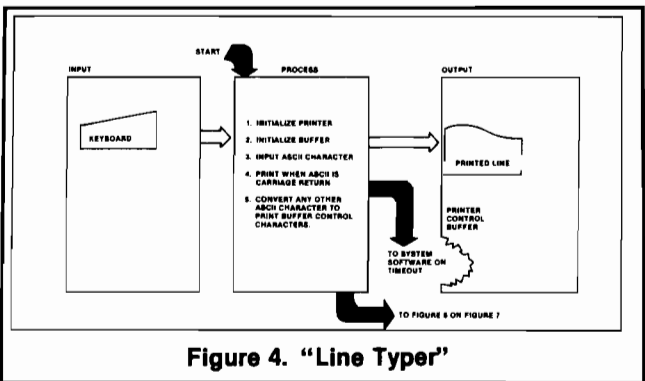
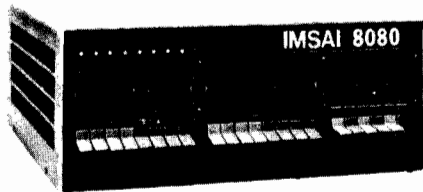


Figure 4. "Line Typer"

The overview of all software is illustrated in Figure 4. This figure is typical of all the module descriptions; it is divided into three boxes, one to show data input to the module, one to show the process performed by the module, and one to

\*The technique is explained in "Systems Design and Documentation" by Harry Katzan, Jr.

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show the data output by the module. Open arrows show data movement from input box through the process box to the output box. Solid arrows show where the process starts and what process comes next.

The overview diagram shows general features rather than complete detail. This process accepts input from a keyboard, has five steps in the process, and produces a printed line when the ASCII character from the keyboard is a carriage return. Other ASCII characters are converted to printer control words and placed in a control word buffer. When the process is finished, control will be returned to step 2 or 3 of the same process. This module is therefore a closed loop; it will continue to accept keyboard input and pass it to the printer until it is interrupted by a reset or a timeout from a late timing mark. Each step of this process will be expanded in the following figures and descriptions. After all the modules are understood, it will be easy to use them as they are or to adapt the coding for other applications.

### Initialization

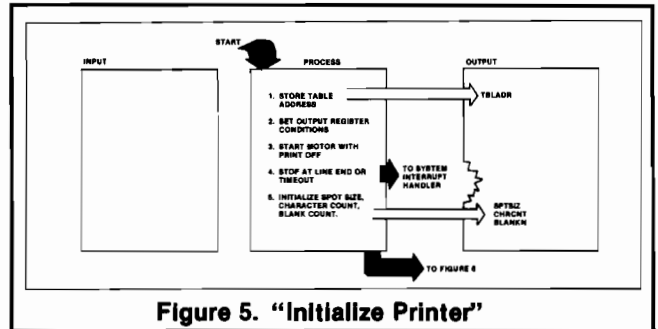


Figure 5. "Initialize Printer"

Printer initialization details are presented in Figure 5. Initialization is performed by a single subroutine called INITPR which is written to be contained in a read-only memory at any location which may be convenient to a system designer who wishes to use the printer. The read-only memory can also contain a table of printer control words; the address of the table is determined by the program and stored in random access read/write memory where it will be referred to by the name TBLADR. The peripheral interface adapter, or an 8-bit output port, is set for all bits to be outputs. The motor is started and allowed to run to the start of a new line. At line end it should set a data bit or generate an interrupt; in the event that this does not occur in a reasonable time, there will be a software interrupt generated. This interrupt can be interpreted by the system operator or system software to start necessary corrective action.

If the printer reaches line end in time, the printer is ready to operate, so default values will be stored in three locations to control the format of the printed line. A line generated by these values will have 44 characters separated by 2/5ths character spacing. The number 1 to control spot size, and therefore character size, is stored and will be referred to by the name SPTSIZ. The number 44 to control number of characters is stored and will be referred to by the name CHRCNT. The number 2 to control space between characters is stored and will be referred to by the name BLANKN. These default values could be modified by other software if desired as long as the product CHRCNT (5+BLANKN) is less than 310.

Line typer software control starts with printer initialization; control passes to buffer initialization when the printer responds or goes to system software when the printer does not respond.

