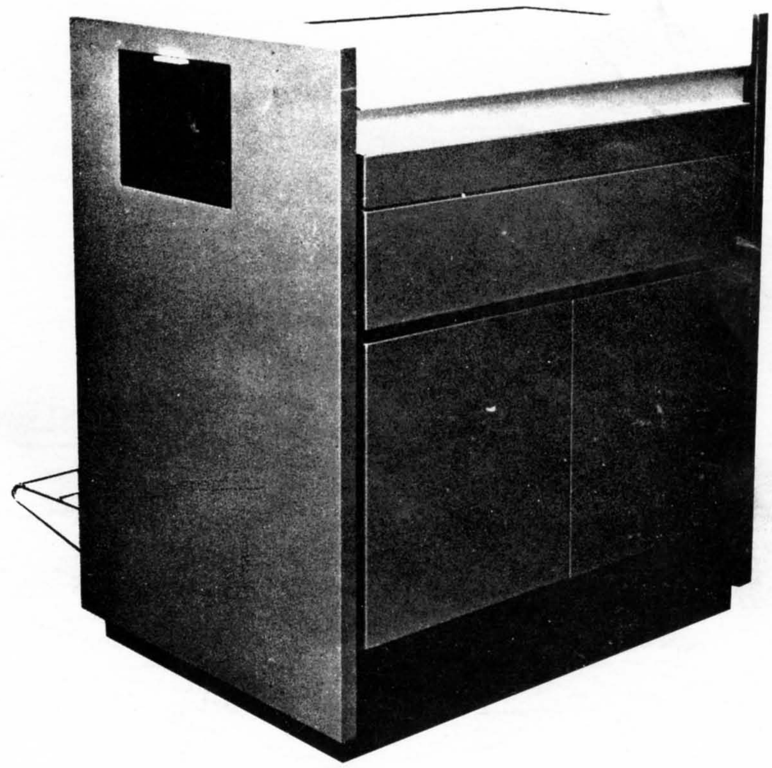
OPERATING INSTRUCTIONS

ChainTrain

LINE PRINTER

MODELS CT-4964, CT-6644, CT-7484



Data Printer Corp

600 MEMORIAL DRIVE
CAMBRIDGE, MASS. 02139

DPC FORM 600-1

PREFACE

This reference manual provides information for the setting up, operation, and operator adjustment of the DPC Chaintrain Line Printer Models CT-4964, CT-6644, and CT-7484. Pertinent printer features are described; procedures for forms loading, ribbon changing, format tape preparation and mounting are set forth; and print quality adjustment information is presented.

The manual is sectionalized for convenient access to operating, set-up, and tape preparation information. Reference information concerning chaintrain character arrangements, format tape characteristics, and paper-feed command coding is contained in an Appendix to the manual.

Customer specified reproducible copies of this manual are available from Data Printer Corp.

Orders for copies of DPC manuals should be directed to your DPC representative or to DPC at the address indicated below.

A form for readers' comments is provided at the back of this manual. If the form has been removed, comments may be sent to DPC at the address indicated below. Comments become the property of DPC.

DATA PRINTER CORP

600 MEMORIAL DRIVE, CAMBRIDGE, MA 02139

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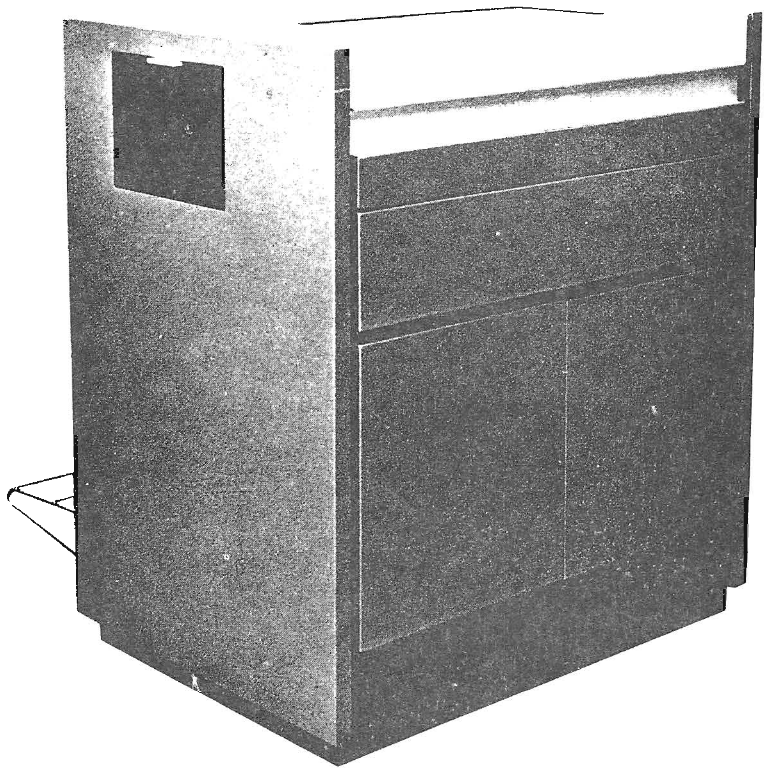


Figure 1. DPC Chaintrain Line Printer, Models CT-4964, CT-6644, CT-7484

INTRODUCTION

GENERAL INFORMATION

The Data Printer Corp Model CT-4964, CT-6644, and CT-7484 CHAINTRAIN Line Printers (Figure 1) are complete computer-driven impact printer systems, featuring a lateral chaintrain type carrier. Hardcopy printout is produced a line at a time from stored digital data, transferred to the printer in the form of print character and paper advance instruction codes from an external device. Printout is recorded in fully-formed character imprints on single-part or multiple-part continuous, sprocket-fed forms.

The standard printer is provided with 132 print positions (columns) horizontally spaced ten (10) to the inch (2,54 cm). Standard vertical spacing is six (6) lines per inch. Vertical spacing and skipping are performed under independent program control for each paper advance operation. Spacing is controlled by the printer buffer; skipping is controlled by a standard 8-channel vertical format unit. A single-line paper advance requires 20 milliseconds: multiple-line spacing and skipping are performed at the rate of 20 inches (50,8 cm) per second. Various form widths from 3-1/2 inches (8,89 cm) to 19-1/2 inches (49,5 cm) over-all are readily accommodated.

The basic character arrangements for the printer are the standard 64-Character (upper case), or the 96-Character (upper and lower case), USASCII Printable Subset arrangements. With either arrangement, any of the different characters provided can be printed in each print position. A variety of other print character arrangements can be provided to meet specific applications.

GENERAL DESCRIPTION

The printer system consists of an electro-mechanical printing mechanism; intimate printer drive, control and line buffer electronics; printer power supply; and all necessary operator controls, indicators, and adjustments contained in a free-standing steel enclosure that is designed for maximum safety and significant enhancement of the visual and aural printer environment. The printing mechanism consists of two major subassemblies: a stationary frame, and a yoke that pivots away from the frame for access to the print area. The paper feed components and the print hammers are mounted on the stationary frame at the back side of the paper path. The ribbon feed components and the chaintrain are mounted on the yoke at the front side of the paper path.

Operator access to the printer is shown in Figure 2. A hinged, balanced canopy at the top of the printer manually opens for access to the yoke, mechanism controls, and the Alarm Indicator Panel. The yoke manually opens and swings forward and down for full access to the print area for forms loading and ribbon changing. Vertical forms-positioning controls are collectively arranged in a protective well at the upper left side of the printer. A sliding panel manually opens for access to this area for vertical forms positioning and format tape loading.

The printer system includes a test panel that provides for operation in a local mode, permitting operator adjustments to be performed on the printer independently of the external device. An opening at the lower rear of the printer enclosure (insert) provides access to the test panel controls.

Forms enter the printer at the front from an enclosed space directly below the yoke, and exit the printer at the rear onto a detachable shelf.

PRINTING METHOD

Printing is accomplished by an electromagnetically-actuated print hammer in each print position impacting the form from behind, pushing a small area of the form against a ribbon and a character type face of the chaintrain in front of the form. The chaintrain is composed of 384 fully-formed character type faces arranged in multiple identical arrays (sets) on 48, 8-character links that are mounted end-to-end in an endless loop. This arrangement permits all of the character type faces to be presented for printing in every print position repeatedly as the motor-driven chaintrain laterally revolves at a constant speed in front of the print hammers.

A complete line is printed in one array-segment of a chaintrain revolution, during which time the form is stationary. Printing occurs only when a comparison shows that the character in alignment opposite a print hammer is identical to the stored data for that print position. The compare-print process is repeated for all print positions as each successive character on the chaintrain moves into print position, until all stored print data has been printed out. Upon completion of the printing of a line, the form is advanced under buffer or tape control to the program-designated position for the next line of print. Ribbon feeding is continuous, and ribbon reversing and tracking are automatically performed to maximize ribbon life.

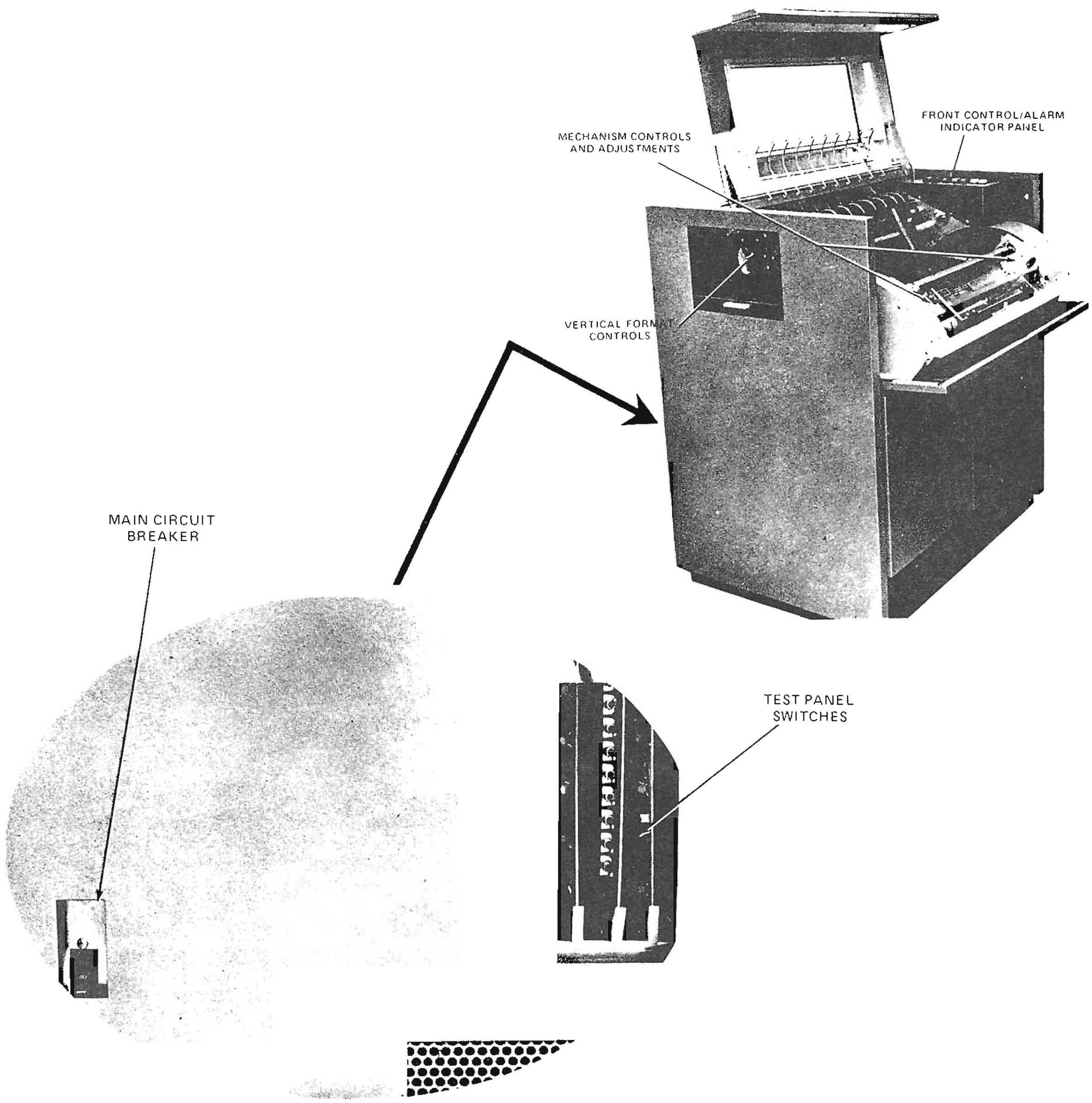


Figure 2. Operator Control Locations

OPERATOR CONTROLS

OPERATOR'S CONTROL PANEL

The pushbutton switches and indicators on the front control panel (Figure 3) provide operator control of the printer and visual indication of printer status during setup, local test operation, and print-run interruptions that require the attention of the operator.

ON (Green)

Pressing the ON indicating pushbutton switch turns on power in the printer, illuminating the switch pushbutton and index's the paper tractors to the next strobe position, provided that:

a. Primary power is applied,
b. The main circuit breaker is in the ON position, and
c. No power alarm condition exists.

OFF (Red)

Pressing the OFF indicating pushbutton switch turns off power in the printer, illuminating the switch pushbutton. When power is on, the OFF switch pushbutton is also illuminated whenever the printer is in a stand-by state with power to the chaintrain and ribbon feed drive motors turned off.

ALARM (Red)

The ALARM indicator is illuminated in the event of an alarm condition that inhibits continued operation in the RUN mode, and which requires operator, or maintenance, attention (see "Printer Status Indications"). During power turn-on and turn-off, the ALARM indicator is momentarily illuminated, providing a lamp check: this should be disregarded unless unduly prolonged.

RUN (Green)

Pressing the RUN indicating pushbutton switch enables the printer for operation with the external device, and illuminates the switch pushbutton, provided that:

a. Printer power is on,
b. The REMOTE/LOCAL switch on the test panel is in the REMOTE position, and

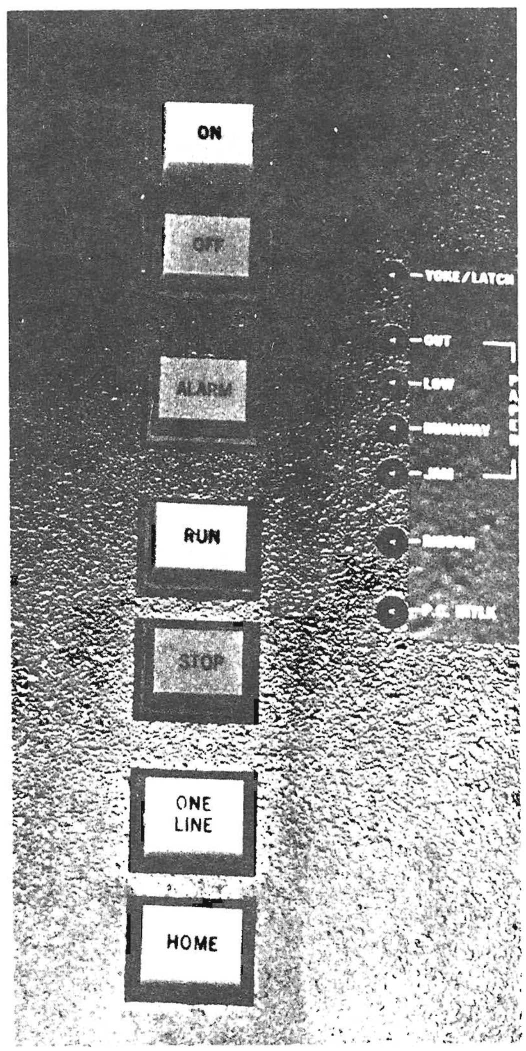


Figure 3. Operator's Control Panel and Alarm Indicator Panel

c. No alarm conditions exist (ALARM indicator is off).

A paper low (last form) condition inhibits continuous operation in the RUN mode. In the event of a paper low condition, manually holding the RUN switch depressed permits continued operation for the form currently in printing position; that is, until the next Top-of-Form (TOF) position is detected.

Upon becoming enabled, the printer remains in a stand-by state with the power to the chaintrain and ribbon feed drive motors turned off (both the ON and OFF indicators illuminated) until the transfer of the first print command from the external device. Similarly, the printer automatically switches to the stand-by state if a print command is not transferred within approximately one minute of the last print operation to conserve power and enhance the aural environment. (Note - Paperfeed commands are executed independently of print commands and have no effect on the stand-by state of the printer.)

STOP (Red)

Pressing the STOP indicating pushbutton switch inhibits continued operation at the completion of the current operation.

If a data transfer is in progress at the time STOP is depressed, operation with the external device is continued for approximately 50 milliseconds to allow for completion of the transfer. At the end of this time, if the transfer has not already been completed, the printer automatically initiates the appropriate operation for whatever data has been transferred at the time, and subsequently inhibits continued operation upon completion of that operation.

ONE LINE (Yellow)

When the printer is in the STOP mode, depressing the ONE LINE pushbutton switch advances the paper tractors, and forms, one linespace.

HOME (Yellow)

When the printer is in the STOP mode, depressing the HOME pushbutton switch advances the paper tractors and forms to the next "home", or Top-of-Form (TOF) position as designated by a punched hole in Channel 1 of the format tape. (Note - If no format tape is installed, the paper tractors and forms will be advanced a single linespace only.)

Slew Paper Controls

When the printer is in the STOP mode, depressing the ONE LINE and HOME pushbutton switches together continuously advances the paper tractors, and slew-feeds the forms, as long as both switches are held down.

PRINTER STATUS INDICATIONS

Visual indication of printer status is provided by the indicating pushbutton switches and indicator on the front control panel, and by the lamps on the Alarm Indicator Panel. Depending upon the condition(s) detected, the indicating pushbutton switches and indicator are illuminated individually or in combinations (Table 1).

OFF (Red)

The OFF indicating pushbutton is illuminated for any of the following conditions:

a. Printer power is turned off,
b. A printer power supply voltage is not present,
c. A hammer driver overcurrent condition is detected,
d. Yoke is open,
e. Yoke latch lever is open, or
f. Printer is in stand-by state (chaintrain and ribbon feed drive motors off).

A hammer driver overcurrent condition is indicated whenever hammer driver supply current is sensed to be flowing anytime other than during a print operation, to protect the printer from potential damage while minimizing the possible loss of data. In the event of a hammer driver overcurrent condition, or the loss of a printer power supply voltage, which require maintenance attention, power in the printer is automatically turned off and operation is immediately stopped.

When the printer power is on, the OFF indicator is also illuminated to indicate that operator attention is required (ALARM indicator illuminated) or that the printer is in a stand-by state (RUN switch pushbutton illuminated).

ALARM (Red)

The ALARM indicator is illuminated for any of the following conditions:

a. Yoke is open,
b. Yoke latch lever is open,
c. Paper runaway condition is detected,
d. Paper out condition is detected,
e. Paper jam/tear condition is detected,
f. A ribbon alarm condition is detected, or
g. Hammer Driver circuit-board interlock circuit is open.

To facilitate operator procedures, the foregoing alarm conditions and the paper low condition, are separately indicated on an Alarm Indicator Panel, located to the right of the operator control panel (Figure 3). Normally, the Alarm Indicator Panel is concealed when the canopy is closed, but is fully accessible upon opening the canopy.

A paper runaway condition is indicated whenever paper is continuously advanced for several forms. Paper runaway can occur if the format tape used is not punched in all channels and the printer receives a Skip-to-Channel instruction that designates an unpunched format tape channel. This alarm condition can be cleared by pressing either the ONE LINE or the HOME pushbutton switch.

A paper-out condition is indicated when a paper low (last form) condition is sensed and a punched hole is detected in vertical format channel 1 ("Home", or Top-of-Form position). When paper is out, follow the procedure described under "Forms Loading" for loading new forms and locating the first line of print.

A paper jam/tear condition is indicated whenever paper is not sensed to be moving thru the print area during a paper advance operation.

A ribbon alarm condition is indicated whenever ribbon is sensed to be out of both the upper and lower ribbon sensors.

In the event of any alarm condition listed above, the printer immediately inhibits continued operation in the RUN mode until the condition is corrected and the ALARM indicator is turned off.

STOP (Red)

The STOP indicating pushbutton is illuminated for any of the following conditions:

a. STOP pushbutton is pressed,
b. Any condition listed above that turns on the ALARM indicator, or
c. A paper low (last form) condition is detected.

Table 1. Front Panel Alarm Status Indications, DPC Chaintrain Line Printer

FRONT PANEL INDICATORS: OFF	ON	ALARM	RUN	STOP	CONDITION(s) DETECTED	CORRECTIVE ACTION(s)
○	○	○	○	○	Primary power not applied (1)	Check main circuit breaker; primary service
○	○	○	○	○	Printer voltage not available	Normal if power OFF; otherwise maintenance attention required
					Hammer driver overcurrent	
○	○	○	○	○	Printer in stand-by state (2) (1)	Generally normal; if prolonged, check external device, program
○	○	○	○	○	Yoke open (3)	Close yoke
					Yoke latch open (3)	Close yoke latch
○	○	○	○	○	Paper out (2) (3)	Insert new forms
					Paper jam/tear (1) (3)	Re-insert forms; check tractor positioning
					Paper runaway (1) (3)	Press ONE LINE or HOME switch to clear; check format tape program; reposition forms as required
					Ribbon alarm (1) (3)	Check that ribbon is threaded through both upper and lower ribbon sensors
					Hammer driver interlock circuit open (3)	Maintenance attention required
○	○	○	○	○	Paper low (2) (3)	Press RUN to complete form
○	○	○	○	○	Printer ready (1) Normal operating status	If no printing occurs and printer does not revert to stand-by after about 1 minute, check interface cabling, interface, program

Notes:
- In the table, an open circle ○ (light) denotes indicator is "on" and a filled circle ○ (dark) denotes indicator is "off".
- Momentary illumination of ALARM indicator during power turn-on/off is normal.

(1) Frequent recurrence or persistence of condition requires maintenance attention.
(2) Condition not sensed or normally occurring in local, internal test mode.
(3) Separately indicated on the Alarm Indicator Panel.

A paper low condition is indicated when less than 5-1/2 inches (14 cm) of paper supply remains in the printer. Operation with the external device is automatically stopped upon detection of paper low. However, manually holding the RUN pushbutton switch depressed permits continued operation for the (last) form currently in printing position until paper is out, that is; until a punched hole is detected in vertical format channel 1. A paper low condition overrides a paper jam indication.

MECHANISM CONTROLS AND ADJUSTMENTS

The printer mechanism controls and adjustments (Figure 4) provide operator access to and adjustment of the printer during setup, and provide operator control of print quality during operation. In normal operation, the canopy and the upper left side panel should be closed to prevent inadvertent operation of the mechanism controls and adjustments.

6/8 LINES PER INCH (Optional Feature)

The optional 6/8 LINES PER INCH switch is used to select either six (6) or eight (8) lines-per-inch (2,54 cm) linespacing.

INFINITE FORMS POSITION Control

This control permits the vertical position of the forms to be adjusted independently of the vertical format unit when the printer is in the STOP mode.

WARNING

> DO NOT attempt to position forms while the printer is operating. This control is directly coupled to the paperfeed drive system and turns as paper is being advanced through the printer mechanism.

Lifting the clutch release lever in the center of the control to the raised position decouples mechanical drive to the paper tractors. The forms can then be repositioned by turning the concentric knob either counter-clockwise to raise the forms, or clockwise to lower the forms.

PAPER HOLDDOWN LATCHES (Upper Tractors)

Pushing upwards on each latch releases the respective spring-loaded paper holddown plate (cover) to the open position for forms removal or loading. The latches are spring loaded to automatically engage the holddown plates in the closed position.

TRACTOR LOCKING LEVERS

The tractor locking levers permit the paper tractors to be individually positioned to accommodate forms of different widths and to laterally position the print-line location on a form. On the upper tractors placing the lever in the raised position releases the corresponding tractor which can then be manually slid to the desired position. Pushing the lever down to its fully lowered position locks that tractor in position for operation. On the lower tractors, placing the lever in the lowered position releases the corresponding tractor which can then be manually slid to the desired position. Pushing the lever up to its upper position locks that tractor in position for operation.

YOKE LATCH LEVER

Pulling the yoke latch lever forward releases the yoke latch, permitting the yoke to be manually pivoted forward by pulling on the yoke handle, allowing full access to the print area for forms loading and ribbon changing. When opened beyond its maximum vertical position, the yoke will continue to swing downward (gravity) to the fully-opened position as shown in Figure 4. The yoke action is dampened to prevent opening or closing too abruptly.

The yoke should be opened only when the printer is in the STOP mode, or when the printer power is off. The yoke latch and the yoke are electrically interlocked to disconnect power to the chaintrain and ribbon feed drive motors when not fully closed. Releasing the yoke latch while the printer is operating will immediately switch the printer to the STOP mode, which might result in the loss of print data, incorrect vertical formatting, and/or a false power alarm indication.

With the yoke latch lever in the forward (yoke released) position, the yoke can be pivoted to the closed position by pushing upwards, then inwards, on the yoke handle until the yoke is fully closed. Pushing the yoke latch lever back as far as it will go latches the yoke in the closed position for printing.

PHASING CONTROL

The PHASING control permits operator adjustment of the over-all lateral alignment of character imprints to correct any left or right side cutoff. Rotation of this control advances, or retards, the timing of print hammer actuation with respect to the position of the character type faces on the moving chaintrain as they pass in front of the print hammers. The control is cam-coupled to permit continued rotation in either direction to adjust the alignment in a reciprocating manner; that is, lateral movement of imprints first in one, then the opposite direction.

IMPRESSION CONTROL

The IMPRESSION control positions the chaintrain closer to, or farther from, the print hammers to permit adjustment of over-all print impression (darkness) with forms and ribbons of different thicknesses and characteristics. Print impression is adjusted by sliding this control either to the right, or to the left. Print impression is darkest with the control at the most right-hand position, and is lightest at the most left-hand position.

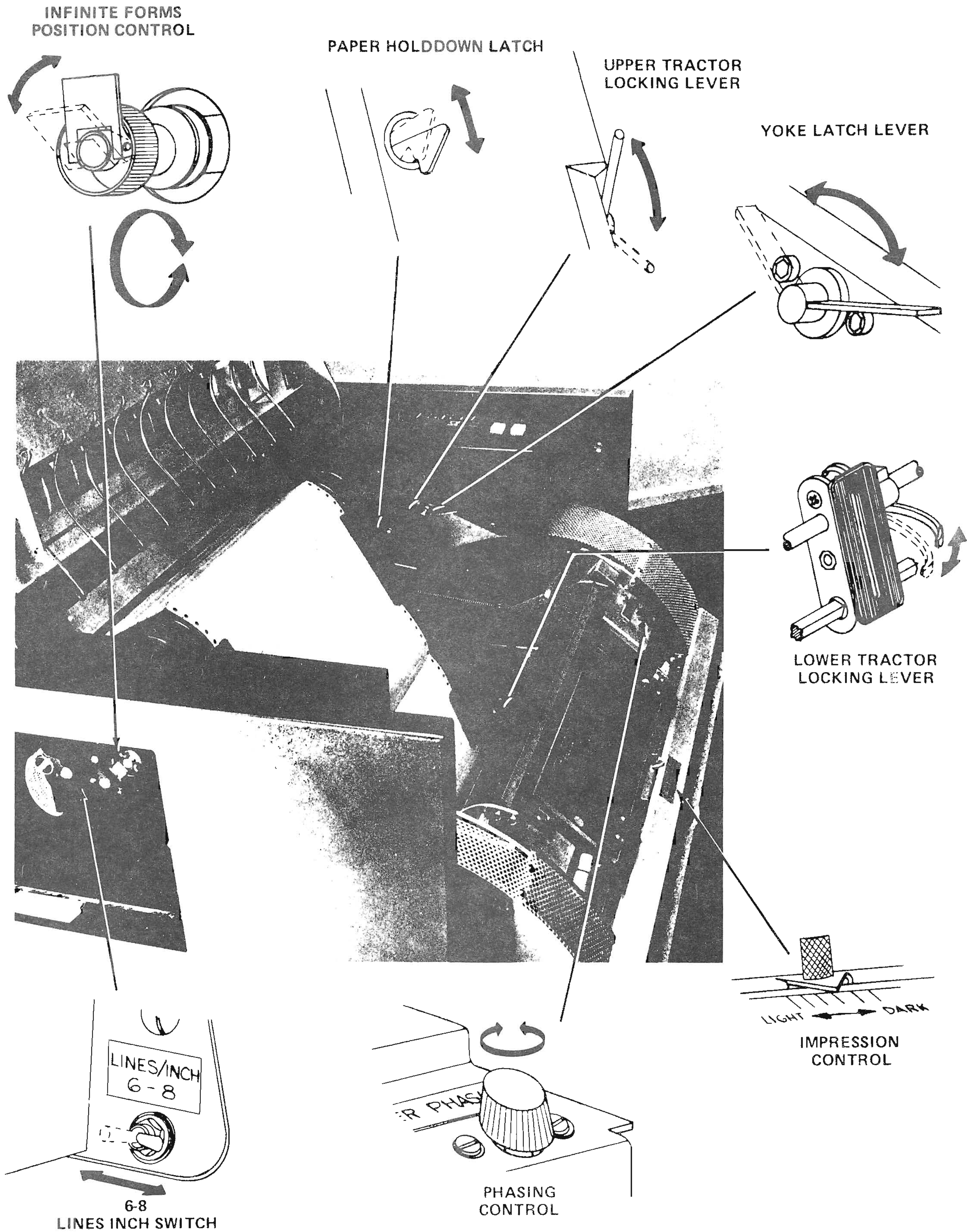


Figure 4. Mechanism Controls and Adjustments

VERTICAL FORMAT CONTROL

GENERAL

The feeding of forms by the printer is performed either by spacing under printer buffer control or by skipping under tape control, as designated by bit position 7 of the Paperfeed Instruction transferred for each paper advance operation. When spacing, paper is fed in a single, continuous operation until the printer buffer has electronically counted off the number (from 0 [none] to 63) of line spaces designated in binary by the instruction. To advance forms by spacing, the vertical format program of each form must be provided by the external device.

For tape control, each application requires a vertical format tape which corresponds in length to the number of linespaces on one or more forms. This tape is prepared with punched holes, arranged in channels, along the length of the tape. Each hole represents a selected line on the corresponding form at which a paper advance is to stop. The tape is read in synchronism with the moving forms in the printer by a multi-channel photoelectric vertical format unit (VFU). When skipping, paper is continuously fed until the next punched hole is detected in the tape channel designated in binary by the instruction. Paperfeed Instruction bit patterns are given in Table 6 of the Appendix.

A printer equipped with the Automatic Linefeed feature[1] can be programmed from the external device to automatically advance paper either a single or double linespace after printing each line, permitting "list" printout to be easily produced without the necessity of programming a Paperfeed Instruction for each line of print. Used in conjunction with an appropriately programmed tape, this feature also provides an automatic paper skip to the Top-of-Form (TOF) position of the next form when the Bottom-of-Form (BOF) position of the current form is detected for perforation step-over. This automatic BOF-to-TOF paper skip is also provided when Automatic Linefeed is programmed in conjunction with the execution of any spacing instruction, or of a Skip-to-BOF Channel instruction[2]. The portion of the original spacing instruction remaining after an automatic BOF-to-TOF paper skip is discarded. Except for a Skip-to-BOF Channel instruction, all other Skip-to-Channel instructions result in a paper advance to the channel designated regardless of the state of Automatic Linefeed.

FORMAT CONTROL TAPE

The tape used for format control depends upon the VFU provided on the particular printer. The standard 8-Channel VFU accommodates standard one-inch (2,54 cm) wide perforated tape, whereas the optional 12-Channel VFU is designed to read 1-5/8 inch (4,13 cm) wide carriage control tape. The recommended tapes for format control of the printer are DPC Part No. A4524 or equivalent for use on the 8-Channel VFU; or DPC Part No. A4568 or equivalent for use on the 12-Channel VFU. Detail format tape characteristics, and format tape supplies and accessories are listed in Tables 7 and 8 of the Appendix.

FORMAT TAPE PREPARATION

The following general instructions should be observed when preparing a vertical format control tape-loop:

1. At least one punch is required in each channel for each form, to avoid the possibility of a paper run-away which might otherwise occur if the printer should be instructed to skip to an unpunched channel.
2. A Channel 1 punch is required for each form to restore the paper tractors to the "Home" position, to stop the printer when it runs out of forms, and to stop paper movement during an automatic

[1]The Automatic Linefeed feature is provided only on printers equipped with the standard DPC printer I/O signal interface configuration.

[2]Automatic linefeed is not recommended for use with input data formats in which the paperfeed instruction is transferred together with the stream of print data characters for a line of print ("Last Character" mode; First Character Interface). Automatic linefeed will interfere with paperfeed instructions so transferred.

BOF-to-TOF paper skip. The Channel 1 punch is normally located to correspond with the first line of printout on a form (TOF).

3. A Channel 8 punch or a Channel 12 punch, depending upon the VFU configuration, is required for each form to initiate an automatic BOF-to-TOF paper skip when programmed.
4. Holes in the tape must be fully punched out (not chadless) and should conform to the hole size and pitch dimensions given in Table 7 of the Appendix.
5. Format tape-loops should be spliced using an overlap joint having an overlap of three feed holes. The trailing end of the tape should overlap the leading end so as to be on the outside of the loop to avoid picking.
6. For best results, format tape-loops should be carefully stored to avoid creasing and contamination, particularly from oil which might reduce tape opacity, and lint particles and chad which might obstruct the punched holes.

The tape preparation method differs in certain details depending upon the VFU configuration, 8 or 12 Channel, and the linespacing, 6 or 8 lines-per-inch (LPI), on the form that a format tape is to be used with.

Eight-Channel, Six LPI Tape Preparation: Eight-channel format tape (DPC Part No. A4524) is prepunched with round holes slightly to one side of the center of the tape for the sprocket-feed drive that advances the tape in synchronism with the movement of forms through the printer. Holes can be punched in up to eight columns, called channels, throughout the length of the tape. Normally, three channels are arranged to the left of the feed holes and are designated Channels 1, 2, and 3 from left-to-right. The remaining five channels are normally arranged to the right of the feed holes and are designated Channels 4 through 8 (left-to-right).

The tape is first marked to an equivalent form(s) length. Mark the left end of the tape as shown in Figure 5 to form a leader and to designate the position of the top edge of the form. Determine the equivalent tape length either by carefully counting feed holes (each feed hole on this tape corresponds to one line on the form at a linespacing of six LPI), or by multiplying the form length in inches (or centimeters) by six-tenths (x6/10ths). Starting from the solid line representing the top edge of the form, measure off, to the right, the equivalent tape length and mark the tape with a second solid line through the feed hole at this point. This second solid line represents the bottom edge of a form.

The marking off of one form should be repeated as many times as the nominal length of a tape loop allows (6.6 inches or 16,76 cm, the equivalent of a standard 11-inch [27,94 cm] fan-fold form). When a tape controls several forms in one revolution through the VFU, the expected life of the tape loop is increased. Cut the tape about 2-1/2 inches (6,35 cm) to the right of the last solid line to form a trailer for positioning the tape in the punching equipment.

The tape should next be marked opposite each feed hole where a hole is to be punched for each paper-skip stop on the form. Each feed hole on tape represents one line on the form at 6 LPI. A mark should first be made for the first line of print position (TOF) on the form. Marks should then be made for each additional paper-skip stop and for the BOF position on the form. Holes may be punched in more than one channel on the same line, and may be punched in successive lines on the same channel. A format tape may be prepared for use with several different forms provided the linespacing, TOF, and BOF are common. Any holes punched in the last four positions on the tape should be repeated in the four positions in the overlap splice section.

After the tape is punched, it is cut squarely on the last solid line and the dashed line (refer to Figure 5), and then looped into an endless belt with the trailing end overlapping the splice section as shown in Figure 6. The mating surfaces of the tape should be cleaned with an eraser to remove any material that might interfere with proper cementing. The back side of the bottom end is then cemented to the top side of the beginning end in the

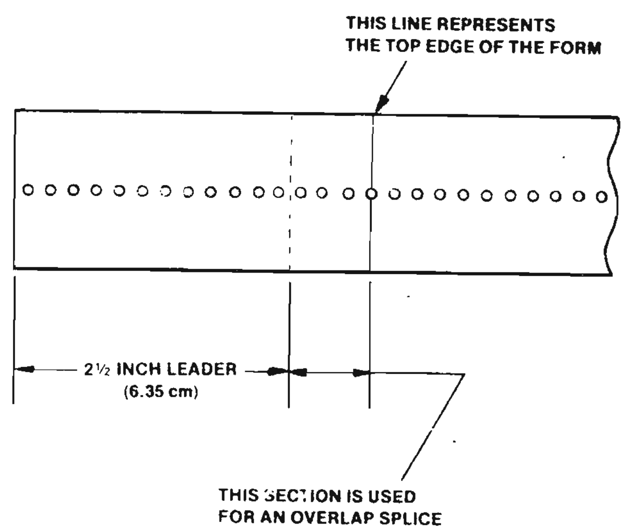


Figure 5. Eight-Channel Format Tape Leader

overlap splice section using a rubber-based contact cement (DPC Part No. A4569 or equivalent). The last solid line should coincide with the first solid line representing the top edge of the form, and the feed holes and punched holes in the splice should coincide when the two ends of the tape are cemented together. Any excess cement should be removed and the holes in the splice should be cleared.

Twelve-Channel, Six LPI Tape Preparation: Twelve-channel format tape (DPC Part No. A4568) is preprinted with guide lines to facilitate layout, manual punching, and splicing. The tape has 12 columns, called channels, indicated by numbered vertical lines. Round holes are prepunched in the center of the tape for the sprocket-feed drive that advances the tape in synchronism with the movement of forms through the printer. A heavy horizontal line through the fourth feed hole from the top end (just below the section marked "glue") represents the top edge of the form. Horizontal lines and feed holes are spaced six to the inch (2,54 cm) along the length of the tape. The horizontal lines are numbered consecutively from the top edge line.

The tape is first marked in the channels on the line opposite each feed hole where a hole is to be punched for each paper-skip stop on the form. At a linespacing of 6 LPI, each horizontal line and feed hole on the tape corresponds to one line on the form. Marking can easily be done by aligning the tape, printed side up, along the edge of the form it is to control, with the heavy solid line even with the top edge of the form. A mark should first be made for the first printing position (TOF) on the form. Marks should then be made for each additional paper-skip stop and the BOF position on the form.

The marking off of one form should be repeated as many times as the nominal length of a tape-loop (11 inches or 27,94 cm; the length of a standard fan-fold form) allows, to maximize the expected life of the tape loop. Next, the line opposite the feed hole corresponding to the bottom edge of the last form should be marked for cutting after the tape is punched. Any holes marked for punching in the last four line locations on the tape should be repeated in the overlap splice section. Holes may be punched in more than one channel on the same line, and may be punched on successive lines in the same channel. A format tape may be prepared for use with several different forms provided the linespacing, and the TOF and BOF positions are common.

After the tape is punched, it should be cut, looped, and cemented as shown in Figure 6 and as described above for eight-channel tape.

Twelve-Channel, Eight LPI Tape Preparation: For a linespacing of 8 LPI on the form, every 1/8th inch (3,18 mm) on the tape corresponds to one linespace on the form. Consequently, the preprinted horizontal lines on the tape, which are spaced six to the inch, are not applicable and, generally, should be ignored when preparing a 12-channel tape for 8 LPI linespacing. Marking of the tape can easily be done by aligning the tape, printed side up, along the edge of either the form it is to control, if the form is preprinted at the appropriate line positions, or a properly graduated scale, keeping in mind that the heavy solid line on the tape represents the top edge of the form.

Tapes for 8 LPI are prepared in much the same manner as described above for 6 LPI, while observing the following precautions:

1. With the top edge of the form even with the heavy horizontal line, every fourth line location should align with every third feed hole on the tape.
2. The bottom edge of the last form represented on tape should align with a tape feed hole.
3. Rectangular holes should not be punched in successive line locations.

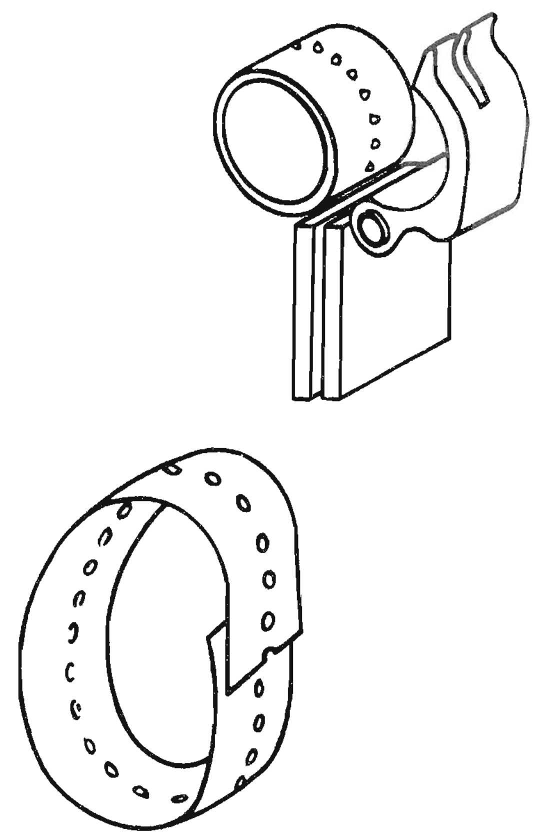


Figure 6. ormat Tape-Loop Over'ap Joint

FORMAT TAPE MOUNTING

1. Place the printer in the STOP mode and open the sliding panel at the upper left side of the printer to gain access to the VFU (Figure 7).
2. Raise the spring-loaded tape hold down (Figure 8) to the open position and carefully remove the move the "old" tape by lifting it up to clear the feed pins, then out.
3. Orient the tape loop to be installed as follows:

   8-Channel VFU - Tape Channel 1 should be outermost. The narrow, three-channel side of the tape should be on the left side of the loop, as viewed from the front of the printer.

   12-Channel VFU - Tape Channel 12 should be outermost. Printing should be on the outside, and the line position numbers should be on the left side of the tape loop as viewed from the front of the printer.
4. Insert the tape loop into the narrow gap between the tape guides and place the top of the loop over the tape drive sprocket so that the feed pins engage the feed holes in the tape. If the tape is for 8 LPI linespacing, position the tape so that the feed hole representing the top **edge** (not TOF) of the form is engaged on a short, flat-topped feed pin to properly index the tape with the paperfeed mechanism.
5. Lightly holding the tape loop taut, lower the tape hold-down (Figure 8).
6. Place the 6/8 LINES PER INCH switch in the appropriate position.
7. Press the HOME switch to position the tractors, and close the sliding panel.

Figure 7. Vertical Format Unit (Typical)

FORMS LOADING

1. Raise the canopy to gain access to the printer yoke and yoke latch lever, and open the front doors to gain access to the paper supply area.
2. Unlatch and pivot the yoke to the open position by pulling the yoke latch lever forward and then pulling the yoke, by its handle, toward you.
3. Unlock and set the paper tractors (Figure 9) to approximate their final position. Normally, the left-hand tractors should be positioned slightly to the left of the first printing position.
4. Open the upper tractor hold-down plates (covers) by pushing the hold-down latches upwards until the spring-loaded plates snap open. Open the

spring-loaded lower tractor hold-down plates by gently pulling upwards and outwards on the hold-down plates.

5. Thread the forms, printing side up, up through the opening between the open yoke and the lower paper platen (Figure 10) and place the form on the paper tractors with the margin feed holes engaged on the tractor feed pins. (Hint - When loading multiple-part forms, fold the first page over before threading so that the parts will not shift while threading.) With the feed holes properly engaged on the feed pins, close the paper hold-down plates.

6. Swing the formscale into place over the form at the printline (Figure 11) by pushing the formscale from the yoke toward the form until it is in place.

7. Referring to the formscale, horizontally position the paper tractors and forms to the desired print location on the form. Lock the left-hand paper tractors in their final position.

8. Tighten the cross-tension on the form by carefully positioning the right-hand paper tractors. The form should be taut but without distortion of the margin feed holes, which might interfere with proper feeding. With the form at the desired cross-tension, lock the right-hand paper tractors in their final position.

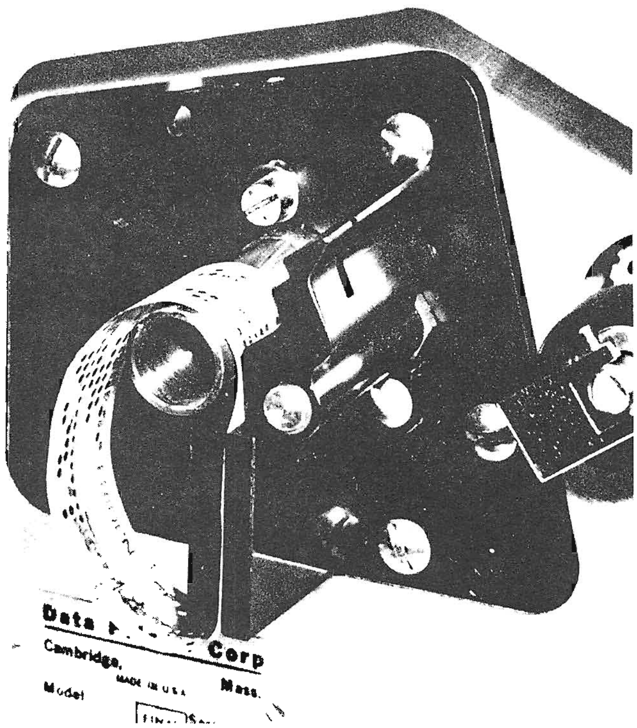


Figure 8. Format Tape Mounting (Typical)

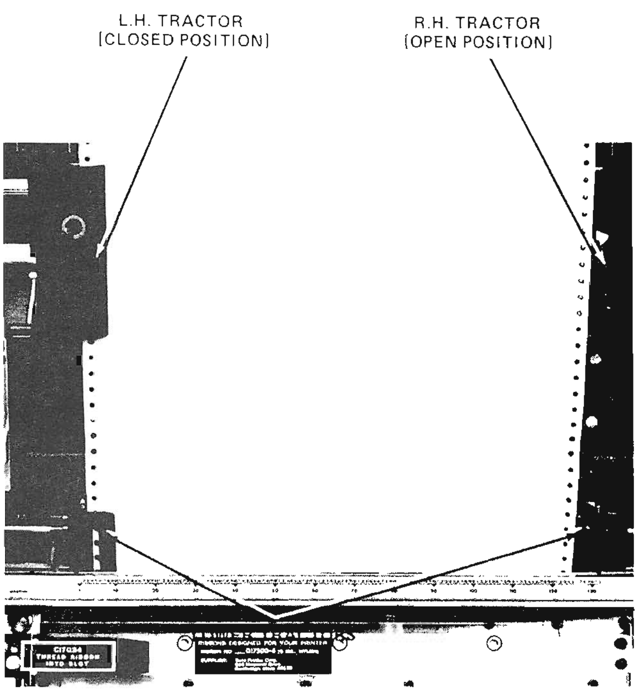


Figure 9. Paper Tractors

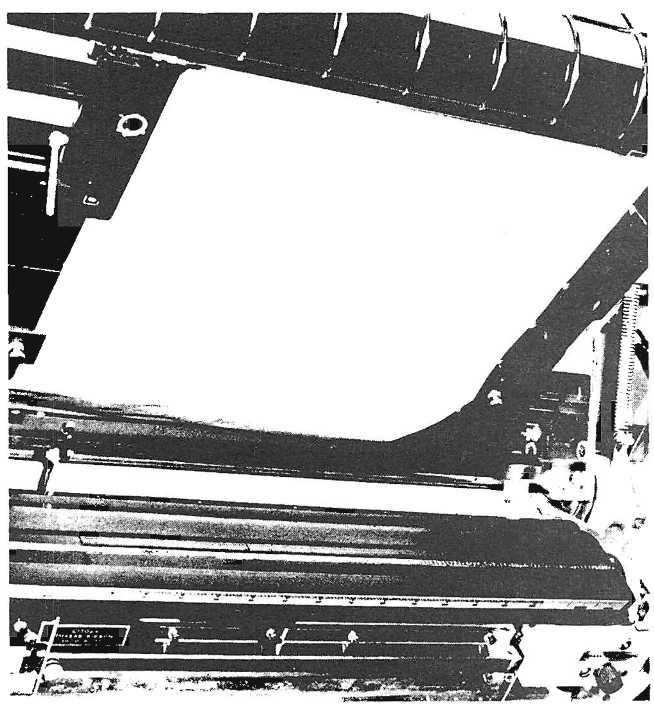


Figure 10. Forms Threading

9. Open the sliding panel at the upper left side of the printer to gain access to the VFU and the Infinite Forms Position control (Figure 12). Check that the proper format tape-loop, if required, is installed in the VFU, and that the 6/8 LINES PER INCH switch, if provided, is in the proper position.
10. Turn printer power on and press the HOME push-button switch to advance the paper tractors to the next "Top-of-Form" position.
11. With the printer in the STOP mode, adjust the vertical position of the forms by means of the Infinite Forms Position control.

WARNING

DO NOT attempt to position forms while the printer is operating. This control is directly coupled to the paperfeed drive system and turns as paper is being advanced through the printer.

Decouple the forms control by raising the clutch release lever, and adjust the vertical position of the forms by turning the control knob until the line on which the first line of print is to appear is just visible above the top edge of the formscale. Re-engage the paperfeed drive by pressing the clutch release lever back into position against the control knob. Close the upper left side panel.

12. Close and latch the printer yoke.

WARNING

BEFORE attempting to close the yoke, check that the print area is free of any obstruction that might interfere with proper operation or that might damage the mechanism. KEEP hands and clothing away from the print area while closing the yoke.

With the yoke latch lever in the forward (release) position, pivot the yoke to the closed position by pulling upwards, then pushing inwards, on the yoke handle until the yoke is fully closed; then push the yoke latch lever back as far as it will go to latch the yoke closed.

13. Check for proper initial settings of the IMPRESSION and PHASING controls, particularly if the thickness or number of parts of the new form is significantly different than that of the old form (refer to "Print Quality Adjustments" for details). Close the canopy.

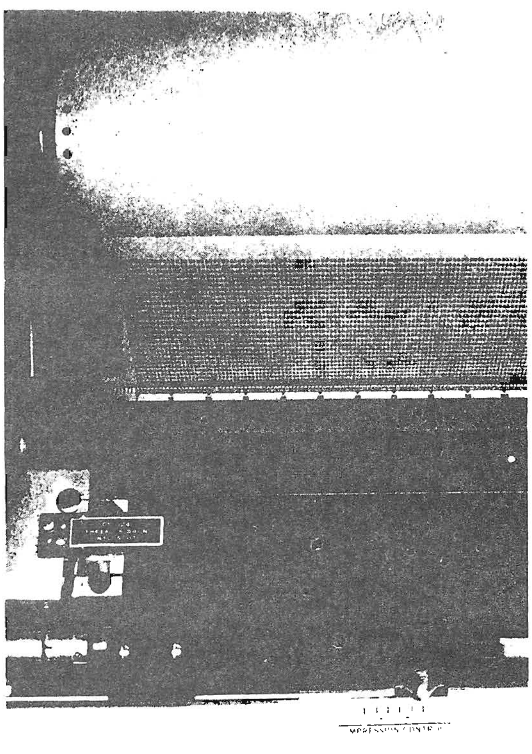


Figure 11. Formscale Position

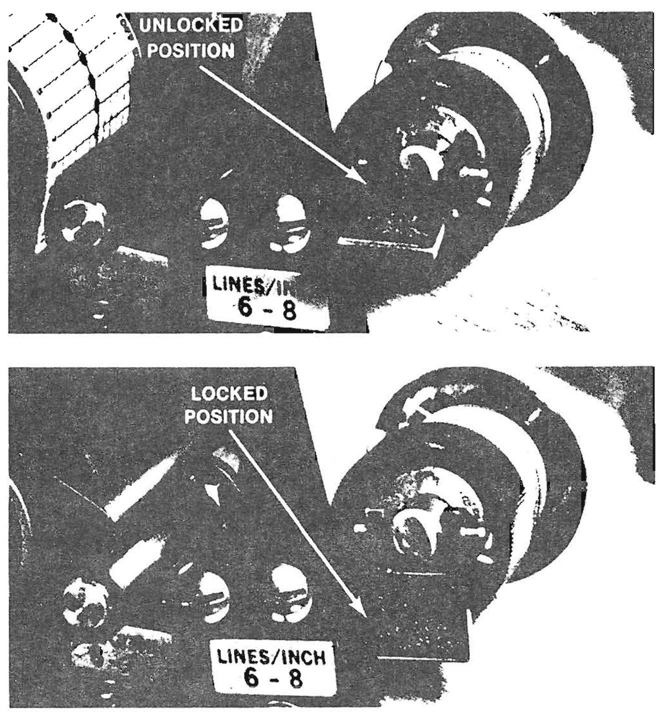


Figure 12. Infinite Forms Position Control

14. Arrange the forms supply directly under the printer yoke so that the forms will feed straight into the printer. If the forms are fed from a carton, take care that the flaps or any ragged edge on the carton will not snag the forms. Close the paper bay doors.
15. Position the paper shelf in the mounting holes at the lower rear of the printer. *Check that the paper shelf grounding cord is plugged in.*
16. When printing begins, check for proper printing and forms handling. The first forms fed out of the printer should be guided onto the paper shelf so that they fold properly and lay flat. During operation, the printout should be occasionally dressed down by jostling the stack to lay flat and by pressing down on the paper to squeeze out trapped air.

RIBBON CHANGING

1. Raise the canopy, and unlatch and pivot the printer yoke to the open position to gain access to the ribbon and ribbonfeed mechanism (Figure 13).
2. Swing the formscale away from the yoke by pushing the formscale towards the forms area, and open the hinged ribbon cover at the top center of the yoke by swinging it towards the front to gain full access to the ribbon and ribbon mandrels.
3. Using the disposable plastic gloves supplied with the new ribbon, push the upper ribbon mandrel to the right, lift out the left end, and remove the mandrel from the mechanism. Temporarily place it on top of the formscale.
4. Push the lower ribbon mandrel to the right, lift out the left end, and remove the mandrel from the mechanism. Grasping both mandrels, slide the ribbon slightly to the right to clear the upper and lower ribbon sensors at the left side of the ribbon path, and remove the ribbon from the printer.
5. When installing a new ribbon, load the full mandrel onto the lower ribbon drive first. With the full mandrel positioned so that ribbon winds from the underside (see Figure 14), place the right-hand end of the mandrel onto the lower right spring-loaded idler hub, push the mandrel to the right and place the left end of the mandrel onto the lower left drive hub with one of the notches in the end of the

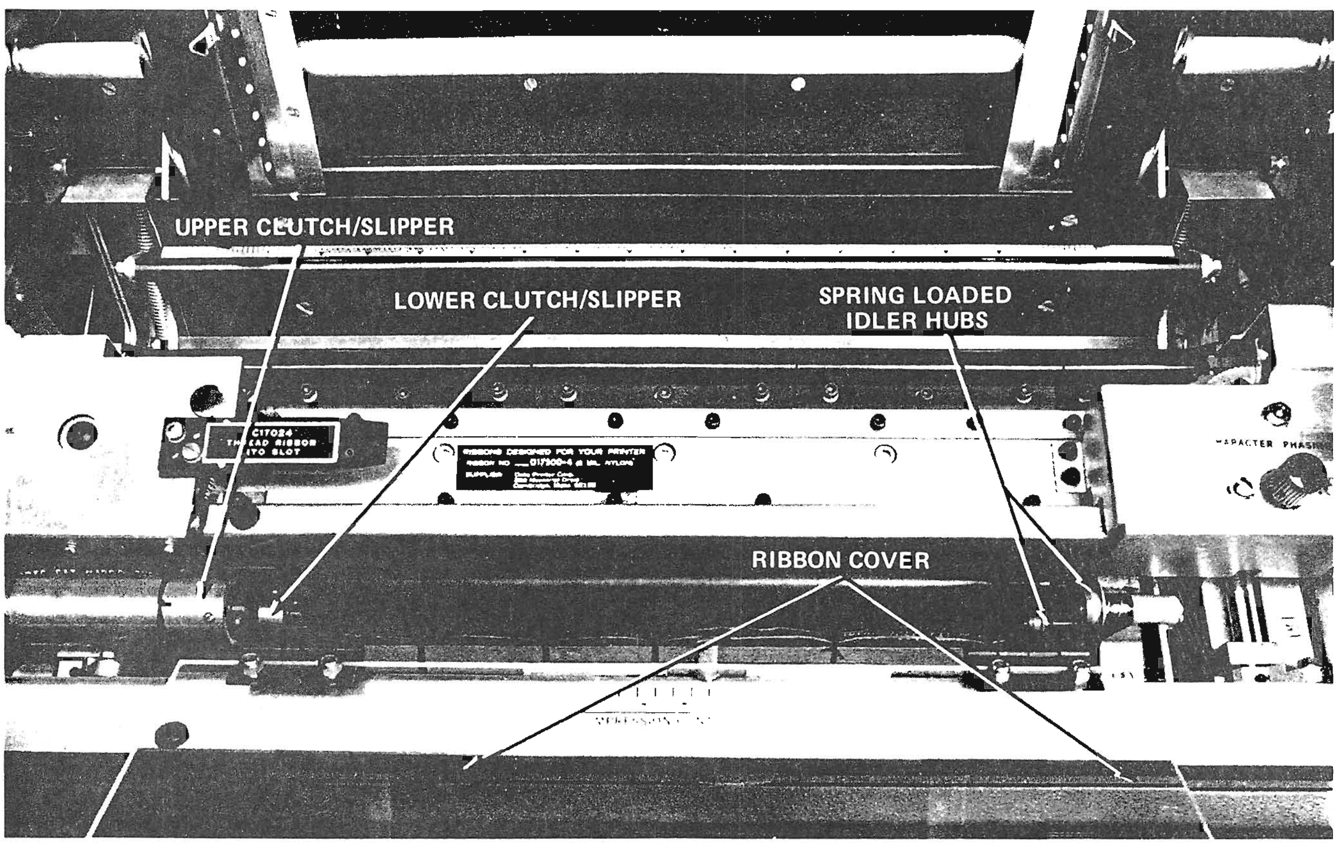


Figure 13. Ribbonfeed Mechanism

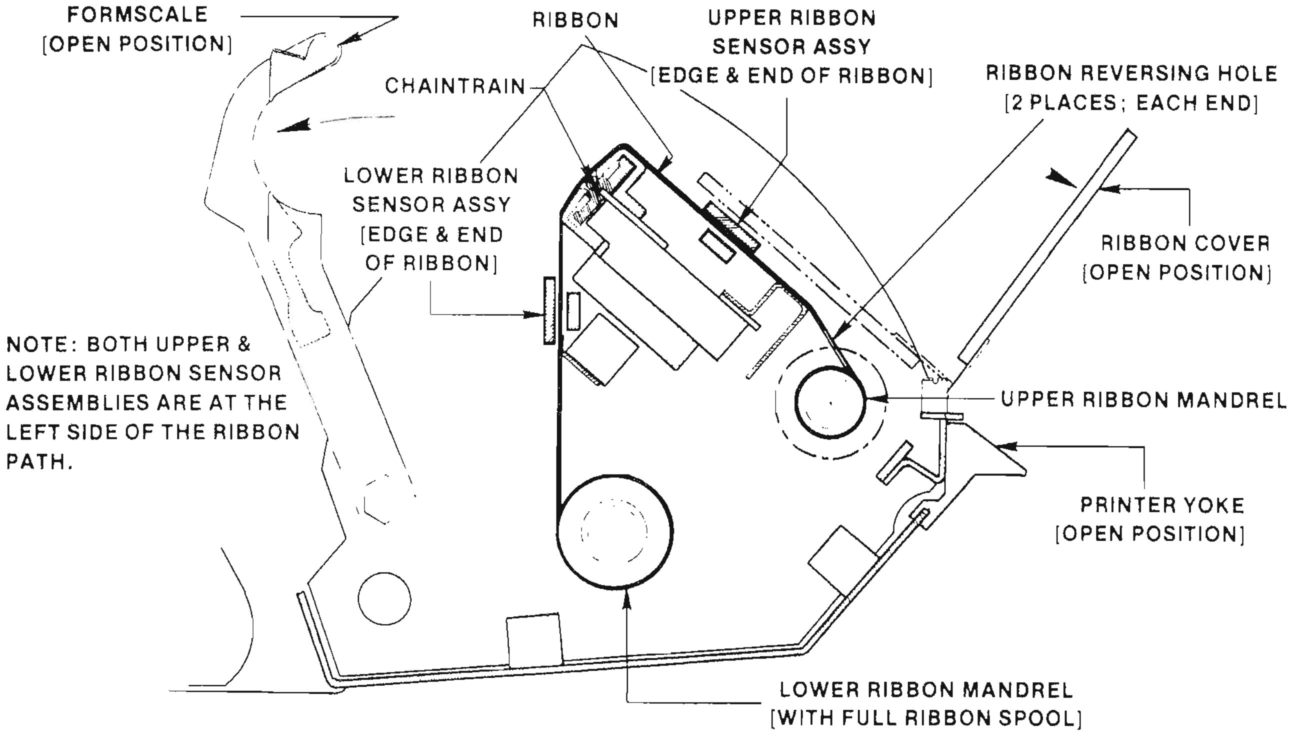


Figure 14. Ribbon Path

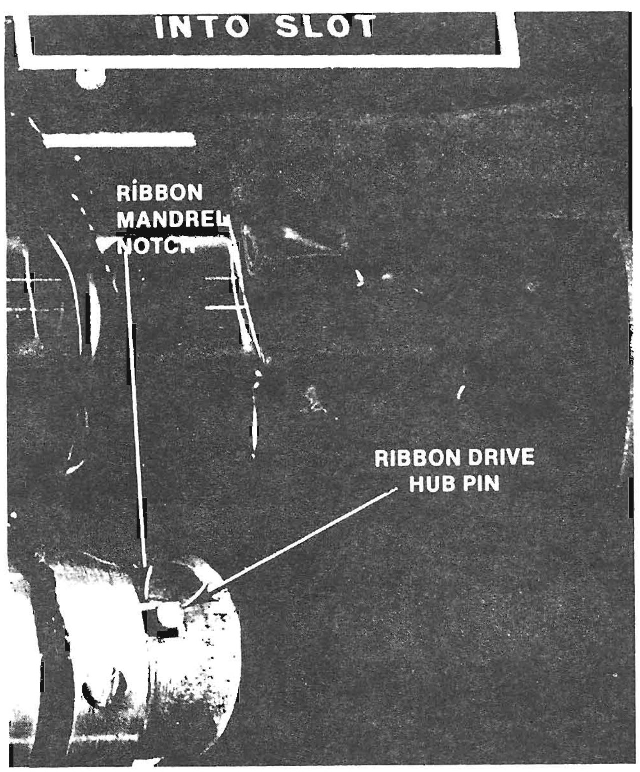


Figure 15. Ribbon Drive Hub and Notched Ribbon Mandrel End

mandrel engaged with the pin on the rim of the drive hub (see Figure 15).

6. Wind the ribbon over the chaintrain as shown in Figure 14, taking care that the left edge of the ribbon is threaded into the slots of both the lower and upper ribbon sensors.
7. Place the right-hand end of the "empty" mandrel onto the upper right spring-loaded idler hub, push the mandrel to the right, and place the left end of the mandrel onto the upper left drive hub with one of the notches in the end of the mandrel engaged with the pin on the rim of the drive hub. (Note - Ribbon should wind onto the top side of the upper mandrel.)
8. Manually turn the upper ribbon mandrel to take up any slack in the ribbon from in front of the chaintrain, and to ensure that the "Ribbon End" holes are located between the upper mandrel and the upper ribbon sensor. Close the ribbon cover.
9. Close and latch the printer yoke. Check for proper settings of the IMPRESSION and PHASING controls. Generally, when a fresh ribbon is installed, the IMPRESSION control should be initially set for light print density (refer to "Print Quality Adjustments" for details). Close the canopy.
10. When printing begins, check that the ribbon is feeding properly.

Generally, fully used or worn ribbons should be discarded and replaced with freshly inked ribbons. However, in some applications when the majority of printout utilizes only one half of the ribbon on either the left or right side, the useful life of a ribbon can be prolonged simply be re-installing the ribbon with the ribbon and ribbon mandrels turned end-for-end, so that the unused half can be utilized, providing the ribbon is not excessively worn and the left side, as installed, does not have a ragged edge. A ragged left edge, or holes in the ribbon, might result in improper ribbon reversing and tracking, and might cause the ribbon to foul in the print mechanism.

RIBBON SENSOR CLEANING

For best results, both the upper and lower ribbon sensors (see Figure 14) should be cleaned on a routine basis, preferably with each ribbon change while ribbon is removed. During printing, small particles of ink and paper tend to accumulate on the ribbon sensing devices. When this accumulation obscures the sensors, the ribbon tracking and/or ribbon reversing functions of the printer will be impaired.

The ribbon sensors can be cleaned either with a soft, lint-free cloth or with the impregnated handcleaning cloth supplied with each DPC ribbon. To clean a ribbon sensor, fold the cloth into a strip and insert a folded edge of the cloth strip into the slot of the ribbon sensor assembly. Gently pull the cloth, from back to front, through the slot to wipe the sensor. Repeat this process several times while exerting a slight downward force on the cloth strip to wipe the sensing devices on one side of the assembly, and several times while exerting a slight upward force on the cloth strip, to wipe the sensing devices on the opposite side of the same assembly.

PRINT QUALITY ADJUSTMENTS

GENERAL

The IMPRESSION and PHASING controls on the printer yoke permit operator adjustment of the over-all print density (darkness of impression) and the over-all horizontal alignment of the printed characters while the printer is operating. It is important that these controls be adjusted to suit each application to achieve the best possible results. To ensure satisfactory print quality, the operator should check these adjustments each time a new form and/or a new ribbon is installed. To ensure acceptable print quality, certain precautions should be observed, namely:

1. Use the ribbon and form(s) recommended for the application.
2. Supervise and adjust the print density as required during operation.
3. Replace the ribbon as required.
4. Clean the chaintrain as required.

When making print quality adjustments, it is important that the IMPRESSION control be adjusted first, then the PHASING control may be adjusted, as these adjustments are interactive.

PRINT DENSITY

Since the thickness of the form and ribbon, the number of parts of the form, the quality and finish of the paper, and the type and condition of the ribbon affect print quality, the IMPRESSION control should be adjusted to provide the best impression obtainable for the particular form and ribbon being used.

Generally, the IMPRESSION control should be initially set to "Light" for:

1. Thick forms in order to avoid smudging.
2. Very thin forms in order to avoid embossing.
3. Fresh ribbons in order to avoid extraneous inking.

The IMPRESSION control should be set to a position intermediate between "Light" and "Dark" for average form thicknesses and used ribbons as experience dictates. Because fresh ribbons contain more ink than used ribbons, the initial print density will be relatively heavy for a given setting of the IMPRESSION control. The more a ribbon is used, the less ink it contains and the lighter the print density becomes. Therefore, the operator should check the print density at the beginning of, and at intervals during, a print operation, and adjust the IMPRESSION control as required to maintain the best possible result. Owing to the wide variation in papers, forms, and ribbons that might be used, and because each application might result in unique ribbon usage, the operator should experiment with an adjustment schedule that provides the optimum result for a particular application.

CHARACTER PHASING

After the IMPRESSION control is adjusted, the PHASING control should be adjusted to horizontally align the printout in all print positions for full-character imprints while printing a full width character, as "M" or "W", to correct for any left or right side cutoff (see Table 2). When printing on multiple-part forms, the last, or bottom part should be checked for proper PHASING adjustment, as any cutoff will be more pronounced on the bottom part than on the top part.

CHAINTRAIN CLEANING

For best results, the chaintrain should be cleaned periodically according to the ribbon and paper(s) used, and the print quality requirements. During printing, small particles of paper and ink tend to accumulate in the counters (open spaces) between the lands (raised portion) of the type faces on the chaintrain. When this accumulation fills the open spaces, the distinctness of the printed character might be affected. Therefore, the chaintrain should be cleaned (with the ribbon removed), first with a vacuum cleaner, then with a soft wire brush and a vacuum cleaner, on a routine basis. When cleaning the chaintrain, it is recommended that a piece of paper be placed between the open yoke, and the print and paperfeed mechanisms to form a trough to catch the material brushed off of the chaintrain.

Table 2. Operator Correctable Printed Character Conditions

PRINTOUT	CONDITION	ADJUSTMENT
MMM	Dark Print, Smudging, Extraneous Inking	Decrease IMPRESSION adjustment.
MMM	Light Print, Voids	Increase IMPRESSION adjustment.
MMM	Left Cutoff	Increase PHASING adjustment for full-character imprint in all positions.
MMM	Right Cutoff	Decrease PHASING adjustment for full-character imprint in all positions.
MMM	Filled Characters	Clean chaintrain

LOCAL TEST

GENERAL

The LOCAL, or internal test, mode of operation exercises all printer functions (except the actual input and output circuitry of the printer interface with the external device) under local control, to permit operator adjustments to be performed on the printer independently of the external device. When operating in the LOCAL mode, printing is automatically performed in a repetitive print-then-feed manner, successively printing lines of a single operator-selected character in all print positions. Test printout can be either single-line or multiple-line spaced by spacing or by skipping.

TEST PANEL CONTROLS

The printer test panel contains the controls necessary to select the LOCAL, internal test mode of operation; the test print character; and the test paper advance instruction. The test panel controls are arranged as shown in Figure 16 at the outer edge of the Character Storage/ Control printed-circuit board in position 4 of the logic electronics basket, and are accessible through an opening at the lower rear of the printer.

REMOTE/LOCAL Switch

This switch selects the mode of printer operation. When in the REMOTE (toggle up) position, printer operation is controlled by the external device connected to the printer interface, and all other test panel controls are logically inhibited so as to be non-interfering while in the REMOTE mode.

When the REMOTE/LOCAL switch is in the LOCAL (toggle down) position, the printer interface with the external device is logically inhibited, and the printer is conditioned to operate automatically as designated by the remaining test panel controls. Operation of the printer in the LOCAL mode is controlled by the operator by means of the RUN and STOP pushbutton switches on the front control panel. The REMOTE/LOCAL switch should be changed to the opposite mode only when the printer is in the STOP mode; should the mode selection be changed while the printer is in the RUN mode,

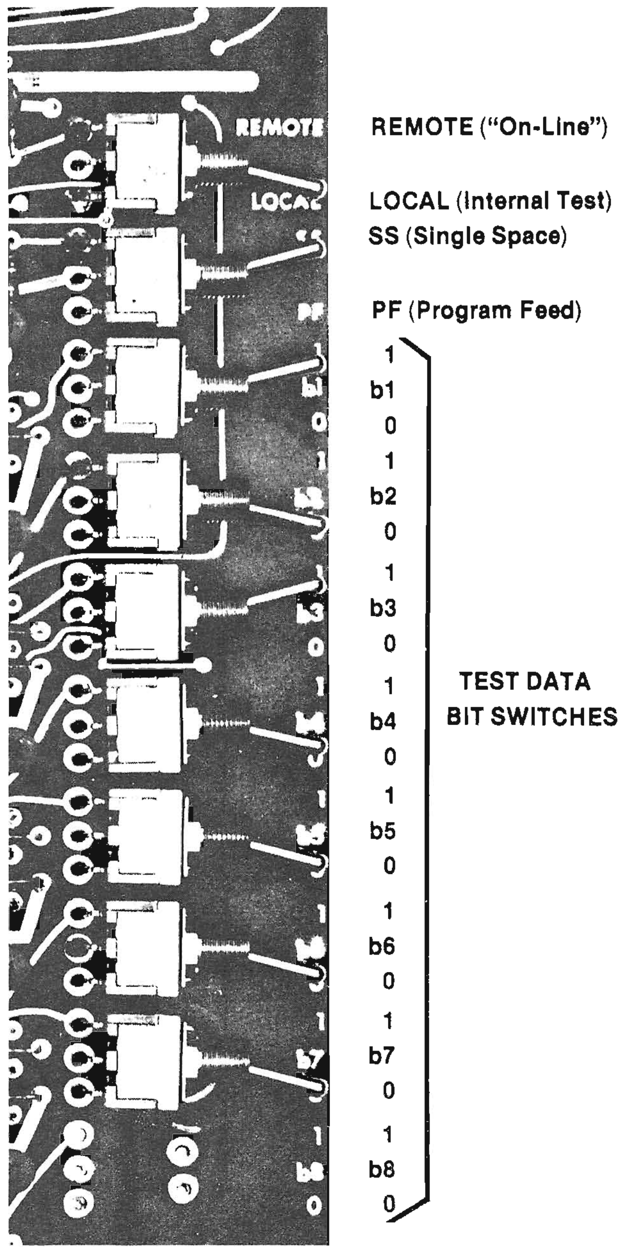


Figure 16. Test Panel Controls, Chaintrain Line Printer

operation will continue as it was prior to the switch change, until the printer is switched to the STOP mode.

SS/PF [Single Space/Program Feed] Switch

This switch is enabled only in the LOCAL mode. When in the SS position (toggle up), paper will be advanced a single (one) linespace after each print operation. When in the PF position (toggle down), paper will be advanced according to the bit pattern set by the Test Data Bit switches "b1" through "b7". (Standard paperfeed command bit-patterns are listed in Table 6 of the Appendix.)

TEST DATA BIT Switches

The test Data Bit switches are used to select a (1) bit pattern which designates the character to be printed and, if the Program Feed mode is also selected, the paper advance instruction to be executed, during operation in the LOCAL mode. The Test Data Bit switches, designated "b1" through "b7" (or optionally, "b8"), correspond to the Data Bus In bit positions on the printer interface with the external device. When a Test Data Bit switch is in the "1" position (toggle up), the corresponding input data bit will be true: conversely, when in the "0" position (toggle down), the corresponding input data bit will be false. The character printed for a given bit pattern depends upon the character sequence arrangement provided on the particular unit.

On printers equipped with the optional Input Parity Check feature, Test Data Bit switch "b8" is used to complete the parity, odd or even, of the test data character code. Incorrect parity will result in the printing of "blanks" (no printout) and, if the Program Feed mode is selected, no paper advance.

INTERNAL TEST OPERATION

The pushbutton switches and indicators on the front control panel provide operator control of the printer and visual indication of printer status (except for paper low and paper out conditions which are logically inhibited) as described in "Operator Controls" when the LOCAL, internal test mode of operation is selected. Pressing the RUN switch initiates printer operation, which will continue automatically until the STOP switch is pressed. Because Print Commands are generated internally in this mode, the chaintrain drive and ribbon drive motors are turned on immediately, and printing commences as soon as the chaintrain comes up to operating speed. Except for the REMOTE/LOCAL switch itself, all other test panel controls may be manipulated to affect printout and paperfeeding while operating in the LOCAL mode.

The character printed and the vertical formatting of test printout are determined by the combination of settings of the SS/PF switch and the Test Data Bit switches. The bit pattern to which the Test Data Bit switches are set determines the character to be printed, and when the Program Feed mode is selected, the paper advance operation to be performed after each line of print. When the Program Feed mode is selected and Test Data Bit switch "b7" is set to the "0" position, paper will be advanced the number (from none to 63) of linespaces designated in binary by the remaining Test Data Bit switches "b6" through "b1" ("b1" is least significant). However, if Test Data Bit switch "b7" is set to the "1" position, paper will be advanced under control of the tape channel (1 to 8, or optionally 12) designated in binary by Test Data Bit switches "b4" through "b1" (ls). (Note - Bit pattern 0000 will be interpreted as a Skip-to-Channel 1 command and; if equipped with an 8-Channel VFU, bit patterns 1001 through 1111, or if equipped with a 12-Channel VFU, bit patterns 1101 through 1111 will be interpreted as Skip 1-Line commands.)

Example: In Figure 16, the Test Data Bit switches are shown set to the 000 0101 bit pattern (reading left-to-right, "b7"-to-"b1"). With the standard 64-Character USASCII chaintrain arrangement, this bit pattern represents the upper-case letter "E" (print data bit b7 is ignored). When the SS/PF switch is set to SS, the printout will be of full lines of the letter "E" with the form advanced a single (one) linespace after printing each line. When the SS/PF switch is set to the PF position, the printout will also be of full lines of the letter "E" but, because "b7" is at "0", the form will be advanced under buffer control for five (5) linespaces according to the bit pattern 00 0101 on the remaining switches "b6" through "b1" after each line of print.

By changing the bit pattern to 100 0101, the printout will continue to be of full lines of the letter "E", and if the SS/PF switch is set to the SS position, paper will be advanced a single linespace after each line of print. However, when the SS/PF switch is set to PF, with Test Data Bit switch "b7" set to "1", paper will be advanced under control of format tape Channel 5 as designated by the bit pattern 0101 set on the remaining Test Data Bit switches "b4" through "b1" after each line of print.

Generally, the Single Space/Program Feed switch should be left in the SS (Single Space) position, and the Test Data Bit switches should be set to the bit pattern that represents a full-width print character, as upper-case letter "M" or "W", to facilitate operator adjustments for print quality.

APPENDIX

Table 3 shows the characters printed from USASCII input data with the standard 64- or 96-character "ASCII" chaintrain arrangements. Space (SP) is represented on these arrangements by an Open Diamond (◊), but its printing is suppressed.

Table 4 shows the characters printed from EBCDI-Coded input data with the 48-character AN, HN or LC chaintrain arrangement and appropriate code converter.

The characters provided by a particular chaintrain arrangement are shown in Table 5. All bit patterns not represented by a character on the chaintrain provided are treated as a space character.

Note - The printer Data Bus In Line and the Test Data Bit switch designations correspond to USASCII bit positions. The EBCDIC-to-USASCII bit correspondency is:

EBCDIC	USASCII	EBCDIC	USASCII
7	1	3	5
6	2	2	6
5	3	1	7*
4	4	0	8*

*Not used with 48-character arrangements.

Table 6 shows the standard Paperfeed Command Codes and Instructions for the DPC Chaintrain Line Printer.

Vertical Format Tape characteristics, and Format Tape Supplies and Accessories are listed in Tables 7 and 8, respectively.

Table 3. United States of America Standard Code for Information Interchange (USASCII), 64 and 96-Character Subsets (for Character Arrangement on Chaintrain, see Table 5)

<table>
<tr><td colspan="5">Bits</td><td>b7</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td colspan="5"></td><td>b6</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td colspan="5"></td><td>b5</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>b4</td><td>b3</td><td>b2</td><td>b1</td><td colspan="2">COL / ROW</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td colspan="2">0</td><td></td><td></td><td>SP</td><td>0</td><td>@</td><td>P</td><td>`</td><td>p</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td><td colspan="2">1</td><td></td><td></td><td>!</td><td>1</td><td>A</td><td>Q</td><td>a</td><td>q</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>0</td><td colspan="2">2</td><td></td><td></td><td>"</td><td>2</td><td>B</td><td>R</td><td>b</td><td>r</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>1</td><td colspan="2">3</td><td></td><td></td><td>#</td><td>3</td><td>C</td><td>S</td><td>c</td><td>s</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>0</td><td colspan="2">4</td><td></td><td></td><td>$</td><td>4</td><td>D</td><td>T</td><td>d</td><td>t</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>1</td><td colspan="2">5</td><td></td><td></td><td>%</td><td>5</td><td>E</td><td>U</td><td>e</td><td>u</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>0</td><td colspan="2">6</td><td></td><td></td><td>&</td><td>6</td><td>F</td><td>V</td><td>f</td><td>v</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1</td><td colspan="2">7</td><td></td><td></td><td>'</td><td>7</td><td>G</td><td>W</td><td>g</td><td>w</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td colspan="2">8</td><td></td><td></td><td>(</td><td>8</td><td>H</td><td>X</td><td>h</td><td>x</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td><td colspan="2">9</td><td></td><td></td><td>)</td><td>9</td><td>I</td><td>Y</td><td>i</td><td>y</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>0</td><td colspan="2">10</td><td></td><td></td><td>*</td><td>:</td><td>J</td><td>Z</td><td>j</td><td>z</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>1</td><td colspan="2">11</td><td></td><td></td><td>+</td><td>;</td><td>K</td><td>[</td><td>k</td><td>{</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>0</td><td colspan="2">12</td><td></td><td></td><td>,</td><td><</td><td>L</td><td>\</td><td>l</td><td>|</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1</td><td colspan="2">13</td><td></td><td></td><td>—</td><td>=</td><td>M</td><td>]</td><td>m</td><td>}</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>0</td><td colspan="2">14</td><td></td><td></td><td>.</td><td>></td><td>N</td><td>^</td><td>n</td><td>~</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>1</td><td colspan="2">15</td><td></td><td></td><td>/</td><td>?</td><td>O</td><td>_</td><td>o</td><td>|||</td></tr>
</table>

64-Character Subset

96-Character Subset

Graphics enclosed in heavy outlines correspond to the indicated subset.

