

CHAPTER 5 THEORY OF OPERATION

5.1 GENERAL

This chapter describes the LA210 Letterprinter's basic principles of operation. The chapter also describes the functions that the printer performs. Refer to the LA210 Field Maintenance Print Set for circuit details while you study this chapter. Refer to the programmer reference manual (EK-LA210-RM) for complete information on character processing, control and escape sequences, and font initialization.

5.2 PHYSICAL OVERVIEW

The LA210 Letterprinter has five basic components: the control panel, control/logic board, printhead, printer mechanism, and power supply. Figure 5-1 shows these components and how they work together.

The control/logic board manages printing, paper advancing, and communication. All other components connect to it. The control/logic board has the following components.

- A microprocessor to manage overall printer operation

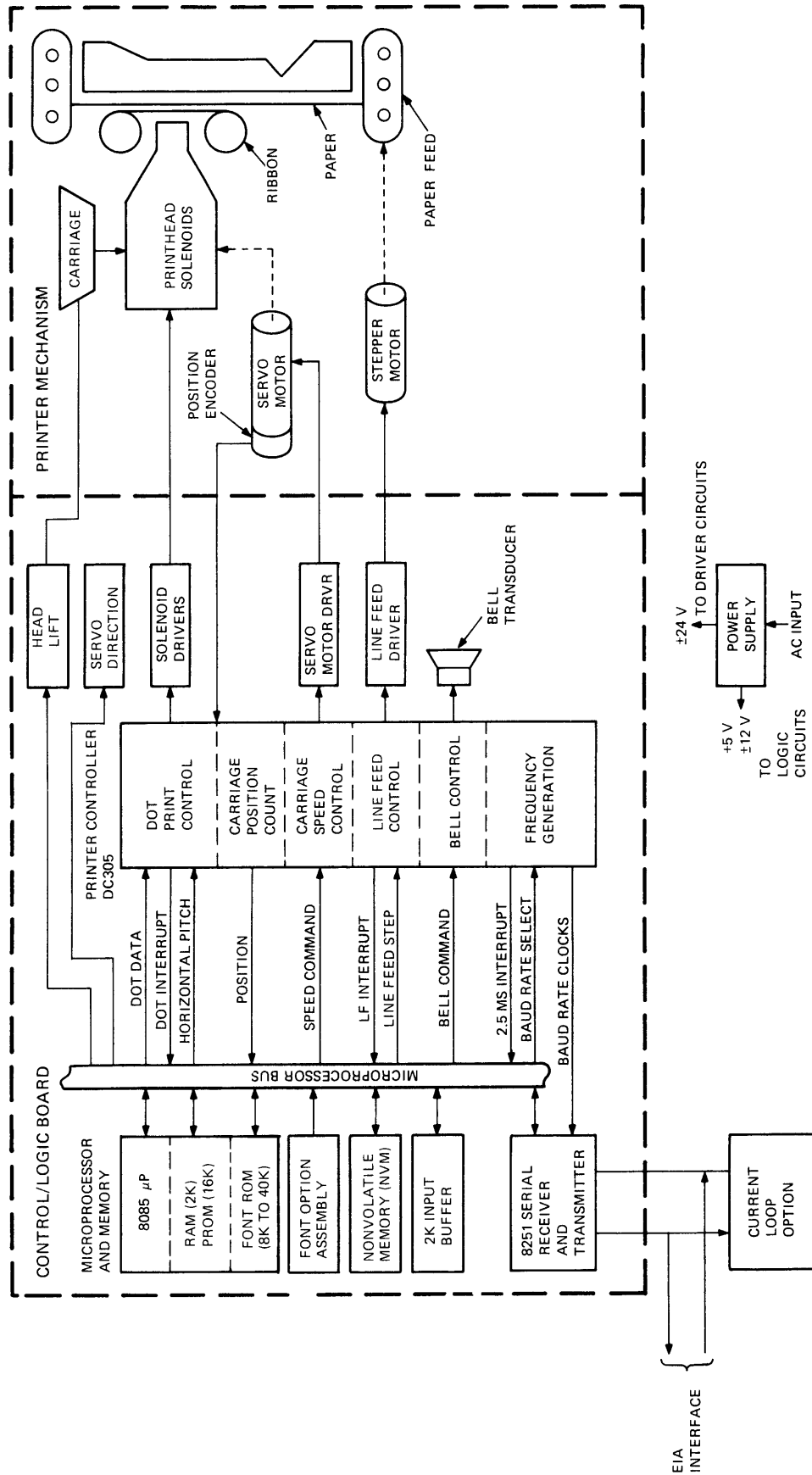
- 24 Kbytes (8 Kbytes plus 16 Kbytes) of ROM that contain a microprogram for operating the printer

- 8 to 40 Kbytes of ROM for character and font storage (1 to 5 ROMs)

- 4 Kbytes of RAM for microprocessor temporary storage and I/O data storage

- The DC305 printer controller that provides an interface between the microprocessor and the electromechanical components

- An asynchronous, serial receiver/transmitter (USART) for data exchange with the host computer



MA-9609D

Figure 5-1 Block Diagram

The printer mechanism has the following mechanical and electromechanical components for impact printing and paper/forms control.

- 9-wire printhead

- Servo motor and position encoder for horizontal printhead motion and position sensing

- Stepper motor for vertical paper movement

- Paper low/out sensors (if installed)

- Platen, friction assembly, and other mechanisms for paper control

- Printhead lift to allow dot overlap

The power supply converts the ac power line into dc voltages used by the printer. The power supply has a switching regulator for high efficiency operation.

5.3 FUNCTIONAL OVERVIEW

The printer examines (parses) characters it receives from the host processor and either treats them as printable characters or as commands. Specific character strings, called escape sequences, change parameters such as vertical and horizontal character pitch, tabs and margins, or alternate character sets.

I/O and processing are divided into the following functions. These functions, and how they work together to implement I/O, are examined in this chapter.

- Microprocessor/control system
- Communication and I/O data processing
- Control panel
- Printing process
- Paper advance process
- Power supply and power distribution

The printer is a microprocessor-controlled system that performs control functions and I/O data processing. The following chapter describes these functions and the hardware and firmware interactions that produce them.

5.4 MICROPROCESSOR CONTROL SYSTEM

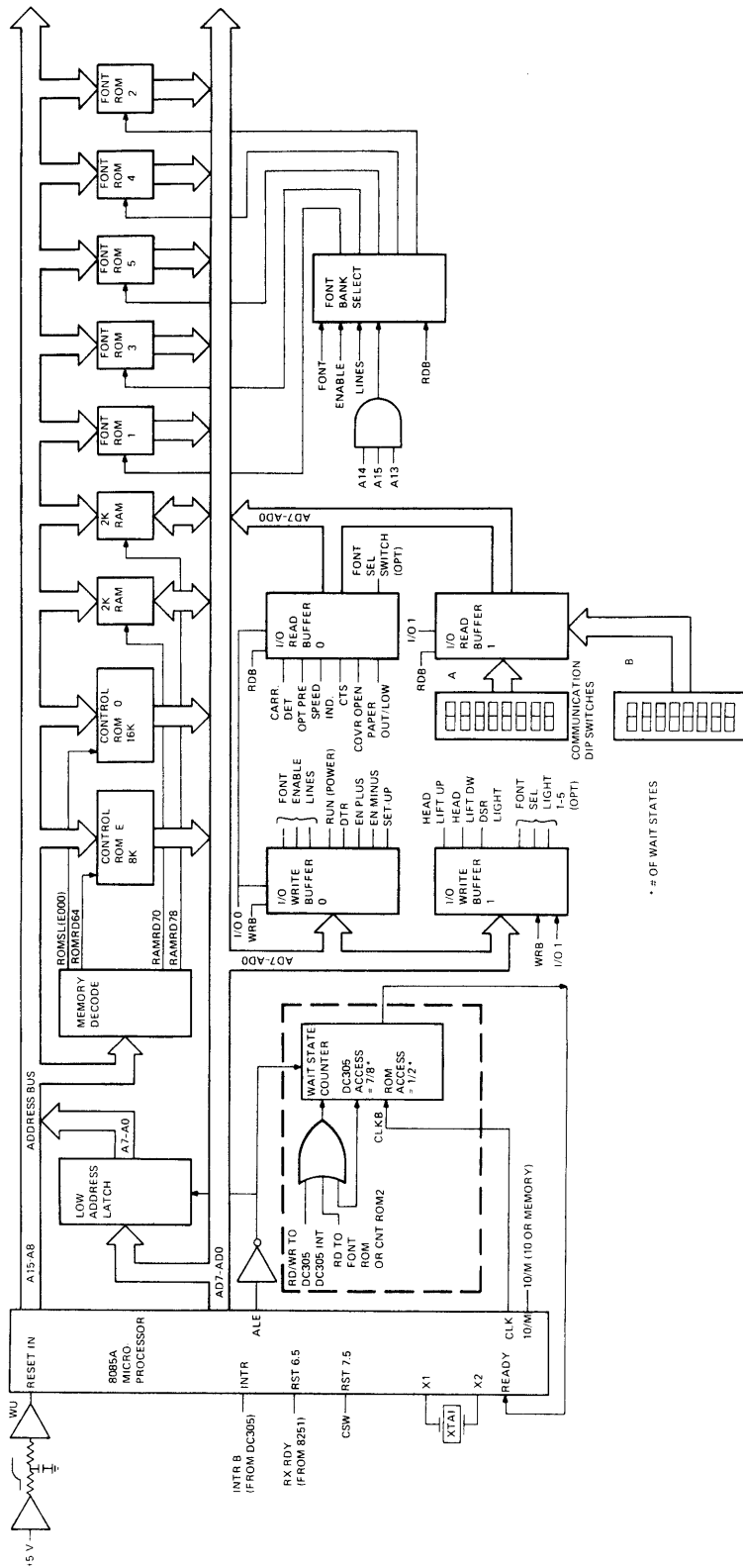
An 8085A microprocessor is the center of the LA210 Letterprinter control system. This microprocessor fetches instructions and data from ROM and RAM, and responds to service requests from various devices in the system. Figure 5-2 shows the microprocessor control system logic. This includes the microprocessor chip, ROM and RAM, address decode logic, some command and status buffering, and associated timing logic.

The wake-up (WU) signal holds the microprocessor RESET IN input low until the +5 V logic voltage reaches its normal level. When WU goes high, the microprocessor's program counter addresses location 0000 and the microprocessor fetches and executes the first instruction from memory.

The microprocessor addresses memory and other devices with a 16-line address bus (A15 through A0). The high address byte (A15 through A8) is asserted on the bus for the duration of the processor cycle. But the low address byte is asserted on the multiplexed 8-line address/data bus (AD7 through AD0) for a short time at the beginning of the cycle, so it must be captured in a register. Signals AD7 through AD0 pass through the low address latch and are frozen for the remainder of the cycle by the falling edge of the address lines enable (ALE) signal. Then the AD lines are free for instructions and other I/O data for the remainder of the cycle.

Although the microprocessor has a 16-bit address (64 Kbytes), only part of the address range is decoded and used. Table 5-1 summarizes the system address map.

The microprocessor addresses devices on the address and data buses as either memory or I/O. The output signal IO/not memory (IO/M) makes the distinction. When low, IO/M enables ROM and RAM and other devices addressed as memory, such as the 8251A USART and DC305 printer controller. When high, IO/M enables I/O devices. The I/O devices in the printer are the many receivers and transmitters that communicate certain command and status information. An I/O write to address 0000₁₆ sends a command to turn the power and ready indicators on or off. This I/O write also enables the data terminal ready (DTR) modem line, and sends motion commands to the servo motor drivers. An I/O read from address 0000₁₆ gets the status of the cover interlock switch, paper out, and paper low switches, and the communication carrier detect signal. An I/O read from address 0001₁₆ reads the setting of the configuration switches.



WA 8024C

Figure 5-2 Microprocessor/Control System Logic

Table 5-1 LA210 System Address Map

Address Range (Hexadecimal)	Decoded Enabling Signal (E33)	Responding Device
0000 -- 0FFF	ROM0+A	ROM 0
1000 -- 1FFF		ROM E
2000 -- 23FF	--	
2400 -- 2FFF	--	
3000 -- 300F	KBDSEL	Control Panel
3010 -- 3FFF	KBDRD	Control Panel
4000 -- 4003	DC305SL	Printer controller
4004 -- 4FFF	DC305SL	Not used
5000 -- 5001	COMSEL	USART
5002 -- 5FFF	COMSEL	Not used
6000 -- 6FFF	CE7	NVM
7400 -- 77FF	RAMRD70	RAM (2K)
7800 -- 7BFF	RAMRD78	
8000 -- 8FFF	--	
9000 -- 9FFF	--	Not used
A000 -- BFFF		ROM 0
C000 -- DFFF	CHRAD0	ROMs (8K each)
E000 -- FFFF	--	ROM (8K)

The microprocessor receives hardware interrupts from the DC305 printer controller and the 8251A USART.* The DC305 raises the INTR B line to the INTR input. Then the DC305 responds to INTR A by asserting an interrupt vector address on lines AD7 through AD0. The 8251A USART raises the RXRDY line to the RST6.5 input. The interrupt types, vector addresses (new program counter value), and descriptions are in Table 5-2.

