INSTRUCTION MANUAL
SPRINTER 40

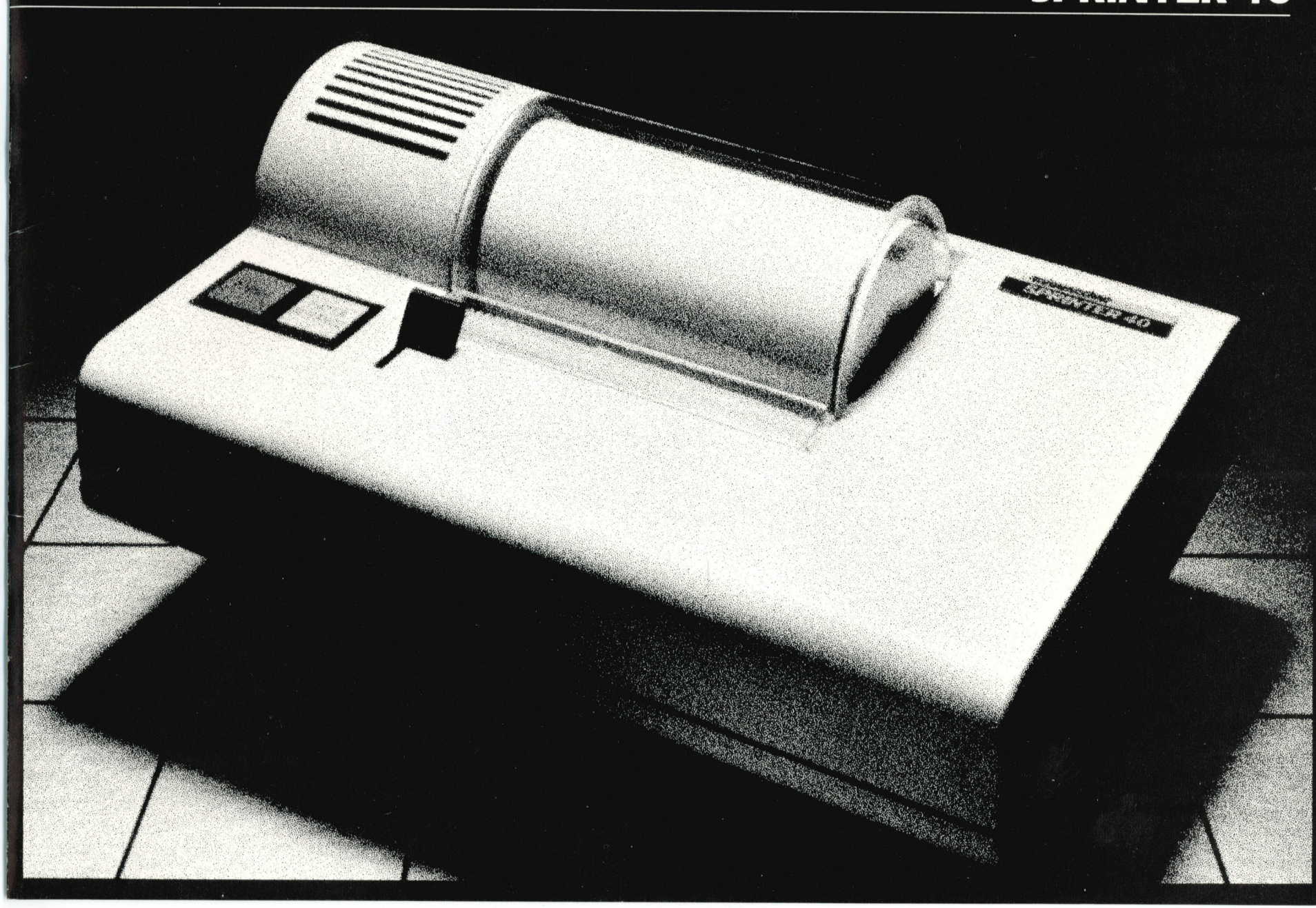


TABLE OF CONTENTS

INTRODUCTION

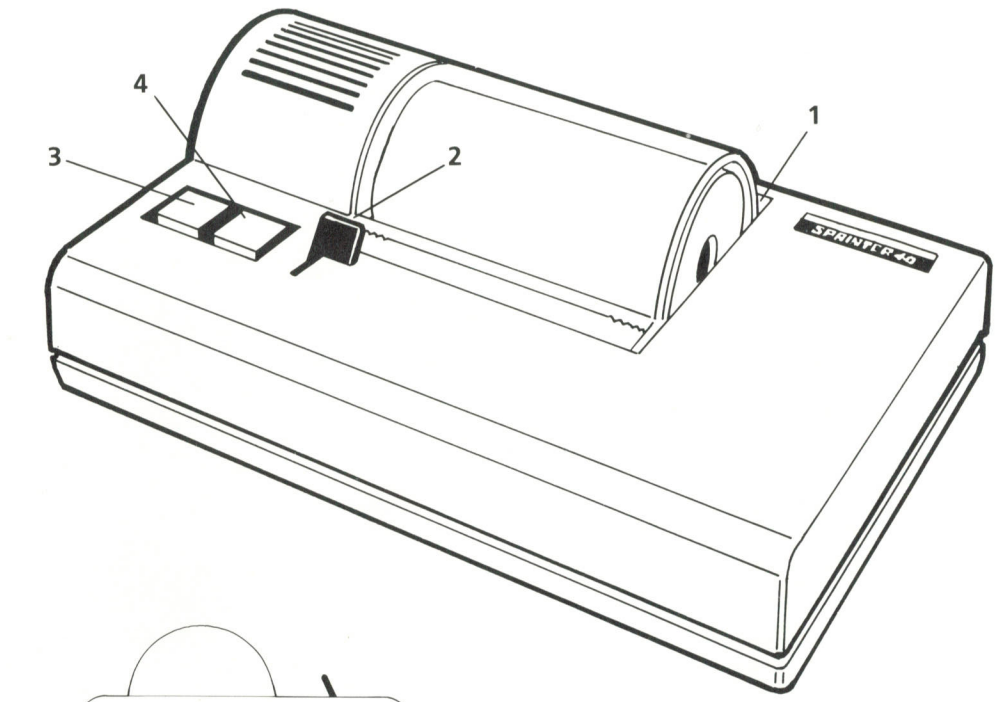
Congratulations on your purchase of the SPRINTER HIGH SPEED THERMAL LINE PRINTER. You now own one of the most reliable printer units ever introduced for use with personal computers, with a printing mechanism backed by field experience with more than a million similar units.

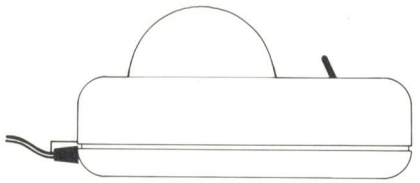
The SPRINTER uses true line-printing technology, in which 40 characters are simultaneously produced as a 5 x 8 character font pattern with a matrix raster of 7 x 10 dots. The dot matrices are contiguous across the printed page and make it possible for the printer to be used as a plotter as well as a character printer.

Lines of dots are produced by an oscillating motion of two thermal heads, each of which simultaneously produces 20 dots on thermographic paper stock. Since the lightweight heads move only a fraction of an inch, they are able to reverse direction very quickly, with high energy efficiency. Their design permits the use of a low-voltage DC motor with low power consumption, which is easily controlled for starting and stopping.

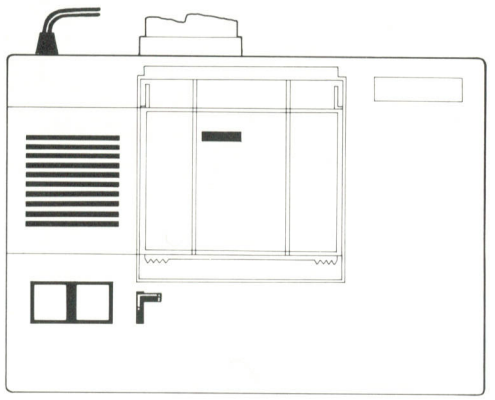
During the printing operation, as the print heads reverse their direction of travel, the paper is advanced one dot position by a gear cam driven by the DC motor. The unique design simplicity is the foundation upon which the reliability and performance of the SPRINTER is built.

The thermal heads used in the SPRINTER PRINTER are made from ceramic-like substrate on which are built 20 printing dot sites. The sites are built up above the substrate to enhance contact with the thermal paper and to reduce frictional drag. Dot impressions are created by selectively heating the thermal head dot sites, which in turn transfer their heat to a point on the paper with which they are in contact. At the point of contact, a special coating on the paper will change color and produce a visible impression. The SPRINTER is capable of creating more than 10,000 dot impressions every second!