### Buffer Initialization

Printer control characters are stored in a buffer in read/write memory until the printer is commanded to print a line. This buffer is initialized by the software illustrated in Figure 6. The software is a single subroutine called CAINIT, and it can be in read-only memory when the system designer



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has established the buffer location and size. The beginning address of the buffer is stored and will be known by the name BUFSTR. The beginning address is also stored in the location called BUFPTR where it will be used as a pointer for the next empty location in the buffer. The Buffer end address is computed and stored in the location called BUFEND. A control word is stored in all buffer locations to cause the motor to run without printing unless the word is changed when a character is input from the keyboard. This has the effect of causing blank lines to be printed when a carriage return is the first character from the keyboard.

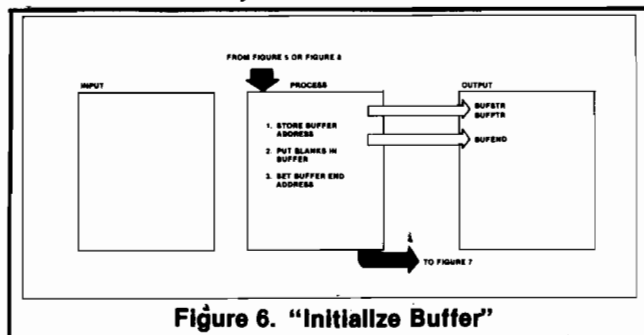


Figure 6. "Initialize Buffer"

Program control comes to this module from printer initialization or from printing a line. Control goes to input an ASCII character from the keyboard.

**Input ASCII**

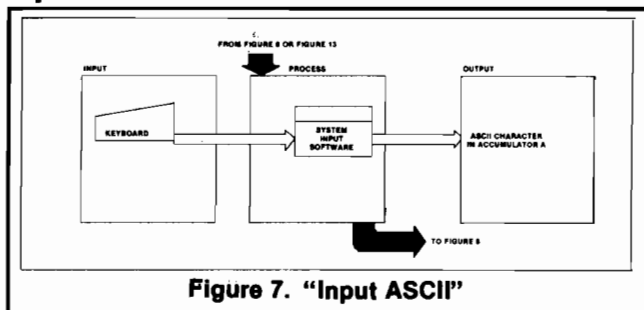


Figure 7. "Input ASCII"

The keyboard input is illustrated in Figure 7. All the software for ASCII input from a serial keyboard is provided in the MIK-BUG routine at location \$E1AC. When program control is passed to that routine and a key is pressed on a serial ASCII keyboard, the ASCII character will be returned in accumulator A. Another system input routine must be established in systems not using the 6800 microcomputer. Program control comes to this module from initializing the buffer or after converting an ASCII character to printer buffer control characters. Control always goes next to print when the ASCII character is a Carriage Return.

**Print When . . .**

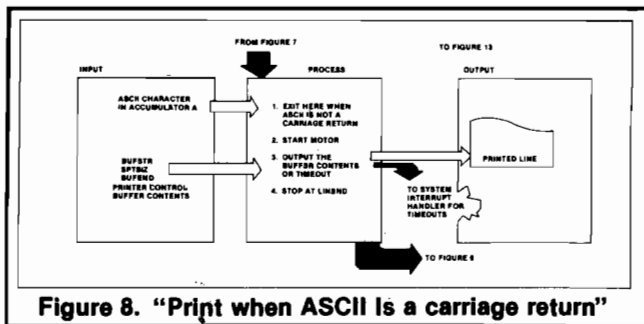


Figure 8. "Print when ASCII is a carriage return"

The process to print when the ASCII character is a carriage return is illustrated in Figure 8. Step one tests the character and exits for all characters except the carriage return. This test is in read/write memory; all the rest is the LINPTR sub-routine and can be in the read-only memory where it can be used as desired by a system designer to print the entire contents of a buffer full of control characters.

The printing process starts the motor and outputs the entire buffer contents under timing controlled by a data input line (or interrupt line) from the timing gear. The motor is then allowed to continue running until the reed switch closes to signal the end of line. If any of the timing signals fail to occur within a reasonable time, an exit will be made to system software to signal a failure. The system operator or system software must then determine what corrective action to take. This timeout facility is provided to prevent the printer program from entering an endless loop in read-only memory — an event which is difficult to diagnose.

This module uses the ASCII character in accumulator A, the buffer start address at BUFSTR, the buffer and address at BUFEND, the spot size control at SPTSIZ, and all the contents of the printer control buffer. The buffer will not have any words to cause printing until control has passed through the module described in Converting to ASCII Characters. A printed line will be output by this module when there are appropriate control characters in the buffer and the input character is a carriage return.

Control comes to this module when an ASCII character has been input. Control goes to convert the character to printer control words when not a carriage return; it goes to the system software when there is a late input from the timing sensor; and it goes to initialize the buffer when a line has been printed successfully.