System timing is established by a crystal connected to the microprocessor. The microprocessor and the D-type latch jointly divide the crystal operating frequency (running at 8 MHz) by 4 and produces the 2 MHz clock B (CLK B) output. CLK B (Figure 5-6) runs to other functional areas and produces printing and communication timing. The microprocessor usually runs continuously, fetching and executing instructions from memory while its READY input is high. The wait state logic (Figure 5-2) pulls READY low whenever there is a write to, read from, or interrupt from the DC305 printer controller. READY low causes a short pause in the microprocessing cycle. This is called a wait state. It allows more time for the DC305 to respond.

* The microprocessor also receives hardware interrupts from the ROM cartridge microswitch in the font option assembly.

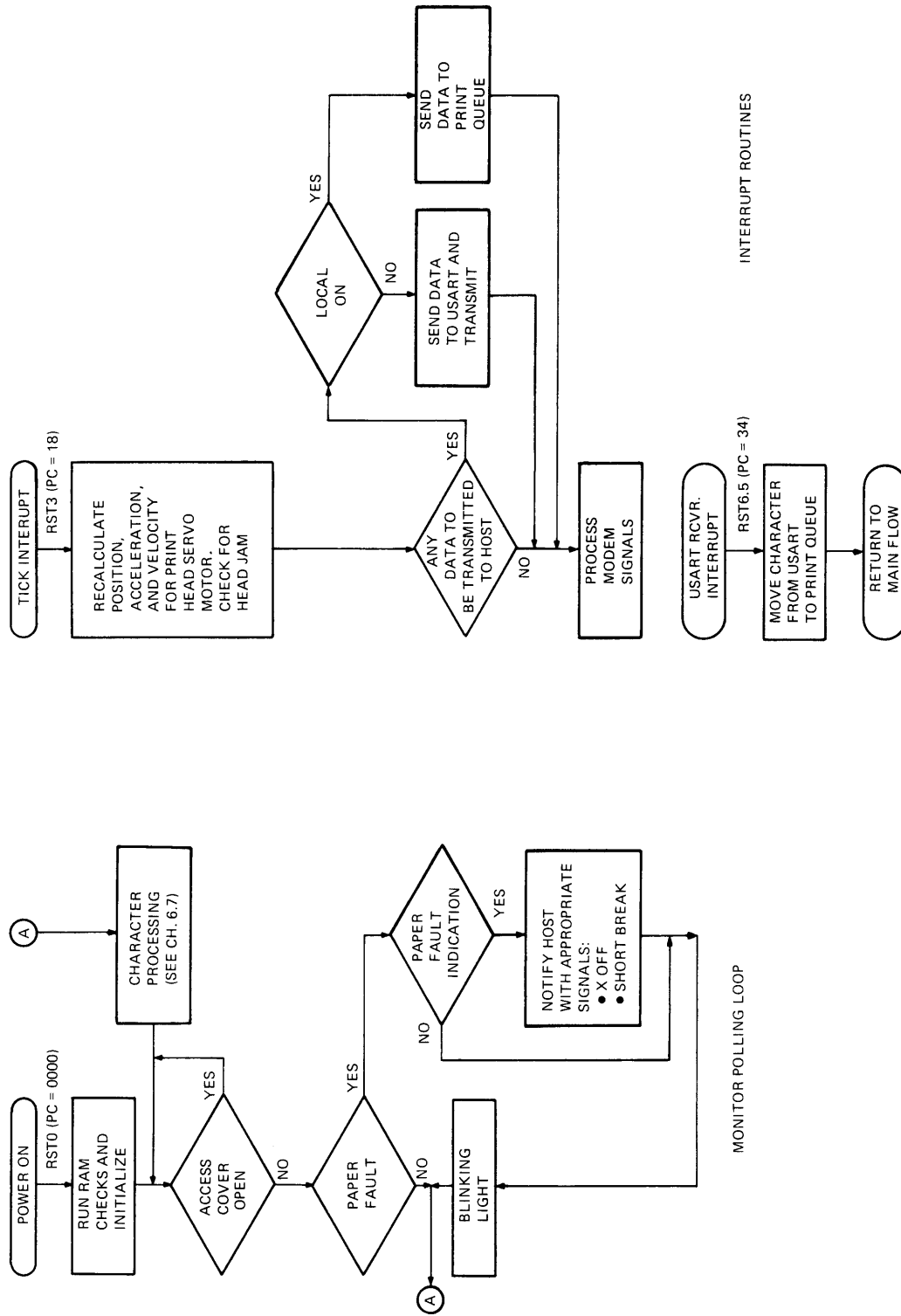
Table 5-2 Hardware Interrupt Vectors

Restart Interrupt Name	Interrupt Vector Address	Microprocessor Interrupt Input	Reason for Interrupt
RST0	0000	RESET IN (WU)	Power-up.
RST1	0008	INTR (INTR B)	Both RST3 and RST5.
RST3	0018	INTR (INTR B)	2.5 ms tick from DC305.
RST5	0028	INTR (INTR B)	DC305 real-time clock timeout (while line feeding) or dot FIFOs are half empty.
RST6.5	0034	RST6.5 (RXRDY)	Character present at USART receiver output.
RST7.5	003C	RST7.5 (CART SW)	DPS cartridge being inserted or removed.

The microprocessor continuously runs a ROM resident microprogram called the monitor. Figure 5-3 shows the basic monitor program loop. While the actual monitor program differs from one printer to another (depending on options present -- graphics, etc.), this figure shows the elements that are common to all.

When you turn the power on, the microprocessor runs a short initialization routine before the printer starts the monitor loop. The microprocessor's sequence of actions in this routine is as follows.

1. Disables all hardware interrupts
2. Performs a write/read check on RAM area
3. Performs a read check on ROM area
4. Displays errors in code ROMs or RAM (level 1)
5. Initializes the DC305 dot print FIFOs
6. Moves parameters from NVM to RAM
7. Initializes the DC305 printer controller
8. Initializes the I/O registers
9. Sets the print carriage to the first legal column
10. Initializes the 8251A USART
11. Sets appropriate baud rates
12. Enables all hardware interrupts
13. Displays power-up and left margin errors (level 2)
14. Tests character ROMs
15. Displays errors in character ROMs (level 3)



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Figure 5-3 Monitor Polling Loop and Interrupt Routines

After executing the initialization routine, the microprocessor branches to the monitor loop. The monitor loop is a polling routine that looks for status information such as access cover open, paper out, and any data to print or process. Some internal status information may be too urgent for the monitor loop to poll. Hardware interrupts handle this critical information and also printer housekeeping. Items that must be handled in real-time, such as control panel scanning and processing high baud rate receiver data, are examples of this critical information. These interrupt routines are shown separately from the monitor loop in Figure 5-3.

5.5 COMMUNICATION AND I/O DATA PROCESSING

The printer interfaces with the host computer through a serial data port. The port includes an 8251A programmable USART and supporting logic. The USART translates parallel and serial data formats and adds or removes start and stop bits as needed.

NOTE

The printer has two sets of internal configuration switches (A and B) that allow the operator to change modes and adapt the printer to the communication requirements of different hosts. These switchpacks are described in Chapter 3, Paragraph 3.3.

5.5.1 Data Format

The printer communicates only asynchronously. In asynchronous communication, bits are added to each data character to synchronize transmission and reception. Figure 5-4 shows the ASCII data format exchanged between the printer and the host computer. Any two data exchanges can originate at random times with clock frequencies that have as much as one percent difference. The protocol assumes random arrival of any character of data, and relies on the synchronization information in the character. This synchronization consists of extra bits appended to the beginning and end of the character. One bit at each end (one start bit and one stop bit) is the most common configuration, although two stop bits are used in transmissions from printer to host.

The start and stop bits are defined with specific states. The state of start bit is different from the idling condition on the line. The data port looks for the transition from the idling state (called mark) to the start bit state (called space), and clocks in the character. The stop bit is the mark state (like the idling state), so the character immediately following the stop bit has the correct mark-to-space transition for synchronization. The data bits between a start and a stop bit are represented by a mark for a 1 and a space for a 0.

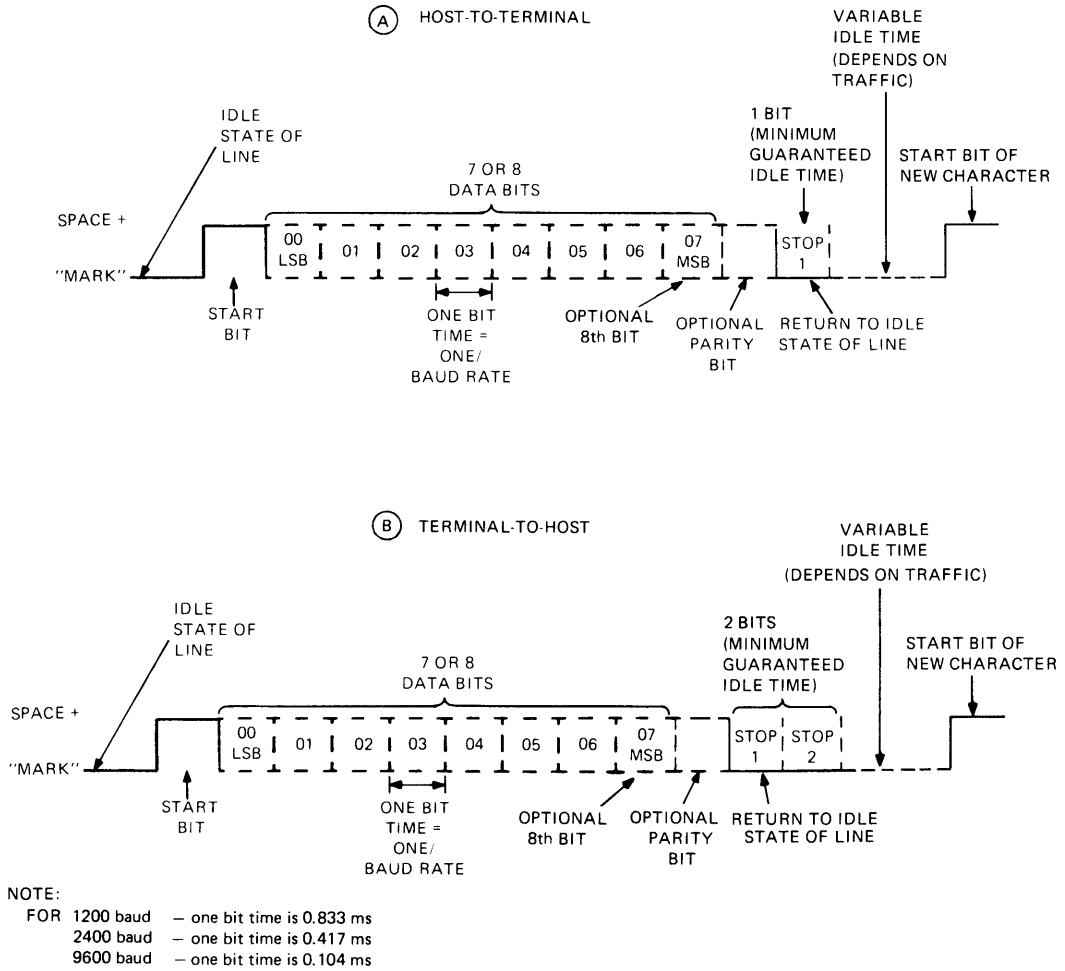


Figure 5-4 Serial Character Format

After the printer transmits the data bits, it sends two stop bits. The printer always ensures that the line is idle for at least two bit's time. The printer only receives data separated by at least one stop bit. Longer idle time is also acceptable.

The printer stays under the host's maximum interrupt rate by not transmitting data faster than 60 char/s (1 character in 16 ms). So, at a transmission speed of 600 baud or more, the idle time between two characters is always significantly longer than two bit's time. It will be a large multiple of the bit rate (for example, 150 times the bit rate at 9600 baud). The idle time is in the range of the bit rate only when transmission speed is 600 baud or less.

The printer receives serial characters using one start bit, seven or eight data bits, an optional bit, a selectable parity bit, and one stop bit. The data bits are transmitted with the least significant bit (LSB) first.

Use switchback B (switches 6, 7, and 8) to select data format and parity. For 7-bit data, the parity bit can be mark, space, odd, or even. For 8-bit data, the parity bit can be mark (or no parity), even, or odd.

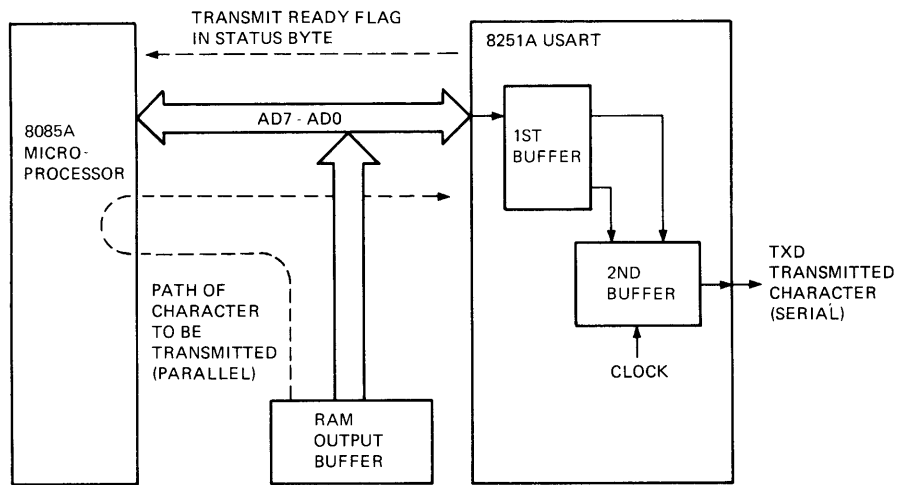
NOTE

Even and odd parity may not be available in certain 8-bit systems because of modem limitations.