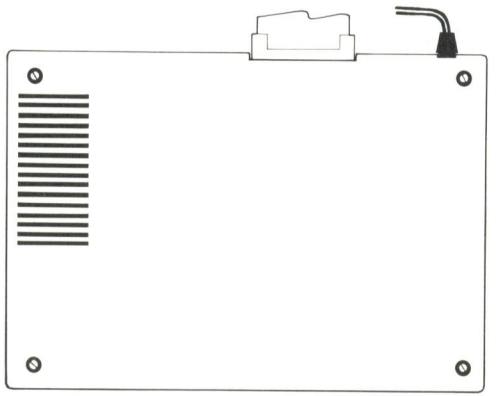




side



top



bottom

DESCRIPTION

The SPRINTER is enclosed in a tough ABS molded case which is extremely resistant to impact damage. The transparent paper cover is made from durable acrylic material similar to that used in aircraft windshields. The fine matte case finish requires no special care and should be cleaned, if necessary, by wiping with a slightly damp cloth. Wax cleaners should not be used. The paper cover may be cleaned with any good quality acrylic cleaner which does not contain abrasives.

The accompanying Figure 1 illustrates the major components of the SPRINTER.

The paper cover **(1)** is hinged to permit a roll of paper to be loaded and positioned.

The paper release lever **(2)** is provided to simplify the threading of a new paper roll into the printing mechanism.

The external power switch **(3)** and the paper advance switch **(4)** are conveniently provided on the front surface of the unit.

Ventilation slots are provided through the top and bottom covers for convection cooling of internal components; the SPRINTER should always be placed on a hard surface so that the cooling vents are not obstructed in any way.

All connections to the SPRINTER are made through an edge-type connector at the rear of the unit.

Access to the SPRINTER components may be gained by first removing the rubber feet under the lower case, and then removing the recessed screws which secure the top and bottom case sections.

POWER REQUIREMENTS

The label on the underside of the lower case will indicate the correct power supply. Serious damage may result from attempting to operate from an incorrect power source. Field modification to convert a unit from one power source to another is not recommended due to possible safety hazards.

The energy-efficient SPRINTER consumes only about 3 watts of power and is silent when not printing. The low power drain makes it convenient to power up with the host computer.

When printing begins, power consumption rises in proportion to the printing speed and to the number of dots being printed. The power consumption, when printing full character lines at 4 lines per second, is approximately 30 watts.

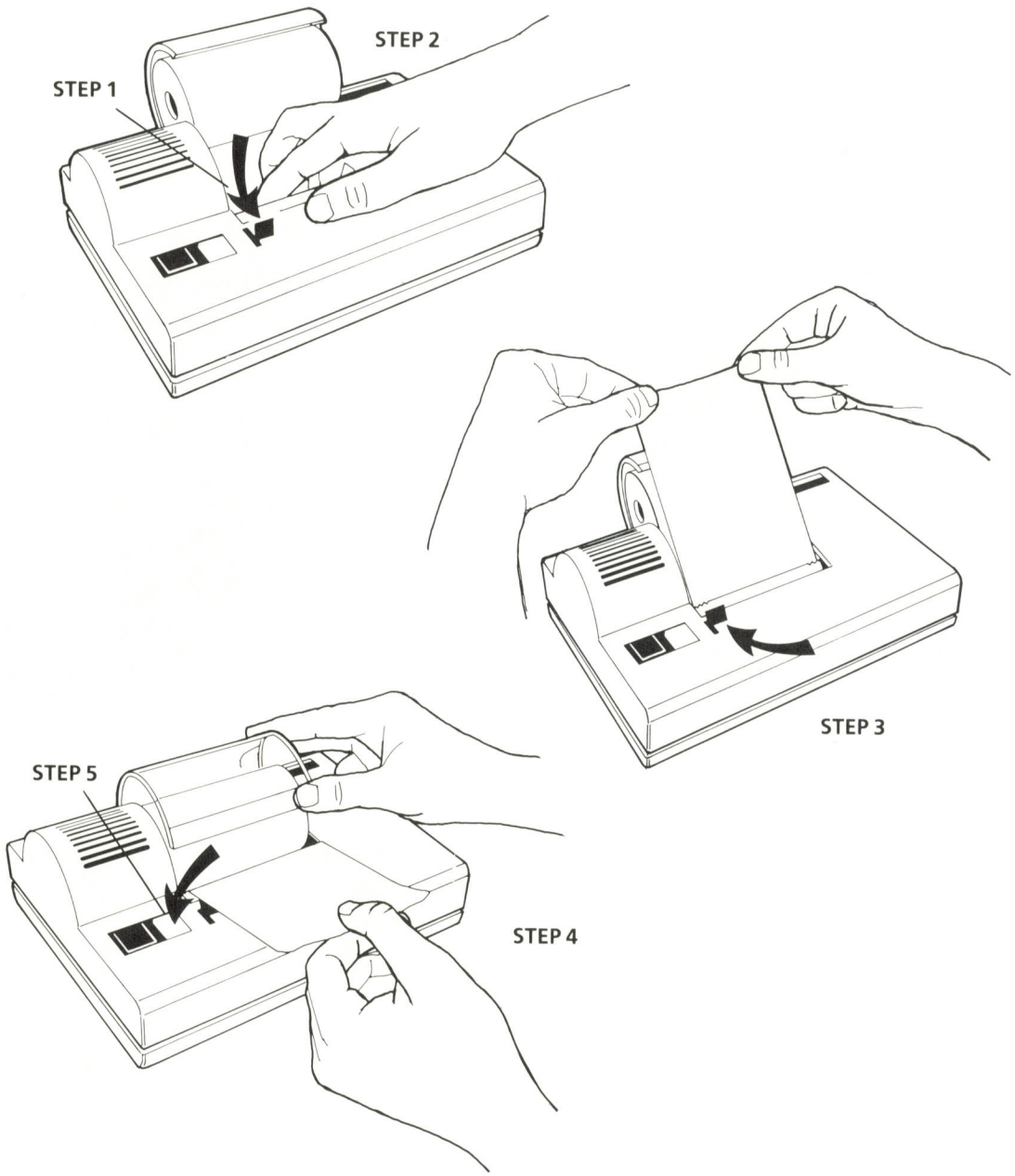
As a reminder to switch the printer off when not in use, the power switch is located on the upper cover, and indicates clearly the **ON** or **OFF** condition by its position.

In addition to providing its own power, the SPRINTER also furnishes regulated 5 volt power at the interface edge connector. When constructing customer interfaces, care should be taken to avoid short-circuits or excessive loads on this power supply. It is shared with the main VLSI (Very Large Scale Integration) controller which operates the printer, and any signals or fluctuations introduced on this line may affect correct printer operation. Current consumption from the edge connector should be limited to 200 milliamps to avoid overheating the printer unit.

PRINTING PAPER

Your SPRINTER is designed to use standard themographic printing paper in roll or fan-fold pack. A 2.5-inch diameter roll of paper, meeting these specifications, has been included with your printer. Insure that the correct paper is always used, for the sensitivity and smoothness of the paper is important for correct operation of the printer. Incorrect or low-quality paper may result in poor heat transfer, smearing and poor print contrast. It is particularly important to avoid use of abrasive papers, which can cause severe head damage in less than two hours of printing. For quality printing and longer head life use recommended grades of paper only. Refer to the Appendix in the back of this manual for a complete summary of paper types.

Your SPRINTER will accept fan-folded paper in addition to paper rolls. A fan-fold stack should be placed behind the printer and threaded under the rear edge of the paper roll cover. Again, use only recommended grades of paper.



LOADING ROLL PAPER INTO THE PRINTER

Paper loading may be easily accomplished by following the correct steps. Refer to Figure 2.

STEP 1 Lift the paper receptacle cover, and pull the paper release lever forward.

STEP 2 For convenience in paper insertion, it is suggested that the paper roll is placed at first in the fully opened paper receptacle cover, with the loose end coming from underneath. Insert the leading edge of the paper below the rubber platen, and push gently with a side-to-side motion until the edge of the paper appears on top of the rubber platen.

STEP 3 Grasp the end of the threaded paper and pull approximately 6 inches of paper through the thermal head area. At this point, insure that the paper is centered on the rubber platen, and is aligned properly. When correct alignment has been confirmed, pull both ends of the paper to insure that it is firmly wound around the rubber platen and return the paper release lever to the rear position.

STEP 4 Roll the paper supply roll forward into the receptacle. Grasp the leading edge of the paper and hold it toward the front of the printing unit, then close the transparent cover.