Only bits b6 through b1 (Octal 00 through 77) are significant with the standard 64-Character chaintrain arrangement.

Only codes 2/0 through 7/15 (Octal 040 through 177) are significant with the standard 96-Character chaintrain. Control codes 0/0 through 1/15 (Octal 000 through 037) are treated as SPace, and DELete, 7/15 (Octal 177) is treated as a printable character (|||).

Table 4. **Extended Binary Coded Decimal Interchange Code (EBCDIC), 48-Character Sets, Arrangements AN, HN and LC (IBM) (for Characters on Chaintrain, see Table 5)**

Bits				b0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
				b1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
				b2	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
				b3	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
b4	b5	b6	b7	COL / ROW	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	0	0	0	0					SP	&	–									0
0	0	0	1	1							/		a	j			A	J		1
0	0	1	0	2									b	k	s		B	K	S	2
0	0	1	1	3									c	l	t		C	L	T	3
0	1	0	0	4									d	m	u		D	M	U	4
0	1	0	1	5									e	n	v		E	N	V	5
0	1	1	0	6									f	o	w		F	O	W	6
0	1	1	1	7									g	p	x		G	P	X	7
1	0	0	0	8									h	q	y		H	Q	Y	8
1	0	0	1	9									i	r	z		I	R	Z	9
1	0	1	0	A																
1	0	1	1	B					.	$	,	#								
1	1	0	0	C					⌑	*	%	@								
1	1	0	1	D					(	)		'								
1	1	1	0	E					+			=								
1	1	1	1	F																

Graphics enclosed in heavy outlines correspond to bit patterns common to AN, HN and LC arrangements.

Lower-case letters print as corresponding upper-case letters when a lower-case letter bit pattern is accepted by a Chaintrain Line Printer system with a 48-Character EBCDIC arrangement.

The graphics ⌑ % @ # of the AN arrangement are dualed with the graphics) (' = respectively of the HN arrangement.

Table 5. DPC Chaintrain Arrangements (Printout Representation)

USASCII Arrangements

Standard 64-Character Subset (Consists of 6 identical arrays of 8 links each; 1 array shown)

@ A B C D E F G	H I J K L M N O	P Q R S T U V W	X Y Z [\ ] ^ _	◊ ! " # $ % & '	( ) * + , − . /	0 1 2 3 4 5 6 7	8 9 : ; < = > ?

Standard 96-Character Subset (Consists of 4 identical arrays of 12 links each; 1 array shown)

<table>
<tr><td>◊ ! " # $ % & '</td><td>( ) * + , − . /</td><td>0 1 2 3 4 5 6 7</td><td>8 9 : ; < = > ?</td><td>@ A B C D E F G</td><td>H I J K L M N O</td></tr>
<tr><td>P Q R S T U V W</td><td>X Y Z [\ ] ^ _</td><td>` a b c d e f g</td><td>h i j k l m n o</td><td>p q r s t u v w</td><td>x y z { | } ~ |||</td></tr>
</table>

EBCDIC Arrangements

AN (48 characters. Consists of 8 identical arrays of 6 links each; 1 array shown)

0 1 2 3 4 5 6 7	8 9 * + , − . /	& A B C D E F G	H I J K L M N O	P Q R S T U V W	X Y Z $ @ # % ¤

HN (48 characters. Consists of 8 identical arrays of 6 links each; 1 array shown)

0 1 2 3 4 5 6 7	8 9 * + , − . /	& A B C D E F G	H I J K L M N O	P Q R S T U V W	X Y Z $ ' = ( )

LC (48 characters. Consists of 8 identical arrays of 6 links each; 1 array shown)

0 1 2 3 4 5 6 7	8 9 * + , − . /	& A B C D E F G	H I J K L M N O	P Q R S T U V W	X Y Z $ @ # % '

(Note - Layouts are neither scaled, nor do the fonts used represent the type style available.)

Table 6. Standard Paperfeed Command Codes For Systems With 8- Or 12-Channel Vertical Format Unit

Octal	Bit Pattern							Paperfeed Function	
	Bit Pos. b7	b6	b5	b4	b3	b2	b1		
000	0	0	0	0	0	0	0	No Paper Advance [Overprint]	
001	0	0	0	0	0	0	1	Space 1 Line	
. . .				. Thru .				. Thru .	
077	0	1	1	1	1	1	1	Space 63 Lines	
100, 120, 140, 160	1	X	X	0	0	0	0	Skip to Channel 1	
101	1	X	X	0	0	0	1	Skip to Channel 1	
102	1	X	X	0	0	1	0	Skip to Channel 2	
103	1	X	X	0	0	1	1	Skip to Channel 3	
104	1	X	X	0	1	0	0	Skip to Channel 4	
105	1	X	X	0	1	0	1	Skip to Channel 5	
106	1	X	X	0	1	1	0	Skip to Channel 6	
107	1	X	X	0	1	1	1	Skip to Channel 7	
110, 130, 150, 170	1	X	X	1	0	0	0	Skip to Channel 8	
								8-Channel VFU:	12-Channel VFU:
111	1	X	X	1	0	0	1	Space 1 Line	Skip to Channel 9
112	1	X	X	1	0	1	0	Space 1 Line	Skip to Channel 10
113	1	X	X	1	0	1	1	Space 1 Line	Skip to Channel 11
114	1	X	X	1	1	0	0	Space 1 Line	Skip to Channel 12
								8- or 12-Channel VFU:	
115	1	X	X	1	1	0	1	Space 1 Line	
116	1	X	X	1	1	1	0	Space 1 Line	
117	1	X	X	1	1	1	1	Space 1 Line	

Note: X denotes bit may be "1" or "0"; state does not affect function

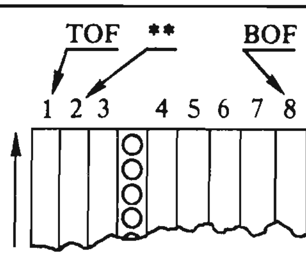
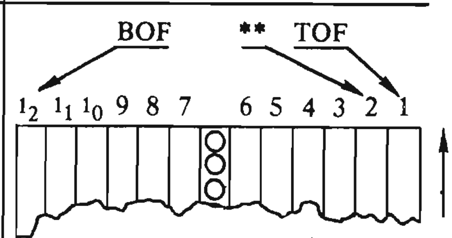
Table 7. Format Tape Characteristics and Channel Designations

A. FORMAT TAPE CHARACTERISTICS:

VFU Channels:	8 (Standard)	12 (Optional)	
Linespacing:	6 LPI	6 LPI	8 LPI
Tape Width:	1.00 in. (2,54 cm)	1.625 in. (4,127 cm)	
Feed Hole Pitch:	0.100 in. (2,54 mm)	0.167 in. (4,24 mm)	
Feed Hole Diameter:	0.046 in. (1,168 mm)	0.103 in. (2,616 mm)	
Punched Hole Pitch:	0.100 in. (2,54 mm)	0.167 in. (4,24 mm)	0.125 in. (3,18 mm)
Punched Hole Size: Diameter (preferred):	0.072 in. (1,829 mm)	0.070 in. (1,778 mm)	0.070 in. (1,778 mm)
Rectangular (Alternate):		0.070 by 0.094 in. (1,778 by 2,388 mm)	(*)

NOTE: * Corresponding hole size listed for 6 LPI may be used provided that punching is limited to alternate positions within a channel.

B. FORMAT TAPE CHANNEL DESIGNATIONS:

VFU Channels:	8 (Standard)	12 (Optional)
Channel Assignments: Numeric Designation: (Tape Travel in Direction Shown by Arrows)		

NOTES: ** VFU Channel provided for "Special Function" for use with VFU output Drivers.

- Except for TOF and BOF, all VFU channels are assigned as may be required by the user.

Table 8. Format Tape Supplies and Accessories

DPC PART	DESCRIPTION	MANUFACTURER & CATALOG NO.	
Ribbon:			
D17500-4	5-mil nylon ribbon 14 inches (35,6 cm) 10 yards (9,14 m) long Black record medium ink		
Format Tape:			
A 4524	1 inch (2,54 cm) wide 10-foot (3,04 m) rolls perforated tape (8-chan)		
A 4568	12-Channel Format Tape 24.95 inch (63,3 cm) long 25 Lengths (Std package)	IBM Corp. MDS Corp.	P/N 429754 P/N 018772302 (Box of 25)
Adhesive:			
A 4569	Rubber-based Contact cement; 3-oz. (88,5 cc) Can (w/applicator)		
Punches:			
*A 4523	8-Channel, 6-LPI Format Tape Punch	Burroughs Corp. OEM Product Sales Los Angeles, CA	Model 453 P/N 16226979
*A 4566	12-Channel, 6-LPI Format Tape Punch	IBM Corp. Armonk, NY	P/N 120910
*A 4567	12-Channel, 6 & 8-LPI Format Tape Punch	Mohawk Data Sciences Corp. Herkimer, NY	P/N 015238401 (See Note **)

NOTES: * DPC Part Number is for identification purposes only; for best delivery, format tape punches should be ordered directly from the manufacturer, using the manufacturer's catalog or part number.
** Formerly MDS Part No. 52384-G1.

Page numbers enclosed in brackets [ ] designate tables and illustrations

R

S

T

U

V

W

Y

Data Printer Corp

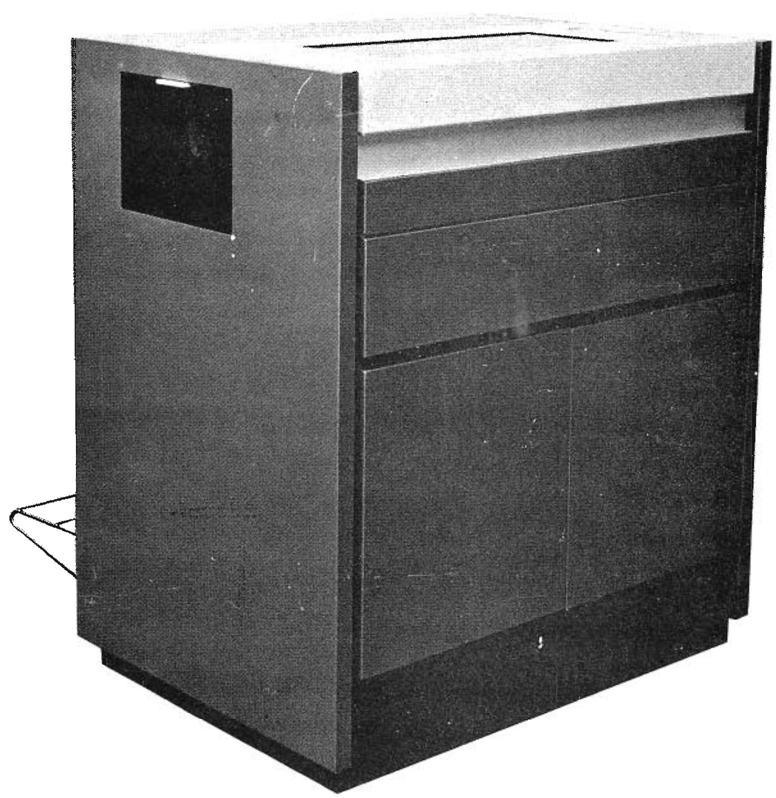
600 MEMORIAL DRIVE
CAMBRIDGE, MASS. 02139

PRINCIPLES OF OPERATION

ChainTrain™

LINE PRINTER

MODELS CT-4964, CT-6644, CT-7484



Data Printer Corp

600 MEMORIAL DRIVE
CAMBRIDGE, MASS. 02139

DPC FORM 600-2

PREFACE

This reference manual is one of four publications that describe the Model CT-4964, CT-6644 and CT-7484 CHAINTRAIN™ Line Printers manufactured by Data Printer Corp, Cambridge, Massachusetts. This manual contains the mechanical and electrical principles of operation of the line printer and provides general information concerning its characteristics, print character sets, options and operating supplies.

The theory of operation described for the CT-6644 and related model DPC Line Printers is also applicable to the CT-6643 and related model DPC Line Printers.

This manual is intended as a training aid and as a reference document. It is intended that the theory of operation descriptions be used in conjunction with the *Parts Breakdown & Circuit Diagrams* manual listed below. Each description of the electrical theory of operation includes a simplified block diagram which is referenced to the appropriate Circuit Diagram(s).

As a convenience to the user, information concerning the functions of the front panel controls, test panel controls, and mechanism controls and operator adjustments is contained in a separate manual; *Operating Instructions* listed below.

For operating instructions, installation and maintenance procedures, and reference diagrams, refer to the appropriate DPC manual listed below:

Operating Instructions; DPC Form No. 600-1

Maintenance; DPC Form No. 600-3

Parts Breakdown & Circuit Diagrams; DPC Form No. 600-4

Customer specified reproducible copies of this manual are available from Data Printer Corp.

Orders for copies of DPC manuals should be directed to your DPC representative or to the address indicated below.

A form for reader's comments is provided at the back of this manual. If the form has been removed, comments may be sent to DPC at the address indicated below. Comments become the property of DPC.

DATA PRINTER CORP

600 Memorial Drive, Cambridge, MA 02139

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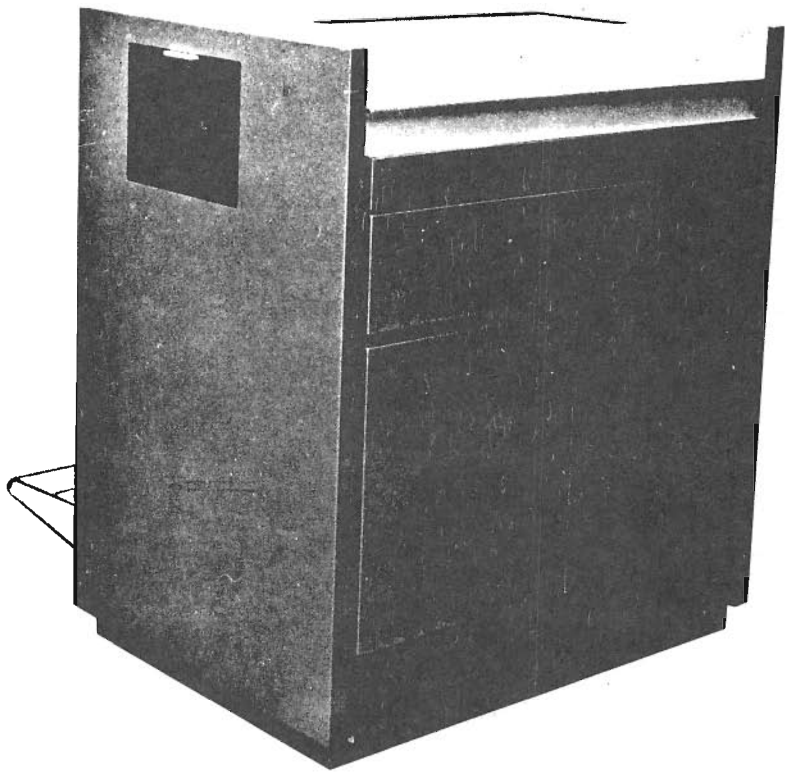

Figure 1-1. DPC Chaintrain™ Line Printer

CHAPTER I

GENERAL INFORMATION

1.1 INTRODUCTION

This chapter contains a general description of the Data Printer Corp CHAINTRAIN™ Line Printer (hereinafter referred to as CT Line Printer). Specifications for the standard printer and associated operating supplies are provided, as are optional printer features and configurations.

The information provided pertains to the complete CT Line Printer system in particular, and to the printer mechanism, electronics, and power supply sub-systems as appropriate. Specific information concerning these printer sub-systems for use as components in other printing systems is available from Data Printer Corp.

1.2 GENERAL DESCRIPTION

The CT Line Printer (Figure 1-1) is a complete computer-driven impact printer featuring a lateral chaintrain type carrier. The printer produces hardcopy output a line at a time from stored digital data, accepted in the form of print character codes and linefeed instructions from an external device. Printout is recorded in fully-formed character imprints on standard single-part or multiple-part continuous, sprocket-fed forms.

Storage is provided for a full line of print data, permitting this data to be transferred in a single operation for a line of print at a rate considerably greater than the equivalent printout rate. The external device, being interlocked with the printer only during data transfer, is free to perform other operations while the printer is busy printing a line from its storage, thereby increasing overall system performance.

The printer interface is fully compatible with the universal DPC-S1003 interface provided on all standard model DPC line printers. This universal bit-parallel, character-serial TTL interface allows the CT Line Printer to be readily attached to an external device.

Printing is accomplished by electromagnetically-operated print hammers impacting the form from behind, pushing a small area of the form against a ribbon and a type carrier that are located in front of the form. The chaintrain type carrier is composed of 384 fully-formed character type faces arranged on 48, 8-character links that are mounted end-to-end on a moving, endless double-belt and are restrained on a monorail track. This arrangement permits all of the character type faces to be presented repeatedly to every print hammer as the chaintrain travels laterally, and assures proper alignment of the characters. The lateral arrangement of the type carrier eliminates the possibility of character imprints being displaced in the vertical direction.

A CT Line Printer's rated print speed (see paragraph 1.3.2, Performance Specifications) is based on the number of single-spaced lines that can be printed per minute (LPM). The actual print speed also depends upon the character set provided and the time required for transferring data and advancing paper. Character sets having a large number of different characters can be repeated on a chaintrain less often and, therefore, are presented for printing less frequently than character sets having a small number of characters.

The basic character arrangements for the CT Line Printer are the standard 64-Character (upper case) and 96-Character (upper and lower case) Subsets described in the "United States of America Standard Code for Information Interchange" (ASCII), X3.4, 1968. With either arrangement, each print position (column) can print any of the different characters provided.

A CT Line Printer can be provided with up to 136 (132 is standard) active print positions (columns). An individual print hammer is provided for each active print position. Print hammers are uniformly spaced ten (10) to the inch (2,54 cm). In normal operation, print speed is independent of the number of active positions.

Forms are advanced through the printer by two sprocket-feed tractors that are driven by a stepping motor which provides accurate, maintenance-free paper positioning. The tractors are operator-adjustable to accommodate forms of various widths from 3-1/2 inches (8,89 cm) to 19-1/2 inches (49,48 cm) overall, and to permit the print location on the forms to be positioned laterally (see Figure 2-1). Vertical form positioning is operator-adjustable over an infinite range. Standard vertical linespacing is six lines per inch. Operator-selectable vertical linespacing of six or eight lines per inch can be provided as an option.

Vertical linespacing and skipping are initiated under independent program control, permitting either a feed-before-print or a feed-after-print sequence of operations. Automatic single or double-space post-print linefeed and perforation step-over functions are program-selectable. A single linespace requires 20 milliseconds; skipping (slewing) and multiple-line spacing is performed at a minimum rate of 20 inches (50,8 cm) per second.

Vertical skipping is controlled either by the printer's buffer (Skip 0 to 63 lines) or by a format tape-loop (Skip to Channel) as designated by instruction codes accepted from the external device. Eight vertical format channels are standard: twelve channels can be provided as an option. The standard eight-channel unit reads 1-inch (2,54 cm) wide, ANSI X3.18 compatible perforated tape. The optional twelve-channel unit reads 1-5/8-inch (4,13 cm) wide, IBM compatible carriage-control tape.

Ribbon feeding, reversing, and tracking are completely automatic. Full-line wide towel-form ribbon is skew-fed, distributing use and compensating for any lateral motion imparted by the moving chaintrain while printing, to maximize ribbon life.

The CT Line Printer is complete with all necessary operator controls and indicators, intimate printer drive and control electronics, print storage, interface, d-c power supply and automatic power sequencer, and an alarm indicator panel. The complete line printer is mounted in a single, free-standing sound deadening steel cabinet. The cabinet fully-encloses the printer mechanism, electronics, power supply, and paper supply compartment. A hinged, balanced canopy manually opens for access to the print area, printer yoke, printer mechanism controls and adjustments, and the alarm indicator panel. A window in the canopy permits viewing of the printout appearing above the print area when the canopy is in the normal closed position. The vertical format unit, linespace selector switch (optional), and forms positioning control are arranged in a protective well at the upper left side of the printer. A sliding panel manually opens for access to the vertical format unit area. The printer yoke, which contains the chaintrain and ribbon mechanisms, is hinged at both ends for maximum stability. The printer yoke manually opens and swings down for full access to the print area for forms loading and ribbon replacement. Two removable hinged doors at the lower front of the cabinet provide access to the enclosed paper supply compartment directly below the printer yoke. A detachable paper shelf is provided for use at the rear of the cabinet to receive printout from the printer. The cabinet covers are designed to provide maximum safety and to significantly enhance the visual and aural environment of the printer system. All panels are easily removed to provide full access to the printer mechanism, electronics and power supply for maintenance purposes.

The complete CT Line Printer includes a test panel which exercises all standard printer functions, permitting maintenance to be performed on the printer independently of the external device. Access to the test panel is gained through an opening at the lower rear of the printer cabinet.

1.3 SPECIFICATIONS

This section summarizes the characteristics of the standard CT Line Printer and pertinent specifications for the printer system performance, signal interface, primary power, physical aspects, and environment.

1.3.1 Characteristics (Standard Printer)

Print Positions (Columns):	132
Print Characters:	64 (mdl CT-6644) or 96 (mdl CT-4964)
Character Spacing:	10 per Inch (2,54 cm)
Vertical Line Spacing:	6 per Inch (2,54 cm)
Vertical Format Unit:	8 Channels
Character Set and Coding:	USASCII (ANSI X3.4, 1968)
Type Carrier:	Chaintrain
Printing Method:	Back-printing Impact

Refer to paragraph 1.5, Options, for information concerning other available line lengths, character sets, linespacing, vertical format unit, and coded character sets. For further information concerning character sets and coding, refer to paragraph 1.6, Chaintrain Arrangements.

1.3.2 Performance Specifications

Rated Printing Speed:	
with 64-Character Set:	600 Lines per Minute
with 96-Character Set:	430 Lines per Minute
Paper Advance Time:	20 Milliseconds per Line
Paper Skipping Rate:	20 Inches (50,8 cm) per Second

NOTE

Rated printing speed is based on the number of single-spaced lines that can be printed per minute with a particular character set, as indicated. For further information, refer to paragraph 4.2.1.1, Print Hammer to Chain Relationship, and paragraph 4.3.5.9, Thru-put.

1.3.3 Signal Interface (Standard Configuration)

This section summarizes the salient features of the standard interface. For a complete description, refer to paragraph 4.3, Printer Interface.

Print Data Codes:	
with 64-Character Set:	6 Parallel Bits (ACSII b6 thru b1)
with 96-Character Set:	7 Parallel Bits (ASCII b7 thru b1)
Paperfeed Instructions:	7 Parallel Bits (DPC Std S1003) Skip None to 63 Line Spaces Skip to Channel 1 to 8
Commands:	Print Paperfeed (Immediate) Automatic Single or Double Space after Print Automatic BOF to TOF Paper Skip (Perforation Stepover)
Data Transfer Rate:	Up to 500-K Externally-strobed Characters per Second (2.0 uSec per Character)
Signal Levels:	
Input Signals:	
Logic "1" (True):	+2.0 V min; +5.5 V max. (+3.3 V Typical)
Logic "0" (False):	+0.8 V
Output Signals:	
Logic "1" (True):	+2.4 min.; +5.5 V max. (+3.3 V Typical)
Logic "0" (False):	+0.4 V
Input Line Termination:	180 Ohms to Vcc 220 Ohms to Signal Ground
Signal Line Length:	Up to 50 Feet (15,2 m) Twisted-pair; Terminated

1.3.4 Primary (Mains) Power Specifications

The CT Line Printer is provided with a universal power supply that can be strapped to permit operation with any combination of a line voltage and line frequency listed below. For field conversion details, refer to the *Maintenance* manual.

Primary Voltage:	100, 115, 200 or 230 VAC ± 10%, Single-Phase	
Line Frequency:	50 ±1 Hz or 60 ±1 Hz	
Primary Current:	At 100/115 VAC	At 200/230 VAC
Avg. Running:	6.0 A RMS	3.0 A RMS
Starting Surge:	*15.0 A RMS	*10.0 A RMS
Dissipation:	2700 BTU per Hour	

*For 0.15 to 0.20 second, typical.

1.3.5 Physical Specifications: (See Figure 1-2)

Height:	42 Inches (106,7 cm)
Width:	36-1/2 Inches (92,7 cm)
Depth:	
Printer Cabinet:	26 Inches (66 cm)
With Hood:	32 Inches (81,3 cm)
With Paper Shelf:	39 Inches (99 cm)
Weight:	570 Pounds (258,5 kg)

1.3.6 Environment Specifications

Operating Environment:	
Temperature Range:	40°F to 95°F (4,4°C to 35°C)
Humidity Range:	40% to 80% RH
Non-Operating Environment:	
Temperature Range:	-25°F to +125°F (-31,6°C to +51,6°C)
Humidity Range:	5% to 95% RH Non-condensing
Temperature Change Rate:	60°F (33,3°C) per Hour max.

1.4 OPERATOR CONTROLS, INDICATORS, AND ADJUSTMENTS

All controls, indicators and adjustments necessary for normal operation of the CT Line Printer are conveniently located in the upper portion of the printer and are arranged, in-so-far-as mechanically possible, in function-related groupings that are readily accessible to the operator. The following paragraphs contain a brief description of each control, indicator and adjustment. For further details concerning function and operation, refer to the *Operating Instructions* manual.

1.4.1 Operator Control Panel

The switches and indicators on the front control panel provide operator control of the printer during set-up, internal test (off-line), and print run interruptions that require the attention of the operator.

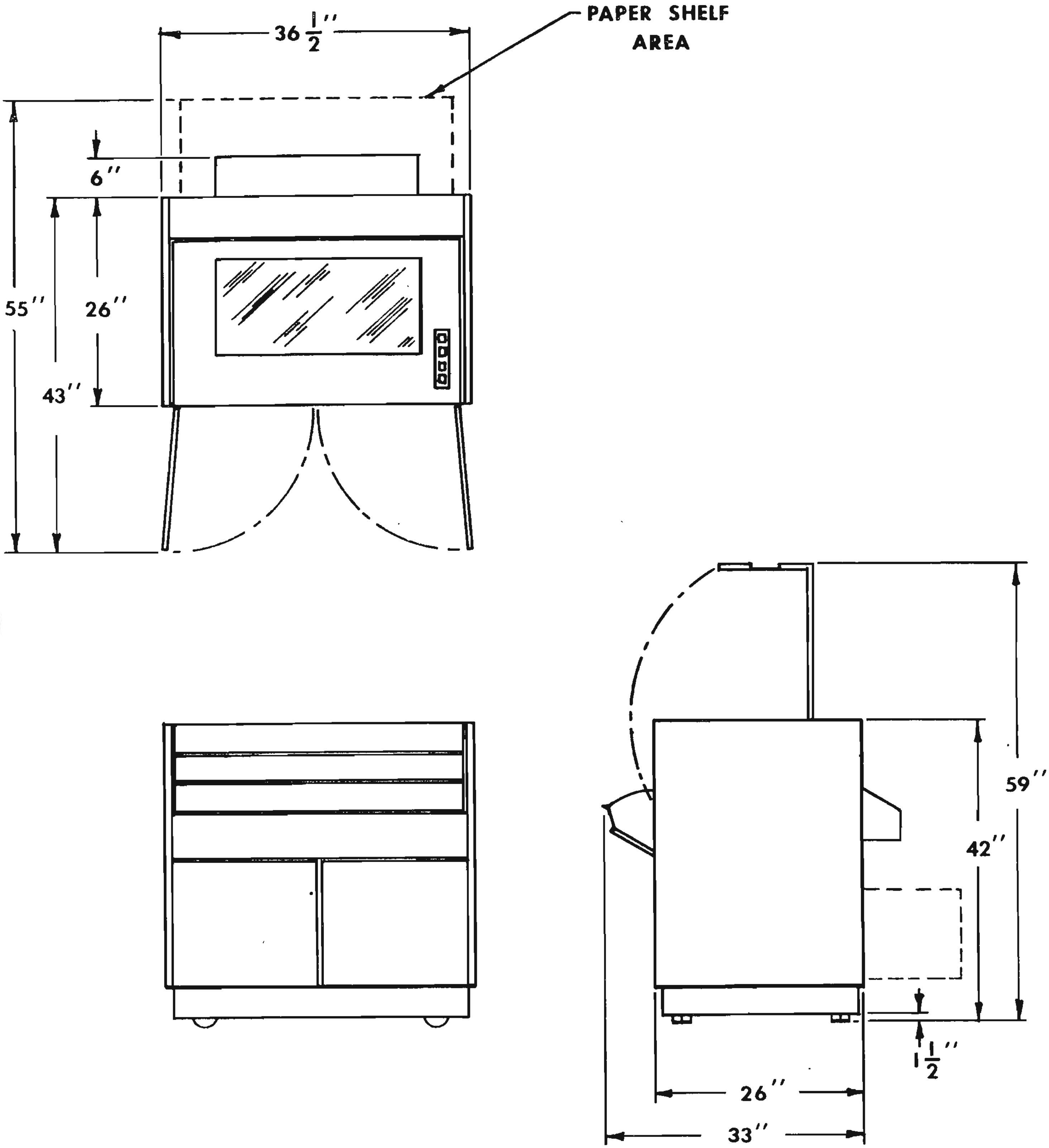

Fig. 1-2. Outlines, DPC Chaintrain Line Printer,
Models CT-4964, CT-6644, CT-7484

The switches and indicators provided on the front control panel are:

1. Power ON – Turns ON power in the printer.
2. Power OFF – Turns OFF power in the printer.
3. ALARM Indicator – Indicates that an alarm condition exists at the printer.
4. RUN Indicating Switch – Enables printer operation.
5. STOP Indicating Switch – Stops printer operation.
6. ONE LINE Switch – Advances paper a single linespace.
7. HOME Switch – Advances paper to the next Top-of-Form position.

Operation of both the ONE LINE and HOME switches causes paper in the printer to be advanced in a continuous, slewing manner.

1.4.2 Alarm Status Indicator Panel[1]

The CT Line Printer is provided with an alarm status indicator panel which displays each of the alarms listed below to facilitate operator procedures. The alarm status indicator panel is concealed when the canopy is in the normal, closed position.

The alarm status indicators provided on the alarm status panel are:

1. Yoke/Yoke Latch – Indicates when the yoke and/or yoke latch are/is not closed.
2. Paper Low – Indicates when less than 5-1/2 inches (14 cm) of paper supply remains below the typeline.
3. Paper Out – Indicates when a Top-of-Form position is sensed while a paper low condition exists at the printer.
4. Paper Runaway – Indicates whenever paper in the printer is continuously slewed for several form lengths.
5. Paper Jam – Indicates whenever paper is sensed not to be moving through the print area during a paper advance operation.
6. Ribbon Alarm – Indicates whenever ribbon is sensed to be out of both the upper and lower ribbon sensors.
7. P.C. Interlock – Indicates whenever a Hammer Driver PCB is not fully seated in its respective position in the printer electronics bay.

1.4.3 Mechanism Controls and Adjustments

The printer mechanism controls and adjustments are arranged in association with the devices they control. In normal operation with the canopy closed, these controls and adjustments are protected against inadvertent operation.

The controls and adjustments provided on the printer mechanism are:

1. Infinite Forms Position Control – permits adjustment of the vertical position of forms independently of the vertical format unit while the printer is not operating (i.e.; in the STOP mode).
2. Tractor Locking Levers – permit the paper tractors to be independently positioned to accommodate forms of different widths.
3. Yoke Latch Lever – Latches the yoke in the closed position for printing.
4. PHASING Control – Advances or retards the print hammer timing with respect to the position of the characters on the moving chaintrain to provide control of the lateral position of character imprints.
5. IMPRESSION Control – Positions the chaintrain closer to or farther from the print hammers to provide control of the print impressions (density) with forms and ribbons of different thicknesses and characteristics.

1.4.4 Test Panel Controls

The controls listed below are arranged on a test panel which is accessible through an opening at the rear of the printer cabinet. These controls select the mode of printer operation and provide for control of the printer while operating in the LOCAL (off-line) test mode.

---

(1) Available on CT-6644 and related model CT Line Printers only.

The controls provided on the test panel are:

1. REMOTE/LOCAL Switch – Selects the mode of printer operation.
2. SS/PF (Single Space/Program Feed) Switch – Selects the mode of paper advance while operating in the LOCAL mode.
3. Data Bit Switches – Used to select the bit pattern of the desired test paperfeed instruction and/or test print character.

1.4.5 Main Circuit Breaker

A circuit breaker, which disconnects primary power to the line printer, is provided to protect the unit and to permit the operator to enable or disable primary power. The circuit breaker is accessible through an opening at the lower rear of the printer cabinet.

1.5 OPTIONS

The optional features available for the CT Line Printer provide a wide variety of characteristics that may be selected to best suit a given application. Options should be specified for a printer at the time of order for factory installation, but may be ordered separately for field installation.

The CT Line Printer options are summarized below and described in the paragraphs that follow.

DPC CT Line Printer Options

Print Positions (Columns):	136
Print Characters:	48 (mdl CT-7484), 128 (mdl CT-31284)[2]
Vertical Line Spacing:	6/8 Lines per Inch (2,54 cm); for units with 12-channel VFU's Operator-Selectable
Vertical Format Unit:	12 Channels
Character Set and Code:	Special per customer requirement
Signal Interface:	First-Character Configuration Odd or Even Input Parity Check Extended Interfacing
Other:	Static Eliminator Paper Puller Special Color(s) Pedestal Configuration

1.5.1 136 Print Positions

This option provides four additional print positions (columns) for a total of 136. The additional print positions are provided at the right end of the standard hammer bank so that the left-most position, No. 1, is located as shown in Figure 2-1 for the standard 132 print positions. This arrangement permits print position No. 1 to be located at the left side of the body (excluding the 1/2-inch [12,7 mm] margins) of forms up to 16.85 inches (42,8 cm) wide overall, regardless of the number of active print positions provided.

1.5.2 Print Character Sets

A CT Line Printer can be provided with a set of 48, 64, 96, or 128 different print characters, either in an available arrangement (see paragraph 1.6, Chaintrain Arrangements) or in a special arrangement (see paragraph 1.5.5, Special Character and Code Sets). The rated printing speed of a CT printer is, for the most part, dependent upon the repeatability of the character set provided, as follows:

(2) Different machine configurations (i.e. models).

Character Set (No. of Characters)	Rated Printing Speed (Lines per Minute)
48	760
64	600
96	430
128	330

1.5.3 6/8 LPI Vertical Line Spacing

This option provides operator-selectable vertical linespacing of six or eight lines per inch (2,54 cm), and is normally provided in conjunction with the optional 12-channel VFU (refer to paragraph 1.5.4, below).

The format tape specified for use with the optional 12-channel VFU readily accommodates the closer punch-hole pitch (spacing) required for eight lines-per-inch linespacing. However, because of the dimensional requirements on the format tape, when eight lines-per-inch spacing is required with rectangular punched holes, the format program should be contrived to avoid punching in successive positions within a tape channel to ensure normal tape life. (For format tape preparation details, refer to the *Operating Instructions* manual.)

1.5.4 12-Channel Vertical Format Unit

This option provides a 12-channel vertical format unit instead of the standard 8-channel VFU. This optional VFU is designed to accommodate 1-5/8-inch (4,127 cm) wide IBM-compatible format tape (DPC Part No. A 4568). With this option, vertical format Channel 12 is reserved for Bottom-of-Form (BOF). (VF Channel is reserved for BOF on the standard 8-channel VFU.)

1.5.5 Special Character and Code Sets

Special print character designs, arrangements (sequences), and/or codes can be provided, subject to DPC approval, in lieu of the standard character designs and basic chaintrain arrangements and coding. For details, see paragraph 1.6, Chaintrain Arrangements.

1.5.6 First-Character Interface

This option provides a first-character interface configuration in place of the standard interface configuration. With this option, the printer will accept the first character transferred for a line of print as the post-print paperfeed instruction for that line. All data for a line of print is transferred with a single Print Command: Paperfeed Command, Automatic Linefeed, and Automatic BOF-to-TOF Paper Skip are not used in this interface configuration. For a complete description, refer to paragraph 4.3, Printer Interface.

1.5.7 Input Parity Check

This option adds input character parity checking capability to the standard interface. With this option, all input data (paperfeed instruction characters and print data codes) are checked for proper character parity, either odd or even as specified at the time of order.

1.5.8 Automatic Linefeed Disabling

The standard interface is normally provided with automatic post-print single or double-space linefeed and BOF-to-TOF paper skip functions that may be enabled at the printer interface under program control. Depending upon customer requirements, these automatic linefeed functions can be disabled on the printer side of the interface at the time of manufacture.

1.5.9 Special Colors

The CT Line Printer is normally provided in standard DPC beige and gray colors. Units can be provided in special color paint(s) subject to DPC approval.

1.5.10 Paper Puller

This option provides a paper puller on the upper rear panel at the printout outlet opening. The paper puller assists the movement of forms above the print area.

1.5.11 Static Eliminator

Under conditions of low humidity, an electrostatic charge might accumulate on the paper and interfere with normal paper handling. This option provides a high-voltage air-ionizing type static bar to neutralize this static charge as paper is fed through the printer.

1.5.12 Extended Interfacing

The standard CT Line Printer is capable of accommodating additional custom-designed front-end interfacing electronics. Spare positions are available in the logic electronics basket for two DPC-type mono or dual printed-circuit boards, or equivalent, and associated 44-position dual edge connectors. D-c power, sufficient for a normal complement of standard TTL integrated-circuits (7400 Series), at ±15, +6.5, and -15 volts is available for custom connection to these spare positions.

Custom-designed front-end electronics must communicate with the printer by means of either the standard interface or the optional first-character interface only, and must be fully compatible with the mechanical, electrical, and functional requirements of the CT Line Printer. Specific information and conditions concerning custom-designed attachments to the printer are available from Data Printer Corp.

1.5.13 Pedestal Configuration

The printer mechanism, electronics and power supply can be provided in a compact, free-standing steel pedestal configuration. This configuration is similar to the standard cabinet configuration described in this manual except for differences in the enclosure, front control panel, and available options. Details concerning the optional pedestal configuration are available from Data Printer Corp.

1.6 CHAINTRAIN ARRANGEMENTS

This section contains information concerning print data codes and character arrangements for use on the CT Line Printer.

1.6.1 Coded Character Sets

1.6.1.1 USASCII (mdls CT-6644 and CT-4964)

The standard coded-character sets for the CT Line Printer are the 64 and 96 Character Printable Subsets defined by the "United States of America Standard Code for Information Interchange" (USASCII), X3.4, 1968. Table 1-1 shows the characters printed from USASCII data when the standard 64-character or 96-character chaintrain arrangement (character sequence) is used. The characters provided by a particular chaintrain arrangement are shown in Figure 1-3.

Table 1-1 is arranged in the USASCII convention of eight columns of 16 rows each. The graphics shown in columns 2 through 5 include the upper-case letters and are printed when the standard 64-character USASCII chaintrain arrangement is used. The graphics shown in columns 2 through 7 also include the lower-case letters and are printed when the standard 96-character USASCII chaintrain arrangement is used. Space (SP), Col. 2/Row 0, is represented on the standard chaintrain arrangements by a Diamond (◇) symbol, but its printing is logically inhibited.

1.6.1.2 EBCDIC (mdl CT-7484)

Any one of the Extended Binary Coded Decimal Interchange Code (EBCDIC) character sets shown in Table 1-2 can be provided on a 48-character CT Line Printer (mdl CT-7484).

Table 1-2 shows the characters printed from EBCDI-Coded data when the 48-Character AN, HN, or LC chaintrain arrangement and appropriate code converter are provided. The characters provided by a particular chaintrain arrangement are shown in Figure 1-3.

Table 1-2 is organized in the conventional manner with 16 columns of 16 rows each. The 4-bit patterns associated with each column and row are shown together with their identifying hexadecimal notation.

All 48 characters on the AN, HN, and LC chaintrain arrangements are printable. Space (SP), hexadecimal 40, is not represented on these arrangements but is separately detected by the printer's logic electronics to provide a blank space in the printed line for each Space code received.

The AN arrangement has four special graphics ¤% @ # where the HN arrangement has) (' =. The assigned EBCDI-Coding for the four special graphics in the AN arrangement are different from the assigned coding for the four special graphics in the HN arrangement. However, if the EBCDI-Code for %, an AN character, is received by a printer equipped with the HN chaintrain, then the dualed graphic (is printed. Conversely, if the EBCDI-Code for =, an HN character, is received by a printer equipped with the AN chaintrain, then the dualed graphic # is printed. This double coding is provided for all four sets of dualed graphics on the AN and HN chaintrain arrangements.

The entire first, second, and third quadrants of the EBCDI Code are effectively folded into the fourth quadrant automatically by the printer. Consequently, hexadecimal codes 01, 41, and 81 are recognized as Hex. C1, which prints as an upper-case letter A. This folding occurs because the bits which define the quadrants are ignored by the printer's logic electronics. This arrangement permits incoming upper-case and lower-case print data to print out using an upper-case 48-character chaintrain.

1.6.2 Chaintrain Character Sequences

The character sequences of DPC chaintrain arrangements are depicted in Figure 1-3. DPC chaintrains consist of an integral multiple of identical arrays of character links (type slugs) arranged end-to-end, with eight characters per link. The number of character links in an array, and the number of different characters provided, depend upon the particular arrangement selected. A complete chaintrain consists of 48, 8-character links (384 character positions).

In Figure 1-3, each chaintrain arrangement is depicted by a character sequence layout of one array, showing all the different characters, by character link, provided. Characters are depicted as printed and in the same sequence as they are arranged on the chaintrain. (Note – The characters appear in mirror-images on the chaintrain itself.)

The graphic symbols used in these layouts serve only to depict the character to be printed and are not representative of actual printout or character type.

1.6.3 Special Chaintrain Arrangements

Special character designs, character sequences, and coded character sets can be provided in place of the standard chaintrain arrangement, subject to DPC approval. To ensure satisfactory results, requirements for special chaintrain arrangements should be carefully reviewed with DPC.

New character designs are subject to certain limitations (height, width, land area, counters, etc.) to achieve the best possible results. Depending upon the typographical characteristics of a non-standard character, printing and ribbon life may be less satisfactory than with standard characters.

When non-standard type is required, particularly if for printing at eight (8) lines per inch (2,54 cm), careful attention should be given to the typographical characteristics of graphics such as diacritical marks, underscore, descenders of lower-case letters, etc. At 8-lpi, such characters may overlap with other characters when printed in successive lines.

Ordinarily, when a new character is substituted for a character in a chaintrain arrangement, the new character assumes the print data code normally associated with the character it replaces. Normally, characters are arranged on a chaintrain in ascending binary coded order. This is necessary because the logic electronics incorporates a binary counting scheme to track the character positions on a chaintrain. This arrangement requires that the input print data code bit patterns used to define the characters of a given set be contiguous, with an "all '1's" bit pattern assigned to the last character of the set. USASCII is an example of such a print code structure.

				Bits b7	0	0	0	0	1	1	1	1
				b6	0	0	1	1	0	0	1	1
				b5	0	1	0	1	0	1	0	1
b4	b3	b2	b1	COL / ROW	0	1	2	3	4	5	6	7
0	0	0	0	0			SP	0	@	P	`	p
0	0	0	1	1			!	1	A	Q	a	q
0	0	1	0	2			"	2	B	R	b	r
0	0	1	1	3			#	3	C	S	c	s
0	1	0	0	4			$	4	D	T	d	t
0	1	0	1	5			%	5	E	U	e	u
0	1	1	0	6			&	6	F	V	f	v
0	1	1	1	7			'	7	G	W	g	w
1	0	0	0	8			(	8	H	X	h	x
1	0	0	1	9			)	9	I	Y	i	y
1	0	1	0	10			*	:	J	Z	j	z
1	0	1	1	11			+	;	K	[	k	{
1	1	0	0	12			,	<	L	\	l	|
1	1	0	1	13			—	=	M	]	m	}
1	1	1	0	14			.	>	N	^	n	~
1	1	1	1	15			/	?	O	_	o	|||

64-Character Subset

96-Character Subset

Graphics enclosed in heavy outlines correspond to the indicated subset.

Only bits b6 through b1 (Octal 00 through 77) are significant with the standard 64-Character chaintrain arrangement.

Only codes 2/0 through 7/15 (Octal 040 through 177) are significant with the standard 96-Character chaintrain. Control codes 0/0 through 1/15 (Octal 000 through 037) are treated as SPace, and DELete, 7/15 (Octal 177) is treated as a printable character (|||).

Table 1-1. United States of America Standard Code for Information Interchange (USASCII), 64 and 96-Character Subsets (for Character Arrangement on Chaintrain, see Figure 1-3)

Bits				b0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
				b1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
				b2	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
				b3	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
b4	b5	b6	b7	COL / ROW	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	0	0	0	0					SP	&	–									0
0	0	0	1	1							/		a	j			A	J		1
0	0	1	0	2									b	k	s		B	K	S	2
0	0	1	1	3									c	l	t		C	L	T	3
0	1	0	0	4									d	m	u		D	M	U	4
0	1	0	1	5									e	n	v		E	N	V	5
0	1	1	0	6									f	o	w		F	O	W	6
0	1	1	1	7									g	p	x		G	P	X	7
1	0	0	0	8									h	q	y		H	Q	Y	8
1	0	0	1	9									i	r	z		I	R	Z	9
1	0	1	0	A																
1	0	1	1	B					.	$	,	#								
1	1	0	0	C					⌑	*	%	@								
1	1	0	1	D					(	)		'								
1	1	1	0	E					+			=								
1	1	1	1	F																

Graphics enclosed in heavy outlines correspond to bit patterns common to AN, HN and LC arrangements.

Lower-case letters print as corresponding upper-case letters when a lower-case letter bit pattern is accepted by a Chaintrain Line Printer system with a 48-Character EBCDIC arrangement.

The graphics ⌑ % @ # of the AN arrangement are dualed with the graphics) (' = respectively of the HN arrangement.

Table 1-2. Extended Binary Coded Decimal Interchange Code (EBCDIC), 48-Character Sets, Arrangements AN, HN, and LC (IBM) (for Characters on Chaintrain, see Figure 1-3)

USASCII Arrangements

Standard 64-Character Subset (Consists of 6 identical arrays of 8 links each; 1 array shown)

@ A B C D E F G	H I J K L M N O	P Q R S T U V W	X Y Z [\ ] ^ _	◊ ! " # $ % & '	( ) * + , − . /	0 1 2 3 4 5 6 7	8 9 : ; < = > ?

Standard 96-Character Subset (Consists of 4 identical arrays of 12 links each; 1 array shown)

◊ ! " # $ % & '	( ) * + , − . /	0 1 2 3 4 5 6 7	8 9 : ; < = > ?	@ A B C D E F G	H I J K L M N O
P Q R S T U V W	X Y Z [\ ] ^ _	` a b c d e f g	h i j k l m n o	p q r s t u v w	x y z { | } ~ |||

EBCDIC Arrangements

AN (48 characters. Consists of 8 identical arrays of 6 links each; 1 array shown)

0 1 2 3 4 5 6 7	8 9 * + , − . /	& A B C D E F G	H I J K L M N O	P Q R S T U V W	X Y Z $ @ # % ⌑

HN (48 characters. Consists of 8 identical arrays of 6 links each; 1 array shown)

0 1 2 3 4 5 6 7	8 9 * + , − . /	& A B C D E F G	H I J K L M N O	P Q R S T U V W	X Y Z $ ' = ( )

LC (48 characters. Consists of 8 identical arrays of 6 links each; 1 array shown)

0 1 2 3 4 5 6 7	3 9 * + , − . /	& A B C D E F G	H I J K L M N O	P Q R S T U V W	X Y Z $ @ # % '

(Note - Layouts are neither scaled, nor do the fonts used represent the type style available.)

Figure 1-3. DPC Chaintrain Arrangements (Printout Representation)

Some industry standard code structures (such as EBCDIC) are not contiguous in the bit pattern assignments for the characters of all common character arrangements. Consequently, such code sets require the additional conversion of input data codes to chaintrain print character codes. Generally the input data code should provide the minimum number of bits necessary to define all of the characters of a given set. (Note – The use of input data codes requiring eight significant bits precludes the Input Parity Check option on the standard unit.)

CHAPTER 2

OPERATING SUPPLIES

2.1 INTRODUCTION

This chapter contains pertinent information concerning standard ribbon, format tapes, and recommended forms for use with the CT Line Printer.

2.2 STANDARD RIBBON

The standard ribbon for the CT Line Printer is a general purpose, inked-fabric, towel-form ribbon with either translucent screen-type leaders or integral reinforced ribbon-reversing holes. Each ribbon is attached to two (2) disposable mandrels (scroll-form) and is provided with a pair of disposable plastic gloves.

DPC Part Number:	D17500-4
Fabric:	5-Mil (0,127 mm) Nylon
Width:	14 Inches (35,6 cm)
Length:	10 Yards (9,14 m)
Ink:	Black Record Medium

Information concerning ribbon "life" is contained in Chapter 3, Print Quality Considerations.

2.3 VERTICAL FORMAT TAPES

The standard format tapes for use on the CT Line Printer are made from a laminated paper-polyester film – paper material having the required opacity, dimensional stability, and tensile strength to provide proper operation over a long period. This material is easily written on and is easily joined with readily available adhesives. Format tape for use with the standard 8-channel vertical format unit (VFU) conforms with the applicable dimensional requirements as defined by ANSI Standard X3.18 (1967) for "One-Inch Perforated Paper Tape for Information Interchange". Format tape for use with the optional 12-Channel VFU is compatible with IBM carriage control tape. The recommended adhesive (DPC Part No. A 4569) is a rubber-based contact cement that is quick-setting and easily cleaned.

DPC Part Number:	A 4524	A 4568
Channels:	8	12
Width:	1 Inch (2,54 cm)	1.625 Inch (4,127 cm)
Feed Hole Pitch:	0.1 Inch (2,54 mm)	0.167 Inch (4,24 mm)
Feed Hole Size:	0.046 Inch (1,17 mm)	0.103 Inch (2,62 mm)
Standard Package:	10-Foot Roll (304,8 cm)	25 Lengths per Package 24.94 Inches per Length (63,3 cm per Length)
DPC Adhesive:	DPC Part No. A 4569	
Type:	Rubber-Based Contact Cement	
Standard Package:	3-Ounce (88,5 cc) Can with Applicator	

For further information concerning format tape, tape-loop preparation, and tape punches, refer to the *Operating Instructions* manual.

2.4 FORMS

The CT Line Printer is designed to accommodate tractor-fed forms. Accordingly, forms must be continuous with standard sprocket-feed holes punched on both margins. Forms can be single-part paper, regular 0.007 inch (0,18 mm) card stock, multiple-part paper with interleaved carbon paper, or multiple-part carbonized or carbonless paper. Forms may be fan-fold or roll form.

2.4.1 Basic Requirements

The basic forms requirements are summarized below:

Forms Width:	3-1/2 Inches (8,89 cm) to 19-1/2 Inches (49,48 cm) overall
Fold Length:	Up to 11 Inches (27,94 cm) between folds with standard paper shelf
Weight:	15 Pound (56,3 grams per square meter) minimum
Thickness:	Up to 0.020 Inch (0,5 mm) with standard tractor adjustment
Feed Holes:	
Diameter:	5/32 Inch (3,96 mm)
Spacing:	1/2 Inch (12,7 mm) center-to-center
Location:	1/4 Inch (6,35 mm) to near edge of paper

The maximum overall form width that will allow a full line of print to be laterally positioned anywhere on the body of the form (except for 1/2 inch [1,27 cm] on both margins) is determined by the number of contiguous active print positions, as shown in Figure 2-1 for the standard 132 print positions, and varies accordingly as shown below:

Contiguous Print Positions	Maximum Overall Form Width (to print anywhere on body)
80	11.65 Inches (29,59 cm)
120	15.65 Inches (39,75 cm)
132	16.85 Inches (42,8 cm)
136	16.85 Inches (42,8 cm)

Fan-fold forms greater than 11 inches (27,94) long exceed the forms-length capability of the enclosed paper supply compartment, and of the standard paper shelf at the rear of the printer, precluding normal intended use. Roll form paper requires ancillary handling equipment (not provided by DPC).

The minimum weight of single-part paper is 15 pounds (56,3 grams per square meter); lesser-weight paper will be embossed, and possibly cut through, when printing certain characters (as Period [.], Comma [,], Hyphen [-], etc.) at normal print density, resulting in unsatisfactory print quality and reduced ribbon life. The thickness of a form should not exceed 0.020 inch (0,5 mm); otherwise, special printer adjustments will be necessary to ensure proper feeding of forms.

Forms should be free of mechanical fasteners (as staples, stitching, etc.) that may interfere with proper feeding or become dislodged and fall into the printer, possibly damaging the printer mechanism. Multiple-part forms should be fastened by gluing at one location only (as at one margin). Multiple gluing (as at both margins, between successive forms, at sub-divisions of a fan fold, etc.) tends to restrict the escape of any air from between the parts, which cushions the impact of the print hammers and thereby reduces image transfer. Gluing should be located outside of the required print image area on a form. Gluing tends to significantly alter the characteristics of a form so that uniform print quality might be difficult to achieve on both the glued and unglued portions.

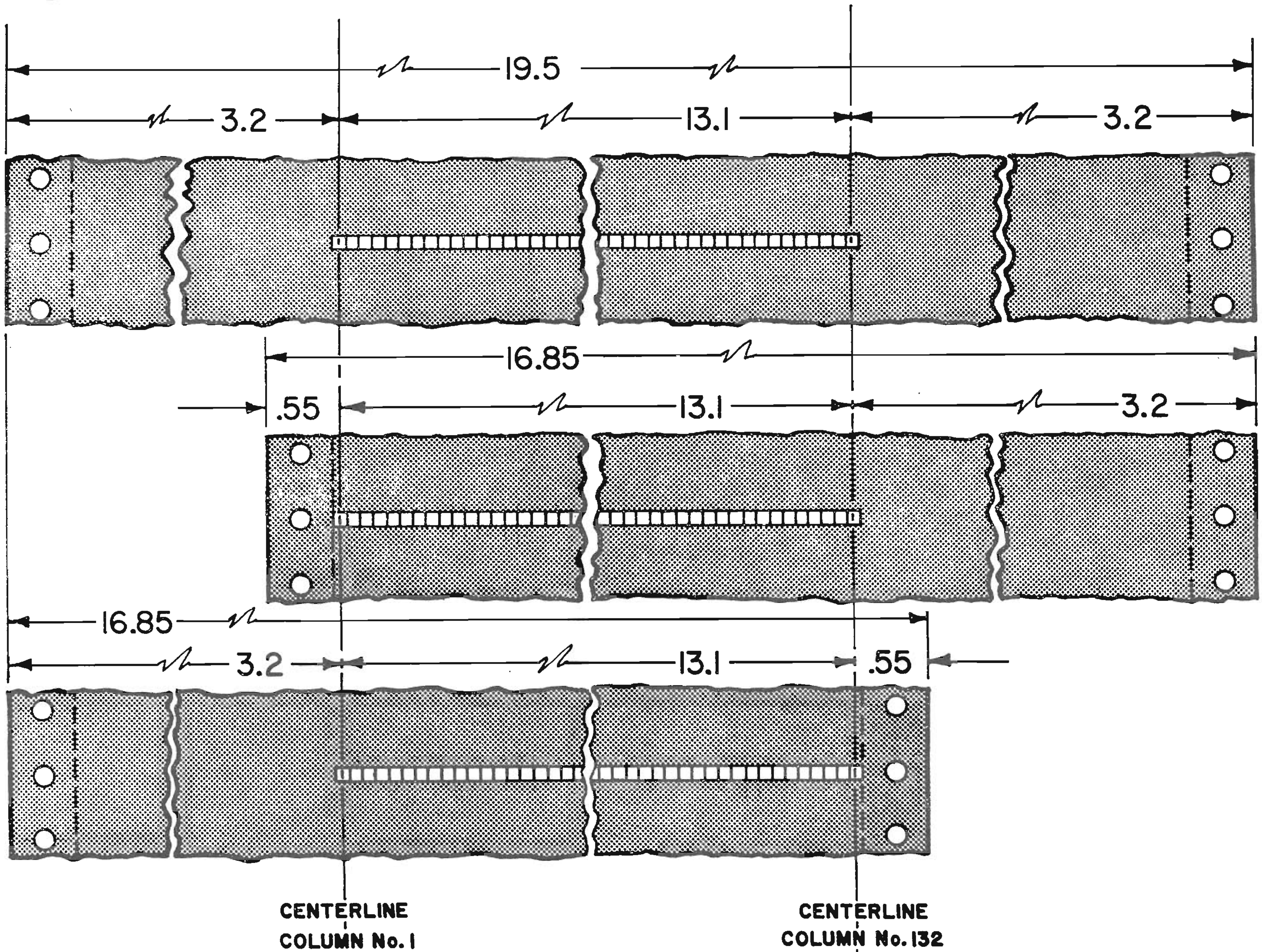

Figure 2-1. 132-Column Print Locations on Wide Forms

Fan-fold forms must be laterally perforated, or rouletted, at uniform intervals along the length of the paper, perpendicular to the edges of the paper, and centered between successive feed holes.

2.4.2 Recommendations

A wide variety of standard general-purpose forms meet the basic requirements cited in the preceding paragraph, and will provide satisfactory results with the CT Line Printer. However, because of the possible variation in results obtained using combinations of different forms, papers, and attachments, any form(s) under consideration should be carefully evaluated before making a substantial commitment for forms. The major suppliers of business forms are well acquainted with the characteristics of computer printers and can provide a comprehensive variety of form constructions for consideration.

To assure acceptable results, a variety of form constructions should be tested, especially if the form is of four or more parts, or is a special purpose form (as combinations of paper and card stock, envelopes, plastic cards, etc.).

The primary objective of evaluation testing concerns the image transfer characteristic of a form. However, the manner in which the forms, and parts of multi-part forms, are attached should also be carefully evaluated.

The following is a partial list of recommendations for achieving best results:

1. Regardless of the number of parts in a multiple-part form, if one part is required to be of heavier stock than the rest, it should be the bottom part for best results.
2. In multiple-part forms, the bottom part should be white for best legibility.
3. For best print alignment, the margin feed holes should be clean cut and should be 0.156 ± 0.003 inches (3,96 ± 0,0076 mm) in diameter.
4. Perforating, or rouletting, of forms should be consistent with normal bursting requirements. The removal (perforating) or incision (rouletting) of excessive material might result in the inadvertent bursting of forms while feeding.
5. Forms should be stored in sealed cartons in an environment consistent with that specified by the supplier. Documents should be fed directly from the carton in which they were shipped.
6. Forms should be free of serrations, protrusions, or large openings to avoid picking while feeding.
7. Forms should consist of new papers. Recycled papers generally exhibit stability, tensile strength and absorption characteristics that are inadequate for impact printing purposes.

CHAPTER 3

PRINT QUALITY CONSIDERATIONS

The CT Line Printer is capable of providing excellent print quality over a wide range of applications: however, correct printer setup is important to achieve the best possible results. Precautions that should be observed to ensure acceptable print quality include:

1. Use of recommended ribbon and form(s) for the application.
2. Supervision and adjustment of the printer for proper print density as required.
3. Replacement of the ribbon as required.
4. Cleaning of the chaintrain.

For general purpose applications, the DPC ribbon D17500-4, or equivalent, is recommended. The forms used should conform to the basic requirements cited in the preceding paragraphs as applicable. Since the quality of the paper and its finish, the number of parts of the form, and the type of ribbon affect print quality, these items should be tested to ensure acceptable results.

In applications where print quality is critical, correct printer adjustment is important. The impression control permits adjustment of the printer to the thickness of the form and ribbon, and to the condition of the ribbon for proper print density (darkness of impression) and printed character stroke width. Because each application may result in unique ribbon usage, it may be necessary to experiment with an impression control adjustment schedule that provides optimum results for a particular application.

Because fresh ribbons contain more ink than used ribbons, the initial print density is relatively heavy for a given impression adjustment. The more a ribbon is used, the less ink it contains and the lighter the print density becomes (and the narrower the printed stroke width becomes). Therefore, print density should be checked at the beginning of, and at intervals throughout, a printout run, and the impression control adjusted to maintain the best possible print density. When the required print density can no longer be obtained, the ribbon should be replaced.

For best results, the chaintrain should be cleaned periodically according to the ribbon and paper(s) used, and the print quality requirements. During printing, small particles of paper and ink tend to accumulate in the spaces between the lands (raised parts) of type faces of the chaintrain. When this accumulation fills the counters (small enclosed spaces) of a character (as the 'white' space in the letter "oh" [o], for example), the distinctness of the printed character may be affected. Therefore, the chaintrain should be cleaned (with ribbon removed), first with a vacuum cleaner, then with a soft wire brush and a vacuum cleaner, on a routine basis. (For complete cleaning instructions, refer to the *Maintenance* manual.)

CHAPTER 4

PRINCIPLES OF OPERATION

4.1 INTRODUCTION

The DPC Chaintrain Line Printer is an electromechanical, chaintrain impact printer which accepts data in the form of character codes from an associated external device, and produces hardcopy printout a line-at-a-time. This chapter describes the principles of operation of the standard printers in this series. The operation and interaction of the printer subsystems, some of which are either entirely mechanical or entirely electronic, while others are electro-mechanical, to provide the character code to printout conversion are explained.

Paragraph 4.2 provides a general description of the printer and its operation, starting with the printing mechanism and continuing, in a direction opposite to that of data flow, to the printer interface with an external device.

Paragraph 4.3 contains a detail discussion of the printer interface with an external device and includes a timing diagram for a typical machine cycle.

Printer control functions are described in paragraph 4.4, commencing with the printer interface and continuing, in the direction of data flow, to the printing mechanism.

4.2 GENERAL DESCRIPTION

DPC Chaintrain Line Printers basically consist of a chaintrain impact printer mechanism with all necessary control, full-line buffer, and interface electronics. This section is principally concerned with the method of presenting character type to the print hammers, the printing process, and the functions of the various printer mechanisms as a prerequisite to understanding the interface and control logic functions, which are fully described in paragraphs 4.3 and 4.4.

For the purpose of this discussion, the printer mechanisms are conveniently arranged into three function-oriented groups:

Print System
Paperfeed System
Ribbonfeed System

The operation of each of these systems is described in turn in the subparagraphs that follow.

4.2.1 Print System

As shown in Figure 4-1, the print system consists of the chaintrain (hereinafter called the "chain"), a chain character strobe generator, and a chain index generator all mounted on the yoke assembly on the front side of the paper path; and a bank of print hammers and their actuators mounted on the hammer bank mounting plate on the back side of the paper path.

Printing occurs when an electromagnetically-operated actuator pushes its corresponding print hammer, compressing a small area of the sandwich of paper form(s) and ribbon from behind against a character type face on the chain. The chain is composed of 384 characters arranged in a single row on a moving, endless belt-loop. This arrangement permits all of these characters to be aligned with every print hammer in the typeline repeatedly as the motor-driven chain travels at a constant speed.

The printing of a line is a quasi-serial process. To ensure proper print-out of data, the character type that become aligned with the various print hammers are continuously tracked for comparison with stored data. A print hammer is fired only when a comparison shows that the aligned character is identical to the stored data for a given position.

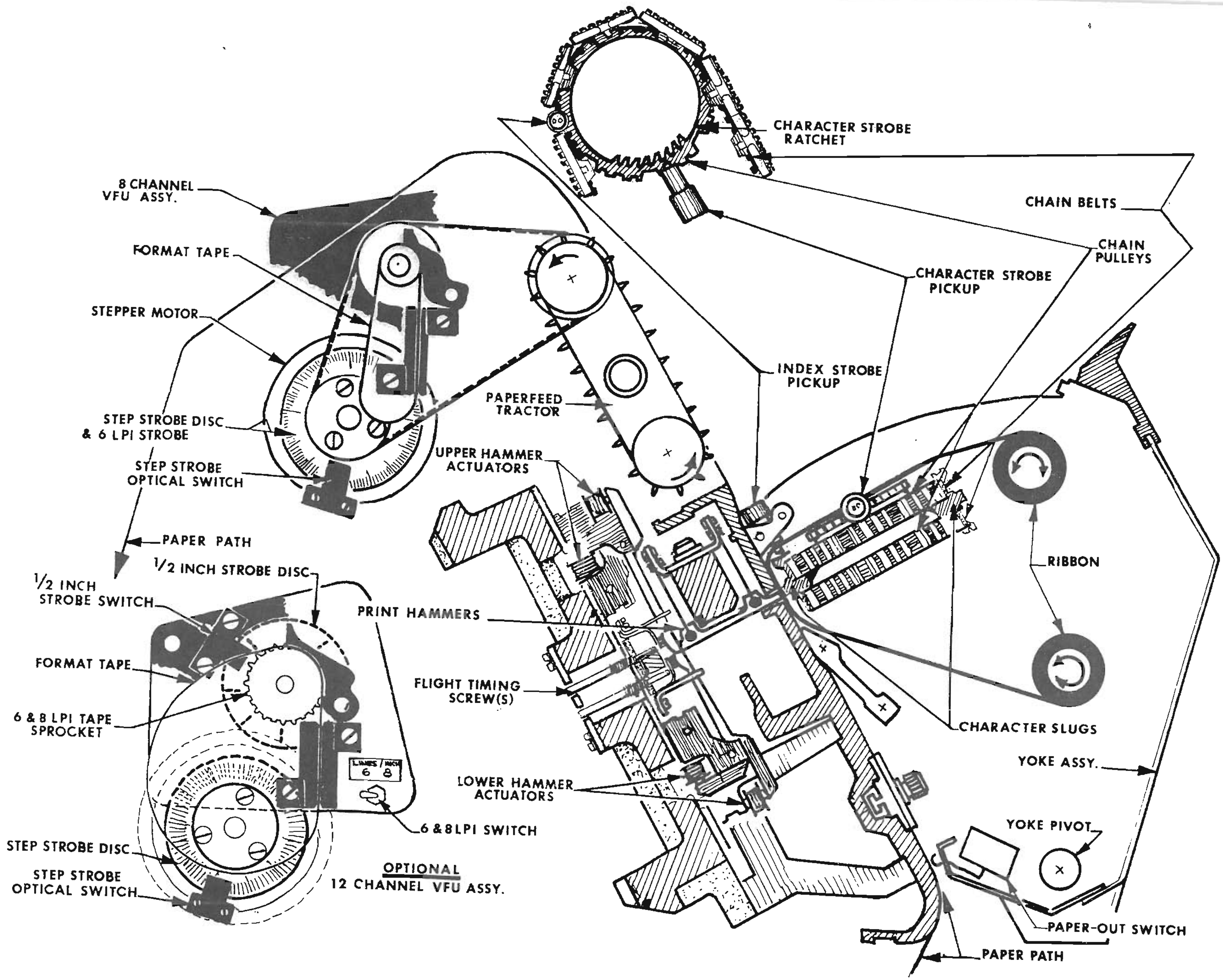

Figure 4-1. Printer Mechanism Cross Section View

The chain tracking and print hammer firing operations adhere to precise timing conditions, based on the construction of the printer, which are derived from synchronizing signals generated by the printer mechanism as the chain moves.

4.2.1.1 Print Hammer to Chain Relationship

The standard typeline consists of 132 individual print hammers uniformly spaced ten-to-the-inch (nominally 0.100 inch, center-to-center) side-by-side in a hammer bank. One (1) print hammer is associated with each print position (column) of printout.

The characters on the chain are arranged in ascending order according to their corresponding contiguous chain character codes (which are not necessarily the same as the corresponding input data codes). The character type faces are uniformly spaced 0.133 inch (3,38 mm), center-to-center, in contrast to the print hammers which are spaced 0.100 inch (2,54 mm), center-to-center. The 3-to-4 relationship of chain characters to print hammers provides alignment of every third (3rd) character with every fourth (4th) print hammer. This causes the sequential alignment of successively higher groups of every third chain character with successively lower groups of every fourth print hammer, as the chain travels from left-to-right, or from print hammer (column) No. 1 towards print hammer (column) No. 132 in front of the bank of print hammers.

As shown in Figure 4-2A, when the character G is in alignment with print hammer No. 4, the next third chain character, D, is in alignment with the next fourth print hammer, No. 8; similarly, character A is in alignment with print hammer No. 12, etc. At the same time, characters H, E, B, etc., are *almost* in alignment with print hammers 3, 7, 11, etc., respectively; characters I, F, C, etc. are progressively further away from alignment with print hammers 2, 6, 10, etc., respectively; and characters J, G, D, etc. are still further away from print hammers 1, 5, 9, etc., respectively, in increments of 0.033 inch (0,846 mm) for each group of characters. This alignment positions some character for printing in front of one-fourth (1/4th) of all print hammers at a time, such as chain characters G, D, A, etc. in alignment with print positions 4, 8, 12, etc., respectively. This means that one character each is in printing position at 33 print hammers of a 132 position (column) typeline at a time.

As the chain moves from left to right, the alignment of characters and print hammers proceeds in the opposite direction, or right to left. The interval during which a group of characters (such as G, D, A, etc. in Figure 4-2A) move into alignment with print hammers 4, 8, 12, etc. is designated Phase 4. At the end of the next interval, Phase 3, the chain has moved to the right just far enough to again align every third character with every fourth print hammer, except that now the entire alignment scheme is incremented by one (1) character and is decremented by one (1) print position (column). Thus, the next higher group of characters (such as H, E, B, etc. in Figure 4-2B) are aligned with the next lower group of print hammers; 3, 7, 11, etc. Likewise, the second next group of characters (such as I, F, C, etc. in Figure 4-2C) are aligned with print hammers 2, 6, 10, etc. during the following interval, Phase 2; and finally, the third next group of characters (such as J, G, D, etc. in Figure 4-2D) are aligned with print hammers 1, 5, 9, etc. during the fourth interval, Phase 1. At the end of Phase 1, one character has been aligned with every print hammer in the typeline.

During the next interval in succession, the chain will have moved to the right just far enough to again align a character with print hammers 4, 8, 12, etc. to begin a repeat of the foregoing process for all print hammers, except that the alignment scheme will be advanced by one (1) chain character. This means that the characters G, D, A, etc., as shown in Figure 4-2A, will be replaced by the next chain character in succession, namely; H, E, B, etc.

Because a character is aligned with only one-fourth of all print hammers during a phase, a print scan of four (4) successive phases is necessary to align some character with all print hammers. Since all or some of the characters aligned during a print scan are not necessarily the ones to be printed, a number of print scans may be required to print the character specified by stored data for each print position. The number of scans required to align the entire set of different characters on the chain depends upon the number of characters in a given set. This relationship is depicted in Figure 4-3 by means of an illustrative twelve-position printer with a ten-character set, 0-9. In this depiction, the characters that become aligned during a particular phase are indicated by circles, squares, triangles, and diamonds, and the intersection of vertical

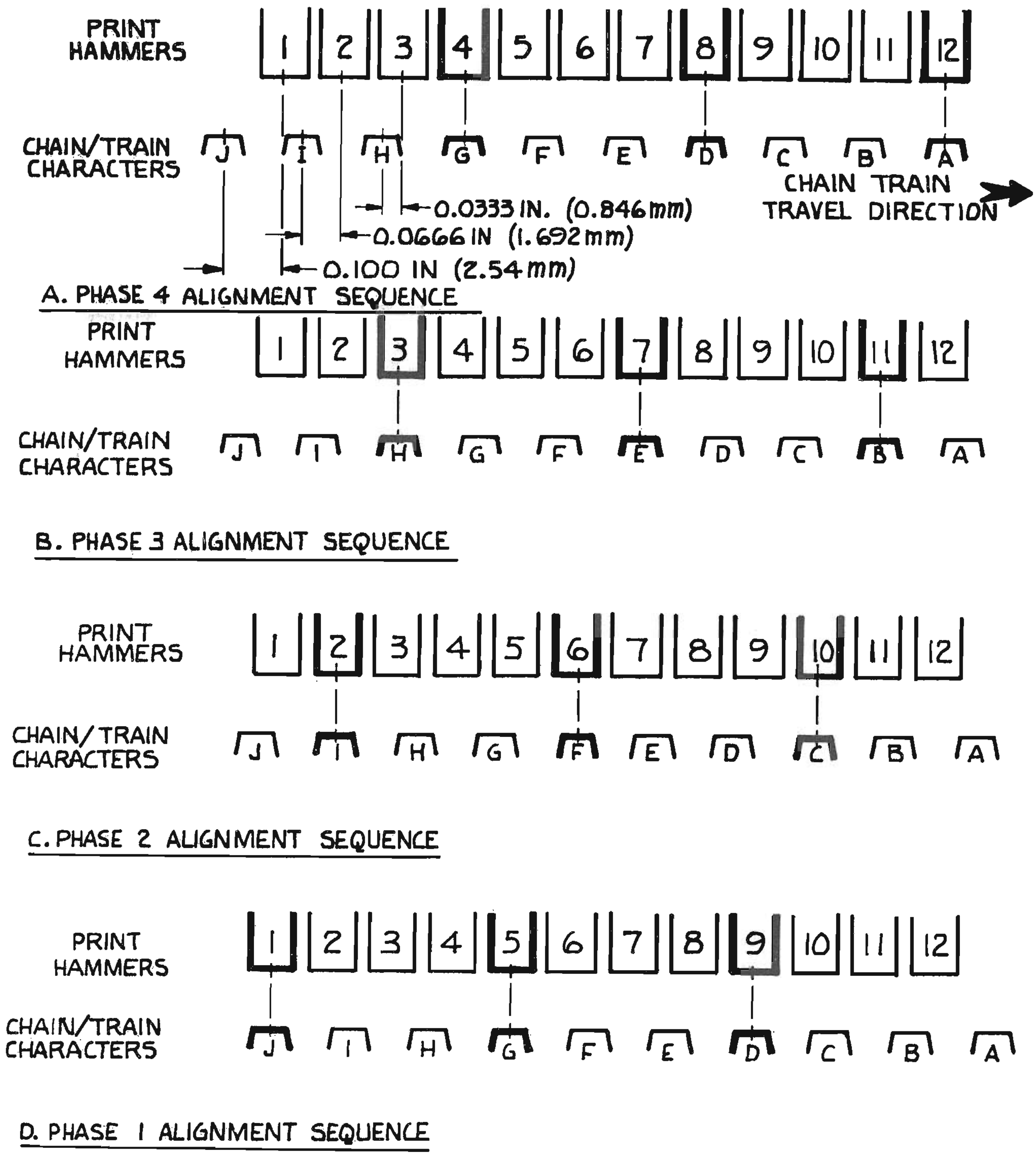

Figure 4-2. Print Hammer to Chaintrain Relationship

lines and diagonal lines show that every character is aligned with every print position in the course of ten print scans, or as many print scans as there are characters in the chain character set.

The chain is constructed of 48 type-slugs arranged end-to-end in a continuous loop and mounted on a double belt. Each type slug contains the faces of eight characters for a total of 8 x 48 or 384 characters in a single row along the length of the chain. These characters are organized into an integral number of identical arrays which are repeated along the length of the chain. Each array contains all of the different characters of a given character set arranged in ascending order according to their corresponding contiguous chain character codes.

As the chain traverses a distance of one array, or character set, one or more arrays are presented to the typeline such that each of the different characters in a set become aligned with every print hammer. Accordingly, a line of print, regardless of length, and consisting of any or all of the different characters in a set, can be printed as the chain traverses the distance of one array-segment, or the corresponding portion of a chain revolution.

The print speed of a chain printer is related, in part, to the repeatability of the character set provided and the frequency with which that set can be presented to the bank of print hammers and printed. A small character set can be repeated on the chain more often, and for a given chain speed, can be printed more frequently than a large character set. The number of arrays on a chain, or the repeatability of a character set depends upon the number of characters in that set. For example: a 64-character set requires eight (8) type slugs; therefore, the entire set can be repeated on a chain six (6) times for a total 6 x 64 or 384 characters. The repeatability and nominal print speed associated with standard size DPC character sets are indicated below:

Characters per Set:	*Type-Slugs per Array:*	*Arrays per Chain:*	*Print Speed (See Note):*
48	6	8	760 LPM
64	8	6	600 LPM
96	12	4	430 LPM
128	16	3	330 LPM

Note – Figures are nominal for continuous printing with single linespacing and with a chaintrain speed of 110 inches per second (nominal).

4.2.1.2 Chain Character Sets and Character Sequences

Standard chain character sets and their character sequences for DPC Chaintrain Line Printers are shown in Appendix B.

Character type-face positions, and the characters that occupy them, within an array (character set) are identified in numeric form according to their sequence of appearance at the typeline by means of a simple counting process. Accordingly, these positions are referenced numerically 1, 2, 3, etc. from left-to-right on the chain as viewed from the print hammers (type face side). Consequently, to facilitate tracking of the chain for comparison, the chain character sequence is contrived such that the character type face appear in the same sequence as the ascending order of their corresponding print data codes.

This scheme requires that a given character set be represented by a contiguous set of print data codes; consequently, the print data codes are not necessarily the same as the corresponding input data codes. Certain industry standard coded character sets, such as the 64-character and the 96-Character Printable Subsets of USASCII, are directly compatible with the chain address scheme requiring only the appropriate arrangement of characters on the chain. Depending upon specific customer requirements, compatibility with other coded character sets may be achieved by means of any or all of the following: translating of input data codes to appropriate chain character codes at the printer, chain character substitution, or special encoding of input data at the external device. The ramifications of achieving this compatibility are discussed in detail elsewhere in this manual.

4.2.1.3 Print Hammer Bank

One electromagnetically operated actuator and a print hammer are associated with each print position (column) in the typeline. The actuators are constructed, in straight and offset

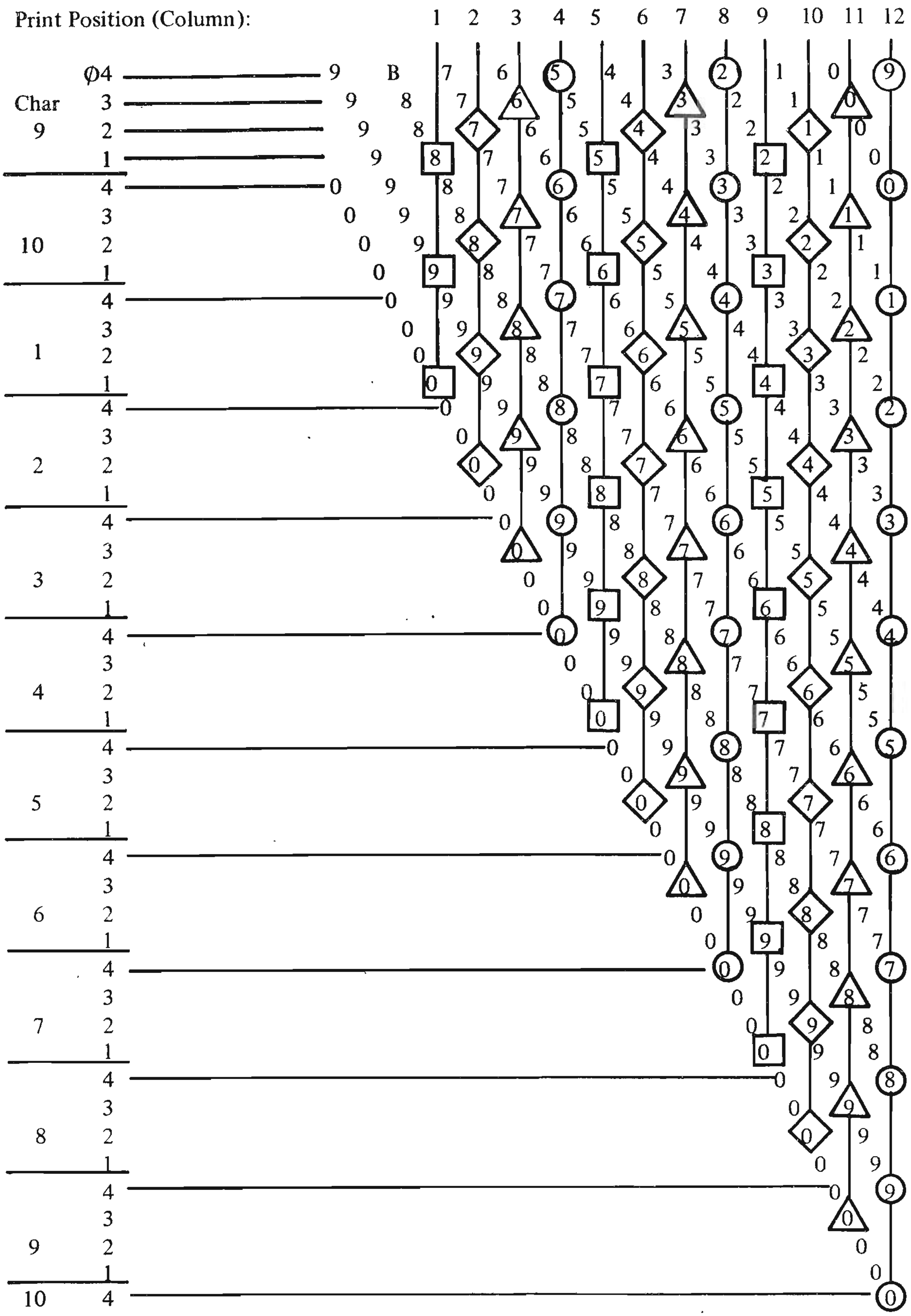

Figure 4-3. Chaintrain Character Alignment Scheme

configurations, to interlace in a four-way pattern in order to accommodate the necessary geometry of the electromagnet coils. The interlace pattern forms four rows of 33 actuators each for a typeline of 132 print hammers. Each row of actuators corresponds to every fourth print hammer such as to also correspond with the phase (interval) during which chain characters are aligned with the print hammers thusly:

Actuators		*Print Scan*	*Print Hammers*
Location	Configuration	(Phase)	(Columns)
Top	Straight	1	1, 5, 9, ... 129, 133
Upper Middle	Offset	3	3, 7, 11, ... 131, 135
Lower Middle	Offset	4	4, 8, 12, ... 132, 136
Bottom	Straight	2	2, 6, 10, ... 130, 134

As shown in Figure 4-1 each actuator is operated by its own electromagnet. When actuated, the armature stroke is transferred through an arm to push the associated print hammer, driving it forward to strike, in turn, the paper form from behind, thereby pushing a small area of the form and ribbon against a type face on the chain resulting in a character impression on the front side of the form. After the hammer impacts against the form, ribbon, and chain, it bounces back against a rubber backstop and, restrained by its supporting flexures, comes to rest.