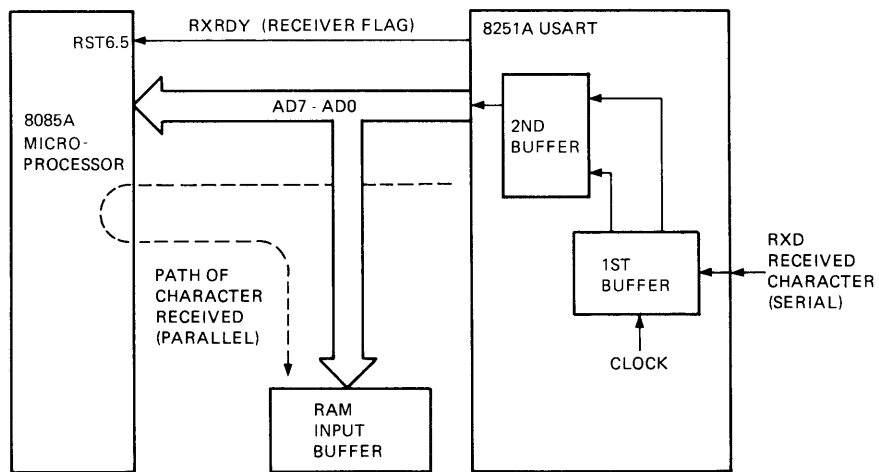
You select the speed at which the serial character is transmitted or received with baud rate (speed) switches 1 through 5 on switchpack B (Figure 3-9).

5.5.2 Data Handling Through the USART

The printer's microprogram controls the USART. The microprocessor sends a set of control bytes to initialize the USART to support the desired communication format. Once programmed, the USART is ready to perform its communication functions. Figure 5-5 shows how data is handled across the serial line and is transmitted and received in the printer.



(a) TRANSMIT DATA



(b) RECEIVE DATA

MA 9608

Figure 5-5 Data Handling in the USART

5.5.2.1 Transmit Data -- When the microprocessor wants to send a character, it requests a status byte from the USART and checks the transmitter ready flag. If this flag is high, the transmit buffer is empty and can accept data. If the flag is low, the microprocessor continues its monitor program and checks the transmitter ready flag later.

When the flag is high, the microprocessor loads a data byte from the RAM output buffer into the USART transmit buffer. The USART is double buffered, meaning there is a second data buffer inside that loads automatically from the first buffer. Start and stop bits and parity (if enabled) are appended to the second buffer's contents and the contents are shifted out onto the transmit data (TXD) line by a continuously running clock. Immediately after the second buffer is loaded, the transmit ready flag goes high and the first transmit buffer can be loaded.

5.5.2.2 Receive Data -- Data from the receive data (RXD) line is shifted into the USART receive buffer (first buffer). When a full character enters the buffer, the start, stop, and parity bits are removed. Parity is checked, and if bad, the parity error flag in the status byte is set. Then the data transfers to the USART receive data buffer (second buffer), and the receive flag (RXRDY) is set. Then the USART requests an interrupt from the microprocessor. While the next character shifts in, the microprocessor has to read the first character. After reading the character, the microprocessor checks the USART status byte to verify the data. If the data is good, it is sent to the input queue in RAM. If the data is bad, the printer can either print the character as received or print the substitute (SUB) character (X or ?). The receiver error processing feature selects receiver error processing. If the microprocessor does not read the receive data buffer in time, the second character writes over the first one, and the first one is lost. Then, an overrun error is reported in the status byte.

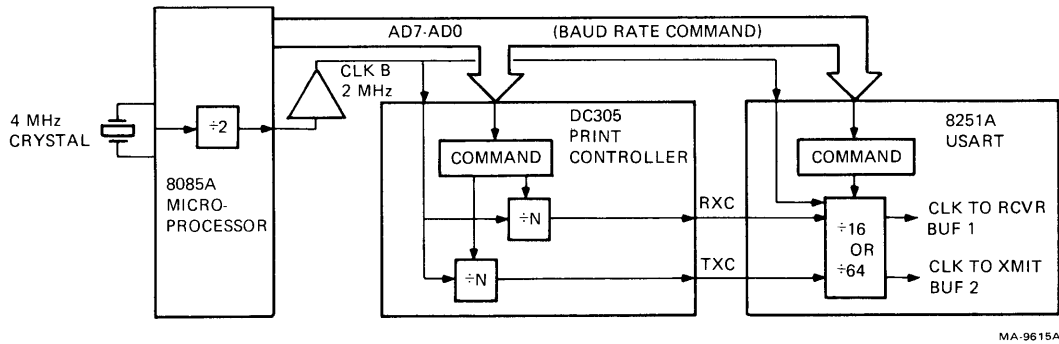


Figure 5-6 Creation of Baud Rate Clocks

5.5.3 Baud Rate Clocks

The printer can be set up or programmed for serial I/O communication at many different transmission rates. The transmission can range from 50 to 9600 baud (bits per second), including split baud rates. Figure 5-6 shows the hardware logic that creates the baud rate clocks. These clocks shift the serial data stream in or out of the USART.

The microprocessor and the D-type latch divide the 8 MHz crystal frequency by 4 and send a 2 MHz CLK B signal to the printer controller (DC305) and USART (8251A) chips. Both chips contain programmable frequency dividers to scale the CLK B input down to the correct baud rate clock. Based on the baud rate (selected with an escape sequence), the microprocessor sends command bytes to the printer controller and the USART. The command bytes specify the mathematical configuration (divisor value) of the frequency dividers. The printer controller has two dividers to allow different receive and transmit baud rates (split baud rates). These dividers send the intermediate transmit (TXC) and receive (RXC) clocks to the USART. Finally, the USART divides the intermediate clocks by 16 or 64 to create the baud rate clock for the transmit and receive buffers.

Table 5-3 shows the clock periods and serial bit rate for each baud rate available.

Table 5-3 USART Baud Rates and Clock Timing

DC305 Output		(USEC)		USART Serial I/O	
Baud Rate		TXC	RXC	Bit Rate	
Tr.	Rec.			Transmit	Receive
50	50	312	312	20.0 ms	20.0 ms
75	75	208	208	13.3 ms	13.3 ms
110	110	142	142	9.1 ms	9.1 ms
134.5	134.5	116	116	7.4 ms	7.4 ms
150	150	104	104	6.67 ms	6.67 ms
200	200	312	312	5.0 ms	5.0 ms
300	300	208	208	3.3 ms	3.3 ms
600	600	104	104	1.67 ms	1.67 ms
1200	1200	13	13	883 USEC	883 USEC
1800	1800	8.7	8.7	556 USEC	556 USEC
2400	2400	6.5	6.5	417 USEC	417 USEC
4800	4800	3.3	3.3	208 USEC	208 USEC
7200	7200	8.7	8.7	139 USEC	139 USEC
9600	9600	6.5	6.5	104 USEC	104 USEC

Split Baud Rates

Tr.	Rec.				
75	600	208	26	13.3 ms	1.67 ms
75	1200	208	13	13.3 ms	883 USEC
150	600	104	26	6.67 ms	1.67 ms
150	1200	104	13	6.67 ms	883 USEC
300	2400	208	26	3.3 ms	417 USEC
300	4800	208	3.3	3.3 ms	208 USEC
600	2400	104	26	1.67 ms	417 USEC
600	4800	104	3.3	1.67 ms	208 USEC

Tr. = Transmit
 Rec. = Receive

5.5.4 Interface Signals

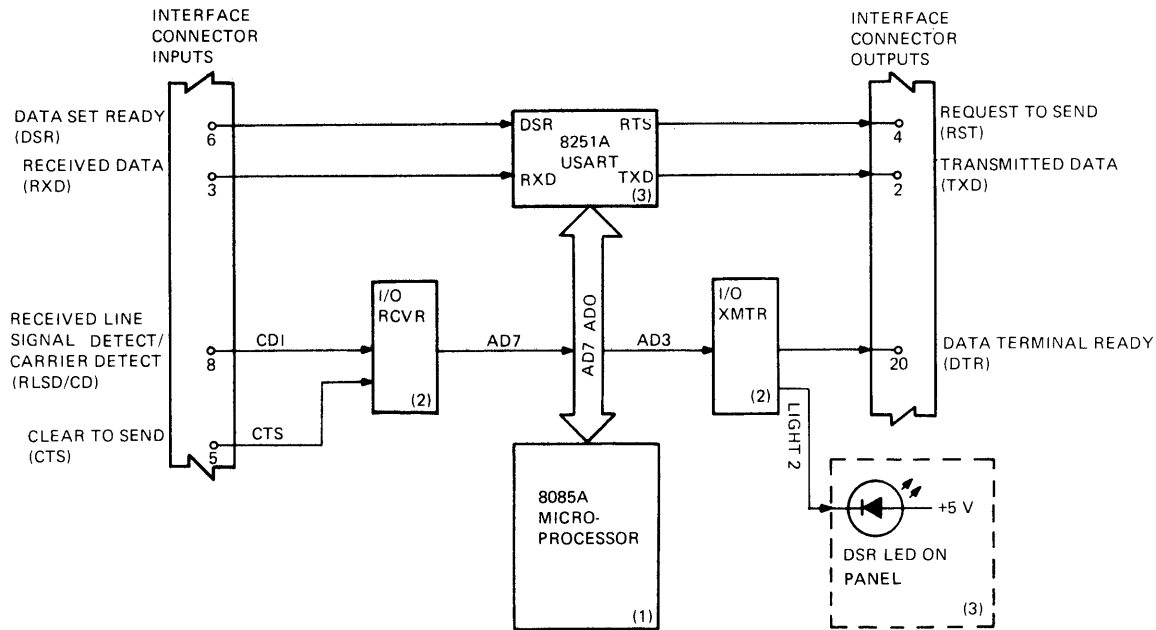
The printer supports full-duplex communication. That is, it can send and receive data at the same time. The printer can also be controlled by a modem. With no modem control, data transmission and reception is always enabled while on-line. With modem control, the printer and the modem recognize the correct EIA signals before transmitting data.

The EIA communication interface complies with the EIA (RS232C) and CCITT (V.24) standards. The EIA connector (type DB-25) pins and signals are defined in Appendix B. The printer supports the following signals.

- Transmit data (TXD)
- Receive data (RXD)
- Request to send (RTS)
- Clear to send (CTS)
- Data set ready (DSR)
- Receive line signal detect (RLSD)
- Carrier detect (CD)
- Restraint (BUSY)
- Speed indicator (SPDI)
- Secondary request to send (SRTS)
- Speed select (SPDS)
- Data terminal ready (DTR)

Figure 5-7 shows how the printer recognizes and controls the interface signals. The TXD and RXD serial lines are discussed in Paragraph 5.5.2. All the modem control lines are controlled by the microprocessor, either directly or through the USART or I/O transmitter/receiver.

The microprocessor examines bit 7 in the USART status byte to determine the state of the DSR line and sets bit 5 in the USART control byte to assert the RTS line. The microprocessor also examines bit 0 of the internal I/O receiver to detect the state of the RLSD line and sets a bit 4 in the internal I/O transmitter to assert the DTR line. The CTS line is loaded into the I/O receiver (register), where the microprocessor examines it. As soon as DSR is present on the input line, the microprocessor activates the I/O transmitter, which raises the DSRL signal to the control panel and lights the DSR indicator on the control panel.



MA-9620B

Figure 5-7 Interface Signal Recognition

5.5.5 Communication Modes

The LA210 controls data transmission and reception on its serial interface by using the modem control lines to generate the full-duplex protocol. Configuration switches let you set the printer for different modem and interface requirements.

NOTE

Refer to Figure 3-10 for the description of the communication switches.

5.5.5.1 Modes of Operation -- The printer operates in three basic modes: on-line, off-line, and self-test.

On-Line Mode -- The printer sends an XON signal when placed on-line (if transmit is enabled). If the appropriate modem signals are present, the printer transmits and receives data from the communication line and processes the received data.

Off-Line Mode -- In off-line mode, the printer stops processing data from the input buffer. The XOFF signal is not sent because the printer is off-line.

The printer goes off-line when you depress the On line/Off line switch or when a fault occurs.

Self-Test Mode -- When the printer is in self-test mode, all modem signals are unasserted, the input buffer clears, and the communication line is ignored. Characters normally sent to the communication line are looped back to the printer. To select this mode, press the Normal/Self Test switch on the control panel to the Self Test (down) position.