STEP 5 Confirm that the paper is feeding correctly by operating the manual paper advance switch. Check that the paper remains properly centered within the thermal head area. When you are satisfied that threading has been satisfactorily accomplished, excess paper may be removed, using the built-in paper tearing edge.

REMOVING A PARTIAL ROLL OF PAPER

In the event that a partially-used paper roll should be removed, follow these simple steps:

STEP 1 Tear off any excess paper protruding from the print head, using the built-in paper tearing edge.

STEP 2 Pull the paper release lever forward to release pressure on the rubber platen.

STEP 3 Open the paper receptacle cover, grasp the partially-used roll and lift it upward and to the rear, moving it gently from side-to-side to prevent binding in the print head area as the paper is withdrawn.

Alternatively, the paper web may be cut with scissors behind the lead-in slot to the printer. The partially-used roll may then be lifted out, and the paper in the printer head ejected by activating the manual paper advance switch until all of the paper has passed through the print head.

LOADING FAN-FOLD PAPER

When using fan-fold paper, the stack should be placed behind the printer. A slot is provided at the rear of the transparent paper cover through which the leading edge of the paper should be inserted with the paper cover closed. Push the paper forward until the paper receptacle is covered, then open the transparent cover and use the same threading procedure described for roll paper. Outgoing paper may be allowed to stack in front of the printer, or behind the incoming stack. Monitor the printer to insure that the incoming and outgoing stacks of paper do not interfere with each other. Insure that the sensitized (glossier) side of the paper has been placed in contact with the thermal heads. If in doubt, cut off a short length of paper and run it through the print head using the manual paper advance switch.

Checking the printer (test mode). A self test mode has been built into the VLSI controller, to provide a simple operational check. When placed into this mode, the printer will repeatedly print the character set across the paper in a continuous pattern. A test mode is entered by holding the paper advance switch active and then pressing the power switch ON. After approximately one second, the printer will begin to print the character set. It will continue printing until the paper advance switch is released, whereupon it will enter the mode selected on the mode selector switch. The correct operation of the printer, the correct loading of the paper, and power availability can all be confirmed in this manner, without changing the configuration of the printer or disconnecting it from its interface. This test mode will also demonstrate the fast printout speed of which the SPRINTER is capable.

CUSTOM INTERFACING

Because there are so many alternative methods of interfacing with various computers, this section will fully explain how the SPRINTER interface operates, so that a custom interface can be constructed, if desired. Interface sets for specific computers are available too. (Refer to the following section: Interfacing to Specific Computers with factory Cables.)

PARALLEL VERSUS SERIAL INTERFACE

The SPRINTER is a very fast synchronous printing mechanism. While it is capable of starting and stopping for individual print lines, it is most efficient when it is furnished data at a rate which will permit it to print continuously. The VLSI controller includes a 40-character buffer which stores the character codes to be printed as they are transmitted from a host computer. This buffer is filled until either the 40-character limit is reached, or until an open "action code" initiates the physical printing of transmitted characters. The formal name of this technique is "single line buffering", which indicates that the buffer cannot be refilled until it has been "emptied" on to the paper by the printer. The rate at which it can then be refilled is a function of the host computer and the interface mode selected.

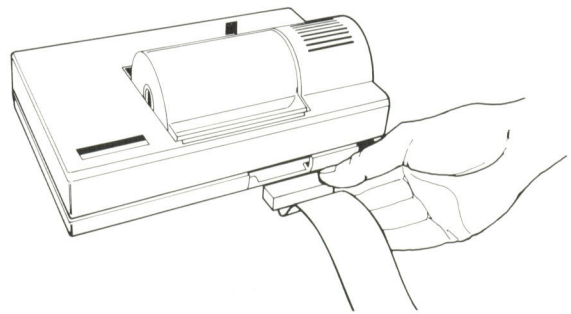
The fastest mode supported by the SPRINTER is the 7-bit parallel interface. When this mode is used, the SPRINTER can be operated at full speed and will appear to print continuously because it is not being slowed by the host computer. The 7-bit parallel interface is recommended because it is usually the least expensive interface to build, and it will permit the unit to be effectively used as a graphic plotter. The mode provides for 7 bits of data to be presented to the SPRINTER with a DATA STROBE signal indicating the validity of the data. The SPRINTER will signal that it can accept the data with a "BUSY" signal which appears momentarily as incoming characters are being examined and buffered, and during the physical printing action. Data cannot be recognized when the busy signal is active.

A complete set of lower serial interface speeds are also provided in the SPRINTER VLSI controller, using the data conventions of the RS-232 data interchange protocol. The most rapid of these protocols takes place at 9600 bits per second and the least rapid at 110 bits per second.

The serial transfer rate of 110 BAUD corresponds to a print rate of ten characters per second. Since the SPRINTER can print at up to 160 characters per second (4 lines x 40 characters/line), this type of interface will seriously degrade the performance of the SPRINTER 40. If a serial interface must be used, we encourage use of the fastest rate supported by the host computer. The serial interface software must also honor the BUSY signal. Typically, it is routed to the host through a 'DATA SET READY' line on the RS-232 connector. With normal computer wiring, this will make the signal available to software on a bit inside a serial interface controller IC, although these devices are not used on all computers (APPLE for example). The polarity of the signal at the destination computer will be determined by the intervening buffers and inverters and will not necessarily be the same in all computers. Interface cables will be available to invert this signal external to the host computer; other cables will be available which will require the inversion be accomplished in the host computer with software. In most cases, if two STOP bits are furnished, the BUSY signal need only be monitored for completion of the printing operation. The buffering step can be accomplished during the STOP bits for characters which do not initiate printing.

OPERATION OF THE SPRINTER 40 PARALLEL INTERFACE

This section will furnish explicit electrical and timing information. Since all data in the SPRINTER 40 are encoded into 7-bit groups (whether character or graphic in nature), only seven data lines are needed to transfer each byte of information. In the passive parallel cable, these data lines are interpreted as TTL active HIGH data levels. Thus a zero (0) bit would be represented by a voltage level between 0 and .4 volts and a one (1) bit would be represented by a voltage level between 2.4 and 5 volts. These data bits are routed directly to the controller device and thus into the input gates of metal oxide semiconductor field effect transistors (MOSFET) which require virtually no current. Thus while they respond to TTL voltage levels, they require no power and can be driven by very low power logic including CMOS logic operated at 5 volt levels. This property makes them vulnerable to damage from high voltage static electricity, however, and care should be taken to avoid touching the edge connector while working on static-prone carpeting. In addition, do not permit signals higher than 5 volts to come into contact with these data lines.



In order to indicate the validity of the seven data lines, another signal must be presented by the host computer to verify that it is placing valid information on them. This strobe signal is accepted on the same trace on the edge connector as the serial input data stream. (NOTE: The complete pinout of this edge connector may be found in the Appendix.)

The DATA STROBE signal is represented by a transition of this line from the TTL LOW level to the TTL HIGH level. This transition may occur at the same time that the seven data lines are changed, thus permitting the entire output of the host on a single eight bit port. Upon receipt of the DATA STROBE transition to the HIGH state, the SPRINTER 40 will pause for approximately 25 microseconds to allow the signals to stabilize on the interface cable, sample the state of the seven data lines to determine the code being sent by the host, and then assert the BUSY signal as an active HIGH level to the host. The host computer must not alter the state of these lines until the BUSY signal is removed (i.e. returned to the LOW level) by the SPRINTER. As long as this sequence is honored, any type of interface may be inserted between the host and the SPRINTER 40. Just prior to the removal of the BUSY signal, another signal known as acknowledge (ACK) is asserted by the SPRINTER. This indicates that the furnished byte of data has been processed. The ACK signal is removed simultaneously with the removal of BUSY. ACK is furnished as an active LOW signal which returns to a HIGH level upon the removal of BUSY. Thus both a pulse type signal (ACK) and a level type signal (BUSY) are available as a basis for constructing other external parallel interfaces.

These signals were developed for a very fast series of printers, to occur very rapidly and to be implemented in discrete hardware logic. In the SPRINTER controller, these signals are implemented in a microprogrammed interface section which permits the same hardware to be used in several different types of interfaces. As a result the timing sequence is expanded although the same relative relations are present. Since most host computers implement their parallel interfaces in software, they will be quite compatible with this technique. The basic software sequence followed in the host should be as follows:

1. Monitor the BUSY signal until it is inactive. If it fails to become inactive, manual corrective action must be taken.
2. Remove the DATA STROBE signal.
3. Assert the DATA STROBE signal and the seven data signals.
4. Pause approximately 30 microseconds.
5. Confirm receipt of data by recognition of the BUSY signal.
6. If BUSY not asserted, printer is inactive or interface has failed. Take appropriate manual recovery action.
7. If BUSY is asserted, begin preparation of next data byte, or next line of characters, as appropriate.
8. Return to step 1 unless all printing has been accomplished.