This module contains the complete interface control software (more detailed description follows in the next four sections of Software Description).

### Exit If ASCII Is Not Carriage Return

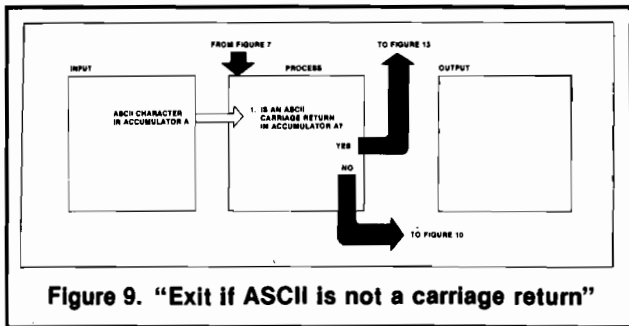


Figure 9. "Exit If ASCII is not a carriage return"

This part of the line typer software is illustrated in Figure 9. The printer control is started when the ASCII character is a carriage return or control goes to convert other characters to printer control words in the buffer.

### Start the Motor

This part of the software is illustrated in Figure 10. The coding is part of the LINPTR subroutine which can be in read-only memory.

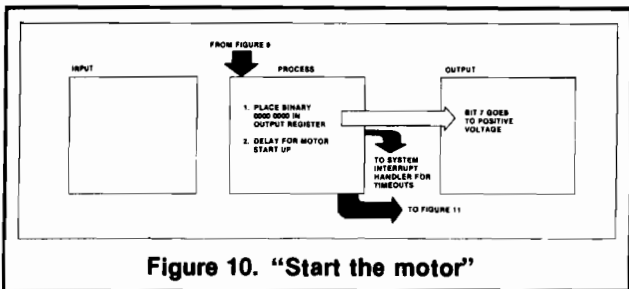


Figure 10. "Start the motor"

A binary word 0000 0000 is placed in the output register. This has the effect of moving bit seven to a low voltage in the interface to cause the motor to start. A time delay is necessary to allow the print head to be placed in contact with the paper. The delay is accomplished by waiting until the reed switch closes before proceeding to the next task. An exit is made to the system interrupt handler if the reed switch does not close.

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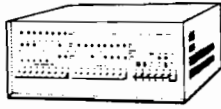
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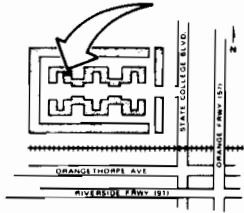
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## Output the Buffer Contents

This part of the software controls the print electrode current. The illustration in Figure 11 shows the detail of operation.

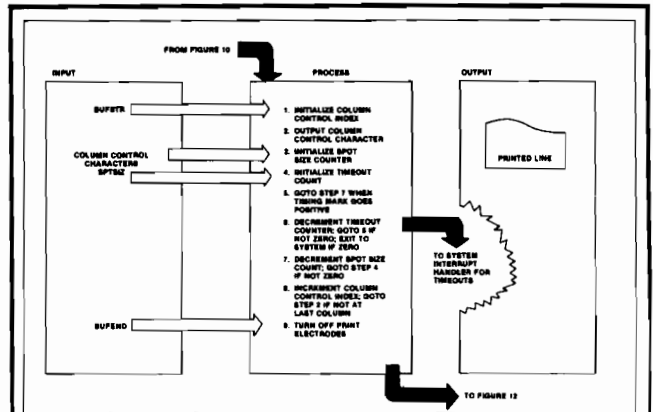


Figure 11. "Output the buffer contents or timeout"

There are three loops in this module. The outer loop starts the column control character index at the start of the buffer as stored in BUFSTR. This loop ends at step 8 where a test is made to see if all column control characters have been output up to the address stored at BUFEND. When all have been output, the print electrodes are turned off and control goes to the next module.

The second loop controls spot size, starting at step 3 and ending at step 7. This loop counts timing marks as specified by SPTSIZ before allowing the column control character to be incremented.

The third loop is at steps 4, 5, and 6, where the timeout counter is decremented while waiting for a timing mark. If the timeout counter reaches zero before a timing mark is received, there will be an exit to the system software.