5.5.5.2 Full Duplex Without EIA Controls -- When the printer is on line, this mode asserts DTR and RTS, ignores modem signals to the printer, and enables receive and transmit. The break and speed/restraint functions described in Paragraphs 5.5.5.3 and 5.5.5.4 are operational, but the disconnect functions are nonoperational.

5.5.5.3 Full Duplex With EIA Controls -- This mode supports a full-modem interface. The following conditions are necessary to make a connection (Figure 5-7).

1. The printer asserts RTS and DTR, and then waits for DSR.
2. RLSD is asserted within 300 ms after DSR is asserted. Then, the printer enables transmit and receive.

This mode also provides automatic disconnect by using the DTR signal.

Full-Duplex Break -- The printer automatically generates a break when there is a fault condition, such as paper out. In full duplex, a break is a space asserted on the TXD line for 275 +/- 10 percent milliseconds if transmission is enabled. If transmission is disabled, the break waits until transmission is enabled or a disconnect is generated.

The host's response to the break signal varies among different host systems.

Full-Duplex Disconnect -- The printer turns DTR off for at least 0.2 seconds plus the DSR delay time, but not longer than 2 seconds. Any of the following conditions causes a full-duplex disconnect.

DSR disappears

RLSD stays unasserted for more than 2 seconds.

Receiver time out is wrong. (DSR is asserted, but then RLSD is not asserted within 20 seconds.)

Paper out switch is enabled and a paper out condition occurs.

Printer is switched to self-test mode.

End of transmission (EOT) control character received while coded disconnect is enabled.

5.5.6 Data Transfer Control Modes

The printer controls its data transfer operation through the speed control and restraint (BUSY) lines and the I/O buffer. The operator selects these functions with the configuration switches.

5.5.6.1 Restraint Mode -- In restraint mode, the printer controls the BUSY line to signal an approaching input buffer overflow. The function is like XON/XOFF. The BUSY signal represents the status of only the XON/XOFF state, not a receive-ready state. If BUSY is on, the host should temporarily suspend data transmission. If BUSY goes OFF, transmission can be resumed. To determine the receive-ready state of the printer, observe DTR and SRTS and set the printer in modem mode.

NOTE

For some applications, the BUSY signal polarity can be inverted with jumper W5 on the logic board (Table 5-4).

5.5.6.2 Speed Control Mode -- Speed control mode provides a control line to select and monitor the data transmission rate. If you select this mode with the configuration switch, the SDPI and SPDS lines exchange speed information between the printer and modem. In this mode, the host instructs the printer to operate at 1200 baud, regardless of the operator-selected rate, when SDPI is ON and at the operator-selected rate when SPDI is OFF.

If you select speed control mode and the receive rate is 1200 baud or greater, the printer asserts SPDS. Otherwise, SPDS is not asserted.

5.5.6.3 Modem/No Modem Mode -- You select this on-line mode through the configuration switches. This mode determines whether the printer responds to the modem input signals or ignores them.

When you select full duplex with no modem control, data transmission and reception are always enabled.

With no modem control, the printer communicates directly with a computer (null modem configurations) or with full-duplex modems that do not support DSR or RLSD.

Full duplex with modem control requires the printer and modem to recognize the correct EIA signals before transmitting data.

Modem control permits the printer to communicate through modems such as the AT&T 103, AT&T 212, Vadec 3400, or equivalent modems.

5.5.7 Input Buffer

The 2K input buffer allows the printer to receive characters faster than it prints them. All characters received, except nulls and deletes, are temporarily stored in the input buffer before further processing. The SUB character is substituted in the input buffer for any character received in error. If the input buffer overflows, a single SUB character is placed in the buffer and the bell sounds.

5.5.7.1 Input Buffer Control -- The input buffer can overflow if communication speed is greater than print speed or if the printer is out of paper or the cover is open. The printer prevents overflow by sending the host a pause/resume signal. This signal is the XON/XOFF or BUSY (restraint) signal. The BUSY signal is useful only for no modem, (hardwired) direct local interfaces. You can invert the BUSY signal polarity with the BUSY jumpers on the logic board.

The printer stores received characters (other than NUL and DEL), in the 2K input buffer. When the printer is ready, the characters are removed from the input buffer and printed. If the printer falls behind by more than 2K characters, the input buffer overflows. If an overflow occurs, the character is lost. A single SUB character is placed in the input buffer and the bell sounds.

There are three ways to avoid input buffer overflows.

1. Use the XON/XOFF or BUSY signal to signal the data source to temporarily stop sending data. Using XON/XOFF or BUSY allows maximum throughput and eliminates fill character calculations and message size limits.
2. Send data to the printer only as fast as it can be printed. When the printer is in draft mode, send data to be printed at a rate of 1800 baud or less. When the printer is in letter quality mode, send data at 300 baud or less. For short lines, multiple form feeds and transmissions faster than 1800 baud, use fill time characters to slow down the effective data transmission rate.

3. Limit the number of characters in the message to the input buffer size. If the buffer is empty, the printer can receive a message of 2K characters without a buffer overflow.

NOTE

In emulation mode, the LA210 gives you a choice of two input buffers -- a 2K buffer and a 0.13K buffer. If your application displays a timeout message, use the 0.13K buffer. Otherwise, use the 2K buffer to reduce the number of data requests from the printer to the host.

5.5.7.2 XON/XOFF and BUSY Signals -- XON/XOFF and BUSY (restraint) prevent input buffer overflows. When you select XON/XOFF and/or BUSY, the printer monitors the number of characters stored in the input buffer. The printer signals the computer to stop sending data by sending an XOFF control character or by turning on the BUSY signal. This happens under either of the following conditions.

The number of characters in the 2048 character input buffer exceeds 1024.

The printer transmits a second XOFF and then receives 60 characters.

The host resumes data transmission when the printer sends an XON control character or sets the BUSY signal to OFF. The printer does this under the following conditions.

The number of characters in the input buffer is less than 30.
The printer is switched on-line (or powered up while on-line).
Communication with the modem has just been established.

The XON/XOFF and BUSY signals are operator selectable features.

5.5.7.3 Fill Time Characters -- The printer can keep up with normal characters when receiving data in draft mode at 1800 baud or less and in letter quality mode at 300 baud or less. But for short lines and multiple form feeds the printer adds time fill characters to slow the overall transmission rate. They are stripped out of the data stream upon reception and do not enter the input buffer. They help the 2K input buffer to regulate data input.

5.5.8 Internal Data Manipulation

Figure 5-8 shows how the microprocessor manages I/O data. Data moved to or from the USART passes through one or both of two areas in RAM. These areas are called queues. There is an input queue and an output queue. Both queues are first-in/first-out (FIFO) buffers. The input queue can be up to 2048 characters long. The output queue is always 16 characters long.

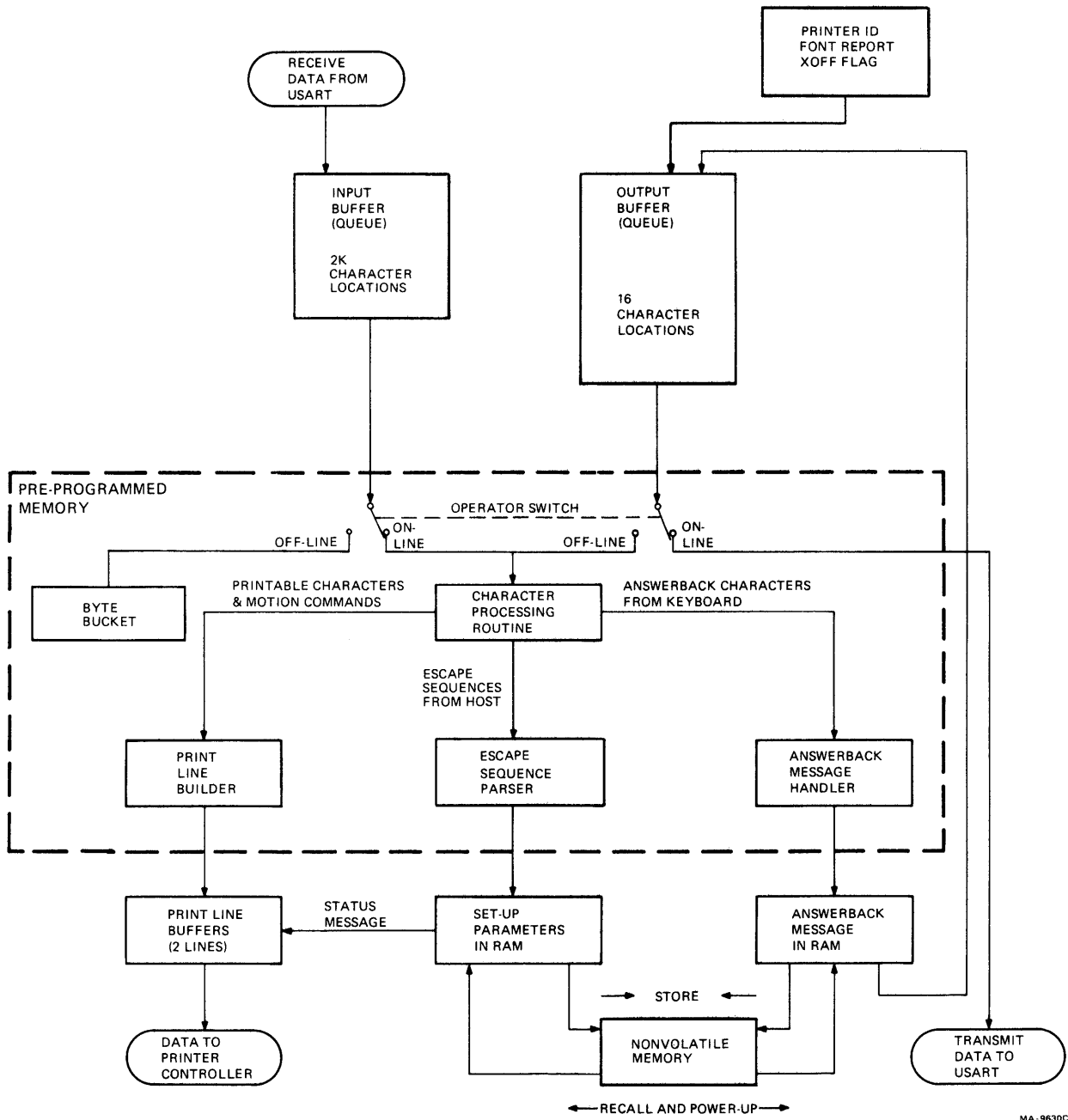
Sources of data for the top of the input queue include the USART receiver and the bottom of the output queue. Sources of data for the top of the output queue are the areas in memory that hold answerback, printer ID, and font report.

During on-line operation, characters are taken off the bottom of the input queue and sent to the character processing routine (one of the microprograms run during monitor polling). Characters on the bottom of the output queue are sent to the USART transmit buffer. In off-line operation, characters on the bottom of the output queue are sent to the character processing routine.

The character processing routine determines character routing. This routine sends printable characters to the print line builder. The routine sends characters from the USART receiver to one of two areas. It sends escape control characters to the escape sequence parser and answerback characters to the answerback message handler. The builder, parser, or handler processes the character. Then the character either changes a parameter or is printed.

5.5.8.1 Nonvolatile Memory -- The nonvolatile RAM (NVM) stores the set-up parameters. The NVM can hold data for about 10 years. The nonvolatile memory is also considered an electrically alterable read only memory (EAROM). It retains the set-up parameters that would otherwise have to be re-entered at every power-up.

The NVM (ER1400) is a 1400-bit memory arranged as 100 14-bit words. Data and addresses enter and leave it in serial form through a single bidirectional line (BD7). Data is conditioned by a level converter before entering or leaving the NVM. Clock A0 shifts information in or out. The 8085A microprocessor decodes the bit stream by using three control lines (BA10, BA9, BA8) which specify the operation in progress. The 8085A microprocessor controls lines BA10 through BA8.