During step 7, when the data from the host is either being buffered or printed, both the host and SPRINTER can be working in parallel. In this manner the host has the maximum time to prepare the next data byte while the SPRINTER is processing the previous data byte, or printing the completed line of characters. This is an important aspect, particularly when graphics information is being transmitted to the SPRINTER.

The BUSY signal and ACK signals are produced by an open collector circuit to prevent problems in the event that they are externally pulled low. This circuit is essentially a 470 ohm resistor tied to the SPRINTER 5 volt supply and pulled to ground by a transistor when these signals are low. There is an additional invisible clamping diode built into the transistor which connects the collector to the main DC supply capacitor. In the event that an inductive load should be connected to either of these lines, these diodes would route any voltage excursions over approximately 35 volts into the SPRINTER power supply. While this is a highly unlikly prospect, the interface designer should be aware of its presence.

This interface port can normally be connected with proper cables to a 'Centronics' type interface cable, although jumpers may have to be modified in some of these units to produce or honor the proper polarity of the BUSY or DATA STROBE signals. In most cases these interfaces can be directly used without modification of resident BASIC software and system PRINT intrinsics. The active Centronics cable contains slight hardware to standardize these signals to the highest speed hardware version of these signals.

SERIAL INTERFACING

When serial interfacing is used, the SPRINTER may only be used as a character printer. This is because it is logistically impossible to furnish data rapidly enough to keep up with the rate at which dots must be furnished to the printer at the serial transmission rates. For more information refer to the GRAPHICS section of this manual. With higher Baud rates, such as 9600 Baud, very high character printing rates may still be achieved. When using serial interfacing, only three data lines are required, SERIAL DATA, GROUND, and BUSY. The data format used is the RS-232 format for serial data with the same ASCII character encoding used for all printing. The serial interface looks for a START bit, eight data bits, and one or more STOP bits.

The information in RS-232 is theoretically encoded as a positive and negative voltage swing centered at zero volts. Signals must theoretically swing more positive than 3 volts to represent a logic zero (0) and more negative than −3 volts to represent a logic one (1). The SPRINTER is more tolerant than this in its interpretation; any signal more positive than 2.4 volts will be recognized as (0) and any signal less than .4 volts will be recognized as logic one (1). This is accomplished by a simple circuit on the SPRINTER controller board which permits either normal TTL levels or RS-232 levels to be connected to the SERIAL DATA/DATA STROBE line. It will also work with CMOS logic, operated at 5 volt levels or higher, providing the logic low level is less than .4 volts.

When the definition of RS-232 is examined, the START bit emerges as a HIGH (>2.4 VOLT) signal and the STOP bit emerges as a LOW (<0.4 VOLT) signal. Data bits appear as apparently inverted, in that zeros are represented as HIGH signals and ones are represented as LOW signals. Although eight data bits must be transmitted and received, the seven bit ASCII coding used implies that the eighth bit must be a logic zero, i.e. a HIGH data bit. (The value is actually ignored.) Data bits are transmitted least significant bit first through most significant bit last. The sequence is thus:

START BIT	(HIGH)
DATA 0	
DATA 1	
DATA 2	
DATA 3	
DATA 4	
DATA 5	
DATA 6	
DATA 7	(HIGH)
STOP BIT	(LOW)
STOP BIT	(LOW)

After the transmission of the complete byte, transmission of the next byte may begin if it is ready. If not, the data line should assume the inactive level which is represented by a LOW level. The BUSY line will be asserted during the START bit and will be removed during either the first or second STOP bit, depending upon the data transmission rate selected. The BUSY signal will thus have been removed before the next START bit time interval begins, unless the printer has initiated a physical printing operation.

INTERFACING TO SPECIFIC COMPUTERS WITH

GENERAL PURPOSE CENTRONICS CABLE

This cable is available with the male 36 pin "tongue and groove" connector. A printed circuit in the cable contains logic to standardize signals from the source and to perform cross connections to the SPRINTER cable. This is an active device and is powered from the 5 volt supply in the SPRINTER while it is powered up.

GENERAL PURPOSE RS-232 CABLE

This cable is wired to mate with normal RS-232 cables and acts as a 'data set'. It furnishes a "data set ready" signal generated from the SPRINTER BUSY signal and terminates in a 25-pin male 'D' type connector. The board includes several jumpers for optional generation of the special signals required by some computers. It terminates in an edge connector for direct connection to the SPRINTER. It is also powered by the SPRINTER.

GENERAL PURPOSE PASSIVE CABLE

This cable furnishes the SPRINTER edge connector on one end of a ribbon cable, giving the user access to every signal in the SPRINTER interface, including the SPRINTER 5 volt power supply. Either special serial or parallel connectors may be connected to this cable to make a custom serial or parallel interface for the computer. The pinout of this cable is included in the cable package.

TRS-80

The SPRINTER 40/TRS-80 interface cable is a parallel interface cable which responds to bus addressing, latches data for the SPRINTER, and furnishes a readable response to interrogation of the BUSY signal recognizable by the standard TRS-80 software. This interface contains several active devices and is automatically powered by the SPRINTER internal power supply. A schematic of the unit is included in its package. With this unit installed, it will be necessary to power up the SPRINTER whenever the TRS-80 is operating, to avoid interference with the internal bus of the TRS-80. No modification of the TRS-80 is required. This unit connects directly to the TRS-80 keyboard edge connector.

Interface can also be accomplished with our general Centronics standard cable using one of the Radio Shack Centronics interface devices. This alternative may be useful if one of the Radio Shack interfaces is already available.

APPLE CARD

The SPRINTER 40/APPLE interface cable is a circuit board, to be inserted in the APPLE computer in one of the device slots. The card draws power from the APPLE power supply and programs the APPLE 6502 processor to execute required protocol to communicate with the SPRINTER, using the parallel interface. The interface card contains software to dump all Apple displays on the SPRINTER by pressing keys on the keyboard. It also connects the SPRINTER to respond to APPLESOFT print commands to permit normal printing. The SPRINTER does not have to be powered up when using the APPLE interface card unless printing is actually under way. The APPLE card requires no modification to the APPLE computer, and obeys the protocol of the APPLE for transferring data to a device controller. It may thus be used with APPLESOFT BASIC or other standard Apple-furnished software packages for character printing. The interface card includes a cable which connects directly to the edge connector on the rear of the SPRINTER.

The Apple can also be used with our active Centronics cable driven by the Apple Centronics printer card, but this is an expensive combination and is not recommended unless the Apple card is already available, since it does not include software for printing Apple displays.

PET INTERFACE

The PET interface requires a modified SPRINTER to support the PET character set. This modification performs the necessary protocol of the IEEE-488 interface and allows the PET IEEE bus connector to be daisy-chained to the SPRINTER in accordance with the bus philosophy. The special SPRINTER unit sold for this purpose will include the special interconnect cable required to connect to the PET computer. The PET modification deletes some standard features of the SPRINTER to make it more uniquely suited to the needs of the PET. Check with your SPRINTER supplier for availability.

ATARI 400 AND 800

The ATARI computers can be interfaced in several ways. The ATARI family of componenets includes printers which interface directly to the main unit, thus consuming some of the interface ports, and printers which interface to the ATARI 850 Centronics port, which then retains the ability to perform additional interfacing. Our cabling interfaces to the 850 Centronics port through use of a simple interconnect cable. In this manner, the SPRINTER is directly accessible through normal print logic in both the 400 and 800 computers. Use of the serial ports on the 850 is not recommended, because the faster parallel port is available.

MATTEL INTELLIVISION

An interface to the Mattel keyboard unit will be made available for direct interface in the near future. Check your supplier for availability.

CHARACTER PRINTING

Character printing may be simply accomplished from all interfaces. The SPRINTER recognizes 96 ASCII character codes as printable characters and prints them. In addition, it recognizes certain other codes with numerical values between 0 and 31 decimal as action codes, which can trigger changes of printing mode. Each of these action codes is explained below. The character font and association with ASCII representation are presented in the Appendix.

Character mode of operation is assumed when the printer is powered up. At this time the print buffer is cleared, the printing speed is set to four lines per second, and the mode switch is tested to determine the interface mode and type of paper being used. Characters will be accepted into the internal print buffer until either the action code 'CR' or 'LF' or CNTRL-R are received, any of which will initiate physical printing. Any characters in excess of the first 40 printable characters sent prior to one of these action codes will be ignored by the SPRINTER; the receipt of these characters will affect nothing but for the time consumed in their transmission. Following the physical printing of any line, the print buffer is immediately cleared before accepting additional characters.