4.2.1.4 Character Strobe and Index Generators

In normal operation, the chain travels by the bank of print hammers at a constant speed and the firing of print hammers is accurately timed such that a print hammer impacts the paper and ribbon against the moving chain at the same moment that the character to be printed is in alignment opposite that print hammer. Because of the inductance of the actuator coil, and the inertia of the actuator arm and the print hammer, the actuators are selected and energized in advance of the exact time that chain characters come into alignment with the corresponding print hammers. The timing of print hammer firing and the identification of chain characters are derived from two streams of synchronizing pulses which are generated at the print mechanism in conjunction with the moving chain, namely; Character Strobe pulses and Index pulses.

A Character Strobe pulse is generated for each character of the chain by a timing ratchet that has 72 evenly-spaced teeth. Arranged as an integral part of the chain drive gear, located at the right-hand end of the chaintrain assembly, this ratchet rotates in conjunction with the moving chain. The teeth are sensed by a variable reluctance transducer, the output of which is amplified and shaped by the Print Control electronics.

The Character Strobe pulse indicates the first alignment of every print scan, but not the alignments that occur during the four successive phases of a print scan. This means that at Character Strobe time, some chain character is in position for firing print hammers 1, 5, 9, etc. The corresponding alignments that occur for the intervening print hammers during the subsequent alignment intervals (Phases 4, 3, and 2) are indicated by Auxilliary Strobe pulses derived from Character Strobe, multiplied by 3, by the Print Timing electronics. The corresponding alignment which is approached, but does not occur, during the last interval (Phase 1) of a print scan, is indicated by the immediately following Character Strobe pulse.

An Index pulse is generated for each array (character set) on the chain by metal slugs arranged along the chain. Located, as an integral part, in the center of the top surface of certain evenly spaced type slugs, designated Head-of-Font (HOF) slugs, the metal slugs represent the chain Index pulses which are the primary synchronization pulses for the chain tracking and comparison electronics. These metal slugs are sensed by a separate variable reluctance transducer, located at the right-hand end of the chaintrain assembly, the output of which is amplified and shaped by the Print Control electronics.

The Index pulse indicates the beginning of a chain character set. One HOF slug is associated with each array on the chain, and is located such as to generate a single Index pulse between the Character Strobe pulse for the last character of one array and the Character Strobe pulse for the first character of the next array. This means that at the next Character Strobe time, the last character of an array is in alignment with print hammer 1, and that the first character of the next array will approach alignment with print hammer 1 during the ensuing print scan.

Because of the necessary physical separation of print hammer 1 and the Index transducer, the HOF slug for a particular array occupies a relative position in a preceding array. This separation corresponds to 132 chain character positions, or 16-½ type slugs. Consequently, the position of the HOF slug in an array is dependent upon the number of characters in that array, as indicated below:

Characters Per Set	*Type Slugs Per Array*	*HOF Slug Location in Array*
48	6	2
64	8	8
96	12	8
128	16	16

Both the Index transducer and the Character Strobe transducer are mounted on a single plate, the angular position of which is adjustable, about a common axis, with respect to the chain and the character strobe ratchet. This arrangement permits the concurrent adjustment of the phasing of both Index and Character Strobe for the exact pulse lead time to actual impact time for proper character alignment. Both a coarse adjustment, for initial factory (or maintenance) setting, and a fine adjustment control, for operator setting, of this phasing are provided.

4.2.1.5 Print Control

The selection and firing of print hammers is performed under control of the Print Control logic electronics which basically consist of two counters; one of which tracks the chain characters while the other tracks the print hammer positions. Because the print mechanism indicates only the beginning of a print scan, the interval between two successive Character Strobe pulses is divided into four uniform phase scans which correspond to the alignment intervals of chain characters with print hammers. Accordingly, the output of the counter tracking the chain is added to an auxilliary counter that generates character codes for those chain characters which become aligned with print hammers during a phase scan. Selection of the print hammers to be fired is determined by the comparison of these chain character codes with stored print data for those print hammers at which alignment occurs during the same scan. Since alignment occurs at the same moment at one-fourth of the available print hammers during a phase, each comparison is temporarily stored in a corresponding register for the simultaneous firing of the selected print hammers at the end of the phase scan. This selection and firing of print hammers is performed for each phase in succession with the chain character code generator and comparator gates updated according to phase.

The principles of print control, briefly outlined in the preceding paragraph for continuity, are fully described in detail in paragraph 4.4 of this manual.

4.2.2 Paperfeed System

The paperfeed system moves paper into position for printing and holds the paper stationary while printing. As shown in Figure 4-1, the paperfeed system basically consists of the paper tractors located above and below the bank of print hammers, a stepping motor mounted behind the left side frame of the printer mechanism, and a step strobe generator, line strobe generator, and vertical format unit all located at the upper left end of the printer. A number of other devices that are associated with the paperfeed system are identified at the appropriate point in the description that follows.

Sprocket-fed, continuous-form paper is moved through the printer by the upper tractors which are driven by a stepping motor. Drive from the motor is coupled through toothed pulleys and a timing belt to a splined drive shaft that is common to both upper tractors. The stepping motor also drives a motor step strobe generator, a 6-LPI (lines-per-inch) strobe generator (or a one-half inch strobe generator if equipped with the optional 6/8 LPI feature), and a vertical format unit in synchronism with the tractors.

Paperfeeding is a controlled process that is accomplished by phase switching the stepping motor through an appropriate number of steps to advance the forms to the next desired linespace. To ensure proper positioning of forms, the linespacing is tracked as paper is moving for recognition of the next desired linespace, which is specified by a stored command for each paperfeed operation. Paper motion stops when it is recognized that the paper either has moved a given number of linespaces or has advanced to a specific linespace on a form. Specific linespaces on a form are identified by a corresponding preprogrammed tape loop, which is read by the vertical format unit as paper is advancing.

4.2.2.1 Stepping Motor

The stepping motor is a phase-switched d-c motor which moves in discrete steps, or angular increments, of 1.8° each, for 200 steps-per-revolution. The motor is stepped by switching pairs of its four phase windings. As with synchronous motors, the rotor seeks a position with respect to the energized windings. In effect, each phase-switching operation acts in the same manner as does one-quarter cycle of a-c excitation, advancing the rotor shaft one step.

The motor-to-tractor gear ratio is such that twenty-four steps move the tractors, and paper, through a distance of one-half inch. Therefore, to move paper one linespace at a linespacing of 6-LPI, or one-sixth inch, eight steps are required. (Similarly, six steps are required to move paper one linespace at 8 LPI.) During a paperfeed operation, the stepping motor is operated, under control of the Paper Control logic electronics, through the appropriate multiple of 8 (or 6) steps necessary to advance paper to the next desired linespace.

To advance paper through the printer, from bottom-to-top, the rotor shaft is advanced in the counter-clockwise direction (as viewed from the rotor shaft end). This is accomplished by phase-switching the motor windings by pairs in the following order:

Step	*Motor Phase*			
	$\phi 1$	$\phi 2$	$\phi 3$	$\phi 4$
1	X			X
2	X	X		
3		X	X	
4			X	X
1	X			X

4.2.2.2 Step Strobe Generator

In a normal paperfeed operation, the stepping motor is operated in a synchronous manner at speeds up to approximately 1000 steps-per-second (approx. 1.0 MS per step) to advance paper in a single continuous motion. The commutation of motor winding pairs is performed in synchronism with the rotating rotor shaft and is timed to lead the actual position of the shaft. Because of the inertia of the rapidly rotating rotor shaft, the stepping motor is decelerated through a number of steps when ending a paperfeed operation to properly stop paper motion. A reduced "hold" power level, applied to the motor winding pair corresponding to the stop step position, secures the rotor shaft, tractors, and paper in position when not feeding paper. The timing of phase switching and the synchronization with linespacing are derived from two streams of pulses generated by the paperfeed system while feeding paper, namely; the motor Step Strobe commutation pulses and the 6-LPI (or ½-Inch) linespace alignment pulses.

Motor Step Strobe pulses are generated by a timing disc which is attached to, and rotates with, the stepping motor rotor shaft. The timing disc has 200 evenly-spaced apertures arranged in a concentric band near its outer edge. Each aperture in this band represents a rotor shaft step position. The apertures are sensed by an associated optical switch (Channel No. 1) which straddles the disc and is aligned with the outer band of apertures. As the disc rotates, light from a light emitting diode (LED) passes through the apertures, energizing a corresponding photosensor, the output of which is amplified and shaped by a self-contained Schmidt Trigger circuit.

The Step Strobe optical switch is mounted on a bracket that is adjustable with respect to the timing disc. This arrangement permits initial factory (or maintenance) adjustment of Step Strobe pulses for the proper lead time of phase switching to actual rotor shaft position for optimum synchronous operation of the stepping motor.

4.2.2.3 6-LPI Strobe Generator (Standard)

The standard DPC Chaintrain Line Printer is equipped to provide a basic linespacing of 6 LPI only. Because of the gear ratio between the stepping motor and the paper tractors, eight stepping motor steps correspond to 1/6th inch, or one linespace, of tractor, and paper, motion at 6 LPI. Accordingly, in the standard printer, a 6-LPI Strobe pulse is generated for every eighth step of the stepping motor by the same timing disc that is used to generate Step Strobe pulses (see paragraph 4.2.2.2). This disc has 25 evenly spaced apertures arranged in an inner concentric band. Each aperture in this band represents a linespace position on the form at 6 LPI, and is aligned with every eighth Step Strobe aperture in the outer band. The 6-LPI Strobe apertures are sensed by an optical switch in Channel 2 of the associated dual optical switch assembly (provided on standard units only).

4.2.2.4 ½-Inch Strobe Generator (6/8-LPI Option)

Printers provided with the 6/8-LPI option are equipped with a one-half Inch Strobe generator *instead* of the standard 6-LPI Strobe generator. The ½-Inch Strobe generator consists of a timing disc and an optical switch assembly located behind the vertical format unit (VFU) mounting plate at the upper left side of the printer mechanism. A 6/8-LPI switch, located on the function related VFU mounting plate, permits operator selection of the desired linespacing.

The ½-Inch Strobe pulses are generated by the timing disc which is attached to and rotates with the VFU tape-sprocket drive shaft. The gear ratio between the VFU sprocket drive shaft and the tractors is such that 45°, or one-eighth, of a timing disc rotation corresponds to one-half inch of tractor, and paper, advance. Accordingly, the timing disc has eight evenly spaced apertures arranged in a concentric band near its outer edge. Each aperture represents a one-half-inch increment of paper advance. The apertures are sensed by the associated optical switch which straddles the disc and is aligned with the band of apertures. As the disc rotates, light from a LED passes through the apertures energizing the corresponding photosensor, the output of which is amplified and shaped by a self-contained Schmidt Trigger circuit.

Because of the relationship of 6 and 8 LPI linespacing, each half-inch of paper advance corresponds to three linespaces at 6 LPI or four linespaces at 8 LPI. Accordingly, the ½-Inch Strobe pulses indicate, in effect, the linespace positions which are common to both 6 and 8 LPI, but not the intervening linespace positions. The intervening linespace positions are indicated by internal Line Strobe pulses derived by the Paper Control logic electronics from motor Step Strobe pulses, divided by either 8 or 6 according to the selected linespacing. Eight steps are required per linespace at 6 LPI; six steps are required per linespace at 8 LPI.

4.2.2.5 Vertical Format Unit

When paperfeeding in the VFU-controlled mode, the linespace positions in which printout is to appear on a form are determined from a pre-punched format tape loop which is advanced and read by the VFU while paper is being advanced. Signals from the VFU serve to identify specific linespace positions and are used, in conjunction with Line Strobe, by the Paperfeed Control logic electronics to decelerate the stepping motor and halt paper feed.

The VFU is a multi-channel photoelectric tape reader and drive mechanism that detects fully-punched holes in a sprocket-fed endless tape-loop. Depending upon customer requirements, a particular printer may be equipped with either a standard eight-channel VFU or an optional twelve-channel VFU. The 8-channel VFU is designed to accommodate one-inch (2,54 cm) wide perforated tape, which is compatible with the applicable requirements of ANSI X3.18 (1967); whereas the 12-channel VFU is designed to accommodate 1-5/8-inch (4,127 cm) wide IBM-compatible carriage control (format) tape. (Refer to the *Operating Instructions* manual for format tape details and channel designations.) However, the basic operation is the same for both the eight and twelve channel units.

VFU signals are generated by the tape loop which is fed through the reader in synchronism with the advancing tractors and paper. The tape loop is read at a read station consisting of an optical switch for each VFU channel. As the tape loop is advanced, infra-red light from a LED associated with each channel passes through the punched holes in the corresponding channel and energizes a corresponding photosensor. The outputs from the photosensors are amplified and shaped by associated self-contained Darlington-connected transistor circuits.

In the standard buffered printer, VFU-controlled paperfeed is based on a skip-to-channel scheme. Normally, holes are punched in predesignated tape channels according to related formatting requirements. Each hole punched in a format tape represents a particular linespace position on the corresponding form. Selection of the linespace position to which the advancing form is to be moved is determined by monitoring the VFU channel designated by the Paperfeed Command Code (paperfeed instruction) stored for each paperfeed operation. When a hole is detected in the designated channel, the paperfeed operation then in progress is stopped with the desired linespace on the form in printing position opposite the typeline. The standard DPC Paperfeed Command Codes (Skip-to-Channel instructions) for the VFU control of paper advance are shown in Appendix C.

In the standard buffered printer, certain VFU channels are used in conjunction with local controls for specific formatting operations. VFU Channel No. 1 is reserved for Top-of-Form (TOF) and VFU Channel No. 8 is reserved for Bottom-of-Form (BOF) on the standard VFU. (On the optional 12-channel VFU, Channels 1 and 12 are reserved for TOF and BOF, respectively.) This arrangement permits the advance of paper to TOF under local, manual control, and the automatic skip of paper from BOF to TOF (skip over the tear-line between forms) when so programmed at the printer interface. VFU Channel 2, and the TOF and BOF VFU channels are also provided at buffered outputs on the Printer Interface. VFU Channel 2 is designated for a "Special Function" as may be defined by the user.

In the absence of a tape in the VFU, the photosensors for all channels are energized continuously. Consequently, a "Skip-to-Channel" paperfeed operation performed under a 'no tape' condition is stopped upon advancing the tractors, and paper, one linespace. In the event an unpunched, or malfunctioning, VFU channel is designated, paperfeeding is automatically stopped by timing circuits in the Paperfeed Control logic electronics.

A spring-loaded tape hold-down lever, which is operator-opened to remove or install a format tape, secures the tape in position on the tape drive sprocket. Tape guides, extending from the tape read station to the tape drive sprocket, assure that the tape is properly positioned at the tape read station without the necessity for tape-loop tensioning, thereby eliminating a principle cause of excessive tape wear.

Because of the fixed gear ratio between the tape drive sprocket and the paper tractors, the tape is advanced a different distance for a linespace of paper advance according to the selected linespacing and, because of the different forms of tape used, the particular VFU configurations; as follows:

VFU CHANNELS:	8	12	
LINESPACING:	6 LPI	6 LPI	8 LPI
Tape Sprocket Arc:	15°	15°	11.25°
Punch Hole Pitch:	.100″	.167″	.125″

This means that for proper operation, a format tape must be prepared using the appropriate punch hole pitch (spacing) according to the particular VFU configuration and linespacing with which that tape is to be used. Normally, a tape loop is prepared such as to correspond in length with the number of linespaces, at the selected linespacing, provided by an integral multiple, usually one, of the form(s) with which that tape is to be used.

4.2.2.6 Paperfeed Control

Paperfeeding is performed under control of the Paperfeed Control and Paper Control (drive) logic electronics which basically consist of two registers; one of which commutates the stepping motor, while the other either tracks the advancing forms or selects the required VFU channel for monitoring according to the programmed mode of control – Linecount or VFU.

In the Linecount mode, the selection of the linespace position at which a paperfeed operation is to be terminated is determined by the examination of the tracking register. Initially loaded with a count of the number of linespaces to be advanced in an operation, the tracking register is updated with each linespace advanced to indicate the number of lines remaining to be advanced. Termination of a Linecount paperfeed operation is determined by the recognition of the final count state of the tracking register.

In the VFU-controlled mode, the selection of the linespace position at which a paperfeed operation is to be terminated is determined by the examination of the selected VFU channel which is designated by the Paperfeed Command Code loaded into the tracking register for each operation. Termination of a VFU-controlled paperfeed operation is determined by the detection of a hole in the corresponding channel of the format tape loop.

After recognition of the desired linespace, the stepping motor is decelerated through three successive steps having successively longer commutation intervals of approximately 1.5, 2.0, and 3.0 MS., which slows the motor and moving paper to a smooth stop with the desired linespace accurately positioned opposite the typeline. The stepping motor phase windings selected in the final step are energized with a reduced "holding" current which secures the motor, paper tractors, and paper in position when not paperfeeding. The stepping motor phase windings, which correspond to paperfeed stopping positions, depend upon the selected linespacing, as shown below:

Linespacing	*Motor Phase*			
	$\phi 1$	$\phi 2$	$\phi 3$	$\phi 4$
6 LPI:		X	X	
8 LPI: Alternately		X	X	
or	X			X

Because printers equipped with the 6/8 LPI option indicate the linespaces which are common to both 6 and 8 LPI only, the motor Step Strobe pulses generated between two successive 1/2-Inch Line Strobe pulses are divided into uniform groups which correspond to the positions of the intervening linespaces at the selected linespacing. Accordingly, Step Strobe pulses are tracked by an auxiliary counter which develops internal line strobe pulses that represent the intervening linespace positions.

The 6 LPI Strobe (or 1/2-Inch Strobe if equipped with the 6/8 LPI option) is used to synchronize the paperfeed control logic and the paperfeed mechanism. An infinite paper position-control, located at the left end of the paper tractor drive shaft, permits operator adjustment of the vertical position of paper with respect to the synchronized paperfeed system.

The principles of paperfeed control, briefly outlined in the preceding paragraphs for continuity, are fully described in paragraph 4.4 of this manual.

4.2.3 Ribbonfeed System

The ribbonfeed system transports towel-form ribbon from one mandrel to another past the typeline. As shown in Figures 4-1 and 4-4, the ribbonfeed mechanisms are all mounted on the yoke assembly in front of the paper path. The ribbonfeed system consists of an upper ribbon mandrel located ahead of the chaintrain and a lower ribbon mandrel located below the chaintrain, between which ribbon is wound past the typeline; corresponding upper and lower ribbon drive motors and clutches located at the left end of the yoke assembly; upper and lower ribbon sensor assemblies located at the left side of the ribbon path; and a ribbon tracking mechanism located at the right end of the yoke assembly.

Ribbon feeding is a controlled process that is accomplished by energizing the appropriate drive motor to wind ribbon alternately onto one mandrel, then the other. The ribbon is monitored for the physical end of ribbon, which is identified by reinforced holes , or translucent fabric leaders, located at both ends of the ribbon. To ensure full use, the direction of winding is reversed when the end of ribbon is detected. Ribbon life is maximized by continuously feeding ribbon during a print operation and by skewing the ribbon feed, which causes the moving ribbon to wander laterally along the typeline distributing ribbon use and compensating for any horizontal motion imparted from the moving chaintrain while printing. To ensure that ribbon is properly positioned laterally at the typeline, the ribbon is continuously edge-sensed. The direction of ribbon skew is reversed, by actuating the appropriate skewing solenoid, when the left edge of ribbon is detected at an allowable limit of ribbon wander.

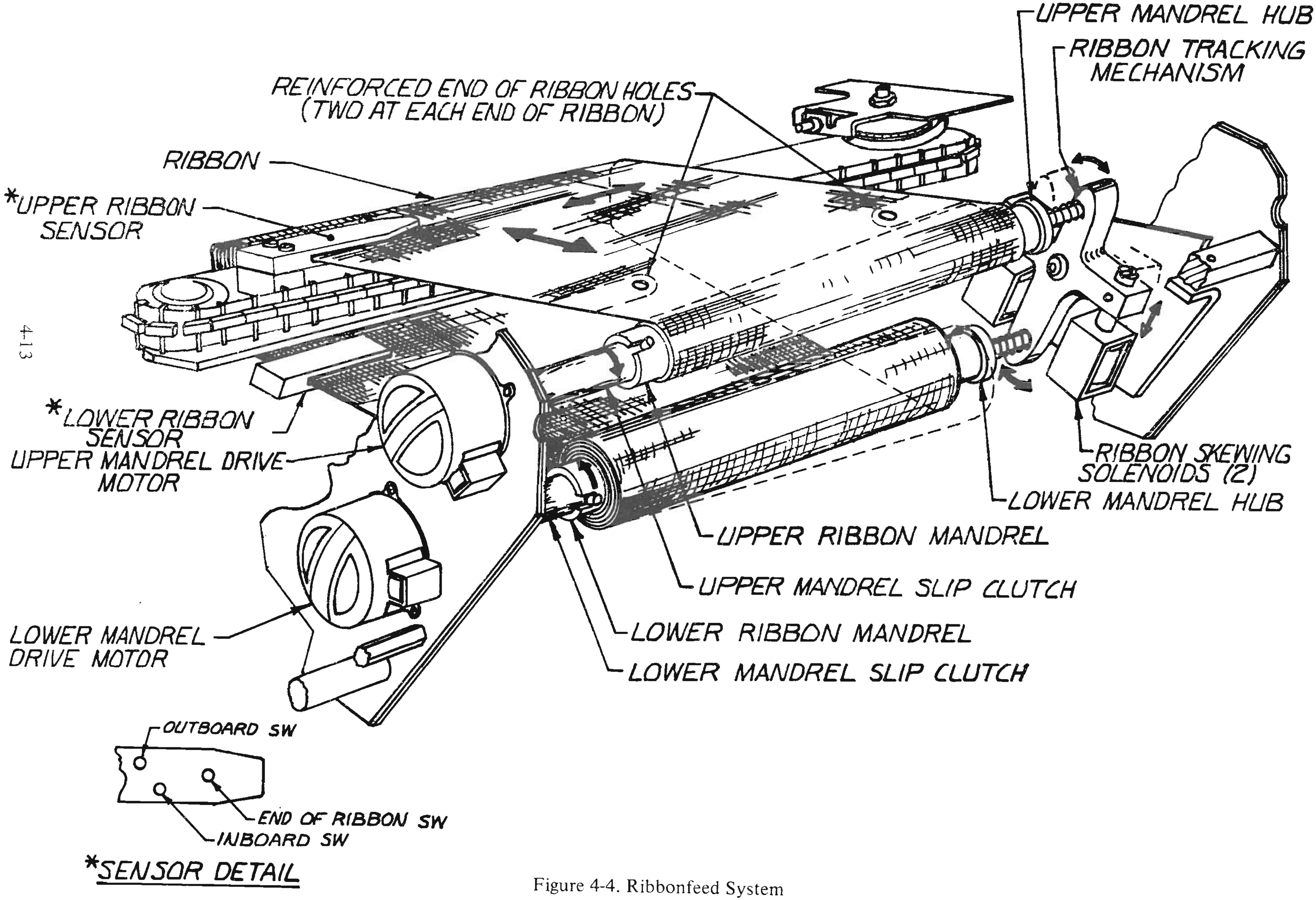

Figure 4-4. Ribbonfeed System

4.2.3.1 Ribbonfeed Mechanism

The ribbonfeed mechanism accepts 14-inch wide towel-form ribbon wound between two standard 15/16-inch O.D. mandrels. Each mandrel is removable and is supported between a drive hub and a corresponding spring-loaded idler hub. Ribbon is fed past the typeline by winding the ribbon onto either one of the two mandrels which are independently driven by an a-c motor associated with each mandrel. Mechanical drive from each motor is transferred through a slip clutch and drive hub to the associated mandrel which is coupled by a matching slot, located at the end of the mandrel, that engages a pin located on the rim of the drive hub.

While feeding ribbon, only one ribbon drive motor is energized at a time. When the upper drive motor is energized, ribbon is wound onto the upper mandrel, moving ribbon upwards past the typeline. Conversely, ribbon is wound onto the lower mandrel, moving ribbon downwards past the typeline, when the lower drive motor is energized. The ribbon motors are wired such that the upper drive hub is rotated in the clockwise direction and the lower drive hub is rotated in the counter-clockwise direction (as viewed from the mandrels); consequently, ribbon is wound onto the top side of the upper mandrel and onto the bottom side of the lower mandrel. The slip clutch associated with the motor which is not energized, engages a series of internal rings, applying a drag on the associated drive hub and mandrel from which ribbon is unwound. Each clutch is factory set to provide the proper ribbon tension to keep the ribbon taut at the typeline and to hold ribbon stationary when not ribbonfeeding.

In normal operation, ribbon is continuously fed whenever printing is required. Ribbon is wound alternately onto one, and then the other, mandrel. The application of a-c power to the ribbon drive motors is performed by the Ribbon Motor Control circuit board, located at the far end of the yoke assembly, under control of the Ribbon Control logic electronics which operate in conjunction with the End of Ribbon sensors.

4.2.3.2 Ribbon Reversing Mechanism

The ribbon reversing mechanism consists of two 5/8-inch diameter reinforced holes, or a translucent fabric leader, located at each end of the ribbon and two End-of-Ribbon photoswitches, one located in the upper sensor assembly and one located in the lower sensor assembly.

As shown in Figure 4-4, the ribbon sensors are located on the left side of the ribbon path. The upper sensor detects the end of ribbon, which is unwound from the upper mandrel, above the typeline: similarly, the lower sensor detects the end of ribbon, which is unwound from the lower mandrel, below the typeline. An End of Ribbon signal is generated at the respective sensor by the hole, or translucent leader, at the left edge of each end of the ribbon. As an end of ribbon feeds through the corresponding sensor, light from a LED passes through the hole, or translucent leader, energizing an associated photosensor, the output of which is amplified and shaped by a Darlington-connected transistor circuit. An End of Ribbon signal is used by the Ribbon Control logic to cause the opposite ribbon mandrel to be driven by switching power to the corresponding drive motor, reversing the direction of ribbon feed.

4.2.3.3 Ribbon Tracking Mechanism

The ribbon tracking mechanism skews the ribbonfeed mechanism such that the feeding ribbon is gradually displaced laterally, between limits, as it passes the typeline (as opposed to tracking ribbon straight). As shown in Figure 4-4, the ribbon tracking mechanism consists of a solenoid-operated skew arm, and an inside and an outside ribbon skew solenoid, all located at the right end of the yoke assembly; and an inboard and an outboard ribbon track sense photoswitch in each of the upper and lower ribbon sensor assemblies located to the left of the ribbon path.

The ribbonfeed mechanism and the feeding ribbon are skewed by the skew arm which is pivoted to rotate to either an inside or outside position corresponding to the driving solenoid. Drive from each solenoid is coupled by a plunger that is pinned to the corresponding side, inside or outside, of the skew arm. As shown in Figure 4-4, the right end of both ribbon mandrels engage corresponding idler hubs that are attached at opposite ends, equidistant from the pivot point, of the skew arm. Rotation of the skew arm revolves the hubs in unison about the pivot point displacing the right end of both ribbon mandrels from their true axial centers. This displacement of the mandrels causes ribbon to be wound in a helical fashion on the winding mandrel. Because the mandrels are not free to move laterally, the winding ribbon is laterally displaced as it "climbs" the helix. Consequently, ribbon is caused to feed along a continuously changing oblique course, or skew, which laterally displaces the moving ribbon proportionately throughout the ribbon path between mandrels and past the typeline. Ribbon is laterally displaced in the direction of the end of the winding mandrel which is positioned nearer the feeding (unwinding) mandrel and typeline. The skewing of both mandrels in unison maintains a constant distance along the ribbon path between mandrels.

Ribbon tracking is a controlled process that is accomplished by energizing the appropriate skew solenoid to skew the feeding ribbon alternately in one, then the other direction between predetermined fixed limits. In the standard buffered printer, ribbon tracking is performed automatically under control of the Ribbon Control logic electronics operating in conjunction with the ribbon track sense photoswitches. These switches detect the presence of the left edge of ribbon at the allowable limits of lateral displacement. Normally, the left edge of ribbon occupies a position somewhere between the right-most limit, designated the Inboard Limit, and the left-most limit, designated the Outboard Limit. The direction of ribbon skew, hence lateral displacement, is reversed when the left edge of ribbon is detected at either limit.

A separate set of inboard/outboard ribbon track sense photoswitches is associated with each ribbon mandrel. The ribbon track sense switches on the upper ribbon sensor assembly are used in conjunction with the upper ribbon mandrel; whereas the ribbon track sense switches on the lower sensor assembly are used in conjunction with the lower mandrel. The inboard and outboard switches are arranged on a sensor such as to permit a total lateral displacement of ribbon of approximately 0.1 inch. The sensor assemblies are located such that the inboard switches are at least 1/4-inch to the left of print hammer 1 (left-most position) to ensure that ribbon is always in position opposite the entire typeline.

Ribbon Track Sense signals are generated by the ribbon as it moves laterally between the guiding arms of a sensor assembly. As shown in Figure 4-5, as the left edge of ribbon moves laterally past a ribbon track sense switch, light from an associated LED passes (or is blocked, depending on direction) through the opening between the guide arms energizing (or de-energizing) a corresponding photosensor, the output of which is amplified and shaped by an associated self-contained Darlington-connected transistor circuit. Because it is the edge of ribbon that is detected, the sensing that ribbon has reached a limit is indicated by opposite signal levels from the inboard and outboard switches. Normally, as shown in Figure 4-5B, light is allowed to pass to an outboard sensor and is interrupted to an inboard sensor by the ribbon. When the ribbon edge reaches an outboard sensor as shown in Figure 4-5C, light is interrupted, turning that sensor off. However, when the ribbon edge reaches an inboard sensor, as shown in Figure 4-5A, light is allowed to pass, turning that sensor on.

Selection of the skew solenoid to be energized is determined by the recognition of the limit at which ribbon was sensed to have last reached and the direction of the ribbonfeed in progress. Because the direction of ribbon skew is determined by the skew position of the winding mandrel, the particular skew solenoid to be energized to laterally displace ribbon in a given direction depends upon the direction of ribbon feed, as follows:

Mandrel	*Solenoid*	*Displacement*
Upper	Inside	Inboard
Upper	Outside	Outboard
Lower	Inside	Outboard
Lower	Outside	Inboard

(Note that, when the direction of ribbon feed is reversed, the direction of ribbon mandrel skew must also be reversed to laterally displace ribbon in a given direction.)

4.3 PRINTER INTERFACE

The printer interface provides the control and data communications path between the buffered Chaintrain Line Printer and an external device. It controls the exchange of signals necessary to transfer data across the interface, and indicates the status of the printer and of paper in the printer to the external device. Remote control of the printer is provided basically by means of a print command and a paperfeed command for each line of print. A print command causes a line to be printed;

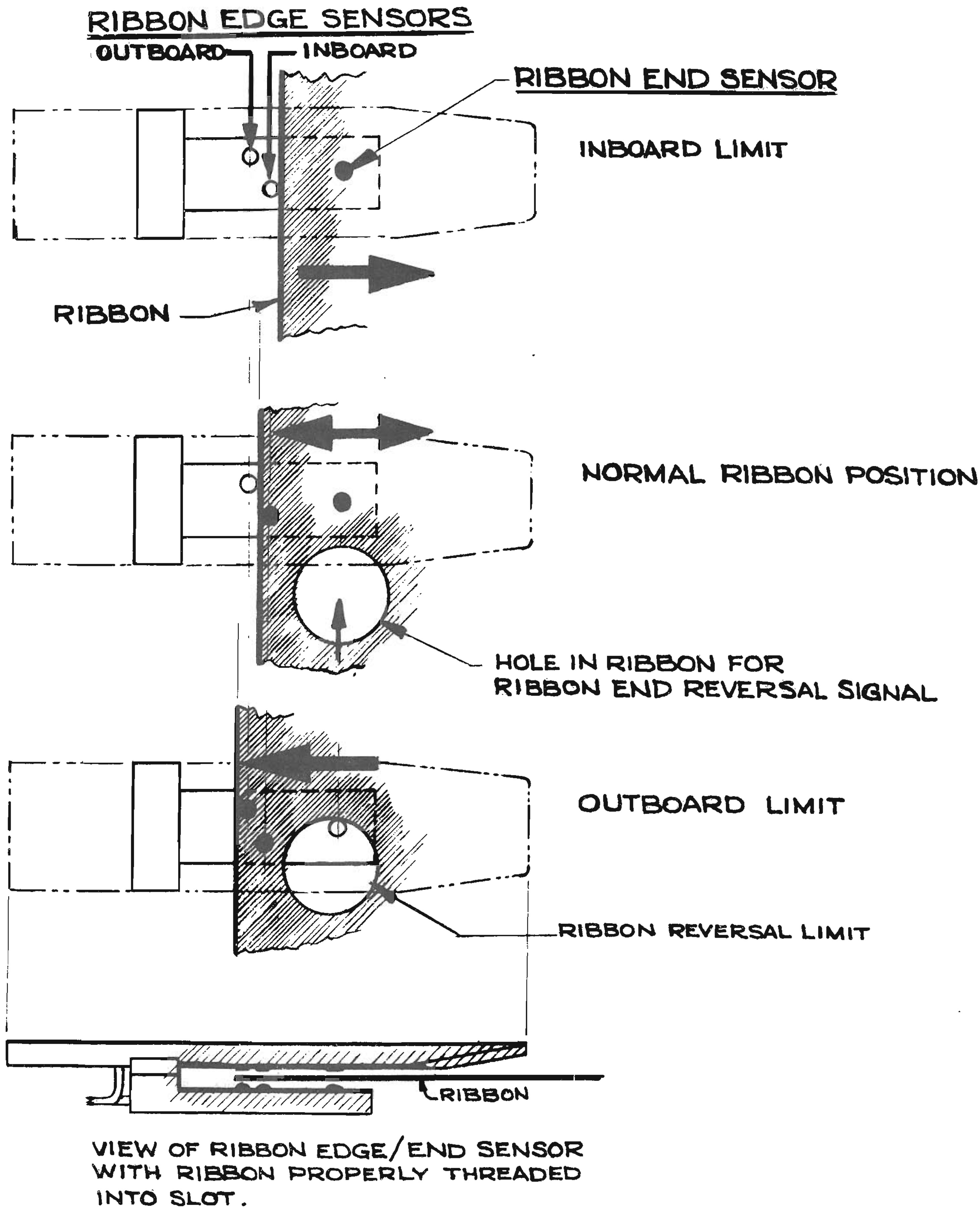

Figure 4-5. Ribbon Track Sense Photoswitches

a paperfeed command, executed alone, causes an immediate-feed operation. If a print command is accompanied by a paperfeed command, printing and paperfeeding are combined automatically in a delayed-feed after print mode of operation. Data for both print commands and paperfeed commands are transferred across the same bit-parallel, character-serial input data channel at externally-strobed rates of up to 500-K characters-per-second. Status and control signals are carried across the interface on separate lines.

Print commands are executed in a burst-mode which transfers all print data for a line of print before the mechanical action of printing the line takes place. Print data is transferred serial-by-character in the same order as it is to appear, left-to-right, in the left-justified printed line. This data is loaded into the printer's line buffer that provides character storage for all print positions in the typeline. The transfer of print data is stopped automatically when the printer buffer is full, or when the external device removes the print command signal. Upon termination of a print command, the mechanical action of printing is started and the external device is freed to perform other operations while the data stored in the printer's buffer is being printed out, thereby increasing overall system performance.

Upon completion of a printing and/or paperfeeding operation, the printer indicates a ready status to the external device which may then issue the command for the next operation at its convenience. The ready status is indicated immediately upon completion of the mechanical portion of the last operation so that the next command can be transferred during the machine delay interval(s) allowed for print hammer recovery and paper settling to permit the maximum thru-put of the printer to be achieved. Depending upon the required paper advance, delayed-feed (after print) operations are performed, and immediate-feed commands can be transferred and executed, in their entirety, during the print hammer recovery interval.

The printer interface can be provided in either of two basic configurations, namely; the Standard Interface Configuration which provides for separate control of print and paperfeed (see paragraph 4.3.1), or a First Character Interface Configuration which provides for combined control of print and paperfeed (see paragraph 4.3.2). Depending upon customer requirements, the printer may also be provided with an Input Parity Check feature[1] (see paragraph 4.3.3), a code converter for EBCDI-Coded print data[2,3] (see paragraph 4.3.4), or both. On the Chaintrain Line Printer, the vertical position of the forms in the printer is indicated at the printer interface (Vertical Format Output Drivers) as a standard feature on both the Standard Interface Configuration and the First Character Interface Configuration.

The standard Chaintrain Line Printer interface is fully compatible (mechanically, electrically, and functionally) with the corresponding configuration of the interface[4] provided on standard DPC drum-type line printers; Models F-80, F-132, F-236, F-306, V-132, V-236, and V-306. Thru-put is commensurate with the particular model of the Chaintrain Line Printer under consideration.

4.3.1 Standard Interface Configuration

The Standard Interface Configuration provides separate controls for print and paperfeed to permit the remote control of printing with independent, automatic, or combined control of paperfeeding. Paperfeed commands can be programmed separately from print commands, to provide an immediate-feed type of operation that may be programmed either in a feed-before-print, or in a feed-after-print sequence, whichever better suits the using system's requirements.

An Automatic Linefeed feature provides separately programmable automatic single, or double linespacing after each line of print, to permit "list" printout to be conveniently programmed without the necessity of a paperfeed command for each line; and/or automatic BOF-to-next-TOF paper skipping, to permit automatic perforation step-over operations (see paragraph 4.3.1.2.4).

Alternatively, a paperfeed command can be combined, in a "Last Character" mode, with the print command for each line of print to provide an automatic delayed-feed after print sequence of operations (see paragraph 4.3.1.2.5).

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(1) Optionally available on Standard Interface Configuration only.
(2) Standard feature on 48-character machines provided with AN, HN, or LC chaintrain arrangement; optional feature on all other models.
(3) Customer-specified print data coding is optionally available on all models.
(4) Reference: DPC Interface Specification S-1003, Rev. C; June, 1973

4.3.1.1 Interface Signal Line Definition

All printer interface signal lines, including those associated with the First-Character configuration and standard options, provided for use in communication between the Chaintrain Line Printer and an external device are depicted in Figure 4-6. The interface signal lines and their use are summarized below and are described in detail in the paragraphs that follow.

The printer interface signal lines and their uses are:

Interface Line	*Use*
RUN Out $\overline{\text{RUN}}$ Out PRINTER READY Out SEND DATA Out	Controls – used to indicate operational status of printer and response to commands from external device.
PRINT COMMAND In PAPERFEED COMMAND In (1) AUTOMATIC LINEFEED In (1) (2) DOUBLE LINE SPACE In (1) (2)	Commands – used by external device to control print and paper advance operations.
DATA BUS POSITION 1 In DATA BUS POSITION 2 In DATA BUS POSITION 3 In DATA BUS POSITION 4 In DATA BUS POSITION 5 In DATA BUS POSITION 6 In DATA BUS POSITION 7 In DATA STROBE In	Data Bus In – used to transfer print data and paperfeed instruction characters from the external device to the printer, parallel-by-bit, serial-by-character.
PAPER LOW Out VFU CHANNEL 1 Out VFU CHANNEL 2 Out VFU CHANNEL 8 (or 12) Out LINE STROBE Out	Status – used to indicate status of paper supply and position of forms in the printer.
DATA BUS POSITION 8 In (Opt) (3) PARITY ERROR Out (Opt) CLEAR In (Opt)	Parity Check Option – used to complete character parity of input data, and indicate and clear parity alarm.

(1) Not provided on First Character Interface Configuration.
(2) Not recommended for use in "Last Character" mode.
(3) Used to complete 8-bit byte if required (Opt): such use precludes Input Parity Check option.

4.3.1.1.1 RUN Out (J221-1/14)[5]

A line from the printer to the external device which, when high (logic "1" level), indicates that the printer is "on-line", that is; the printer is ready for operation and the printer interface is enabled for communication with the external device.

4.3.1.1.2 $\overline{\text{RUN}}$ Out (J221-5/18)

A line from the printer to the external device which, when low (logic "O" level), indicates that the printer is "on-line". This signal is the complement of the RUN signal (J221-1/14) and is provided to permit the external device to sense the true status of the printer interface when printer power is off or when the interconnecting signal cable between the printer and the external device is disconnected. Depending

(5) The notation enclosed in parentheses ( ) denotes the interface connector and the pin connections of the signal/return for the listed signal line.

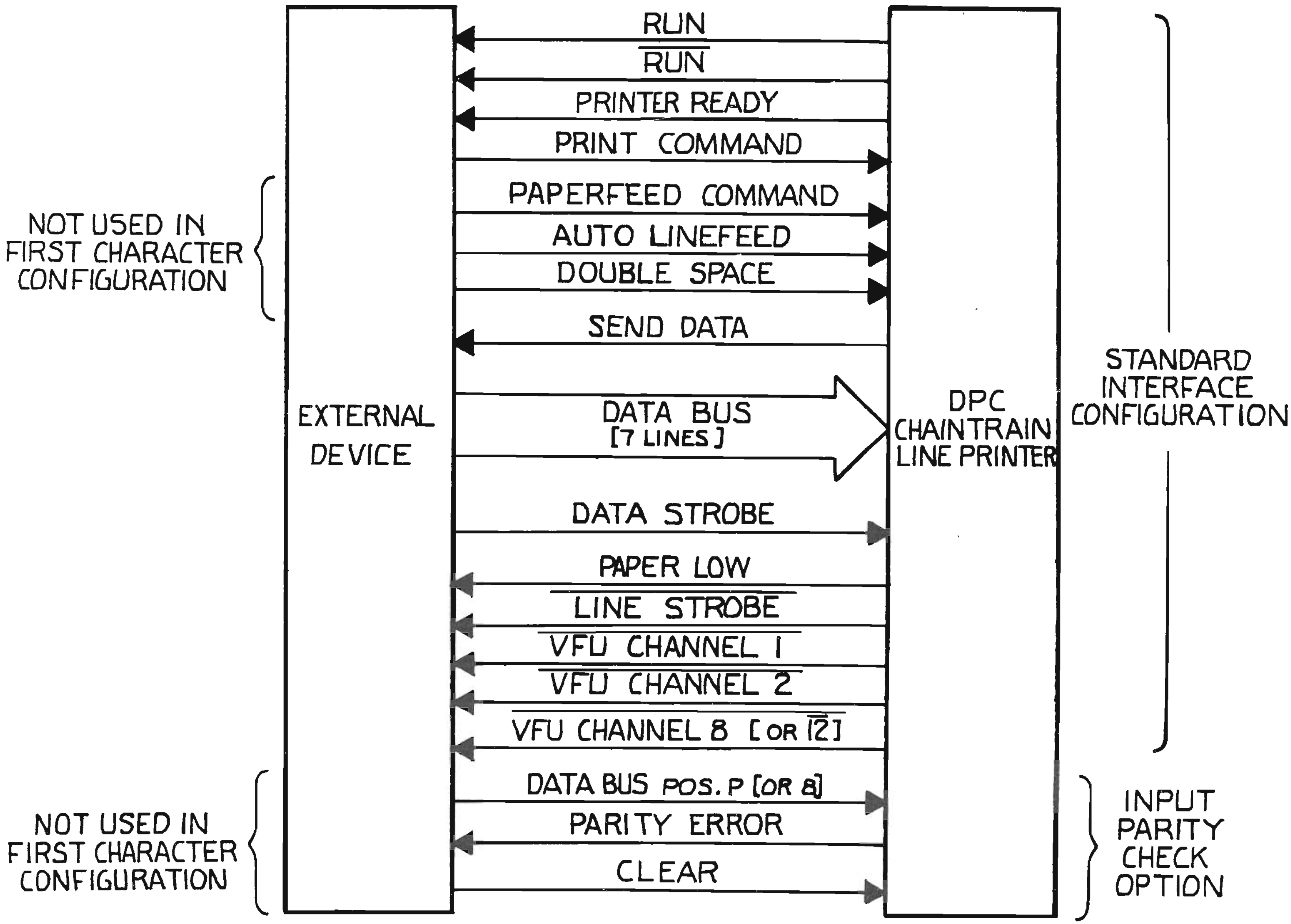

Figure 4-6. Printer Interface Signal Lines

upon the nature of the line termination at the receiver end, the RUN signal input at the external device may provide a false indication of the status of the printer interface under such power and cable conditions.

4.3.1.1.3 PRINTER READY Out (J221-2/15)

A line from the printer to the external device which, when high, indicates that the printer is ready to accept a command. PRINTER READY remains high until the transfer of a command is complete, that is; during the loading of all information characters into the printer buffer; and goes low upon detection of the fall (high-to-low level transition) of the appropriate COMMAND line. The PRINTER READY signal remains low while the printer is busy executing the accepted command(s) and goes high upon completion of the mechanical portion of all specified operation(s).

4.3.1.1.4 PRINT COMMAND In (J222-4/17)

A line from the external device to the printer that is used to designate the transfer of print information for a line of print to the printer and, subsequently, to initiate the printing of that information. When PRINTER READY is high, the rise (low-to-high level transition) of PRINT COMMAND initiates a Load Data cycle during which print data characters are transferred to the printer's line buffer (see paragraph 4.3.1.1.6; SEND DATA). Once initiated, the Load Data cycle is maintained as long as PRINT COMMAND remains high or until a buffer-full condition is sensed at the printer.

The Load Data cycle is terminated either upon detection of the fall of PRINT COMMAND or automatically upon detection that a data character has been loaded into the printer's line buffer for the last print position in the typeline. The termination of the Load Data cycle is indicated at the printer interface by the fall of SEND DATA. Upon sensing the termination of the Load Data cycle, the external device must remove the PRINT COMMAND, if high, to initiate printing. The fall of PRINT COMMAND initiates a Print cycle during which the mechanical action of printing the stored data is performed.

4.3.1.1.5 PAPERFEED COMMAND In (J222-3/16)[6]

A line from the external device to the printer that is used to designate the transfer of a paperfeed instruction to the printer and, when transferred independently of PRINT COMMAND, to subsequently initiate the designated paper advance operation. When PRINTER READY is high, the rise of PAPERFEED COMMAND initiates a Load Paperfeed cycle during which one paperfeed instruction character is transferred to the printer (see paragraph 4.3.1.1.6; SEND DATA). Once initiated, The Load Paperfeed cycle is maintained as long as PAPERFEED COMMAND remains high or until a paperfeed instruction is accepted by the printer.

The Load Paperfeed cycle is terminated automatically upon detection that a paperfeed instruction character has been loaded into the printer buffer's paperfeed control circuits (indicated at the printer interface by the fall of SEND DATA). Upon sensing the termination of the Load Paperfeed cycle, the external device must remove the PAPERFEED COMMAND to enable execution of the paperfeed instruction. When a PRINT COMMAND is not present, or stored, the fall of PAPERFEED COMMAND initiates a Feed Paper cycle during which the mechanical action of moving paper is performed.

When a PAPERFEED COMMAND accompanies a PRINT COMMAND, a Load Paperfeed cycle is started, and takes precedence if a Load Data cycle is in progress, upon recognition of the PAPERFEED COMMAND: however, execution of the instruction so transferred is automatically delayed until the mechanical action of printing the associated print data has been completed (see "Last Character" mode; paragraph 4.3.1.2.5).

(6) Provided on Standard Interface Configuration only.

4.3.1.1.6 SEND DATA Out (J221-4/17)

A line from the printer to the external device which, when high, indicates that the printer recognizes a command and is ready to accept the transfer of information characters.

When responding to PRINT COMMAND, the rise of SEND DATA indicates the start of a Load Data cycle and that the printer is ready to accept data for printing on a line. When responding to PAPERFEED COMMAND, the rise of SEND DATA indicates the start of a Load Paperfeed cycle and that the printer is ready to accept the next data character as a paperfeed instruction. SEND DATA remains high as long as the printer is ready to accept data, that is; for the duration of either load cycle. SEND DATA is removed (goes low) upon termination of a load cycle; or if one load cycle is started while the other is in progress, upon termination of the last load cycle to be completed (see "Last Character" mode; paragraph 4.3.1.2.5).

4.3.1.1.7 DATA STROBE In (J222-5/18)

A line from the external device to the printer which, when high, indicates that valid data is present on the DATA BUS lines. When SEND DATA is high, one complete cycle (rise-fall) of DATA STROBE effects the transfer of an information character to the printer.

4.3.1.1.8 DATA BUS In Lines (J222-6/19 through 12/25)

Seven lines, designated BUS 1 through BUS 7, from the external device to the printer that are used to transfer print data and paperfeed instruction characters to the printer. Only one type of information can be transferred at a time as designated by the accompanying command.

Information on the DATA BUS In lines is transferred parallel-by-bit, serial-by-character by an externally-generated DATA STROBE pulse for each character. The DATA BUS In lines are arranged such that BUS 1 always carries the least significant (low-order) data bit, and BUS 2 through BUS 7 carry the remaining bits in ascending order. This arrangement corresponds directly with standard USASCII bit positions, and with EBCDI-Coded data bit positions as shown in Table 4-1, below.

Table 4-1. Organization of DATA BUS In Lines

DATA BUS (Line Position)	BINARY (Position Value)	USASCII (Bit Position)	EBCDIC[1] (Bit Position)
1	1	1	7
2	2	2	6
3	4	3	5
4	8	4	4
5	16	5	3
6	32	6	2
7	64	7	1
8[3]	128	P[2]	0

(1) Standard feature on machines provided with 48-character AN, HN, or LC chaintrain arrangement; optional on all others.
(2) Optionally available on Standard Interface Configuration only.
(3) Option; see text, below.

DATA BUS In lines 1 through 7 are required as a minimum to transfer paperfeed instruction characters. Depending upon the print data code and chaintrain arrangement provided, up to seven USASCII or eight EBCDIC bit positions may be necessary to transfer print information characters. When less than a full complement of bit positions is required to transfer print data, the printer ignores the unused bit positions (see Appendix B).

4.3.1.1.9 AUTO LINEFEED In (J222-1/14)[7,8]

A line from the external device to the printer that is used to program automatic post-print linefeed and automatic BOF-to-TOF[9] paper skip operations. When AUTO LINEFEED is high at the termination of a Print cycle (i.e.; upon completion of the mechanical action of printing a line), the printer automatically advances paper a single or double linespace (see DOUBLE SPACE, below). If a BOF position is detected during an automatic linefeed operation, the printer automatically continues advancing paper to the next TOF position.

When AUTO LINEFEED is high during execution of a Skip-to-BOF or any Spacing (Skip-"n"-Lines) PAPERFEED COMMAND, and a BOF position is detected, the printer automatically converts the stored paperfeed instruction to a Skip-to-TOF command and stops the paper advance at the next TOF position. The remainder, if any, of a Spacing command so modified is discarded. Except for a Skip-to-BOF command, all other Skip-to-Channel commands result in a paper advance to the channel specified regardless of the state of AUTO LINEFEED.

4.3.1.1.10 DOUBLE SPACE In (J221-10/23)[7,8]

A line from the external device to the printer which, when high, in conjunction with AUTO LINEFEED, programs a double-linespace automatic post-print linefeed operation.

4.3.1.1.11 PAPER LOW Out (J221-12/25)

A line from the printer to the external device that is used to inducate the status of the paper supply in the printer. The rise of PAPER LOW indicates that paper is nearly depleted; that is, less than half of the last 11-inch (27,94-cm) form, or less than approximately 5.5 inches (14 cm) of paper, remains to be printed. The advance of paper to the next linespace (i.e.; the next paperfeed Line Strobe) following the detection of a paper low condition, causes the printer to switch to the STOP mode at the completion of the associated paperfeed operation (indicated at the printer interface by RUN going low).

After the printer switches to the STOP mode, if a paper out condition does not exist, the remainder of the form currently in printing position can be printed under operator control. Printing will continue as long as the RUN pushbutton switch is held down (depressed) or until the next TOF position is detected by the printer. Normally, the next TOF position indicates that the last form has moved completely out of the print position and that a paper out condition exists, which inhibits continued operation of the printer in the remote-RUN mode until the paper supply is replenished.

4.3.1.1.12 $\overline{\text{LINESTROBE}}$ Out (J221-20/7)

A line from the printer to the external device that is used to indicate each linespace of paper advance and, when low, to indicate that valid data is present on the $\overline{\text{VFU CHANNEL}}$ Out lines. A negative-going pulse of approximately five microseconds is generated for each linespace the paper tractors, and paper, are advanced by the printer.

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(7) Provided on Standard Interface Configuration only.
(8) Function available as a convenience to the user, and as such is not necessary for proper operation. Function is not recommended for use in the "Last Character" mode. When not required, the signal line should be terminated to its respective return or d-c ground. If specified at the time of order, the signal line(s) will be terminated at the printer at the time of manufacture.
(9) BOF and TOF positions are designated by the format tape used; see paragraph 4.2.2.5.

4.3.1.1.13 VFU CHANNEL Out Lines (J221-21/8; -24/11; -19/6)

Three lines, designated VFU CH 1, VFU CH 2 and VFU CH 8/12, from the printer to the external device that are used to transfer vertical forms position information to the external device. A low level on any of these lines during a LINE STROBE pulse indicates that the paper tractors, and paper, have advanced to the position designated by a punch in the corresponding channel of the vertical format tape. Normally, the VFU CH 8/12 line is arranged to correspond with the last channel of the VFU provided. (Refer to paragraph 4.2.2.5; Vertical Format Unit, for detail information.)

4.3.1.1.14 DATA BUS 8 In (J222-2/15)[10]

An optional line from the external device to the printer that is used to transfer the character parity bit when provided in conjunction with the Input Parity Check option (see paragraph 4.3.3) or to transfer the most significant data bit (EBCDIC bit position "O") when provided in conjunction with chaintrain arrangements requiring eight-bit print data (see Table 4-1). The data on this line is transferred in conjunction with the transfer of data on the DATA BUS In lines.

4.3.1.1.15 PARITY ERROR Out (J221-3/16)[11]

An optional line from the printer to the external device which, when high, indicates that the printer has detected an error in the character parity of input data. (Refer to paragraph 4.3.3 for details.)

4.3.1.1.16 CLEAR In (J221-9/22)[12]

An optional line from the external device to the printer that is used to clear a parity error indication and to cancel any load or print operation in progress at the printer (refer to paragraph 4.3.3 for details).

4.3.1.2 Standard Interface Operation

Functionally, the operation of the Standard Interface Configuration may be considered as consisting of four basic sub-cycles (called "cycles" in the descriptions that follow, for clarity). These cycles are: the *Load Data* cycle, during which print data is transferred from the external device to the printer's line buffer; the *Print* cycle, during which the mechanical action of printing the stored data is performed; the *Load Paperfeed* cycle, during which a single paperfeed instruction character is transferred from the external device to the printer; and the *Feed Paper* cycle, during which the mechanical action of advancing paper is performed. Each *Print* cycle is automatically followed by a fixed machine-delay that allows for the print hammers and actuators to recover, and each *Feed Paper* cycle is automatically followed by a fixed machine-delay that allows for paper to settle, before the next *Print* cycle is permitted to be started. In order to achieve maximum throughput, the interface logic is arranged to permit either load cycle to occur during either machine delay, and to permit the *Feed Paper* cycle to occur during the print hammer recovery interval. Separate delays independently govern the maximum repetition rate of the *Print* and *Feed Paper* cycles to be safely within the design limitations of the printer.

4.3.1.2.1 Typical Machine Cycle

For the purpose of this discussion, the interval from the beginning of operations for one line of print to the corresponding beginning of operations for the next line of print is called a "machine cycle". In the normal mode of operation with the Standard Inter-

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(10) Provided with either Input Parity Check Option (Std. Interface Configuration only) or with 8-bit print data; these options are mutually exclusive.

(11) Input Parity Check Option; available on Std. Interface Configuration only.

(12) Input Parity Check Option; available on Std. Interface Configuration only. Clear is connected to DC RTN on units not equipped with the Input Parity Check Option.

face Configuration, print and paperfeed operations are programmed and executed independently of one another; hence, a typical machine cycle will consist of the load and mechanical action cycles, and the appropriate machine-delay interval, for both a print operation and a separate feed operation. These cycles and delays can be considered as being performed in six steps as listed, together with their interface connotations, below:

Step	*Sub-cycle*	*Interface Connotation*
A.	Load Data	Transfer Print Information
B.	Print	No Operation (Printer Busy)
C.	Hammer Recovery	Jump to D (Machine Delay)
D.	Load Paperfeed	Transfer Paperfeed Instruction
E.	Feed Paper	No Operation (Printer Busy)
F.	Paper Settle	Jump to A (Machine Delay)

In the normal mode of operation, the printer will be ready to accept the next command upon completion of a *Print* cycle (B) or a *Feed Paper* cycle (E); that is, during the respective machine-delay interval (C) or (F). Therefore, to maximize throughput, the *Load Data* cycle (A) is usually performed during the Paper Settle interval (F), and the paperfeed operations (cycles D and E, and interval F) generally occur during the Hammer Recovery interval (C). A machine cycle may commence with the *Load Data* cycle (A) or the *Load Paperfeed* cycle (D), depending upon the desired sequence of the print and paperfeed operations for a line of print.

Operation of the Standard Interface Configuration in the normal mode is depicted in Figure 4-7; Interface Timing Diagram. This diagram shows the relationship of the basic cycles and the pertinent interface signals, in a print-then-feed sequence of operations, for a typical machine cycle. Numbers enclosed in parentheses ( ) along each waveform denote the usual sequence of events, and are used to key the descriptions that follow. An Interface Flow Diagram, that depicts the logical sequence of events, is provided in Appendix A for the reader's reference.

As shown in Figure 4-7, communication between the external device and the printer is performed under control of the printer buffer electronics, and is normally accomplished by the exchanging of interactive control signals (PRINTER READY, PRINT or PAPERFEED COMMAND, and SEND DATA) and the transfer of externally-strobed information (on the DATA BUS) for each print or paperfeed operation. The interface signal sequences and operations associated with PRINT and PAPERFEED COMMAND signals are described in detail for all modes of operation (normal, automatic linefeed, and Last Character) in the paragraphs that follow.

4.3.1.2.2 Print Command Signal Sequence

As shown in Figure 4-7, the printer notifies the external device that it is "on-line" by raising RUN (1) and dropping $\overline{\text{RUN}}$ (not shown). The rise of PRINTER READY (2) indicates that the printer is ready to accept a command. The external device responds to PRINTER READY by raising PRINT COMMAND. The printer, in turn, responds to the appearance of PRINT COMMAND (3) by raising SEND DATA (4), indicating the start of a *Load Data* cycle [A]. The external device may now proceed with the transfer of print information characters. (Note - Events (2) and (3) may occur in reverse order; see Timing Considerations, paragraph 4.3.5.)

Print information is transferred serially-by-character in the same order as the corresponding printout is to appear in the printed line, from left-to-right commencing with print position (column) 1. The transfer of information is accomplished by the external device placing the bit pattern (code) for a character on the DATA BUS (5) and generating an associated DATA STROBE pulse (6). This process, (5) and (6), is repeated for each character to be transferred until all characters for a line of print have been transferred; that is, until the printer buffer is full or the external device terminates the transmission.

In the event of a buffer-full condition (as shown in Figure 4-7), the printer responds to the transfer of the last character (7) by dropping SEND DATA (8). The external device responds to the fall of SEND DATA by dropping PRINT COMMAND. The printer, in

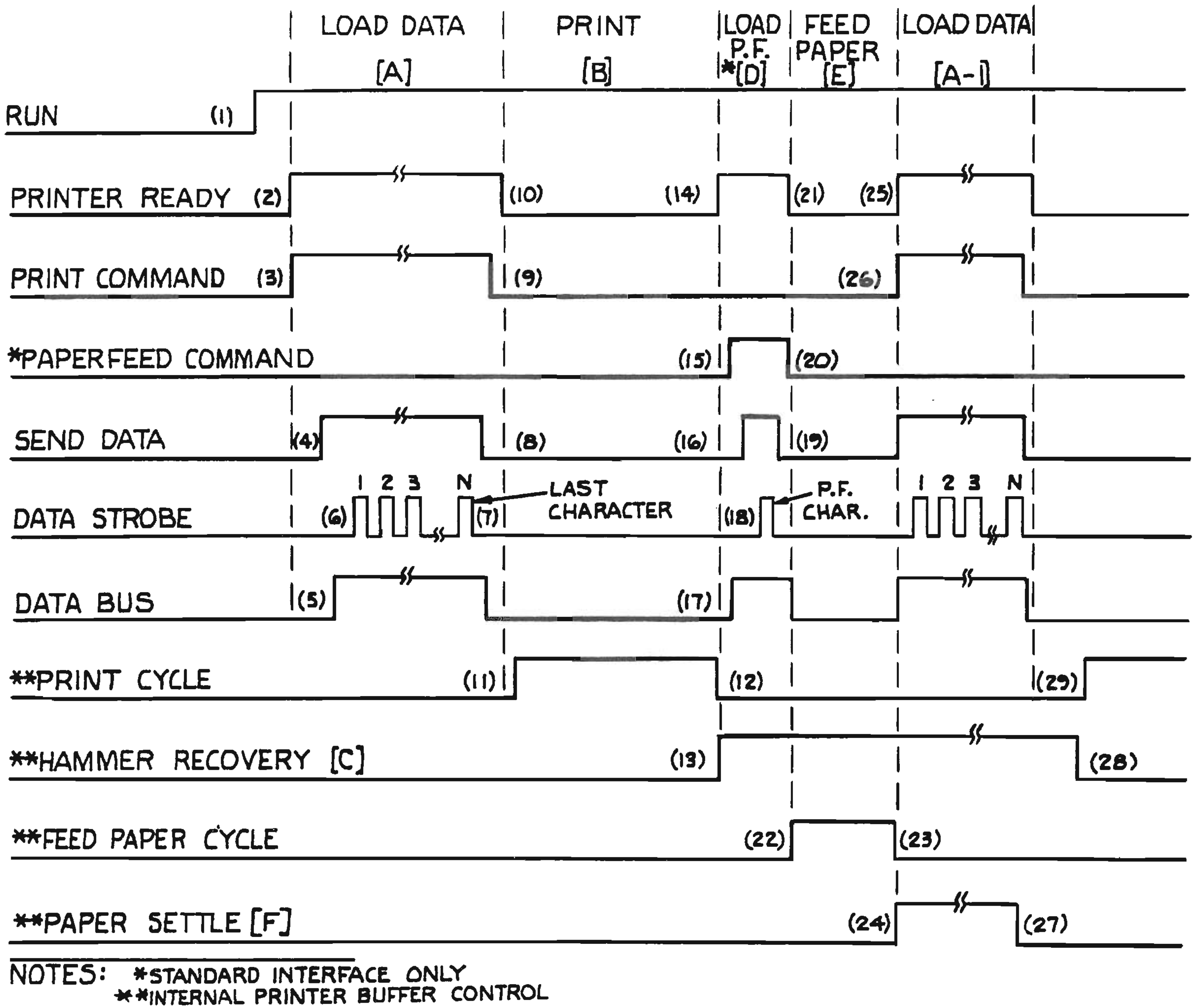


Figure 4-7. Interface Timing Diagram

turn, responds to the fall of PRINT COMMAND (9) by dropping PRINTER READY (10), indicating the start (11) of the *Print Cycle* [B]. (Note - Any data appearing at the printer interface when SEND DATA is low, will be ignored; that is, it will not be stored and will not be printed.)

In the case of a short line (one having less characters, including spaces, than the number of available print positions), the external device may terminate the transmission by dropping PRINT COMMAND after transferring the last character. As shown in Figure 4-8, the printer will respond to the fall of PRINT COMMAND (a) by immediately dropping both SEND DATA (b) and PRINTER READY (c), indicating the termination of the *Load Data* cycle [A] and the start (d) of a *Print* cycle [B], respectively. Printing will not occur in those print positions for which no data was transferred.

The printer holds PRINTER READY low for the duration of the *Print* cycle. As shown in Figure 4-7, when the printer buffer has been emptied and all required print hammers have been fired, the *Print* cycle [B] is concluded (12) and a machine-delay interval [C] is started (13). This delay inhibits the start (29) of the next *Print* cycle until the print hammers that were fired during the *Print* cycle [B] just completed are allowed to recover. In conjunction with the start of the Hammer Recovery interval [C], the printer raises PRINTER READY (14) to indicate that it is not busy and is ready to accept the next command.

4.3.1.2.3 Paperfeed Command Signal Sequence (Normal Mode)

In the normal mode of operation, as shown in Figure 4-7, when a *Print* cycle is concluded (12) the printer again raises PRINTER READY (14) to request the next command. The external device normally responds to *this* PRINTER READY by raising PAPERFEED COMMAND. The printer, in turn, responds to the rise of PAPERFEED COMMAND (15) by raising SEND DATA (16), indicating the start of a *Load Paperfeed* cycle [D]. (Note - Events (14) and (15) may occur in reverse order; see Timing Considerations, paragraph 4.3.5.)

The external device may now transfer a single (one) paperfeed instruction character to the printer. This is accomplished by the external device placing the bit pattern (code) for the desired paperfeed instruction on the DATA BUS (17) and generating an associated DATA STROBE pulse (18).

The printer responds to the transfer of the paperfeed instruction by dropping SEND DATA (19), indicating completion of the *Load Paperfeed* cycle [D]. The external device then responds to the fall of SEND DATA by dropping PAPERFEED COMMAND. The printer, in turn, responds to the fall of PAPERFEED COMMAND (20) by dropping PRINTER READY (21), indicating the start (22) of a *Feed Paper* cycle [E].

The printer holds PRINTER READY low for the duration of the *Feed Paper* cycle [E] to indicate that the printer is busy. When paper has been advanced to the position designated by the paperfeed instruction, the *Feed Paper* cycle is concluded (23) and a separate machine-delay interval [F] is started (24). This delay inhibits the start (29) of the next *Print* cycle until the paper, which was in motion during the *Feed Paper* cycle [E] just completed, is allowed to settle. In conjunction with the start of the Paper Settle interval [F], the printer raises PRINTER READY (25) to indicate that it has completed the paperfeed operation and is ready to accept the next command.

The external device may now initiate a repetition of the print and paperfeed command signal sequences as described in the foregoing paragraphs for the next line of print (i.e.; next machine cycle). Typically, as shown in Figure 4-7, the external device responds to the rise of PRINTER READY (25) following a PAPERFEED COMMAND by raising PRINT COMMAND (26) which initiates the next *Load Data* cycle [A-1]. (Note - Events (25) and (26) may occur in reverse order.) Usually the next *Load Data* cycle [A-1] occurs during the Paper Settle interval [F] following the immediately preceding *Feed Paper* cycle and, because of the short time required to complete some paperfeed operations, may also occur during the Hammer Recovery interval [C] following the last *Print* cycle [B]. When the *Load Data* cycle [A-1] is completed and the associated PRINT COMMAND is removed (goes low) while either of these delay-intervals are in progress, the printer will inhibit the start of the next *Print* cycle (29) until both machine delays [C] and [F] have elapsed (27, 28).

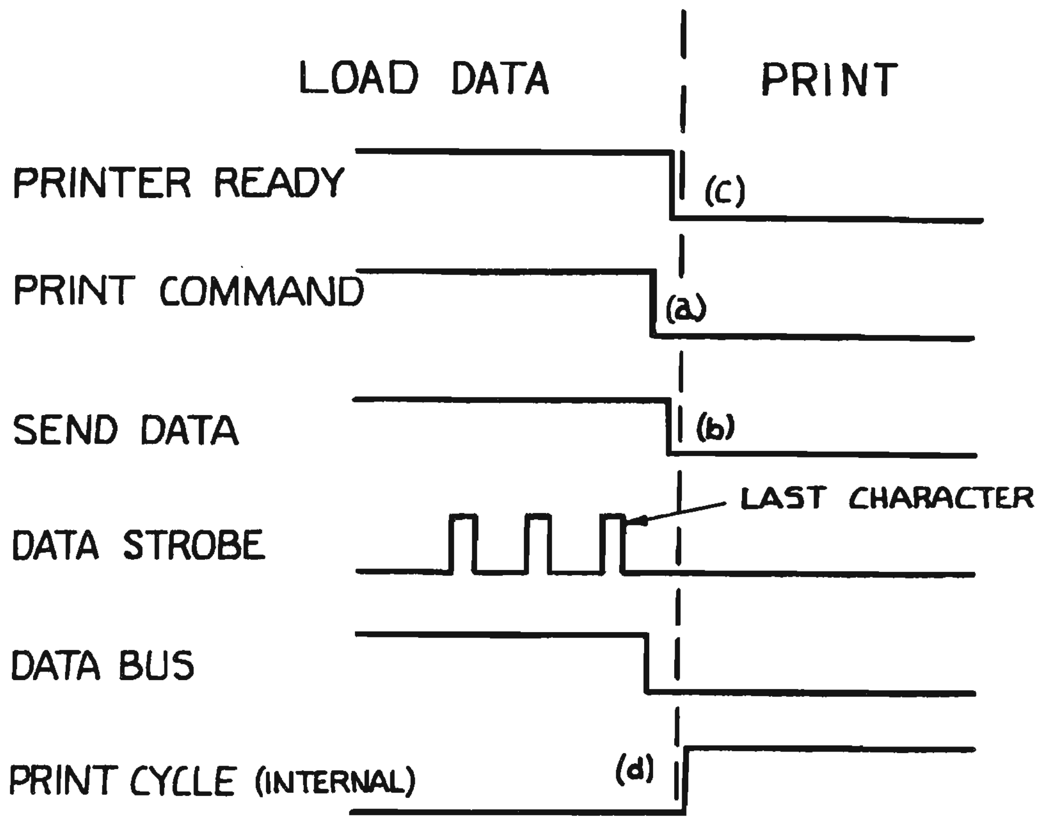


Figure 4-8. Signal Sequence, Remote Termination of PRINT COMMAND

4.3.1.2.4 Automatic Linefeed

The Automatic Linefeed feature provided on the Standard Interface Configuration is enabled by the external device simply raising AUTO LINEFEED and, if required, DOUBLE SPACE during the appropriate period of a machine cycle, depending upon the type of operation required, namely; automatic single, or double space, post-print linefeed (List-type printout) or programmed BOF-to-next-TOF paper skip (perforation step-over).

Automatic Post-Print Linefeed: When AUTO LINEFEED is high at the conclusion of a *Print* cycle, the printer automatically initiates a *Feed Paper* cycle without the necessity of a PAPERFEED COMMAND and associated *Load Paperfeed* cycle. Hence, AUTO LINEFEED may be used in lieu of PAPERFEED COMMAND when a single or double-spaced feed-after-print mode of operation is required.

Since PRINTER READY is maintained low for the duration of a *Print* cycle, there is no indication of the impending conclusion of a *Print* cycle. Consequently, the external device must anticipate the termination of the appropriate *Print* cycle to properly enable the automatic linefeed function. As shown in Figure 4-9, in response to the fall of the appropriate PRINTER READY (a), the external device should raise AUTO LINEFEED (b) and, if required, DOUBLE SPACE (c). Upon completion of the subsequent *Print* cycle (d), the printer will automatically initiate a *Feed Paper* cycle (e) to advance paper either one linespace or, if DOUBLE SPACE is high, two linespaces (f).

The automatic linefeed function operates in conjunction with the VFU to also provide an automatic paper skip to the next TOF position if a BOF position is detected while performing an automatic linefeed operation. As shown in Figure 4-9, if a hole is detected in the last VFU channel (k) during an automatic *Feed Paper* cycle [E], that *Feed Paper* cycle will continue until a hole is detected in the first VFU channel (1).

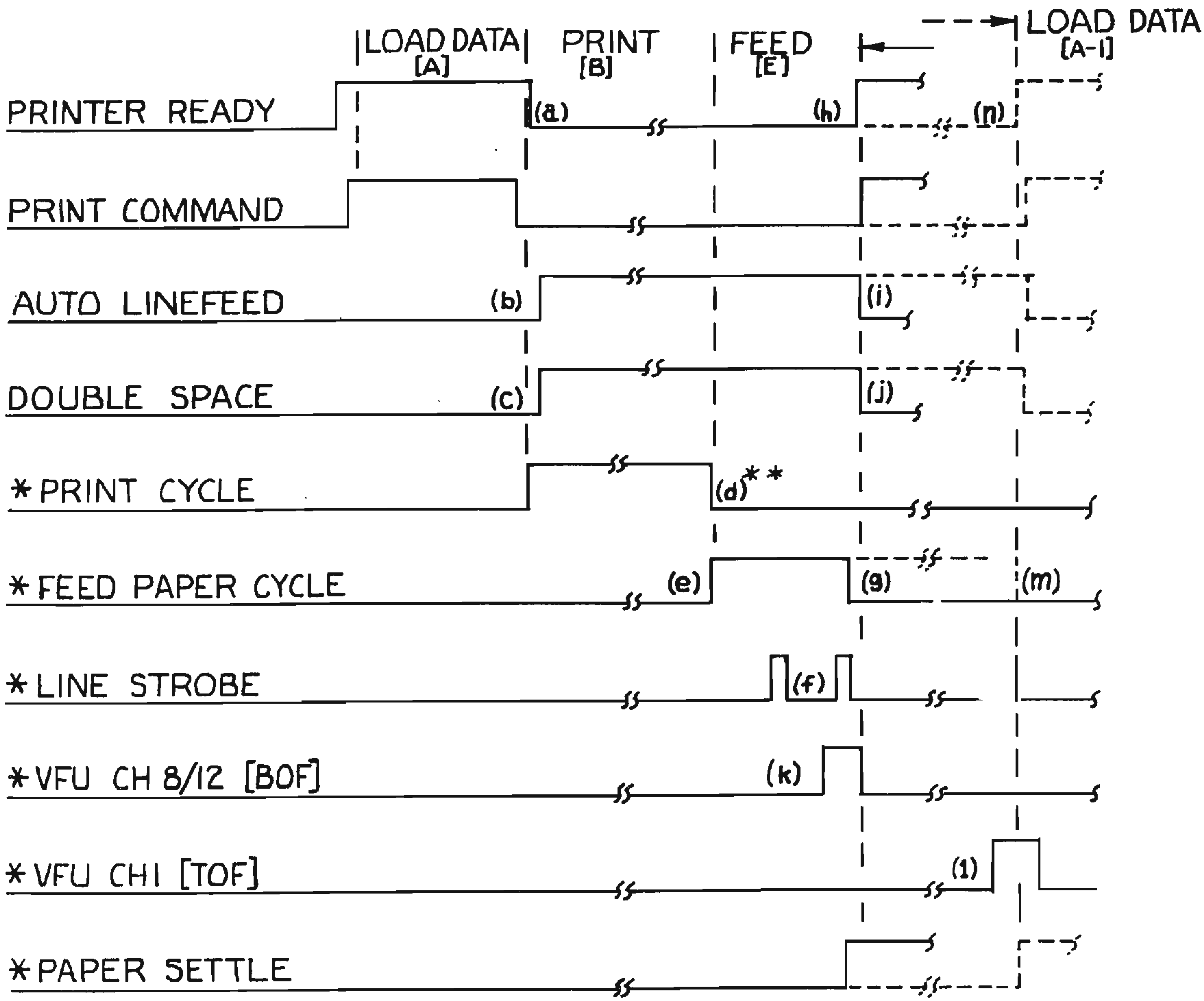
AUTO LINEFEED and, if required, DOUBLE SPACE should be maintained high for the duration of the *Print* [B] and *Feed Paper* [E] cycles until the next rise of PRINTER READY (h or n) which indicates that the printer has completed the print and subsequent automatic linefeed operations. When continuous operation in this manner is required, as when producing list-type printout, the automatic linefeed feature may be enabled throughout an entire operation by the external device holding AUTO LINEFEED and, if required, DOUBLE SPACE high at all times. This enables both the automatic post-print linefeed and the automatic paper skip functions as described in the preceding paragraphs.

Programmed Automatic BOF-to-next-TOF Paper Skip: When operating in the normal mode, if AUTO LINEFEED is high during a *Feed Paper* cycle which was initiated by a PAPERFEED COMMAND to Skip-to-BOF or to Space from 1 to 63 Lines, and a BOF position is detected while feeding, the printer will automatically convert the stored paperfeed instruction to a Skip-to-TOF command and will stop the current paper advance at the next TOF position[13]. Hence, AUTO LINEFEED may be used as a command modifier to provide automatic perforation step-over operations.[14]

As shown in Figure 4-10, the external device may raise AUTO LINEFEED (b) in conjunction with PAPERFEED COMMAND (a) or, at the latest, in response to the fall of PRINTER READY (c) dollowing PAPERFEED COMMAND. The ensuing *Feed Paper* cycle [E] will be performed as designated by the PAPERFEED COMMAND unless a BOF position is detected. If a hole is detected in the last VFU channel (e) during the *Feed Paper* cycle, the remainder of the stored paperfeed instruction will be discarded and the *Feed Paper* cycle will be continued until a hole is detected in the first VFU channel (f).

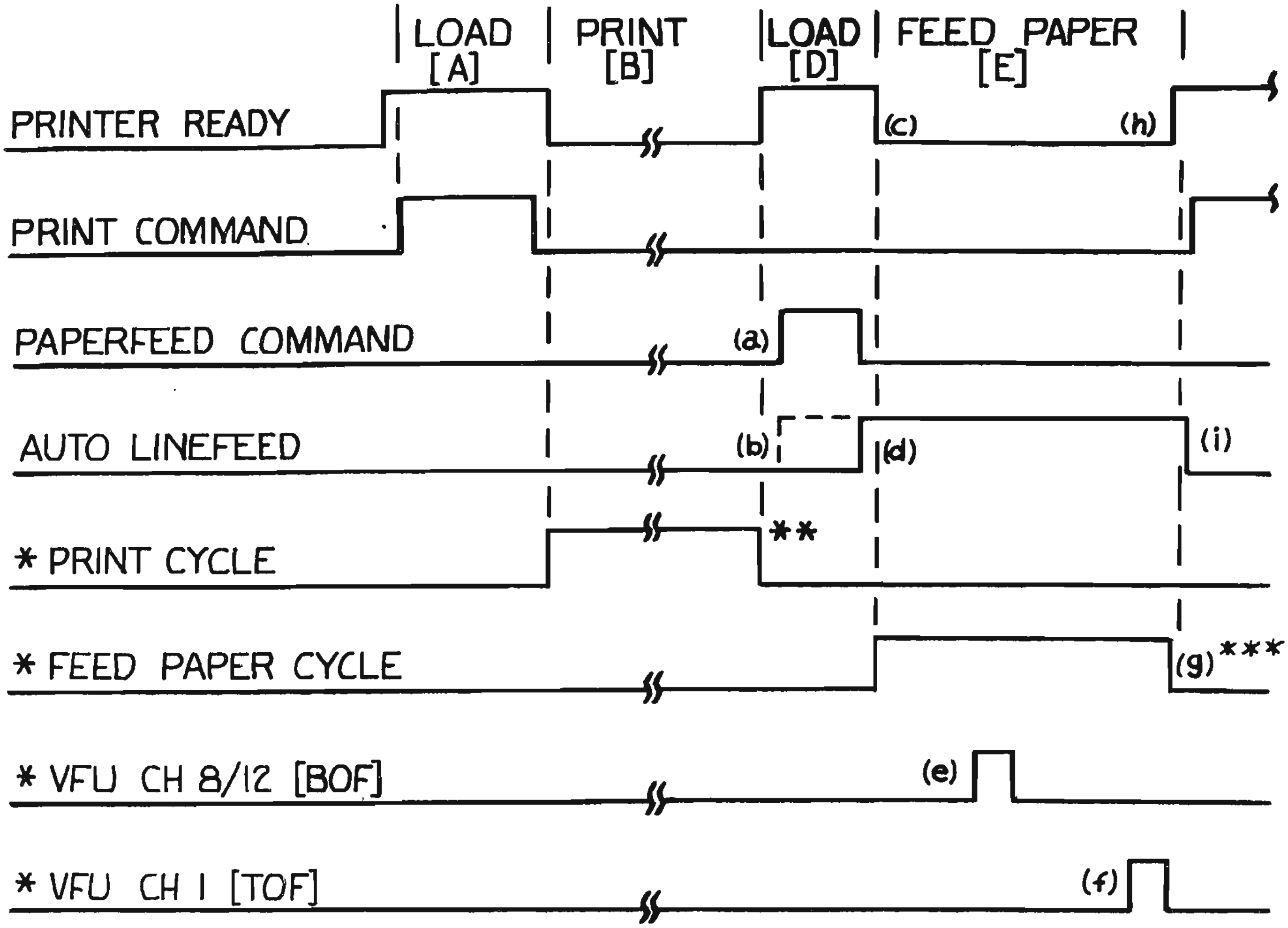
(13) All other Skip-to-Channel commands will result in a paper advance to the channel specified regardless of the state of AUTO LINEFEED.