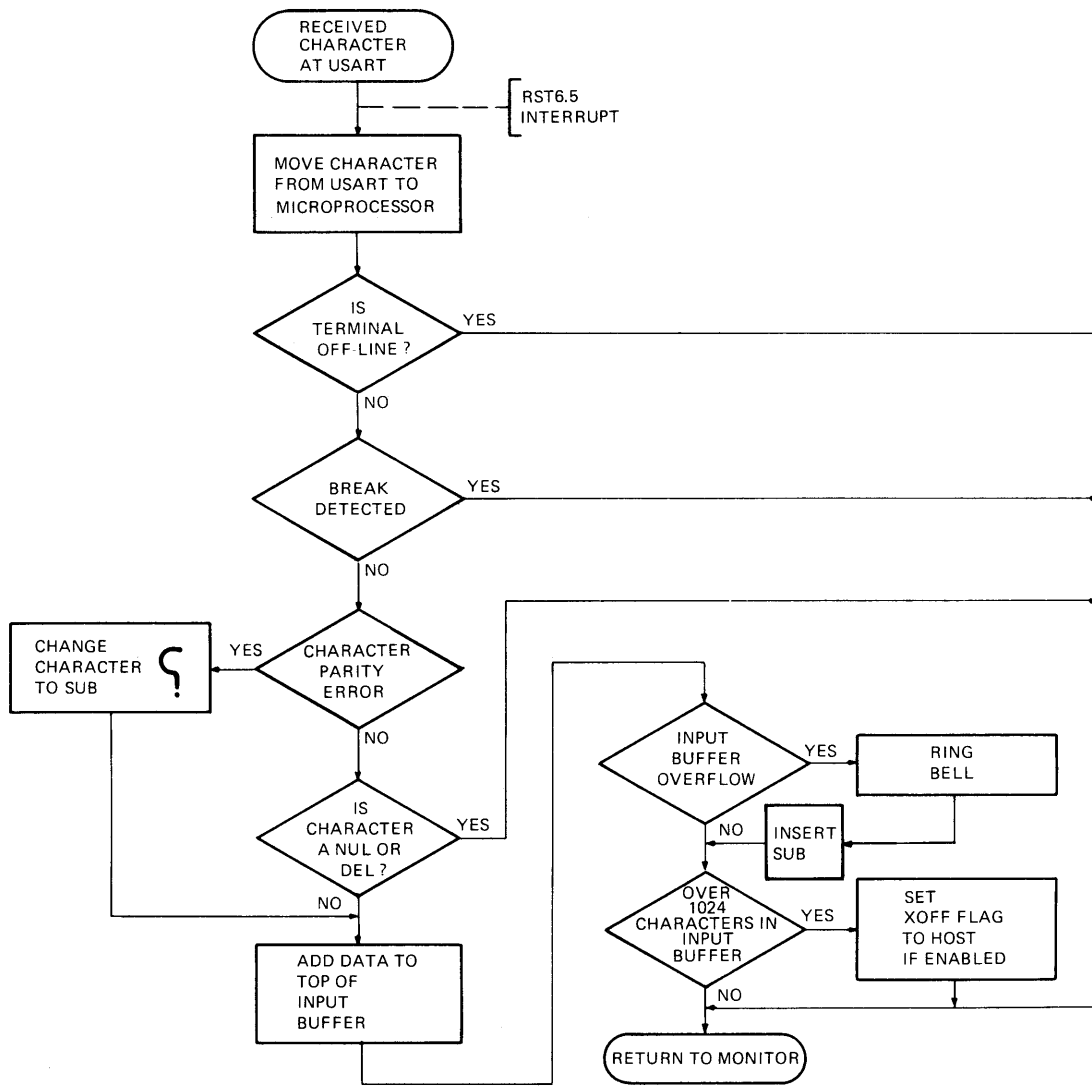


MA-9630C

Figure 5-8 Internal Data Management

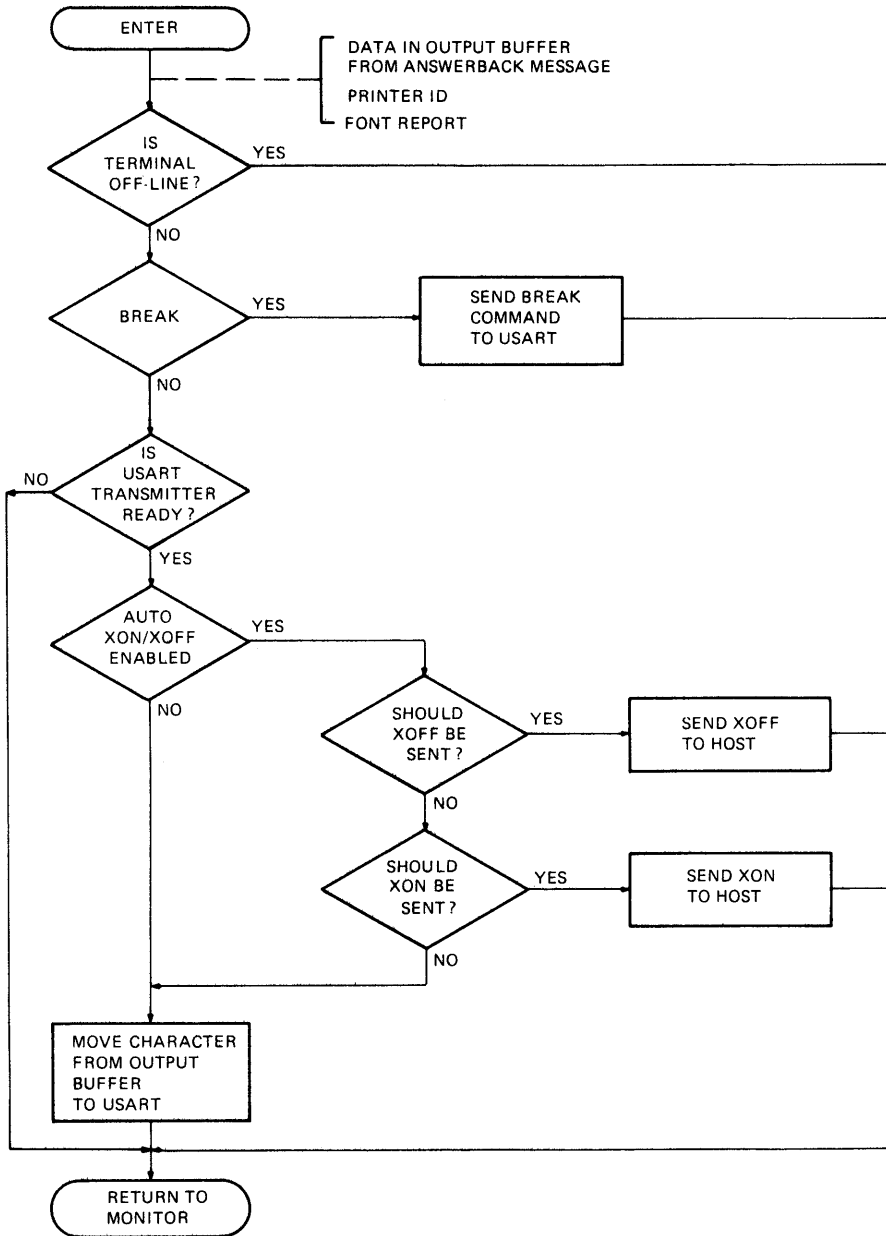
5.5.9 Communication Firmware

Figures 5-9 and 5-10 show the primary microprogramming tasks that run when a character is sent to or from the USART. Figure 5-9 shows the receive character processing routine. This routine runs when the USART raises the RXRDY line to the microprocessor and the microprocessor generates an RST6.5 interrupt. Figure 5-10 shows the transmit character processing routine. This routine runs when the microprocessor wants to send a character to the USART.



MA-9626B

Figure 5-9 Receive Character Processing Routine



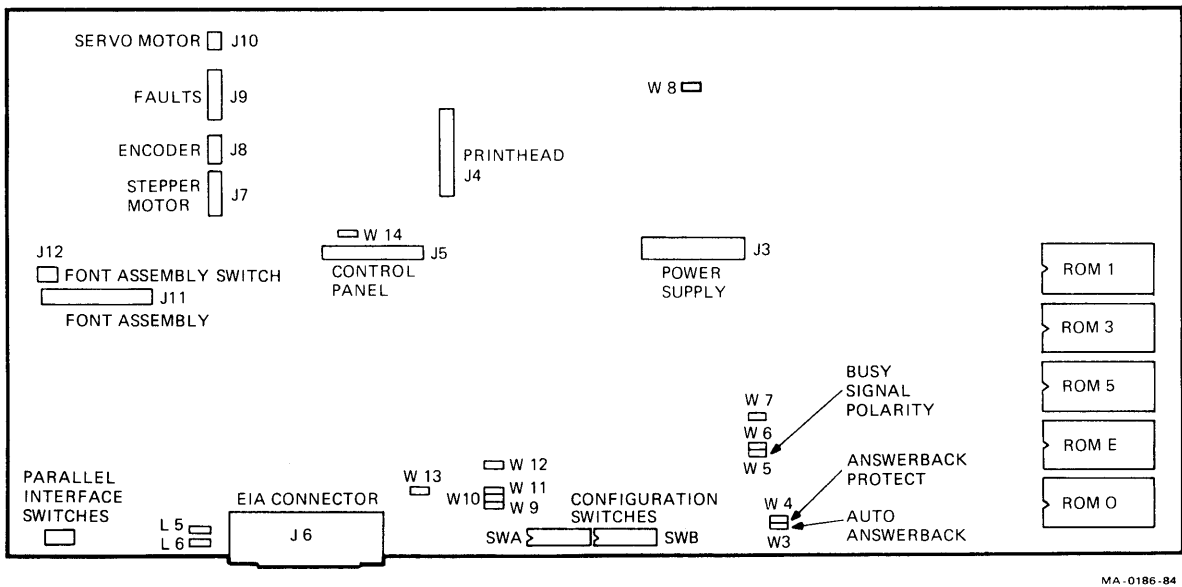
MA-9627B

Figure 5-10 Transmit Character Processing Routine

5.5.10 EIA and Functional Jumpers

The printer's logic board has several jumpers for selecting operation and EIA circuit features (Figure 5-11). In standard board configuration, all jumpers are installed. You have to cut certain jumpers to disable some of the EIA communication circuits. You can remove some of the jumpers to change board configuration to meet European communication requirements. You can also remove the jumpers to provide some operator-selectable communication features.

Table 5-4 lists the EIA jumpers and other functional jumpers on the logic board. To change any of the jumper selectable features, remove the logic board (Paragraph 8.4).



MA-0186-84

Figure 5-11 EIA and Functional Jumpers

Table 5-4 Jumper-Selectable Features

Functional Jumpers	Functions
W1,W2	Not used
W3 -- Autoanswerback	
Installed	Disables auto answerback.
Removed	Enables auto answerback. (Answerback message is sent when communication link is established.)
W4 -- Answerback message protect	
Installed	Answerback message is unprotected. (Message can be erased or changed.)
Removed	Answerback message is protected. (Message cannot be erased or changed.)
EIA Jumpers	Function
W5 -- BUSY signal polarity	Printer State Busy Signal
Installed (Standard)	Busy On (1) Ready Off (0)
Removed (Alternate)	Busy Off (0) Ready On (1)
W6, W7	Factory use
W8 -- Protective ground	
Installed	Connects signal and protective ground for RS232 interface.
Removed	Disconnects signal ground from protective ground for X21BIS interface.
W9 -- Ring indicator	Not used
W10 -- Speed indicator	
Installed	ON
Removed	OFF

Table 5-4 Jumper-Selectable Features (Cont)

Functional Jumpers	Functions
W12 -- Speed select	
Installed	ON
Removed	OFF
W13 -- Secondary request to send	
Installed	ON
Removed	OFF
W14	Reserved for future use

NOTE

ON means an EIA signal line is connected to the EIA interface. OFF means an EIA signal line is disconnected and the EIA signal is not available on the EIA interface.

5.6 PRINTING/PRINthead POSITIONING PROCESS

This section describes how the printer processes data stored in RAM buffers and forms printed characters. It also describes how the printhead and carriage move to align the dots that make up characters.

5.6.1 Overview

The LA210 is an impact printer that uses a 9-wire solenoid-activated printhead. The printhead is driven horizontally and bidirectionally, and prints characters within a 7(W) X 9(H) (draft) or 33 X 18 (letter quality) dot matrix.

The printer can contain several DPSS (dot pattern sets) for different fonts and character sets. You can select a DPS from either the host computer or the printer. You usually select a DPS in order to print in a different font.

In addition to defining fonts and character sets, the DPS defines the density, speed, and size of letter quality printing. A DPS always uses a 7(W) X 9(H) matrix for draft printing, and either 33 X 9 or 33 X 18 for letter quality printing. The matrix used for letter quality printing depends on the model of the DPS selected. The denser the matrix, the slower the print speed. DPSS are stored on the plug-in ROM chips or cartridges. The DPSS used with the LA210 Letterprinter are listed in Appendix C of this manual.

NOTE

For details about DPS operation see the Programmer Reference Manual. Paragraph 6.2 in this manual describes font ROMs on plug-in chips and cartridges.

In draft mode, the maximum print speed is 240 characters per second. In letter quality mode within a 33 X 18 matrix, the maximum printing speed is 40 characters per second.

NOTE

To select letter quality mode, use an appropriate plug-in ROM (see Appendix C).

The throughput for different combinations of horizontal pitch and line length, while printing in the standard letter quality mode within a 33 X 18 matrix, is as follows.

Pitch	Characters per Line		
	132	60	10
10	30 char/s	28 char/s	17 char/s
12	34 char/s	31 char/s	21 char/s

The maximum traversal rate while printing in graphic mode is 7 inches per second.

Regardless of printing mode or characters printed per second, no more than 2400 dots per second can be printed.

5.6.2 Printing Format

Each DPS has a standard spacing, usually 10 or 12 characters per inch. In letter quality mode you can print characters at the standard pitch and double the width of the standard pitch (5 and 10 or 6 and 12 characters per inch). In draft mode, you can print a DPS at all available pitches, regardless of the selected font. In letter quality printing, you can select only the pitch available on the installed font. The pitch is controlled by escape sequences. Table 5-5 shows the pitch parameters for draft and letter quality mode.