Carriage Return Decimal (13) Octal (15) Hex (D)

The 'CR' character is used to cause normal printing of a character line. If fewer printable characters than 40 have been buffered prior to the receipt of this code, the buffered characters will be printed starting at the leftmost column on the page. Blank characters will be printed in the remaining right columns corresponding to the empty positions in the buffer. Since many computers contain software which generate the 'CR' and 'LF' in paired combinations, the SPRINTER will ignore the second of these if they are sent in pairs. The physical printing operation will begin when any of the three codes are received. If this operation is followed by the receipt of one of the other codes, this second code will be absorbed by the controller without action. Subsequent receipt of every repeat immediately following one of these codes will result in the printing of a single blank character line. This pattern is broken by the receipt of any other code by the controller.

Line Feed Decimal (10) Octal (12) Hex (A)

The LF code functions identically to the Carriage Return. A carriage return following it will be absorbed (in a similar manner to the situation described for Carriage Return.)

CNTRL-R Decimal (18) Octal (22) Hex (12)

This action code is treated identically to the carriage return and has the same relationship to the line feed code. The only manner in which it differs is that when it initiates physical printing, and the printed buffer contains fewer than 40 characters, the buffered characters will be right-justified in the print buffer, and the vacated positions will be filled with blanks prior to printing. Thus information will appear to have been shifted to the rightmost column prior to being printed. The use of the CNTRL-R is to suggest "Right justify".

VERTICAL-TAB Decimal (11) Octal (13) Hex (0B)

This action code followed by another code causes the SPRINTER to execute a multiple line feed. The next code transmitted after the CNTRL-M is interpreted by the SPRINTER as a binary number, indicating how many lines should be skipped in the multiple line feed. The meaningful range of values are 1 through 127, represented as some 7-bit ASCII code. Precisely this many lines will be printed as blank character lines following receipt of the second code.

FORM FEED Decimal (12) Octal (14) Hex (0C)

Receipt of this code causes the SPRINTER to skip eight lines if the fan-fold switch is set to "roll paper," or in all early units. In later units, if the switch is set to fan fold paper mode, receipt of this code will cause the SPRINTER to skip to the head of the next logical page, based on the size and its position on the current page.

CNTRL-G Decimal (7) Octal (7) Hex (7)

This code can be thought of as an escape to GRAPHICS code. It can be received when using a parallel interface capable of supplying data rapidly to the printer. Following receipt of this code the SPRINTER will immediately actuate the print mechanism and enter graphics mode of operation. It will remain in this mode as long as data is received rapidly enough to satisfy the data rate required by the moving printer. If at any time data is not received for printing, the printer will be stopped and the controller will clear the print buffer and return to normal character mode. This code may be meaningfully received following power up, or at any time when the print buffer has been cleared. If it is received when the print buffer contains information, the contents of the buffer will be cleared prior to starting the printer. For more information refer to the section on GRAPHICS.

CNTRL-S Decimal (19) Octal (23) Hex (13)

Later models of the SPRINTER include the ability to control the speed of the print mechanism at three different speeds. While the normal speed of the unit at power up is approximately four lines per second, the print mechanism can also be operated at three and two lines per second. This action is initiated by the transmission of the CNTRL-S code followed by an ASCII decimal valued code of either 2, 3, or 4 (see table in the Appendix for the ASCII name of these codes). The ability to respond to speed control is a function of the VLSI controller and early units can be updated to obtain this ability by replacement of the controller. The primary purpose of this ability is to reduce the data rate required from the host computer during graphics mode.

CNTRL-Q Decimal (17) Octal (21) Hex (11)

This code is used in later units to set the logical page size of fan fold paper. (See auto-fan fold mode.) This code must be followed by a subsequent code which is interpreted as the binary value (1-127) of the logical page. A size of zero will be ignored. When this code is received, the printer is assumed to be set to approximately three lines from the top of a page.

AUTO-WRAPAROUND

Later models of the SPRINTER also include the ability to 'wraparound' any characters in excess of the 40 characters which will fit onto the normal print line. In this mode, the printer interface will go 'BUSY' following the receipt of the fortieth character and will physically print the characters in the buffer, clear the buffer, and return to accept more characters. In this manner, if the host contains unmodifiable software (such as in a ROM BASIC system) which will try to print character lines wider than forty characters, the SPRINTER will automatically print these extra characters on the following line rather than truncating them. This permits the SPRINTER to be used in applications formerly requiring an 80 column printer. Auto-wraparound is selected by one of the mode switches located in the paper feed chute.

When operating in auto-wraparound mode, it is possible to have the SPRINTER left or right justify any partial line which is wrapped around. In this manner, the tail end of lines may be displayed on the right side of the page which is more aesthetically pleasing to some observers, particularly when tabular oriented information is being printed such as assembly languages or PASCAL. The right justified wraparound matches the style used by many programmers of right justifying short continuations of lines of program code rather than continuing them to the beginning of the following line. The right or left justify mode is only functional when auto-wraparound has been selected. The logic for both auto-wraparound and auto-justify are contained in the VLSI controller and are available on any SPRINTER using the later model controller chip.

AUTO-FAN FOLD PAPER MODE

Fan-folded paper may be used with any SPRINTER. A slot at the rear of the paper cover permits external paper insertion. Later models also include additional logic in the controller to track the volume of material being printed on a conceptual page of paper, and to skip across the fold line between pages automatically. There is no hardware outside the controller to physically identify the page boundary. The page boundary is determined by instructing the controller through the transmission of CNTRL followed by another code indicating the number of lines which should be on the page. This number is encoded as the number of TOTAL lines on the page, including six blank lines printed by the controller when the end of the logical page is reached. when the SPRINTER reaches this TOTAL-6 lines, it will automatically print six blank lines, placing three of these at the end of the current page, and three of them at the top of the following page.

When paper is loaded into the SPRINTER and the fan-fold mode is active, the SPRINTER will assume (at power up, or following any use of the PAPER ADVANCE switch), that the operator has positioned the paper approximately three lines from the top of a new sheet. The SPRINTER will subsequently hold this approximate position at the top of following pages, assuming that it has been programmed with the proper line length. The default page size has been set for the 11-inch-high paper recommended for use with the SPRINTER. Since the SPRINTER cannot distinguish whether fan-fold paper is being used, this mode may also be used with roll paper. In this manner, pseudo pages of up to 120 physical lines may be printed on roll paper, with six-line gaps automatically being inserted by the SPRINTER as text is printed. This permits the operator to cut the printed areas apart, or fold the output to achieve a fan-fold listing. The controller also accounts for page length during the printing of graphics material, so that pictures may be merged with normal text without interference with page boundaries. However, if graphics mode is entered and continued across a page end, the SPRINTER will print a continuous block of graphic material.

Fan-fold paper can be used on any model SPRINTER without the use of the auto-fanfold feature. In this case, printing will occur across the fold seams of the paper, producing a continuous output.

PRINTING GRAPHICS INFORMATION

The graphic plotter mode is provided in addition to the normal mode in which information is sent to the SPRINTER as ASCII codes causing it to draw the fonts of characters from its internal character pattern memory. In plot mode, the host computer sends the same 7-bit bytes of information, but the actual bits sent are plotted as dots across the 280-dot line of the printer. Each of the 40 thermal dot sites prints seven dots, producing the total dot line. The printing mechanism must run continuously because there are no interline blanks. All data transfer to the SPRINTER takes place while the print heads are reversing direction. The high speed of the parallel interface is required, since forty bytes must be transferred during each reversal.

In a normal application, the host computer will develop a graphic bitmap or plotting array of dots. This will represent the dot data transferred to the SPRINTER when plotting. The role of the host computer is to prepare, as necessary, the next dot line while the previously transmitted line is being printed. When operating the SPRINTER at four lines per second, this implies that forty dot lines will be printed each second, or that a complete dot line will be printed each twenty five milliseconds. The host computer must be able to prepare forty bytes of data during approximately twenty milliseconds, and transfer it during the remaining approximately five milliseconds. Short, simple assembly language routines running in any of the common host microprocessors will normally meet this requirement.