## Stop At Line End

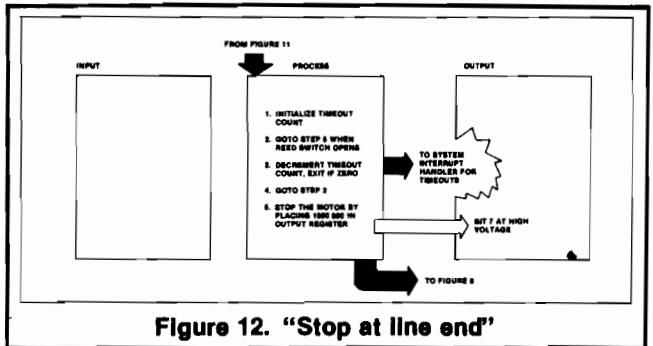


Figure 12. "Stop at line end"

This module is illustrated in Figure 12. It delays until the reed switch opens at line end and then puts a binary 1000 0000 in the output register to turn off the motor and print electrodes. A timeout loop is included to exit to system software in case the reed relay does not open within a reasonable time.

## Convert ASCII Characters

The module to convert ASCII characters to printer control words is illustrated in Figure 13. This is a single subroutine called CACTPB in read/write memory. In code for the 6800 computer, the stack pointer is saved in the first step. It is used in transferring words from the conversion table to the print control buffer and is restored at step six to provide correct return to the control program.

Next, the ASCII character is tested to determine if it is in the printable set; nonprintable characters will be ignored. A printable ASCII character will be converted to five words for control of the print electrodes and moved to the buffer location indicated by the buffer storage pointer. Inter-character blank columns will be provided in the buffer by incrementing the buffer

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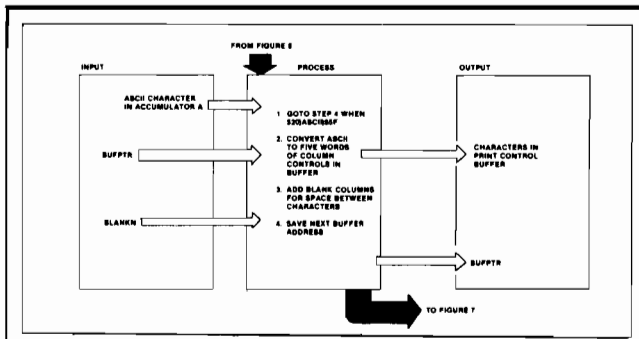


Figure 13. "Convert ASCII character to printer control words"

storage pointer an additional number, as indicated by *BLANKN*, before storing the pointer for use the next time.

This routine uses the ASCII character in accumulator A, the table of conversion from ASCII to column control words, the buffer storage pointer at *BUFPTR*, and the spacing control at *BLANKN*. It updates the buffer control pointer, outputs control words to the buffer, and leaves a value called *TBLCHR* which points to the character moved from the conversion table.

Control comes to this routine from "print when ASCII is a carriage return" and goes to "input ASCII."

### COMPUTER SOURCE CODE FOR THE 6800

Program listings are provided for 6800 computers in Listing 1. The comments consist of references to appropriate sections of the software description for detail of the functions being performed. A lookup table named *TABLE* provides *CACTPB*, the bit patterns for conversion of ASCII code to seven bit column control words. The Line Typer starts at address *\$3A5B*; an additional entry point at *\$3A70* will allow entries via the "G" command to the *MIKBUG* monitor to stop the motor in case of a software interrupt and to restart at the proper address again by another "G" command.

The memory map for this code after assembly is provided in Table 2.

Table 2. Memory Map for 6800

3FB4	top of 44 character buffer
3E80	beginning of buffer
3DFF	top of table
3CC0	start of table
3C7C	LINPTR
3C4F	INITPR
3C2E	BEQOT
3C0D	BNEOT
3C06	XDELAY
3C00	DELAY
3B81	top of auxiliary routines
3B70	GSTART
3B5B	TESTPR
3B1F	CACTPB
3B00	CAINIT

### SUMMARY

The printer is extremely flexible and works well in just about any system configuration. Although only software for the 6800 was shown, the techniques discussed and demonstrated work with 8080 type machines. □