(14) Not recommended for use in the "Last Character" mode. In this mode the *Print* and *Feed Paper* cycles are indistinguishable at the printer interface and, should AUTO LINEFEED be high at the end of a *Print* cycle, it would interfere with the previously loaded paperfeed instruction (see paragraph 4.3.1.2.5).



NOTES: * INTERNAL PRINTER BUFFER CONTROL
** HAMMER RECOVERY INTERVAL C NOT SHOWN FOR CLARITY

Figure 4-9. Signal Sequence, Automatic Post-print Linefeed



NOTES: *INTERNAL PRINTER BUFFER CONTROL
**HAMMER RECOVERY INTERVAL [C] NOT SHOWN FOR CLARITY
***PAPER SETTLE INTERVAL [F] NOT SHOWN FOR CLARITY

Figure 4-10. Signal Sequence, Automatic BOF-to-next-TOF Paper Skip

AUTO LINEFEED should be maintained high for the duration of the *Feed Paper* cycle [E] until the next rise of PRINTER READY (h). In response to the rise of PRINTER READY following a PAPERFEED COMMAND, the external device must remove AUTO LINEFEED (i) to permit continued operation in the normal mode.

4.3.1.2.5 Last Character Mode

When a feed-after-print mode of operation is required, the PAPERFEED COMMAND may be interleaved with the PRINT COMMAND for a line of print, that is; a *Load Paperfeed* cycle may be caused to occur at any point in the stream of print data characters being transferred to the printer during a *Load Data* cycle, or immediately thereafter while PRINT COMMAND remains high. The paperfeed instruction transferred in the manner will be stored by the printer for execution automatically after the associated print data is printed out. The term "Last Character" refers to the usual implementation of this mode of operation.

In the last character mode of operation of the Standard Interface Configuration, print and paperfeed commands are combined for execution in only a feed-after-print sequence; hence, a typical machine cycle can be considered as being performed in the six basic steps (see paragraph 4.3.1.2.1), but in the order as listed, together with their interface connotations, in the tabulation that follows.

Step	*Sub-Cycle*	*Interface Connotation*
A.	Load Data	Transfer Print Information
D.	Load Paperfeed	Transfer Paperfeed Instruction
B.	Print	No Operation (Printer Busy)
C.	Hammer Recover	No Operation (Internal Jump to E)
E.	Feed Paper	No Operation (Printer Busy)
F.	Paper Settle	Jump to A (Machine Delay)

In this mode, the printer will be ready to accept data only upon completion of a *Feed Paper* cycle [E]; that is, during the machine-delay interval [F]. The paperfeed operations (cycle E and interval F) are generally completed during the Hammer Recovery interval [C[. Therefore, to maximize throughput, the *Load Data* cycle [A] and the *Load Paperfeed cycle* [D] are usually performed during the Paper Settle interval [F].

Insertion of a paperfeed instruction character into the stream of print data characters being transferred during a *Load Data* cycle [A], is accomplished simply by the external device raising PAPERFEED COMMAND while maintaining PRINT COMMAND high. As shown in Figure 4-11, in response to the rise of PAPERFEED COMMAND (e) while PRINT COMMAND is high (b), the printer conditions itself to accept the next character transferred (f) as a paperfeed instruction (P). After the inserted paperfeed character is transferred, the printer automatically reverts back to the *Load Data* cycle [A] in progress at the time regardless of the state of PAPERFEED COMMAND, unless a buffer-full condition exists at the printer. Note that because SEND DATA (c) remains high for the duration of the *Load Data* cycle [A], there will be no indication at the printer interface of the *Load Paperfeed* cycle [D] performed before the printer buffer is filled.

When all data for a line of print has been transferred, the external device must terminate the transmission by dropping both PAPERFEED COMMAND and PRINT COMMAND. The printer responds to the fall of the command to be removed last (either g or i) by dropping SEND DATA (j) and PRINTER READY (k), indicating the start of *Print* cycle [B]. Upon completion of the *Print* cycle, the printer automatically initiates a *Feed Paper* cycle (not shown) to execute the previously loaded paperfeed instruction (P). PRINTER READY remains low until both the *Print* and *Feed Paper* cycles have been completed.

In the event of a buffer-full condition, the printer, as shown in Figure 4-12, will remove SEND DATA (e) upon loading the last character (N) for a line of print. In response, the external device should raise PAPERFEED COMMAND while maintaining PRINT COMMAND high. In response to the rise of PAPERFEED COMMAND (f), the printer will raise SEND DATA (g) to indicate the start of a *Load Paperfeed* cycle [D]. Upon transfer (h) of the paperfeed instruction (P), the printer will again remove SEND DATA (i). In response to the fall of SEND DATA, the external device must remove both PAPERFEED COMMAND and PRINT

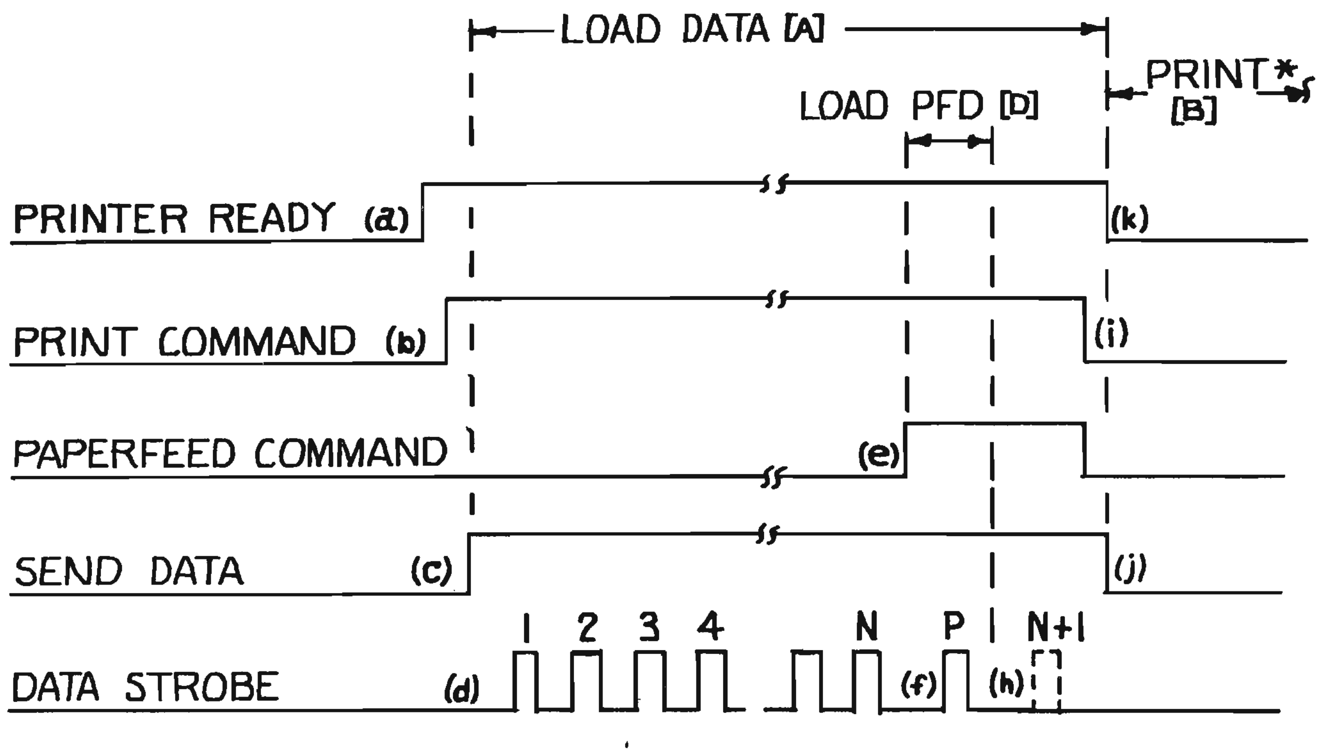


Figure 4-11. Signal Sequence, Last Character Mode, Remote Termination of PRINT COMMAND

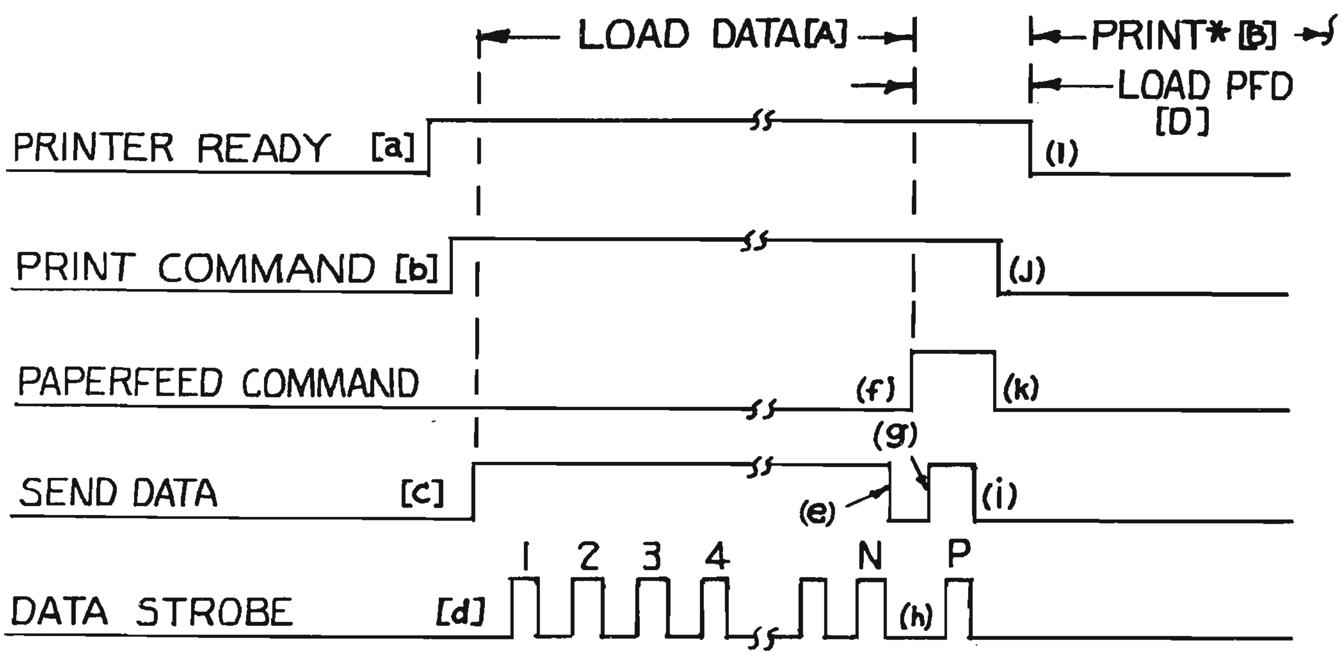


Figure 4-12. Signal Sequence, Last Character Mode, Printer Buffer is Full Condition

COMMAND to initiate their execution. The printer responds to the fall of the command to be removed last (either j or k) by dropping PRINTER READY (l), indicating the start of *Print* cycle [B].

4.3.2 First-Character Interface Configuration

The First-Character Interface Configuration provides the simplest means of communication between the DPC Chaintrain Line Printer and an external device. With this interface configuration, only one command is necessary to transfer the paperfeed instruction and the print data for a line of print. The first character transferred in the stream of information characters for a line of print is accepted as a paperfeed instruction for a delayed-feed after print sequence of operations. An immediate-feed operation can also be effected by the external device terminating the communication for that operation after transferring a single ("first") character to the printer.

4.3.2.1 First-Character Interface Signal Lines

The printer interface signal lines provided with the First-Character Interface Configuration for use in communication between the Chaintrain Line Printer and an external device are depicted in Figure 4-6. The applicable interface signal lines and their use are summarized, and are described in detail, in paragraph 4.3.1.1; except as may be otherwise indicated in the following paragraphs.

4.3.2.1.1 RUN Out (J221-1/14)[15]

A line from the printer to the external device which, when high, indicates that the printer is "on-line" (see 4.3.1.1.1).

4.3.2.1.2 $\overline{\text{RUN}}$ Out (J221-5/18)

A line from the printer to the external device which, when low, indicates that the printer is "on-line" (see 4.3.1.1.2).

4.3.2.1.3 PRINTER READY Out (J221-2/15)

A line from the printer to the external device which, when high, indicates that the printer is ready to accept a command (see 4.3.1.1.3).

4.3.2.1.4 PRINT COMMAND In (J222-4/17)

A line from the external device to the printer that is used to designate the transfer of paperfeed and print information for a line of print to the printer and, subsequently, to initiate the printing and delayed-feeding of that information. When PRINTER READY is high, the rise of PRINT COMMAND initiates a *Load Data* cycle during which a first-character paperfeed instruction character and print data characters are transferred to the printer (see 4.3.2.1.5; SEND DATA). Once initiated, the *Load Data* cycle is maintained as long as PRINT COMMAND remains high or until a buffer-full condition is sensed at the printer.

The Load Data cycle is terminated either upon detection of the fall of PRINT COMMAND or automatically upon detection that a data character has been loaded into the printer's line buffer for the last print position in the typeline. The termination of the *Load Data* cycle is indicated at the printer interface by the fall of SEND DATA. Upon sensing the termination of a *Load Data* cycle, the external device must remove PRINT COMMAND, if high, to initiate the print and paperfeed operations. The fall of PRINT COMMAND, following the transfer of print data, initiates a *Print* cycle during which the mechanical action of printing the data stored in the printer's line buffer is performed; subsequently, the printer automatically initiates a *Feed Paper* cycle during which the mechanical action of moving paper is performed according to the stored first-character paperfeed instruction. The fall of PRINT COMMAND following the transfer of a single character will cause the printer to initiate a *Feed Paper* cycle without any printing.

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(15) The notation enclosed in parentheses ( ) denotes the interface connector and the pin connections of the signal/return leads for the listed signal line.

4.3.2.1.5 SEND DATA Out (J221-4/17)

A line from the printer to the external device which, when high, indicates that the printer recognizes a PRINT COMMAND and is ready to accept the transfer of information characters. The rise of SEND DATA indicates the start of a *Load Data* cycle and that the printer is ready to accept the immediately following (the first) data character as a paperfeed instruction. After accepting the first character, the printer conditions itself to accept the following characters as print data. SEND DATA remains high as long as the printer is ready to accept data; that is, for the duration of a *Load Data* cycle. SEND DATA is removed upon termination of a *Load Data* cycle (see 4.3.2.1.4; PRINT COMMAND).

4.3.2.1.6 DATA STROBE In (J222-5/18)

A line from the external device to the printer which, when high, indicates that valid data is present on the DATA BUS In lines (see 4.3.1.1.7).

4.3.2.1.7 DATA BUS In Lines (J222-6/19 through 12/25)

Seven lines, designated BUS 1 through BUS 7, from the external device to the printer that are used to transfer information characters to the printer. The type of information transferred is determined by the relative sequential position of a character following the rise of SEND DATA. (Also, see 4.3.1.1.8.)

4.3.2.1.8 PAPER LOW Out (J221-12/25)

A line from the printer to the external device that is used to indicate the status of the paper supply in the printer (see 4.3.1.1.11).

4.3.2.1.9 $\overline{\text{LINE STROBE}}$ Out (J221-20/7)

A line from the printer to the external device that is used to indicate each linespace of paper advance and, when low, to indicate that valid data is present on the $\overline{\text{VFU CHANNEL}}$ Out lines (see 4.3.1.1.12).

4.3.2.1.10 $\overline{\text{VFU CHANNEL}}$ Out Lines (J221-21/8; -24/11; -19/6)

Three lines, designated $\overline{\text{VFU CH 1}}$; $\overline{\text{VFU CH 2}}$, and $\overline{\text{VFU CH 8/12}}$, respectively, from the printer to the external device that are used to indicate the vertical position of the forms in the printer (see 4.3.1.1.13).

4.3.2.1.11 DATA BUS 8 In (J222-2/15)

An optional line from the external device to the printer that is used to transfer the most significant data bit (EBCDIC bit position "0") when provided in conjunction with a chaintrain arrangement requiring eight-bit print data (see Table 4-1). The data on this line is transferred in conjunction with the transfer of data on the DATA BUS in lines.

4.3.2.2 First-Character Interface Operation

Functionally, the operation of the First-Character Interface Configuration may be considered as consisting of three basic sub-cycles (called "cycles" in the descriptions that follow, for clarity). These cycles are: the *Load* cycle, during which the paperfeed instruction and print data for a line of print are transferred from the external device to the printer; the *Print* cycle, during which the mechanical action of printing the stored print data is performed; and the *Feed* cycle, during which the mechanical action of moving the paper in the printer is performed. Each *Print* cycle is automatically followed by a fixed-interval machine-delay that allows for the print hammers and actuators fired during that *Print* cycle to recover; and each *Feed* cycle is automatically followed by a fixed-interval machine-delay that allows for the paper, which was in motion during that *Feed* cycle, to settle. In order to permit the maximum throughput to be achieved, the interface logic is arranged such that the *Load* cycle may occur during the paper settle interval. Separate delays independently govern the maximum repetition rate of the *Print* and *Feed* cycles to be safely within the design limitations of the printer.

4.3.2.2.1 Typical Machine Cycle (First-Character Interface)

With the First-Character Interface Configuration, a typical machine cycle will consist of the three basic sub-cycles which are performed in sequence together with the appropriate machine-delays; hence a typical machine cycle may be considered as being performed in five steps in the order as listed, together with their interface connotations, below:

Step	*Sub-Cycle*	*Interface Connotation*
A.	Load	Transfer Paperfeed Instruction Transfer Print Data
B.	Print	No Operation (Printer Busy)
C.	Hammer Recovery	No Operation (Internal Jump to E)
E.	Feed	No Operation (Printer Busy)
F.	Paper Settle	Jump to A (Machine Delay)

The printer will be ready to accept data for the next line of print upon completion of a *Feed* cycle [E]; that is, during the Paper Settle interval [F]. Therefore, to maximize throughput, the *Load* cycle [A] is usually performed during the Paper Settle interval [F]. Generally, the *Feed* cycle [E] and the Paper Settle interval [F] are completed during the Hammer Recovery interval [C].

Operation of the First-Character Interface Configuration is depicted in Figure 4-13; "Signal Sequence, First-Character Interface". This diagram shows the relationship of the basic cycles and the pertinent interface signals for a typical machine cycle. Numbers enclosed in parentheses ( ) along each waveform denote the usual sequence of events, and are used to key the descriptions that follow. An Interface Flow Diagram, that depicts the logical sequence of events, is provided in the Appendix A for the reader's reference.

As shown in Figure 4-13, communication between the external device and the printer is performed under control of the printer buffer electronics, and is normally accomplished by the exchanging of interactive control signals (PRINTER READY, PRINT COMMAND, and SEND DATA) and the transfer of externally-strobed information (on the DATA BUS) for each line of print. The interface signal sequences and printer operations are described in detail for both delayed-feed (print-then-feed) and immediate-feed (paperfeed only) modes of operation in the paragraphs that follow.

4.3.2.2.2 Delayed-Feed After Print Operation

As shown in Figure 4-13, the printer notifies the external device that it is "on-line" by raising RUN (1) and dropping $\overline{\text{RUN}}$ (not shown). The rise of PRINTER READY (2) indicates that the printer is ready to accept a command. The external device responds to PRINTER READY by raising PRINT COMMAND. The printer, in turn, responds to the appearance of PRINT COMMAND (3) by raising SEND DATA (4), indicating the start of a *Load* cycle [A]. The external device may now proceed with the transfer of information characters. (Note - Events (2) and (3) may occur in reverse order; see "Timing Considerations", paragraph 4.3.5.)

The transfer of information is performed serially-by-character, and is accomplished by the external device placing the bit pattern (code) for a character on the DATA BUS (5) and generating an associated DATA STROBE pulse (6). This process, (5) and (6), is repeated for each character to be transferred until all information (paperfeed and print) for a line of print has been transferred; that is, until the printer's line buffer is filled or the external device terminates the transmission.

The first character transferred following the rise of SEND DATA (4) is accepted as the paperfeed instruction (P) for that line. The next character (7), and those following, will be accepted as print data for printout which is to appear in the printed line, from left-to-right commencing with print position 1, in the same order as transferred.

In the event of a buffer-full condition (as shown in Figure 4-13), the printer responds to the transfer of the last character (8) by dropping SEND DATA (9). The external device responds to the fall of SEND DATA by dropping PRINT COMMAND. The printer, in turn, responds to the fall of PRINT COMMAND (10) by dropping PRINTER READY (11), indicating the start of the *Print* cycle [B] (12). (Note – Any data appearing at the printer interface when SEND DATA is low will be ignored; that is, it will not be stored and will not be printed.)

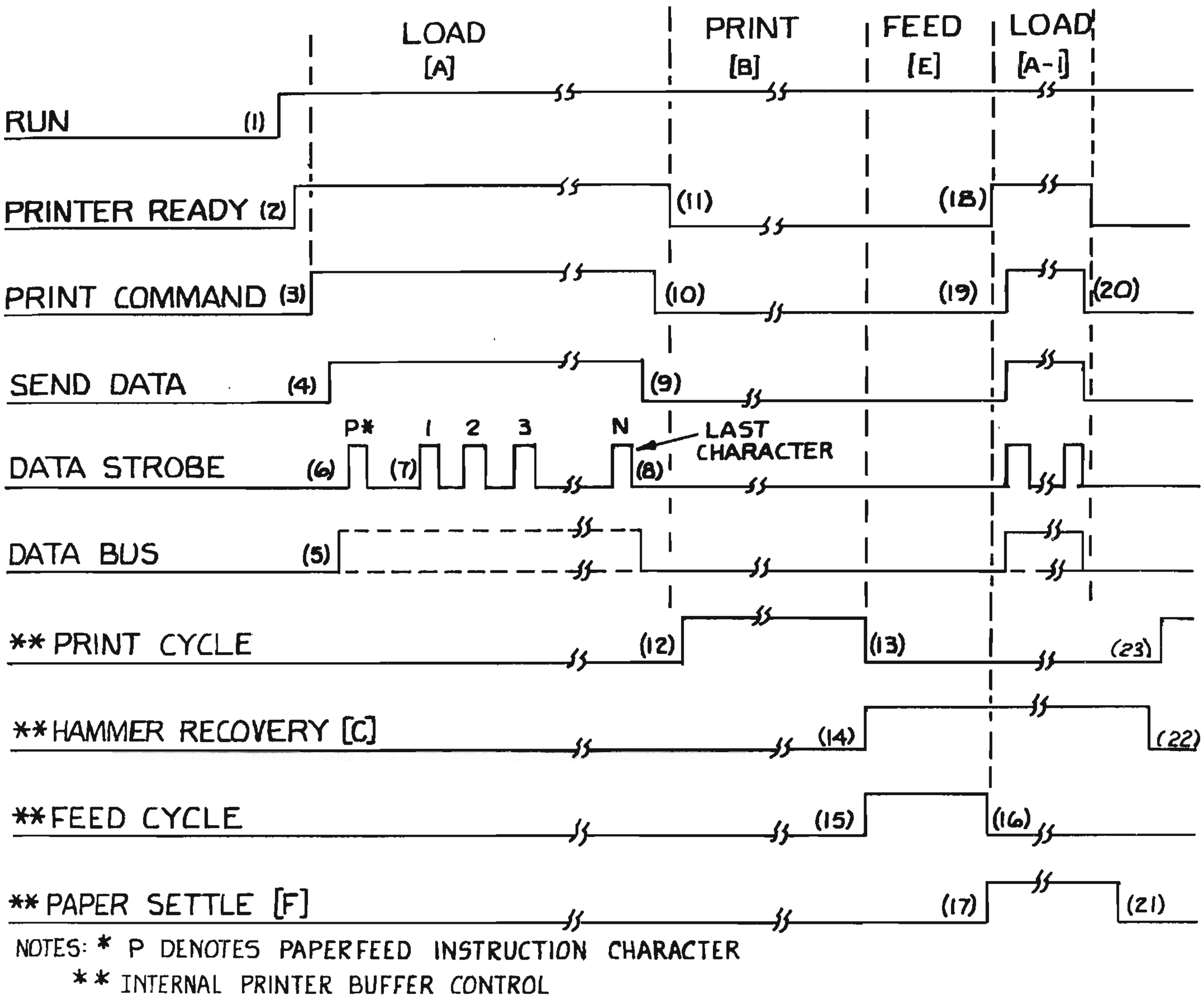

Figure 4-13. Signal Sequence, First-Character Interface

In the case of a short line (one having less characters, including spaces, than the number of available print positions), the external device may terminate the transmission by dropping PRINT COMMAND after transferring the last print data character. The printer will respond to the fall of PRINT COMMAND by immediately dropping both SEND DATA and PRINTER READY, indicating the termination of the *Load* cycle and the start of a *Print* cycle, respectively. Printing will not occur in those print positions for which no data was transferred.

As shown in Figure 4-13, when the printer buffer has been emptied and all required print hammers have been fired, the *Print* cycle [B] is concluded (13) and a fixed-interval machine delay [C] is started (14). This delay inhibits the start (23) of the next *Print* cycle until the print hammers that were fired during the *Print* cycle [B] just completed are allowed to recover. In conjunction with the start of the Hammer Recovery interval [C], the printer automatically starts a *Feed* cycle [E] (15). When paper has been advanced to the position designated by the previously accepted paperfeed instruction (P), the *Feed* cycle [E] is concluded (16) and a separate fixed-interval machine delay [F] is started (17). This delay inhibits the start of the next *Print* cycle (23) until the paper, which was in motion during the *Feed* cycle [E] just completed, is allowed to settle. The printer holds PRINTER READY low for the duration of both the *Print* [B] and *Feed* [E] cycles until the *Feed* cycle [E] is concluded. In conjunction with the start of the Paper Settle interval [F], the printer raises PRINTER READY (18) to indicate that it has completed the print and paperfeed operations for a line of print and is ready to accept the next PRINT COMMAND.

The external device may now initiate a repetition of signal sequence as described in the foregoing paragraphs for the next line of print (i.e.; next machine cycle). Typically, as shown in Figure 4-13, the external device responds to the rise of PRINTER READY (18) by raising PRINT COMMAND (19) which initiates the next *Load* cycle [A-1] during the Paper Settle interval [F]. (Note – Events (18) and (19) may occur in reverse order.) Usually the *Load* cycle [A-1] is completed during the Hammer Recovery interval [C]. When the *Load* cycle [A-1] is completed and the associated PRINT COMMAND is removed (goes low) while either of these delay-intervals are in progress, the printer will inhibit the start of the next *Print* cycle (23) until both machine delays [C] and [F] have elapsed (21, 22).

4.3.2.2.3 Immediate-Feed Only Operation

If the external device terminates a *Load* cycle after the first character is transferred, the printer will perform an immediate-feed ("Feed on Command") operation. As shown in Figure 4-14, the rise of PRINTER READY (a) indicates that the printer is ready to accept a command. The external device responds to PRINTER READY by raising PRINT COMMAND. The printer, in turn, responds to the appearance of PRINT COMMAND (b) by raising SEND DATA (c), indicating the start of a *Load* cycle [A]. The external device may now transfer the paperfeed instruction character by placing the appropriate bit pattern (code) on DATA BUS and generating an associated DATA STROBE pulse (d).

After transfer of the paperfeed instruction character (P) is complete, the external device removes PRINT COMMAND. The printer will respond to the fall of PRINT COMMAND (e) by immediately dropping SEND DATA (f) and PRINTER READY (g), indicating the termination of the *Load* cycle [A] and the initiation of a *Feed* cycle [E]. The actual start of the *Feed* cycle [E] (h) occurs upon completion of an internal scan of the printer's line buffer memory (*) to ensure that no print data is stored. When paper has been advanced to the position designated by the paperfeed instruction (P), the *Feed* cycle [E] is concluded (i) and a fixed-interval machine delay [F] is started (j). This delay inhibits the start of the next *Print* cycle (not shown) until the paper, which was in motion during the *Feed* cycle [E] just completed, is allowed to settle.

The printer holds PRINTER READY low for the duration of the *Feed* cycle [E]. In conjunction with the start of the Paper Settle interval [F], the printer raises PRINTER READY (k) to indicate that it has completed the paper advance operation and is ready to accept the next command.

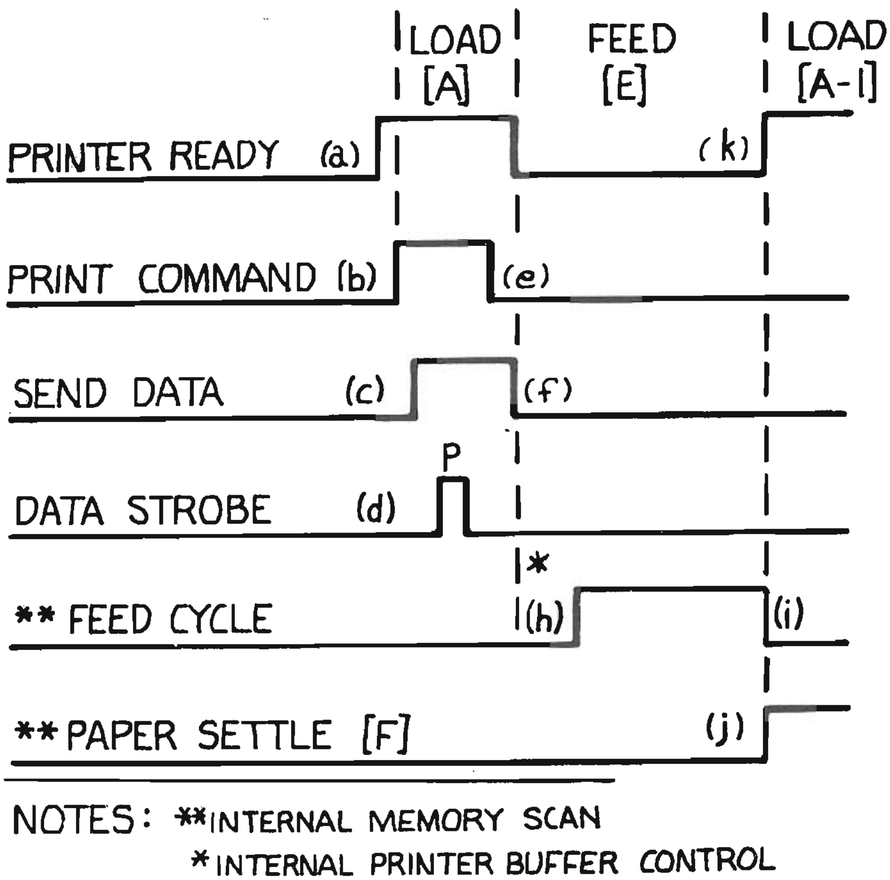

Figure 4-14. Signal Sequence, Immediate-Feed Only Operation, First-Character Interface

4.3.3 Input Parity Check (Option)[16]

The input Parity Check option provides the printer with the capability of checking all input data for either ODD or EVEN[17] character parity. Both paperfeed instruction characters and print data characters are checked for proper parity as they are being received by the printer. Input data characters sensed to have incorrect (invalid) parity are treated as "blank" characters: that is, they are not loaded, per se, into the printer buffer. Hence, invalid paperfeed instruction characters will result in no paper motion, and invalid print data characters will result in corresponding "blank" spaces in the printout. Indication that a parity error has been detected is provided at the interface to permit the external device to cancel the command in progress and subsequently retransmit the data, or to ignore the error and continue operation.

4.3.3.1 Input Parity Interface Signal Lines

Printers provided with the Input Parity Check option are equipped with three additional active interface signal lines as described in detail in the paragraphs that follow. These interface signal lines are also depicted in Figure 4-6 and briefly described in paragraph 4.3.1.1 under the paragraph references listed below.

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(16) Available on the Standard Interface Configuration only; use precludes eight (8) bit input data.

(17) ODD or EVEN parity checking is determined by jumper connections on the Character Storage/Control electronics board; refer to appropriate *Part Breakdown & Circuit Diagrams* manual for details.

4.3.3.1.1 DATA BUS 8 In (J222-2/15)[18] (See also 4.3.1.1.14)

An optional line from the external device to the printer that is used to complete the character parity of the associated bit-pattern on the DATA BUS In lines. The number of logical "l" bits in the bit pattern, including the parity bit, must be odd when odd parity checking is required: conversely, that number must be even when even parity checking is required.

4.3.3.1.2 PARITY ERROR Out (J221-3/16) (See also 4.3.1.1.15)

An optional line from the printer to the external device that is used to indicate that an error in character parity has been detected in the input data associated with the command in progress. Upon detection of the first character in error, the PARITY ERROR signal will go high and remain high until the load cycle in progress is terminated. PARITY ERROR can rise only during a *Load Data* (PRINT COMMAND) or a *Load Paperfeed* (PAPERFEED COMMAND) cycle. Invalid paperfeed instructions are not transferred: however, a "blank" character is loaded into the line buffer for each invalid print data character.

4.3.3.1.3 CLEAR In (J221-9/22) (See also 4.3.1.1.16)

An optional line from the external device to the printer that is used to cancel a data transfer operation in progress, to clear a parity error indication, and to condition the printer for a retransmission of data. When PRINTER READY is high, the rise of CLEAR[19] terminates the *Load* cycle in progress at the printer (PRINTER READY, and SEND DATA if high, will go low), which clears the parity checking circuits (PARITY ERROR, if high, will go low). The subsequent fall of CLEAR[20] initiates a line-buffer clear cycle[21] during which PRINTER READY remains low. (Note – A paperfeed instruction, once accepted as valid by the printer, cannot be cancelled and must be executed.)

4.3.3.2 Input Parity Check Operation

Each input data character is checked for proper parity as it appears at the printer interface. As shown in Figure 4-15, as the levels on the DATA BUS In lines stabilize for a character (a), the parity checking circuits determine the validity of that character's parity (b). Immediately following the appearance of the associated DATA STROBE (c), if the character is sensed to have incorrect parity, the printer raises PARITY ERROR (d). If the invalid character is a paperfeed instruction, it will *not* be transferred to the paperfeed control area of the printer buffer; if the invalid character is print data, a "blank" character will be loaded in its place into the printer's line buffer. The PARITY ERROR signal remains high until the *Load* cycle in progress is terminated.

Clear Error: A *Load* cycle may be terminated by means of CLEAR to cancel the data transfer operation in progress and to clear the PARITY ERROR indication in preparation for a retransmission of the data. As shown in Figure 4-15, the external device responds to PARITY ERROR by transmitting a CLEAR pulse any time before dropping the COMMAND in progress. The printer responds to the rise of CLEAR (e) by terminating the *Load* cycle in progress, resetting the parity error circuits and dropping PRINTER READY (f), SEND DATA (g), and PARITY ERROR (h). Upon the subsequent fall of CLEAR (i), the printer initiates an internal line-buffer clear cycle that purges the printer's memory of all stored data and conditions the printer for a retransmission of the print data for a line of print. Upon completion of the line-buffer clear cycle, the printer raises PRINTER READY (j) to indicate that it has completed the buffer clearing operation and is ready to accept a new command or a retransmission of the pre-

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(18) The notation enclosed in parentheses ( ) denotes the interface connector and the pin connections of the signal/return leads for the listed signal.

(19) CLEAR should be raised only when PRINTER READY is high; should CLEAR rise during a *Print* cycle, the print operation will be prematurely terminated, which may result in an erroneous Hammer Driver Overcurrent alarm indication (see 4.4.1.2.8).

(20) The CLEAR pulse must have a duration of 500 nsec. or greater.

(21) A line-buffer clear cycle requires approximately 300 usec. to complete.

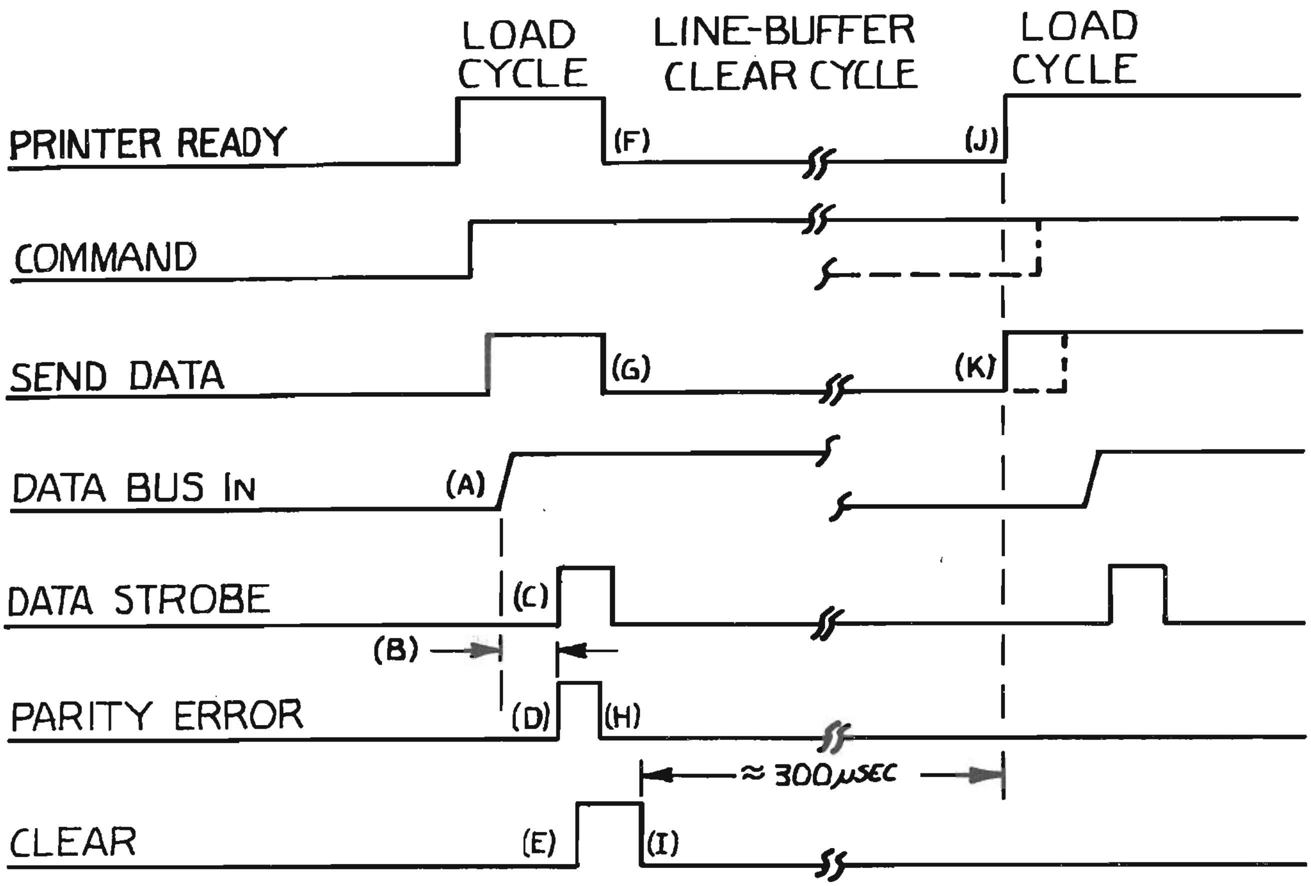

Figure 4-15. Signal Sequence, Input Parity Check Option

vious command. If the appropriate COMMAND line is high at this time, the printer will also raise SEND DATA (k) to indicate that it is ready to accept a retransmission of the previous data.

If a parity error indication is the result of an invalid paperfeed instruction, the PARITY ERROR indication may be cleared by the external device simply dropping PAPERFEED COMMAND. Because invalid paperfeed instruction characters are not transferred to the paperfeed control area of the printer buffer, the printer will remain in condition to accept a (retransmitted) paperfeed instruction following such a parity error indication. In the normal mode of operation (Standard Interface Configuration), the external device may respond to PARITY ERROR when PAPERFEED COMMAND is high by dropping PAPERFEED COMMAND. The printer will respond to the fall of PAPERFEED COMMAND by terminating the *Load Paperfeed* cycle, resetting the parity error circuits and dropping PRINTER READY, SEND DATA, and PARITY ERROR. Because the invalid paperfeed instruction was not transferred, a *Feed Paper* cycle is not started and no paper motion occurs. Consequently, after the fall of PRINTER READY and SEND DATA, the printer immediately raises PRINTER READY to indicate that it is ready to accept a retransmission of the previous paperfeed instruction or a new command. In response to the rise of PRINTER READY, the external device may retransmit the preceding PAPERFEED COMMAND in the normal manner. Once a paperfeed instruction character is accepted as valid by the printer, it cannot be cancelled by means of the CLEAR pulse and must be executed.

Ignore Error: A *Load Data* or a *Load Paperfeed* cycle in which a parity error is detected may be allowed to continue in the normal manner ignoring the PARITY ERROR indication. In response to the fall of the appropriate COMMAND, the printer terminates the load cycle in progress, resetting the parity error circuits (PRINTER READY, SEND DATA, and PARITY ERROR, if high, will go low), and initiates the corresponding mechanical action cycle (*Print* or *Feed Paper*). Because invalid paperfeed instruction characters are not transferred to the printer buffer, execution of a PAPERFEED COMMAND having a parity error will result in *no* paper motion which, in turn, may result in overprinting. Similarly, because a "blank" character is loaded into the printer's line buffer for each invalid print data character, execution of a PRINT COMMAND having a parity error will result in a "blank" space in the printed line corresponding to each input print data character sensed to have incorrect parity. This arrangement provides readily visible indication of the location of invalid print data characters to facilitate diagnosis, and permits overprinting with an immediately repeated transmission of the PRINT COMMAND.

Test Panel: An additional Test Data Bit switch, designated "b8", is provided on the Test Panel of printers equipped with the Input Parity Check Option. This switch functionally corresponds to the DATA BUS 8 In line (see 4.3.3.1.1), and is used to complete the parity of all test data characters (print and paperfeed) when operating the printer in the LOCAL mode (refer to *Operating Instructions* manual for details). The Test Data Bit 8 switch must be set to provide the proper parity for each different test data character. Incorrect parity will result in the printing of "blanks" (Hence, *no* printout) and, if the Program Feed (PF) mode is selected, *no* paper advance during local test operation.

4.3.4 EBCDI-Coded Print Data

An appropriate code converter which provides the printer with the capability of accepting EBCDI-Coded print data is provided as a standard feature on DPC Chaintrain Line Printers equipped with a 48-character, arrangement AN, HN, or LC chaintrain; and can be provided as an optional feature on printers equipped with any other chaintrain arrangement.[22,23] The code conversion is accomplished by an appropriately programmed read-only-memory (ROM) that is arranged in the print-compare logic at the output of the printer's line buffer. Basically, each ROM input address (position) corresponds to each possible bit pattern of the print data code. The content of each ROM position is preprogrammed with the chain character-position code (machine code) for the appropriate graphic on the particular chaintrain arrangement with which the ROM is to be used. This memory is addressed by the stored print data as it is sequentially read-out of the line buffer during each print-scan operation. The codes read out of the addressed ROM positions are compared with the machine codes for the chaintrain characters as they are brought into printing position by the moving chaintrain. When a code read out of the ROM matches a machine code, the corresponding print hammer is fired, printing the character.

Generally, for 48 and 64-character EBCDIC arrangements, the entire first, second, and third quadrants of the EBCDI Code are folded into the fourth quadrant automatically by the printer (see Table 1-2). This folding occurs because the EBCDIC bits b0 and b1, which define the quadrants, are ignored. Consequently, a bit pattern normally appearing in the first, second, or third quadrant will be recognized as appearing in the fourth quadrant. For example: Hexadecimal 01 (0000 0001), Hex. 41 (0100 0001), and Hex. 81 (1000 0001) ("a") will be recognized as Hex. C1 (1100 0001), which normally prints as an uppercase letter "A". This folding arrangement permits incoming lowercase and uppercase print data to be printed as uppercase data with a 48 or 64-character chaintrain arrangement. Similarly, for 96 and 128-character EBCDIC arrangements, the first and second quadrants are folded into the third and fourth quadrants, respectively (EBCDIC bit "b0" is ignored).

Normally, the codes for NULL (0000 0000), SPace (0100 0000), and any bit pattern *not* assigned to a character on the corresponding chaintrain arrangement, are treated as "SPace" characters. Hence, for each NULL, SPace, or unassigned print data character received by the printer, a corresponding "blank" space will appear in the printed line.

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(22) Refer to paragraph 1.6; "Chaintrain Arrangements" for details concerning available EBCDI-Coded print character sets and chaintrain arrangements.

(23) Code conversion for other customer-specified print data codes and/or chaintrain arrangements can be provided as a special feature.

The designations "b1", "b2", etc., used to identify bit positions on the DATA BUS and the Test Data Switches correspond to the standard USASCII convention where bit position "b1" = 2^0 (least significant). Since the EBCDIC convention is normally transposed with respect to the USASCII convention (EBCDIC bit position "b7" = 2^0), care must be taken to ensure that the DATA BUS bit positions from the external device properly match the corresponding bit positions at the printer interface according to binary position value (see Table 4-1).

4.3.5 Timing Considerations

The following interface signal timing considerations must be observed for proper operation of the DPC Chaintrain Line Printer.

4.3.5.1 Command Signal

Normally, only one COMMAND line should be high at a time. For exception, refer to 4.3.1.2.5; "Last Character Mode".

4.3.5.2 Command Recognition

Recognition by the printer of a COMMAND is indicated by the rise of SEND DATA at the printer interface. When issuing either a PRINT COMMAND or a PAPERFEED COMMAND, the external device must maintain that command high for a minimum of 100 Nanoseconds following the fall of the associated DATA STROBE (see Figure 4-16).

4.3.5.3 Command Execution

Completion of the data transfer, or load, portion of an operation is indicated by the fall of SEND DATA. The actual execution of a command, indicated by the fall of PRINTER READY, will not occur until the respective COMMAND goes low. This interlocking of a COMMAND with PRINTER READY ensures that a single command will be accepted only once.

Due to the interlocking of the COMMAND and PRINTER READY signals, the external device may raise a COMMAND before the rise of PRINTER READY (i.e.; while PRINTER READY is low). For example: If the printer is busy executing a PRINT COMMAND, PRINTER READY will be low but the external device may now raise the next COMMAND; upon the completion of the *Print* cycle, PRINTER READY will rise, followed immediately by the rise of SEND DATA, indicating that the COMMAND has been recognized by the printer.

4.3.5.4 Valid Data

Data presented on the DATA BUS must be valid (stabilized) for a minimum of 100 Nanoseconds before the rise of the associated DATA STROBE, and must remain valid for a minimum of 100 Nanoseconds following the fall of that DATA STROBE (see Figure 4-16).

4.3.5.5. DATA STROBE Pulse

The DATA STROBE pulse may have any width (duration) from 0.5 to 10.0 Microseconds. The printer will accept DATA STROBE pulses, and the associated data, at any rate up to 500-K Characters-per-Second (2.0 usec. per character, minimum) (See Figure 4-16).

4.3.5.6 AUTO LINEFEED Signal (Standard Interface Configuration)

Since the external device has no way of determining the exact time that a *Print* cycle will be completed, and since the AUTO LINEFEED signal must be high at that time to enable the automatic linefeed function, the external device should anticipate the completion of a *Print* cycle by raising and maintaining AUTO LINEFEED high, if required, during the *Print* cycle; that is, from the time PRINTER READY falls (beginning of the *Print* cycle) until PRINTER READY rises again (indicating the completion of the print and automatic linefeed operations).

4.3.5.7 Protection Against Loss of Data

With the printer operating in the RUN mode, depression of the STOP pushbutton switch will cause the RUN signal to fall immediately unless the printer is busy executing either a print or load operation. If a load cycle is in progress when STOP is depressed, approximately fifty

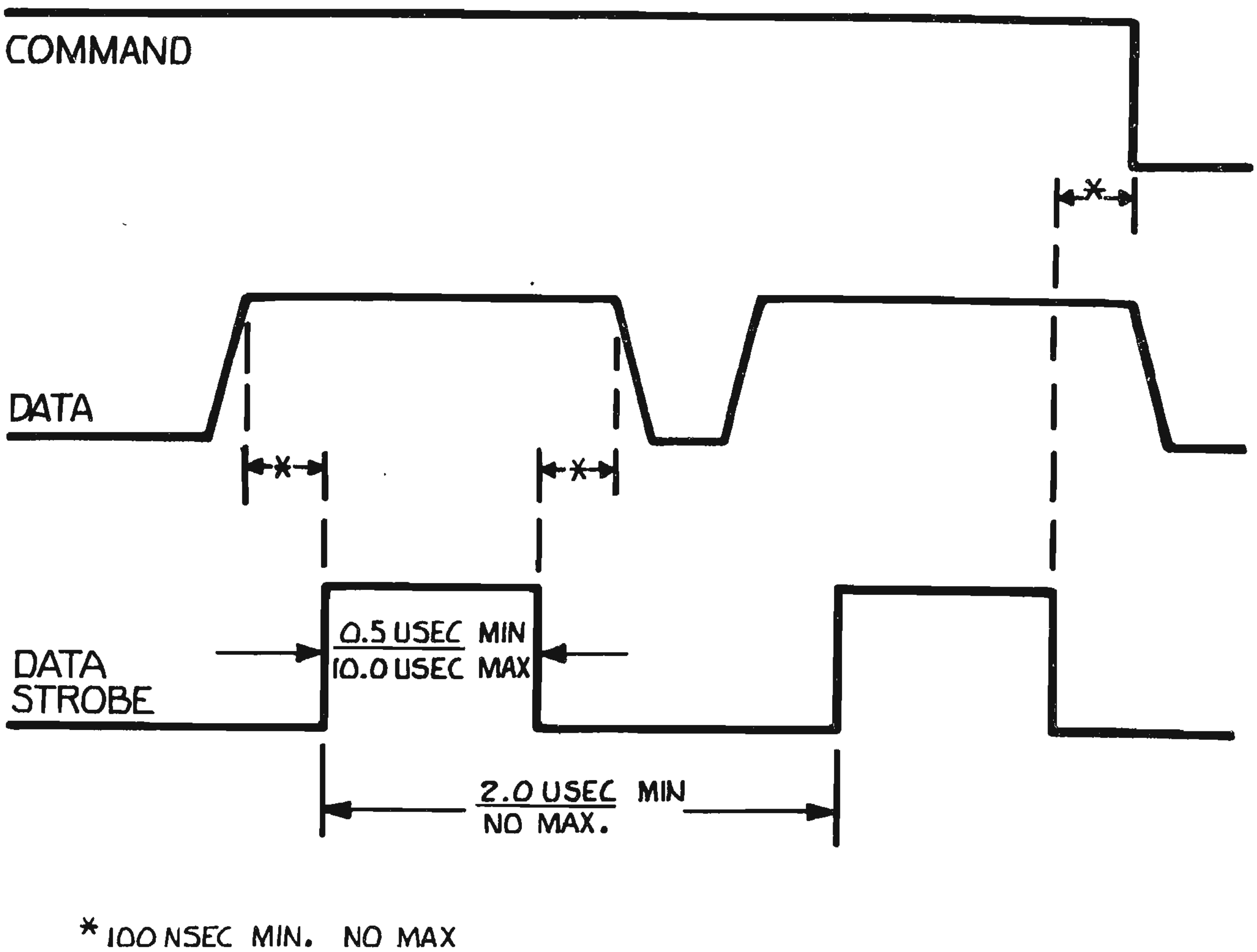


Figure 4-16. Interface Signal Timing Considerations

Milliseconds will be allowed for the completion of the load cycle. At the end of this period, if the external device has not terminated the load cycle, the printer will force the termination (PRINTER READY and SEND DATA will go low).

If a PRINT COMMAND had initiated the load cycle, a *Print* cycle will then be executed, printing whatever data had been transferred to the printer's line buffer up to that time. At the completion of the *Print* cycle, RUN will go low.

If the *Load* cycle had been initiated by a PAPERFEED COMMAND, RUN will fall upon the termination of the *Load* cycle; if in fact a paperfeed instruction character had been transferred, the paperfeed operation will then be executed.

If a *Print* cycle is in progress when the STOP switch is depressed, the *Print* cycle will be allowed to continue to completion, at which time RUN will fall.

4.3.5.8 CLEAR (Input Parity Check Option)

The CLEAR pulse must have a duration of 500 Nanoseconds or greater. There is no restriction on the maximum pulse width of CLEAR; however, since the clearing of the printer's line buffer will not actually begin until the fall, or trailing edge, of the CLEAR pulse is recognized at the printer, the CLEAR pulse should be reasonably short so as not to unduly delay the next operation. The line-buffer clear cycle requires approximately 300 Microseconds to complete.

4.3.5.9 Thru-put

The thru-put attainable with the Chaintrain Line Printer depends upon several factors. In general, the printing speed attainable with a particular chaintrain arrangement (character set) depends upon the repeatability of the arrangement on the chaintrain and the frequency with which it can be presented to the typeline for printing. Other factors, as the vertical formatting required and the response time of the external device, also affect the printing speed, or thru-put, actually achieved.

4.3.5.9.1 Printing Speed

The continuous printing speed with single-line spacing is calculated for a given chaintrain arrangement (character set) using the following formula (4.1):

Nominal Printing Speed
With Single-Line Spacing

$$\frac{60}{(C+2)(1.21)+20} \times 10^3 = \text{LPM} \qquad (4.1)$$

where: C = The number of characters, including any non-printables provided, in chaintrain arrangement (character set).

This formula (4.1) assumes continuous printing of a like printout pattern on all lines of print. When printing random text, however, some lines may require less than a full presentation of a character array to be printed out. Consequently, the printing speed can be variable and, generally, will be slightly greater than the calculated nominal speed.

The formula (4.1) applies for continuous printing with single-line spacing (programmed or automatic). When multiple-line spacing or skipping operations are performed, the additional paper advance time must be added to the denominator of the formula. The additional paper advance time is calculated using the appropriate formula (4.2, 4.3) that follows:

Additional Paper Advance Time

For six (6) LPI Linespacing:	$8(n - 1)$ = Additional Time in MS	(4.2)
For Eight (8) LPI Linespacing:	$6(n - 1)$ = Additional Time in MS	(4.3)

where: n = Total number of linespaces per line of print.

Example: Assuming a standard chaintrain arrangement for the standard 64-character Subset of USASCII. The number of characters in one array on the chaintrain is 64. Using formula (4.1), the calculated nominal printing speed for continuous, single-line spaced printing is:

$$\frac{60}{(64+2)(1.21)+20} \text{ X } 10^3\text{, or 600 LPM.}$$

Assuming continuous printing with the same chaintrain arrangement but with a spacing of five lines at six LPI after each line of print. Using formula (4.2), the calculated additional paper advance time is:

8 (5-1), or 32 Milliseconds.

Adding this additional paper advance time to the denominator of formula (4.1), the calculated nominal printing speed for continuous, five-line spaced printing becomes:

$$\frac{60}{(64+2)(1.21)+20+32} \text{ X } 10^3\text{, or 455 LPM.}$$

When variable line spacing or skipping is performed, the *average* additional paper advance time per printed line per unit repetition of the vertical format program must be added to the denominator of formula (4.1) to calculate the average printing speed. The average additional paper advance time per printed line is calculated using the following formula (4.4):

$$k\left(\frac{n-m}{m}\right) = \text{Average Additional Time in MS} \qquad (4.4)$$

where: k = 8 for six LPI linespacing, or 6 for eight LPI linespacing.
n = Number of linespaces per unit repetition of vertical format.
m = Number of printed lines per unit repetition of vertical format.

Example: Assuming continuous printing with the same chaintrain used in the preceding example, but with random spacing such that only 33 lines are printed on a form having 66 lines spaced six to-the-inch. Using formula (4.4), the calculated average additional paper advance time per printed line per form is:

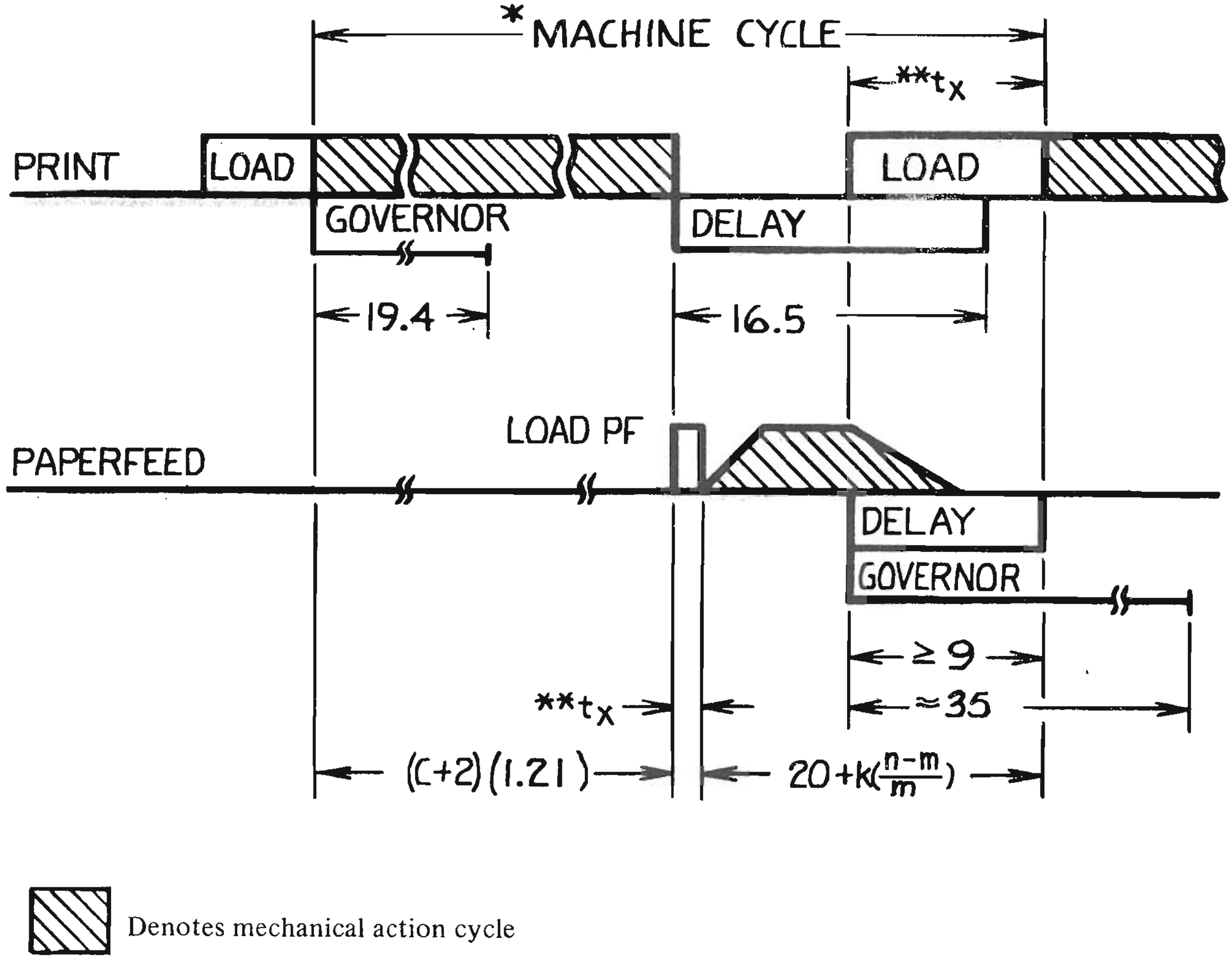
$$8\left(\frac{66-33}{33}\right)\text{, or 8 MS per printed line.}$$

Adding this average additional paper advance time per printed line to the demoninator of formula (4.1), the calculated average printing speed for continuous, randomly spaced printing defined above becomes:

$$\frac{60}{(64+2)(1.21)+20+8} \text{ X } 10^3\text{, or 556 LPM.}$$

4.3.5.9.2 External Device Response

The maximum thru-put attainable with a given chaintrain arrangement and vertical format requirement is achieved when the continuous printing and feeding operations are performed in contiguous succession with no delays for external device response and data transfer. In order to permit the maximum thru-put to be achieved, the printer interface logic is arranged to accept data for a line of print during the Paper Settle interval following each paperfeed operation; and to accept a paperfeed instruction (Standard Interface; normal mode) and perform a single-line paper advance operation during the Hammer Recovery interval following each print operation. Accordingly, the external device must complete all responses and transfer data for a line of print during the Paper Settle interval, or within approximately nine Milliseconds of the appropriate rise of PRINTER READY (see Figure 4-17). (Note – To ensure the transfer of data for a full line of print, the data transfer rate should be greater than 16-K characters-per-second [62.5 uS per character]). Similarly, in the normal mode of operation with



Denotes mechanical action cycle

NOTES:

* Average machine cycle = $(C+2)(1.21)+20+k(\frac{n-m}{m})+(t_x-9)$.

** Must be less than 9 to achieve maximum attainable thru-put.

*** Standard Interface Configuration; normal mode only: should be less than 60 usecs. to achieve maximum attainable thru-put. Not required if Automatic Linefeed or "Last Character" mode, or if First-Character Interface.

– All figures are in Milliseconds (MS) unless indicated otherwise.

Figure 4-17. Thru-put Timing Diagram, Chaintrain Line Printer the Standard Interface Configuration, the external device should complete all responses and transfer a paperfeed instruction character within approximately 60 uS following the appropriate rise of PRINTER READY (i.e.; during a Hammer Recovery interval).

As shown in Figure 4-17, upon completion of the mechanical portion of a print operation, a fixed-interval machine delay of approximately 16.5 MS is automatically started at the printer to allow the print hammers that were fired during the print operation just completed to recover before they can be fired again. During this Hammer Recovery interval, further firing of the print hammers is inhibited. In addition to the Hammer Recovery interval, the next successive print operation is also governed by a separate fixed-interval machine delay of approximately 19.4 MS which is started at the beginning of each *Print* cycle. This delay delays the start of the Hammer Recovery interval in the event of a short *Print* cycle. In such an event, this "print rate governor" and the Hammer Recovery interval will occur in succession so that a new print operation can occur in no less than every 19.4 + 16.5, or 35.9 MS. Although considered impractical for continuous operation, this arrangement allows an absolute maximum thru-put of 1670 LPM.

Upon completion of the mechanical portion of a paper advance operation, a fixed-interval machine delay of approximately 9 to 14 MS is automatically started at the printer to allow the paper which was in motion during the paperfeed operation just completed to settle before starting the mechanical portion of the next print operation. During this Paper Settle interval, further firing of the print hammers is inhibited. The mechanical portion of successive paper advance operations is governed by a separate fixed-interval machine delay of approximately 35 MS which is started in conjunction with the start of the Paper Settle interval (see Figure 4-17). During this "paperfeed governor" interval, further paperfeeding is inhibited which, in the event successive paper advance operations with *no* intervening print operations are required, will delay the start of the mechanical portion of the next paper advance operation. In such a circumstance, a new paper advance operation can occur in no less than every 35 + 20 - 9 + k(n - 1) MS, or in no less than every 46 MS, if single-line spacing (minimum interval). Although considered impractical for normal operation, this arrangement allows successive paper advance operations to be performed with *no* printing at rates up to approximately 1300 LPM.

4.3.5.10 Stand-by State

Upon becoming enabled (when RUN rises), the printer will remain in a stand-by state with power to the chaintrain drive motor and the ribbon-feed motors turned off until the printer recognizes the first PRINT COMMAND transferred from the external device. Similarly, the printer will automatically switch to the stand-by state if a PRINT COMMAND is not received within approximately one minute following the last print operation to conserve power and to enhance the aural environment. (Note – PAPERFEED COMMANDs are executed independently of PRINT COMMANDs and have no effect on the stand-by status of the printer.)

4.4 PRINTER CONTROL FUNCTIONS

All data storage and printer control functions necessary to produce full lines of printout on a line-at-a-time basis are provided by the buffer, or logic electronics, of the Chaintrain Line Printer (see Figure 4-18). This section provides a description of the data storage and printer control functions commencing with the printer interface and continuing, in the direction of data flow, to the print and paperfeed mechanisms. For the purpose of this discussion, the data storage and printer control functions are conveniently arranged into three major functional groups, namely;

Character Storage and Print Control,

Paperfeed Control, and

Ribbonfeed Control.

Each function is described in terms of initiating input command signals and input data received at the printer interface; strobe pulses, status signals, and feedback signals derived from the printer mechanism; and the resulting output pulses and levels transmitted from the buffer to the various electro-mechanical devices in the printer mechanism. Figure 4-19 depicts the functional relationship of the logic electronics to the character storage and the various electro-mechanical devices in the printer mechanism. It should be noted that the character storage, print, and paperfeed control

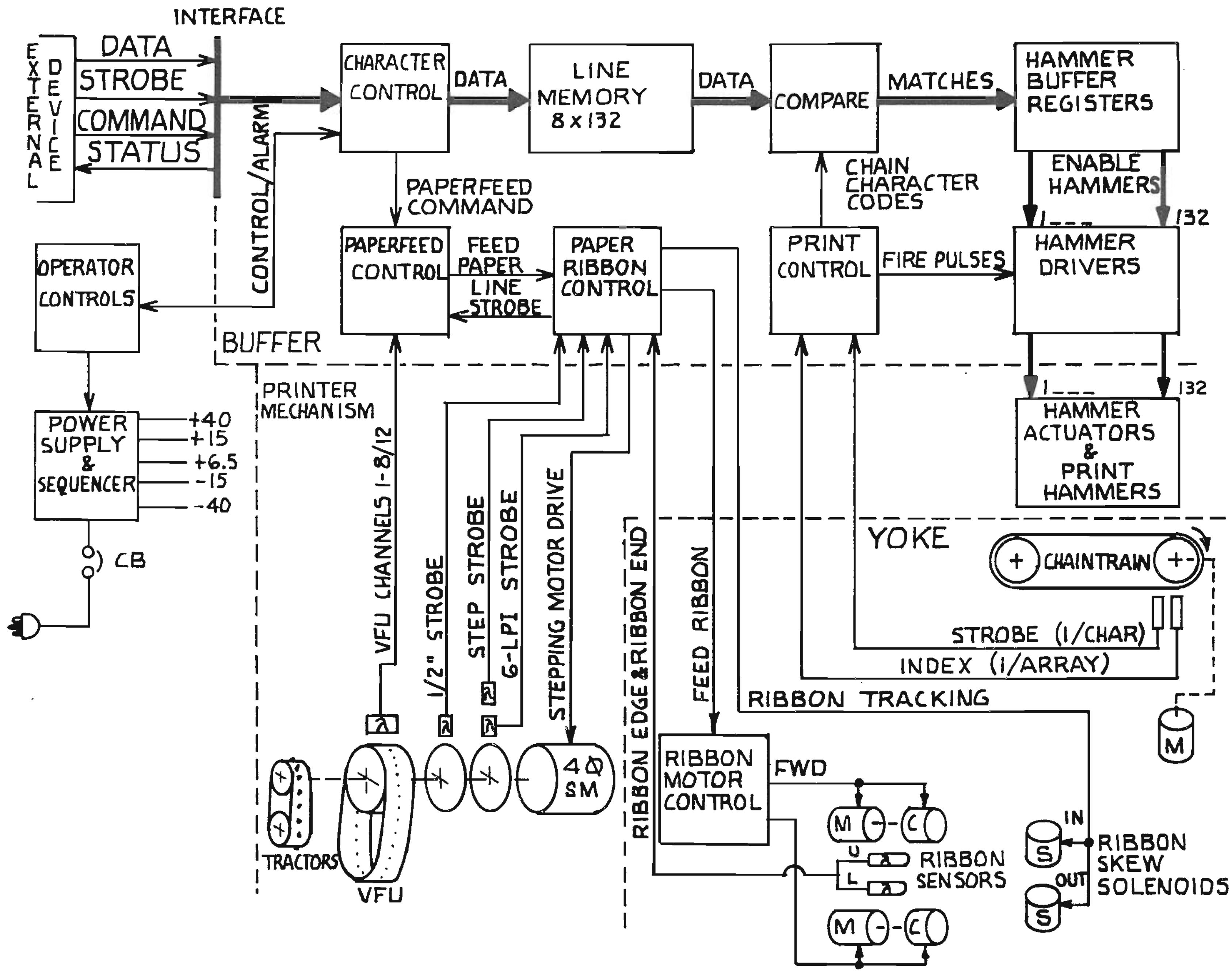


Figure 4-18. Simplified Block Diagram, DPC Chaintrain Line Printer

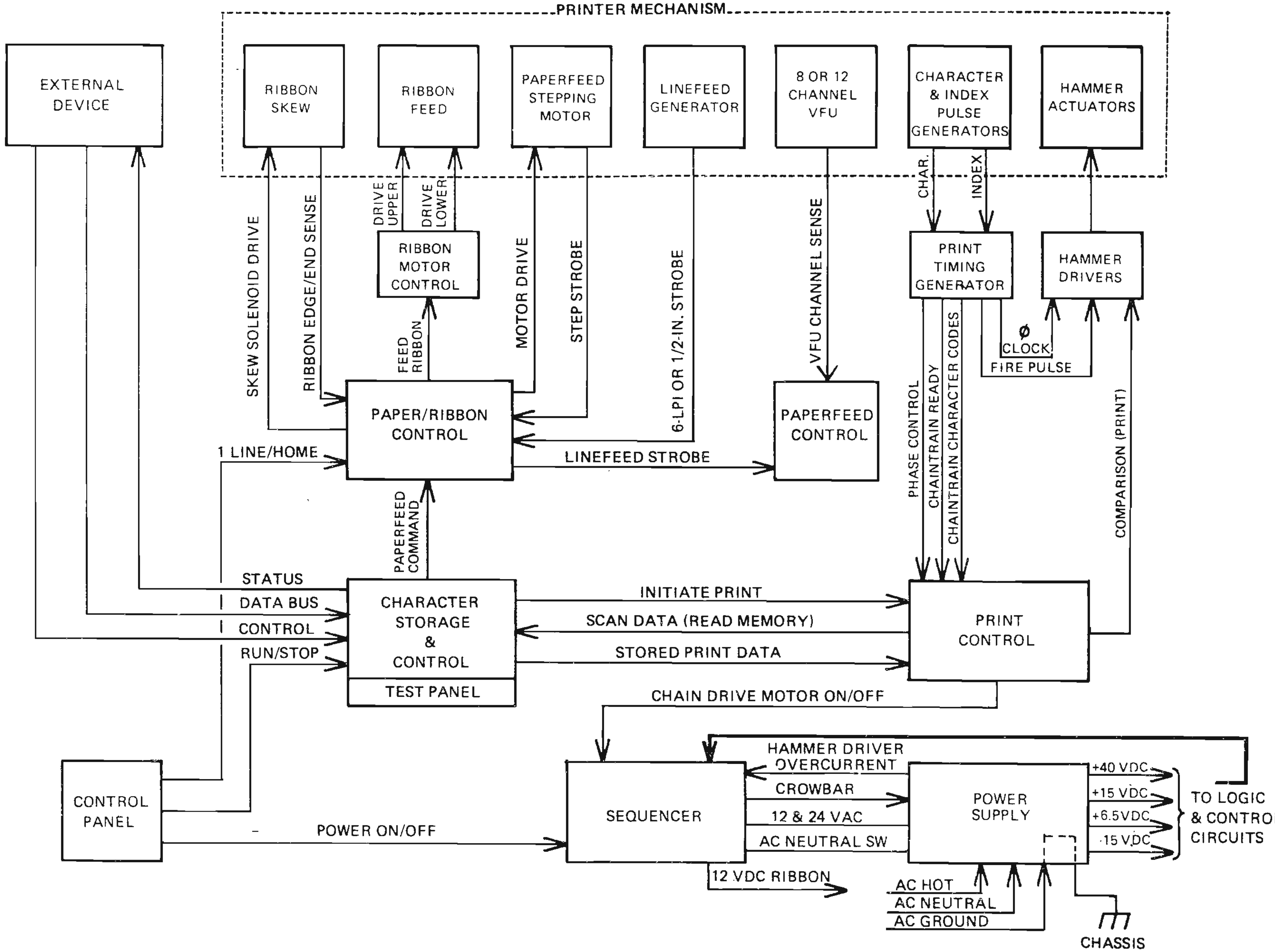


Figure 4-19. Functional Block Diagram, Logic Electronics, DPC Chaintrain Line Printer

functions are normally initiated and performed according to information received at the printer interface from the external device, but the ribbonfeed control functions are automatically initiated by the printer.

4.4.1 Character Storage and Print Control

Character Storage, or line-buffer memory, is provided for a full 132-character (standard) line of print data. This storage permits the transfer from the external device to the printer of all print data for each line of print in a single operation and at a rate considerably greater than the printing speed of the printer. Accordingly, the external device is interlocked with the printer only during the data transfer operation so that the external device may perform other operations while the printer is busy printing out the stored print data.

The character storage and print control logic functions control the loading of input print data into character storage and the scanning of the stored data for printout. After all print data for a line of print has been loaded into the line buffer, a *Print* cycle (the mechanical portion of a print operation) is initiated. In conjunction with each alignment of character type faces on the moving chaintrain with the print hammers, the stored print data is scanned and compared with those characters in printing position. Whenever a "match" occurs, the hammer actuator associated with the matching print data's position in character storage is enabled. When the contents of the entire line-buffer memory have been scanned, all enabled hammer actuators are "fired', causing the printing of all matched characters in their respective print positions. The scanning and comparison process is repeated for each successive alignment of chaintrain characters with print hammers until all stored print data has been printed out. The mechanical portion of the print operation, or *Print* cycle, is then terminated to allow the next operation to be performed.

4.4.1.1 Load Data

As shown in Figure 4-18, input data from the external device is received at the printer interface and, if print data, is loaded into the printer's line memory. Figure 4-20 depicts the character storage control logic and the line memory in greater detail with the principle elements shown in heavy outlines for emphasis. As shown in Figure 4-20, the character storage control logic basically consists of an 8-level by 132-location shift register which serves as the printer's Line Memory (2), and a Memory Address Tracking Counter (7) which counts each data character as it is loaded into the Line Memory to prevent memory overruns (this same counter is also used during a *Print* cycle to position the data in the Line Memory and to track that data during a print scan).

When the external device raises PRINT COMMAND and the printer is ready, the Character Control logic (8) raises SEND DATA and initiates a *Load Data* cycle; that is, the printer conditions itself to accept and store input data for subsequent printout. During a *Load Data* cycle, externally-generated DATA STROBE pulses are routed through the Clock Gate (6) to increment the Memory Address Tracking Counter (7) and, via the Write Pulse Gate (5), to clock the Line Memory (2). Each DATA STROBE pulse results in the transfer of an input data character from the Data Input Gates (1) to the highest location, No. 132, of the Line Memory. As subsequent DATA STROBE pulses appear, the content of the Line Memory is shifted down one (1) location at a time, and the Memory Address Tracking Counter is incremented by one (1) count. When the Memory Address Tracking Counter reaches the count of 132, which corresponds to the last location in the Line Memory (and the last print position, No. 132, in the typeline), further Memory Write pulses are inhibited at the Write Pulse Gate (5). At this time, the End-of-Line (EOL) Register (10) is set. An EOL condition indicates that the buffer is full and is used to reset the Data Request Register (9) which, in turn via the Character Control logic (8), terminates the *Load Cycle* and removes SEND DATA.

4.4.1.1.1 Memory Data

Although the external device can transfer eight-bit data characters, only the significant low-order data bits of input data are normally loaded into the Line Memory, depending upon the particular coded-character set provided. For 96-character USASCII print character sets, data bits 1 through 7 are loaded into the Line Memory; for the standard 64-character USASCII, and 48-character EBCDIC print character sets, only bits 1 through 6 are considered significant. By

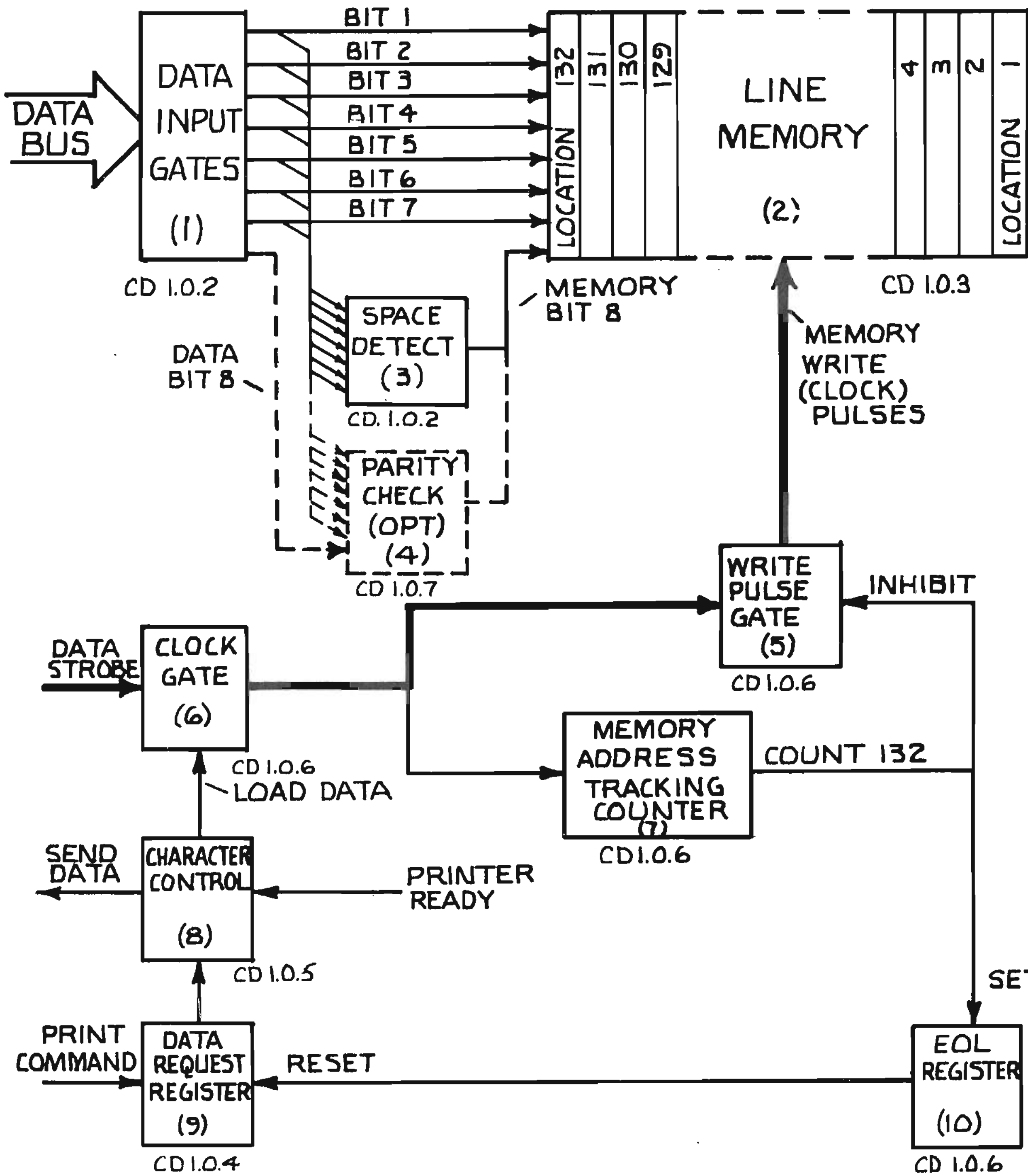


Figure 4-20. Simplified Block Diagram, Character Storage Control Logic

ignoring the two most-significant EBCDI-Coded input data bits (EBCDIC bit positions "b0" and "b1"), the entire first, second, and third EBCDI Code quadrants effectively fold over into the fourth quadrant, permitting uppercase character printout of corresponding lowercase character codes. By ignoring the most significant USASCII-coded input data bit (USASCII bit position "b7"), the entire 64-character printable subset becomes contiguously coded from Octal 00 (@) to Octal 77 (?), permitting a straight-forward binary counting technique to be used in tracking the characters on the chaintrain.