Table 5-5 Pitch Parameters

Draft Quality 10- or 12-Pitch DPS		Letter Quality 10-Pitch DPS 12-Pitch DPS			
Char. per Inch	Char. per Line	Char. per Inch	Char. per Line	Char. per Inch	Char. per Line
10	132	10	132	12	158
12	158	10	132	12	158
13.2	168	10	132	12	158
16.5	217	10	132	12	158
5	66	5	66	6	79
6	79	5	66	6	79
6.6	84	5	66	6	79
8.25	108	5	66	6	79

The printhead matrix provides three levels of printing quality and character resolution: draft quality, letter quality, and optional correspondence quality.

The dot resolution for the three printing modes is as follows.

Letter quality, high resolution	330 dots per inch horizontal 144 dots per inch vertical
Correspondence quality, medium resolution	330 dots per inch horizontal 72 dots per inch vertical
Draft quality, low resolution	70 dots per inch horizontal (10 pitch) 72 dots per inch vertical
Graphic printing	72 to 330 dots per inch horizontal 72 dots per inch vertical

5.6.2.1 Draft Quality (Low Density) -- Draft quality characters print on a 7 X 9 dot matrix to define 70 to 85 percent of the character cell (a character cell is 1/10 inch for a 10-pitch character). In draft mode, horizontally adjacent dots cannot be printed. In pitches 10, 12, 13.2, and 16.5, the matrix is 7 X 9 and the distance between dots varies to produce the needed character width. Pitches 5, 6, 6.6, and 8.25 expand the 7 X 9 matrix to 8 X 9, with 50 percent less horizontal resolution than single width pitches that can print adjacent dots.

5.6.2.2 Letter Quality (High Density) -- The 10-pitch letter quality characters print on a 33 X 18 matrix without printing horizontally adjacent dots. The 33-dot width defines the entire 1/10 inch of the character cell, including the space between characters. This wide matrix lets you print horizontal adjacent dots (for solid lines). In a 12-pitch character, the dots remain the same distance apart. But there are only 28 dots in the horizontal direction (28 X 18).

5.6.2.3 Optional Correspondence Quality (Medium Density) -- This mode is almost the same as letter quality, high density mode. The horizontal matrix is the same. You can print solid, horizontal lines. The only difference is that the vertical matrix is 9, not 18.

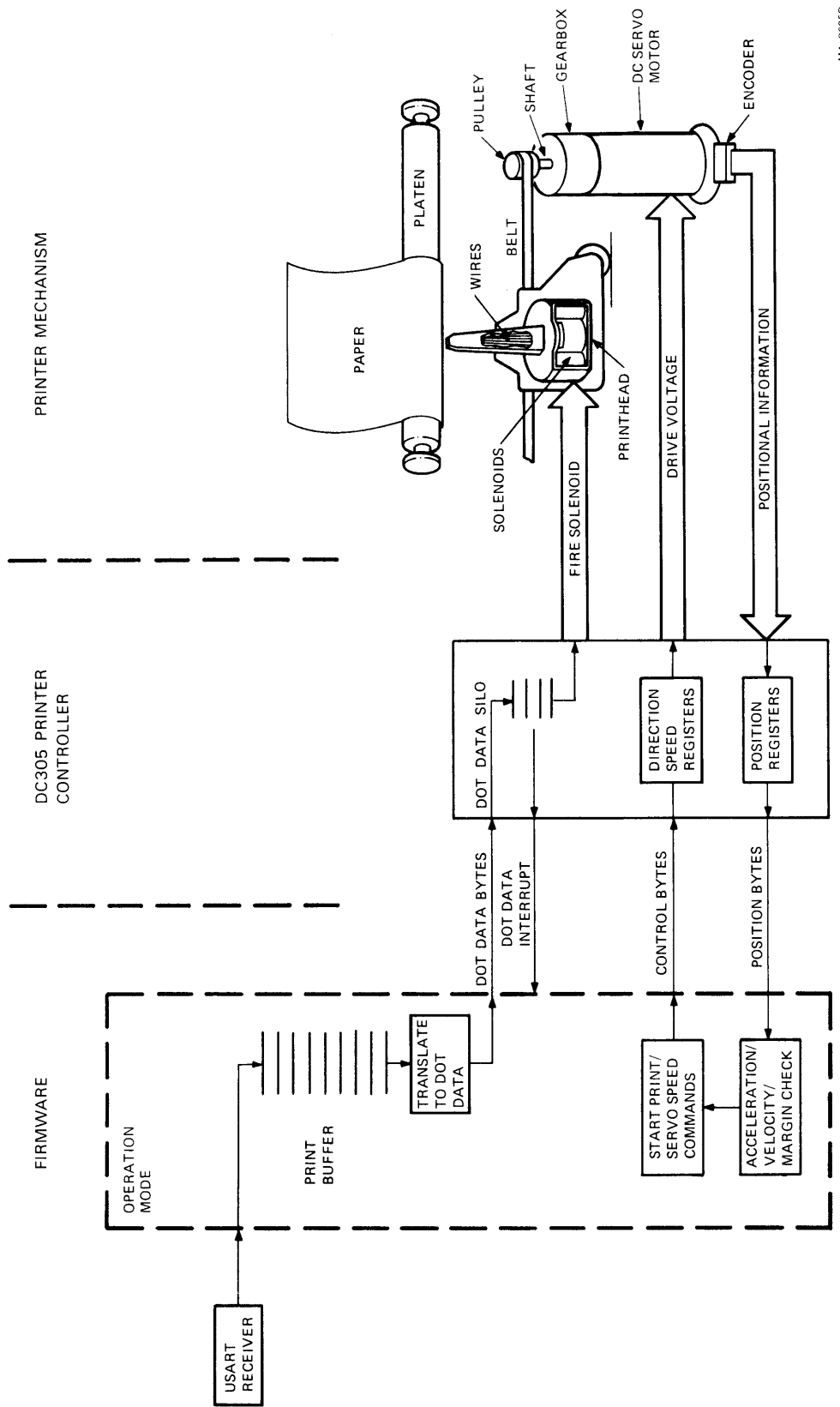
5.6.2.4 Graphic Printing -- The printer prints text characters as they are received. But in graphic printing, each character received equals a specific set of dots to be printed. Columns of dots are collected and printed in groups of 30. A group of columns is printed when 30 columns of dots accumulate in the buffer, or when an exit graphic mode command is received. Because any dot pattern may be specified, and because there is no space between characters in graphic mode, you can get high dot density in every address position. Because most graphic printing is contiguous, it is much slower than in text mode.

5.6.3 DC305 Control Functions

The DC305 printer controller chip controls printhead positioning and printing. The printer uses the DC305 for special functions that the microprocessor cannot perform. The DC305 performs the following functions.

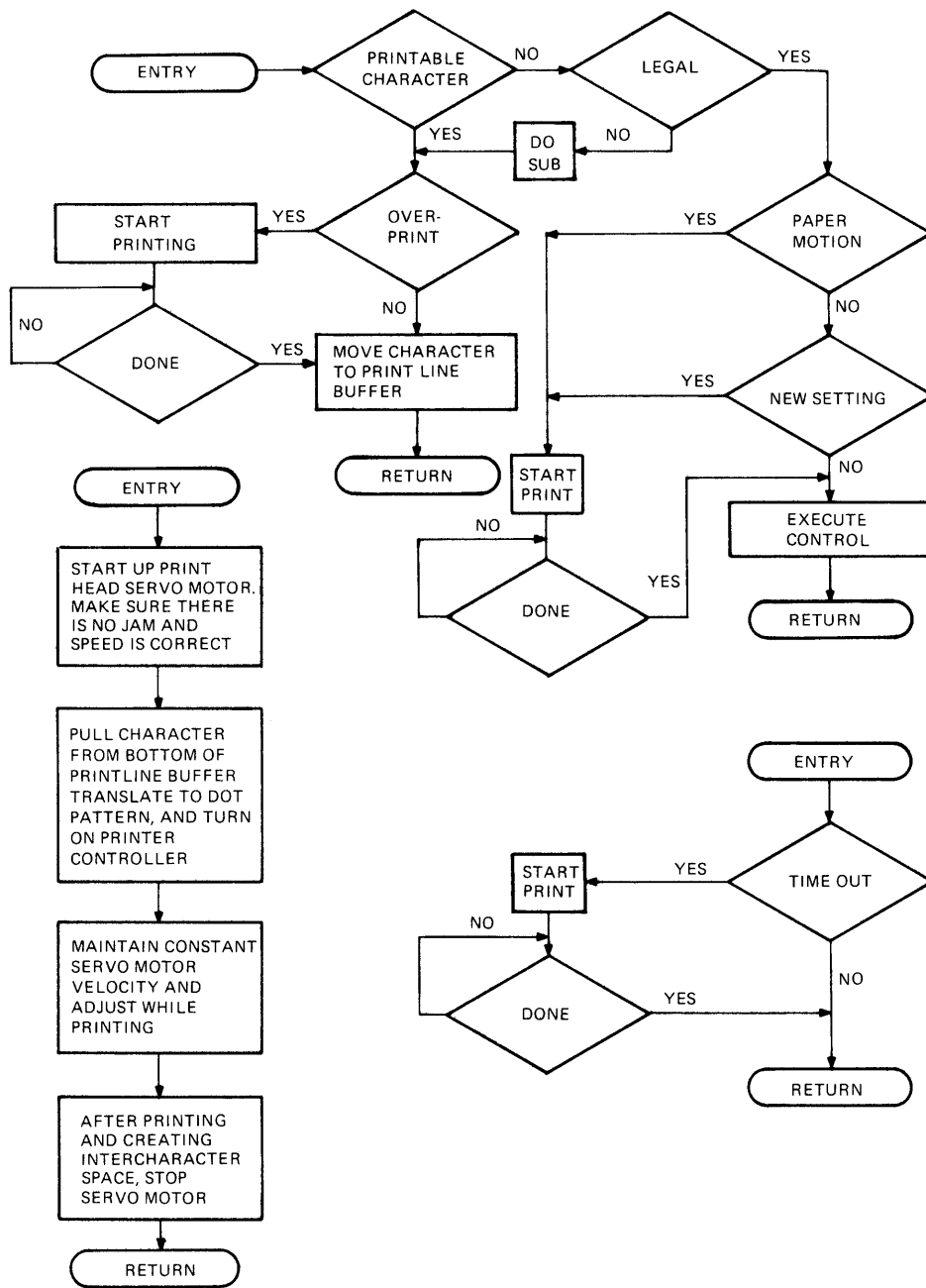
- Printhead servo motor control
- Printhead position tracking
- Printhead solenoid control

Figure 5-12 shows a functional diagram of the printhead positioning process. The microprocessor/control logic sends commands to the DC305 to print from one character to a whole line of characters (up to 217 characters per line). These commands include a start print command which initializes printhead positioning, and a servo motor speed and direction command. Servo speed depends on the horizontal character pitch and the density selected. Figure 5-13 shows the flow of the print character logic routine.



MA 96250

Figure 5-12 Printing/Head Positioning Process



MA-0014-85

Figure 5-13 Print Character Routine

A position encoder mounted at the back of the servo motor connects directly to the motor shaft. The encoder sends a pulse train to the DC305. Then the DC305 uses a register to monitor the current head position anywhere across the carriage assembly. The microprocessor queries this position register regularly to determine printhead acceleration, velocity, and position relative to the selected left and right margins.

During printhead acceleration, the DC305 requests the first bits of character information required for printing. The ASCII representation of the character from RAM must be translated into a series of vertical dots. The microprocessor translates this data and sends groups of dot data bytes to the DC305 on request. Each dot data byte is an encoded pattern of dot bits. The DC305 uses these bits to fire specific head solenoids to create the desired characters on paper. In graphic mode, a different type of translation is performed. Each graphic character the host sends is processed and printed as a single vertical pattern of dots.

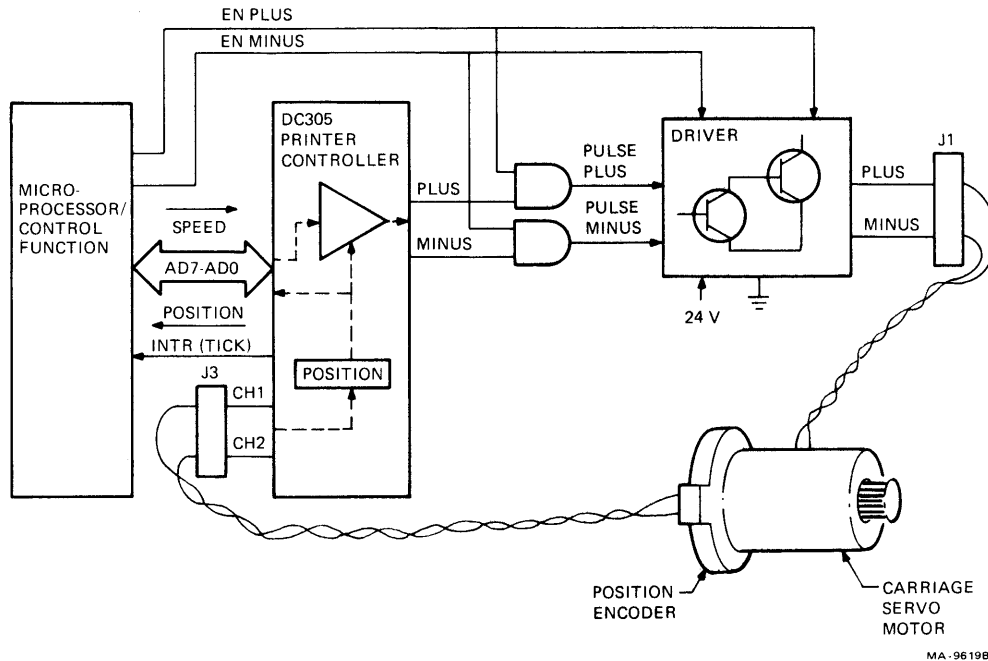
When the printhead is in the correct position, the DC305 fires the solenoids simultaneously for the first vertical dot column. After firing two dot columns, the DC305 shifts more dot data to output. At the same time, the DC305 sends a hardware interrupt to the microprocessor which requests more dot data bytes. This process continues until the characters are completely printed. Then the microprocessor signals the printhead servo motor to slow down and stop.