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# Program Listing

00001	NAM	TABLE		
00002	OPT	MEM		
00003	ORG	\$3CC0		
00004	FDB	0		
00005	FDB	0		
00006	FCB	0		
00007	FDB	0		
00008	FDB	\$4F00		
00009	FCB	0		
00010	FDB	7		
00011	FDB	7		
00012	FCB	0		
00013	FDB	\$147F		
00014	FDB	\$147F		
00015	FCB	\$14		
00016	FDB	\$242A		
00017	FDB	\$7F2A		
00018	FCB	\$12		
00019	FDB	\$2313		
00020	FDB	\$864		
00021	FCB	\$62		
00022	FDB	\$304E		
00023	FDB	\$5926		
00024	FCB	\$50		
00025	FDB	4		
00026	FDB	\$201		
00027	FCB	0		
00028	FDB	\$1C		
00029	FDB	\$2241		
00030	FCB	0		
00031	FDB	\$41		
00032	FDB	\$221C		
00033	FCB	0		
00034	FDB	\$1408		
00035	FDB	\$3E08		
00036	FCB	\$14		
00037	FDB	\$808		
00038	FDB	\$3E08		
00039	FCB	8		
00040	FDB	\$40		
00041	FDB	\$3000		
00042	FCB	0		
00043	FDB	\$808		
00044	FDB	\$808		
00045	FCB	8		
00046	FDB	\$60		

00097	3D5B	0201		
00098	3D5D	7109		
00099	3D5F	06		
00100	3D60	3E41		
00101	3D62	5D55		
00102	3D64	5E		
00103	3D65	7E09		
00104	3D67	0909		
00105	3D69	7E		
00106	3D6A	7F49		
00107	3D6C	4949		
00108	3D6E	36		
00109	3D6F	3E41		
00110	3D71	4141		
00111	3D73	22		
00112	3D74	7F41		
00113	3D76	4122		
00114	3D78	1C		
00115	3D79	7F49		
00116	3D7B	4949		
00117	3D7D	41		
00118	3D7E	7F09		
00119	3D80	0909		
00120	3D82	01		
00121	3D83	3E41		
00122	3D85	4149		
00123	3D87	79		
00124	3D88	7F08		
00125	3D8A	0808		
00126	3D8C	7F		
00127	3D8D	0041		
00128	3D8F	7F41		
00129	3D91	00		
00130	3D92	2040		
00131	3D94	413F		
00132	3D96	01		
00133	3D97	7F08		
00134	3D99	1422		
00135	3D9B	41		
00136	3D9C	7F40		
00137	3D9E	4040		
00138	3DA0	40		
00139	3DA1	7F02		
00140	3DA3	0402		
00141	3DA5	7F		
00142	3DA6	7F04		
00143	3DA8	0810		
00144	3DAAB	7F		
00145	3DAB	3E41		
00146	3DAD	4141		

FDE \$201  
 FDB \$7109  
 FCB 6  
 FDB \$3E41  
 FDB \$5D55  
 FCB \$5E  
 FDB \$7E09  
 FDB \$909  
 FCB \$7E  
 FDB \$7F49  
 FDB \$4949  
 FCB \$36  
 FDB \$3E41  
 FDB \$4141  
 FCB \$22  
 FDR \$7F41  
 FDB \$4122  
 FCB \$1C  
 FDB \$7F49  
 FDB \$4949  
 FCB \$41  
 FDB \$7F09  
 FDB \$909  
 FCB 1  
 FDB \$3E41  
 FDB \$4149  
 FCB \$79  
 FDB \$7F08  
 FDB \$808  
 FCB \$7F  
 FDB \$41  
 FDB \$7F41  
 FCB 0  
 FDB \$2040  
 FDB \$413F  
 FCB 1  
 FDB \$7F08  
 FDB \$1422  
 FCB \$41  
 FDB \$7F40  
 FDB \$4040  
 FCB \$40  
 FDB \$7F02  
 FDB \$402  
 FCB \$7F  
 FDB \$7F04  
 FDB \$810  
 FCB \$7F  
 FDB \$3E41  
 FDB \$4141