GRAPHICS DATA TRANSFER

Upon receipt of the CNTRL-G code, causing entry to graphics mode, the controller will start the print mechanism and allow it to accelerate to speed. When a complete pair of blank dot lines has been printed and the print mechanism reverses its direction of travel, the BUSY condition will be removed from the interface and the SPRINTER will attempt to accept data from the host computer. It can accept forty bytes, of seven dots each, within a specified period of time determined by the rate of speed at which the mechanism is operating. Later units allow the speed to be varied between 4, 3, and 2 lines per second. As the SPRINTER is waiting for data to be received, a timing counter is activated for each byte. If the data byte has not been received before this counter clears, the interface signals the controller that a 'graphic timeout' has occurred. This will result in an exit from graphics mode and a return to the mode established before graphics mode was entered. This timeout insures that all data can be received prior to the thermal heads passing the points at which they must print the buffered dots. The transmitted dots are stored in the internal buffer and printing occurs as the mechanism passes over the proper position on the paper. Upon receipt of the fortieth byte of information for each dot line, the SPRINTER interface will remain BUSY until completion of the physical printing operation. No explicit action code is required or allowed for initiation of the physical printing. The timeout period for each byte transfer to the SPRINTER is given in the following table for each printing speed:

Printing Rate	Max time between NOT BUSY and next DATA STROBE	(later units)
4 lps	40 μs	40 μs
3 lps	70 μs	130 μs
2 lps	100 μs	220 μs

ORIENTATION OF THE GRAPHIC MATRIX

Within each line of dots, the first byte of data plotted will be placed in the leftmost print column and the fortieth byte will be placed in the rightmost column. The most significant bit within each byte (DATA 6) will be printed in the leftmost side of each byte and the least significant bit (DATA 0) will be printed in the rightmost side of each byte of dots. The printed image will be, at most, 280 dots in width, but there is no particular limit on its length, as long as data can be furnished rapidly enough. In most computers, the realistic limit will correspond to the size of the bitmap which can be stored in the host computer's memory. In some applications it may help to think of the image rotated 90 degrees. For example, it would be impossible to print the contents of an eighty column display across the width of the printer, but quite possible to dump this same information rotated 90 degrees since such an image would require typically 240 dot lines in height by 560 dot columns in width.

Whenever the printing mechanism is stopped at the completion of a block of graphic printing, there will always be a group of several blank dot lines, corresponding to the acceleration and deceleration time of the print mechanism. It is impossible to eliminate this phenomena, but this will normally cause no problem because some interblock spacing is usually desirable between graphics and surrounding text.

GRAPHICS BROWNOUT

More power is used in the conversion of the thermal paper than is needed to operate the printer motor or the controller board. Normal character printing consumes a relatively small amount of power since character patterns are relatively sparse, and characters are separated by blank columns and rows. When printing graphics, potentially many more dots must be produced corresponding to 'black' areas in the dot raster. While all-black rasters are not particularly interesting or useful, they can conceivably occur. To avoid this the SPRINTER has been designed to print at full speed at 50% duty cycle. It will print half or fewer of the dots at full speed, or, in later models, all of the dots at half speed (2 lines/second). Some additional reserve capacity insures that short bursts of dark printing (several dot lines) can be printed normally if this condition is not sustained.

In the event that sustained dark printing is attempted, protective circuitry in the SPRINTER power supply will activate within approximately eight dot lines and reduce the power to the print mechanism. This will appear as a slowing of the printer and a lightening of the print image. This condition can be thought of as a power brownout . It means "SLOWDOWN!" When the unit is operated at one of the lower speeds such as 3 or 2 lines per second, the rate of power usage is inherently reduced. It is recommended that 2 lines per second be used for printing of very dark images. If sustained black printing is attempted, a protective thermal fuse in the power supply may also be activated. This will necessitate opening the printer case and replacing the fuse before the printer can be used further.

CUSTOMER SERVICING OPERATIONS

In normal operation your SPRINTER should print many hundreds of thousands of lines without requiring service. The following service operations are described because they might be required eventually. We want you to know how to perform them correctly if they should become necessary.

OPENING THE SPRINTER CASE

STEP 1 UNPLUG THE SPRINTER FROM ITS WALL OUTLET AND THE HOST COMPUTER. Never attempt to perform any service step with the unit connected to any other device. Remove any roll paper contained in the paper compartment.

STEP 2 Remove the plastic handle from the paper release lever by pulling up on the handle, without bending it. The handle is held by friction on the lever it covers.

STEP 3 Pull out the four small rubber feet under the case. The feet are held in place by friction. This will provide access to four recessed screws. Remove the screws with a small straight blade screwdriver by rotating them counterclockwise.

STEP 4 Hold the case together while it is turned upright, then lift the upper case from the lower case.

CLOSING THE SPRINTER CASE

STEP 1 Insure that the paper release lever is placed in the forward position. Insure that the power cord strain relief is inserted into the opening in the rear of the case. Insure that the printer is firmly attached to the controller board, and that all circuit boards and the power transformer are firmly attached to the lower case. Insure that no foreign objects (tools, screws, paper, etc.) remain inside the case and that the ventilation slots are unobstructed.

STEP 2 Place the upper case on top of the lower case, and align correctly. Holding the two case halves together, invert the unit and reinstall the four screws. Reinsert the four rubber feet into the screw holes on the lower case. Note that these feet are necessary to insure that the SPRINTER sits high enough to allow ventilation of the case.

STEP 3 Reinstall the paper release lever on its shaft and load the printer with paper.

STEP 4 Place the printer into self test mode to confirm correct reassembly.

REMOVAL OF THE PRINTER MECHANISM

STEP 1 Release the ribbon cables by lifting alternately on each end of each connector and removing the ribbon cable at an angle. If the connector appears to bind, do not force it, but work alternately at each end of the connector until it loosens. There are two 21 position connectors, and a small 6 position connector. NEVER SHARPLY FOLD THE RIBBON CABLES AS THIS MAY CAUSE INTERNAL FAILURE OF THE PRINTED CONDUCTORS AND MAY REQUIRE REPLACEMENT OF THE PRINTER MECHANISM.

STEP 2 Remove the four 8-32 screws holding the printer to the posts on the printed circuit board. Lift the printing mechanism vertically until it is clear of the mounting posts.

REPLACEMENT OF THE PRINTER MECHANISM

STEP 1 Replace the print mechanism on the four mounting posts. Reinsert the four screws holding the printer to the posts.

STEP 2 Replace the two 21-position ribbon connectors into their respective sockets by holding firmly onto the reinforced area just above the edge of the connector, and pressing them vertically into the connectors.

STEP 3 Replace the smaller connector, insuring that the wires pass under the edge of the sheet metal just behind the socket and emerge to the right side of the connector. The ribbon should not be forced forward. Insure that the ribbon portion of the cable rises up and over the corner of the printing unit and that it does not interfere with either the connections to the printer motor or the nearby other ribbon connector. BE PARTICULARLY CAREFUL THAT YOU DO NOT SHARPLY FOLD THIS SMALL RIBBON CABLE AS YOU INSERT THE CONNECTOR.

REPLACEMENT OF THERMAL HEADS

STEP 1 Remove the printer mechanism as described above.

STEP 2 Locate the wire spring which extends from the top surface of the thermal head pressure plate around under the printer to a metal cross bar on the underside of the printer. Place a thin bladed screwdriver between the spring and the metal cross bar, and lift the spring free of the small hole in which it resides. Perform the same operation on the end of the spring inserted into the pressure plate, on the top side. The spring may now be slid out of the print mechanism, leaving the pressure plate pressed loosely against the platen.

STEP 3 Gently work the pressure plate out of the positioning notches. The pressure plate will not release entirely from the printer; the goal is to release it enough to obtain access to the underside of the pressure plate by lifting and folding it backwards, away from the platen.

STEP 4 Loosen the small screws holding the spring fingers against the thermal head, until the thermal head can be slid from under the fingers.

STEP 5 Install the new thermal head, being careful to align the conductive pads in the head with the conductive pads on the end of the ribbon cable. Tighten the small screws along the pressure plate.

STEP 6 Work the pressure head back into the positioning slots and reinstall the pressure spring. Note that the spring is not symmetrical, but has a top and bottom side to help clear the ribbon connector. Install the spring to match the orientation of the undisturbed side.

STEP 7 If necessary, replace the other thermal head using the same procedure.

STEP 8 Replace the printer mechanism, following the above instruction, and close the SPRINTER case. The printer may then be tested using test mode.

STEP 9 The printer should now be fully operational if the work has been successfully completed. It may be necessary to print for a while after service work, to allow the pressure heads to seat and the heads to wear in. Noticeable print lightness of either head, or print lightness at one side of either head indicates incorrect seating of the pressure plate. Correct and adjust before printing. Contact with paper is important; it must be uniform to avoid damage to the new heads.

STEP 10 If there is slight relative misalignment between the two thermal heads, either of the heads may be moved slightly with a small screwdriver after installation until satisfactory alignment is achieved. This must be a small movement, to avoid breaking contact between the conduction sites on the head and the ribbon cable under the pressure plate.