5.6.4 Servo/Head Positioning

The servo/head positioning logic and microcode accelerates the printhead (up to 25 inches per second), maintains printhead velocity during impact, and decelerates the printhead when printing is complete. For nonprinting motion (spaces, returns, line feeds), the printhead speed is maintained at 45 inches per second. Figure 5-14 shows the logic for this process.

The microprocessor sends speed and direction commands to the DC305 printer controller chip. The speed command specifies the direction of head movement and the carriage servo motor's speed. The binary value of the speed command is based on how far the printhead is from where it should be. The microprocessor adjusts the speed command as the printhead moves closer to the start print location. The printhead reaches the start print location at a speed that lets it start printing immediately.

The DC305 uses two pulse streams to control carriage speed. These are the output signals PLUS and MINUS. PLUS and MINUS are ANDed with EN PLUS and EN MINUS from the microprocessor/control logic to produce PULSE PLUS and PULSE MINUS.



MA-96198

Figure 5-14 Servo/Head Positioning Logic

PULSE PLUS and PULSE MINUS are input to the servo driver network where they are conditioned and current-amplified. Both pulse streams are duty cycled to produce the correct output power to the servo motor. The output must be proportional to the binary value of the speed command.

The position of the printhead is measured by an incremental, 2-channel encoder mounted on the back of the servo motor. Channel 1 (CH1) and channel 2 (CH2) both have a square wave output. The output of one channel leads the output of the other channel by 90 degrees. Therefore, their binary states change in quadrature (00, 01, 11, 10, 00) as the carriage moves. The CH1 and CH2 position signals enter the DC305 where they accumulate in a position register. The microprocessor reads this register every tick interrupt (in 2.5 ms intervals). If necessary, the microprocessor corrects the printhead's speed and position over the carriage.

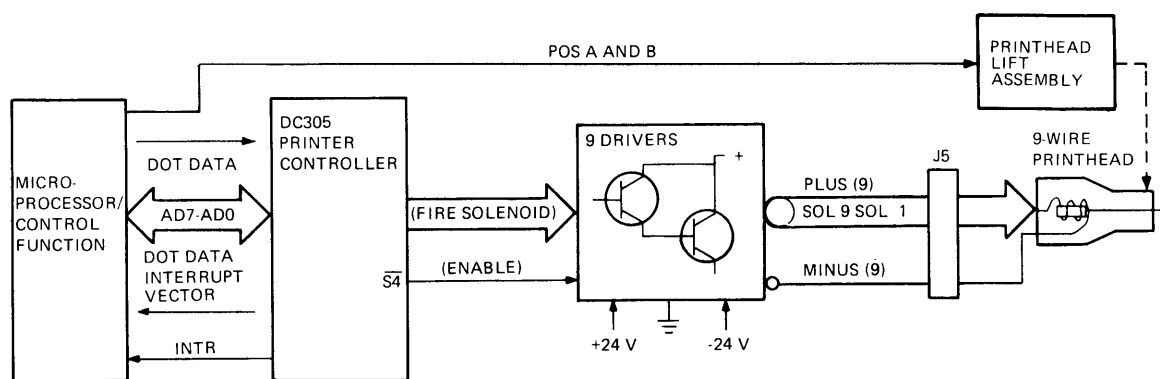
5.6.5 Character Printing

Figure 5-15 shows the logic for impact printing. When there is at least one character to print, the microprocessor/control logic clears the first-in/first-out dot buffers (dot FIFOs) in the DC305. Then the microprocessor/control logic loads the dot FIFOs with the first four columns of character or graphic dot data. The dot FIFOs are used to buffer and transmit character or graphic dot patterns from the microprocessor to the printhead solenoid drivers.

When the carriage speed and position are correct for printing, the microprocessor enables printing and the dot interrupt by sending commands to the DC305. Printhead motion signals from the carriage position encoder combine with horizontal pitch set-up data to trigger a countdown timer. The timer turns on selected head drivers, then turns them off at the end of the count. The dot FIFOs advance the next column of dot data to the solenoid driver inputs.

When there is room for more than two dot columns of data in the FIFOs, the DC305 sends a dot data interrupt (RST5) to the microprocessor, asking that it load more dot data. When there is no more dot data to be printed, the microprocessor disables the dot interrupt, and sends a print stop command to the DC305.

When the DC305 turns on a head driver, the driver output (PLUS signal) goes low for the corresponding solenoid of the SOL1 through SOL9 set. This energizes the head solenoid through the appropriate line and drives the assigned head wire out of the head to impact the ribbon and paper.



MA-9621B

Figure 5-15 Printing Logic

5.6.6 Printhead Lift Function

Printhead lift is used in high density, letter quality printing when the character matrix is 33 X 18 dots. For this kind of printing, the printhead makes two passes along each line.

When letter quality printing is requested, the microprocessor commands the first pass of the printhead from left to right in the upper (normal) printing position (shift out) (Figure 5-15). The printhead position is controlled by a head lift magnet that connects to the printhead assembly (Figure 5-16). The POS A signal keeps the magnet and the linkage in the upper printing position. After the first pass, the carriage returns to the beginning of the line. The microprocessor sends the POS B SHIFT IN signal to energize the head lift magnet. The magnet is energized for approximately 200 milliseconds and is pulled into the SHIFT IN position. In the shift in position, the actuator (linkage) is on the lower part of the magnet. This pulls the printhead down by one half of one dot size. Then the printhead makes the second left-to-right pass along the line, to complete the characters. At the end of the line, POS B changes back to POS A and the head raises to normal position. Figure 5-17 shows some samples of head lift operation.

5.6.7 Microcode

Figure 5-13 shows a simplified flow of the internal microcode that controls printing and carriage motion.

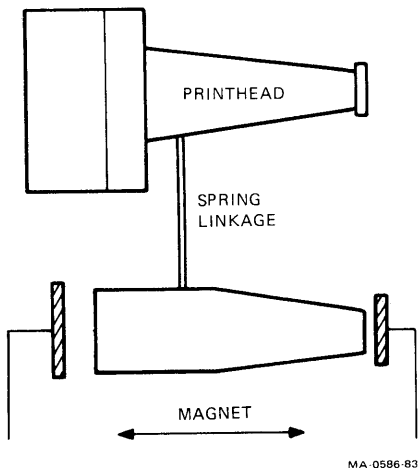


Figure 5-16 Simplified Headlift Functional Diagram

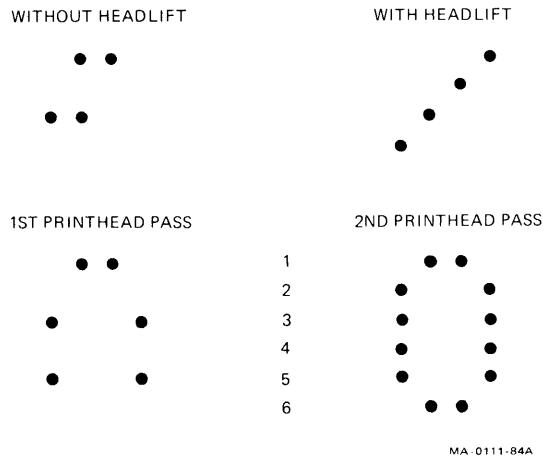


Figure 5-17 Headlift Operation Samples

5.6.8 Print Process Routines in IBM/Epson Emulation Mode

This section describes the print process routines used in emulation mode.

The printer uses an intermediate buffer to process characters and character attributes. For each character printed, the absolute position counter increments by the width of the character based on the pitch. The intermediate buffer translation occurs when the printer receives a line terminator. The printer creates a new print segment each time the pitch or resolution changes.

5.6.8.1 Line Printing -- To process the emulation attributes, the printer makes two printing passes on lines where the attributes are used. Processing for each attribute is as follows.

Double Height -- Performed by printing six dots in each of two passes with a partial line feed after the first pass.

High Resolution -- Requires two passes with a head shift after the first pass.

Superscript -- Requires two passes separated by a head shift.

The following tables show which dot lines are assigned to printwires for superscript. If no printwire is specified for a dot line, then the dot line is ignored in the printing pass.

First Pass

Dot Line	Printwire
1	1
2	--
3	4
4	--
5	--
6	--
7	--
8	--
9	5

Before the second pass, the headlift mechanism shifts the printhead down by one half of one dot.

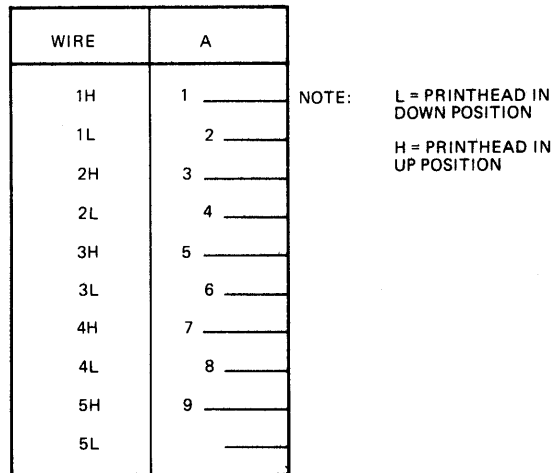
Second Pass

Dot Line	Printwire
1	--
2	1
3	--
4	2
5	--
6	3
7	--
8	4
9	--

Figure 5-18 shows the algorithm for superscript implementation.

NOTE

An underlined superscript looks like a dot line 9 underline.



MA-0019-85

Figure 5-18 Superscript Algorithm Implementation

Subscript -- Requires two passes separated by a head shift. The following tables show which dot lines are assigned to printwires. If no printwire is specified for a dot line, the dot line is ignored in the printing pass.

First Pass

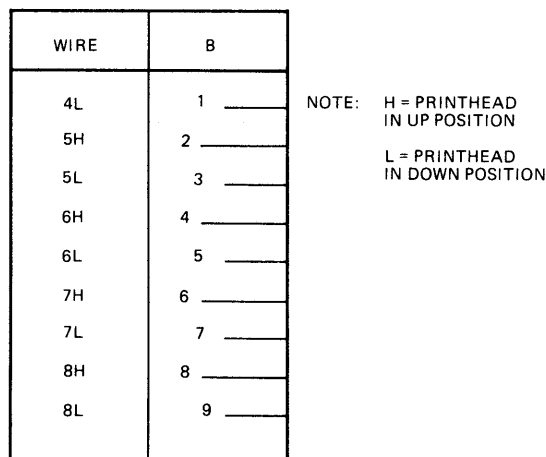
Dot Line	Printwire
1	--
2	5
3	--
4	6
5	--
6	7
7	--
8	8
9	--

Before the second pass, the headlift mechanism shifts the printhead down by one half of one dot.

Second Pass

Dot Line	Printwire
1	4
2	--
3	5
4	--
5	6
6	--
7	7
8	--
9	8

Figure 5-19 shows the algorithm for subscript implementation.



MA-0018-85

Figure 5-19 Subscript Algorithm Implementation

Double Height With High Resolution -- Requires four passes. Six dots are printed in each pass.

Subscript or Superscript with High Resolution -- Translates to high resolution. Requires two printing passes with a head shift after the first pass.

Double-Height Subscript or Superscript -- Requires two passes. The print shrinks at the top half of the double-height character, and drops the bottom half.

Bolding -- Requires two passes. Second pass overprints dots printed on first pass.

5.6.8.2 Form Handling and Line Feed Routines in IBM/Epson Emulation Mode -- The 1/48 inch stepping motion together with the 1/144 inch head lift motion approximates the positioning requirements for emulation mode. In text mode, head lifts are used for high resolution, superscript, and subscript characters. In graphic mode, head lifts are used to approximate the requirements of 1/216 inch and 1/72 inch print motion commands. The bottom margin is expressed in 1/216 inch units. Vertical position counters keep track of the position within 1/216 inch.

There is no line resynchronization after a vertical pitch change.