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00047	3D08	6000	FDB	\$6000	* .	00147	3DAF	3E	FCB	\$3E	* O
00048	3D0A	00	FCB	0		00148	3DB0	7F09	FDB	\$7F09	
00049	3D0B	2010	FDB	\$2010		00149	3DB2	0909	FDB	\$909	* P
00050	3D0D	0804	FDB	\$804		00150	3DB4	06	FCB	6	
00051	3D0F	02	FCB	2	* /	00151	3DB5	3E41	FDB	\$3E41	
00052	3D10	3E51	FDB	\$3E51		00152	3DB7	5121	FDB	\$5121	* Q
00053	3D12	4945	FDR	\$4945		00153	3DB9	5E	FCB	\$5E	
00054	3D14	3E	FDB	\$3E	* 0	00154	3DBA	7F09	FDB	\$7F09	
00055	3D15	0042	FDB	\$42		00155	3DBC	1929	FDB	\$1929	* R
00056	3D17	7F40	FDR	\$7F40		00156	3DBE	46	FCB	\$46	
00057	3D19	00	FCB	0	* 1	00157	3DBF	4649	FDB	\$4649	
00058	3D1A	4261	FDB	\$4261		00158	3DC1	4949	FDB	\$4949	
00059	3D1C	5149	FDB	\$5149		00159	3DC3	31	FCB	\$31	* S
00060	3D1E	46	FCB	\$46	* 2	00160	3DC4	0101	FDB	\$101	
00061	3D1F	2141	FDB	\$2141		00161	3DC6	7F01	FDB	\$7F01	
00062	3D21	454B	FDB	\$454B		00162	3DC8	01	FCB	1	* T
00063	3D23	31	FCB	\$31	* 3	00163	3DC9	7F40	FDB	\$7F40	
00064	3D24	1814	FDB	\$1814		00164	3DCB	4040	FDB	\$4040	
00065	3D26	127F	FDB	\$127F		00165	3DCD	7F	FCB	\$7F	* U
00066	3D28	10	FCB	\$10	* 4	00166	3DCE	1F20	FDB	\$1F20	
00067	3D29	2745	FDB	\$2745		00167	3DD0	4020	FDB	\$4020	* V
00068	3D2B	4545	FDB	\$4545		00168	3DD2	1F	FCB	\$1F	
00069	3D2D	39	FCB	\$39	* 5	00169	3DD3	3F40	FDB	\$3F40	
00070	3D2E	3C4A	FDB	\$3C4A		00170	3DD5	3840	FDB	\$3840	* W
00071	3D30	4949	FDB	\$4949		00171	3DD7	3F	FCB	\$3F	
00072	3D32	30	FCB	\$30	* 6	00172	3DD8	6314	FDB	\$6314	
00073	3D33	0171	FDB	\$171		00173	3DDA	0814	FDB	\$814	* X
00074	3D35	0905	FDB	\$905		00174	3DDC	63	FCB	\$63	
00075	3D37	03	FCB	\$3	* 7	00175	3DDD	0708	FDB	\$708	
00076	3D38	3649	FDB	\$3649		00176	3DDF	7008	FDB	\$7008	* Y
00077	3D3A	4949	FDB	\$4949		00177	3DE1	07	FCB	7	
00078	3D3C	36	FCB	\$36	* 8	00178	3DE2	6151	FDB	\$6151	
00079	3D3D	0649	FDB	\$649		00179	3DE4	4945	FDB	\$4945	* Z
00080	3D3F	4929	FDR	\$4929		00180	3DE6	43	FCB	\$43	
00081	3D41	1E	FCB	\$1E	* 9	00181	3DE7	007F	FDB	\$7F	
00082	3D42	0063	FDB	\$63		00182	3DE9	4141	FDB	\$4141	* [
00083	3D44	6300	FDB	\$6300	* :	00183	3DER	00	FCB	0	
00084	3D46	00	FCB	0		00184	3DEC	0204	FDB	\$204	
00085	3D47	0000	FDB	0		00185	3DEE	0810	FDB	\$810	* \
00086	3D49	4033	FDB	\$4033		00186	3DF0	20	FCB	\$20	
00087	3D4B	00	FCB	0	* ;	00187	3DF1	0041	FDB	\$41	
00088	3D4C	0814	FDB	\$814		00188	3DF3	417F	FDB	\$417F	* J
00089	3D4E	2241	FDB	\$2241		00189	3DF5	00	FCB	0	
00090	3D50	00	FCB	0	* <	00190	3DF6	0402	FDB	\$402	
00091	3D51	1414	FDB	\$1414		00191	3DF8	7F02	FDB	\$7F02	* -
00092	3D53	1414	FDB	\$1414		00192	3DFA	04	FCB	4	
00093	3D55	14	FCB	\$14	* =	00193	3DFB	081C	FDB	\$81C	