PAPER JAMS

Under normal operation, there should be no problem with paper jamming in the mechanism. In the event that small roll-ends of paper are removed or reinstalled into the printer, care should be taken that the tightly curled paper does not wrap under the paper stripper bar during the loading operation. If this does occur, the paper may begin to wrap around the platen until a thick roll of paper builds between the pressure plate and platen and stalls the printer. This is a difficult situation to remedy since the platen will not readily rotate backwards. It is best avoided by careful loading practices.

If such a jam does occur, unplug the SPRINTER to remove power and try the following techniques to remove the jam.

1. Release the pressure lever, tear off the supply of the paper, and attempt to push the incoming paper into the mechanism, thus unwinding it from the outside of the spiral. This will have to be repeated for as many times as the paper is wrapped around the platen.

2. If this method fails, slicing the paper across the roller may have to be attempted. An alternative is to remove the print mechanism from the case and massage the paper from around the roller.

3. NEVER under any circumstances place tools between the thermal heads and the platen. The probability of damage to the thermal heads is very high under these circumstances.

The best solution to this problem is PREVENTION, by careful loading of the printer in the first place and monitoring the correct feeding at the initiation of printing.

LUBRICATION

The printer mechanism does not normally require lubrication. Small amounts of grease are located on the oscillating bar where it enters the metal side plates of the printer. Unless this grease becomes contaminated with dirt or other foreign material, it need not be replaced. Prolonged operation of the unit at high temperatures may cause the lubricant to thin excessively. In the unlikely event that this occurs, a slightly heavier lubricant may be applied to the sliding contact surfaces. The motor is permanently lubricated and should not require additional lubrication during its service life.

DOT TIMING ADJUSTMENT

The controller board contains a potentiometer which is factory adjusted during assembly to set the thermal dot heating time correctly. This potentiometer should not be used as a 'volume control' to set user-preferred dot intensity levels. Operation at the extreme dark setting with normal tolerances on components may result in excessive heating times for the thermal heads. The factory setting is difficult to restore without a logic analyzer or storage oscilloscope, so tampering is unwise.

DOT ALIGNMENT

In the event that a replacement print mechanism is installed, it may be necessary to adjust the dot alignment drum on the printer. This is a serrated white plastic tab extending slightly from the rear of the printer behind the motor compartment. On new printers, this drum is secured with adhesive on the tab and/or on another smooth tab extending slightly from under the right side of the printer. The adhesive may be cracked by slightly moving the tab left or right. Moving this tab will cause alternate rows of dots to move left or right with respect to each other, thus achieving vertical alignment between rows.

The easiest method for achieving alignment is to place the SPRINTER into self test mode and then adjust the tab while it is printing. Since this must be accomplished with the protective case open, WE DO NOT RECOMMEND THAT THIS STEP BE UNDERTAKEN BY THE OWNER DUE TO THE POSSIBLE EXPOSURE TO LINE VOLTAGES INSIDE THE PLASTIC CASE.

FUSE SERVICE

In the event that the fuse fails due to thermal or mechanical abuse, it may be replaced by opening the case and removing it from the spring clips in the unit. NEVER OPEN THE CASE WITHOUT DISCONNECTING THE SPRINTER FROM THE POWER OUTLET AND FROM ANY OTHER DEVICE TO WHICH IT IS CONNECTED TO AVOID SERIOUS SHOCK HAZARD. Replace the fuse with a similar fuse of the same rating, to insure protection of the power supply and to prevent possible fire hazard. The correct fuse rating is identified on the external lable on the underside of the lower case.

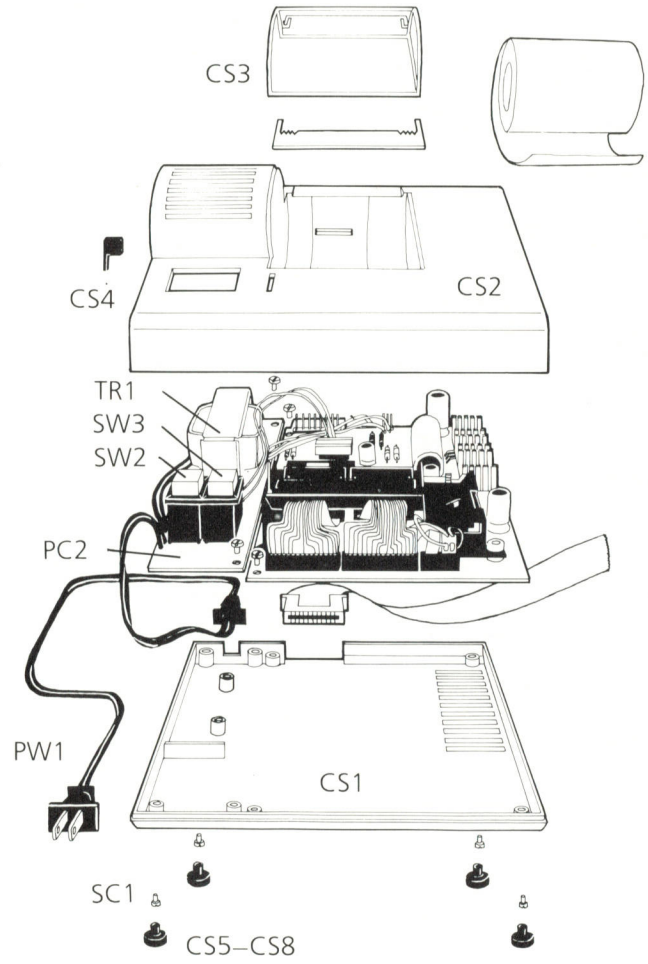
REPLACING THE VLSI CONTROLLER

In the event that the VLSI controller is damaged by incorrect interfacing or is being changed, it may be replaced by opening the case and removing it from the 40 pin socket. It should first be loosened by carefully inserting a thin blade screwdriver alternately under each end of the chip until it can be lifted from the socket. The pins on the replacement unit should be carefully checked to insure that they are correctly aligned, before inserting them into the socket. The chip should be oriented so that pin 1 (with the small dot molded into the corner) is nearest the left front corner of the SPRINTER.

Other maintenance requires laboratory service equipment and spare parts for the unit. Many dealers either offer this service or are familiar with local service centers in your area. If you cannot find satisfactory local service, a service and warranty service center operated by the manufacturer is available. Consult the warranty card enclosed for details.

COMPONENT PARTS IN THE SPRINTER 40 PACKAGE

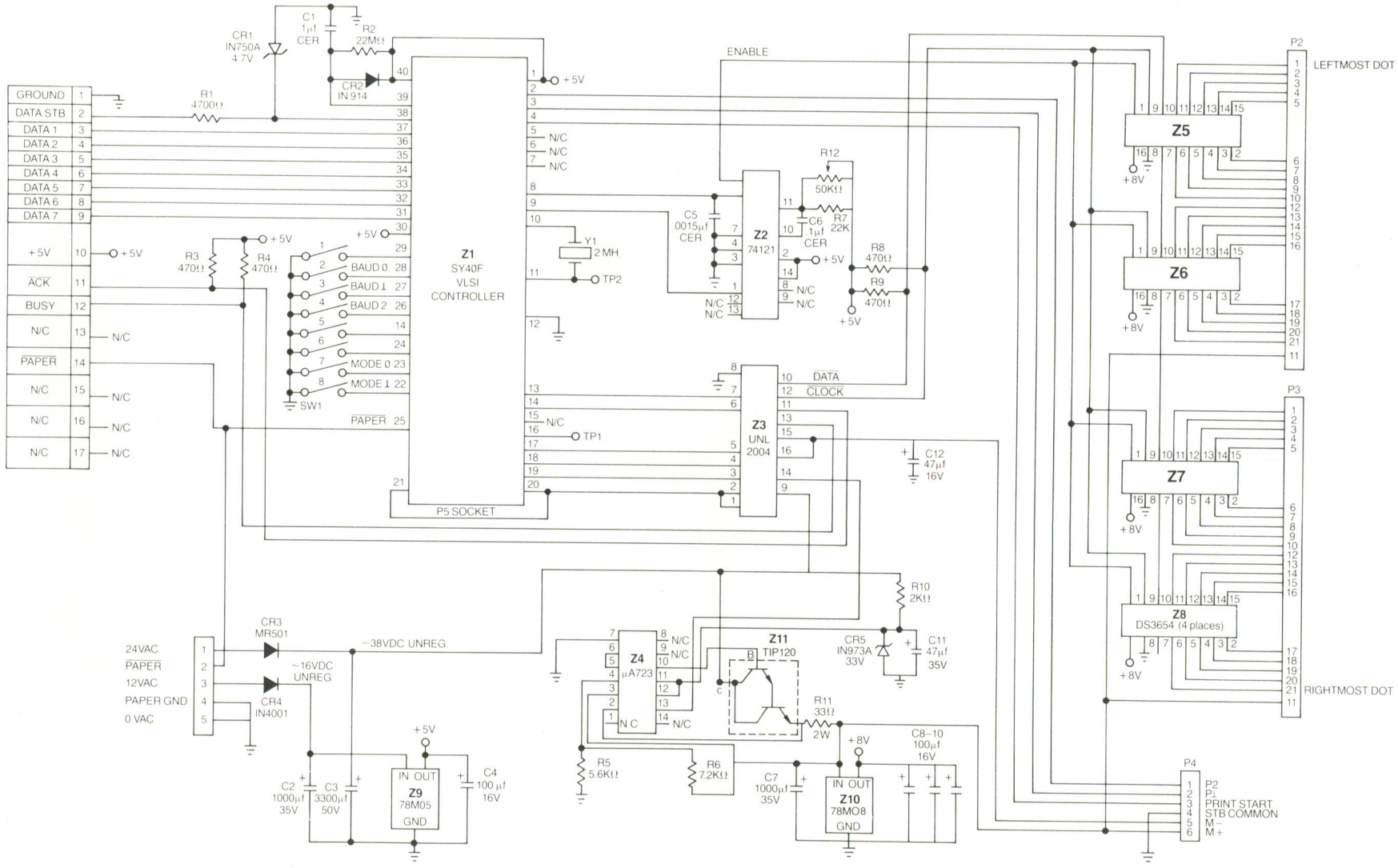
CS1	Lower plastic main case with label
CS2	Upper plastic main case with nameplate
CS3	Plastic paper roll cover and cutter
CS4	Plastic paper release lever
CS5–CS8	Rubber feet
SW2	Power switch
SW3	Paper feed switch
PC2	Power printed circuit board
PW1	117 v 60 Hz Power cord
PW2	220 v 50 Hz Power cord
FU1	Slo-blo fuse
TR1	110/220 VAC 50-60 Hz 24 v 1.3 amp Power transformer
SC1	Set of case screws
IM1	User instruction manual
IM2	User warranty card