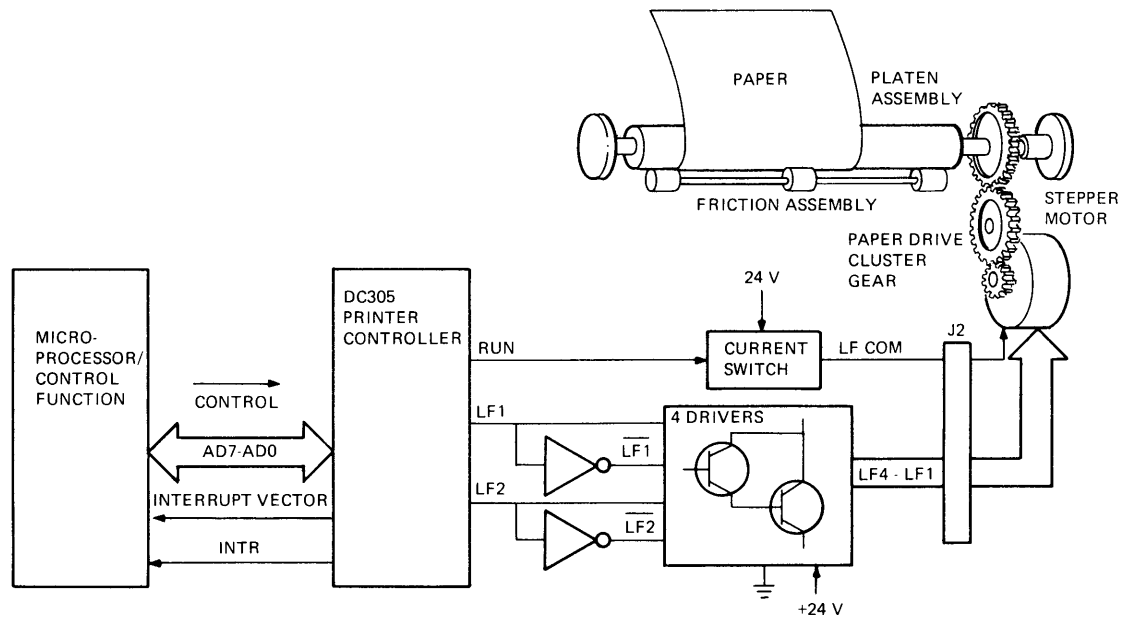
When printing double-height characters, the printer moves the paper up slightly. The printer accounts for this motion before executing the next line feed. If the line spacing is smaller than the partial motion necessary to print the two halves of a double-height character, the next line feed is ignored.

5.7 PAPER ADVANCING

Paper is advanced by the paper feed subsystem, which has the following parts.

- Stepper motor
- Paper drive cluster gear
- Platen assembly
- Friction assembly
- Associated circuitry on the logic board
- Tractor assembly

Figure 5-20 shows the paper feed subsystem. When the microprocessor/control logic identifies a line feed character in the print buffer, it sends 3 control bytes to the DC305 printer controller chip. One of these control bytes sets up a real-time clock in the DC305. A line feed motor control byte issues a 2-bit state field to the motor drivers. This state field controls the polarity of the voltage to each of the line feed stepper motor windings. A third control byte issues a bit that controls the amplitude of the current in the stepper motor windings. A higher current is used to run the motor than to hold a steady position.



MA-0016-85

Figure 5-20 Paper Feed Subsystem Logic

The state field directly affects the DC305 motor control output lines LF1 and LF2. These lines and their complements are input to the line feed motor driver to form a 4-phase control field. The motor control outputs operate in the following sequence of states to control paper movement.

Paper Step	Upward Paper Motion		Downward Paper Motion	
	LF1	LF2	LF1	LF2
1	0	0	0	0
2	0	1	1	0
3	1	1	1	1
4	1	0	0	1
5	0	0	0	0

The four driver outputs, LF1 through LF4, connect to the stepper motor through jack J2. At any given time, two outputs are driving current through two stepper motor windings. The sequence in which the windings are energized determines which way the motor turns. The motor windings connect at a common point (LF COM) and return through the current switch. When the DC305 asserts the RUN signal, the current switch changes from the holding current mode to the higher, running current mode.

As the stepper motor advances through a paper step, the real-time clock (initialized at the beginning of the command) times out and causes an interrupt. The microprocessor recognizes the interrupt, reinitializes the clock, and sends the next state control command to the DC305, if needed. This enables a different combination of motor windings. The sequence of interrupts and state change commands continues until the line feed motor has advanced the other components of the paper feed subsystem to the correct point.

The paper drive cluster gear transfers the rotary motion of the stepper motor armature to the platen assembly. The platen turns, and the pressure caused by the friction assembly lets the platen move the paper. If the tractor assembly is installed, the friction assembly is disabled because the tractor pins pull the paper across the platen. Tractors permit flat surface feeding, which eliminates slippage in multipart forms. With tractors, most paper motion is upward only, because tractors cannot push the paper far back across the platen and down. But for printing subscript and superscript characters, the tractors pull the paper 1/12 inch in reverse.

5.8 FONT ASSEMBLY

The font assembly accesses the logic board through a cable bus buffer (81LS97).

When the ROM cartridge is inserted in a slot, the microswitch trips to the ON position and sends the CART SW FALSE signal to the 8085A microprocessor. When the cartridge is fully plugged into the slot, the microswitch returns to OFF position and sends the CART SW ON signal to the microprocessor. This signal evokes the internal microprocessor interrupt that suspends all printing operations until the cartridge status and font ROMs are verified. Through the microprocessor bus, the microprocessor sends the CART EN signal to the ROM cartridge. Then the microprocessor polls all font ROMs and uses their checksum to verify the presence of any ROM.* Then the microprocessor can send a read command to the ROM cartridge. It sends the read command upon receiving either an escape sequence from the host or when you depress a font select switch.

During power-up, font indicator 1 on the control panel turns off while all the other indicators turn on. This indicates the default condition when DPS selection is made via computer select sequence. During automatic operation, the indicator that is off shows which DPS was selected from the host.

* If the font cartridge is removed from the slot, the microprocessor cannot verify the presence of the ROM and reacts accordingly.

You can select the DPS manually (with or without the ROM cartridges installed) with the DPS select switch. Each time you press the switch, the counter in the microprocessor increments from 0 (computer select status) by 1 to a maximum of 5. The microprocessor polls the available ROMs and selects one corresponding to the contents of the counter.

The first time you press the switch, DPS 1 is forced, overriding the previous selection. All characters print in the first DPS only. Indicator 1 is on and all others are off. Each time you press the switch, the lit indicator goes off, the next DPS is forced, and the corresponding indicator turns on. This sequence continues until you select the fifth DPS. The sixth time you depress the switch, the font counter overflows. Then the count returns to 0 and the stand-by host selection is forced. All the indicators light, except for the host-selected DPS indicator. The printer returns to the computer select condition and prints characters in this DPS.

5.9 POWER SUPPLY AND DISTRIBUTION

The printer uses the H7844 power supply. The H7844 provides additional input filtering to satisfy FCC Class B requirements. The power supply is a completely self-contained module. It is in the rear of the printer enclosure.

5.9.1 Power Distribution

Power is distributed through the printer as shown in Figure 5-21. Line voltage (115/230 Vac) enters the supply through a detachable power cord. The supply transforms line voltage into five direct current voltages: +5, +12, -12, +24, and -24 Vdc. The dc power exits the supply at connector J2, is conducted across an 8-wire cable, and enters the control/logic board through the power connector.

The control/logic board uses the +5 Vdc supply for general logic voltage, the +/-12 Vdc supplies for communication line conditioning, and the +/-24 Vdc supplies for the printhead/servo motor and stepper motor driver circuits.

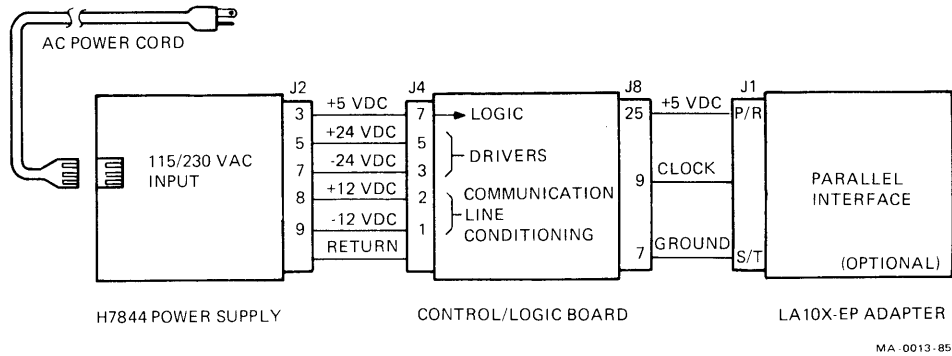


Figure 5-21 Power Distribution

5.9.2 H7844 Power Supply

This section lists the specifications for the H7844 power supply and describes its functions.

5.9.2.1 Specifications -- The H7844 is a pulse-width modulated, flyback, switch-mode power supply. The following list shows the I/O specifications for the H7844.

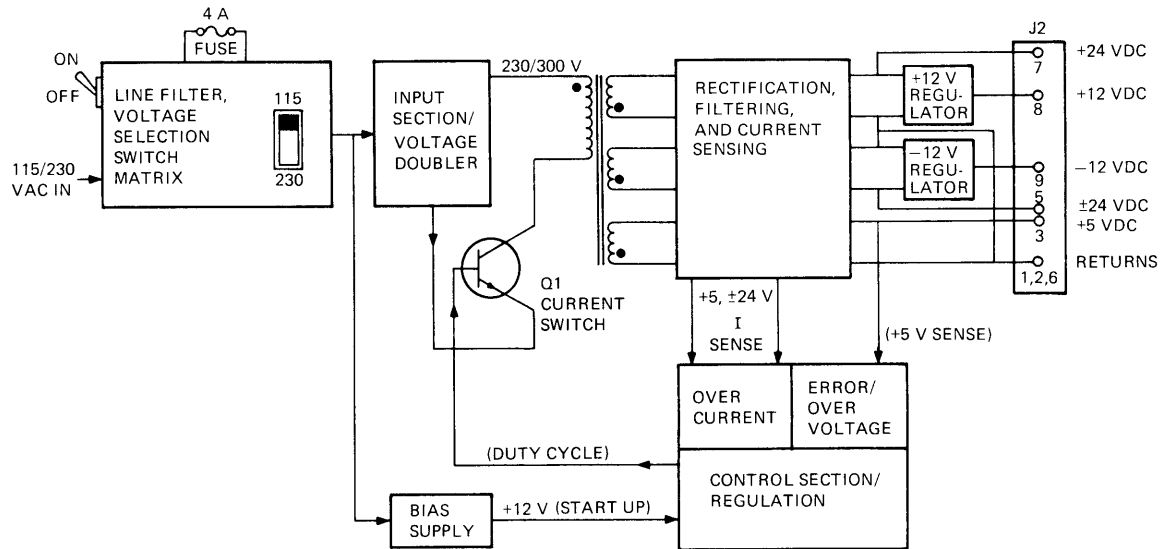
Input

90 to 128 Vac, 47 to 63 Hz @ 1.3 A
 180 to 245 Vac, 47 to 63 Hz @ 0.7 A
 154 W maximum

Output

+5.1 Vdc, +/-5% @ 3.0 A maximum
 +12 Vdc, +/-5% @ 0.2 A maximum
 -12 Vdc, +/-5% @ 0.2 A maximum
 +24 Vdc, +/-10% @ 2.2 A maximum
 -24 Vdc, +/-10% @ 1.0 A maximum

Voltage and current can be in any combination that equals 96.6 W. All outputs are overcurrent protected; +5 V is overvoltage protected at +5.4 Vdc.



MA-9631A

Figure 5-22 Power Supply Functional Block Diagram

5.9.2.2 Functional Description -- Figure 5-22 is a functional block diagram of the H7844 power supply. AC line voltage entering the supply is filtered, fused, and passes through a voltage selection switch matrix. AC voltage from the matrix goes to a low current bias supply that provides a +12 startup voltage to the control circuitry. This bias voltage is provided so that, at power-up, the supply's switching elements start up in a predictable way.

AC voltage from the matrix also goes to the input section where it is rectified. When operating from a 230 Vac source, rectification is accomplished through a full-wave bridge and input to the transformer (T3) primary winding. If the source voltage is 115 Vac, it is rectified through a voltage doubler network and approximately 300 Vdc is input to the primary.

The control section starts up by producing a chopped waveform to the base of the switch transistor (Q1). The switch transistor turns on, causing current to conduct through the transformer primary. When the control section turns the switch transistor off, the stored energy in the transformer primary is transferred to the three secondaries. This constitutes the flyback action, making the effective energy profile in the transformer a leading-ramp sawtooth.

Secondary voltages are rectified and filtered to produce the +5, +24, and -24 V outputs. The +12 V regulated output is developed from the +24 V supply through a 3-terminal linear regulator. Similarly, the -12 V regulated output is developed from the -24 V supply through a 3-terminal linear regulator.

Resistors in the +5 and +/-24 V supplies develop current sense signals that provide part of the feedback input to the control section. The other part of the feedback is formed by +5 V sense. Together, the two feedback elements cause the control section to act as a regulator, varying the chopping frequency and duty cycling to the current switch. The duty cycle of the 34 kHz chopping frequency is changed as a function of the voltage sense feedback. The frequency is halved (17 kHz) when overcurrent is sensed.

The +/-24 V supplies do not have regulators, nor do their outputs return to the control section to form part of the feedback network. Instead, they are cross-regulated from the +5 V supply.