00094	3D56	0041	FDB	\$41		00194	3DFD	2A08	FDB	\$2A08	
00095	3D58	2214	FDB	\$2214		00195	3DFF	00	FCB	0	* -
00096	3D5A	08	FCB	8	* >	00196			END		

```

00540 3A35 C9 00 ADC B #500
00550 3A37 97 29 STA A TBLCHK+1
00560 3A39 D7 28 STA B TBLCHK
00570 3A3B 9E 28 LDS TBLCHK
00580 3A3D DE 20 LDX BUFPTR
00590 3A3F C6 05 #505
00600 3A41 32 PUL A
00610 3A42 A7 00 STA A 0,X
00620 3A44 08 INX
00630 3A45 5A DEC B
00640 3A46 26 F9 BNE *-5
00645 *-1.5.3***
00660 3A48 D6 2E LDA B BLANKN
00680 3A4A 08 INX
00690 3A4B 5A DEC B
00700 3A4C 26 FC BNE *-2
00705 *-1.5.4***
00710 3A4E DF 20 STX BUFPTR
00720 3A50 9C 2C CPX BUFEND
00730 3A52 26 04 BNE CAEXIT
00740 3A54 DE 2A LDX BUFPTR
00750 3A56 DF 20 STX BUFPTR
00760 3A58 9E 24 CAEXIT LDS SCRATCH
00770 3A5A 39 KTS
00775 *-TO 1.1***
00800 3A5B BD 3C4F TESTPR JSH
00805 *-TO 1.2***
00810 3A5E 8D A0 BSK
00815 *-1.3***
00820 3A60 BD E1AC INCHAK JSH
00830 3A63 81 0D #50D
00835 *-1.4.1**
00840 3A65 26 05 BNE *-7
00845 *-TO 1.4.2*
00850 3A67 BD 3C7C LINPTR
00860 3A6A 20 F2 BNA TESTPR+3
00865 *-TO 1.5**
00870 3A6C 8D B1 BSK
00880 3A6E 20 F0 BNA
00890 3A70 CE 3A7A GSTART LDX #SWIEND
00900 3A73 DF 6C STX #6C
00910 3A75 BD 3A5B JSH
00920 3A78 20 F6 BRA
00930 *-SET A048 TO GSTART FOR MONITOR ENTRY
00940 3A7A 86 80 SWIEND LDA A #80
00950 3A7C B7 8006 STA A PTHD;
00960 3A7F 7E E0E0 JMP #E0E0
01000 3C00 OHG $3C00
01010 INTVCT EQU 006A
01020 3C00 C6 FF DELAY LDA B #5FF
01030 3C02 5A DEC B
01040 3C03 26 FD BNE *-1
01050 3C05 39 KTS
01060 3C06 8D 05 XDELAY BSK
ENEOTO
01070 3C08 8D F6 BSK
01080 3C0A 8D 22 RSH
01090 3C0C 39 KTS
ENEOTO
01100 3C0D 86 14 LDA A #514
01110 3C0F B7 8007 STA A PTHCn
01120 3C12 B6 8006 LDA A PTHDh
01130 3C15 C6 FF LDA B #5FF
01140 3C17 D7 24 STA B SCRATCH
01150 3C19 D7 25 STA B SCRATCH+1
01160 3C1B B6 8007 LDA A PTHCk
01170 3C1E 84 40 AND A #540
01180 3C20 26 0B BNE *-13
01190 3C22 7A 0025 DEC SCRATCH+1
01200 3C25 26 F4 BNE *-10
01210 3C27 7A 0024 DEC SCRATCH
01220 3C2A 26 ED BNE *-17
01230 3C2C 3F SWI
KTS
01240 3C2D 39 ENEOTO
01250 3C2E 86 04 LDA A #504
01260 3C30 B7 8007 STA A PTHCk
01270 3C33 B6 8006 LDA A PTHDh
01280 3C36 C6 FF LDA B #5FF
01290 3C38 D7 24 STA B SCRATCH
01300 3C3A D7 25 STA B SCRATCH+1
01310 3C3C B6 8007 LDA A PTHCk
01320 3C3F 84 40 AND A #540
01330 3C41 27 0B BEQ *-13
01340 3C43 7A 0025 DEC SCRATCH+1
01350 3C46 26 F4 BNE *-10
01360 3C48 7A 0024 DEC SCRATCH
01370 3C4B 26 ED BNE *-17
01380 3C4D 3F SWI
01390 3C4E 39 KTS
*-1.1***
01395 INITPH BSK *-2
01400 3C4F 8D 00 PUL A
01410 3C51 32 PUL B
01420 3C52 33 *-1.1.1**
01425 ADD B #56E
01420 3C53 CB 6E STA A TBLADR
01430 3C55 97 26 STA B TBLADR+1
01440 3C57 D7 27 *-1.1.2***
01445 CLK