COMPONENT PARTS FOR EM 1840 40 COLUMN PRINTER CONTROLLER BOARD

BOARD NAME	DESCRIPTION OF COMPONENT		USAGE
Z1	SY40F	(or SPRINTER 40) VLSI Controller	Main printer controller
Z2	74121	One shot multivibrator	Thermal dot timer
Z3	ULN2004	Transistor Array	General drivers
Z4	µA723CN	Precision voltage regulator	V th power regulator
Z5–Z8	DS3654	Solenoid Driver	Thermal dot drivers
Z9	7805	5 volt regulator	5 volt power regulator
Z10	7808	8 volt regulator	8 volt power regulator
Z11	TIP120	5 Amp Darlington Transistor	V th pass transistor
C1	.1 µfd 12 volt ceramic disc		Reset timing cap
C2	1000 µfd 35 volt Radial Electrolytic		5 volt raw DC capacitor
C3	3300 µfd 50 volt Axial Electrolytic		Main raw DC capacitor
C4	100 µfd 16 volt Radial Electrolytic		5 volt storage cap
C5	.0015 µfd ceramic disc		Input filter on 74121
C6	.1 µfd 12 volt ceramic disc		Dot timing cap
C7	1000 µfd 35 volt Radial Electrolytic		V th storage capacitor
C8–C10	100 µfd 16 volt Radial Electrolytic		8 volt storage caps
C11	47 µfd 35 volt Radial Electrolytic		723 supply cap
C12	47 µfd 16 volt Radial Electrolytic (early units only)		Motor smoothing cap
CR1	1N750A	4.7 volt 400 mwatt Zenar Diode	Serial Data clamp diode
CR2	1N914	Small Signal Diode	Reset cap charge drain
CR3	MR501	Motorola 100 volt 3 amp Diode	V th power diode
CR4	1N4001	1 amp Diode	5 volt power diode
CR5	1N973A	33 volt 400 mwatt Zenar Diode	Voltage protect µa723

BOARD NAME	DESCRIPTION OF COMPONENT	USAGE
R1	4700 ohm ¼ watt resistor	RS-232 input
R2	22 Meg ohm ¼ watt resistor	Reset timing resistor
R3	470 ohm ¼ watt resistor	ACK pullup
R4	470 ohm ¼ watt resistor	BUSY pullup
R5	5.6 Kohm ¼ watt resistor	V th voltage setting
R6	7.2 Kohm ¼ watt resistor	V th voltage setting
R7	22 Kohm ¼ watt resistor	sets basic dot time
R8	470 ohm ¼ watt resistor	Dot CLOCK pullup
R9	470 ohm ¼ watt resistor	Dot DATA pullup
R10	2 Kohm ¼ watt resistor	μa723 supply resistor
R11	.33 ohm 2 watt resistor	current sense resistor
R12	Piher 904 miniature pot 50 Kohm	trims dot time
HS1–HS3	Heat Sink IERC LAE66A4CB	TO-220 heat sinks
P1	5-pin Berg Stick	Connect to swtich PC
P2–P3	21-position Burndy Ribbon Socket	Printer Connectors
P4	6-position Burndy Ribbon Socket	Printer Connector
P5	40 pin low profile DIP Socket	Controller socket
SW1	8 position solderable DIP switch	Sets controller modes
Y1	2 Mhz Crystal	Controller oscillator
SC1–SC4	8-32 ¼" long binder head screws	printer to board
SC5–SC10	6-32 ⅜" Hex Head Screws	heat sinks
NU1–NU4	¼" dia ¼" high 8-32 internally threaded swageable post	printer mounting
NU5–NU10	6-32 Hex Nuts	heat sinks mounting
PC1	Printed Circuit Board 8" x 7.1" Single Sided FR-4	
PR1	Olivetti PU1840/4 40 column thermal printer	



SCHEMATIC 40 COLUMN PRINTER

RECOMMENDED PAPER TYPE

JAPAN PAPER + PULP CO. (JUJO)

	TP50KM-A (BLACK)
	TP50CM-A (BLUE)
ROLLS	
	110MM WIDE
	40M LONG
	62MM DIAM MAX

NCR

	ROLL OR FAN-FOLD PAPER TYPE NO.
	T-1301 (BLUE)
	T-1302 (BLACK)
FAN-FOLD	
	4.34 x 11" PAGE SIZE APPROX. 200 PAGES
ROLLS	
	4.34" WIDE
	131 FEET LONG
	2.45" DIAM MAX

Packages of 4 rolls are available retail.
(Bulk orders can be made)

DIP SWITCH

POSITION	1	NOT USED		
POSITIONS	2	3	4	BAUD RATE SELECT
	ON	ON	ON	110 CPS
	OFF	ON	ON	150
	ON	OFF	ON	300
	OFF	OFF	ON	600
	ON	ON	OFF	1200
	OFF	ON	OFF	2400
	ON	OFF	OFF	4800
	OFF	OFF	OFF	9600
POSITION	5	NOT USED		
POSITION	6	NOT USED		
POSITIONS	7	8	INTERFACE SELECT	
	ON	ON	TEST MODE	
	ON	OFF	PARALLEL	
	OFF	ON	SERIAL	
	OFF	OFF	UNDEFINED	

REAR EDGE-CONNECTOR

PIN	1	GROUND (ON THE RIGHT, IN REAR VIEW)
	2	DATA/STROBE/SERIAL DATA
	3	DATA 1
	4	DATA 2
	5	DATA 3
	6	DATA 4
	7	DATA 5
	8	DATA 6
	9	DATA 7
	10	+ 5VDC OUT
	11	$\overline{\text{ACK}}$
	12	BUSY
	13	NO CONNECTION
	14	$\overline{\text{PAPER FEED}}$
	15	NO CONNECTION
	16	NO CONNECTION
	17	NO CONNECTION

ASCII 7-BIT-CODE CHARACTER-SET TABLE

LSD	MSD	0 000	1 001	2 010	3 011	4 100	5 101	6 110	7 111
0	0000	RESET		SP	0	@	P	`	p
1	0001			!	1	A	Q	a	q
2	0010		RJ	"	2	B	R	b	r
3	0011			#	3	C	S	c	s
4	0100			$	4	D	T	d	t
5	0101			%	5	E	U	e	u
6	0110			&	6	F	V	f	v
7	0111			'	7	G	W	g	w
8	1000			(	8	H	X	h	x
9	1001			)	9	I	Y	i	y
A	1010	LF		*	:	J	Z	j	z
B	1011			+	;	K	[	k	
C	1100			,	<	L		l	|
D	1101	CR		-	=	M	]	m	
E	1110				>	N		n	
F	1111			/	?	O		o	DEL

12-20-80/1,000