4.4.1.1.2 Memory Bit 8

During a *Load Data* cycle, the control logic generates a Memory Bit 8 for every data character, except "SPace" and "illegal" characters, and characters sensed to have incorrect parity (Input Parity Check option only), loaded into the Line Memory to identify valid print data in memory. Memory Bit 8 is used by the Print Control logic to determine if the Line Memory is empty (i.e.; all data has been printed out).

Space Detect: As each input data character is received at the printer interface, it is examined by the Space Detect logic (3) to determine if that character is a predefined code for "SPace" or is an "illegal" code[24] (i.e.; a code not represented by a character on the chaintrain). In the event of either a "SPace" code or an "illegal" code, the loading of a Memory Bit 8 into the Line Memory is inhibited for that character to suppress its printing. Thereby, a blank space will appear in the printed line for each such code received by the printer.

Parity Check (Option): As each input data character is received at the printer interface, it is examined by the Parity Check logic (4) to determine if that character has proper parity. If a parity error is detected, the loading of a Memory Bit 8 into the Line Memory is inhibited for that character to suppress its printing. Thereby, a blank space will appear in the printed line (if executed) for each character sensed to have incorrect parity.

4.4.1.1.3 Memory Clearing

During a *Load Data* cycle, the recirculation of stored data from location 1 to location 132 of the Line Memory is inhibited. As each input data character is received, the Line Memory is first shifted, then loaded with the new input data character. Consequently, any invalid data remaining in memory after completing the preceding print operation will be shifted out of the Line Memory and will not be recirculated, so that any such remainder cannot interfere with the new input data.

4.4.1.2 Print Control

As shown in Figure 4-18, during a *Print* cycle the data stored in the Line Memory is compared in synchronism with the moving chaintrain with Chain Character Codes to determine the character to be printed in each print position for which valid print data is stored. Figure 4-21 depicts the print control logic in greater detail with the principle elements shown in heavy outline for emphasis. As shown in Figure 4-21, the print control logic basically consists of Print Scan Logic (12) which provides *Print* cycle timing and synchronization with the moving chaintrain; a Memory Scan Clock (13) which clocks the Line Memory (2) and the Hammer Driver Registers (17-20) in synchronism; a Memory Address Tracking Counter (7) which tracks the position of data in the Line Memory and the Hammer Driver Registers; a Chain Character Code Generator (14) which generates a binary count code for each character on the moving chaintrain as they come into alignment with the print hammers; Compare Gates (11) which compare the data read out of the Line Memory with Chain Character Codes; and four (4) Hammer Driver Registers (17-20) which temporarily store the results of comparisons for each chaintrain character alignment interval until the chaintrain (hereafter called "chain" for clarity) has moved into proper position for firing the appropriate hammer actuators and print hammers (not shown).

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(24) Illegal Code detection is provided by the Space Detect logic only in conjunction with a USASCII-coded 96-character print set. When required, illegal code detection for EBCDI-Coded print character sets is provided by an appropriate code converter (see 4.4.1.2.9).

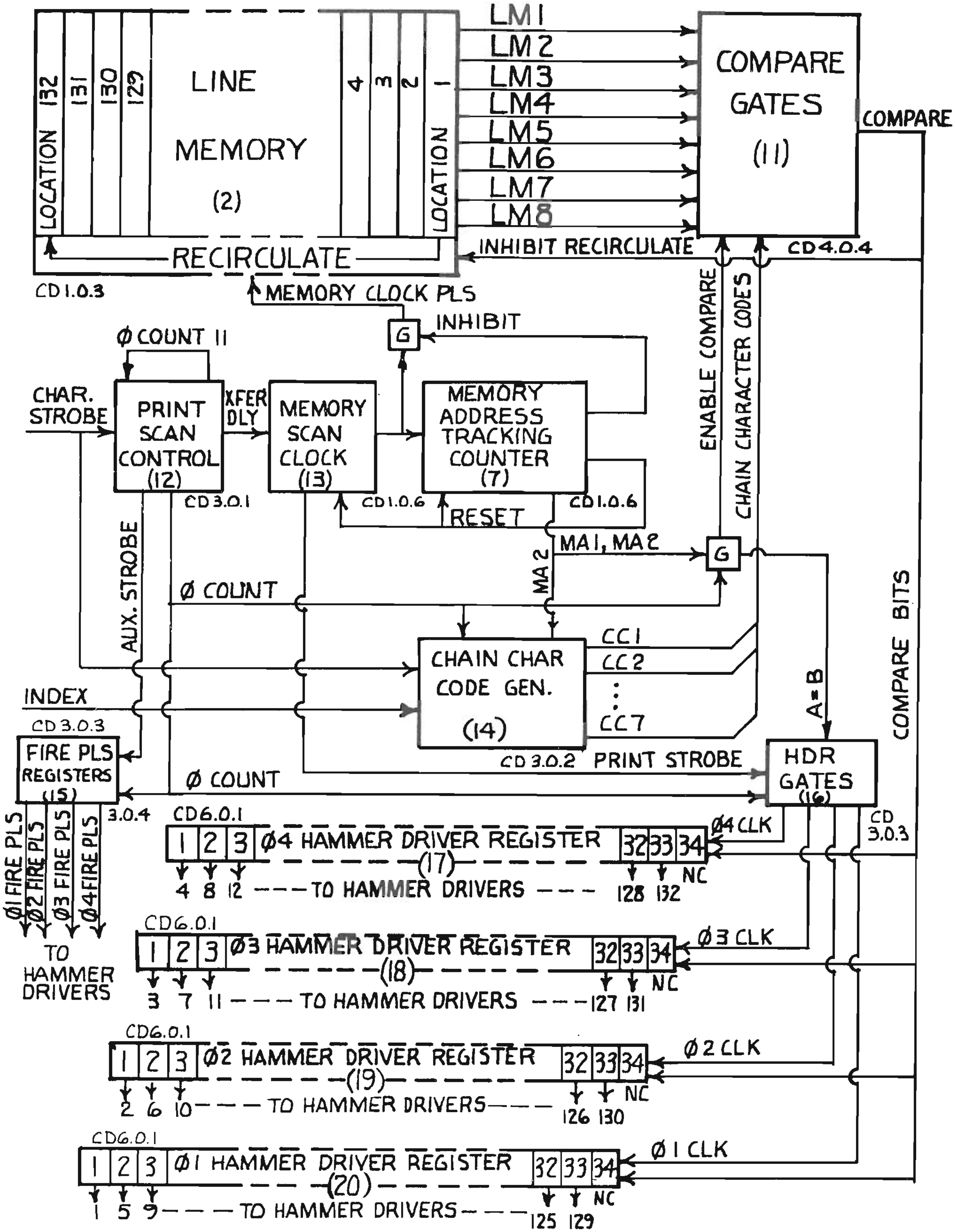

Figure 4-21. Simplified Block Diagram, Print Control Logic

Because of the 3-to-4 relationship of print hammer spacing[25] to chain character spacing[26], an alignment of characters on the moving chain with print hammers can occur at only one-fourth of the print hammers at a time. Consequently, as shown in Figure 4-22 A, every third chain character will align with every fourth print hammer during an alignment interval. As the chain travels across the line of print hammers, successively higher sets of every third chain character become aligned with successively lower sets of every fourth print hammer. The chain character alignments occur such that in four (4) successive alignment intervals, or when the chain has travelled the distance of one (1) character space, some character will have been aligned with every print hammer. Accordingly, as shown in Figure 4-22 B, the interval between successive characters on the moving chain, designated a "Print Scan", is divided into four (4) uniform sub-intervals called "Phase Scans". Phase scans are conveniently designated according to the lowest print position at which an alignment occurs during a phase scan; namely, in the order of occurrence, Phase 4, 3, 2, and 1. (Refer to paragraph 4.2.1.1 for a detail description of the chain character to print hammer relationship.)

Accordingly, during a Print Scan, the Line Memory (2) is scanned in its entirety four times, once for each chain character alignment phase (hereafter called "phase" for clarity), under control of the Print Scan Control logic (12) which synchronizes each phase scan with the moving chain and conditions the print control logic according to phase. Each location in the Line Memory (2) corresponds to a like-numbered print hammer; however, because an alignment of chain characters can occur at only every fourth print hammer, only the contents of every fourth Line Memory location, according to phase, are examined for printability during a phase scan. Hence, during a phase scan for Phase 4, for example, only locations 4, 8, 12, etc., through 132 are examined as these locations correspond to those print hammers at which some chain character comes into alignment during Phase 4. The print hammers at which some chain character becomes aligned during each phase are depicted in Figure 4-22 and are listed below:

Phase:	*Print Hammers (At which some chain character becomes aligned)*
4	4, 8, 12, 16, 20, 24, 28, ... , 132
3	3, 7, 11, 15, 19, 23, 27, ... , 131
2	2, 6, 10, 14, 18, 22, 26, ... , 130
1	1, 5, 9, 13, 17, 21, 25, ... , 129

Similarly, the Chain Character Code Generator (14) is conditioned by the Print Scan Control logic at the beginning of each phase scan to produce the proper binary code which identifies the chain character in alignment with the lowest print hammer, and, because of the chain character alignment scheme, the Chain Character Code Generator is conditioned to produce the proper Chain Character Code for every third lower chain character in conjunction with the scanning of every fourth Line Memory location according to phase. Hence, as shown in Figure 4-22, during a phase scan for Phase 4 for example, the initial Chain Character Code will be for the graphic Equals (=) which aligns with print hammer 4. Subsequently, in conjunction with the scanning of every fourth Line Memory location, the Chain Character Code Generator is conditioned by the Memory Address Tracking Counter (7) to produce the proper code for every third preceding graphic in the chaintrain arrangement, as follows[27]:

Print Hammer:	4	8	12	16	20	24	28	...	132
Graphic:	=	:	7	4	1	.	+	...	]
Comparison:	1	2	3	4	5	6	7	...	33

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(25) Print hammers are nominally spaced 0.100-inch (2,54-mm), c-c.

(26) Chaintrain characters are nominally spaced 0.133-inch (3,38-mm), c-c.

(27) The graphics shown correspond to the ϕ 4 alignment of the first print scan following chain Index with the standard 64-character USASCII chaintrain arrangement. Different graphics will be aligned during the corresponding intervals of subsequent print scans and with different chaintrain arrangements.

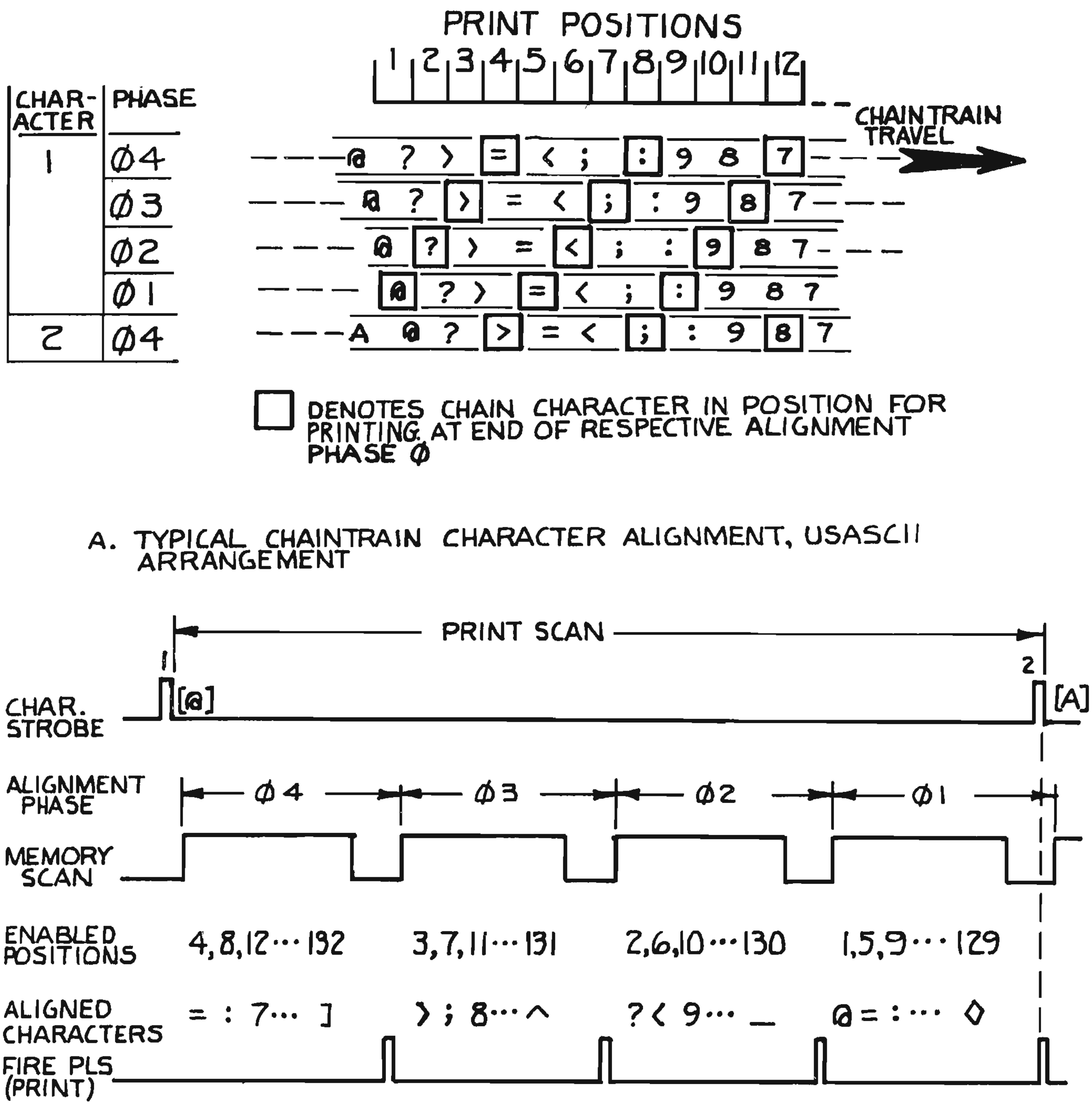

Figure 4-22. Typical Chaintrain Character Alignment and Print Scan

A phase scan is performed during the interval preceding the corresponding alignment of chain characters with print hammers (i.e.; as the chain characters are coming into alignment). During this time, the contents of the entire Line Memory are scanned. At the beginning of each phase scan, the Print Scan Control logic starts the Memory Clock (13) which generates a stream of timing pulses that increment the Memory Address Tracking Counter and shift the contents of the Line Memory. The contents of the Line Memory are shifted down, one location at a time, to the terminal location, No. 1. As the contents of each location associated with the current phase are shifted into the terminal location, they, if valid print data, are examined for comparison, bit-for-bit, with the current Chain Character Code at the Compare Gates (11). When a valid comparison occurs (i.e.; the print data and chain character codes match), the highest logation, No. 34, of the appropriate Hammer Driver Register (17, 18, 19 or 20, depending upon the current phase) is loaded with a "print" bit and the "matched" print data character is not recirculated into the Line Memory (hence, "matched" print data is shifted out of memory). If the terminal location is empty or contains an invalid data character, of if the comparison is invalid, a "no print" bit is loaded into the Hammer Driver Register and the contents of the terminal location are recirculated to the highest location, No. 132, of the Line Memory to permit comparison during a subsequent print scan. Similarly, the contents of the intervening Line Memory locations, which are not associated with the current phase, are recirculated as they appear in the terminal location to permit comparison during a subsequent phase scan.

According to the current phase, every fourth shift of the contents of the Line Memory is accompanied by a shift of data in the corresponding Hammer Driver Register. When the Memory Address Tracking Counter reaches the count of 132, further shifting of the Line Memory is inhibited, leaving the recirculated data in their original locations in preparation for a subsequent scan. In the interim, the data in the Hammer Driver Register will have been shifted down 33 times to locations 2 through 34. However, the Hammer Driver Registers each consist of 34 locations.[28] Accordingly, the Memory Scan Clock is allowed to continue until the Memory Address Tracking Counter reaches the count of 136, to produce one (1) additional Hammer Driver Register shift pulse. At this time, the data in the Hammer Driver Register will be positioned in locations 1 through 33 which correspond to the print hammers associated with the current phase. Hence, the locations which correspond to the Line Memory locations of the "matched" print data characters will then contain a "print" bit which enables the corresponding Hammer Driver (not shown). When the chain moves into proper position at the end of the current phase, the enabled Hammer Drivers are "fired" to energize the correspondong Hammer Actuators (not shown) which results in the printing of the "matched" characters in their respective print positions.

The process of scanning and comparing stored print data, and of printing "matched" characters is repeated for each phase in succession; and is repeated for each print scan (i.e.; each time the chain moves the distance of one character) in succession until all stored valid print data is printed out. Since only some of the characters that become aligned during a print scan may be the required characters for printing in the specified print positions, a number of print scans may be necessary to completely print out all of the stored data. The number of print scans necessary depends upon the data and the position of the chain; however, in no case will the number of print scans associated with the actual printing exceed the number of characters on the chain-train arrangement with which a particular printer is equipped. It should be noted that two additional print scans are required to initiate and terminate each *Print* cycle, or operation (see 4.4.1.2.6 and 4.4.1.2.7 for details).

4.4.1.2.1 Print Scan Control

The Print Scan Control logic (12) tracks the chain character alignment intervals, or phases, and synchronizes the scanning of stored print data with the current phase of the moving chain to ensure proper registration of printout. Figure 4-23 depicts the Print Scan Control logic in greater detail and shows the normal sequence of the print scan control signals. As shown in Figure 4-23, the Print Scan Control logic basically consists of a Phase Counter (21) that tracks the chain character alignment intervals, or phases, that occur during each print scan; a Phase

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(28) Provided to permit 136 print positions, if required.

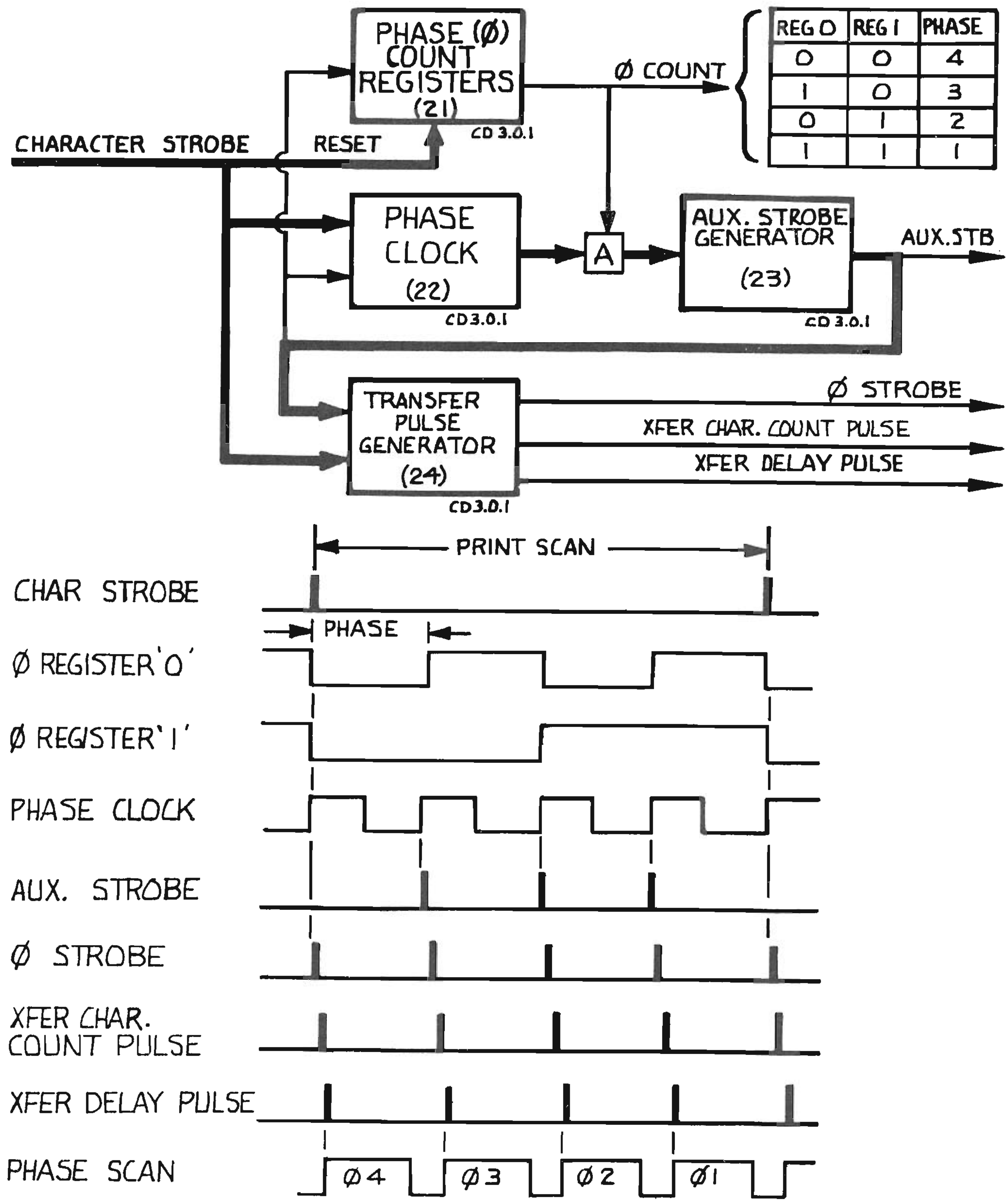

Figure 4-23. Simplified Block and Signal Sequence Diagrams, Print Scan Control

Clock (22) and an Auxilliary Strobe Generator (23) which time the start of successive phase scans; and a Transfer Pulse Generator (24) which generates a sequence of pulses that condition the print control logic at the beginning of each phase scan.

A Character Strobe pulse is generated for each character on the moving chain by the Character Strobe Generator (not shown) located on the chaintrain assembly (refer to paragraph 4.2.1.4 for details). Each Character Strobe pulse[29] signals the start of a print scan which, because of the chain character alignment scheme, is divided into four (4) uniform sub-scans, called phase scans, by the Print Scan Control logic.

The events that occur during a print scan are depicted in Figure 4-23 and are briefly described below. Each Character Strobe pulse resets the Phase Count Registers (21) to the count of 0 (binary 00) which indicates the first of the four phases, Phase 4, of a print scan, and starts the Transfer Pulse Generator (24) and the Phase Clock (22). The Transfer Pulse Generator produces a sequence of three pulses; ϕ Strobe, Transfer Character Count, and Transfer Delay which clear, and transfer a new chain character count into the Chain Character Code Registers (see 4.4.1.2.3), and start the Memory Scan Clock (13), respectively. Upon completion of each Phase Clock cycle, the Auxilliary Strobe Generator (23) produces an Auxilliary Strobe pulse which times the firing of the print hammers selected during the phase scan just completed, increments the Phase Counter to indicate the next phase, and restarts the Transfer Pulse Generator and Phase Clock to start the next phase scan. When the Phase Counter reaches the count of 3, which indicates the last of the four phases, Phase 1, of a print scan, the Auxilliary Strobe Generator is inhibited from producing a pulse at the end of the current (i.e.; fourth) Memory Clock cycle to stop further phase scanning until the next Character Strobe pulse appears. The next Character Strobe pulse starts the next print scan as described above and times the firing of the print hammers selected during the Phase 1 scan just completed.

The timing of the firing of print hammers by Character Strobe pulses ensures proper lateral registration of printout in those print positions associated with Phase 1. The period of the Memory Clock cycle is maintenance adjustable to permit proper lateral registration of printout to be achieved in those print positions associated with phases 4, 3, and 2, in which printing is timed by Auxiliary Strobe pulses.

4.4.1.2.2 Memory Scan Control

The Memory Scan Control logic clocks the Line Memory (2) and the appropriate Hammer Driver Register (17-20), and tracks the position of data in the Line Memory and Hammer Driver Register during each phase scan. Figure 4-24 depicts the Memory Scan Control logic which pertains to phase scanning functions and shows the normal sequence of memory scan signals. As shown in Figure 4-24, the Memory Scan Control logic basically consists of a Scan Data Register (25) that enables the Memory Scan Clock for each phase scan; a Memory Scan Clock (13) which times the scanning and comparison of the contents of the Line Memory, and the shifting and loading of data in the appropriate Hammer Driver Register; and a binary Memory Address Tracking Counter (7) that counts Memory Scan Clock cycles to identify the phase with which each Line Memory location is associated, and to properly position the contents of the Line Memory and the appropriate Hammer Driver Register at the completion of each phase scan.

A Transfer Delay pulse is generated for each phase (i.e.; chain character alignment interval) by the Print Scan Control logic (12). During a *Print* cycle, after all initiate print functions are completed, each Transfer Delay pulse signals the start of a phase scan which is allowed to continue until the contents of all 132 locations have been shifted through the Line Memory, and the data in the appropriate Hammer Driver Register is properly positioned for printing.

The events that occur during each phase scan are depicted in Figure 4-24 and are briefly described below. (Note – The logic associated with the initiate print functions is purposely omitted from this discussion for clarity; refer to paragraph 4.4.1.2.6 for details.) Each Transfer Delay pulse sets the Scan Data Register (25) which, in turn, starts and enables the Memory

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(29) At Character Strobe time, some chain character is in proper position for printing at the print positions associated with ϕ 1 (i.e.; print hammers 1, 5, 9, etc., through 129) which have been selected during the preceding print scan.

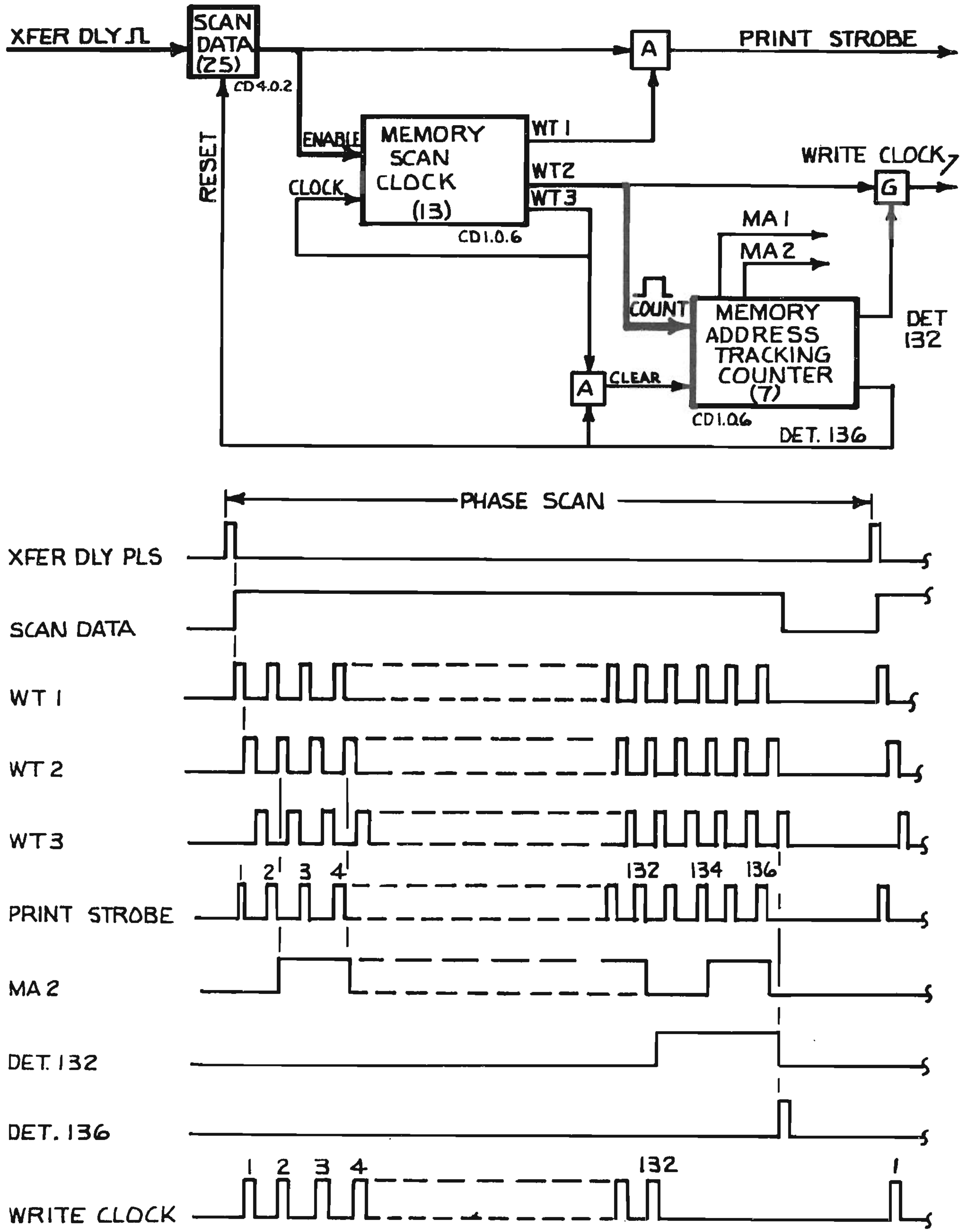


Figure 4-24. Simplified Block and Signal Sequence Diagrams, Print Cycle Functions, Memory Scan Control

Scan Clock (13). The Memory Scan Clock repeatedly produces a sequence of three Write Time (WT) pulses until the Scan Data Register is reset. The Write Time pulses, WT1, WT2, and WT3 are used to derive Print Strobe pulses that time the shifting and loading of data in the appropriate Hammer Driver Register; to increment the Memory Address Tracking Counter and derive Write Clock pulses that time the shifting of the contents of the Line Memory; and to restore the comparison logic after each comparison, respectively. Upon completion of each WT3 pulse, the Memory Scan Clock is restarted to produce the next sequence of Write Time pulses.

At the beginning of each phase scan, the Memory Address Tracking Counter (7) is in the clear state with a count of zero (0000 0000). Each time the contents of the Line Memory are shifted at Write Pulse time (i.e.; WT 2 time), the Memory Address Tracking Counter is incremented by one (1) to keep track of the original location of the stored data currently shifted into the terminal location, No. 1, of the Line Memory. Since each Line Memory location corresponds to a print hammer, the output of the counter serves to identify the print position of each stored print data character as it is shifted into position for comparison. Accordingly, the outputs of the two low-order counter stages, MA1 and MA2, identify the phase with which each shifted data character is associated, as follows:

Memory Address: 128 – 16	8 4 2 1	*Memory Location And Print Hammer Position*	*Phase:*
x x x x	x x 0 0	1, 5, 9, 13, 17, 21, 25, ... , 129	1
x x x x	x x 0 1	2, 6, 10, 14, 18, 22, 26, ... , 130	2
x x x x	x x 1 0	3, 7, 11, 15, 19, 23, 27, ... , 131	3
x x x x	x x 1 1	4, 8, 12, 16, 20, 24, 28, ... , 132	4

x denotes either 1 or 0.

The MA1 and MA2 counter outputs enable the Compare Gates (11) to examine only the contents of those locations associated with the current phase for comparison with Chain Character Codes.

When the Memory Address Tracking Counter reaches the count of 132 (1000 0100), further Write Clock pulses are inhibited, which leaves any remaining data in their original locations in the Line Memory in preparation for a subsequent scan. However, the Memory Scan Clock is allowed to continue until the count of 136 is reached in order to provide for an additional shift of the appropriate Hammer Driver Register which properly positions the data in that register for printing. (This additional shift is necessary because each Hammer Driver Register is equipped with 34 locations, one more than required for the 33 comparisons that occur during a phase scan for 132 print positions.) When the Memory Address Tracking Counter reaches the count of 136 (1000 1000), the Scan Data Register is reset to inhibit further cycling of the Memory Scan Clock, and the Memory Address Tracking Counter is cleared to the count of zero (0000 0000) by the last WT 3 pulse generated by the Memory Scan Clock, thereby terminating the phase scan.

4.4.1.2.3 Chain Character Code Generator

The Chain Character Code Generator (14) tracks the characters on the moving chaintrain and produces a Chain Character Code for each chain character coming into alignment with the appropriate print hammers during each phase. Figure 4-25 depicts the Chain Character Code Generator in greater detail: the sequence of control signals is shown together with a typical set of Chain Character Codes generated during a print scan in Figure 4-26. As shown in Figure 4-25, the Chain Character Code Generator basically consists of an Index Register (26) that presets a Master Counter at the beginning of each array (set) of characters on the chain; a Master Counter (27) which generates a binary code for each character position on the chain; a Full Adder (28) that modifies the binary code produced by the Master Counter according to the current phase; a Character Code Register (30, 31) that stores the Chain Character Codes, per se; and "Add Three" logic (29) which modifies the stored Chain Character Code according to the Line Memory location currently being examined for comparison for printing (i.e.; those locations which correspond to print hammer positions associated with the current phase).

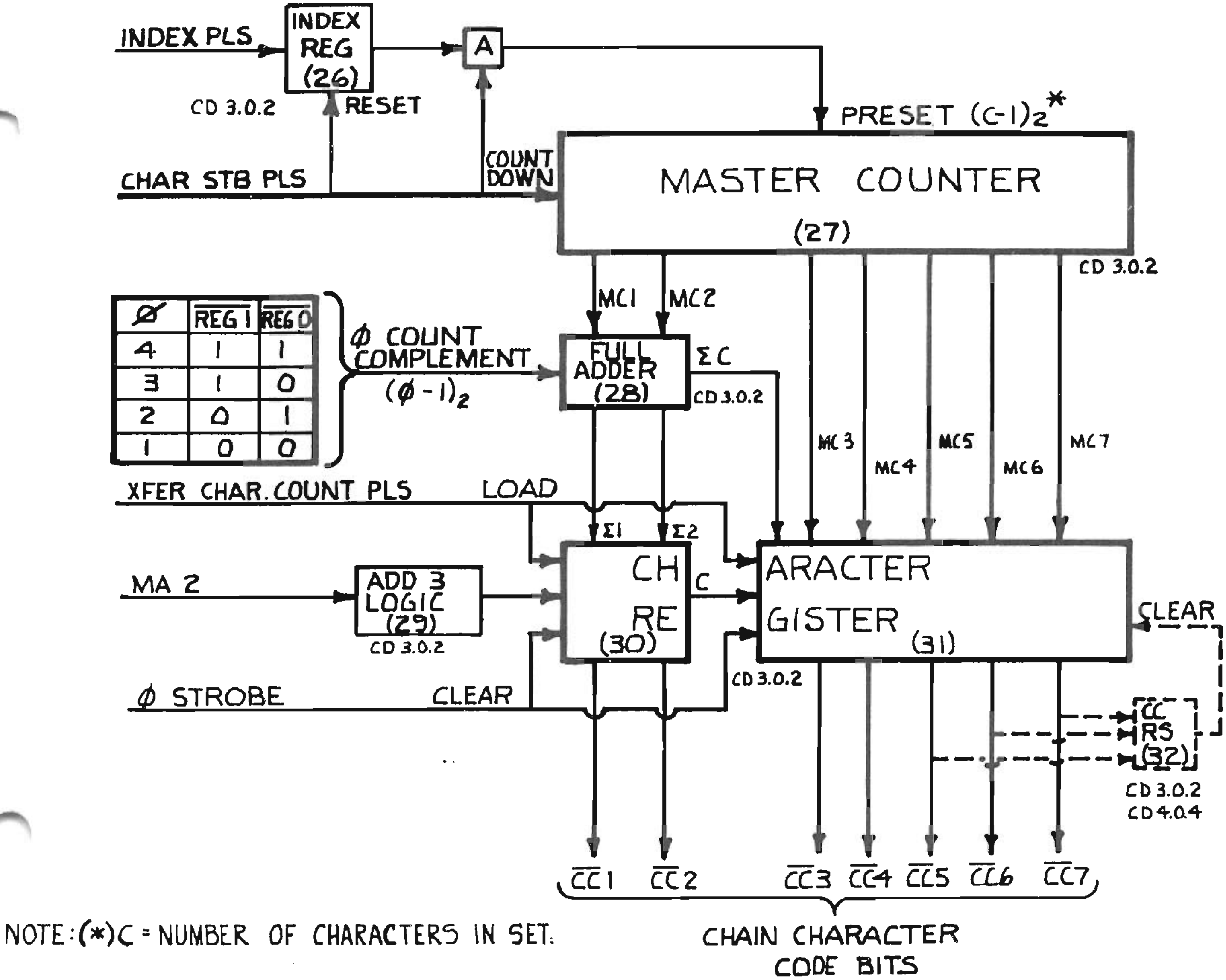
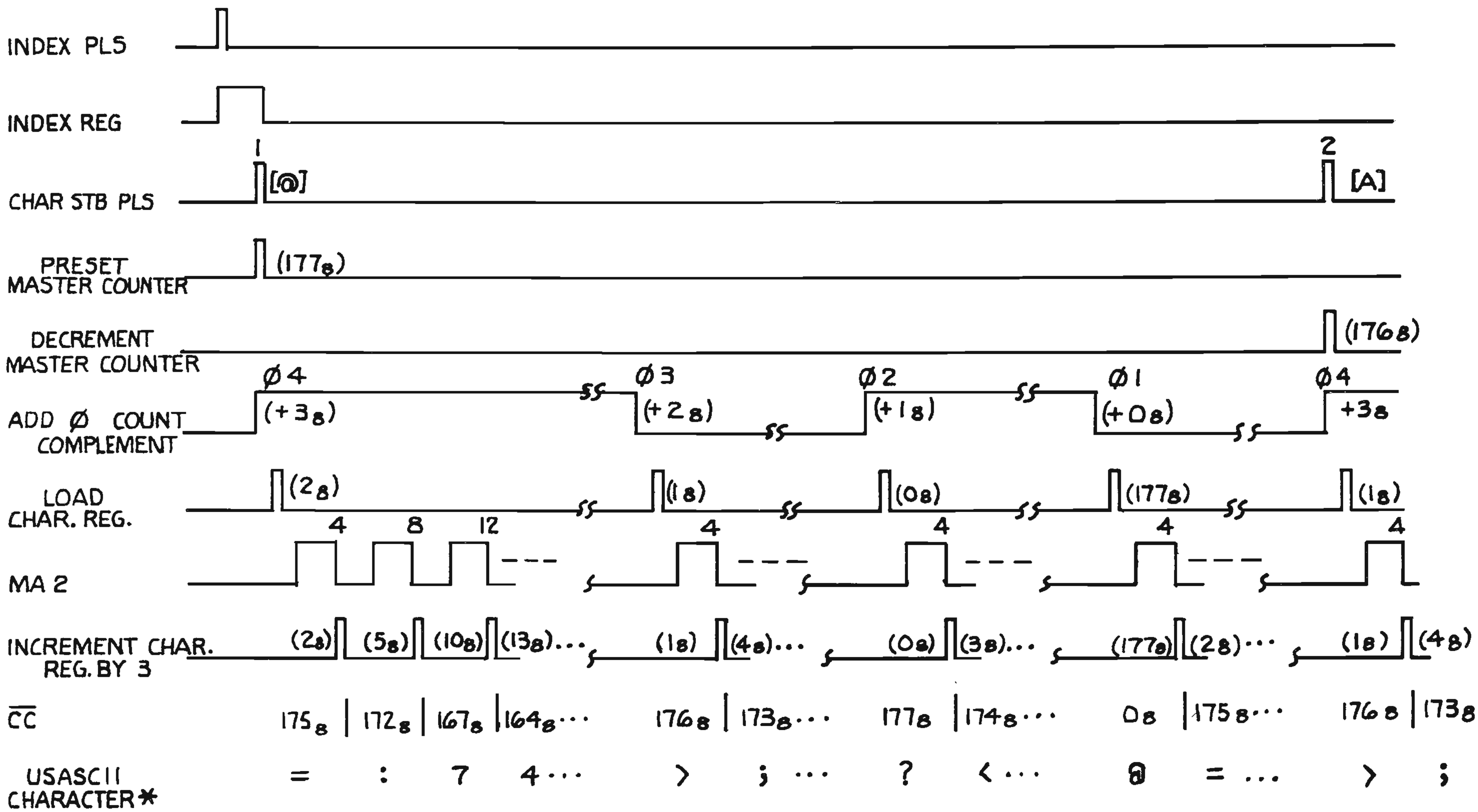


Figure 4-25. Simplified Block Diagram, Chain Character Code Generator

The character positions, and the graphics that occupy those positions, in each array on the chain are identified according to their sequence of presentation to the beginning of the type-line by a contiguous ascending binary Chain Character Code (refer to paragraph 4.2.1.2 for details). Because of the lateral organization of characters on the chain (i.e.; repeated identical arrays) and the chain character alignment scheme, only every third preceding chain character can become aligned for printing at every fourth print hammer at a time (see Figure 4-22). Consequently, and because the Line Memory is scanned sequentially by location, Chain Character Codes are generated during each print scan according to chain position, phase, and associated Line Memory (and print hammer) location. Accordingly, the generation of Chain Character Codes can be considered as being performed in three steps, as follows:

1. *Count* – In which an ascending binary count is generated for the next chain character to be presented to the beginning of the typeline,
2. *Phase Adjust* In which the chain character count is adjusted according to the current phase, and



NOTE: (*) STANDARD 64-CHARACTER SET DEPICTED (CC BIT 7 IS IGNORED AT COMPARATOR); CHARACTER CORRESPONDENCY MAY VARY ACCORDING TO CHAINTRAIN ARRANGEMENT PROVIDED.

Figure 4-26. Signal Sequence and Counter States, Chain Character Code Generator, Standard 64-Character Set

3. *Code Generate* – During which the adjusted count is decremented according to the print hammer associated with the current phase for which stored print data is currently being examined for comparison.

The events that occur in the generation of Chain Character Codes during a print scan are shown, together with a typical set of counter states and Chain Character Codes (Octal notation) with a standard 64-character chaintrain arrangement, in Figure 4-26 and are briefly described below. The appearance at the typeline of each character and the beginning of each array of characters on the chain are indicated by a Character Strobe pulse and an Index pulse, respectively, that are produced as the chain moves by their respective generators (not shown) located on the chaintrain assembly (refer to paragraph 4.2.1.4 for details). Each Character Strobe pulse indicates the approach of the next chain character in sequence to become aligned with the first print hammer, No. 1, in the typeline[30] and signals the start of a print scan. Index pulses are normally adjusted to occur between the Character Strobe pulses associated with the last character of one array and the first character of next array to appear at the typeline.

Count – Each Index pulse sets an Index Register (26) to indicate that the beginning of the next array of characters on the chain is approaching the first print hammer of the typeline. When the Index Register is set, the first Character Strobe pulse following an Index pulse presets the Master Counter (27) to the *complement* of the Chain Character Code which identifies the first character location, and the graphic that occupies that location, of the next array of characters on the chain. As shown in Figures 4-22 and 4-26, for the standard 64-character USASCII chain arrangement (see Table 1-1 and Figure 1-3 for codes and character sequence on chain), the Master Counter is preset to Octal 177 (1 111 111) which is the complement of the Octal Code 00(000 000) that designates the graphic Commercial At (@). (NOTE – Only bits b6 through b1 [Octal 00 through 77] are significant to the printer with the standard 64-character arrangement.)

In conjunction with the presetting of the Master Counter, the Index Register is reset (at the trailing edge of the first Character Strobe pulse following Index) to enable the Master Counter. Subsequently, the Master Counter is decremented (counted down) by one count for each successive Chain Character Strobe pulse, to produce the complement of the Chain Character Code for each character location, and the graphic that occupies each location, in the array as they are presented, in sequence, to the first print hammer position of the typeline. For the standard 64-character chain arrangement, the Master Counter produces character counts as follows:

Char. Location (After Index)	*Master Count*		*Chain Character Code*		*Graphic (USASCII)*
	Bits	*Octal*	*Bits*	*Octal*	
1	*1 111 111	(1)77	0 000 000	00	@
2	1 111 110	(1)76	0 000 001	01	A
3	1 111 101	(1)75	0 000 010	02	B
4	1 111 100	(1)74	0 000 011	03	C
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
64	1 000 000	(1)00	0 111 111	77	?

NOTE: Asterisk (*) denotes preset count

Phase Adjust – As described in the preceding paragraphs, each Character Strobe pulse signals the start of a print scan which, because of the chain character alignment scheme, is uniformly divided into four (4) phase scans. Accordingly, at the beginning of each phase scan, the Master Counter output is adjusted according to the current phase. As shown in Figure 4-25, the com-

(30) At Character Strobe time, the current chain character is in proper position for firing the Hammer Driver and Actuator for print hammer 1; however, the determination to print would have been made during the preceding print scan.

plement of the current phase count, which is derived from Character Strobe by the Print Scan Control logic (12), is added to the current character count by a Full Adder (28). The resultant count is the complement of the Chain Character Code that identifies the preceding character location, and the graphic that occupies that location, on the chain which becomes aligned with the lowest print hammer position, 4, 3, 2 or 1, during the respective phase. For example: as shown in Figures 4-22 and 4-26, the adjusted character counts for the first print scan of the standard 64-character chain arrangement will be, according to phase, as follows:

Location	*Master Count*	*Phase*	*Phase Count (Complement)*	*Adjusted Count*	*Chain Character Code*	*Graphic (USASCII)*
1	1 111 111	4	11	0 000 010	(1) 111 101 75	=
		3	10	0 000 001	(1) 111 110 76	>
		2	01	0 000 000	(1) 111 111 77	?
		1	00	1 111 111	(0) 000 000 00	@

Subsequently, the adjusted character count is loaded into the Character Code Register (30, 31) at the beginning of each phase scan by Transfer Character Count and Transfer Delay (not shown) that are generated by the Print Scan Control logic.

Code Generate – As shown in Figure 4-25, the complement of the character count in the Character Code Register (30, 31) is read out as the Chain Character Code which is compared with the stored print data to determine printability. As described in the preceding paragraph, the adjusted character count transferred to the Character Code Register at the beginning of each phase scan identifies the chain character that will become aligned with the lowest print hammer position during that phase. Subsequently, in conjunction with every fourth shift of the Line Memory, the character count in the Character Code Register is incremented by decimal 3 (11) to produce the Chain Character Code that identifies every third preceding chain character that becomes aligned with every fourth print hammer during the current phase. Upon completion of each MA2 signal, which is generated by the Memory Address Tracking Counter (7), the "Add Three" logic (29) is enabled to increase the character count in the Character Code Register by a count of three (3). For example: as shown in Figures 4-22 and 4-26, the incremented character counts for the first phase scan (i.e.; for Phase 4) of the first print scan (after Index) of the standard 64-character chain arrangement will be as follows:

Line Memory Shift	*Line Memory Location**	*Adjusted Count***	*Increment Count by:*	*Character Count*	*Chain Character Code****	*Graphic (USASCII)*
0-3	1-4	0 000 010	- --- ---	0 000 010	(1) 111 101 75	=
4-7	5-8		0 000 011	0 000 101	(1) 111 010 72	:
8-11	9-12		0 000 011	0 001 000	(1) 110 111 67	7
12-15	13-16		0 000 011	0 001 011	(1) 110 100 64	4
.	.		.	.	.	.
.	.		.	.	.	.
.	.		.	.	.	.
128-131	129-132		0 000 011	1 100 010	(0) 011 101 35	]

NOTES: *Line Memory locations correspond to print hammer positions.
**Character Count shown for Phase 4.
***High-order bit is ignored with 64-character chain arrangement.

The process of generating Chain Character Codes is repeated for each phase scan in succession as described above but with the appropriate adjusted character count according to phase. At the beginning of each phase scan, the Character Code Register is cleared, in preparation for the transfer of the next adjusted character count, by a Phase (ϕ) Strobe pulse which is generated by the Print Scan Control logic.

The process of generating Chain Character Codes is repeated for each print scan (i.e.; each Character Strobe pulse) for successive chain characters as they appear at the beginning of the typeline until all stored data has been printed. A character count is generated for each chain character location by the Master Counter as long as the printer is ready and the chaintrain drive motor is turned on. This arrangement provides a current character count at all times to permit a *Print* cycle to be started with the next chain character to be presented to the beginning of the typeline following an Initiate Print signal (see 4.4.1.2.6) so as to minimize the time required to perform a print operation.

48 And 96-Character Chain Codes – Chain Character Codes for 48 and 96-character chain arrangements (i.e.; character sets) are produced in the same manner as described in the preceding paragraphs for a 64-character arrangement except for the Master Counter preset count and the Character Code Register recycle count. In order to preserve the USASCII-correspondency of the Chain Character Codes, the Master Counter is preset at the beginning of each array of characters to the binary count (C-1) that corresponds to the number of characters (C) in an array. Hence, the last count (down) of the Master Counter will be Octal 000 (0 000 000) which results in a Chain Character Code of Octal 177, or 77 as required, ([1] 111 111) to identify the last character location in an array. Accordingly, the Master Counter preset count is different according to the character set provided, as shown below:

Characters per Array (C)	*Master Counter Preset*			*Chain Character Code of First Character in Array*	
	Decimal (C-1)	*Octal*	*Bits*	**Bits*	*Octal*
48	47	057	0 101 111	(1) 010 000	20
64	63	**177	1 111 111	(0) 000 000	00
96	95	137	1 011 111	0 100 000	040
128	127	177	1 111 111	0 000 000	000

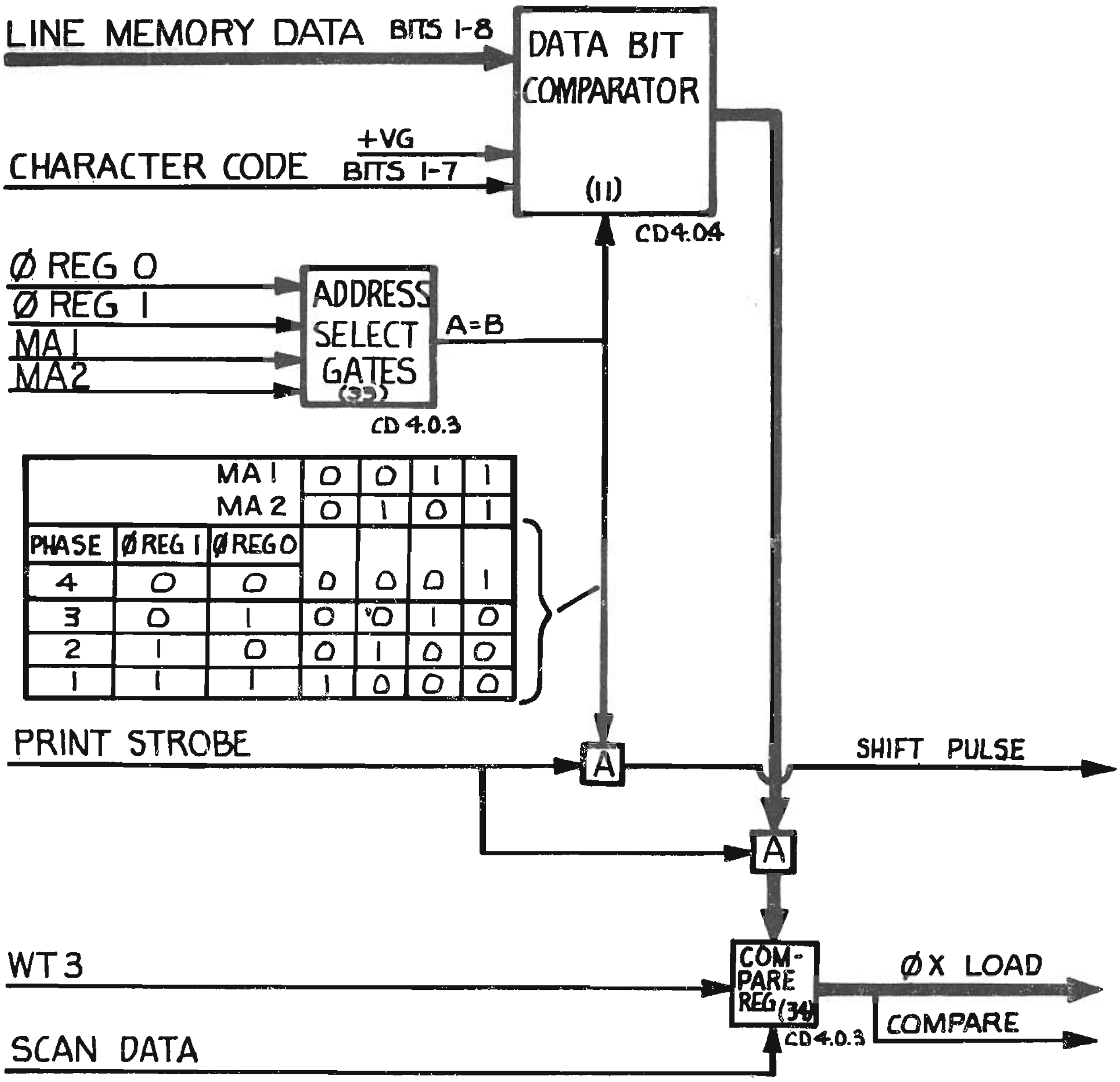
NOTES: *Bits shown in parentheses ( ) are ignored.
**The high-order bit is ignored, hence is irrelevant.

Similarly, the Character Code Register is recycled whenever its count exceeds the binary count (C-1) that corresponds to the number of characters (C) in an array. Whenever the Character Code Reset (CCRS) gates (32) detect a corresponding Chain Character Code of Octal 037 or less (0 0xx xxx) for a 96-character array, or of Octal 17 or less ([x] 00x xxx) for a 48-character array, the five high-order stages, CC3 through CC7, of the Character Code Register (31) are reset to the count of 0 000 0xx, or the equivalent Chain Character Code of 1 111 1xx. The two low-order stages, CC1 and CC2 (30), are *not* reset at this time in order to retain the proper chain character count for the next third preceding character. Because the Character Code Register is a binary counter, it automatically recycles when the count of 127 is exceeded and, since the high-order stage, CC7, is ignored for a 64-character array, the count recycles when the count of 63 is exceeded.

4.4.1.2.4 Data Comparison Control

The Data Comparison logic (11) selectively examines the data read out of the Line Memory for comparison with Chain Character Codes to determine their printability. Figure 4-27 depicts the Data Comparison logic in greater detail; the sequence of control signals for a typical phase scan is shown in Figure 4-28 together with a set of typical Chain Character Codes. As shown in Figure 4-27, the Data Comparison logic basically consists of a Data Bit Comparator (11) which compares valid print data and Chain Character Codes on a bit-for-bit basis; an Address Select Gate (33) that selects the Line Memory locations to be examined according to the current phase; and a Compare Register (34) that temporarily stores the result of each compare examination for loading into the appropriate Hammer Driver Register (17-20).

The Data Bit Comparator (11) is enabled only as those locations in the Line Memory that are associated with the current phase are shifted into the terminal location, No. 1. This selective enabling is accomplished by the Address Select Gates (33) which are conditioned by the outputs (A) of the Phase Count Registers (21) to produce an enabling signal (A=B) whenever the two low-order stages, MA1 and MA2, of the Memory Address Tracking Counter (7) reach the corresponding count (B) according to the current phase, as indicated by the truth table in Figure 4-27. (Note – The memory address count is advanced as the Line Memory is shifted: consequently, when the contents of location 1 are in the terminal location, the MA1 – MA2



		MA1	0	0	1	1
		MA2	0	1	0	1
PHASE	ØREG 1	ØREG 0				
4	0	0	0	0	0	1
3	0	1	0	0	1	0
2	1	0	0	1	0	0
1	1	1	1	0	0	0

Figure 4-27. Simplified Block Diagram, Data Comparison Logic

count will be 00; when the contents of location 2 are in the terminal location, the MA1 – MA2 count will be 01; etc.) Thereby, the Data Bit Comparator is enabled only while the contents of every fourth location, according to the current phase, are present in the terminal location of the Line Memory.

When the Data Bit Comparator is enabled, the contents of the terminal location of the Line Memory and the current Chain Character Code are compared bit-for-bit. Line Memory Data Bit 8 is compared against a constant logic "1" level to determine the validity of each character examined. If the data is valid, and the significant data bits compare with the current Chain Character Code, the Compare Register (34) is set at the next Print Strobe time (see Figure 4-28). The set state of the Compare Register provides a "print" level for loading into the appropriate Hammer Driver Register, and a Compare signal that inhibits the recirculation of stored data from location 1 to location 132 of the Line Memory. If the terminal location is empty (i.e.; the data was compared and printed during a previous scan or no data was loaded [space fill]) or contains an invalid data character (i.e.; data that is not to be printed as "Space" characters and data received with an error in parity), or if the comparison is invalid (i.e.; the stored

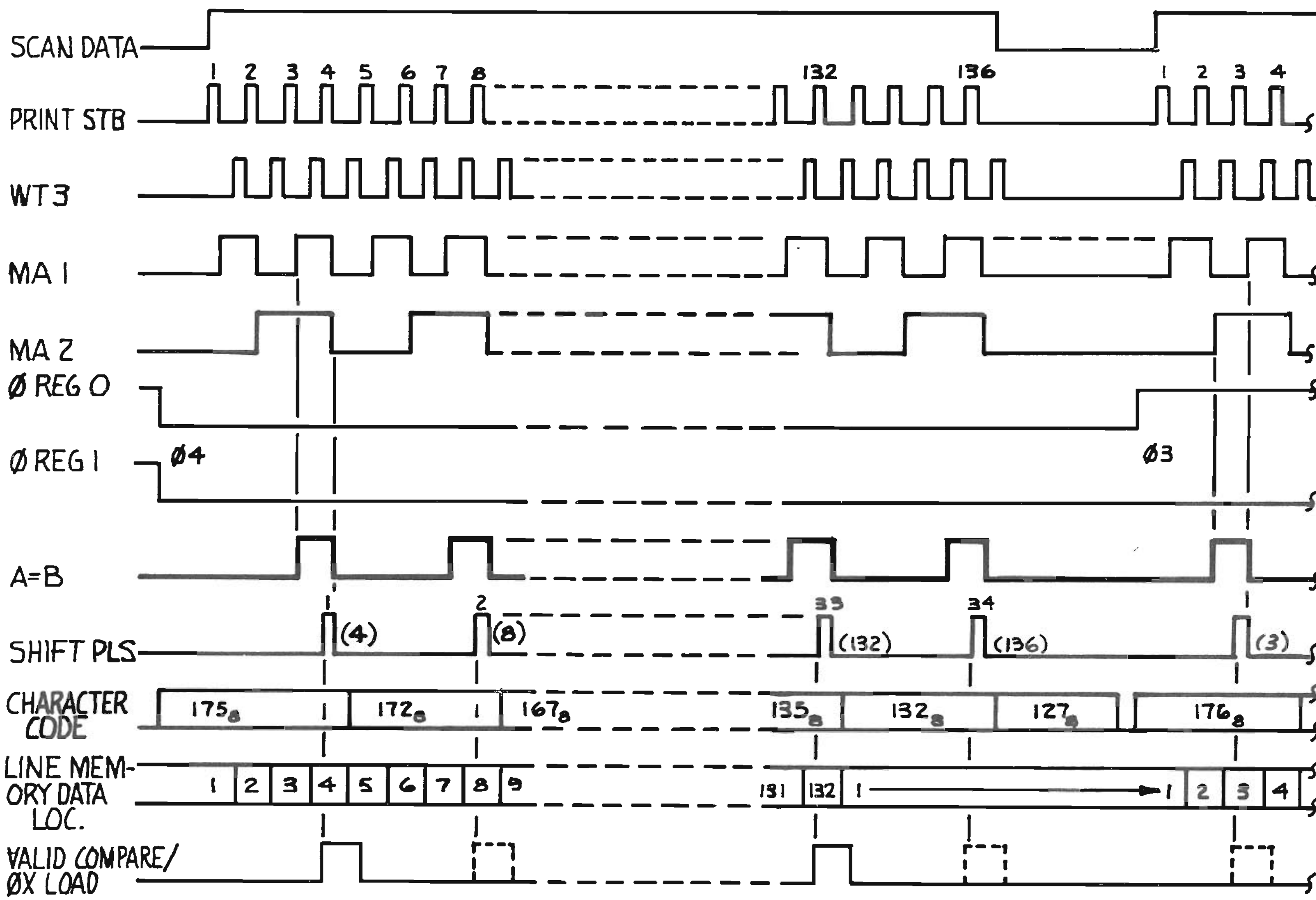


Figure 4-28. Signal Sequence, Typical Phase-Scan Comparison, 64-Character Set

print data and current Chain Character Code do not match, bit-for-bit), the Compare Register is *not* set. The reset state of the Compare Register provides a "no print" level for loading into the appropriate Hammer Driver Register, and allows the recirculation of stored data from the terminal location to location 132 of the Line Memory to permit comparison during a subsequent scan. The Comparison Register is clocked to the reset state by WT3 pulses generated by the Memory Scan Clock (13) to reset it after each comparison in preparation for the next comparison.

A Hammer Driver Register Shift pulse accompanies each comparison to load the result of comparison into the appropriate register. A Shift pulse is generated for every fourth Print Strobe pulse as selected by the Address Select Gates according to phase and the current memory address count. As shown in Figure 4-28, a Shift pulse is generated in conjunction with Print Strobe pulse 4 and every fourth Print Strobe pulse thereafter during a Phase 4 scan, and in conjunction with Print Strobe pulse 3 and every fourth Print Strobe pulse thereafter during a Phase 3 scan, etc.

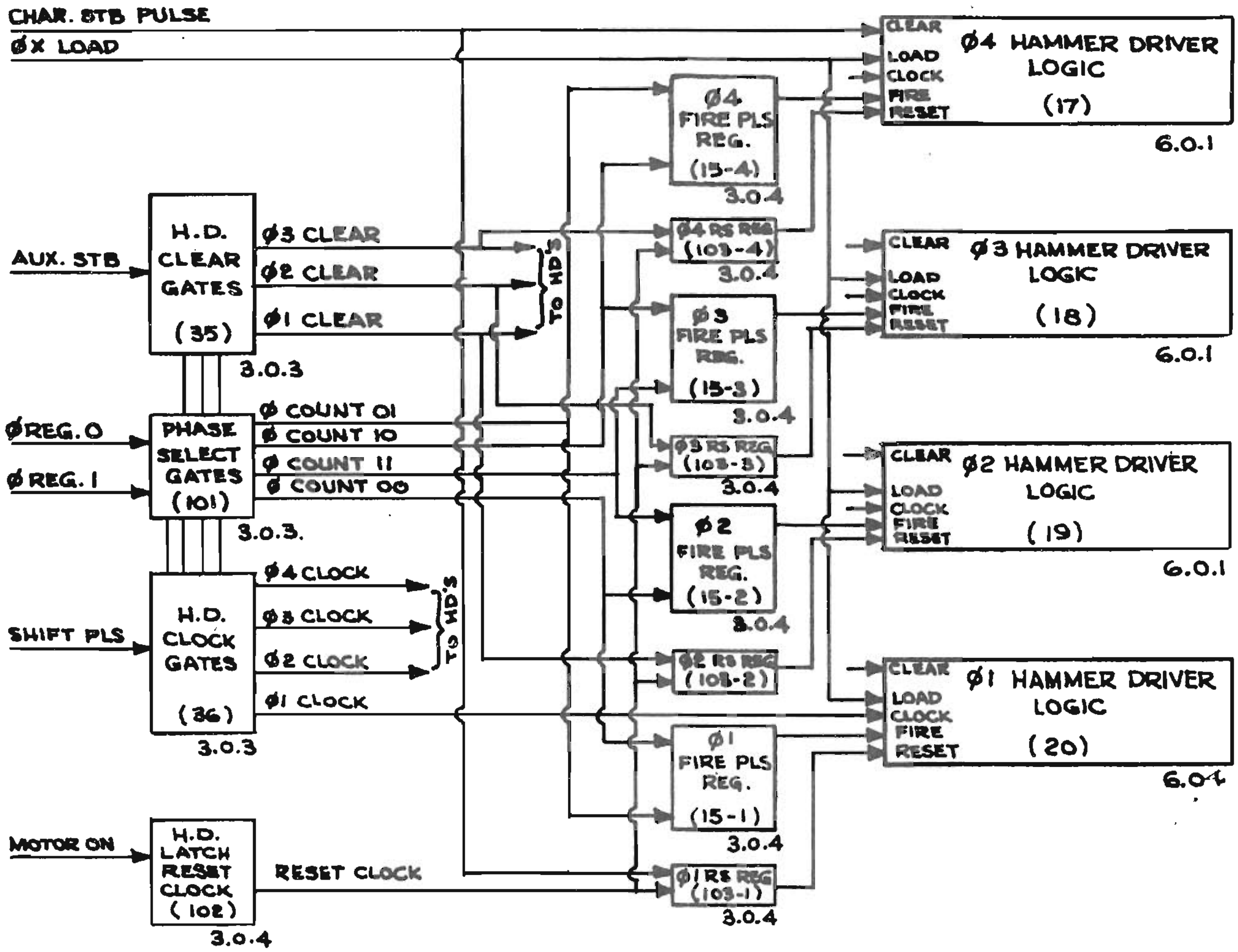
4.4.1.2.5 Hammer Driver Register Control

The Hammer Driver Registers temporarily store the result of each comparison achieved during each phase scan until the chain moves into position for firing the appropriate Hammer Actuators and while the corresponding Hammer Driver Latches are being set. Because of the time required to load a Hammer Driver Register and fire the corresponding Hammer Actuators, the comparison and Hammer Actuator firing operations for successive chain character alignments, or phases, overlap. Consequently, a separate Hammer Driver Register is required for each phase. Further, because the interval between successive characters on the moving chain (1.21 MS) is less than the proper Hammer Actuator firing period (1.35 MS) (when the chain is operated at 110 ips), the Hammer Actuators of a phase that were selected during the preceding print scan will still be firing during the comparison and firing operations for the current print scan. Consequently, a separate Latch is required for each Hammer Driver and Hammer Actuator with an independently generated latch reset for each phase. The standard Hammer Driver Register control logic is designed to automatically adjust to different chain speeds when a lower chain speed is required.

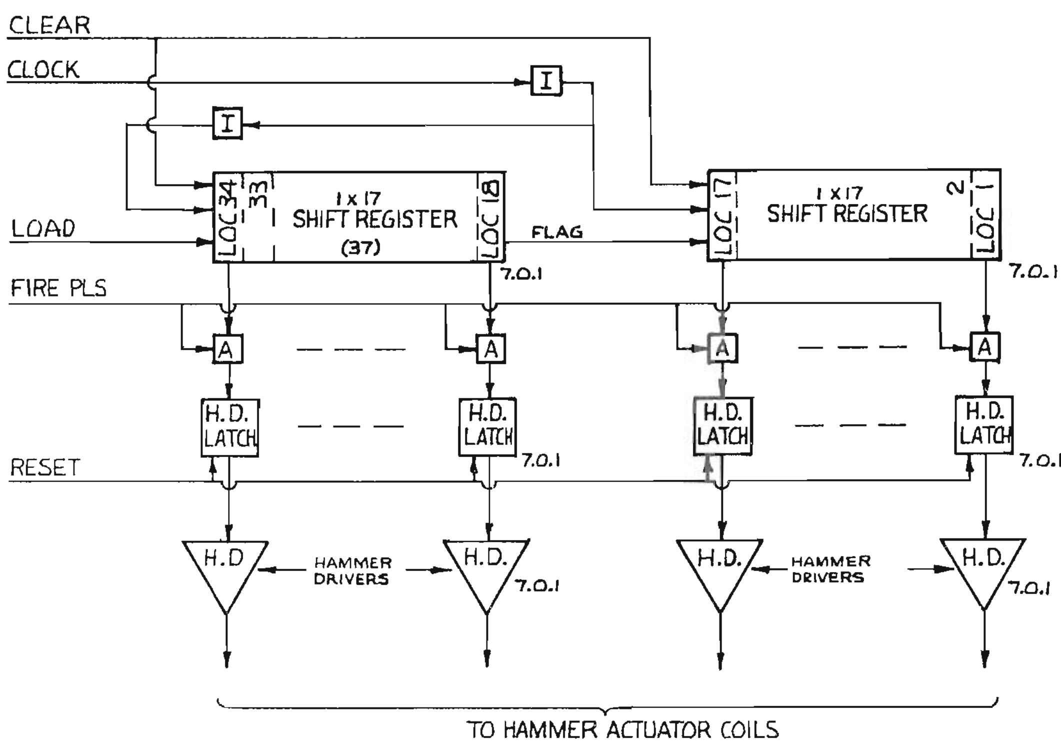
The organization of the Hammer Driver Registers and the Hammer Driver Register control logic is depicted in Figure 4-29A. Figure 4-29 B depicts the details of a typical High Speed Hammer Driver Register. The sequence of signals associated with the Hammer Driver Register operations that occur during a typical print scan are shown in Figure 4-30A for normal, high-speed operation, and in Figure 4-30B for special, low-speed operation of the chain.

As shown in Figure 4-29A, the Hammer Driver Register Control logic basically consists of Hammer Driver (H.D.) Clear Gates (35) that direct Auxilliary Strobe pulses to the appropriate Hammer Driver Register according to phase to clear the Hammer Driver Register of all stored "print" bits; H.D. Clock Gates (36) that direct Shift Pulses according to phase to load the appropriate Hammer Driver Register with the results of comparison; Phase Select Gates (101) that steer the H.D. Clear and H.D. Clock gates, and condition the Fire Pulse registers according to phase; a H.D. Latch Reset Clock (102) which provides the basic timing for firing the Hammer Actuators; a Fire Pulse Register (15) for each phase which latches the selected Hammer Drivers; a ϕ Reset Register (103) for each phase which times the resetting of the latches for the Hammer Drivers selected during the preceding print scan; and four (4) Hammer Driver Registers (17 through 20) that store the results of comparison and energize the selected Hammer Actuators for each phase. Further, as shown in Figure 4-29B, each Hammer Driver Register basically consists of two (2) cascaded single-level, 17 position shift registers (37, 38) that provide a total of 34 locations for storing the results of comparison for each phase; 34 Hammer Driver Latches that independently control the drive to the selected Hammer Drivers to permit the simultaneous firing of different Hammer Actuators during successive print scans; and 34 Hammer Driver circuits that energize the Hammer Actuators which, in turn, mechanically drive the print hammers. A separate hammer driver latch, hammer driver circuit, hammer actuator, and print hammer are associated with each location of the Hammer Driver Shift Register according to phase (see paragraph 4.4.1.2).

The events that occur during a typical print scan are depicted in Figures 4-30A and 4-30B, and are briefly described below. Each Character Strobe pulse indicates the approach of the next character on the chain to be presented for printing in Print Position 1, and signals the start of a print scan which, because of the chain character alignment scheme, is divided into four uniform

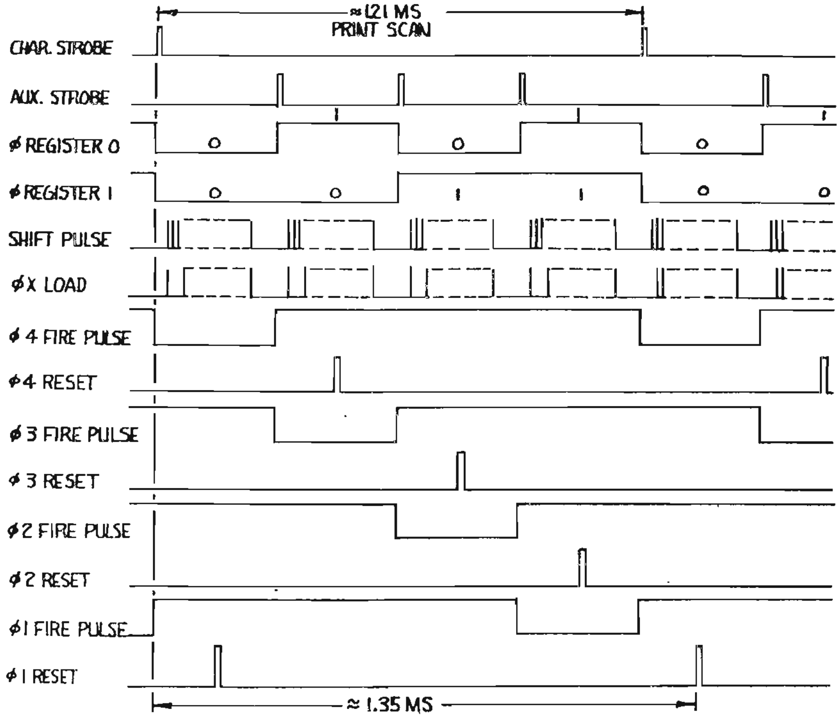


4-29A HAMMER DRIVER CONTROL

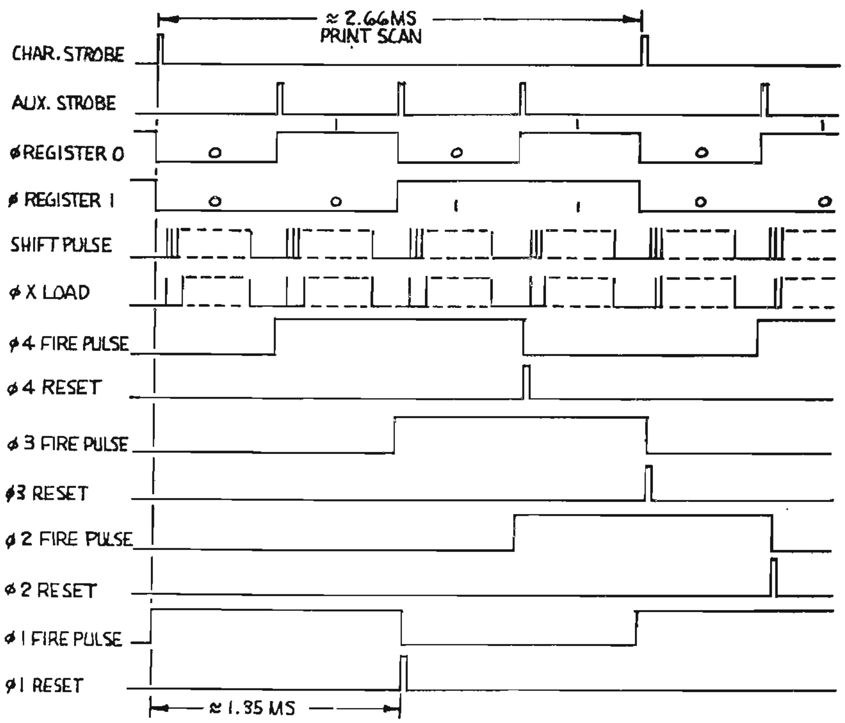


4-29 B. H.S. HAMMER DRIVER LOGIC (TYPICAL)

Figure 4-29. Simplified Block Diagram, Hammer Driver Control



4-30A. TYPICAL SIGNAL SEQUENCE HAMMER DRIVER CONTROL, NORMAL, HIGH-SPEED CHAIN OPERATION



4-30 B. TYPICAL SIGNAL SEQUENCE HAMMER DRIVER CONTROL, SPECIAL, LOW-SPEED CHAIN OPERATION

Figure 4-30. Signal Sequence, Hammer Driver Control, Typical Print Scan

Phase Scans that correspond to the chain character alignment intervals 4, 3, 2 and 1 in succession. Accordingly, at Character Strobe time, the Shift Registers (37, 38) of the ϕ4 Hammer Driver Register (17) are cleared in preparation for the loading of "print" bits. In conjunction with the start of the first phase scan (ϕ4); the H.D. Clock Gates (36) are conditioned by the outputs of the Phase Count Registers (21) to route Shift pulses as Clock pulses to the ϕ4 Hammer Driver Register. During the ensuing phase scan, the contents of every fourth Line Memory location associated with Phase 4 (i.e.; Locations 4, 8, 12, etc.) are compared with the current Chain Character Code to determine their printability. Each comparison is accompanied by a Shift pulse that is routed through the H.D. Clock Gates as a ϕ4 Clock pulse. The leading edge of each ϕ4 Clock pulse shifts the contents of the low-order Hammer Driver Shift Register (38) down one location towards Location 1 and loads Location 17 with a "print" or "no print" Flag bit according to the current state of Location 18 of the high-order shift register. The trailing edge of each ϕ4 Clock pulse shifts the contents of the high-order Hammer Driver Shift Register (37) down one location towards Location 18 and loads Location 34 with a "print" or "no print" bit according to the current state of the Compare Register (34). When all 132 locations of the Line Memory have been scanned, the data in the ϕ4 Hammer Driver Shift Register will have been shifted 33 times into Locations 2 through 34. Because there are 34 locations in the shift register (to accommodate 136 print positions, if required), the Memory Scan Control logic (7, 13) continues cycling to provide one additional Shift pulse which shifts the data into the proper locations, namely Locations 1 through 33 which are associated with the Phase 4 print hammer positions 4, 8, 12, etc., through 132. At this time the ϕ4 Hammer Driver Shift Register locations that correspond to the Line Memory locations of "matched" print data (i.e.; valid comparison) will contain a "print" bit.

At the beginning of the next phase scan (for Phase 3), when the Phase Count Registers are incremented to ϕ Count 01, the ϕ4 Fire Pulse Register (15-4) is set to generate a ϕ4 Fire Pulse signal. The ϕ4 Fire Pulse sets those Hammer Driver Latches that correspond to the ϕ4 Hammer Driver Shift Register locations containing an enabling "print" bit. The Hammer Driver Latches that are set enable the Hammer Driver circuits to energize the coils of the corresponding Hammer Actuators which, in turn, drive their associated print hammers forward to print the "matched" characters in their respective positions in the printed line.

In conjunction with the start of the scan for Phase 3, the Print Scan Control logic (21) generates an Auxiliary Strobe pulse which is routed through the H.D. Clear Gates (35) as a ϕ3 Clear pulse. The ϕ3 Clear pulse clears the Shift Registers (37, 38) of the ϕ3 Hammer Driver Register (18) in preparation for loading during the ensuing scan of the Line Memory and, as a "Clear ϕ3 Strobe" pulse, loads the first location of the 132-location shift-type ϕ4 Reset Register (103-4). The Clear ϕ3 Strobe pulse is shifted through the ϕ4 Reset Register, one location at a time, under control of the H.D. Latch Reset Clock (102) that is normally adjusted (maintenance) to operate at approximately 100-KHz (i.e.; 10.23 Micro-seconds per clock cycle). The output of the ϕ4 Reset Register resets the ϕ4 Hammer Driver Latches which, in turn, turn off the Hammer Driver circuits, thereby controlling the period during which the selected Hammer Actuators are energized to approximately 1.35 MS.

Normal, High-Speed Operation:

When operating with a chain speed of 110 ips, the period during which the Hammer Actuators are energized (approximately 1.35 MS) exceeds the nominal interval between Character Strobe pulses, or approximately 1.21 MS. Consequently, depending upon the data to be printed, those Hammer Drivers of a given phase that are fired during a print scan will continue to be fired during the corresponding phase of the next print scan when other hammer drivers of that phase can be fired. Accordingly, the Fire Pulse Register for each phase remains in the set state for the next two successive phase scans to inhibit the resetting of those Hammer Driver Latches associated with those Hammer Driver Shift Register locations that contain a "print" bit for the current print scan while the remaining Hammer Driver Latches that were set during the preceding print scan are reset by the output of the appropriate ϕ Reset Register. As shown in Figure 4-29A, the Fire Pulse Registers (15) are reset when the Phase Count Registers are incremented to the respective phase count plus two.

Special, Low-Speed Operation:

If required, the DPC CT-6644 and related model CT Line Printers can be equipped to operate with a chain speed of less than 110 ips. When operating with a special, low-speed chain, the Hammer Driver Control logic automatically conditions itself to reset the Fire Pulse Registers in conjunction with the resetting of the respective Hammer Driver Latches. As shown in Figure 4-30B, this timing is necessary to permit the Hammer Driver Latches to be reset at the proper time (i.e.; by the output of the respective ϕ Reset Registers.

The process described in the preceding paragraphs for printing during Phase 4 is repeated, using the appropriate Hammer Driver Register, for each phase in succession and for each chain character (i.e.; print scan) in succession until all valid stored print data is printed out.

4.4.1.2.6 Initiate Print Functions

The Print Control logic associated with the Initiate Print functions is depicted in Figure 4-31 with the principle elements and signal paths shown in heavy outlines for emphasis. As shown in Figure 4-31, the Initiate Print logic basically consists of an End-of-Line (EOL) register (10), a Data Request register (9), and a Printer Ready (PTR RDY) register (40) that control the acceptance of print data at the printer interface and the registration of stored input data in the Line Memory; a Print Command Latch (P.C. Latch) register (41) that stores the fact that a PRINT COMMAND has been received; an Initiate Print register (43) that synchronizes the start of a *Print* cycle with the proper registration of data in the Line Memory; and a Print register (45) that enables a *Print* cycle to be performed when the printer is ready.

In the Remote mode of operation, each *Print* cycle is initiated in response to a command from the external device (i.e.; by the removal of the PRINT COMMAND signal at the printer interface). However, the actual start of a *Print* cycle is controlled by the Print Control logic to occur only when:

- Data is properly positioned in the Line Memory,
- The hammers that were "fired" during the preceding print operation have been allowed to recover,
- The paper in the printer is not in motion, and
- The chaintrain drive motor is turned on and the chaintrain is up to proper operating speed.