01450 3C59 7F 8007 LDA A #500
01460 3C5C 86 FF LDA A PTHDk
01470 3C5E B7 8006 LDA A #504
01480 3C61 86 04 STA A PTHCk
01490 3C63 B7 8007 *-1.1.3**
01495 LDA A #500
01500 3C66 86 00 STA A PTHDk
01510 3C68 B7 8006 BSK XDELAY
01520 3C6B 8D 99 *-1.1.4**
01525 BSK
01530 3C6D 8D 49 *-1.1.5***
01535 LINEND+3

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\* COPYRIGHT 1978 EPA 1/16/78

00010	NAM	PKDRVR
00015	1978 EPA	\$3A00
00020	ORG	MEM
00030	OPT	\$22
00040	CHKCNT EQU	\$24
00050	0022	\$23
00060	0024	\$26
00070	0023	\$28
00080	0026	\$2A
00090	0028	\$20
00100	002A	\$2C
00110	0020	\$2E
00120	002C	\$3E80
00130	002E	\$8006
00140	3E80	\$8007
00150	8006	
00195	8007	
00200	*1.2****	
00205	CAINIT LDX	#BUFLOC
00210	*1.2.1***	
00220	STX	BUFSTR
00230	STX	BUFPTH
00240	LDA A	CHKCNT
00250	STA A	SCRTH
00260	LDA B	#S00
00270	ADD B	#S05
00275	*1.2.2***	
00280	STA A	O,X
00290	INX	
00300	DEC B	
00310	BNE	*-4
00320	DEC	SCRTH
00330	BNE	*-13
00335	*1.2.3***	
00340	STX	BUFEND
00350	RTS	
00355	*1.5****	
00400	CACTPB STS	SCRTH
00410	SUB A	#S20
00415	*1.5.1***	
00420	BLT	CAEXIT
00430	CMP A	#S3F
00435	*1.5.1***	
00440	BGT	CAEXIT
00445	*1.5.2***	
00450	CLC	
00460	TAB	
00470	ASL A	
00480	ASL A	
00490	ABA	
00500	LDA B	TBLADK
00510	ADC B	#S00
00520	CLC	
00530	ADD A	TBLADK+1

01540	3C6F	86	01	LDA A	#S01
01550	3C71	97	23	STA A	SPTSIZ
01560	3C73	86	2C	LDA A	#S2C
01570	3C75	97	22	STA A	CHRCNT
01580	3C77	86	02	LDA A	#S02
01590	3C79	97	2E	STA A	BLANKN
01600	3C7B	39		RTS	
01700	3C7C	0F		LINPTR SEI	
01705				*1.4.2**	
01710	3C7D	86	00	LDA A	#S00
01720	3C7F	B7	8006	STA A	PTRDR
01730	3C82	8D	82	BSR	XDELAY
01735				*1.4.3.1*	
01740	3C84	DE	2A	LDX	BUFSTR
01745				*1.4.3.2*	
01750	3C86	A6	00	LINLUP	LDA A O,X
01760	3C88	B7	8006	STA A	PTRDR
01765				*1.4.3.3*	
01770	3C8B	D6	23	LDA B	SPTSIZ
01780	3C8D	37		CHRLUP	PSH B
01790	3C8E	B6	8006	LDA A	PTRDR
01795				*1.4.3.4*	
01800	3C91	C6	0F	LDA B	#S0F
01810	3C93	D7	24	STA B	SCRTH
01820	3C95	D7	25	STA B	SCRTH+1
01830	3C97	B6	8007	LDA A	PTHCR
01835				*1.4.3.5*	
01840	3C9A	2B	0B	BMI	*+13
01845				*1.4.3.6*	
01850	3C9C	7A	0025	DEC	SCRTH+1
01860	3C9F	26	F6	BNE	*-8
01870	3CA1	7A	0024	DEC	SCRTH
01880	3CA4	26	EF	BNE	*-15
01890	3CA6	3F		SWI	
01895				*1.4.3.7*	
01900	3CA7	33		PUL B	
01910	3CA8	5A		DEC B	
01920	3CA9	26	E2	BNE	CHRLUP
01925				*1.4.3.8*	
01930	3CAB	08		INX	
01940	3CAC	9C	2C	CPX	BUFEND
01950	3CAE	26	D6	BNE	LINLUP
01955				*1.4.3.9*	
01960	3CB0	86	00	LDA A	#S00
01970	3CB2	B7	8006	STA A	PTRDR
01975				*1.4.4.1*	
01980	3CB5	BD	3C0D	LINEND	JSH BNEOTO
01985				*1.4.4.5*	
01990	3CB8	86	80	LDA A	#S80
02000	3CBA	B7	8006	STA A	PTRDR
02010	3CBD	0E		CLI	
02020	3CBE	39		RTS	
02030				END	