Accordingly, the Initiate Print functions can be considered as being performed in four steps, as follows:

1. *Chaintrain Ready* – During this step, the chaintrain drive motor, if not already turned on, is turned on and the chaintrain is checked for proper operating speed.
2. *Command Recognition* – In this step, a buffer-full condition and/or a command to initiate printing are recognized.
3. *Data Registration* – During this step the input data stored in the Line Memory is properly positioned with the first data character received positioned in the terminal location, No. 1, to:
   A. Provide automatic space-fill when less than a full line of data has been received for a line of print, and
   B. Clear the Memory Address Tracking Counter to the count of zero (0 000 000) in preparation for the first scan of a *Print* cycle.
4. *Synchronization* – In this step, the actual start of a Print cycle is synchronized with the Print Rate Governor, Hammer Recovery Delay, paper motion, and the chaintrain.

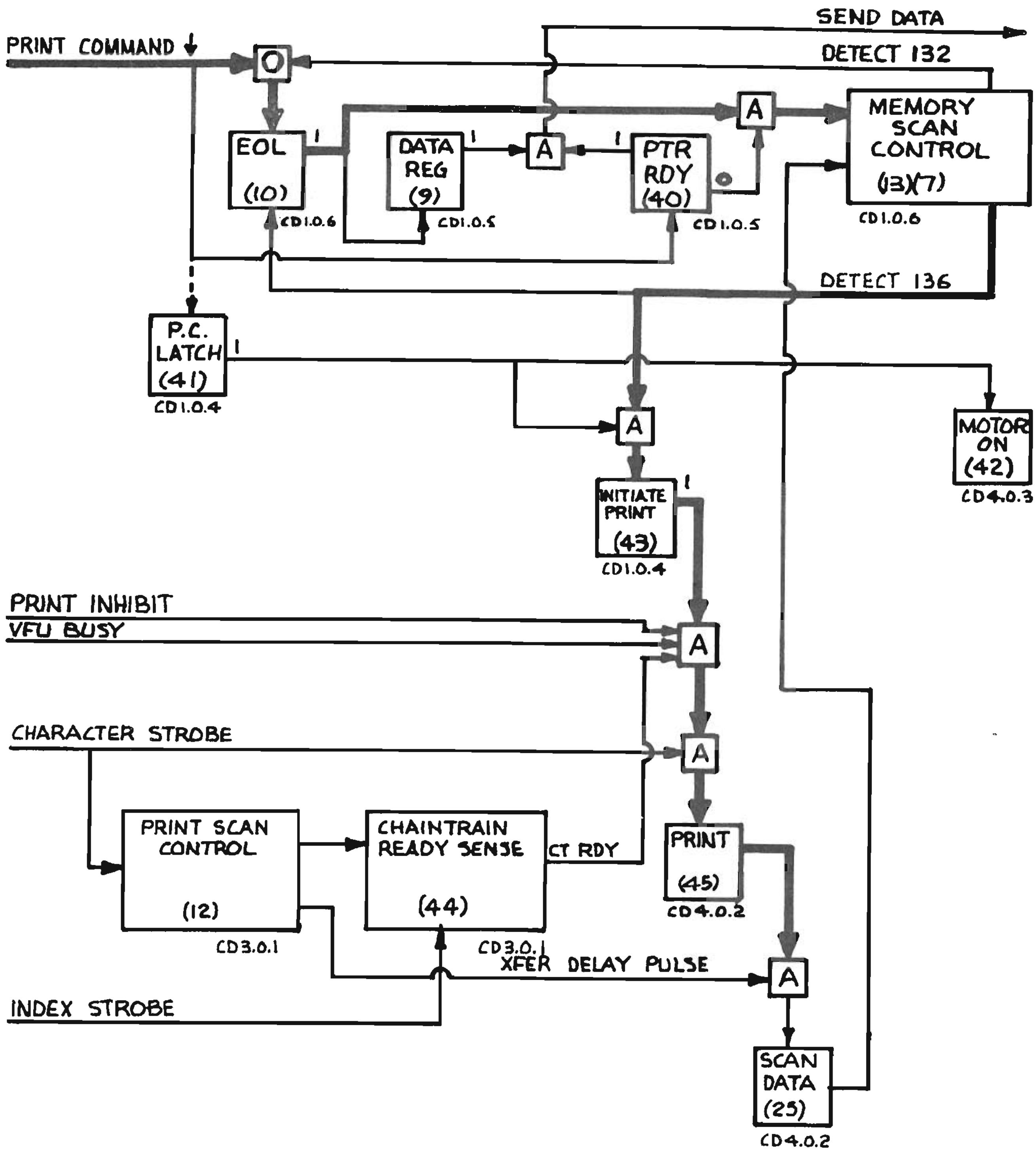


Figure 4-31. Simplified Block Diagram, Initiate Print Control

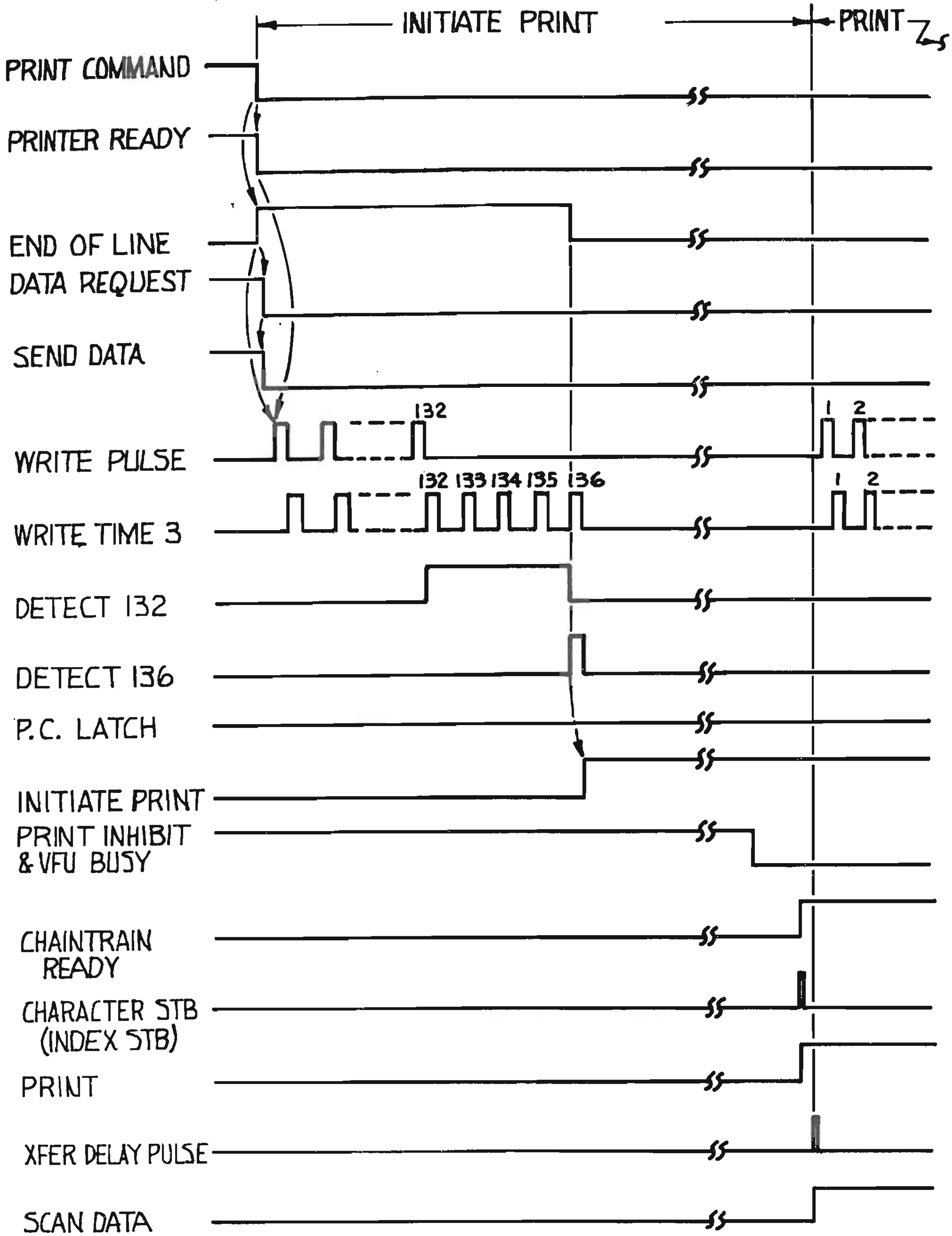


Figure 4-32. Signal Sequence, Initiate Print with Remote Termination of Data Transfer

The events that occur while initiating print are shown in Figure 4-32 for the remote termination of a print data transfer (i.e.; when there is less than a full line of input data characters transferred) and in Figure 4-33 for a buffer-full termination of a print data transfer. These events are briefly described in the paragraphs that follow.

Remote Termination:

Chaintrain Ready – To conserve power, the chaintrain drive motor is turned on only during intervals when printing is required. Hence, the chaintrain drive motor is not turned on until the first PRINT COMMAND is received following either the rise of the RUN signal at the printer interface (see 4.3.1.1.1) or the automatic switching of the printer to theStand-By State (see 4.4.1.2.7). Accordingly, the setting of the P.C. Latch register (41) by the rise of PRINT COMMAND (at the start of a *Load Data* cycle), sets the Motor On register (42), if not already set, to turn on the chaintrain drive motor (not shown). As the chain accelerates, the interval between successive Character Strobe pulses is periodically checked for proper operating speed of the chain (refer to "Chaintrain Ready Logic", below, for details). The actual start of a *Print* cycle is inhibited until the chain is sensed to be up to proper operating speed.

Command Recognition – As shown in Figures 4-31 and 4-32, the removal ("1"-to-"0" transition) of PRINT COMMAND resets the PTR RDY register (40), removing the PRINTER READY signal to the external device, and sets the EOL register (10). The setting of EOL, in turn, resets the Data Request register (9) which removes the SEND DATA signal to the external device to indicate that the fall of PRINT COMMAND is recognized at the printer.

Data Registration – When EOL is set and PTR RDY is reset, the Memory Scan Control logic (7, 13) is enabled to continue clocking the Line Memory until the count of 132 is reached (refer to 4.4.1.2.2 for details). During this time, each Write Pulse shifts the contents of the Line Memory down, one location at a time, to the terminal location, No. 1, to position the first input data character received for the line in the terminal location, and loads a "blank" character code (with *no* bit 8) into the highest location, No. 132, to provide "space fill" characters to the end of the line. Subsequently, the Memory Scan Clock (13) is allowed to continue until the count of 136 is reached to clear the Memory Address Tracking Counter (7) to the count of zero (0 000 000) in preparation for the first scan of the Line Memory of the ensuing *Print* cycle. With the P.C. Latch register (41) set, when the count of 136 is reached, the Initiate Print register (43) is set to condition the printer to start a *Print* cycle when all necessary conditions are present.

Synchronization – With the Initiate Print register set, the next Character Strobe pulse following the completion of all necessary conditions for printing sets the Print register (45) to start the *Print* cycle in synchronism with the moving chain (i.e.; at the start of the next print scan). The setting of the Print register is inhibited for any of the following conditions:

A. The chaintrain is not up to proper operating speed (Chaintrain Ready),
B. A Hammer Recovery delay interval is in progress (Print Inhibit), or
C. A paper advance operation or a Paper Settling delay interval is in progress (VFU Busy).

With the Print register set, the Scan Data register (25) is enabled to be set by the Transfer Delay Pulse that is generated at the beginning of each phase scan by the Print Scan Control logic (12) (refer to 4.4.1.2.1 for details).

Buffer-Full Termination:

The events that occur while initiating print when a buffer-full condition occurs are basically the same as described in the preceding paragraphs for initiating print when a print data transfer is remotely terminated. However, because the Line Memory capacity is reached before the PRINT COMMAND signal is removed in this circumstance, the events that occur during the Command Recognition step are reversed and the events that occur during the Data Registration step are slightly modified. The events that occur while initiating print when a buffer-full condition occurs are depicted in Figure 4-33 and are briefly described in the paragraphs that follow.

Command Recognition -- As shown in Figure 4-33, when a full 132-character line of print data has been loaded into the Line Memory, the Memory Address Tracking Counter (7) raises "Detect 132" which inhibits Write Pulses (hence, further loading and shifting of the Line Memory) and sets the EOL register (10). The setting of the EOL register, in turn, resets the Data Request register (9), which removes the SEND DATA signal to the external device to indicate that no further data can be accepted by the printer. The printer now waits for the external device to respond to the removal of SEND DATA.

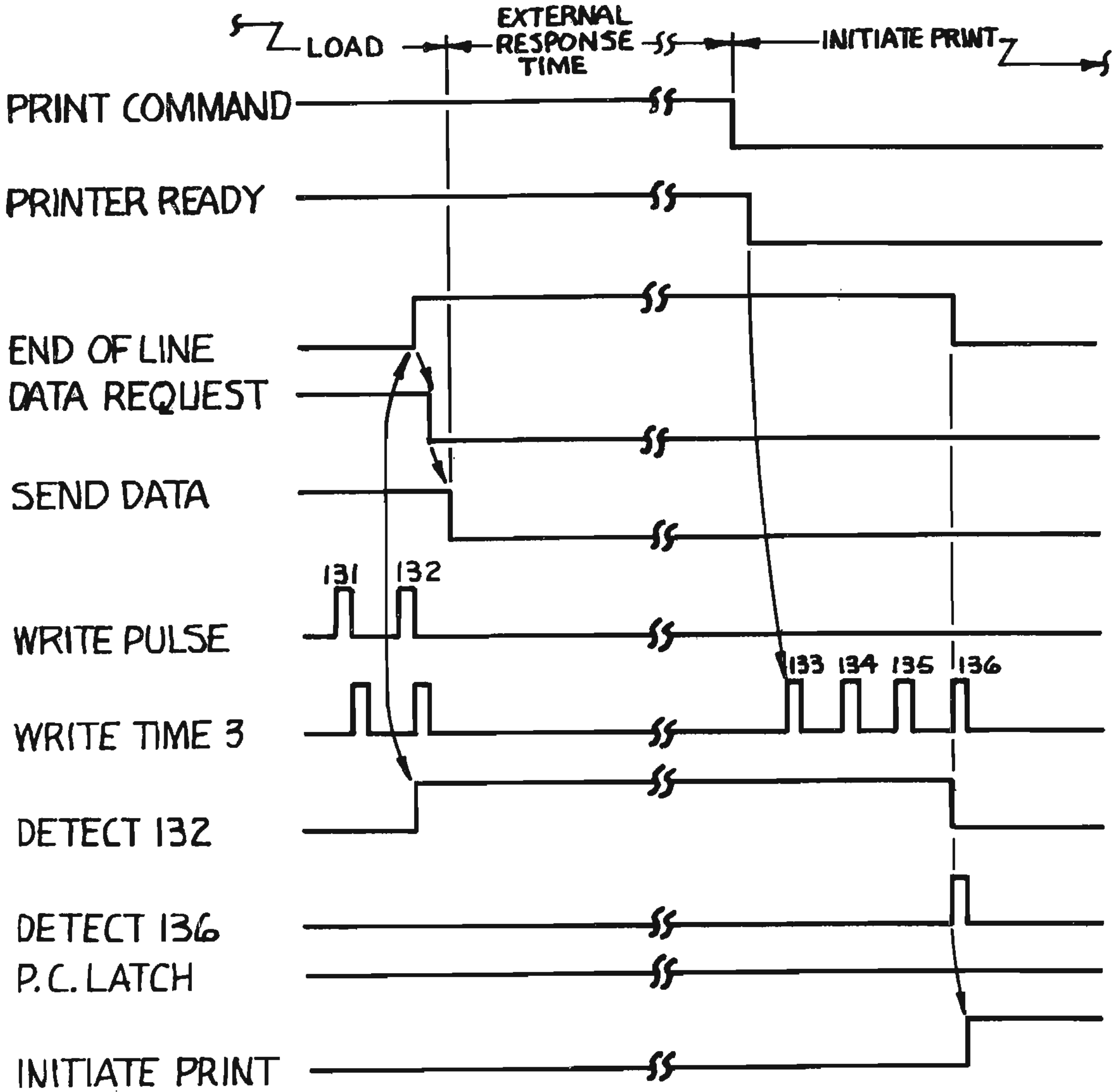


Figure 4-33. Signal Sequence, Initiate Print with Buffer-Full Termination of Data Transfer

Data Registration – In response to the fall of SEND DATA, the external device removes PRINT COMMAND, the fall of which resets the PTR RDY register (40). When PTR RDY is reset with EOL set, the Memory Scan Control logic (7, 13) is enabled to continue until the count of 136 is reached to clear the Memory Address Tracking Counter (7) to the count of zero (0 000 000) in preparation for the first memory scan of the ensuing *Print* cycle. With the P.C. Latch register (41) set, when the count of 136 is reached the Initiate Print register (43) is set to condition the printer to start a *Print* cycle when all necessary conditions are present.

Chaintrain Ready Logic:

The Chaintrain Ready Sense logic (44) periodically checks the speed of the accelerating chain when the chaintrain drive motor is turned on and inhibits the start of a *Print* cycle until the chain is moving at the proper operating speed. Figure 4-34 depicts the Chaintrain Ready Sense logic in greater detail and shows the sequence of signals involved in checking the speed of the chain. As shown in Figure 4-34, the Chaintrain Ready Sense logic basically consists of a Sample Pulse generator (46) which examines the stream of Character Strobe pulses from the accelerating chain at electronically timed intervals; an Index Register (26) that selects the first Character Strobe pulse following an Index pulse for timing each examination; and a Chaintrain Ready (CT RDY) register (47) that indicates when the proper operating speed of the chain has been reached.

As shown in Figure 4-34, each Character Strobe pulse initiates a sequence of four phase scans by the Print Scan Control logic (12) (refer to 4.4.1.2.1 for details). During the last phase scan of each print scan, when the Phase Count is at the count (11) for Phase 1, the fall of "ϕ Clock 2" triggers the Sample Pulse Generator (46) to produce a sampling pulse (of approximately 40 Microseconds duration) in conjunction with the completion of the current print scan. Normally, the completion of a print scan occurs in conjunction with the beginning of the next print scan when the chain is moving at the proper speed. Consequently, the next Character Strobe pulse should occur within the Sample Pulse time at the completion of the current print scan (see enlarged view "A"). If the next selected Character Strobe pulse (i.e.; Index Strobe) occurs within the Sample Pulse interval, the CT RDY register (47) is set and the Print register (45) is enabled to be set. However, if the chain is accelerating and is not up to speed, the interval between successive Character Strobe pulses will exceed the electronically timed interval of their respective print scans and the next selected Character Strobe pulse (Index Strobe) will occur sometime after the Sample Pulse has been completed; hence, the CT RDY register will not be set and the start of the next *Print* cycle will be inhibited.

When the chaintrain drive motor is turned on, the exact position of the chain with respect to the typeline is indeterminate. Accordingly, the chain speed is checked and the start of the next *Print* cycle is enabled on the first Character Strobe pulse that follows an Index pulse, namely; Index Strobe. Index Strobe serves to indicate that the first character of the next array on the moving chain is approaching the beginning of the typeline and is used to preset the Master Counter (27) of the Chain Character Code Generator (14) to the corresponding character count to synchronize the printer control electronics with the moving chain (refer to 4.4.1.2.3 for details). Once the chain is up to speed and the Master Counter is synchronized, the printer is conditioned to permit a *Print* cycle to be started with the next chain character to be presented to the beginning of the typeline following the setting of the Initiate Print register[31], so as to minimize the time required to perform a print operation. Hence, it is *not* necessary for the chain to be in a particular position with respect to the typeline in order to begin a print operation.

4.4.1.2.7 Terminate Print Functions

The Print Control logic associated with the Terminate Print functions is depicted in Figure 4-35 with the principle elements and signal paths shown in heavy outlines for emphasis. As shown in Figure 4-35, the Terminate Print Control logic basically consists of a Print Finish Enable regis-

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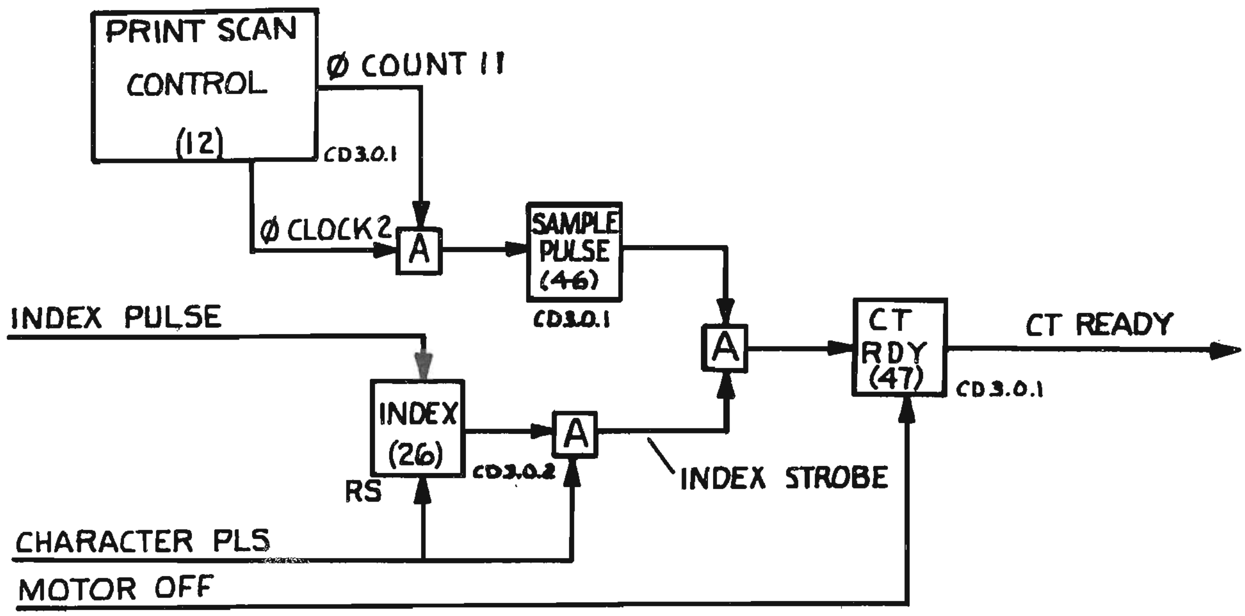
(31) Also referred to as "asynchronous printing".



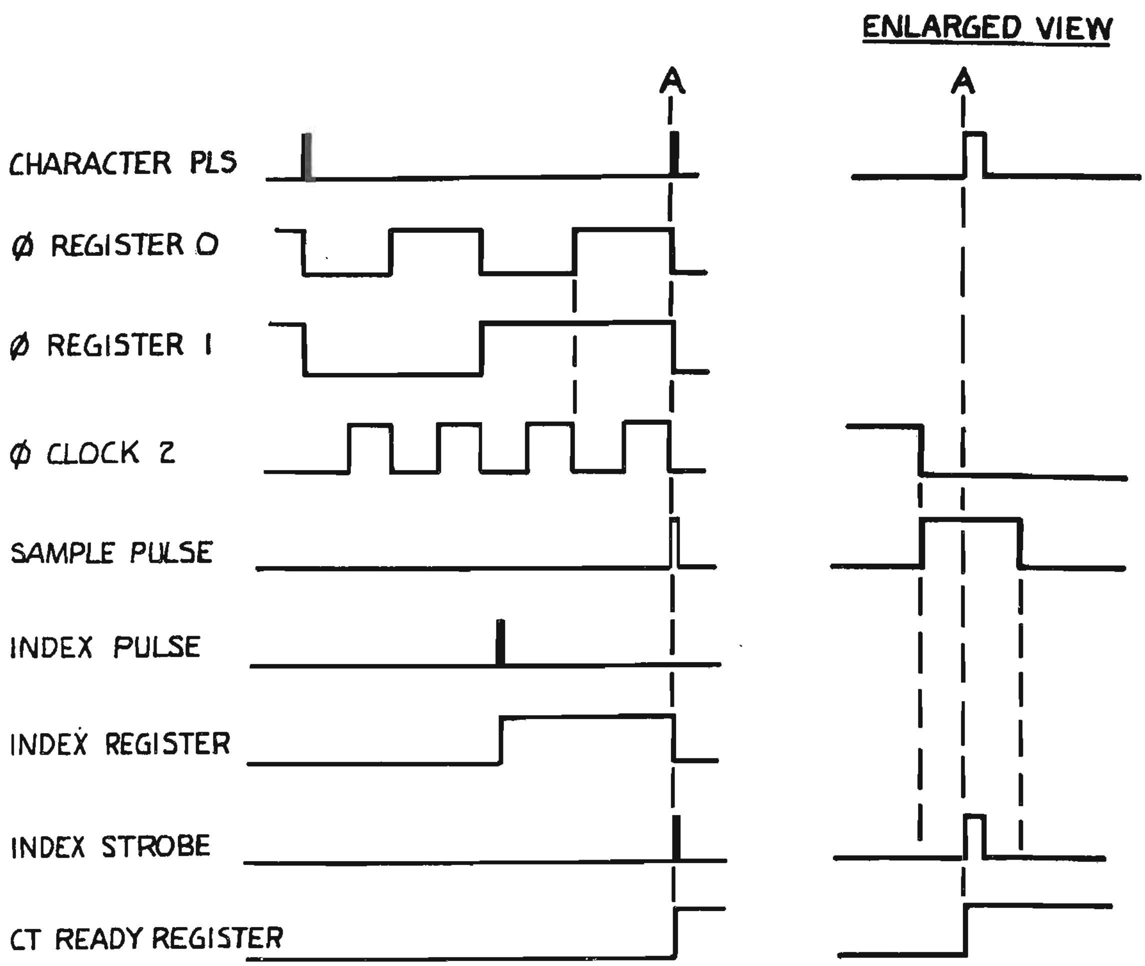


Figure 4-34. Simplified Block Diagram and Signal Sequence Diagram, Chaintrain Ready Logic

ter (48) that determines when the Line Memory is emptied of all valid print data, and a Print Finish register (49) that terminates the current print operation and conditions the printer to commence with the next operation.

Once initiated, a *Print* cycle continues until all stored valid print data has been printed out. Line Memory Bit 8, which is loaded with each valid print data character (refer to 4.4.1.1.2), is used to signify when all stored data has been printed out. Because the print data corresponding to each "matched" character are not recirculated into the Line Memory, there will be no Bit 8's remaining when all valid print data has been printed out (refer to 4.4.1.2.4). Accordingly, a *Print* cycle is terminated following the first scan of the Line Memory in which no Line Memory Bit 8's are detected. Upon termination of a *Print* cycle, the printer is conditioned to either request the next command from the external device, or, if a linefeed instruction is stored ("Last Character" mode or First-Character Interface) or automatic linefeed is programmed at the interface, to commence with a *Feed Paper* cycle. In conjunction with the termination of a *Print* cycle, the Print Governor is enabled to continue operating in order to govern the maximum print speed and to inhibit the start of the next *Print* cycle, until the print hammers that were "fired" during the cycle just completed have been allowed to recover (see Figure 4-37); in addition, the Chaintrain Motor-Off Delay is triggered, or retriggered if a delay interval is in progress, to provide a delay interval for the next PRINT COMMAND to be received before automatically switching the printer to the Stand-By State with power to the chaintrain drive and ribbon drive motors turned off (see Figure 4-40).

The events that occur during the termination of a *Print* cycle are shown in Figure 4-36 and are briefly described in the paragraphs that follow.

Print Cycle Termination:

As shown in Figures 4-35 and 4-36, the Print Finish Enable register (48) is set by the Scan Data register (25) at the beginning of each phase scan in anticipation of an empty memory condition (refer to 4.4.1.2.2 for phase scan details). During each phase scan, if any valid print data remains in the printer buffer, a Line Memory (LM) Bit 8 will be read out of the Line Memory for each location containing a valid print data character. The first such LM Bit 8 read out during a phase scan resets the Print Finish Enable register to prevent the *Print* cycle from being terminated. This process is repeated for each phase scan in succession until no valid print data remains in the Line Memory.

When no valid print data remains in the Line Memory, no LM Bit 8's will be read out. Consequently, the Print Finish Enable register will remain set after the first phase scan in which an empty memory condition is indicated. With the Print Finish Enable register set, the trailing edge of the next Character Strobe pulse sets the Print Finish register (49) which, in turn, resets the Print Command (P.C.) Latch register (41). During the ensuing phase scan, with the P.C. Latch register reset, the Initiate Print register (43) is reset when the Memory Address Tracking Counter reaches the count of 136.

Subsequently, with Initiate Print reset, the leading edge of the following Character Strobe pulse (shown in dashed lines) resets the Print register (45) which, in turn, terminates the *Print* cycle and resets the Print Finish Enable register. Concurrently, with Print Finish still set, the same Character Strobe pulse generates an End Print Pulse (EPP) that is used to initiate an automatic linefeed paper advance operation if programmed at the printer interface. With Print Finish Enable reset, the trailing edge of the same Character Strobe pulse resets the Print Finish register which, in turn, sets the Printer Ready (PTR RDY) register (40) if a feed paper operation is not required. When set, the PTR RDY register places a signal level on the PRINTER READY line to the external device to indicate that the printer has completed the preceding command and is ready to accept the next command.

Print Governor:

The Print Governor controls the minimum interval between the start of successive *Print* cycles and provides a delay following each *Print* cycle to allow the print hammers that were "fired" to recover before beginning the next *Print* cycle. The Print Governor logic is depicted in Figure 4-37. As shown in Figure 4-37, the Print Governor basically consists of a Delay Enable register (50) that enables the governor to operate during each *Print* cycle in which actual printing (i.e.; print hammer "firing") is required (Note – The Print Governor is not used during a *Print* cycle for which *no* valid print data is stored); a Print Delay Counter (51) that counts Character Strobe pulses to determine the appropriate delay intervals; and a Count 16 register

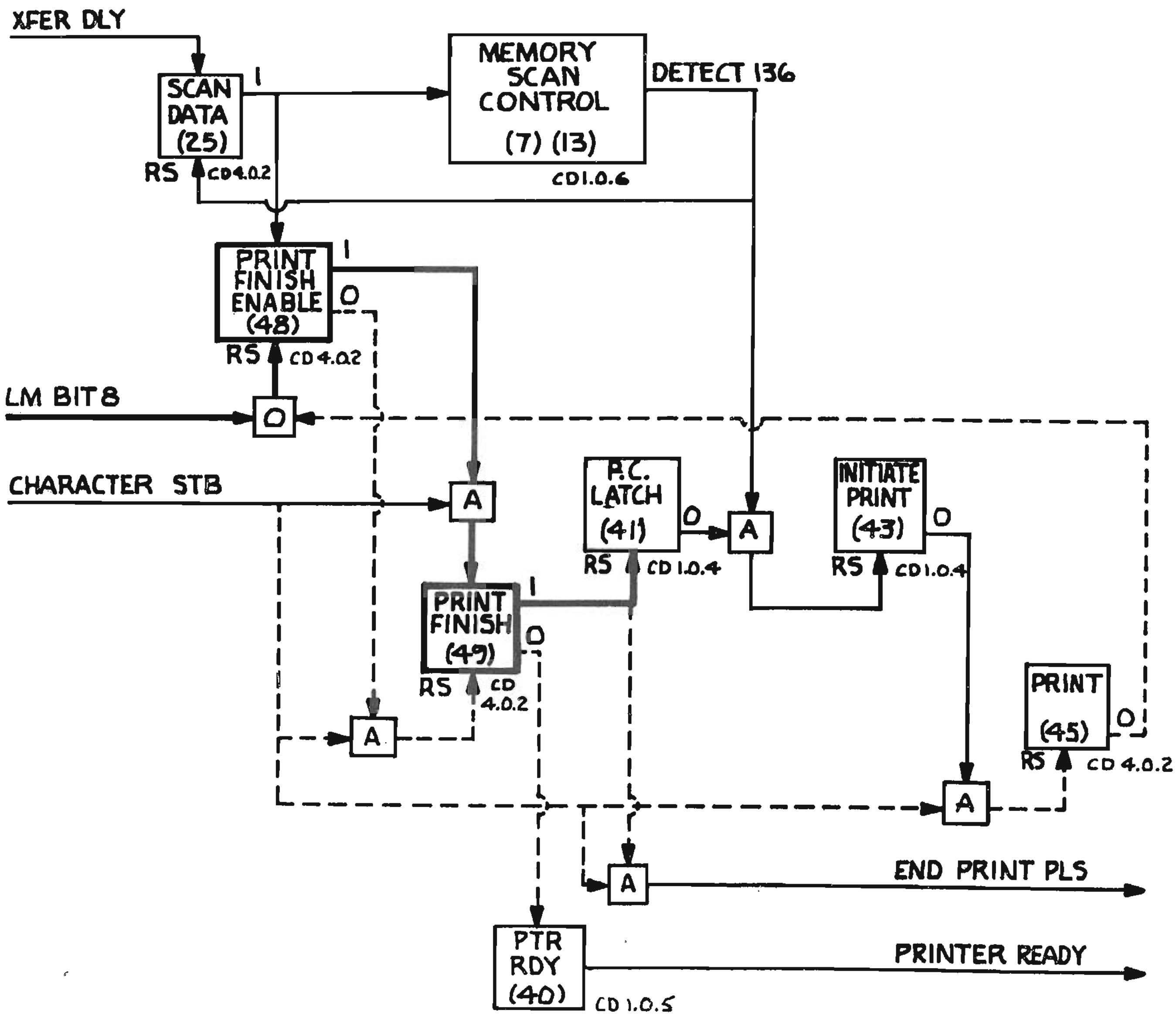


Figure 4-35. Simplified Block Diagram, Terminate Print Control

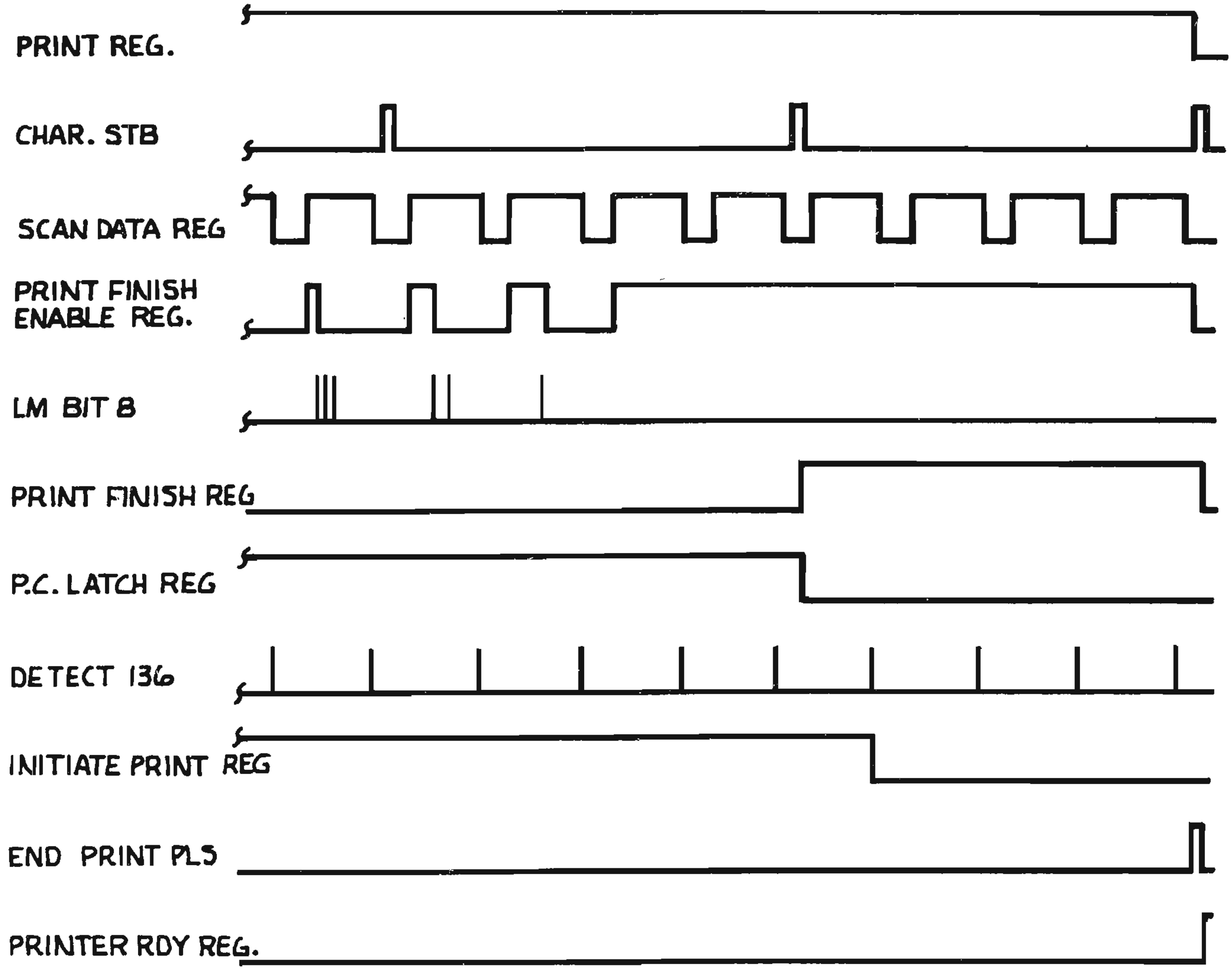


Figure 4-36. Signal Sequence, Terminate Print Functions

(52) that determines the Character Strobe count necessary in addition to the Hammer Recovery interval to provide the proper minimum interval between successive *Print* cycles.

Operation of the Print Governor is performed during each *Print* cycle in two steps; one that commences with the beginning of the *Print* cycle to determine the print rate governing interval, and a subsequent step that commences with the ending of the Print cycle to determine the hammer recovery delay interval. The Print Governor events that occur during a typical *Print* cycle are shown in Figure 4-38 and are briefly described in the paragraphs that follow.

As shown in Figures 4-37 and 4-38, the first LM Bit 8 read out of the Line Memory during the first phase scan of a *Print* cycle sets the Delay Enable register (50). With the Delay Enable register set, the Print Delay Counter (51) is enabled to count successive Character Strobe pulses. (If no LM Bit 8 is read out of the Line Memory, the Print Governor is not enabled, consequently the next *Print* cycle can be started at any time following the current cycle.) When the second (2nd) count of 8 (1000) is reached, the Count 16 register (52) is set which, in turn, inhibits the Print Delay Counter from counting further Character Strobe pulses during the current *Print* cycle.

At the termination of the current *Print* cycle, the reset state of the Print register (45) is AND'ed with the set state of the Delay Enable register to produce a Print Inhibit signal that inhibits the start of the next *Print* cycle, until the Hammer Recovery delay interval has been completed (see Figure 4-31), and enables the Print Delay Counter to resume counting Character Strobe pulses. When the count of 12 (1100) is reached, or a total of 28 counts, the Delay register is reset which, in turn, resets the Print Delay Counter and the Count 16 register, inhibits further counting, and removes the Print Inhibit signal to permit the next *Print* cycle to be started anytime thereafter.

In the event of a short *Print* cycle (i.e.; one that requires less than 16 Character Strobe pulse intervals to complete), the print rate governing interval of 16 counts and the hammer recovery delay interval of 12 counts run sequentially, as shown in Figure 4-39, for a total of 28 counts.

Chaintrain Motor-Off Delay:

To conserve power, the chaintrain drive motor is automatically turned off when printing is not required for a period of approximately one (1) minute following the last print operation. As shown in Figures 4-40A and B, at the termination of each *Print* cycle, the resetting of the P.C. Latch register (41) triggers, or retriggers if a delay interval is in progress, a Retriggerable One-Shot (53). Should the next *Print* cycle occur before the Retriggerable One-Shot times out, the Motor On register (42) will remain set and the Retriggerable One-Shot will be retriggered. However, should the Retriggerable One-Shot be allowed to time out, the fall of the output of the One-Shot will reset the Motor On register which, in turn, causes the power to the chaintrain drive motor to be turned off. This motor is automatically turned on again when the next PRINT COMMAND is received by the printer (see Figure 4-31; paragraph 4.4.1.2.5).

4.4.1.2.8 Hammer Driver Check

The Hammer Driver Current Sensing circuit, depicted in Figure 4-41, constantly senses for current flowing in the +40 VDC supply lead to all hammer driver circuits. Normally this supply current should be flowing only while the hammer drivers are being "fired" during a *Print* cycle. However, in the unlikely event of a circuit malfunction in which a hammer driver circuit fails to turn off, this supply current would be constantly flowing at times beyond the termination of the *Print* cycle during which the malfunction occurs. Whenever the +40 VDC hammer driver supply current is sensed to be flowing at any time other than during a *Print* cycle, power in the printer is automatically turned off to protect the associated hammer actuator coil(s) from potential damage and operation is immediately stopped to minimize the possible loss of data (i.e.; Hammer Driver Overcurrent alarm – see *Operating Instructions* manual.)

As shown in Figure 4-41, the Hammer Driver Current Sensing circuit basically consists of a self-starting, 8-KC Multivibrator (54) that drives the sensing circuit whenever printer power is turned on; an a-c coupled, saturable reactor toroid, through which the +40 VDC hammer driver supply lead passes, that senses when hammer driver current, i_{hd}, is flowing; a Sample Pulse Generator (55) which logically derives a sampling pulse from the Multivibrator output to properly sample the output of the saturable reactor toroid; a Schmidt Trigger circuit (56) that

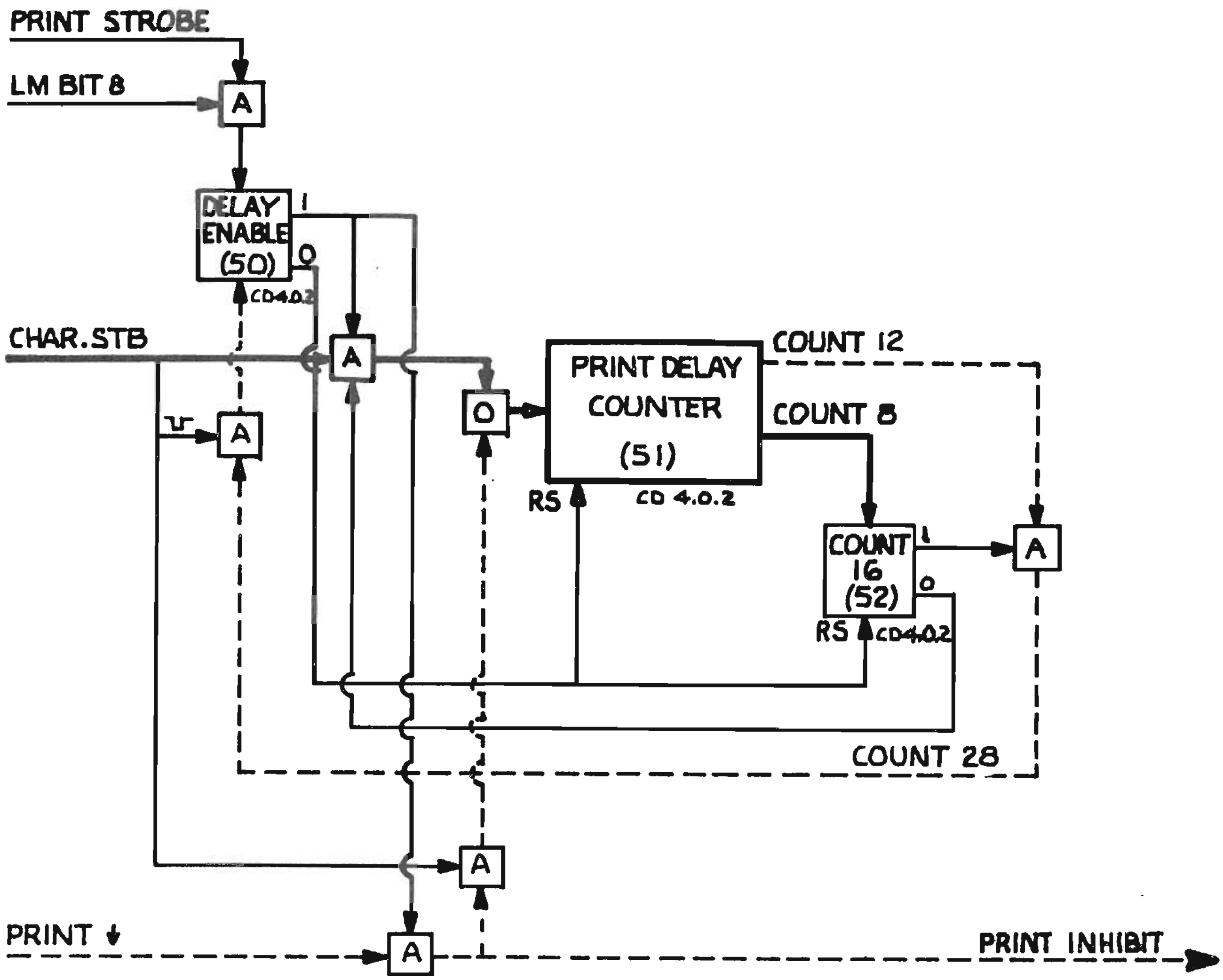


Figure 4-37. Simplified Block Diagram, Print Governor

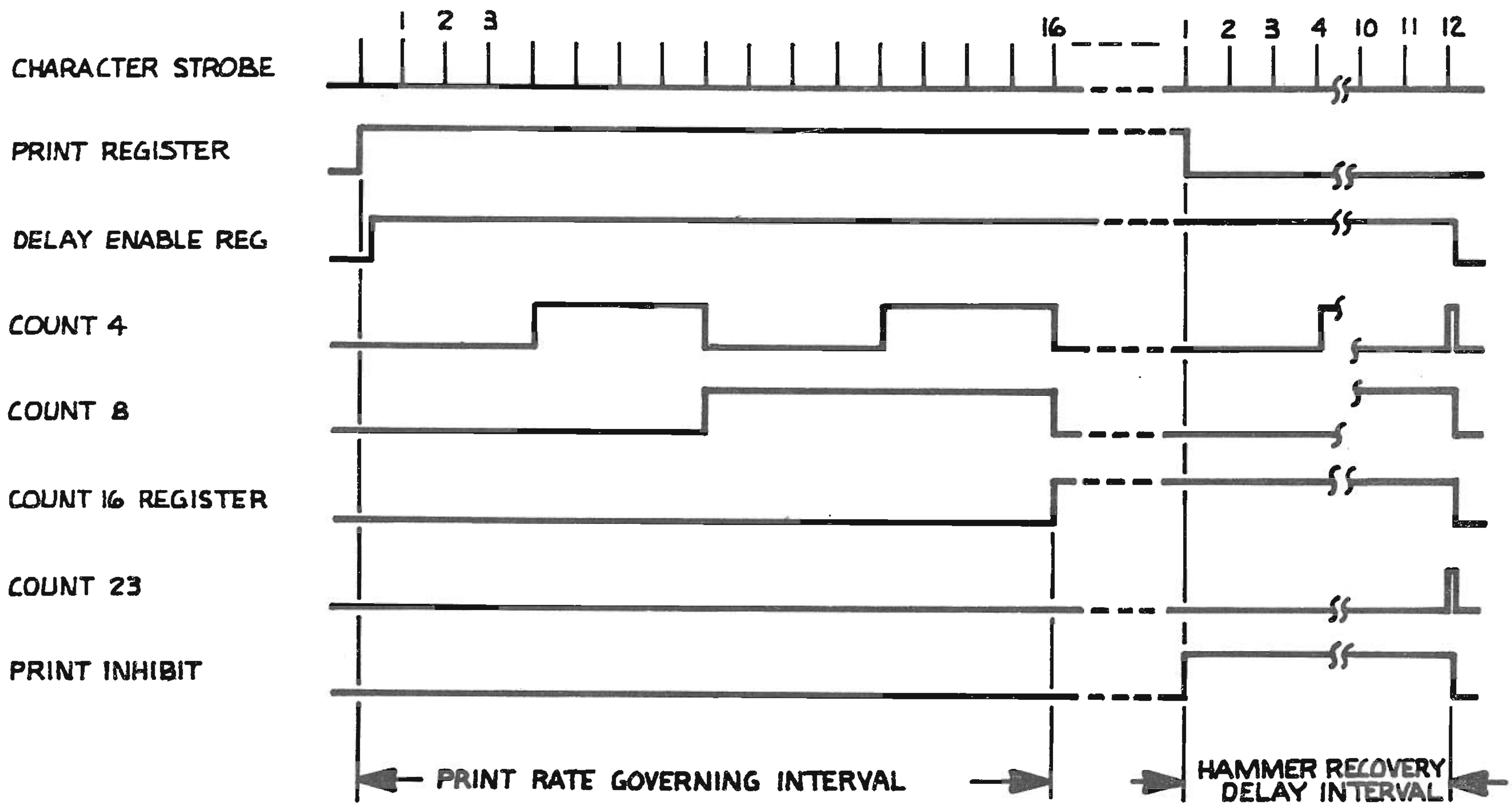


Figure 4-38. Signal Sequence, Print Governor, Typical Print Cycle

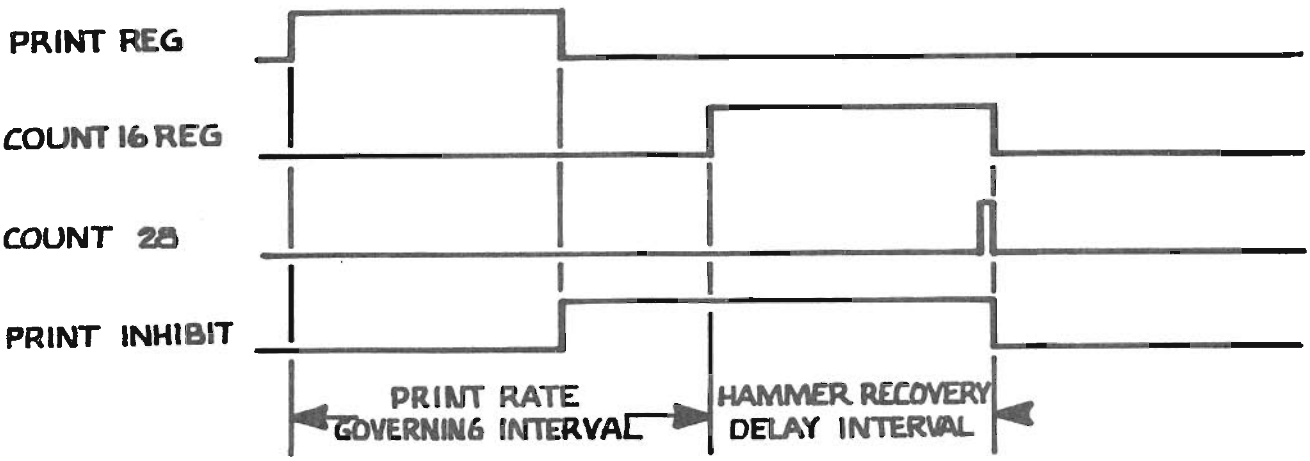
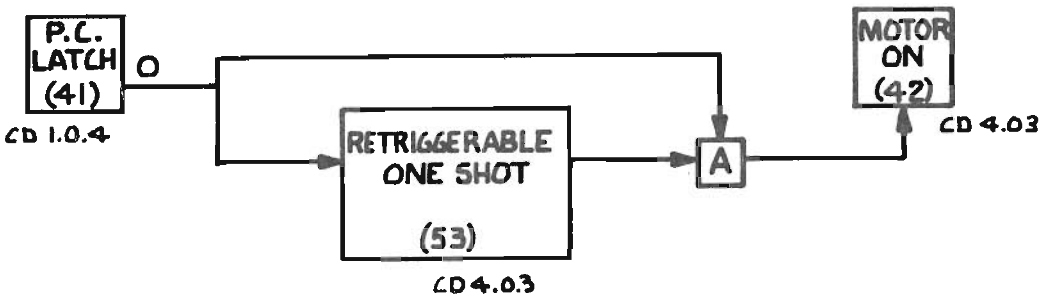


Figure 4-39. Simplified Signal Sequence, Print Governor, Short Print Cycle



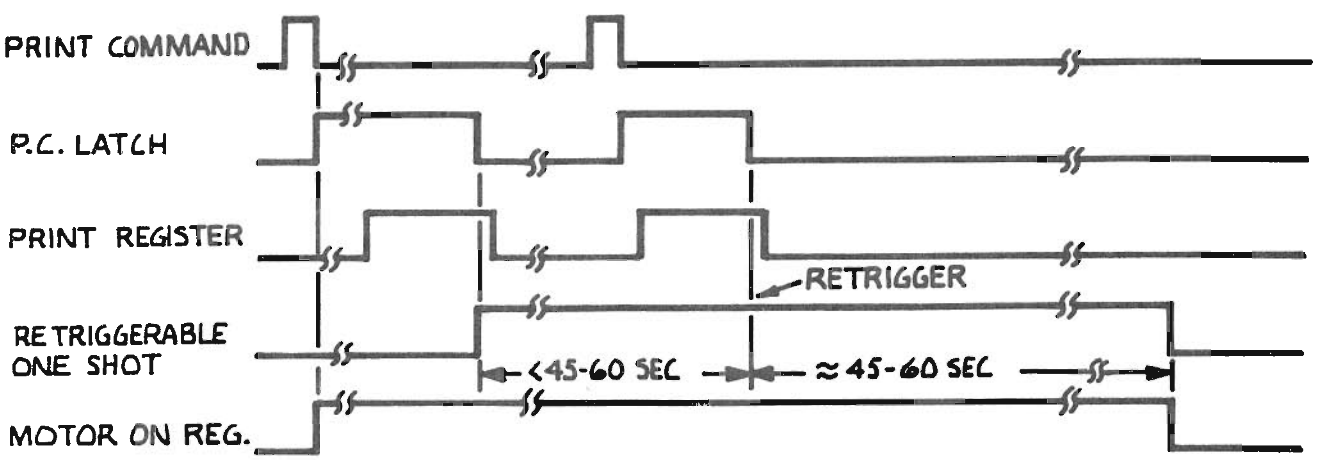


Figure 4-40. Simplified Block Diagram and Signal Sequence Diagram, Chaintrain Motor-Off Delay

shapes the output of the toroid; a Latch (57) that is set whenever hammer driver supply current is sensed to be flowing at any time other than during a *Print* cycle; a relay, K4; and a silicon controlled rectifier (SCR) that shorts the +40 VDC BUS and energy bank (not shown) through a ~~low-resistance resistor~~, $R7_3$ to discharge power to the hammer drivers and, thereby, start an automatic power turnoff sequencing operation.

The flow of current, i_{hd}, in the +40 VDC hammer driver supply lead is sensed by the toroidal saturable reactor. The apparent inductance of the reactor and, hence, the reflected impedance, Z_r, of the reactor winding vary as a function of the current flowing in the supply lead which passes through the center of the toroid. The change of impedance alters the waveshape of the Multivibrator square-wave that is a-c. coupled to the reactor winding and Schmidt Trigger circuit (56) according to current flow in the supply lead as depicted in Figure 4-42. As shown in Figure 4-42A, when *no* current is flowing in the supply lead, the coupled waveshape will decay slowly such as to reach an adjustable (maintenance) reference voltage level, E_{ref}, at the end of the positive half-cycle interval. However, when current *is* flowing in the supply lead, the coupled waveshape will decay more rapidly such as to reach and cross over the reference level before the end of the positive half-cycle interval as shown in Figure 4-42B. This cross-over of the reference voltage level is used to determine that current is flowing in the +40 VDC hammer driver supply lead.

The events that occur during a typical cycle of the Multivibrator (54) when no hammer driver supply current is flowing (normal) and when current is flowing are depicted in Figure 4-43. During each positive half-cycle (of approximately 60 Microseconds) of the Multivibrator, waveshape (a), a square-wave is coupled to the saturable reactor toroid, the Sample Pulse Generator (55), and an integrating network (represented by capacitor C20). The signal developed at the integrating network (b) is logically combined with the Multivibrator output (a) by the Sample Pulse Generator to produce a sampling pulse (c) that is delayed and narrowed to be within both ends of the coil pulse (d). The portion of the coil pulse that is more positive than the adjustable reference voltage, E_{ref}, is shaped by a Schmidt Trigger circuit (56). When the HD Sample signal, which is produced by the Print Control logic whenever printing is not required (that is, when the Print register (45) is in the reset state), is present, the output of the Schmidt Trigger circuit is sampled by the sample pulse (c).

Normally, when hammer driver supply current is *not* flowing, the output signal (e) from the Schmidt Trigger circuit will be present for the duration of the sample pulse (c). Consequently, a Latch Input signal (f) will *not* be produced and the Latch register (57) will remain in the reset state which permits printer operation to continue. However, should hammer driver supply current be flowing, the coil pulse (d) will decay more rapidly which, in turn, will cause the output signal (e) from the Schmidt Trigger circuit (when properly adjusted) to be shortened so as to be removed during the sample pulse interval (c). When the HD Sample signal is present, the removal of the Schmidt Trigger output signal (e) during the sample pulse interval (c) causes a Latch Input signal (f) to be produced (for the remainder of the sample pulse interval) which sets the Latch register. The setting of the Latch register causes relay K4 to be operated which, in turn, closes a set of normally-open contacts to +15 VDC to turn on a silicon controlled rectifier (SCR). The turning on of the SCR discharges the +40 VDC BUS and energy bank (not shown) through a low-resistance (approximately 0.1 Ohm) resistor to immediately remove power to the hammer driver circuits and, thereby, to start an automatic power turn-off sequencing operation, stopping printer operation.

4.4.1.2.9 Code Conversion (ROM Print Control)

The ROM Print Control logic depicted in Figure 4-44 provides proper print data code conversion when an EBCDI-Coded chaintrain arrangment[32] or, depending upon the print data code and chain character sequence, a special customer-specified chaintrain arrangement is provided on a particular printer unit. The ROM Print Control logic converts the stored print data as it is read out of the Line Memory to the appropriate Chain Character Code[33] that identifies the character positions, and the graphics that occupy those positions, in each array on the chaintrain. Correspondency between the input print data code and the characters provided by a particular chaintrain arrangement is determined by the particular programmed Read-Only Memory (ROM) unit provided.

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(32) Refer to Section 1.6; "Chaintrain Arrangements" for details concerning available EBCDI-Coded print character sets and chaintrain arrangements.

(33) Refer to Paragraph 4.4.1.2.3 for Chaintrain Character Coding details.

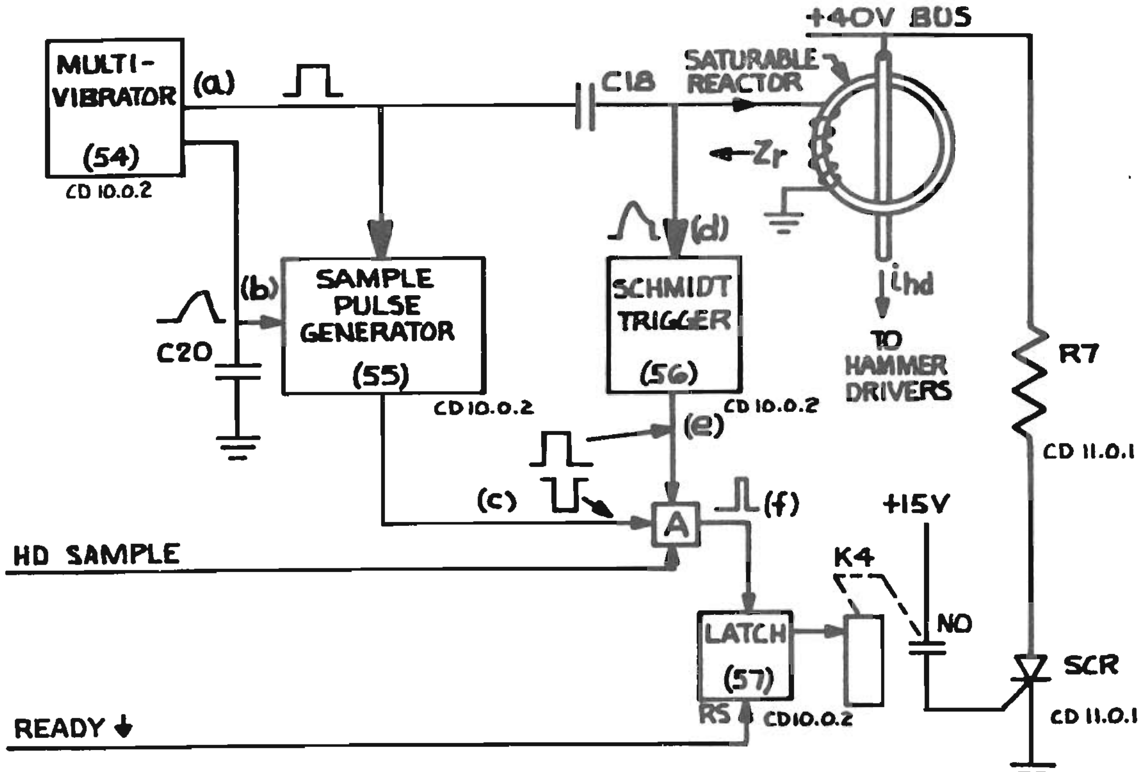

Figure 4-41. Simplified Block Diagram, Hammer Driver Current Sensing Circuit

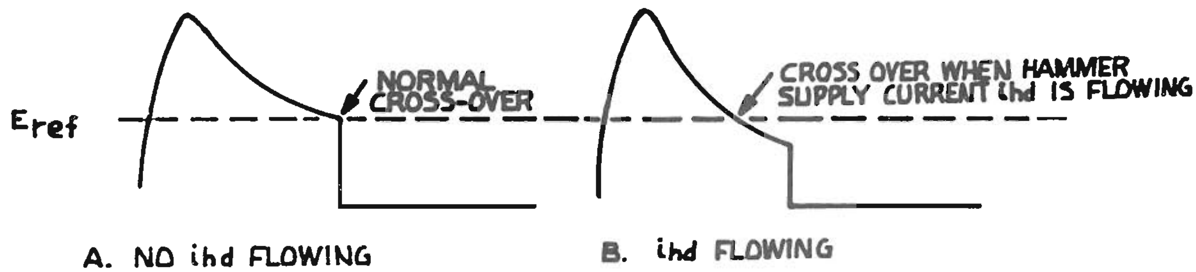

Figure 4-42. Typical Waveshapes, Saturable Reactor Toroid Coil, Hammer Driver Current Sensing Circuit

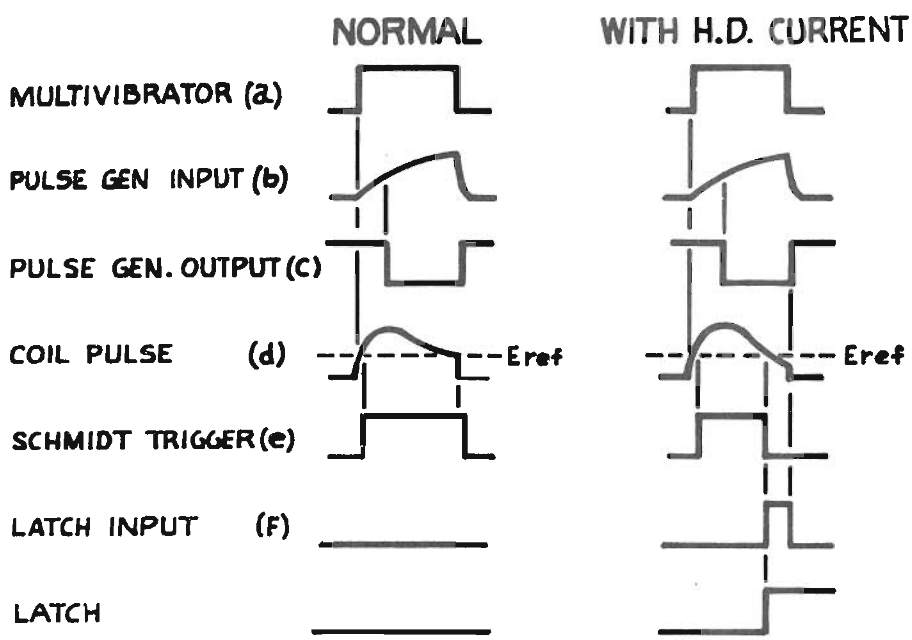

Figure 4-43. Typical Signal Sequences, Hammer Driver Current Sensing

As depicted in Figure 4-44, the ROM Print Control logic provides a code converter between the output of the Line Memory (2) and the input to the Data Bit Comparator (11). Basically, this code conversion logic consists of a pluggable, 256 x 4 ROM (58) which provides the conversion from input print data coding to chain character coding; a Holding register (59) that stores the high-order bits (b5, b6) read out of the ROM during the first half-cycle of operation for each print data character; an Ignore Flag register (61) that stores the ignore flag bits (b7, b8) read out of the ROM during the first half-cycle of operation for each print data character; an Ignore Gate (62) that is prewired to detect the proper combination of ignore flag bits according to the character set (i.e.; 48, 64, or 96 characters); and a One-Shot (60) that addresses the ROM to alternately read out the four high-order bits (b5-b8) or the four low-order bits (b1-b4) for each code-converted print data character.

Generally the ROM is programmed in two independent fields of 64, 6-bit print data characters each, permitting up to two different code conversion schemes to be provided by a single pluggable ROM unit. The Print Control logic is prewired to select the proper field when a single code conversion scheme is required, or can be provided with a switch to select either field when a dual code conversion scheme is required (i.e.; two code conversions such as EBCDIC-to-ASCII and ASCII-to-ASCII). Because of the 256 x 4 architecture of the ROM, each field is further organized in two (2) half-fields each. One half-field is programmed with the appropriate ignore bits and high-order Chain Character Code bits, and the other half-field is programmed with the appropriate low-order Chain Character Code bits, for each input print data character code as indicated in Figure 4-45.

The code conversion functions that occur during each print character compare cycle (see paragraph 4.4.1.2.4 for details) are depicted in Figure 4-46. During a *Print* cycle, as each stored print data character is shifted into the terminal location, No. 1, of the Line Memory, data bits LM 1 through LM 6 address a preselected field, A or B, of the preprogrammed ROM (58) to obtain the appropriate Chain Character Code for the corresponding print graphic. Each such code conversion is performed in two (2) half-cycles; one half-cycle for the high-order Chain Character Code data bits, and a second half-cycle for the remaining low-order data bits. As shown in Figures 4-44 and 4-46, each WT-3 pulse (or Transfer Delay pulse when reading the first character out of the Line Memory at the beginning of a phase scan) triggers a One-Shot (60) to address the appropriate half-field of the ROM. When the output of the One-Shot is high (approximately 150 Nanoseconds duration), the first half-field of the ROM is addressed and the corresponding ROM output is loaded into the Holding register (59) (converted data bits b5 and b6) and the Ignore Flag register (61) (converted data bits b7 and b8). Subsequently, when the output of the One-Shot is low, the second half-field of the ROM is addressed and the corresponding ROM output (converted data bits b1 through b4) is applied directly to the Data Bit Comparator in conjunction with the outputs of the Holding register and Line Memory bits LM 7 (most significant data bit) and LM 8 (valid print data flag). Immediately following each WT-3 pulse, a Print Strobe pulse samples the output of the Data Bit Comparator (11) to set the Compare register (34) if a comparison, or "match", exists, bit-for-bit, between the ROM output code and the current Chain Character Code.

The ROM output codes that correspond to input data codes for SPace, NULL, and any other codes that are to be ignored by a printer that is equipped with a given chaintrain arrangement, are preprogrammed with a combination of Ignore Flag bits, F_A and F_B, in the high-order half-field. The Ignore Flag bits are used to determine the printability of each ROM output code according to the size of the character set provided on the printer, as indicated in the table below.

Ignore Flags F_A	F_B	*Printable when used with:*
0	0	48-Character Set
0	X	64-Character Set
X	1	96-Character Set
1	1	Non-printable

Ignore Flag Connotations

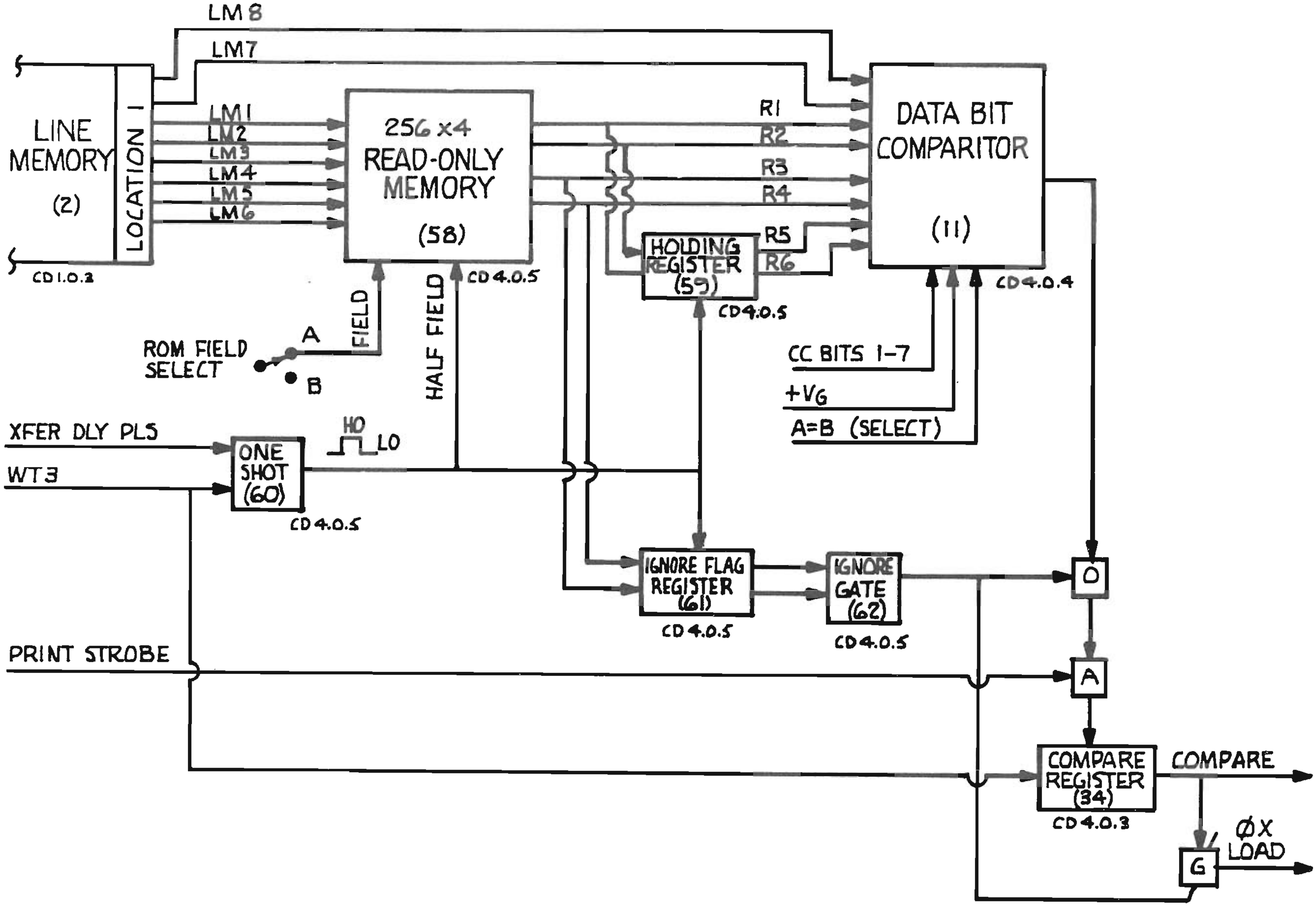

Figure 4-44. Simplified Block Diagram, Code Converter Logic, ROM Print Control

HALF CYCLE	FIRST				SECOND			
CHAIN CHARACTER CODE BITS	F_B	F_A	b_6	b_5	b_4	b_3	b_2	b_1

Figure 4-45. Output Character Code Format, ROM Print Control

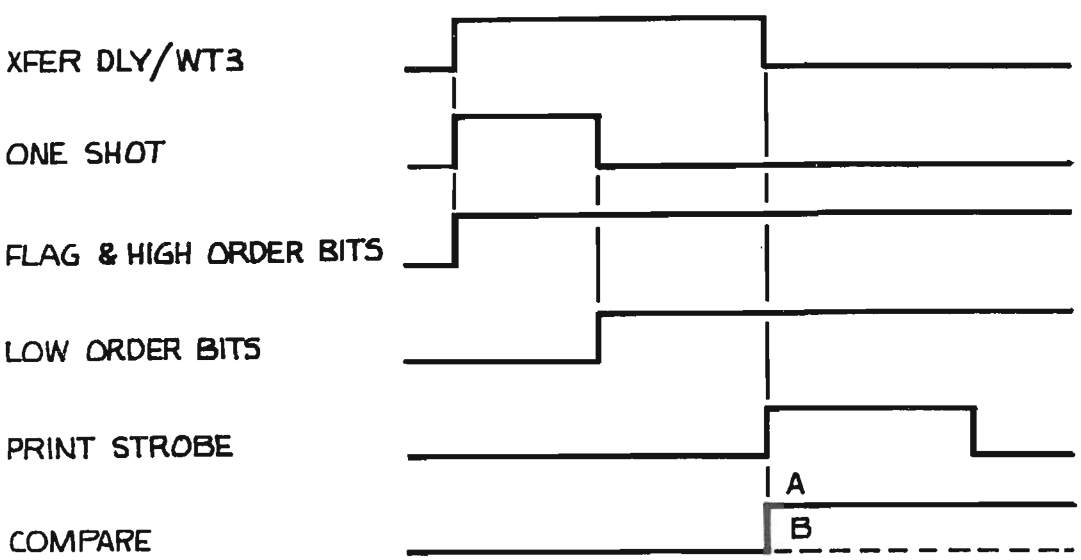

Figure 4-46. Signal Sequence, Character Code Conversion Cycle, ROM Print Control

Whenever the Ignore Gate (62), which is prewired according to the character set provided, detects an ignore combination of Ignore Flag bits stored in the Ignore Flag register (61) for each character, the Compare register (34) is set to produce a "Compare" signal that inhibits the recirculation of the corresponding input data character to remove that character from the Line Memory. The "ØX Load" signal, which is normally produced when the Compare register is set, is inhibited by the Ignore Gate to load a "no print" bit into the appropriate Hammer Driver Register, thereby providing a "blank" space in the printed line for each such input print data character that is received and ignored by the printer.

4.4.2 Paperfeed Control

The feeding and positioning of paper in the printer mechanism are performed in response to a single paperfeed instruction for each paper advance operation and are controlled from positioning and synchronizing signals fed back from the vertical format unit (VFU), and the stepping motor strobe and line strobe generators of the paperfeed drive system described in paragraph 4.2.2. A character storage, or Linecount register, is provided for the paperfeed instruction. This storage permits the transfer, from the external device to the printer, of a single paperfeed instruction character at a time; either independently of (Standard Interface), or in conjunction with ("Last Character" mode or First-Character Interface), the transfer of print data. Accordingly, the external device is interlocked with the printer only during the data transfer and is freed to perform other operations while the printer is busy feeding paper.

The Paperfeed Control logic controls the loading of the paperfeed instruction character into the Linecount register and the subsequent operation of the paperfeed drive stepping motor. Normally, after the paperfeed instruction character is loaded, a *Feed Paper* cycle, the mechanical action portion of a paper advance operation, is initiated[34]. During the *Feed Paper* cycle, the paperfeed drive stepping motor is phase-switched through the appropriate number of steps necessary to advance paper to the line position designated by the paperfeed instruction.

The positioning of the paper is controlled either in a Linecount mode (Space "n" Lines) under control of the Paperfeed Control electronics or in a VFU mode (Skip-to-Channel "n") under control of a preprogrammed vertical format tape-loop, as designated by the particular paperfeed instruction received for each paper advance operation[35]. When the Linecount mode is designated, paper is advanced in a single, continuous operation until the Paperfeed Control logic has electronically counted off the number of linespaces (from 0 to 63) designated in binary by the instruction. For vertical format tape-loop control, each application requires a tape-loop which corresponds in length to the number of spaces on one or more forms. This tape-loop is prepared by the user with punched holes, arranged in channels, along the length of the tape according to the vertical format program(s) required. Each punched hole represents a line position on the corresponding form(s) at which a Skip-to-Channel paper advance operation can be stopped. The tape-loop installed on the VFU is read in synchronism with the moving forms by a multi-channel photoelectric tape reader (part of the VFU). When the VFU mode is designated, paper in the printer is advanced in a single, continuous operation until the next punched hole is detected in the format tape channel designated in binary by the instruction.[36]

When the paper has advanced the designated number of linespaces or to the next punched hole in the designated channel of the vertical format tape-loop, the *Feed Paper* cycle is terminated and the paperfeed drive stepping motor is decelerated to bring the moving paper to a smooth stop with the designated line position on the form accurately positioned opposite the typeline. In conjunction with the termination of a *Feed Paper* cycle, a Paper Settle delay is started which inhibits the start of the next *Print* cycle until the paper has been allowed to settle.

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(34) For exceptions; see 4.3.1.2.5, "Last Character" mode and 4.3.2, First-Character Interface Configuration.

(35) Standard Paperfeed Command Codes are listed in Appendix C.

(36) Also see paragraph 4.3.1.2.4, "Automatic Linefeed".

4.4.2.1 Load and Initiate Paperfeed

As shown in Figure 4-18, input data from the external device is received at the printer interface and, if a paperfeed instruction character, is loaded into the Paperfeed Control Linecount register. Figure 4-47 depicts the control logic associated with the load paperfeed instruction and initiate feed functions. As shown in Figure 4-47, the load and initiate paperfeed control logic basically consists of a six-stage Linecount Register (63) that stores the paperfeed instruction for each paper advance operation and, if the Linecount mode is designated, is used to count the number of linespaces paper is to be advanced; a Vertical Format (VF) Sample register (64) that enables only a single character to be accepted as the paperfeed instruction at a time; a Load Paperfeed (PF) Latch (65) that permits only a single PAPERFEED COMMAND to be accepted at a time; a No Linefeed Detect gate (66) that inhibits the start of a *Feed Paper* cycle when no paper advance is designated by the instruction received; a Paperfeed (PF) Latch Enable register (67) which is used to set the PF Latch when initiating a paper advance operation; a Paperfeed (PF) Latch (68) that enables a *Feed Paper* cycle to start when the PRINT COMMAND signal is removed; a Linecount (LC) Latch (69) that is normally set to condition the Paperfeed Control logic to operate in the Linecount mode; and a Vertical Format Unit (VFU) Feed register (70) which conditions the Paperfeed Control logic to operate in the VFU mode when bit 7 of the paperfeed instruction is at the logic "1" level.

The events that occur during the loading of a paperfeed instruction character and the initiation of a *Feed Paper* cycle are depicted in Figure 4-48 and are briefly described in the paragraphs that follow.

When the printer is ready (PRINTER READY is high) and the PAPERFEED COMMAND signal is raised[37], the VF Sample register (64) is set which, in turn, raises SEND DATA and enables the printer to accept the following data character as a paperfeed instruction. The rise of SEND DATA sets the Load PF Latch (65) which, in turn, inhibits any further response to the current PAPERFEED COMMAND signal.

With the VF Sample register in the set state, the next DATA STROBE pulse causes a "Feed Pulse" to be produced that loads the low-order six bits, bits 1 thru 6, of the paperfeed instruction character into the Linecount Register (63) and, if other than a "no linefeed" (0 000 000) instruction, sets the PF Latch Enable register (67). The "Feed Pulse" also resets the VF Sample register which, in turn, removes the SEND DATA signal and inhibits any further response to signals appearing on the DATA STROBE line (thereby ensuring that only one data character is accepted for each PAPERFEED COMMAND). The setting of the PF Latch Enable register, in turn, sets the PF Latch (68) which enables a *Feed Paper* cycle to be initiated upon the subsequent removal of the current PAPERFEED COMMAND signal.

Normally, the LC Latch (69) is reset at the termination of each *Feed Paper* cycle to condition the Paperfeed Control logic to perform the next paperfeed operation in the Linecount mode. However, if Bit 7 of the paperfeed instruction is high (i.e.; logical "1"), the VFU Feed register (70) is set at "Feed Pulse" time. The setting of the VFU Feed register, in turn, resets the LC Latch to condition the Paperfeed Control logic to perform the next paperfeed operation in the VFU mode.

As each paperfeed instruction character appears at the printer interface, it is examined for a "No Linefeed" code (i.e.; bit pattern 0 000 000) by the No LF Detect gate (66). When a "No Linefeed" instruction is detected, the loading of the Linecount Register and the setting of the PF Latch Enable (67) and VFU Feed (70) registers are inhibited so that a *Feed Paper* cycle will not be started unnecessarily.

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(37) PRINTER READY and PAPERFEED COMMAND may occur in either order – for details, refer to paragraph 4.3.1.2.3, "Paperfeed Command Signal Sequence".

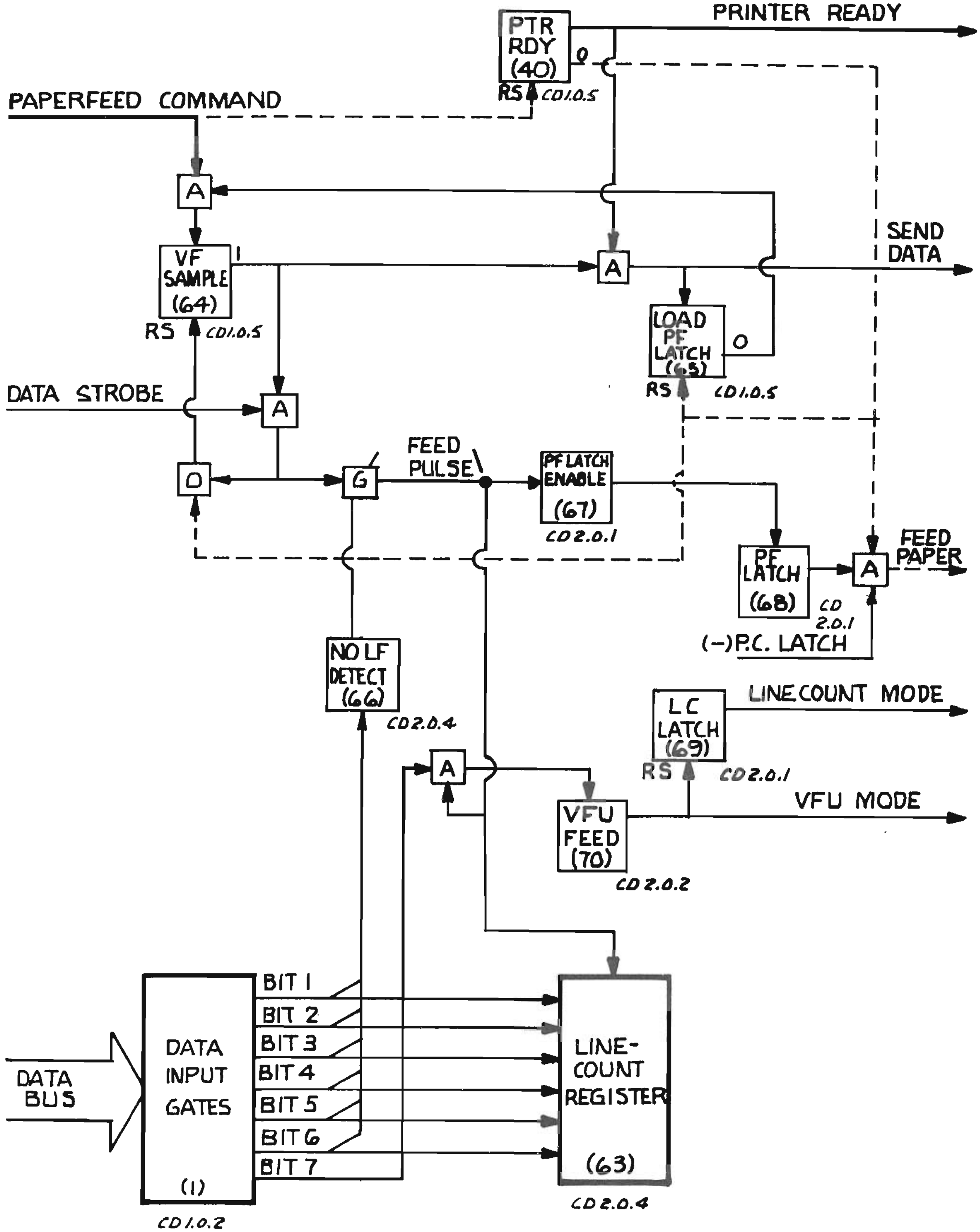

Figure 4-47. Simplified Block Diagram, Load and Initiate Paperfeed Logic

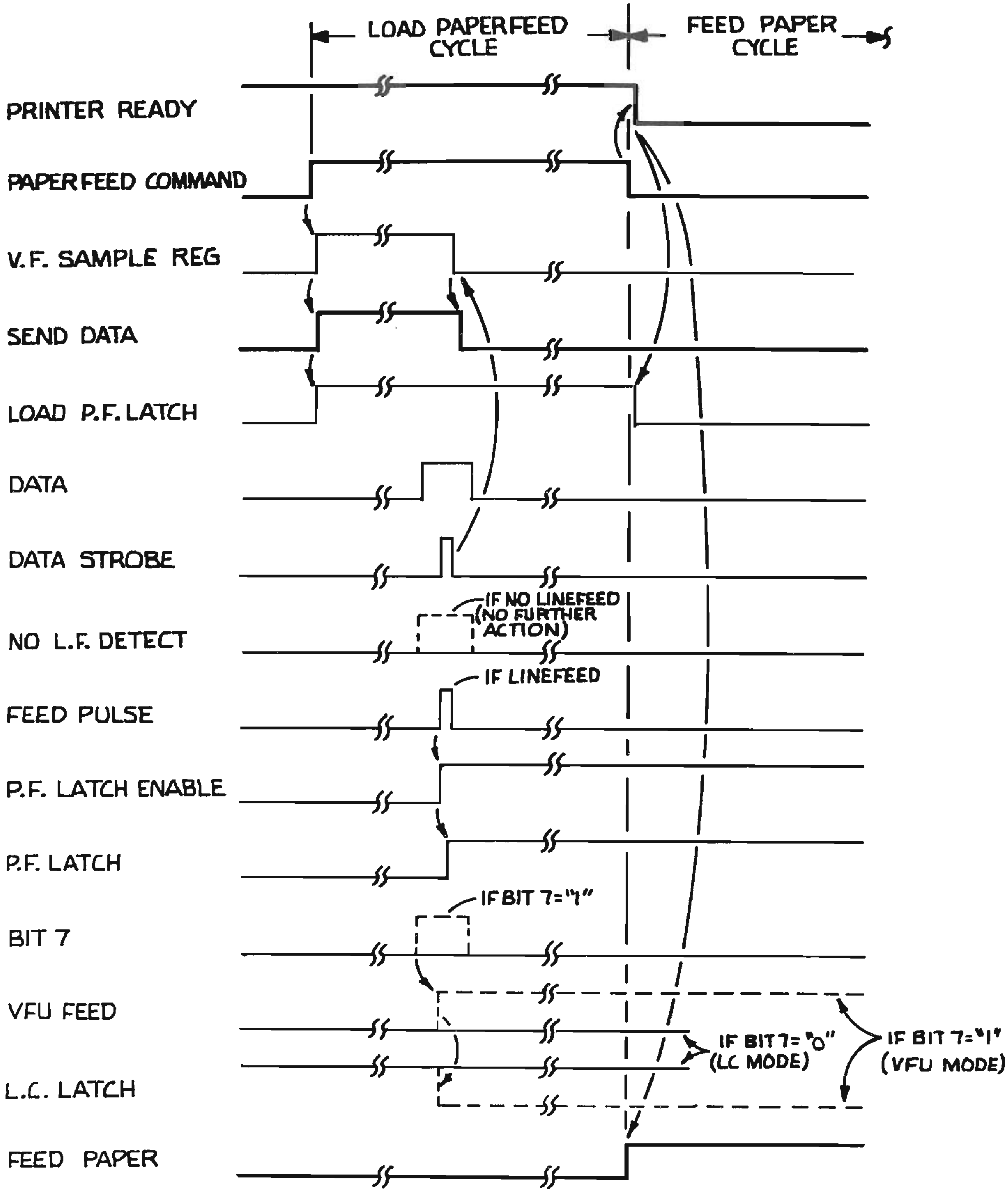

Figure 4-48. Signal Sequence, Typical Load and Initiate Paperfeed Functions

When the PAPERFEED COMMAND signal is removed, the Printer Ready (PTR RDY) register (40) is reset[38,39]. The resetting of the PTR RDY register, in turn, resets the Load PF Latch to enable the printer to respond to the next PAPERFEED COMMAND and, with the PF Latch in the set state, causes a "Feed Paper" signal to be produced that enables the Stepping Motor Control logic to operate the paperfeed drive stepping motor (see paragraph 4.4.2.3). The resetting of PTR RDY also resets the VF Sample register (64), if set, in the event a paperfeed instruction character is not transferred with a PAPERFEED COMMAND.

4.4.2.2 Feed Control

The Feed Control logic determines when the moving paper has been advanced to the position designated by the paperfeed instruction. This is accomplished either by counting "Line Strobe" pulses, that are generated by the Stepping Motor Control logic for each linespace paper is advanced, when the Linecount mode is designated, or by sensing for a punched hole in the designated channel of a vertical format tape-loop when the VFU mode is designated.

The principle elements of the Paperfeed Control logic are depicted in Figure 4-49. As shown in this figure, the Paperfeed Control logic basically consists of the Linecount Register (63) that stores the paperfeed instruction when operating in the VFU Feed mode or tracks the number of linespaces paper is advanced when operating in the Linecount mode; a Final Count Detect gate (71) that senses when paper has been advanced the number of linespaces designated by the linefeed instruction; a Decoder (72) that selects the VFU Channel designated by the paperfeed instruction; Feed Control logic (73) synchronizes the termination of paperfeed with Line Strobe pulses which are generated as paper is advanced; Stepping Motor Control logic(74) that controls the operation of the paperfeed drive stepping motor; Motor Drive circuits (75) that energize the phase-windings of the stepping motor; a Vertical Format Unit photo-electric tape reader (76) (part of the printer mechanism) which reads a vertical format tape-loop in synchronism with the moving paper; and a set of VFU Comparison Gates (77) that selectively monitor the Channel outputs of the VFU Reader.

As described in the preceding paragraph, when paperfeed is required the Feed Control logic (73) raises the Feed Paper signal. The Feed Paper signal enables the Stepping Motor Control logic to operate the paperfeed drive stepping motor thru an appropriate number of steps to advance paper to the desired position. The stepping motor, in turn, drives the paper tractors (not shown) which advance the paper thru the printer mechanism. As the paper is moved thru the printer, the Stepping Motor Control logic generates an internal "Line Strobe" pulse for each linespace of paper advance from Step Strobe and either 6-LPI or 1/2-Inch Strobe pulses fed back from the corresponding paperfeed strobe generators (refer to paragraph 4.4.2.4 for details). This internally-generated "Line Strobe" signal is used to track the number of linespaces that paper has been advanced, and is used to synchronize the termination of a paper advance operation with the linespace locations on the form when the paperfeed instruction is completed.

4.4.2.2.1 Linecount Mode (Spacing)

When the Linecount mode is designated, paperfeeding is controlled simply by tracking the linespaces that the paper in the printer mechanism has been advanced. During the *Load Paperfeed* cycle described in paragraph 4.4.2.1, the Linecount Register is loaded with the *complement* of the paperfeed instruction appearing on the DATA BUS. Subsequently, as the paper is ad-

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(38) When operating in the "Last Character" mode, the PRINT COMMAND signal, if high, must also be removed to perform this function (Standard Interface only).

(39) EPP is used to perform this function on the First-Character Interface or when Automatic Linefeed is programmed on the Standard Interface – refer to paragraph 4.4.1.2.7 for EPP details.

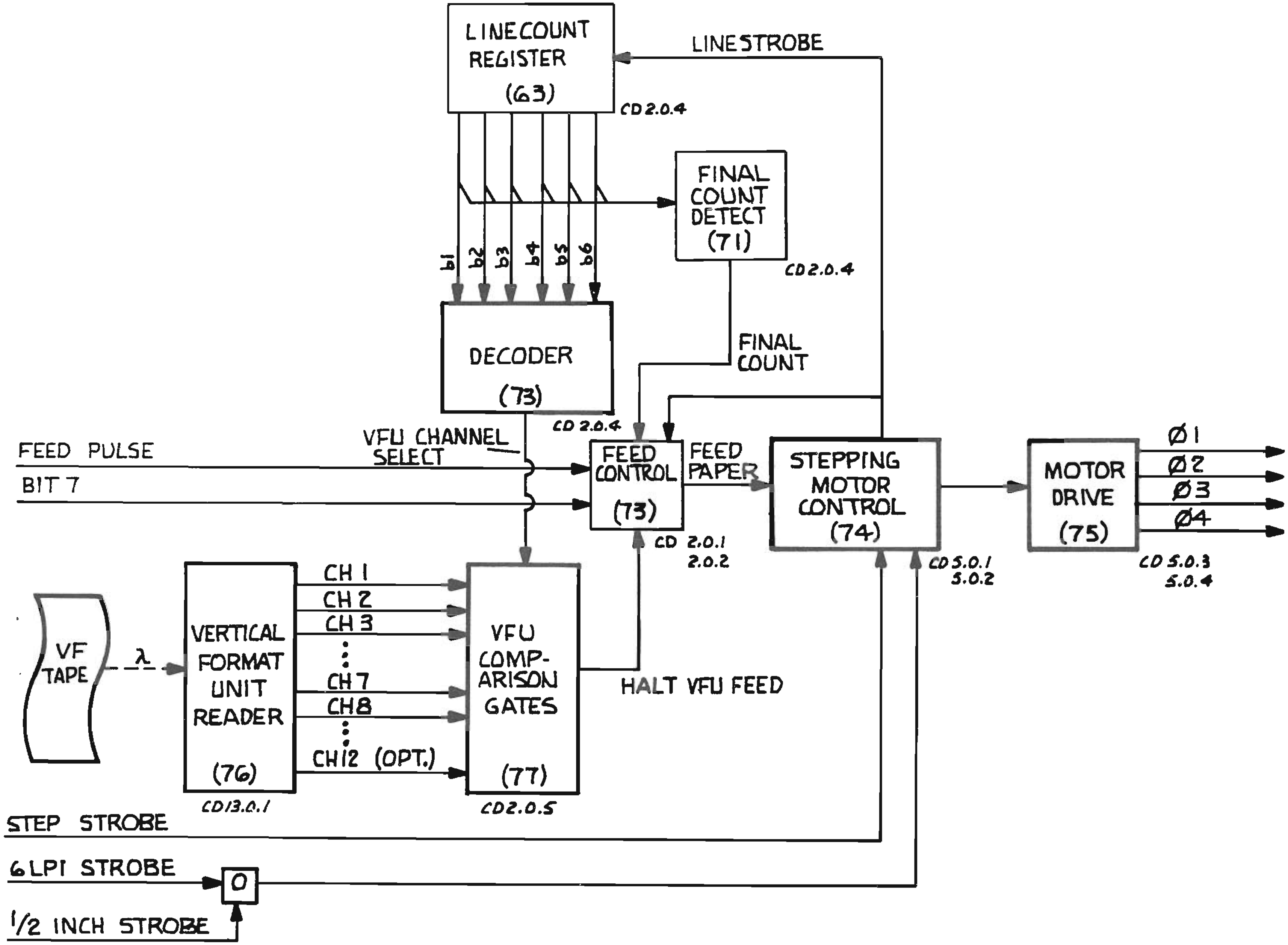


Figure 4-49. Simplified Block Diagram, Paperfeed Control

vanced through the printer, the Linecount Register is incremented by the "Line Strobe" signals to indicate the binary complement of the number of linespaces remaining to be fed after each "Line Strobe". When the linecount reaches the count of 63 (i.e.; 111 111, the binary complement of 000 000, or no lines), the Final Count Detect gate (71) raises the "Final Count" signal which, in turn, enables the Feed Control logic (73) to remove the Feed Paper signal to stop the paper advance operation.

4.4.2.2.2 VFU Feed Mode (Skipping)

When the VFU Feed mode is designated, paperfeeding is controlled simply by monitoring a selected vertical format channel. The Decoder (72) decodes the four low-order bits of the stored paperfeed instruction to enable the VFU Comparison gate (77) that corresponds to the VFU Channel designated in binary as shown in the table below. When a punched hole is sensed in the vertical format tape-loop channel corresponding to the enabled VFU Comparison Gate, the VFU Comparison Gate logic raises the "Halt VFU Feed" signal which, in turn, enables the Feed Control logic (73) to remove the Feed Paper signal to stop the paper advance operation. Whenever a non-existant channel is designated, as Channels 9-15 with the standard 8-Channel VFU or Channels 13-15 with the optional 12-Channel VFU, the Paperfeed Control logic is conditioned to stop paperfeeding after paper has been advanced a single linespace. Whenever there is no tape-loop installed in the VFU, the sensors in the VFU reader will be constantly energized; consequently, the "Halt VFU Feed" signal will be constantly high and any Skip-to-Channel paper advance operation will be stopped after a single linespace regardless of the channel designated.

Paperfeed Instruction Code	*Linecount Register Content*	*Channel*
0000	1111	1
0001	1110	1
0010	1101	2
0011	1100	3
0100	1011	4
0101	1010	5
0110	1001	6
0111	1000	7
1000	0111	8
1001	0110	9*
1010	0101	10*
1011	0100	11*
1100	0011	12*
1101	0010	Space 1 line
1110	0001	Space 1 line
1111	0000	Space 1 line

* 12-Channel VFU only; space 1 line if 8-Channel VFU.

4.4.2.2.3 Terminate Paperfeed

Regardless of the mode and paper advance requirements, each *Feed Paper* cycle is terminated in synchronism with the moving paperfeed drive system such that when paper motion ceases, the designated linespace on the form is accurately positioned opposite the typeline. The Feed Control logic (73) associated with the terminate paperfeed function is shown in greater detail in Figure 4-50. As shown in Figure 4-50, the terminate paperfeed control logic basically consists of the PF Latch Enable register (67), PF Latch (68), LC Latch (69), and VFU Feed register (70) described in paragraph 4.4.2.1, above; a Vertical Format (VF) Reset one-shot (78) that resets the Paperfeed Control logic when a paper advance is complete; a Paperfeed (PF) Governor one-shot (79) that controls the repetition rate of successive paper advance operations; and a Paper Settle Delay one-shot (80) that inhibits the start of the next *Print* cycle until the paper is allowed to settle to a complete stop following each *Feed Paper* cycle.

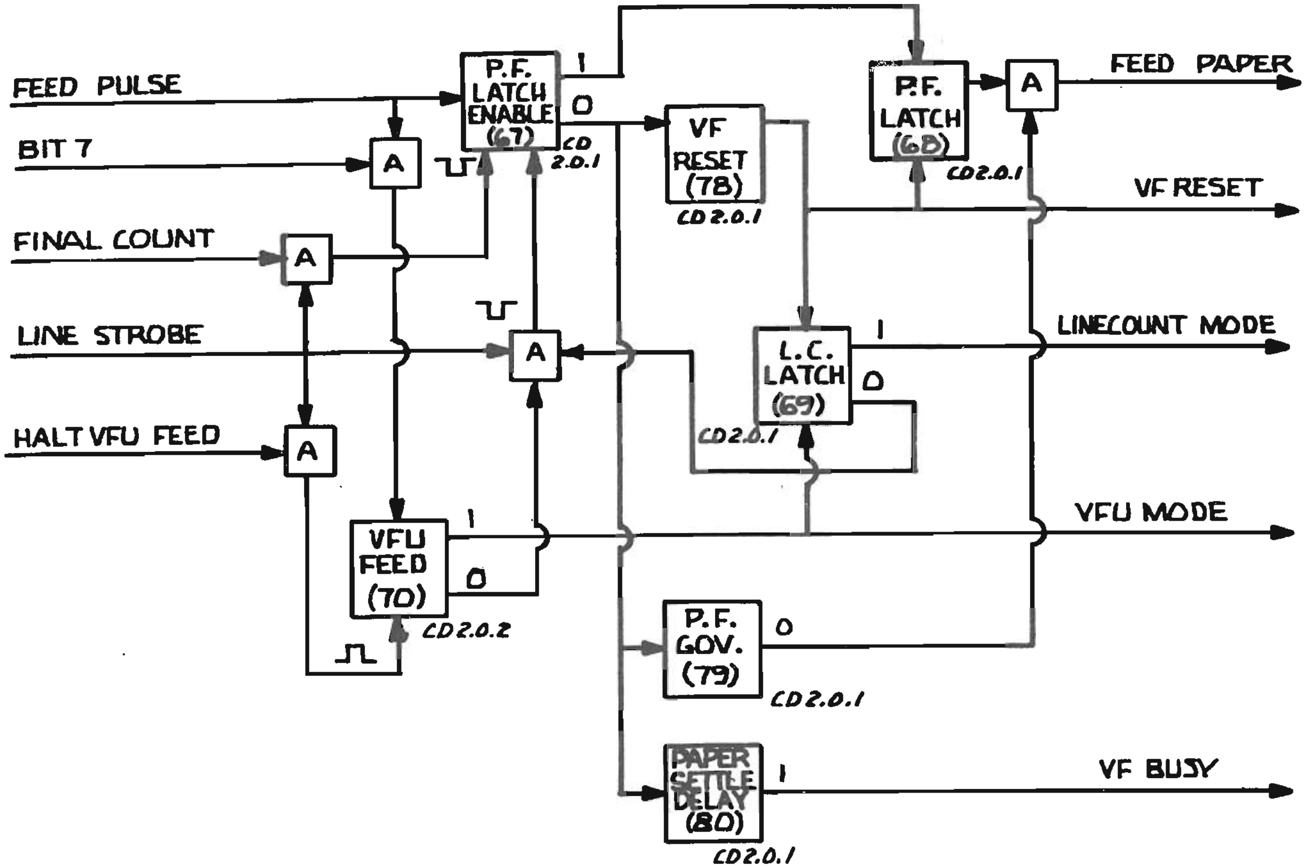


Figure 4-50. Simplified Block Diagram, Terminate Paperfeed Logic

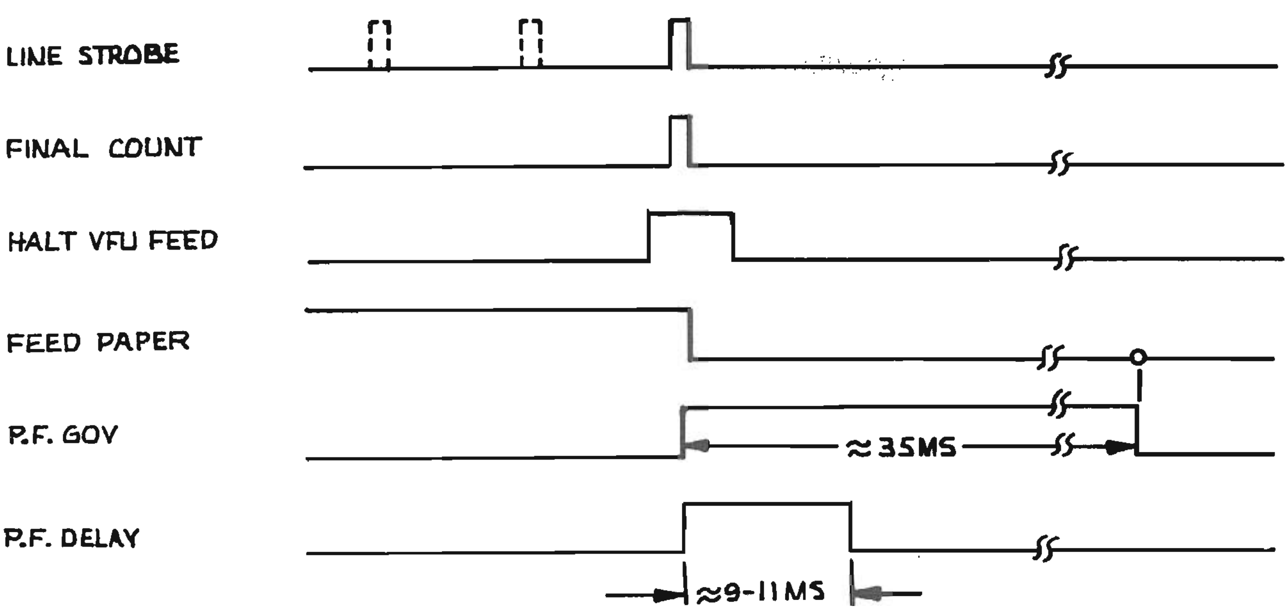


Figure 4-51. Signal Sequence, Terminate Paperfeed Functions

The events that occur during the termination of a typical *Feed Paper* cycle are depicted in Figure 4-51 and are briefly described in this and the following paragraphs. As shown in Figures 4-50 and 4-51, following the rise of "Halt VFU Feed" when operating in the VFU Feed mode, the rise of the next internally-generated "Line Strobe" resets the VFU Feed register (70) which, in turn, disables the VFU Feed mode and enables the LC Latch (69) to be set. With the LC Latch and the VFU Feed register in the reset state, the subsequent trailing-edge of "Line Strobe" resets the PF Latch Enable register (67). Similarly, the trailing-edge of the next "Line Strobe" following the rise of "Final Count" resets the PF Latch when operating in the Linecount mode.

The resetting of the PF Latch Enable register triggers the VF Reset one-shot (78) which, in turn, generates a "VF Reset" pulse. The "VF Reset" pulse clears the Linecount Register (63); resets the PF Latch (68) which, in turn, removes the "Feed Paper" signal to stop the current paper advance; and, with the VFU Feed register in the reset state, sets the LC Latch (69), if not already set, to restore the Paperfeed Control logic to the Linecount mode in preparation for the next paper advance operation.

In conjunction with the triggering of the VF Reset one-shot, both the PF Governor one-shot (79) and the Paper Settle Delay one-shot (80) are triggered. The PF Governor inhibits the next "Feed Paper" signal for approximately 35 MS following the completion of a *Feed Paper* cycle to control the maximum repetition rate at which successive paper advance operations can be performed. Similarly, the Paper Settle Delay extends the "VF Busy" signal for approximately 9 to 11 MS following the completion of a *Feed Paper* cycle. During this Paper Settle Delay interval, the setting of the Print register (see paragraph 4.4.1.2.6) is inhibited to delay the start of the next *Print* cycle until the paperfeed drive system has been decelerated to a smooth stop, and the paper that was in motion during the *Feed Paper* cycle just completed has been allowed to settle.

4.4.2.3 Stepping Motor Control and Drive

When paperfeed is required, the paperfeed drive stepping motor is operated in a synchronous manner through an appropriate number of step positions under control of the Stepping Motor Control logic (74) and Motor Drive circuits (75) as shown in Figure 4-49. The Stepping Motor Control logic and Motor Drive circuits are depicted in greater detail in Figure 4-52. As shown in Figure 4-52, the Stepping Motor Control logic and Motor Drive circuits basically consist of a Start Step Strobe one-shot (81) that is used to initiate stepping motor operation; a Current Control register (82) that sets the level of current through the motor windings at either a high level for operation or a low level to hold the stepping motor and paper stationary when not feeding paper; a Strobe Shaping one-shot (83) that regenerates Step Strobe pulses fed back from the Step Strobe Generator; a Retriggerable One-Shot (84) that retriggers the Step Strobe one-shot in the event Step Strobe pulses are not received when paperfeeding is required; an Index Feed register (85) that enables an initial synchronizing paper advance operation to be performed when printer power is turned on; a Decelerate Step Strobe Generator (86) that provides a stream of delayed step strobe pulses to decelerate the stepping motor to a smooth stop; Motor Phase Control logic (87) that controls the switching of drive to the stepping motor phase windings; four Motor Winding Drivers that energize the corresponding stepping motor phase windings; a Step Strobe Counter (88) that derives internal "Line Strobe" pulses from the number of steps the motor has been advanced according to the selected linespacing; a Strobe Latch (89) that staticizes the appropriate paperfeed strobe pulses fed back from either the 6-LPI or 1/2-Inch Strobe Generator to synchronize the Feed Control logic (73); and a Line Strobe one-shot (90) that generates internal "Line Strobe" pulses.

The events that occur during a representative operation of the paperfeed drive stepping motor are depicted in Figure 4-53, and are described in the paragraphs that follow. Generally, these events can be considered as being associated with four basic functions, namely; stepping motor operation, "Line Strobe" derivation, linespace synchronization, and stepping motor deceleration. For details concerning the various paperfeed drive system devices associated with the operation of the Stepping Motor Control and Drive logic, refer to paragraph 4.2.2.

4.4.2.3.1 Stepping Motor Operation

Stepping motor operation is controlled by the "Feed Paper" signal from the Paperfeed Control logic and by Step Strobe pulses fed back from the Step Strobe Generator. As shown in Figures 4-52 and 4-53, the rise of "Feed Paper" enables the Strobe Shaping one-shot (83) and triggers the Start Step Strobe one-shot (81). The Start Step Strobe one-shot output, in turn, enables the Motor Phase Control logic (87) to initiate stepping motor operation. Subsequent Step Strobe pulses, generated by the Step Strobe Generator as the stepping motor turns, are regenerated by the enabled Strobe Shaping one-shot (83) to continue stepping motor operation. The rise of "Feed Paper" also sets the Current Control register (82) which, in turn, conditions the Motor Winding Drivers to energize the selected motor windings at the full, operating current level.

The Motor Phase Control logic (87) consists of a two-stage Johnson counter, the outputs of which are used to commutate drive to the stepping motor phase windings. Each Step Strobe pulse increments the Johnson counter as shown in the table below to step the stepping motor to the next step. As shown in the table, the motor is stepped by energizing the phase windings in sequence such that a pair of windings are energized at a time. To advance the motor, the pair of windings immediately leading the current motor position is energized. As with synchronous motors, the rotor seeks a position with respect to the energized windings. As the rotor turns through a step position, the first winding of the pair of windings currently energized is turned off and the next winding in succession is switched on, forming a new pair of energized windings to advance the rotor to the next step position. In normal operation the stepping motor is operated in a synchronous manner at speeds of up to approximately 1000 steps-per-second (approximately 1.0 MS per step) to advance paper in a single, continuous motion for each paper advance. This is accomplished by the maintenance-adjustment of the Step Strobe Generator, such that the Step Strobe pulses and, thereby, the phase commutation occur at the optimum lead time with respect to the motor position.

Step	*Counter Stage*		*Energized Phase Windings:*			
	A	*B*				
1	0	0			3	4
2	1	0	1			4
3	1	1	1	2		
4	0	1		2	3	

The phase (ϕ) outputs of the Motor Phase Control Johnson counter turn on corresponding Motor Winding Drivers which, in turn, energize the selected motor windings. Each Motor Phase Driver is a self-controlled chopper circuit that limits the current flowing through the corresponding winding according to a maintenance-adjusted reference level provided by the Current Adjustment potentiometer, R38, which is common to all four driver circuits. When a self-contained voltage comparator (not shown) senses that the voltage developed by the exponentially rising winding current across an associated return resistor (not shown) exceeds the reference level, the driver is temporarily turned off. Conversely, when the voltage across the return resistor decays to a level below the reference level, the driver is again turned on.

The operation of the paperfeed drive stepping motor continues in the manner described above until the Paperfeed Control logic removes the "Feed Paper" signal (i.e.; until paper has been advanced either the required number of linespaces or to the required vertical format position).

4.4.2.3.2 "Line Strobe" Derivation

Internal "Line Strobe" pulses, that are used by the Paperfeed Control logic to determine when to terminate a *Feed Paper* cycle, are generated by the Stepping Motor Control logic from synchronizing signals fed back from the printer mechanism. As paper is being fed through the printer mechanism, an internal "Line Strobe" pulse is generated for each linespace of paper advance. In a printer provided with the standard 6 LPI linespacing feature, the internal "Line Strobe" pulses are generated directly from pulses fed back from the 6-LPI Strobe Gener-

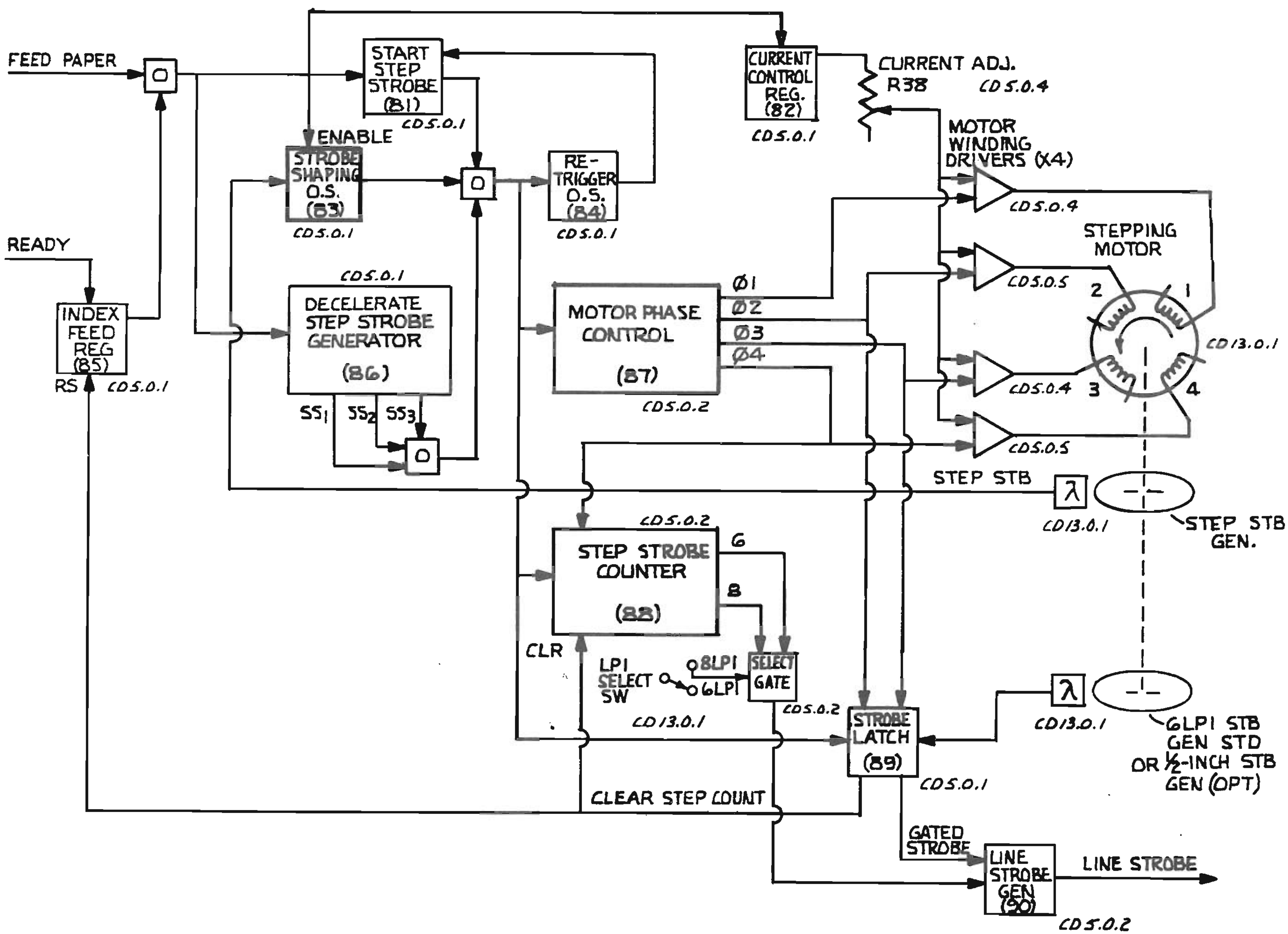


Figure 4-52. Simplified Block Diagram, Stepping Motor Control and Drive

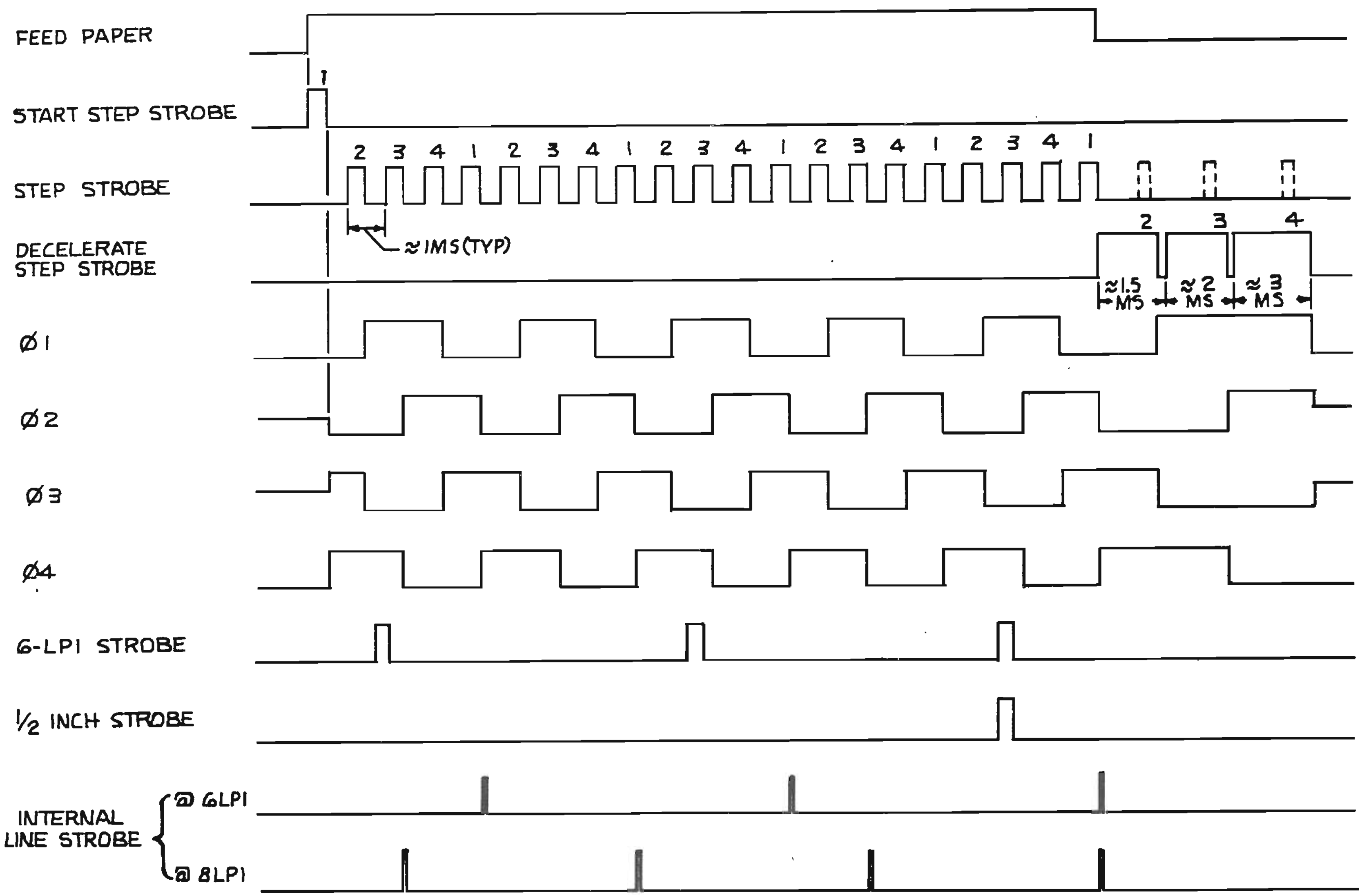


Figure 4-53. Representative Signal Sequence, Stepping Motor Control

ator that produces a pulse for every linespace, at 6 LPI, of paper advance. However, in a printer provided with the optional 6/8 LPI linespacing feature, the standard 6-LPI Strobe Generator is replaced by a 1/2-Inch Strobe Generator that produces a pulse for every 1/2-inch (1,27 cm) of paper advance. This increment of paper advance corresponds to three linespaces at 6 LPI, or four linespaces at 8 LPI; hence, each "1/2-Inch Strobe" pulse represents a line position on the form that is common to both 6 and 8 LPI linespacing. Accordingly, the "Line Strobe" pulses that represent the intervening line positions, at 6 or 8 LPI, between successive "1/2-Inch Strobe" pulses are derived from the stream of "Step Strobe" pulses used to control the paperfeed drive stepping motor.

Because of the motor-to-tractor gear ratio, twenty-four steps of the stepping motor are required to advance the paper through a distance of 1/2 inch (1,27 cm). Consequently, eight steps are required to advance the paper 1/6th inch (4,233 mm) or one linespace at 6 LPI, and six steps are required to advance the paper 1/8th inch (3,175 mm) or one linespace at 8 LPI. Accordingly, with the optional 6/7-LPI linespacing feature, internal "Line Strobe" pulses are derived by counting "ϕ Step" (i.e.; Step Strobe) pulses in groups of 6 or 8, depending on the linespacing manually selected by means of the 6/8 LINES PER INCH switch.

As shown in Figure 4-52, internal "Line Strobe" pulses are derived by the Step Strobe Counter (88) that consists of two separate counters; a single-stage binary counter which is incremented each time the ϕ4 motor winding is turned on, and a modified Johnson counter and binary counter arrangement that counts "ϕ Step" pulses. When 6-LPI linespacing is selected, the Select Gate is conditioned to read the output of the single-stage binary counter (1). As shown in the table below, this counter completes a full cycle every other time the ϕ4 motor winding is turned on which corresponds to every eighth (8th) step of the stepping motor. As this counter completes a cycle, the Line Strobe Generator one-shot (90) is triggered to produce an internal "Line Strobe" pulse that represents a line position on the form at 6 LPI.

6-LPI LINE STROBE DERIVATION

Step	*ϕ4*	*Counter 1*	*"Line Strobe"*
*1	1	0	1
2	1	0	
3	0	0	
4	0	0	
1	1	1	
2	1	1	
3	0	1	
4	0	1	
1	1	0	1

8-LPI LINE STROBE DERIVATION

Step	*Counter 2*			*"Line Strobe"*
	C	*B*	*A*	
*1	0	0	0	1
2	0	0	1	
3	0	1	1	
4	1	0	0	
1	1	0	1	
2	1	1	1	
3	0	0	0	1

*Common to both 6 & 8 LPI

Similarly, when 8-LPI linespacing is selected, the Select Gate is conditioned to read the output of the modified Johnson and binary counter (2). As shown in the table above, this counter completes a full cycle on every sixth (6th) step of the stepping motor. As this counter completes a cycle, the Line Strobe Generator (90) is triggered to produce an internal "Line Strobe" pulse that represents a line position on the form at 8 LPI.

4.4.2.3.3 Linespace Synchronization

The derivation of internal "Line Strobe" pulses and, thereby, the operation of the paperfeed drive stepping motor are also synchronized with the paperfeed drive system to permit the moving paper to be stopped with the required linespace accurately positioned opposite the typeline. Synchronization with the paperfeed drive system is achieved by means of the strobe pulses fed back from either the standard 6-LPI Strobe Generator or the optional 1/2-Inch Strobe Generator, depending on the linespacing feature required.

As shown in Figure 4-52, the output of the appropriate strobe generator is connected to a Strobe Latch logic circuit (89). The Strobe Latch logic staticizes each paperfeed strobe pulse which, when the corresponding generator is properly adjusted, normally occurs during Step 2 of the motor winding switching sequence; that is, while the $\phi 1$ and $\phi 4$ motor windings are energized as shown in Figure 4-53 (also see paragraph 4.4.2.3.1). When a paperfeed strobe pulse has been received, the Strobe Latch is latched when both the $\phi 2$ and $\phi 3$ motor windings are energized (i.e.; during the subsequent Step 4). With the Strobe Latch set, a "Clear Step Count" pulse and a "Gated Strobe" pulse are generated during the *next* "ϕ Step" (i.e.; Step Strobe) time. The "Clear Step Count" pulse clears the Step Strobe Counter and the "Gated Strobe" pulse inhibits the Line Strobe Generator from producing a pulse when the Step Strobe Counter is cleared. Subsequently, the trailing edge of the "Gated Strobe" pulse triggers the Line Strobe Generator which, in turn, produces an internal "Line Strobe" pulse that is synchronized with the paperfeed drive system. Depending upon the linespacing feature required, a strobe-indexed "Line Strobe" pulse is generated either for every line position on the form when the standard 6-LPI linespacing feature is required, or for those line positions that are common to both 6 and 8 LPI when the optional 6/8 LPI linespacing feature is required.

4.4.2.3.4 Stepping Motor Deceleration

A paper advance operation is stopped when the Paperfeed Control logic determines that paper has been advanced to the line position designated by the stored paperfeed instruction and, consequently, removes the "Feed Paper" signal to the Stepping Motor Control logic (see paragraph 4.4.2.2). However, because of the inertia of the rapidly moving paperfeed drive system, it is necessary to decelerate the stepping motor through three successive step positions to bring the paper to a smooth, accurately positioned stop. When the "Feed Paper" signal is removed, the Strobe Shaping one-shot (83) is inhibited from responding to further pulses fed back from the Step Strobe Generator, and the Decelerate Step Strobe Generator (86) is enabled. The Decelerate Step Strobe Generator consists of three cascaded one-shots. When enabled, these one-shots sequentially trigger through integrating resistor-capacitor coupling networks to produce a series of three pulses having successively longer, maintenance-adjustable periods of 1.5, 2.0 and 3.0 MS, respectively. As shown in Figures 4-52 and 4-53, these pulses are OR'd together to drive the Motor Phase Control logic and the Step Strobe Counter. The periods of these pulses correspondingly delays the switching of the stepping motor windings for the next three steps, which decelerates the moving paperfeed drive system. The trailing edge of the last of the three pulses generated by the Decelerate Step Strobe Generator resets the Current Control register (82) to condition the Motor Winding Drivers to energize the last selected pair of motor windings at a reduced current level sufficient to hold the stepping motor and paper stationary while not feeding paper.

4.4.2.3.5 Index Feed

When the printer power is turned on, the printer automatically advances the paperfeed drive system to index the paper tractors and vertical format unit at a Strobe-indexed stop position, which synchronizes the Paperfeed Control logic with the stepping motor and the appropriate paperfeed strobe generator. The appearance of the "Ready" signal at the Index Feed register (85) is slightly delayed when printer power is turned on. When d-c power is applied, the temporary low state of the "Ready" signal sets the Index Feed register which, in turn, initiates a paper advance operation. Following the detection of a 6-LPI Strobe pulse, or a 1/2-Inch Strobe pulse, the Step Strobe Counter (88) and the Index Feed register (85) are reset when the $\phi 3$ and $\phi 4$ stepping motor windings are turned on (i.e.; at the beginning of Step 1 of the motor winding switching sequence). Subsequently, the Decelerate Step Strobe Generator (86) operates the stepping motor through the next three steps while the Motor Phase Control logic (87) switches drive to motor windings $\phi 1$ and $\phi 4$, then $\phi 1$ and $\phi 2$, and finally to $\phi 2$ and $\phi 3$, at which the stepping motor is stopped (i.e.; through motor winding switching sequence Steps 2, 3, and 4, respectively). Thereafter, when terminating subsequent paper advance operations, the stepping motor will be stopped with the $\phi 2$ and $\phi 3$ motor windings energized (Step 4) when 6-LPI linespacing is required. Similarly, when 8-LPI linespacing is required, the stepping motor will be stopped with either the $\phi 2$ and $\phi 3$ motor windings energized (Step 4), or with the $\phi 1$ and $\phi 4$ motor windings energized (step 2), depending on whether the *total* number of linespaces advanced after the initial synchronization (indexing) is even or odd, respectively.

At the start of an Index Feed operation, the actual position of the stepping motor rotor with respect to the motor windings is indeterminate until a paperfeed strobe is detected and the motor winding commutation is stopped with the $\phi 2$ and $\phi 3$ motor windings energized. Consequently, the stepping motor may be out of phase with the motor windings initially energized until the rotor catches up with the strobe-indexed stop position. (Note – The pair of motor windings initially energized is selected at random; the Motor Phase Control logic is not preset at the beginning of a paper advance operation.) Should the rotor lead the initial pair of windings to be energized, the rotor will turn in the reverse direction (i.e.; clockwise) for one, possibly two, step positions, until the rotor reaches an energized pair of windings whereupon, the rotor will change direction and turn in phase with the energized windings as they are commutated in the forward direction (i.e.; counter-clockwise).

The Retriggerable One-Shot (84) provides for continued operation of the stepping motor, but at a slow rate, in the event Step Strobe pulses are not received from the Step Strobe Generator when paperfeeding is required. In such an event, the Retriggerable One-Shot, which is normally retriggered approximately every one MS by the "ϕ Step" pulses, will "time out" in approximately seven MS after being triggered by the initial "ϕ Step" pulse that is generated by the Start Step Strobe one-shot (81). When paperfeeding is required (i.e.; either the "Feed Paper" signal is present or the Index Feed register [85] is set), the fall of the output of the Retriggerable One-Shot triggers the Start Step Strobe one-shot to produce a second "ϕ Step" pulse. This "ϕ Step" pulse, in turn, advances the Motor Phase Control logic to the next step in the motor winding switching sequence, and triggers the Retriggerable One-Shot to repeat another cycle in this mode of operation, until paper has been advanced to the designated position.

4.4.2.4 Paper Jam Detection

While feeding paper, the printer automatically senses for paper motion. Paper motion detection is accomplished by photo-electrically sensing the motion of the lower paper tractors which are driven by the moving paper that is pulled through the print area by the upper paper tractors while feeding paper. Should the paper in the printer jam, break between the upper and lower tractors, or otherwise fail to feed through the print area and drive the lower tractors, a Paper Jam alarm condition will be indicated on the Alarm Status Indicator Panel and the printer will immediately be switched to the STOP mode of operation. In the event of a Paper Low condition, which results in a similar no-motion condition of the lower paper tractors, the Paper Jam alarm is logically inhibited to permit printing on the remainder of the form.

Figure 4-54 depicts the Paper Jam Detect logic and shows an illustrative sequence of the signals involved in sensing paper motion. As shown in Figure 4-54, the Paper Jam Detect logic basically consists of a retriggerable Motion Strobe One-Shot (97) which generates an output pulse for each reflective band on the rotating paper motion Strobe Wheel; a retriggerable Motion Sense One-Shot (98) which times the interval between successive Motion Strobe pulses; a No Motion Register (99) which indicates when Motion Strobe pulses have not been received; and a Paper Jam Register (100) which indicates when a no-motion, or paper jam condition has been detected.

During a paper advance operation, the moving paper drives the lower paper tractors which, in turn, rotate a Strobe Wheel that is attached to a shaft which is common to both lower tractors. Alternating reflective and non-reflective bands are arranged about the periphery of the Strobe Wheel and are spaced such that Motion Strobe pulses are normally produced at a rate greater than that which Line Strobe pulses are generated at a linespacing of 8-LPI. The bands are sensed by a maintenance-adjustable prefocused sensor consisting of a LED and a photosensor. As the Strobe Wheel rotates, infra-red light from the LED is reflected off of the reflective bands and energizes the associated photosensor, the output of which is amplified and shaped by an associated operational amplifier in the printer electronics.

As shown in Figure 4-54, the amplified and shaped output pulses from the Motion Sensor trigger the Motion Strobe One-Shot (97). The Motion Strobe One-Shot, in turn, triggers the

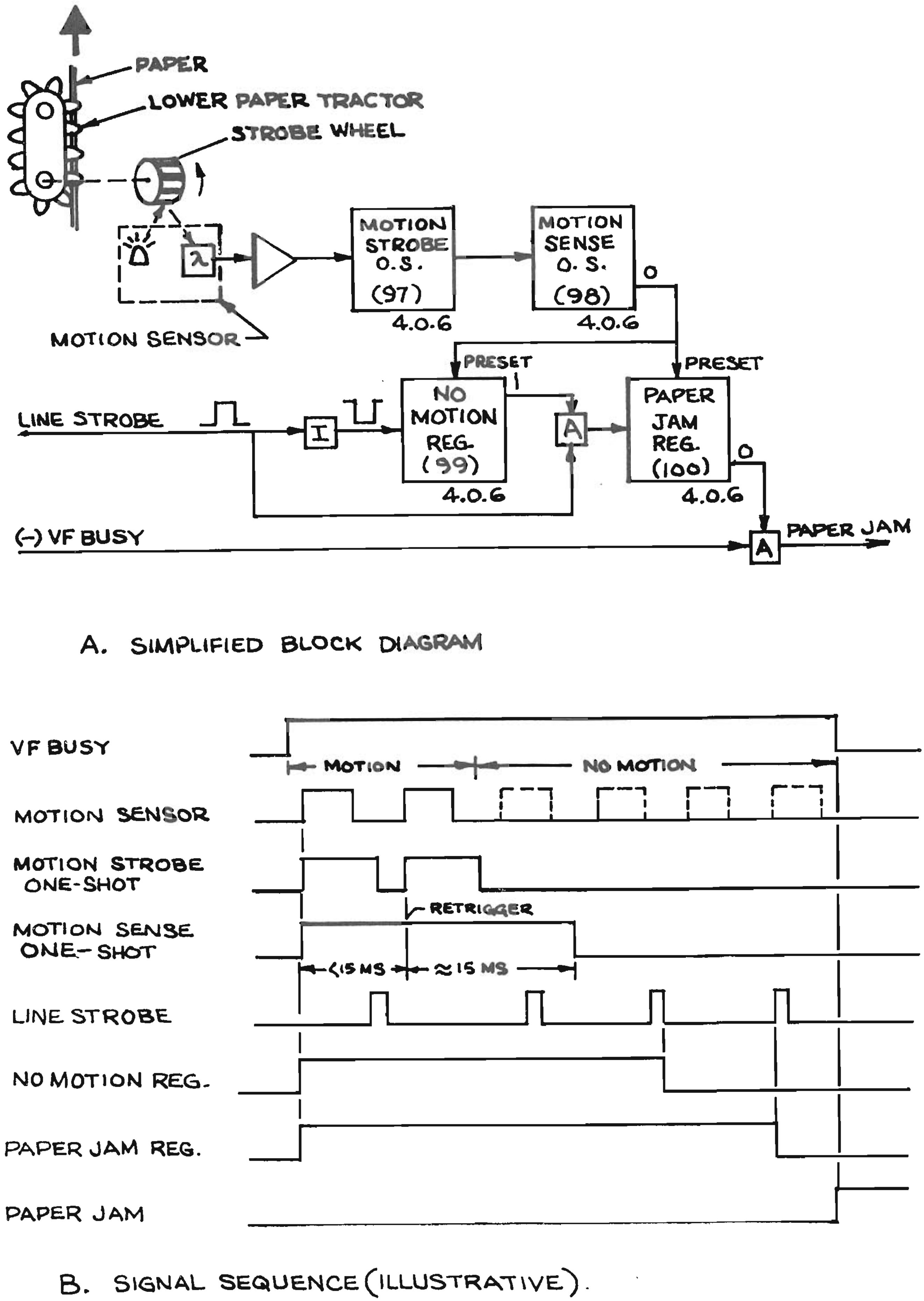


Figure 4-54. Simplified Block Diagram, Paper Jam Detect Logic

Motion Sense One-Shot (98) which has a fixed timing interval of approximately 15 MS. During this interval, the output of the Motion Sense One-Shot holds both the No Motion Register (99) and the Paper Jam Register (100) in the preset (i.e.; logic "1") state.

Normally, when properly feeding paper, the stream of output pulses from the Motion Sensor continually retriggers the Motion Strobe One-Shot and, consequently, the Motion Sense One-Shot which holds the No Motion and Paper Jam registers in the preset state while "VF Busy" is active (i.e.; while feeding paper). However, should the paper fail to drive the lower paper tractors, the Motion Sense One-Shot will not be triggered (or if previously triggered, will not be retriggered and will time out) and will not hold the No Motion and Paper Jam registers in the preset state. While the paperfeed drive system is operating, both the No Motion and the Paper Jam registers are continually sampled by Line Strobe pulses generated by the Line Strobe Generator (90) (see paragraph 4.4.2.3.). The first Line Strobe pulse following the removal of the preset level will reset the No Motion register which, in turn, conditions the input to the Paper Jam register. Subsequently, if no motion is sensed in the meanwhile, the next Line Strobe pulse will reset the Paper Jam register to indicate that a Paper Jam alarm condition has been detected.

4.4.3 Ribbonfeed Control

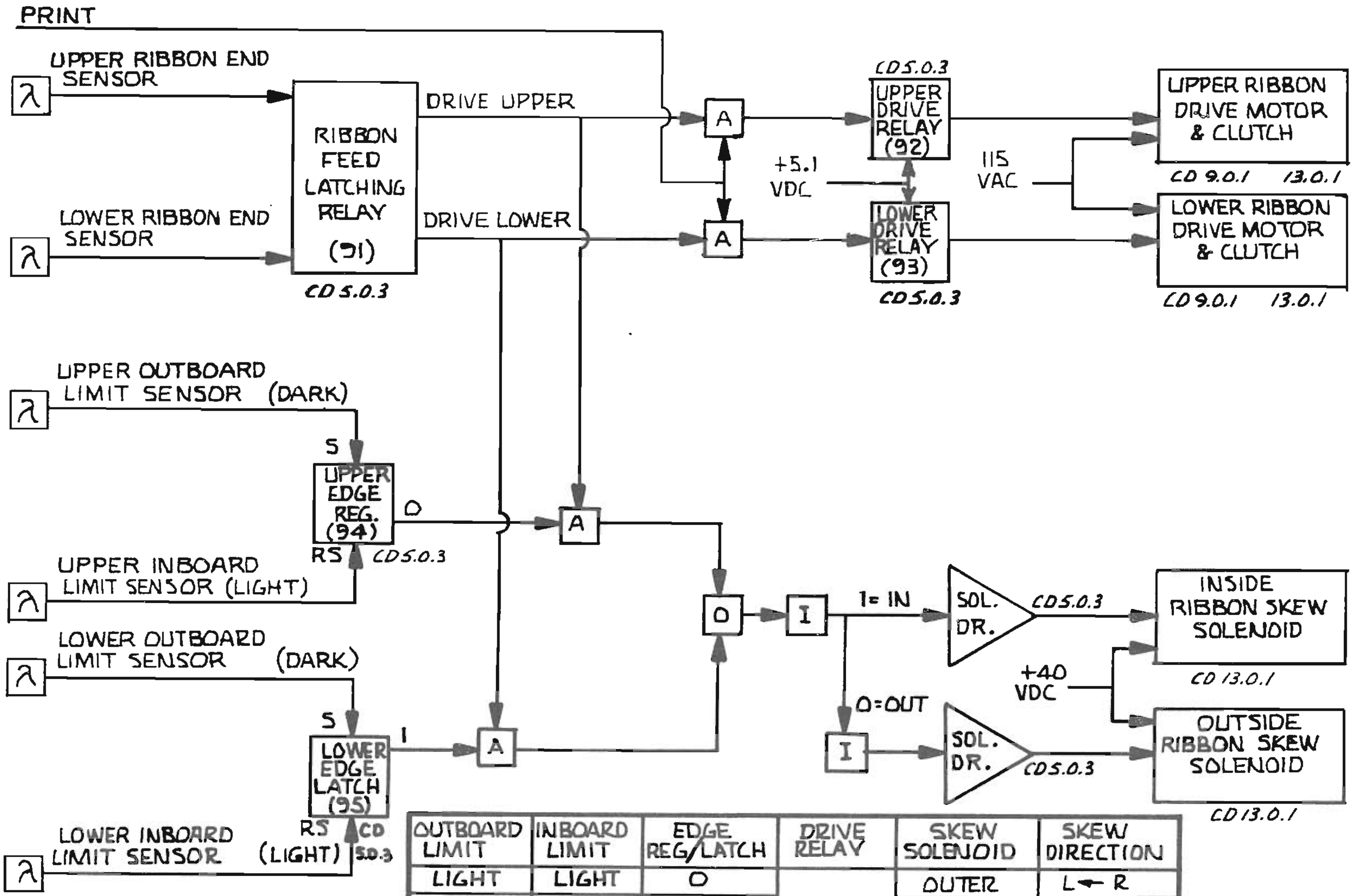
The feeding and tracking of ribbon in the printer mechanism are performed in a continuous manner whenever printing is required, and are controlled automatically from signals fed back from ribbon limit sensors in the upper and lower ribbon sensor assemblies (refer to paragraph 4.2.3. for Ribbonfeed System details). Normally ribbon is fed in one direction until the opposite end of the ribbon is detected whereupon, the direction of ribbonfeed is reversed; the ribbon is then fed in the opposite direction until the other end is detected and the direction of feed is again reversed. As ribbon is feeding, it is skewed to the left or to the right to cause the ribbon to wander laterally between limits as it moves across the typeline to distribute ribbon usage. Ribbonfeeding is accomplished by energizing either the upper ribbon drive motor and clutch, or the lower ribbon drive motor and clutch, depending on which end of the ribbon was last sensed. Similarly, ribbon tracking is accomplished by energizing either the inside or the outside ribbon skew solenoid, depending on the edge limit at which ribbon was last sensed and the direction of ribbon feed.

The Ribbonfeed Control logic is depicted in Figure 4-55. As shown in Figure 4-55, the Ribbonfeed Control logic basically consists of a latching-type Ribbon Feed Relay (91) that controls the direction of ribbon feed; Upper (92) and Lower (93) Drive Relays that apply enabling drive to respective thyristors that, in turn, apply 115 VAC drive to the corresponding ribbon motor and cluth; an Upper Edge register (94) that indicates the last upper limit sensor at which the left edge of ribbon was sensed; and a Lower Edge Latch (95) that indicates the last lower limit sensor at which the left edge of ribbon was sensed; and two (2) Solenoid Drivers that apply +40 VDC drive to either the inside or outside skew solenoid, according to the last limit indicated and the direction of ribbon feed as shown in the table included in the figure.

4.4.3.1 Ribbon Feeding and Reversing

Ribbon feeding and reversing are controlled by the Ribbon Feed Latching Relay (91) and the Upper (92) and Lower (93) Drive Relays. The two Drive Relays (92 and 93) are enabled by the Print register whenever printing is required to apply drive to the appropriate ribbon motor control circuit. Each ribbon motor and clutch combination is energized at 115 VAC by an associated thyristor, which is turned on when the corresponding Drive Relay is operated.

The direction of ribbonfeed is controlled by the latching-type Ribbon Feed Relay (91) which is latched in either the open or closed position in response to signals fed back from the lower and upper Ribbon End Sensors, respectively. While the upper ribbon mandrel is being driven, ribbon is wound onto the upper mandrel from the lower mandrel: hence, when the lower Ribbon End Sensor detects a "Ribbon End" hole 40 in the ribbon (which indicates that all usable ribbon has been removed from the undriven mandrel), the appropriate coil of the Ribbon Feed Relay is energized to open the relay contacts which, in turn, switches drive, via the Lower Drive Relay (93), to the lower Ribbon Drive Motor and Clutch and, thereby, reverses the direction of ribbonfeed. Conversely, while the lower ribbon mandrel is being driven, ribbon is wound onto the lower mandrel from the upper man-



OUTBOARD LIMIT	INBOARD LIMIT	EDGE REG/LATCH	DRIVE RELAY	SKEW SOLENOID	SKEW DIRECTION
LIGHT	LIGHT	O	UPPER	OUTER	L← R
LIGHT	DARK	X		X	L↔R
DARK	DARK	I		INNER	L → R
LIGHT	LIGHT	O	LOWER	INNER	L←R
LIGHT	DARK	X		X	L↔R
DARK	DARK	I		OUTER	L→R

Figure 4-55. Simplified Block Diagram, Ribbonfeed Control Logic

drel: hence, when the upper Ribbon End Sensor detects a "Ribbon End" hole[40], the opposite coil of the Ribbon Feed Relay is energized to close the relay contacts which, in turn, switches drive, via the Upper Drive Relay (92), to the upper Ribbon Drive Motor and Clutch. The Ribbon Feed Relay remains latched in the position to which it was last switched when printer power is turned off, so that ribbon will continue to be fed in the same direction when power is subsequently turned on.

4.4.3.2 Ribbon Tracking

Ribbon tracking is controlled by the Upper edge Register (94) and the Lower Edge Latch (95) which are set or reset in response to signals fed back from corresponding upper and lower Outboard Limit and Inboard Limit sensors, and the Ribbon Feed Relay (91) which controls the direction of ribbonfeed. When the upper ribbon mandrel is being driven, the state of the Upper Edge register controls the direction of ribbon skew and, thereby, the direction of lateral ribbon wander at the typeline: conversely, when the lower ribbon mandrel is being driven, the direction of ribbon skew is controlled by the state of the Lower Edge Latch.

As indicated by the table in Figure 4-55, when the upper ribbon mandrel is being driven, the "set" state of the Upper Edge register selects the Inside Ribbon Skew Solenoid which, when energized at +40 VDC by the associated Solenoid Driver, will position the right-hand end of the ribbon mandrels to cause the moving ribbon to wander to the right; and the "reset" state of the Upper Edge register selects the Outside Ribbon Skew Solenoid which, when energized at +40 VDC by the associated Solenoid Driver, will position the right-hand end of the ribbon mandrels to cause the moving ribbon to wander to the left. When the upper ribbon mandrel is being driven, a "dark" signallevel (+) from the Upper Outboard Limit Sensor (which indicates that the ribbon has reached the outboard, or left, limit of lateral wander) "sets" the Upper Edge register which remains set until a "light" signal level (–) is generated by the Upper Inboard Limit Sensor (which indicates that the ribbon has reached the inboard, or right, limit of lateral wander). The "light" signal level from the Upper Inboard Limit Sensor "resets" the Upper Edge register, which remains reset until a subsequent "dark" signal level is generated by the Upper Outboard Limit Sensor, thereby repeating the cycle.

When the lower ribbon mandrel is being driven, the "set" state of the Lower Edge Latch selects the Outside Ribbon Skew Solenoid, which causes the moving ribbon to wander to the right; and the "reset" state of the Lower Edge Latch selects the Inside Ribbon Skew Solenoid, which causes the moving ribbon to wander to the left. A "dark" signal level (+) from the Lower Outboard Limit Sensor (which indicates that the ribbon has reached the outboard, or left, limit of lateral wander) "sets" the Lower Edge Latch, which remains set until a "light" signal level (–) is generated by the Lower Inboard Limit Sensor (which indicates that the ribbon has reached the inboard, or right, limit of lateral wander). The "light" signal level from the Lower Inboard Limit Sensor "resets" the Lower Edge Latch, which remains reset until a subsequent "dark" signal level is generated by the Lower Outboard Limit Sensor, thereby repeating the cycle. Note that, when the direction of ribbonfeed is changed, the selection of the energized Ribbon Skew Solenoid is also changed to continue the lateral wander of the moving ribbon in the same dierction.

4.4.3.3 Ribbon Motor-Off Delay

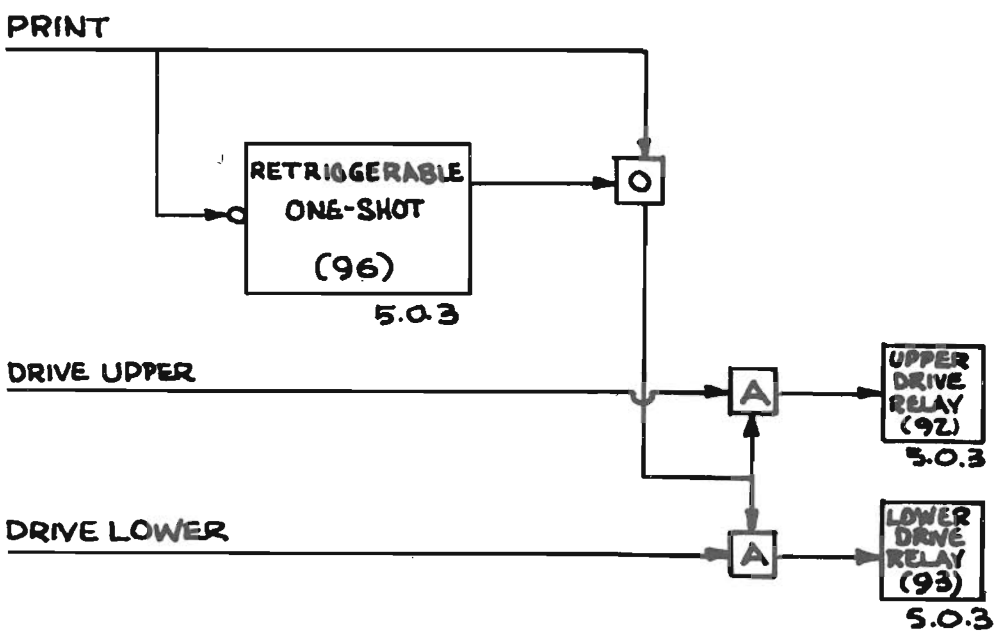
The ribbon drive motors are automatically turned off when printing is not required to conquired to conserve power and prevent ink smudging on the paper when an outward fold is stopped near the typeline. However, the turning off of the ribbon drive motors is delayed to provide continuous ribbonfeed when continuous printing is required.

As shown in Figure 4-56, at the end of each *Print* cycle, the resetting of the Print register (45) triggers a Retriggerable One-Shot (96) which keeps the appropriate Drive Relay (92 or 93) and associated Ribbon Drive Motor turned on for a period of approximately 150 MS.

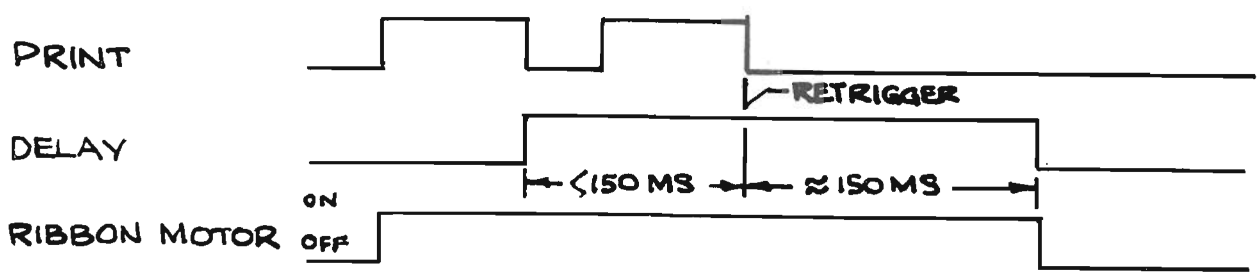
---

(40) Standard DPC ribbons produced after mid-1975 for the Chaintrain Line Printer are provided with translucent fabric leaders instead of "Ribbon End" holes. The translucent leaders serve the same function as the "Ribbon End" holes provided in earlier ribbons.

Should the next *Print* cycle occur before the end of this period, the energized Drive Relay and associated Ribbon Drive Motor will remain turned on and the Retriggerable One-Shot will be retriggered at the termination of the *Print* cycle when the Print register is reset. However, should the Retriggerable One-Shot time out and the Print register remain reset (i.e.; no printing required), the fall of the Retriggerable One-Shot's output will turn off the energized Drive Relay and Ribbon Drive Motor. The appropriate Drive Relay and Ribbon Drive Motor will be turned on again by the set state of the Print register when the next print operation is required (refer to paragraph 4.4.1.2.5 for Initiate Print details).



A. SIMPLIFIED BLOCK DIAGRAM



B. SIGNAL SEQUENCE

Figure 4-56. Simplified Block Diagram, Ribbon Motor Off Delay

NOTES

NOTES

Data Printer Corp

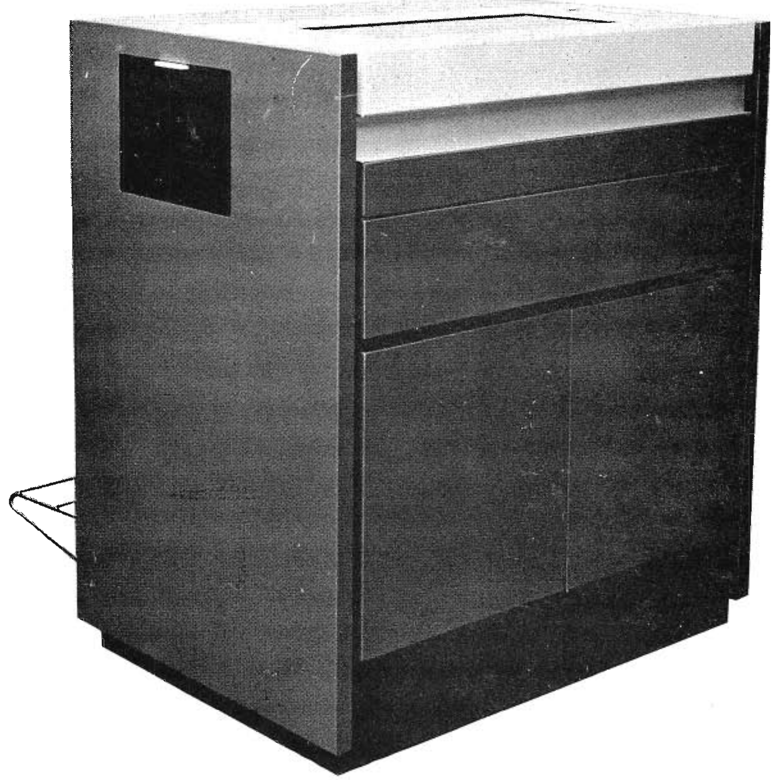
600 MEMORIAL DRIVE
CAMBRIDGE, MASS. 02139

MAINTENANCE INSTRUCTIONS

ChainTrain™

LINE PRINTER

MODELS CT-4964, CT-6644, CT-7484



Data Printer Corp

600 MEMORIAL DRIVE
CAMBRIDGE, MASS. 02139

DPC FORM 600-3

PREFACE

This reference manual is one of four publications that describe the CT-6644 and related Model CHAINTRAIN™ Line Printers manufactured by Data Printer Corp, Cambridge, Massachusetts. This manual covers the installation and maintenance of the CHAINTRAIN Line Printer. For operating instructions, principles of operation, and reference information, refer to the appropriate DPC reference manual listed below.

Principles of Operation, Form No. 600-2
Operating Instructions, Form. No. 600-1
Parts Breakdown & Circuit Diagrams, Form. No. 600-4

Customer specified reproducible copies of this manual are available from Data Printer Corp.

Orders for copies of DPC manuals should be directed to your DPC representative or to DPC at the address indicated below.

A form for readers' comments is provided at the back of this manual. If the form has been removed, comments may be sent to DPC at the address indicated below. Comments become the property of DPC.

DATA PRINTER CORP
600 Memorial Drive, Cambridge, MA 02139

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This manual provides information concerning the installation, maintenance, and adjustment of the CT-6644 and related Models of the DPC CHAINTRAIN Line Printer. Information concerning site planning, unpacking and repacking the printer, and primary power and signal interface cabling is contained in Chapter 2. Chapter 3 contains a recommended preventive maintenance routine and detail procedures for the maintenance and adjustment of the printer.

1.2 REFERENCE MANUALS

In addition to the specific information contained in this manual, a thorough understanding of the mechanical and electronic operation of the line printer, described in *Principles of Operation*, DPC Form No. 600-2, is required to properly maintain the printer.

It is intended that the maintenance procedures provided in this manual be used in conjunction with the *Parts Breakdown & Circuit Diagrams* manual, DPC Form No. 600-4. Each maintenance procedure is referenced to the appropriate Illustrated Parts Breakdown (IPB) figure and Circuit Diagram (CD) figure.

Information concerning operation of the printer, loading forms and installing ribbon, and format tape preparation is contained in *Operating Instructions*, DPC Form No. 600-1.

1.3 SAFETY

Safety cannot be overemphasized. To ensure your own personal safety and to avoid potential damage to the printer, observe all warning and caution labels and precautions at all times. Always check that the printer is connected to the proper primary power and that the printer and associated external equipment are properly grounded.

CHAPTER 2

INSTALLATION GUIDELINES

2.1 INTRODUCTION

This chapter contains information concerning site planning, unpacking and repacking, cabling, accessory installation, and initial power turn-on and testing.

2.2 SITE PLANNING

The overall dimensions of the DPC CT Line Printer with yoke and canopy in their fully opened and normally closed positions, and with the paper shelf installed, are shown in Figure 2-1. Figure 2-2 illustrates the location and size of cable openings and of the recommended service access area. Note that the weight of the complete CT Line Printer is approximately 570 pounds (258,5 kg); accordingly, the flooring must be capable of supporting this load.

For the purpose of estimating room air conditioning requirements, the printer dissipation is rated at 2700 BTU per hour: the normal operating environment is from 40° F to 95° F (4,4° C to 35° C) at relative humidities of from 40% to 80%. Ambient air is drawn into the printer through a filter located at the bottom of the lower rear panel of the cabinet. Accordingly, the rear of the printer should not be enclosed so as to obstruct the flow of ambient air into the printer enclosure.

Primary electrical service (Mains) and signal interface cabling must be consistent with the requirements of the particular unit (see paragraph 2.4, Cabling, for further information).

Doorways and passageways should be somewhat larger than the printer unit to ensure adequate clearance. It should be noted that the shipping container is somewhat larger than the printer itself, requiring correspondingly larger openings and sufficient space for unpacking (see paragraph 2.3).

2.3 UNPACKING/REPACKING

The DPC CHAINTRAIN Line Printer is shipped in a corrugated box which is attached to removable wooden cross-braces and skids at the base of the printer unit (see Figure 2-3). The cross-braces are bolted to the skids that, in turn, are bolted to the base of the printer cabinet.

The shipping container is designed to be easily lifted, intact, over the unit. Sufficient overhead clearance, free of obstructions as lighting fixtures, raceways, etc., should be provided to permit ready removal, or replacement, of the container.

The over-all dimensions of the shipping container are:

Height:	50 Inches (1,27 m)
Width:	43-1/2 Inches (1,10 m)
Depth:	36 Inches (0,91 m)

Only common tools are necessary to unpack, or repack, the printer, namely:

- Pry bar and/or claw hammer
- 11/32-Inch "Spin-Tight" wrench
- 1/2-Inch open-end wrench
- 5/8-Inch wrench
- 3/4-Inch wrench

2.3.1 Unpacking Procedure

To remove the shipping container and skids from the printer unit, proceed as indicated below. In the steps that follow, the numbers enclosed in brackets [ ] refer to Figure 2-3.

(Note – All packing material should be carefully removed and retained for re-use in a future shipment and/or storage of the printer.)

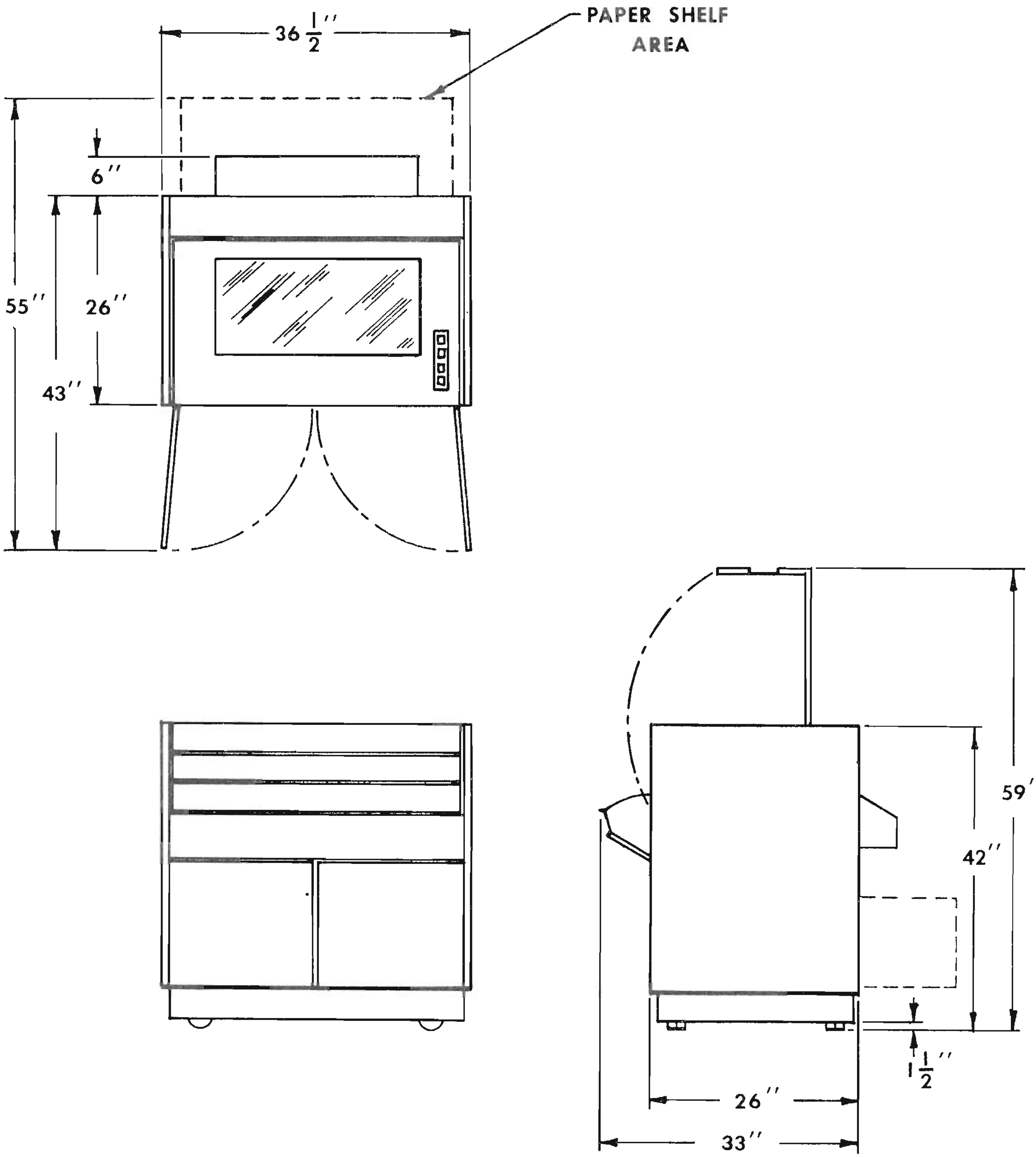

Figure 2–1. Outlines, DPC Chaintrain Line Printer, Models CT–4964, CT–6644, CT–7484

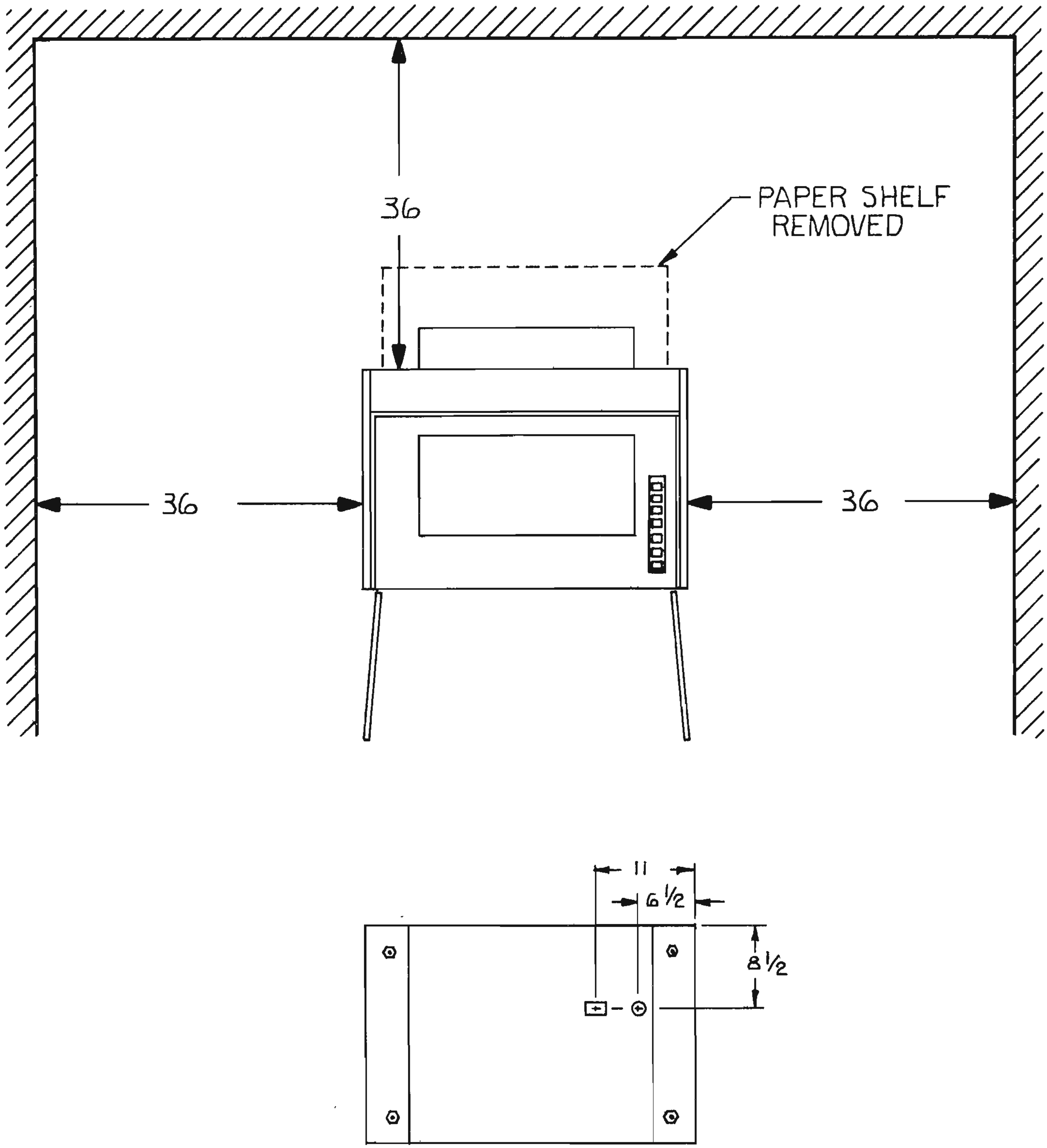

Figure 2–2. Recommended Service Access Area, DPC Chaintrain Line Printer,
Models CT–4964, CT–6644, CT–7484

A. Carefully pry off the four wooden cleats [1] that are nailed to the bottom of the sides of the corrugated box [2] covering the printer unit. Remove the box by lifting it up and over the printer unit.
B. Remove the base skirts [3] and the wire rack [4] from the corrugated canopy cover, and remove the canopy cover [5] from the top of the printer.
C. Open the protective wrapping [6] only at the lower front of the printer to gain access to the front doors. (The printer is wrapped in paper to protect the painted surfaces during handling. This wrapping should be left in place until the printer is positioned in its permanent location.)
D. Remove the glides [7], maintenance manuals [8], hood [9] and any other items packed in the enclosed space behind the front doors.
E. Using a 5/8-inch wrench, remove the hardware securing the front and rear cross braces [10] to the skids [12]. Remove the two cross braces. (Suggestion – To retain the hardware, replace it onto the exposed cross-brace bolts protruding from the skids.)
F. To maneuver the printer off of the skids, raise the printer about 3 inches (about 8 cm) above the floor. If this is done manually, use one of the cross braces as a lever, at either the front or rear of the printer, to lift *one* end of the printer at a time. Use the remaining cross brace to support the unit under the raised skid. Using a 3/4-inch wrench, unscrew the four shipping screws [11] from the underside of the printer and slide the skids out from under the printer.
G. Using a 1/2-inch open-end wrench, install the glides in the shipping screw holes in the base of the printer from the underside of the unit. Adjust the glides to be above the castors if the unit is to be moved about. Carefully lower, **DO NOT DROP**, the printer onto the floor.
H. With the printer in its permanent location, remove the protective wrapping and adjust the glides to support and level the unit.
I. Attach the hood [9] to the upper rear panel at the paper exit opening. Attach the front and rear base skirts [3] to the printer base, then attach the side base skirts [3] to the ends of the front and rear base skirts.
J. Remove the lower rear panel by turning the two quarter-turn fasteners counter-clockwise and lifting the panel upwards, then outwards, to gain access to the electronics bay and power supply. Visually inspect the equipment for damage. Check that each printed-circuit board is in its proper position and is fully seated.
K. Remove the two upper-most power supply mounting screws and carefully swing the power supply down to the open position to gain access to the line cord and strain relief bracket. Uncoil the line cord and stuff it through the opening in the printer base. Mount the strain relief bracket onto the printer base. Replace the power supply and the lower rear panel. Hang the wire rack [4] in the holes provided at the lower rear of the cabinet and plug the wire rack grounding cord into the jack located at the left rear (as viewed from the back of the printer) of the printer base.

CAUTION

BEFORE attempting to apply primary power to the printer, read paragraph 2.4.1.

2.3.2 Repacking Procedure

The original packing material should be re-used when reshipping or storing the printer. To repack the printer, proceed as follows:

A. Remove the ribbon (refer to the *Operating Instructions* manual for detail instructions); disconnect and remove the wire rack; remove the hood; and remove the side base skirts, and then the front and rear base skirts. Disconnect primary power to the printer and remove the lower rear panel and carefully swing the power supply down to the open position to gain access to the line cord and strain relief bracket. Dismount the strain relief bracket from the printer base and draw the line cord into the printer. Coil the line cord and securely tape it to the printer base beneath the power supply. Replace the power supply and lower rear panel.
B. Check for loose hardware and thoroughly clean the unit. Check that the yoke is latched in the closed position; that the canopy, upper left side panel and lower rear panel are closed; and that all removable panels are in place and secured.

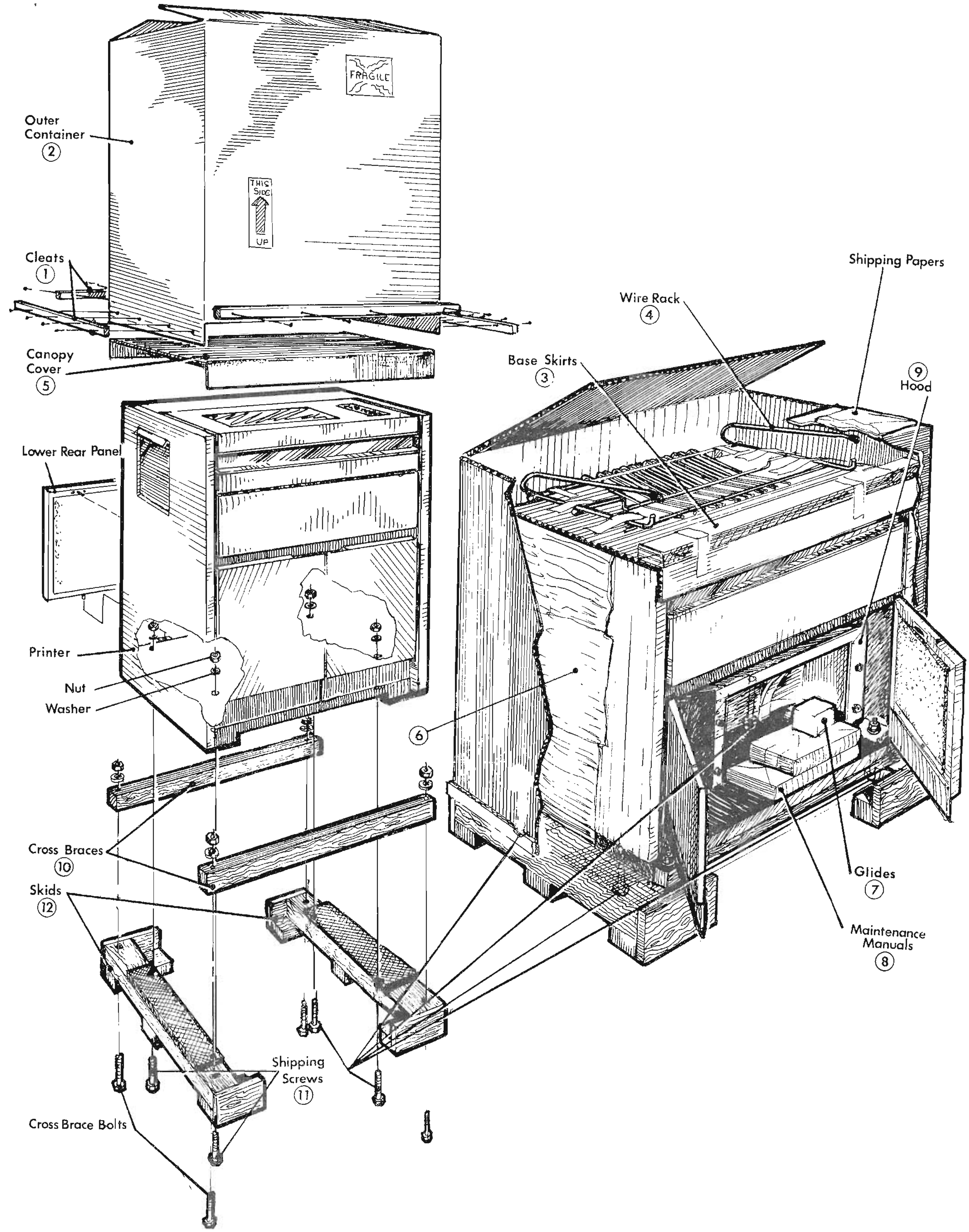

Figure 2–3. Shipping Container Unpacking Instructions, DPC Chaintrain Line Printer, Models CT–4964, CT–6644, CT–7484

C. Maneuver the printer onto the skids by raising the unit about 3 inches (about 8 cm) above the floor. If this is done manually, raise one end at a time using one of the cross braces as a lever, at either the front or rear of the printer. Using a 1/2-inch open-end wrench, remove the glides from the underside of the printer. Slide a skid under the raised end, using the remaining cross brace to support it up against the bottom of the printer base. Using a 3/4-inch wrench, install and tighten two shipping screws to clamp the skid to the printer base. Carefully lower **(DO NOT DROP)** the printer down onto the floor. Repeat the foregoing instructions for the other skid.

D. With the fastening hardware removed from the cross brace bolts, place a cross brace over the bolts protruding from the skids at the front of the printer, and another at the rear of the printer. Place a large fender washer, a standard washer, and a nut on each bolt (four places) and tighten to securely clamp the cross braces to the skids.

E. Box the four glides, and together with the maintenance manuals, hood, and any other material to be packaged in the printer, securely tape to the floor of the enclosed space behind the front doors.

F. Wrap the printer in heavy wrapping paper to protect the painted surfaces during transit; retain the wrapping paper with one-inch (2,54 cm) wide fibre-glass or nylon-reinforced strapping tape, taking care that the tape does not come into contact with any painted surfaces.

G. Place the canopy cover on top of the printer and securely tape the base skirts and the wire rack to the top of the canopy cover (see Figure 2-3).

H. Place the corrugated box over the printer unit. The bottom of the box should fit snugly around the outsides of the skids and cross braces.

I. Close and seal the top flaps of the box using one-inch (2,54 cm) wide fibre-glass or nylon-reinforced strapping tape.

J. Attach a wooden cleat at the bottom of each side of the box and securely nail to the skids and cross braces with 8-d common nails. The cleat location can be determined from the existing holes in the original container.

2.4 CABLING (Refer to Figure 2-2)

2.4.1 Primary Power Cable

The standard printer is supplied with a 6-foot (1,83 m) length of 3/c AWG #18 (including safety), Type SJT power cord with a domestic standard 3-prong plug.

CAUTION

A grounding conductor is required as a part of the branch circuit that supplies power to the printer. Its wire size and insulation shall be identical to that of the grounded and ungrounded branch supply conductors. The color of the conductor insulation is green or green with one (1) or more yellow stripes.

The grounding conductor must be connected to ground at the service equipment.

The branch circuit attachment plug receptacles that are used to supply power to the printer shall be of a grounding type. The grounding conductor serving these receptacles shall be connected to the grounding conductor that serves the printer.

CT-6644 and related model CHAINTRAIN Line Printers are equipped with a universal power supply that is internally strapped for operation with the primary line voltage and line frequency specified at the time of order. The unit can easily be converted to any of the primary voltage and line frequency configurations listed below. (Refer to Chapter 3 for detail conversion instructions.)

100 VAC, 50 Hz	100 VAC, 60 Hz
115 VAC, 50 Hz	115 VAC, 60 Hz
200 VAC, 50 Hz	200 VAC, 60 Hz
230 VAC, 50 Hz	230 VAC, 60 Hz

2.4.2 Signal Interface Cabling

A cable access opening is provided at the base of the printer cabinet (see Figure 2-2) for signal interface cabling. Two (2) cable connectors, which mate with the printer interface connectors, are provided with the printer for attachment to the customer's interface cable (not provided by DPC). The printer interface connectors are accessible upon removing the P.C. card cover at the rear of the paper supply compartment. Note that the interface cable(s) should be no more than 50 feet (15,2 m) long. (Refer to the *Principles of Operation* manual for signal interface specifications, and to paragraph 3.2.5 for signal interface connector details.)

2.5 ACCESSORY INSTALLATION

A wire-form paper shelf is normally shipped in the same container with the printer unit. The shelf should be installed at the lower rear of the printer unit as shown in Figure 2-1. A set of holes is provided in the rear of the cabinet support members to permit adjustment of the paper shelf to best accommodate the forms used. The paper shelf must be grounded to the printer frame by inserting the grounding cord plug into the connector at the left rear (as viewed from the back of the printer unit) of the cabinet base.

2.6 INITIAL POWER TURN-ON AND TEST

CAUTION

BEFORE attempting to apply primary power to the printer, check the service voltage and frequency against the line voltage and frequency ratings of the printer shown on the nameplate located behind the hinged panel at the middle front of the printer. Application of other than the rated voltage and frequency may result in damage to the printer.

With the Main Circuit Breaker, accessible through an opening at the lower left rear of the printer cabinet in the OFF position, apply correct primary power to the printer unit. Place the Main Circuit Breaker in the ON position, the red Power OFF indicator on the front control panel should be illuminated, indicating that primary power is applied.

Install ribbon and paper, and, with the REMOTE/LOCAL switch, accessible through an opening at the lower rear of the printer cabinet, in the LOCAL position, check the control panel and mechanism controls for proper operation. (For set-up procedures and operating instructions, refer to the *Operating Instructions* manual.)

Operate the printer in the LOCAL, internal test mode. Check for proper character printout, line-spacing, and multiple-line paper-feeding. Prepare and install a test format tape-loop, having readily discernable programs in all channels, and check for proper paper-skipping operation. Check for proper operation of the yoke and the yoke latch lever interlocks, and of the paper low and paper out alarms.

Set the Test Data Bit switches on the test panel to print a full-highth character (as the numeral "0" or the upper-case letter "E"). Inspect the printout for clipping at either the tops or bottoms of the characters to check if the yoke and chaintrain have shifted during transit. If clipping is apparent, the condition should be corrected as described in paragraph 3.5.1.5.

Check that the chaintrain is being properly lubricated and that the lubricant bottle, located on the printer yoke, just below the chaintrain and to the left of the ribbon edge sensors, is full.

CHAPTER 3

MAINTENANCE PROCEDURES

3.1 INTRODUCTION

This chapter provides information concerning the maintenance and adjustment of the Data Printer Corp CHAINTRAIN Line Printer. Machine locations and numbering are provided in paragraph 3.2; commercially-available and special tools, and the necessary shims, required to properly maintain the line printer are listed in paragraph 3.3; paragraph 3.4 provides a recommended preventive maintenance routine; alignment and adjustment procedures are detailed in paragraph 3.5; replacement procedures are described in paragraph 3.6; and important conversion procedures are described in paragraph 3.7. In addition to the specific information contained in this chapter, a thorough understanding of the principles of operation discussed in the *Principles of Operations* manual is required to properly maintain the printer.

Safety cannot be overemphasized. To ensure your own personal safety and to avoid potential damage to the printer, observe all warning and caution labels and precautions at all times. Always check that the printer and any test equipment are properly grounded. The Main Power circuit breaker, located at the lower right rear of the printer enclosure, disconnects primary power to the printer except to the line filter which is located within the power supply unit itself. Always keep hands and clothing away from all moving parts (chaintrain, belts, timing discs, etc.) while the printer is operating. Always check that the maintenance override on the Yoke Closed interlock switch is reset before restoring the printer to normal service.

CAUTION

DO NOT operate the printer for extended periods with the yoke closed and with no paper and no ribbon installed otherwise damage to the printing mechanism may result. When printing with no paper is required to align the mechanism, operation should be limited to the minimum necessary to perform the adjustment. When operating in the LOCAL mode, always check that there is an adequate supply of paper in the printer before leaving the unit unattended. (In the LOCAL mode the Paper Low and Paper Out alarms, which normally stop printer operation automatically when paper runs out, are disabled to facilitate maintenance procedures.)

In the descriptions and procedures that follow, Illustrated Parts Breakdown and Circuit Diagram figure references refer to the appropriate "Parts Breakdown & Circuit Diagrams" manual for the model CHAINTRAIN line printer under consideration.

3.2 MACHINE LOCATIONS AND NUMBERING

This section provides information concerning the identification of internal printer cabling and chassis, the identification of printed-circuit board (PCB) connectors and pins, hammer actuator and actuator connection locations, machine nameplate locations, major subassembly serial number information, interface connector pin assignments, and the location and types of fuses in the printer.

3.2.1 Cable and Chassis Identification

The internal printer cabling is graphically depicted in Circuit Diagram 13.0.1; "Chaintrain Interconnecting Wiring Diagram". Generally, interconnecting cables are identified according to the device or group of devices to which they are connected.

Electrical devices and connectors are identified by a letter prefix that indicates the type of device, and a three digit number that identifies the particular part according to location, as follows:

Prefix:	*Type of Device:*
A	Photoelectric (IR) Sensor
B	Motor
I	Indicator
J	Jack
L	Coil
P	Plug
RP	Reluctance Pickup
S	Switch
SB	Static Bar
S/I	Switch/Indicator
T	Transformer
TB	Terminal Block

Number:	*Location (Chassis):*
1XX	Printer Mechanism, including yoke and front control panel.
2XX	Logic Electronic Bay, including printer interface.
3XX	Power Supply.
4XX	Power Sequencer.

For example: As shown in Circuit Diagram Figure 13.0.1, the designator "TB 401" refers to Terminal Block 1 on the Power Sequencer.

The internal power interconnections between the Power Supply, Power Sequencer, and Logic Electronics Bay are indicated in Circuit Diagrams Figures 12.0.1, "Primary AC Power Distribution Diagram", and 11.0.1, "Power Supply Schematic Diagram".

3.2.2 PCB Connector and Pin Identification

Printed-circuit boards (PCB's) are arranged on the printer according to function as indicated in the paragraphs that follow.

3.2.2.1 Ribbon Motor Control Card (Reference IPB Figure 85 and CD Figure 9.0.1)

The Ribbon Motor Control card is located at the left end of the printer yoke assembly (chassis 100), adjacent to the upper and lower ribbon drive motors and clutches. Connections are made to this card at solder eyelets arranged about its periphery. The eyelets are identified by alphanumeric designators, as A1, A2, B1, etc., from top-to-bottom, right-to-left.

WARNING

TURN OFF the Main circuit breaker before removing the protective panel and attempting to service the Ribbon Motor Control card. Primary AC power exists at several points on this card.

3.2.2.2 Logic Electronics Bay (Chassis 200) (Reference IPB Figures 20 and 83)

All logic PCB's plug into connectors (sockets) in a mother-board/daughter board arrangement. The edge connectors into which the logic-circuit boards insert are arranged in two (2) rows of up to 15 locations each (connectors are provided as required for each logic-circuit board). As viewed from the wiring side, the upper row of connectors is designated "A" and the lower row is designated "B". The connector (and logic-card) locations are numbered from 1 to 15, from right-to-left[1]. Each edge connector has a total of 44 contacts arranged in two columns. The wire-wrap terminals of these contacts pass through holes in the mother board to the wiring side. These terminals are numbered 1 - 14 in post office fashion from left-to-right and top-to-bottom on the wiring side as shown in Figure 3-1.

(1) In the standard line printer, positions 1 and 2 are unused.

These mother-board connector terminals are identified by a numeric-alphanumeric designator, as 4A8 ((-) Printer Ready), which indicates the location, connector row and connector terminal, respectively. (Note — On the Logic Diagrams, CD Figures 1.0.1 through 8.0.1, only the connector row and connector terminal are shown for each signal line, as A8; the logic card location in the Logic Electronics Bay is indicated at the lower right corner of each logic diagram.)

All interconnecting signal lines to/from the mother board plug onto double-sided tab connections at the bottom edge of the mother board. Attachment to the mother board is made by means of four (4) plugs, P209 through P212, arranged from left-to-right, respectively. Each plug has a total of 34 pin positions arranged in two rows. These pins are lettered, A-U except G, I, O and Q, from left-to-right on the wiring side and are numbered, 1-17, from right-to-left on the card side of the mother board (i.e.; pin 1 is opposite pin A, pin 2 is opposite pin B, etc.). The pins of these plugs are individually removable, by means of a pin extraction tool (AMP 91073-1), to facilitate maintenance and/or replacement. Figure 3-2 shows the pin designations for the tab connections and plugs.

All connections to the print-hammer actuators are made to double-sided tab connections to the top edge of the mother board (see paragraph 3.2.4).

3.2.2.3 Sequencer PCB (Chassis 400) (Reference IPB Figures 80 and 82, and CD Figures 10.0.1 and 10.0.2)

The Sequencer PCB is mounted on the Power Supply (chassis 300) as shown in IPB Figure 80. All wiring connections to the Sequencer PCB are made at screw terminals arranged on two barrier-type terminal blocks labeled TB 1 (TB 401) and TB 2 (TB 402). As shown in IPB Figure 82, these terminals are designated from left-to-right, from 1 thru 20 on TB 1, and from 1 thru 8 on TB 2. A toroidal coil L401, which is connected to TB 401-15 and TB 401-16, is physically located behind (towards the Power Supply) the Sequencer PCB and is arranged about the +40 VDC Hammer Actuator/Driver supply lead from the Power Supply. This coil must be disconnected before the Sequencer PCB can be removed.

WARNING

Primary and secondary AC Voltages exist at certain terminals and at several places on the sequencer PCB. Use caution when performing maintenance checks on or in the area of this board; always turn OFF the Main circuit breaker before attempting to service or remove the Sequencer PCB.

CAUTION

Certain IC packs on the Sequencer PCB are electrically referenced to AC Neutral instead of DC Return; refer to the Logic Diagram, CD Figures 10.0.1 and 10.0.2, for details.

3.2.2.4 Alarm Panel PCB (Reference IPB Figure 86 and CD Figure 13.0.1)[2]

The Alarm Panel PCB is mounted to the underside of the Front Control Panel. All wiring connections to the Alarm Panel PCB are made at solder eyelets arranged at one end of the board. The eyelets are readily identified with their corresponding alarm indicator LED's.

3.2.3. Universal Power Supply (Chassis 300) (Reference IPB Figures 80 and 81, and CD Figure 11.0.1)

The Universal Power Supply (P/N D 10515) is provided in a single configuration with appropriate fusing and internal strapping for operation with the primary line voltage and frequency specified at the time of order (refer to the Logic Diagram, CD Figure 11.0.1, for details).

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(2) Provided on cabinet configuration CT-6644 and related model CT Line Printers only.

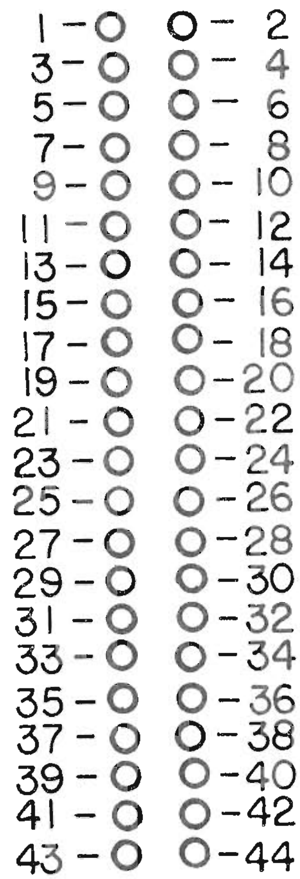

Figure 3-1. PCB Edge Connector Terminal Designations
(Wiring Side)

Figure 3-2. Double-Sided Tab Plug Pin Designations
(Wiring Side)

CAUTION

> Application of primary input power having other than the voltage and frequency indicated on the label attached to the Universal Power Supply may result in damage to the printer unit. For fusing and strapping information for other line voltages and frequencies, refer to paragraph 3.7 of this manual.

Except for the 40 VDC Hammer Actuator/Driver supply leads to the Logic Electronics Bay, power output and control leads connect to the Power Supply at screw terminals arranged on a single barrier-type terminal block labeled TB 1 (TB 301) located at the lower rear of the chassis (see IPB Figure 81). The +40 VDC (white) and the 40 VDC Return (black) Hammer Actuator/Driver supply leads connect to bolt terminals on the bus bars labeled "+" and "-" "40 VDC OUTPUT", respectively, at the lower center of the chassis. The bus bars are accessible upon removing the Sequencer PCB (see IPB Figure 80). (Note — The +40 VDC Hammer Actuator/Driver supply lead passes thru the center of a toroidal coil L401, which is connected to TB 401 of the Sequencer PCB. The toroidal coil must be disconnected before the Sequencer PCB can be removed.) All power connections to the Logic Electronics Bay (chassis 200) are soldered directly to the p-c motherboard of the electronics bay.

All internal strapping connections for the required primary line voltage and frequency are accomplished at a separate terminal block TB 2 (TB 302), located at the lower left of the chassis, and a pluggable connector, P1/J1 (60-Hz) or J2 (50-Hz), located at the upper center of the chassis, as shown in IPB Figure 81.

WARNING

> Primary AC Voltage exists at certain terminals and at several places on the Power Supply. Use caution when performing maintenance checks on or in the area of this chassis: always disconnect the *line cord* to the printer before attempting to service or remove the Power Supply.

3.2.4 Hammer Actuators

3.2.4.1 Actuator Locations (Reference IPB Figure 55)

One (1) Hammer Actuator is provided for each Print Hammer (i.e.; each print position, or column, in the typeline). As shown in Figure 3-3, the 132 (136 optional) actuators are arranged in four (4) rows of 33 (34 optional) actuators each. The actuators are configured in "Straight" and "Offset" configurations to interlace in a four-way pattern in order to accommodate the necessary geometry of the electromagnetic coils. As indicated in IPB Figure 55, the two outermost rows (top and bottom rows) consist of "Straight" actuators and the two inner-most rows (upper and lower middle rows) consist of "Offset" actuators. As shown in Figure 3-3, the actuators in each row correspond with every fourth print hammer, and each row of actuators corresponds to a Phase Scan as shown below:

ACTUATOR ROW Location/Configuration	PHASE SCAN	PRINT HAMMERS (Columns)
Top/Straight	1	1, 5, 9, . . . 129, (133)[3]
Upper Middle/Offset	3	3, 7, 11, . . . 131, (135)
Lower Middle/Offset	4	4, 8, 12, . . . 132, (136)
Bottom/Straight	2	2, 6, 10, . . . 130

(3) Optional feature, provided as required.

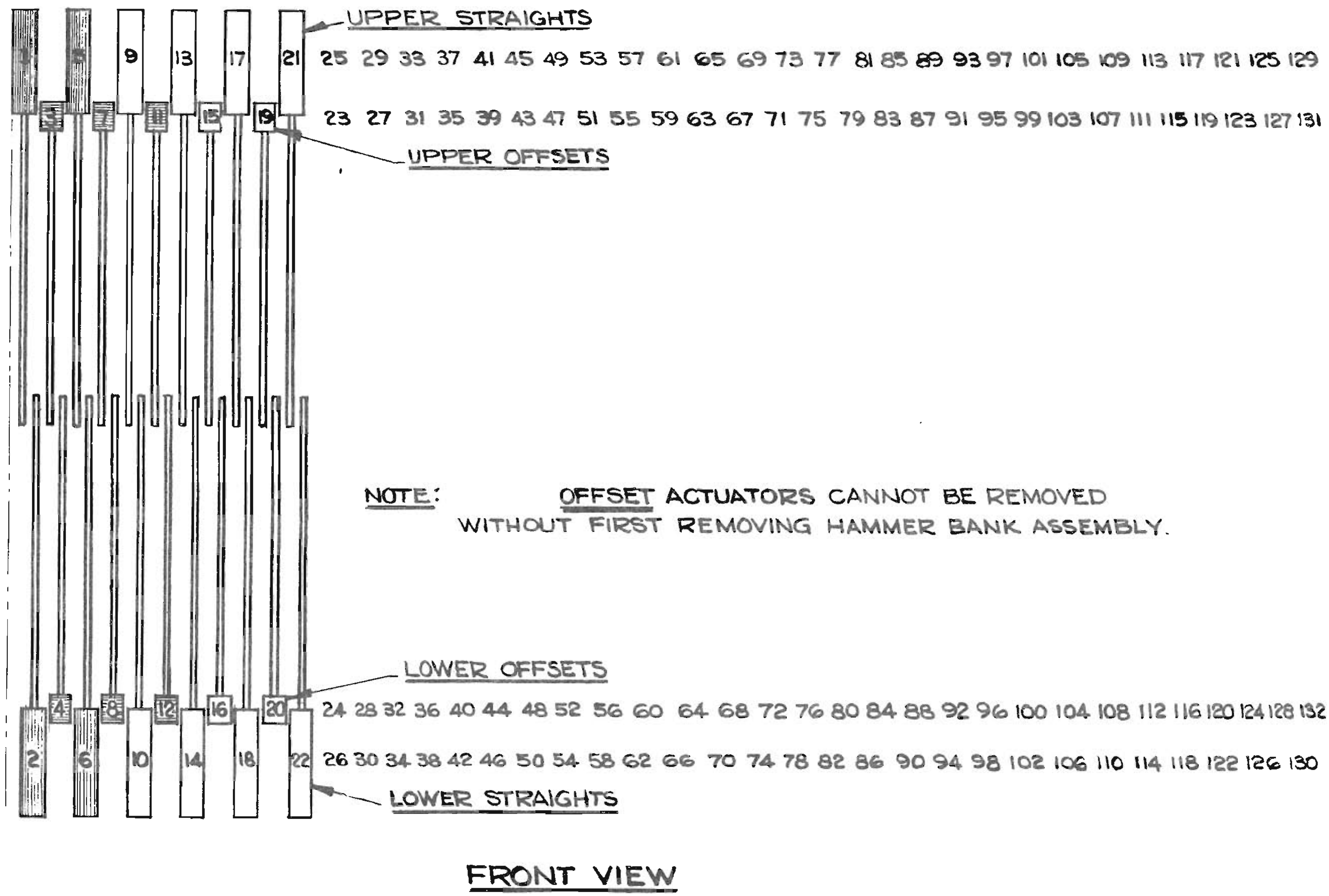

Figure 3-3. Hammer Actuator Locations, Front View

3.2.4.2 Actuator Wiring (Reference IPB Figures 55 and 83, and CD Figure 8.0.1)

The leads from the Hammer actuators connect to double-sided tabs at the top edge of the Logic Electronics Bay (chassis 200) p-c motherboard (see IPB Figure 83). Connection to the motherboard is made by means of eight (8) plugs, P201 thru P208, arranged from left-to-right (card insertion side view). Each of these connectors is associated with a Hammer Driver PCB in positions 7 thru 14, respectively. (Note — There are two Hammer Driver PCB's for each Phase Scan.) The Hammer Actuator leads are organized on the plug connectors according to actuator location (i.e.; Phase Scan) and associated Hammer Driver PCB as shown in CD Figure 8.0.1 and as indicated by the card cage label, as follows:

PLUG	HD PCB (Pos.)	HAMMER ACTUATORS Location[4]	Print Positions (Columns)
P201	7	Top Left	69, 73, 77, . . . 129, (133)[3]
P202	8	Bottom Left	70, 74, 78, . . . 130, (134)
P203	9	Upper Mid Left	71, 75, 79, . . . 131, (135)
P204	10	Lower Mid Left	72, 76, 80, . . . 132, (136)
P205	11	Top Right	1, 5, 9, . . . 65
P206	12	Bottom Right	2, 6, 10, . . . 66
P207	13	Upper Mid Right	3, 7, 11, . . . 67
P208	14	Lower Mid Right	4, 8, 12, . . . 68

Each hammer actuator cable plug has a total of 34 pin positions arranged in two rows. The pins are lettered A thru U, except G, I, O and Q, from right-to-left on the wiring side of the motherboard, and are numbered 1 thru 17 from left-to-right on the card insertion side of the motherboard (i.e.; Pin A is opposite Pin 1, Pin B is opposite Pin 2, etc., as shown in Figure 3-2). The pins on these plugs are easily removable by means of a pin extraction tool (AMP 91073-1).

The Hammer Actuator coil leads are color-coded for proper magnetic polarity. The pins must be inserted into the appropriate plug with the blue lead from a Hammer Actuator in a numbered pin position and the associated white lead in the opposing lettered pin position.

3.2.5 Printer Interface Connections

3.2.5.1 Standard Printer Interface Connectors (Reference IPB Figures 20 and 83)

All input and output signal connections to the interface of the standard CHAINTRAIN line Printer are made at two (2) connectors (jacks) labeled J221 (lower) and J222 (upper) at the right side of the Logic Electronics Bay (chassis 200) as viewed from the wiring side (see IPB Figures 20 and 83). Each jack consists of an Amphenol 17-20250-1, or equivalent, connector having 25 female pins, numbered 1 thru 25, arranged in two rows as shown in Figure 3-4. The pins of these connectors are easily removable by means of a pin extraction tool and are easily insertable by means of a pin insertion tool (see paragraph 3.3).

Each printer unit is provided with two (2) matching 25-pin male plug connector assemblies for customer-attachment to the interconnecting interface cable (customer supplied) as follows:

A. Connector; Amphenol 17-10250-1 or equivalent.
B. Hood; Amphenol 17-312-01 or equivalent.
C. Latching Assembly; Amphenol 17-529 or equivalent.

The pins of the matching plug are easily removed by means of a male pin removal tool and are easily inserted by means of the proper pin insertion tool (see paragraph 3.3 for tool listing).

3.2.5.2 Interface Connector Pin Assignments (Reference CD Figures 1.0.1, 1.0.2, 1.0.4, 1.0.5, 1.0.7, 2.0.2 and 2.0.3)

All standard printer interface connector pin assignments, including those associated with the optional First-Character Interface Configuration and all standard options, are listed in Table 3-1. For interface signal definitions and electrical characteristics, refer to the *Principles of Operation* manual.

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(4) As viewed from rear of printer.

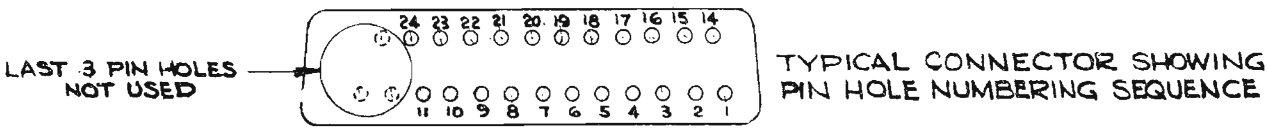


Figure 3-4. Printer Interface Connector Pin Layout
(Jack Wiring Side)

3.2.6 Logic Electronics PCB's (Reference IPB Figures 74 thru 79, and CD Figures 1.0.1 thru 7.0.2)

All standard Logic Electronics printed-circuit boards, including those associated with all standard options, are listed according to Logic Bay position in Table 3-2. Note that a H.S. ROM Print Control PCB is used in logic bay position 5. Whenever code conversion is required, the specific code-character correspondency is determined by the particular chain arrangement and the read-only-memory (ROM) used (see Table 3-3). Whenever a PCB is replaced, all related adjustments should be checked and reset as required. Each PCB type is uniquely keyed to prevent insertion into the incorrect Logic Bay position.

3.2.7 Chaintrain Drive Motor and Cable Assembly (Reference IPB Figure 62 and CD Figure 13.0.1)

One (1) type of Chaintrain Drive Motor (B101) and Cable Assembly is used on all standard CT-6644 and related model CT Line Printers regardless of the input power configuration. Operation with different input power voltages is achieved by means of internal power wiring strapping on the Universal Power Supply. A two-position motor pulley provides for operation with either 60-Hz or 50-Hz input power when used with the appropriate drive belt as indicated in Table 3-4.

TABLE 3-1. INTERFACE CONNECTOR PIN ASSIGNMENTS (Standard)

Connector P221		Connector P222	
PIN NO.	SIGNAL	PIN NO.	SIGNAL
1	Run	1	*Auto Linefeed
14	Return	14	Return
2	Printer Ready	2	**Bus P/Bus 8
15	Return	15	Return
3	***Parity Error	3	*Paperfeed Command
16	Return	16	Return
4	Send Data	4	Print Command
17	Return	17	Return
5	$\overline{\text{Run}}$	5	Data Strobe
18	Return	18	Return
6	Return	6	Bus 1
19	****$\overline{\text{VFU Ch 8/Ch 12}}$	19	Return
7	Return	7	Bus 2
20	$\overline{\text{Line Strobe}}$	20	Return
8	Return	8	Bus 3
21	$\overline{\text{VFU Ch 1}}$	21	Return
9	***Clear	9	Bus 4
22	Return	22	Return
10	*Double Space	10	Bus 5
23	Return	23	Return
11	Return	11	Bus 6
24	$\overline{\text{VFU Ch 2}}$	24	Return
12	Paper Low	12	Bus 7
25	Return	25	Return

NOTES:
* Not used on First-Character Interface configuration.
** Used for Input Parity bit or for 8th data bit (options).
*** Used only for Input Parity Checking option.
**** Last channel of VFU provided.
All unused signal lines should be returned to their respective returns or to d-c ground.

TABLE 3-2. LOGIC ELECTRONICS PRINTED-CIRCUIT BOARDS (Standard)

Logic Bay Pos.	Description	Options					Part Number
		ODD Parity	EVEN Parity	136 Col.	8-Bit Data	ROM	
3	Paperfeed Control						D12006
4	Character Storage & Control						D12004
		X					D12004G3
			X				D12004G3
				X			D12004G4
					X		TBD
		X		X			D12004G5
			X	X			D12004G5
				X	X		TBD
5	H.S. ROM Print Control						D12036 (1)
						X	D12036G2 (2)
6	H.S. Print Timing Generator						D12028
7-14	H.S. Hammer Driver						D12026
15	Paper/Ribbon Control						D12012

NOTES: (1) For use with contiguous, binary-sequential coded (ASCII) chaintrain only.
(2) ROM identification required for proper code-character conversion (see Table 3-3).

TABLE 3-3. PROGRAMMED READ-ONLY-MEMORIES (Standard)

ROM P/N*	ROM FIELD	Input Code**	Chaintrain Arrangement**
12556	A	EBCDIC	48 LC
	B	EBCDIC	48 AN
		EBCDIC	48 HN
12553	A	EBCDIC	64 USASCII***

NOTES: * For use on ROM Print Control PCB D 12036.
** For coding and character set details, refer to *Principles of Operation* manual.
*** Provides EBCDI-Code conversion for all graphics except [,], \ and ^ .

TABLE 3-4. CHAINTRAIN DRIVE MOTOR AND CABLE ASSEMBLIES (Standard)

Motor & Cable Assy	Power Supply	Line Voltage	Line Frequency	Chaintrain Drive Belt
B15531 G3	Universal D10515	100, 115, 200, 230	60 Hz	Gates 3M335
			50 Hz	Gates 3M345

3.2.8 Fuse Location, Type and Rating (Reference IPB Figure 81, and CD Figure 11.0.1)

All fuses used in the CHAINTRAIN Line Printer are located on the power supply (chassis 300) at the lower rear of the printer. As shown in IPB Figure 81, the fuse holders are arranged in a single row at the lower portion of the power supply panel and are designated F 1 thru F 7 from right-to-left (as viewed from the rear of the printer). The type and rating of the fuses depend upon the primary a-c line voltage as indicated in Table 3-5, below.

TABLE 3-5. FUSE TYPE AND RATING

Fuse	Power Supply:	Universal	
	DPC Part:	D10515	
	Primary AC:	115 VAC	230 VAC
1		MDA, 15A	MDA, 7A
2		MDA, 10A	
3		AGC, 1.5A	
4			
5		ABC, 12A	
6		MDA, 5A	
7		AGC, 4A	

3.2.9 Machine Nameplate Location (CT-6644 and Related Models) (Reference IPB figure 3)

Two nameplates are affixed to each printer on the front yoke cover which is accessible upon opening the hinged front panel. The right nameplate lists the printer model number and the unit serial number of the machine. The left nameplate indicates the NFPA type and the voltage, frequency and power (KVA) ratings for the primary a-c power input to the unit. (NOTE — The voltage and frequency ratings are also indicated for the primary a-c power input to the unit on the panel of the power supply (chassis 300) at the lower left rear of the printer behind the lower rear panel. The information on both the power supply label and on the left nameplate must agree: in the event of field conversion, both of these labels must be changed as appropriate (see paragraph 3.7 for conversion details).)

CAUTION

Application of input power having other than the voltage and frequency indicated by the machine nameplate and the power supply label may result in damage to the unit.

3.2.10 Major Subassembly Serial Numbers

Major subassemblies are serial numbered as described in the paragraphs that follow.

3.2.10.1 Mechanism

The mechanism serial number is marked on the outside of the left sideplate below the vertical format unit.

3.2.10.2 Console

The console serial number is affixed on the outside of the rear frame over the power supply.

3.2.10.3 Electronics Bay

The electronics bay serial number is marked on the decal at the top left of the assembly.

3.2.10.4 Power Supply

The power supply serial number is located on the manufacturer's label at the lower portion of the power supply panel.

3.2.10.5 Printed-Circuit Boards

All printed-circuit boards are stamped on the face side with either the date of manufacture or a control number.

3.3 RECOMMENDED TOOLS

The tools listed below are recommended for use in maintaining the printer. Most of these tools are commercially available. Special tools that are custom-designed for proper adjustment of the printer are available from Data Printer Corp.

3.3.1 Commercially-Available Tools

Allen Hex Key — 1/16 inch
Allen Hex Key — 5/64 inch
Allen Hex Key — 3/32 inch
Allen Hex Key — 7/64 inch
Allen Hex Key — 9/64 inch
Allen Hex Key — 1/4 inch
Lug Crimping Tool — AMP 902721
Lug Crimping Tool — Amphenol 357-100
Lug Crimping Tool — ETC Inc. HT-910
Lug Crimping Tool — Shure STAKE WT-145A
Open-end Wrench — 5/16 inch
Open-end Wrench — 3/8 inch
Open-end Wrench — 7/16 inch
Open-end Wrench — 9/16 inch
Pin Extraction Tool — AMP 91073-1
Pin Insertion/Removal Tool consisting of:
  a. Handle — Amphenol 364-200
  b. Insertion Bit — Amphenol 356-400-1
  c. Removal Bit, Female — Amphenol 356-400-5
  d. Removal Bit, Male — Amphenol 356-400-6
Pliers, Needle-nose — Utica 755U or equivalent
Potentiometer Adjustment Tool
Push-Pull Scale, 0-15 lb, 4 oz/division — Chatillon Scale LP-15
Push-Pull Scale, 2 lb x 1/2-oz/division and 1 kg x 10 grams/division — Chatillon Scale 516-1000
Screwdriver — 1/4 x 4 inch
Screwdriver — 3/8 x 6 inch
Screwdriver — 5/16 x 8 inch
Spin-Tight Hex Wrench — 5/16 inch
Spin-Tight Hex Wrench — 1/2 inch
Steel Pocket Scale, 6 inch

3.3.2 Special Tools

Actuator Forming Tool (3-prong pliers) — DPC B9033
Extender PCB — DPC D12018
Feeler Gauge Set (Shim stock) — DPC A19004
Tractor Gap Gauge — DPC A19000
Tractor Pin Alignment Gauge — DPC A9110
Type Slug Loading Rail — DPC A19001
Type Slug Pliers (Step) — DPC A 19002
Type Slug Pliers — DPC A19003

3.3.3 Shims

0.005 inch thick x 0.188 inch I.D. — DPC A31012-001
0.005 inch thick x 0.380 inch I.D. — DPC A4511
0.005 inch thick x 0.505 inch I.D. — DPC A31011-001
0.005 inch thick x 0.600 inch I.D. — DPC A14080
0.005 inch thick x 0.725 inch I.D. — DPC A14022-3
0.010 inch thick x 0.390 inch I.D. — DPC A6140
0.010 inch thick x 0.715 inch I.D. — DPC A14022-2
0.030 inch thick x 0.505 inch I.D. — DPC A31011-002

3.3.4 Oscilloscope

Tektronix Model 465 or equivalent

3.4 PREVENTIVE MAINTENANCE GUIDELINES

This section provides a recommended schedule of preventive maintenance (PM) tasks which should be considered as a flexible guide subject to modification to accommodate the conditions of each installation. Unless a PM operation reduces downtime, it is unnecessary. When the printer is operated under extreme environmental conditions, dusty or chemical atmospheres, and/or in excess of forty (40) hours per weekly interval, the frequency of performing PM operations should be increased accordingly.

The basic steps of PM for the printer are cleaning, lubricating and checking as indicated in Table 3-6. Lubrication should be applied only in the quantity necessary to supply the immediate area involved. Always wipe off any excess lubricant. On the CHAINTRAIN Line Printer, keep lubricants away from:

The ribbon,
the paper path,
grommets,
the hammer actuators,
the print hammers,
all drive belts,
timing and ribbon sensors,
wiring, and
all electrical components.

Be visually alert for trouble indications whenever the printer is being serviced. Look for loose wires and pins, need for lubrication, badly worn parts, overheated components, loose hardware, chafed cables, dirt and corrosion. Do only the scheduled PM on a unit that is operating satisfactorily.

Pulse checking is the basic tool in the maintenance of electronic circuits. Do not adjust pulses unless the condition of the machine warrants it.

3.5 ALIGNMENT AND ADJUSTMENT PROCEDURES

This section provides the alignment and adjustment procedures which must be followed to ensure proper operation of the Data Printer Corp CHAINTRAIN Line Printer. The procedures are arranged according to basic functional system (i.e.; Print, Paperfeed and Ribbonfeed) with related mechanical and electrical alignments and adjustments arranged in their normal order of precedence. Hence, for a given set of procedures, the final adjustment appears last and, accordingly, each procedure assumes that all related adjustments appearing ahead of it will have already been completed. The descriptions assume that the reader is familiar with the location and operation of the printer mechanisms and electronics.

It is intended that the procedures be used in conjunction with the "Parts Breakdown & Circuit Diagrams" manual for the particular model printer under consideration. To facilitate reference, all procedures are referenced to the appropriate IPB and CD figures of that manual.

Access to the printer mechanisms and electronics requires the removal of certain panels depending upon the location of the part(s) to be adjusted (refer to IPB Figure 1 for details). The descriptions assume adequate access will have already been provided.

WARNING

Except when specifically required otherwise, always disconnect primary a-c input power (line cord) to the printer before attempting to perform any alignment or adjustment procedure.

TABLE 3-6. RECOMMENDED PREVENTIVE MAINTENANCE ROUTINE

FREQUENCY	LOCATION	CLEAN	LUBRICATE	CHECK
Each ribbon change	Printer Yoke	Using soft, lint-free cloth, or hand cloths (2), clean both upper & lower ribbon sensors.		
Weekly	Print Area	Vacuum paper dust from platens and paper tractors.		
	Static Eliminator	Use a soft brush and clean foreign matter from static bar (1).		Check the operation of each needle point on the static eliminator.
Monthly	Chaintrain	Clean the type faces with a soft wire brush and vacuum cleaner.		
Quarterly	Lower Rear Panel	Inspect air filter and clean as required.		
	Printer Yoke		Check and replace chain-train lubricant with DPC B 15020 as required	Check the chain drive belt for proper tension. Check the Index Strobe and Character Strobe generators for proper output. Check the paper drag fingers for 260 ± 20 grams paper tension.
	Logic Electronics			Check the hammer "Fire" pulses for 1.4 Volt amplitude and 1.35 MS duration at TP 1 of each Hammer Driver PCB.
	Print Hammer and Actuator bank			Print full line of M's and check phasing adjustment and phase scan timing. Check for proper flight timing of each hammer.

TABLE 3-6. RECOMMENDED PREVENTIVE MAINTENANCE ROUTINE (Continued)

FREQUENCY	LOCATION	CLEAN	LUBRICATE	CHECK
Semi-Annually	Paperfeed Strobe Gen's	Clean the line feed strobe sensors.		Check for proper output from the 6-LPI or 1/2-Inch Strobe Generator.
	Logic Electronics and Stepping Motor			Check stepping motor drive for 0.8 V amplitude and 1.0 MS stepping interval at TP 2 of the Paper / Ribbon PCB. Check that delayed step timing pulses occur in successive intervals of 1.5, 2.0 and 3.0 MS when stopping paperfeed. Check paperfeed operation by making a "pencil scope" and readjust as required.
	Vertical Format Unit			With a properly prepared format tape-loop check the output from VFU Channel 1 for proper alignment with "Gated 1/2-Inch Strobe" at 6-LPI, and at 8-LPI if provided.
	Sequencer			Check the crowbar circuit for proper operation while simulating a Hammer Drive overcurrent condition.
	Enclosure			Check that all fans are operating.
Annually	Tractor drive		Grease Infinite Form Position control clutch release lever/thrust washer (3).	Check paperfeed drive belt for proper tension.
	Vertical Format Unit		Light oil VFU holdown pivot pin.	
	Printer Mechanism	Vacuum clean area as required	Light oil Impression Control slide and linkage. Grease yoke latch linkage and pins (3). Light oil yoke latch compression spring and lever pivot.	Check for loose fasteners, frayed wire insulation, worn sleeving and excessively worn parts. Check chaintrain for damaged type slugs and type faces.

TABLE 3-6. RECOMMENDED PREVENTIVE MAINTENANCE ROUTINE (Concluded)

FREQUENCY	LOCATION	CLEAN	LUBRICATE	CHECK
Annually	Printer Mechanism		Light oil spring-loaded ribbon roll idler rods. Lightly grease formscale pivot pins and spring anchor pins (3). Light oil ribbon cover hinges; wipe off excess.	Check chaintrain for proper fit in guides.
	Enclosure	Clean all exterior surfaces.	Lubriplate canopy stop link/nylon washers. Light oil canopy hinges.	Check canopy stop linkage for proper, safe operation.
	Enclosure	Clean paper supply compartment	Light oil front door hinges and front yoke skirt hinges	

NOTES:
(1) Built-up deposits can be removed by pressing a soft pencil eraser on each needle point in turn and slightly twisting. Ink and resistant coating, if any, can be removed by wiping the needle points with Renuzit (CAUTION – Other commercial cleaning solutions might damage the plastic parts of the static eliminator).
(2) Provided with DPC ribbons.
(3) Use general purpose Auto-Moly grease only.

Periodic PM operations are to be repeated in each successive PM interval. Hence, weekly operations are to be repeated during the monthly PM operation; monthly operations are to be repeated during the quarterly PM operation; etc.

3.5.1 Print System Adjustments

3.5.1.1 Yoke Latch/Interlock Switch Adjustments

3.5.1.1.1 Yoke Latch Switch Adjustment (Reference IPB Figure 33 and CD Figures 5.0.1 and 13.0.1)

The Yoke Latch Switch [SW107] and switch bracket must be properly adjusted as indicated by Figure 3-5 to avoid erroneous Yoke Latch Open alarm indications which inhibit printer operation. As shown in the lower diagram, the Yoke Latch Switch is actuated by the yoke latch crank which holds the switch contacts in the open position when the Yoke Latch Lever is in the "close latch" position. When the lever is placed in the "open latch" position, the crank is rotated away from the switch which permits the NC switch contacts to close.

Operation of the Yoke Latch switch can be checked either with an ohmmeter or, with printer power turned on, by observing the ALARM indicator. [Note — The yoke should be closed and paper should be installed in the printer when checking the Yoke Latch switch adjustment.]

3.5.1.1.2 Yoke Interlock Switch (Reference IPB Figure 33 and CD Figures 5.0.1 and 13.0.1)

The Yoke Interlock Switch [SW108] is a self-contained spring-loaded actuator and switch assembly. It has no adjustment and should not require maintenance throughout its life.

3.5.1.2 Chaintrain Adjustments

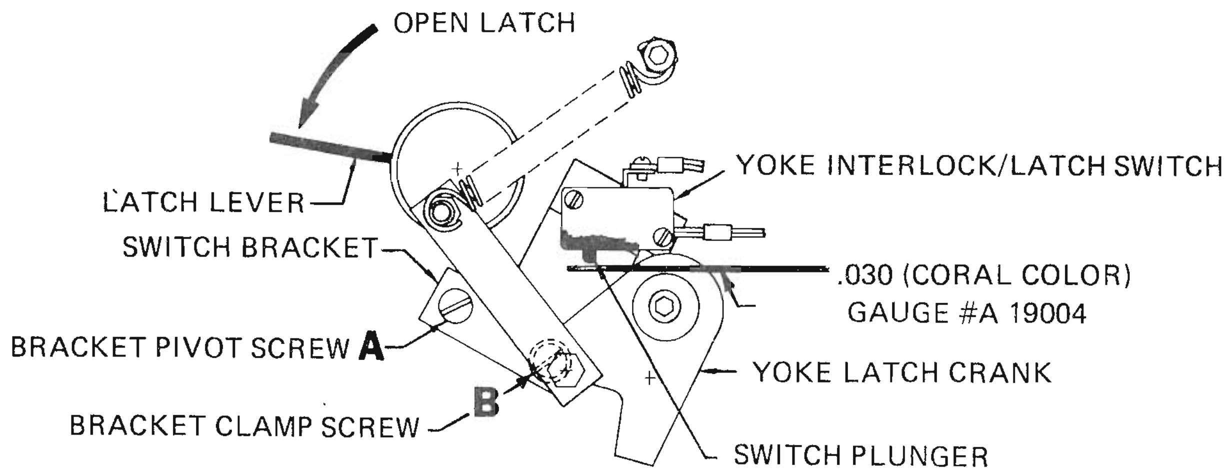
The adjustment procedures that follow pertain to the ribbon/slug guides and the chaintrain drive.

3.5.1.2.1 Ribbon/Slug Guides Adjustment (Reference IPB Figure 59)

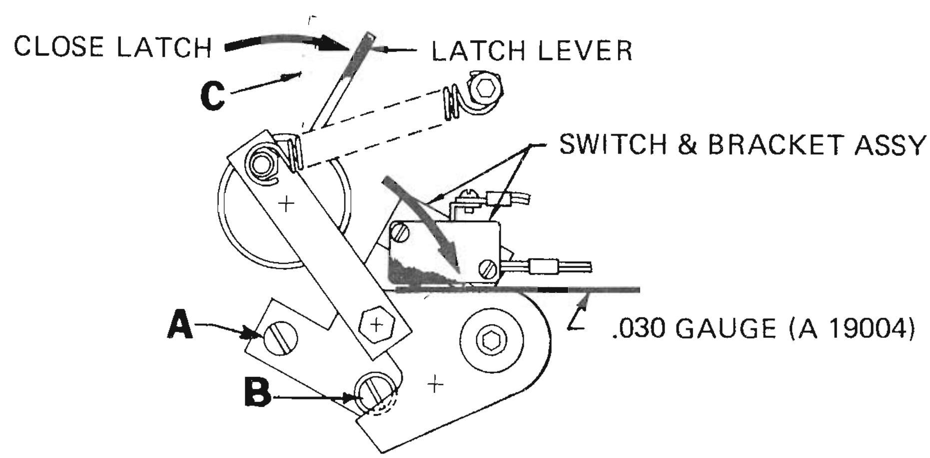
The type slugs on the chaintrain ride on slug guide rails (front and rear) and are guided at the front of the yoke assembly by upper and lower ribbon/slug guides as shown in Figure 3-6 (also see IPB Figure 59). The ribbon/slug guides are arranged in five (5) sections, namely; three central sections (designated 1, 2 and 3 in Figure 3-6) which are located in the print area opposite the bank of print hammers, and two end sections — one at each end of the chaintrain. The upper and lower ribbon/slug guides, particularly those in the central sections, must be properly adjusted to attain the best possible print quality.

With the printer yoke in the open position, adjust the upper and lower ribbon/slug guides of one (1) section at a time, starting with section 1 and proceeding to sections 2 and 3 and the end sections as follows:

1. Loosen [DO NOT REMOVE] the screws that fasten the upper and lower ribbon/slug guides in the section to be adjusted. The screws should be loosened only enough so that the lockwashers will hold the guides in position during adjustment.
2. Push the type slugs in the section being adjusted firmly against the front slug guide rail so that they seat squarely against the rail (opposite point "A" in Figure 3-6).
3. While holding the type slugs firmly against the guide rail, carefully move the upper and lower ribbon/slug guides in so that they *lightly* touch against the type-slug bearing pads (i.e.; push against points "B" and "C" in Figure 3-6).
4. With the ribbon/slug guides properly positioned, tighten the fastener screws.
5. MANUALLY rotate the chaintrain drive pulley in the clockwise direction (as viewed from above) for a complete revolution of the chaintrain and check that the type slugs pull through the slug guides easily. Relieve a guide as necessary where any tightness occurs.
6. Repeat Steps 1 through 5, above, for all sections, manually checking that the type slugs are easily pulled through the guides with each section adjusted.
7. After all sections have been adjusted, check that all ribbon/slug guide fastener screws have been tightened before applying power to the unit.

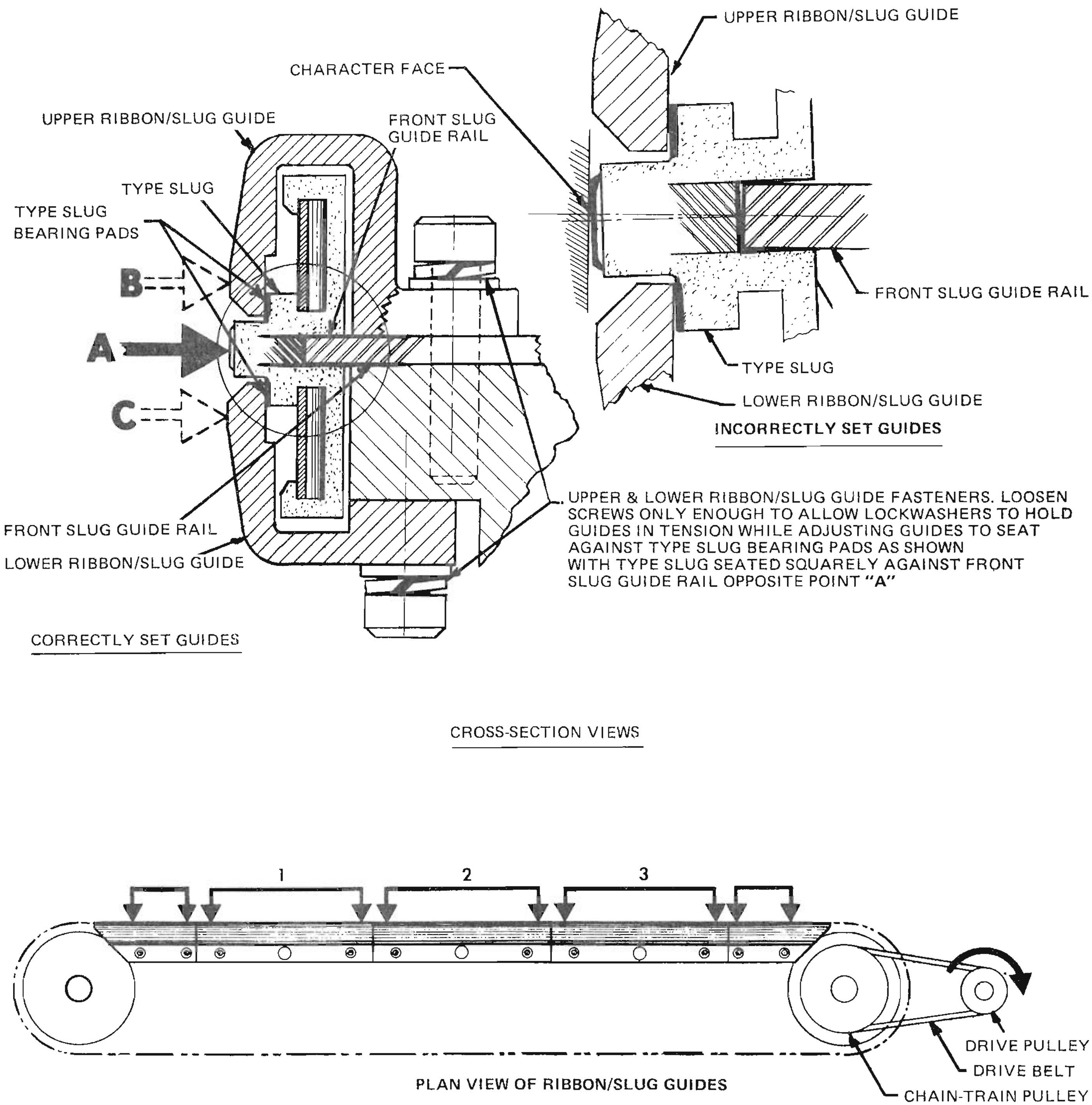


STEP 1: LOOSEN SCREWS **A and B.** (MOVE LATCH LEVER UPWARD FOR ACCESS TO SCREW **B**). SCREWS MUST NOT BE OVERLY LOOSE BUT SUFFICIENT ENOUGH SO THAT SWITCH BRACKET CAN BE PIVOTED UP & DOWN. OPEN LATCH LEVER TO POSITION SHOWN. INSERT .030 THICK GAUGE (CORAL COLOR) UNDER SWITCH PLUNGER. NOTE: USE FEELER GAUGE NO. A19004 FOR THIS ADJUSTMENT.



STEP 2: CLOSE LATCH LEVER TO POSITION SHOWN. PIVOT SWITCH AND BRACKET ASSEMBLY DOWNWARD UNTIL SWITCH PLUNGER AND GAP GAUGE ARE FULLY BOTTOMED AGAINST YOKE LATCH ASSEMBLY AS SHOWN. HOLD THIS POSITION AND TIGHTEN SCREWS **A & B.** REMOVE GAP GAUGE. SLOWLY MOVE LATCH LEVER BACK FROM CLOSED POSITION TO APPROX. **C** POSITION AS INDICATED. SWITCH SHOULD "OPEN" AND "CLOSE" IN THIS POSITION.

Figure 3-5. Yoke Latch Switch Adjustment



UPPER & LOWER RIBBON/SLUG GUIDES IN SECTIONS 1, 2 & 3 ARE LOCATED IN THE PRINT AREA. THESE SECTIONS MUST BE CAREFULLY POSITIONED TO ATTAIN BEST POSSIBLE PRINT QUALITY. ADJUST ONE SECTION AT A TIME, STARTING WITH 1 (UPPER & LOWER). HOLD TYPE SLUGS DOWN FIRMLY AGAINST FRONT SLUG GUIDE RAIL POINT "A" AND MOVE UPPER & LOWER RIBBON/SLUG GUIDES IN LIGHTLY AGAINST TYPE SLUG BEARING PADS (PUSH AT POINTS "B" & "C"). TIGHTEN SCREWS. MANUALLY ROTATE DRIVE PULLEY IN DIRECTION SHOWN. TYPE SLUGS MUST PULL THROUGH SLUG GUIDES EASILY. REPEAT THIS ADJUSTMENT FOR ALL SECTIONS AND ROTATE DRIVE PULLEY WITH EACH SECTION ADJUSTED. RELIEVE AS NECESSARY WHERE TIGHTNESS OCCURS. BEFORE POWERING UP CHECK ALL SCREWS TO ENSURE THEY HAVE BEEN TIGHTENED.

CAUTION: WHEN STARTING UP CHAIN POWER DOWN IMMEDIATELY IF CHAIN DOES NOT RESPOND AND IS IN A STALLED CONDITION OR APPEARS TO BE INTERMITTENTLY SLOWING DOWN (CHAIN IS NOT UP TO SPEED DUE TO TIGHTNESS IN ADJUSTMENT.

Figure 3-6. Ribbon/Slug Guide Adjustment

CAUTION

When starting up the chaintrain, turn OFF power IMMEDIATELY if the chaintrain does not respond and is in a stalled condition or if it appears to be intermittently slowing down [not up to speed due to tightness in adjustment].

3.5.1.2.2 Chaintrain Drive Adjustments (Reference IPB Figures 58 and 62)

Drive from the Chaintrain Drive Motor (B101) is coupled to the chaintrain through two pulleys and a belt as shown in Figure 3-7. The chaintrain drive system must be properly aligned and adjusted to ensure minimum wear and optimum performance. Detail procedures for adjusting the alignment of the chaintrain drive pulleys and for adjusting the tension of the chaintrain drive belt are provided in Figure 3-7.

For 60-Hz input power, the drive belt should be in the lower Motor Pulley position which, in turn, should be aligned with the Slug Drive Pulley S/A.

For 50-Hz input power, the appropriate drive belt should be in the upper Motor Pulley position which, in turn, should be aligned with the Slug Drive Pulley S/A.

3.5.1.2.3 Character and Index Strobe Pickup Adjustment (Reference IPB Figure 58 and CD Figures 4.0.1 and 13.0.1)

Character and Index (Head-of-Font) strobe pulses are generated by reluctance pickups RP101 and RP102, respectively, which are mounted on a common pickup mount subassembly at the right-hand end of the chaintrain. The Character Strobe pickup operates in conjunction with the ratchet pulley on the top of the slug drive pulley subassembly; the Index Strobe pickup operates in conjunction with magnetic inserts which are mounted on the upper part of one type-slug in each character array (set) on the chaintrain. Both of these pickups must be properly adjusted to produce the optimum output to ensure proper operation of the printer.

The initial gap settings and the normal output pulse waveforms for both the Character and Index strobe pickups are indicated in Figure 3-8. The initial gap setting is a "ball-park" adjustment: the final gap setting is determined by the respective pickup output pulse waveshape.

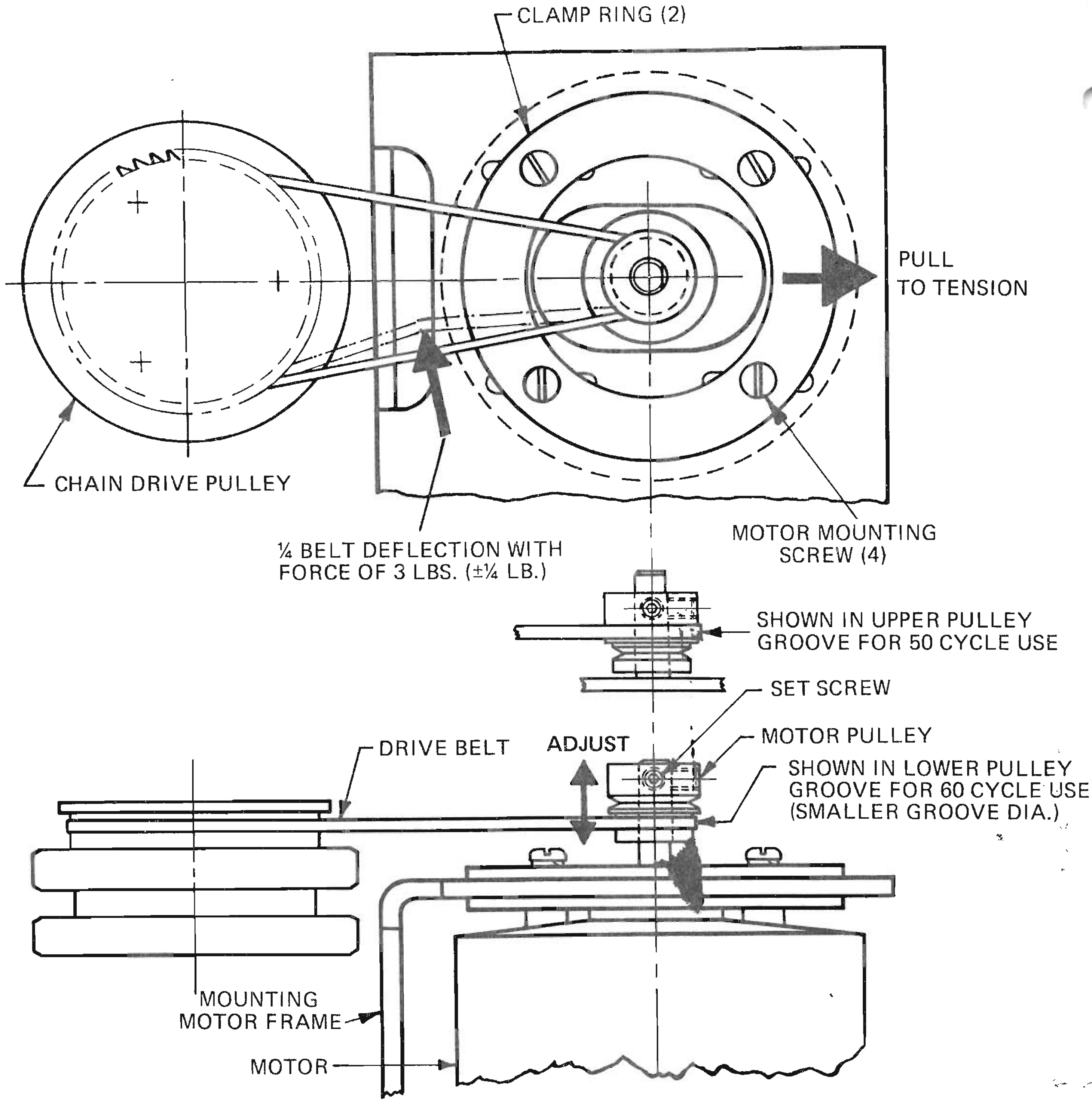
To adjust the Character and Index strobe pickups, proceed as follows:

1. With power to the printer turned OFF, remove the phasing bracket subassembly to gain access to the pickup mount subassembly and pickups.
2. Loosen the hex locknuts on each pickup and turn the threaded pickups to an initial gap setting of 0.0015 inch (0,038 mm) (see Figure 3-8).

CAUTION

Adjust the pickups with respect to the *highest* ratchet tooth or type-slug insert, as appropriate, to avoid making contact with the tip of a pickup which may result in damage to the equipment.

3. Tighten the hex locknuts and manually turn the chaintrain drive pulley in the clockwise direction (as viewed from above) for a complete revolution of the chaintrain to check that the gap settings have not changed during the tightening of the locknuts. If a pickup is making contact with a tooth or insert, readjust the pickup before proceeding.
4. Turn the printer ON and check the pickup outputs at 5B32 [Character Strobe] and 5B38 [Index Strobe] on the Logic Electronics motherboard for the proper output pulse waveshape as shown in Figure 3-8.
5. If further adjustment is required, turn OFF printer power and re-adjust the appropriate pickup as necessary. Tighten the locknuts and re-check.
6. When both pickups are properly adjusted, turn OFF printer power and replace the phasing bracket subassembly. Take care that the eccentric on the phasing bracket engages the mating slot in the pickup mount S/A.



STEP 1: TENSIONING DRIVE BELT:
LOOSEN 4 MOTOR MOUNTING SCREWS & PULL MOTOR IN DIRECTION INDICATED TO TENSION DRIVE BELT. TIGHTEN SCREWS & CHECK BELT TENSION. USE CHATILLON SCALE NO. LP-15, PUSH-PULL TYPE 0-15 LB. SCALE, 4 OZS./DIVISION.

STEP 2: ALIGNING MOTOR PULLEY TO CHAIN DRIVE PULLEY:
LOOSEN SET SCREWIN MOTOR PULLEY & ADJUST PULLEY UP OR DOWN TO ALIGN MOTOR PULLEY WITH CHAIN DRIVE PULLEY. DRIVE BELT MUST BE PARALLEL WITH GROOVES OF BOTH PULLEYS. TIGHTEN SET SCREWIN MOTOR PULLEY.

Figure 3-7. Chaintrain Drive Adjustments

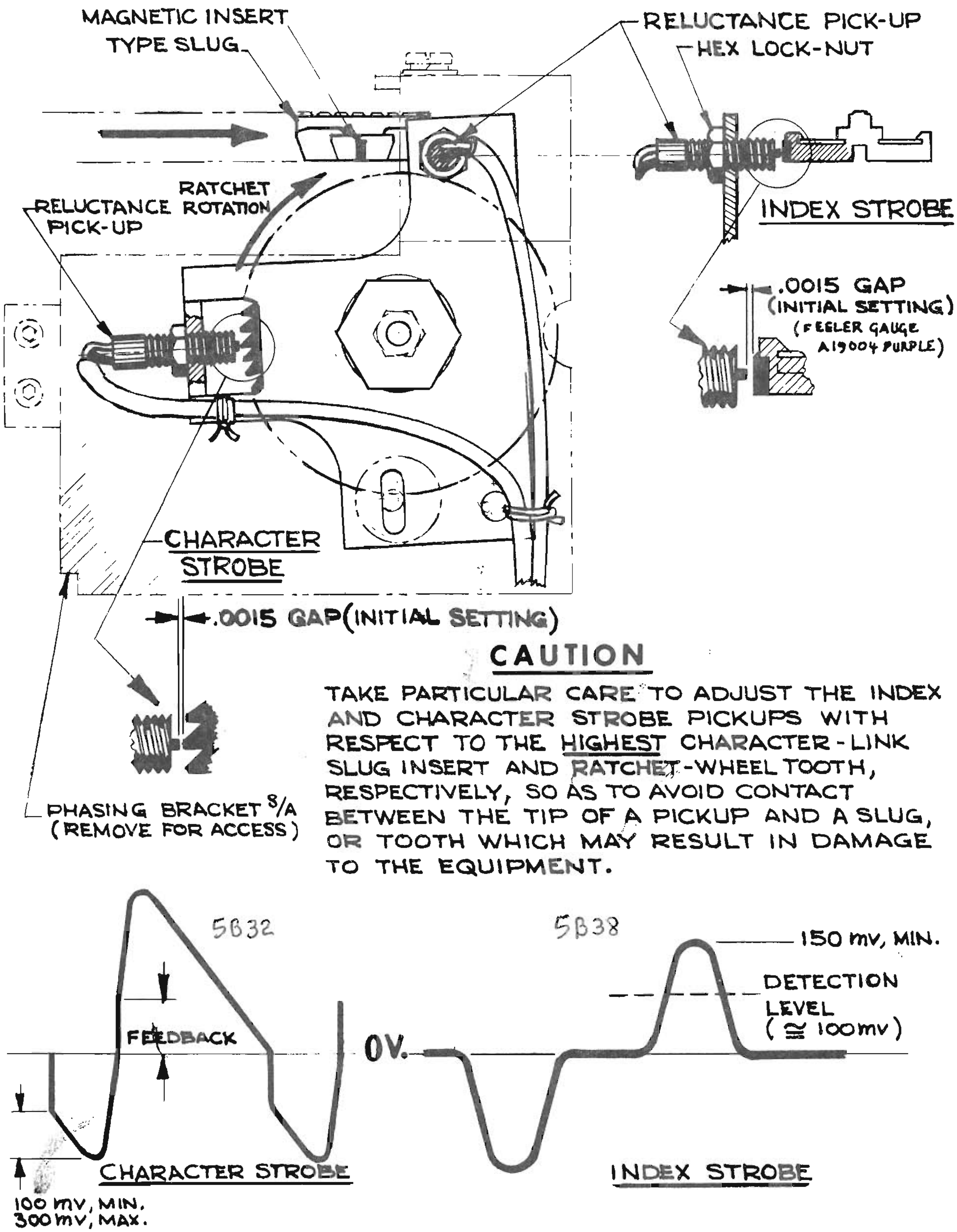


Figure 3-8. Character and Index Strobe Pick-up Adjustments

3.5.1.2.4 Chaintrain Cleaning (Reference IBP Figure 58)

To maintain the best possible print quality, the type faces on the chaintrain should be cleaned on a routine basis according to printer usage, the ribbon and paper(s) used, and the print quality requirements. During printing small particles of paper and ink tend to accumulate in the open spaces (counters) between the raised portion (lands) of the type faces. When this accumulation fills the open spaces, the distinctness of the printed characters might be adversely affected.

The chaintrain can be cleaned with the printer yoke in the open position and the ribbon removed. A sheet of paper should be placed between the open yoke and the printer mechanism to form a trough to protect the print hammers and paperfeed mechanism, and to catch the material removed from the chaintrain. With power to the printer turned OFF, the type faces should be cleaned first with a vacuum cleaner, then with a *soft* wire brush, while manually rotating the chaintrain in the clockwise direction to expose each type slug (character link).

CAUTION

DO NOT use cleaning solutions of any kind on the chaintrain. The use of solutions might result in contamination of the chaintrain lubricant and, consequently, might result in damage to the printing mechanism.

3.5.1.3 Hammer Actuator Alignment

Each hammer actuator arm must be aligned with its associated aligner (locator) comb so as to fully clear the adjacent tines, and must also be centered on the end of the associated print hammer. Figure 3-10 shows the details of aligning the actuator arms with the aligner comb, and Figure 3-11 shows the details of aligning the actuator arms with the ends of the print hammers, with the aid of three-prong pliers [DPC Part B9033]. Both the platen and the hammer bank assembly must be removed to gain access to all of the actuator arms.

To align the hammer actuator arms, proceed as indicated by the following procedures.

3.5.1.3.1 Hammer Bank Removal (Reference IPB Figures 52 and 53)

To remove the hammer bank assembly proceed as follows:

1. Remove the two (2) mounting screws at each end of the platen and remove the platen to gain access to the hammer bank assembly.
2. Refer to Figure 3-9. Remove the two (2) socket-head screws ["A"] that fasten the ends of the hammer bank assembly to the right and left platen support/hammer bank mounting brackets.
3. Carefully lift out the hammer bank assembly to gain full access to all of the hammer actuator arms. Place the hammer bank assembly on a smooth, clean surface with the "U"-shaped hammer channel facing down.

CAUTION

DO NOT attempt to remove the hammer bank assembly by removing the upper platen support screws from the rear of the actuator mounting frame assembly. If removed in this manner, the hammer bank will be free to fall and may be damaged.

3.5.1.3.2 Actuator and Aligner Comb Adjustment (Reference IPB Figures 55 and 56)

Figure 3.10 illustrates the proper method of aligning the hammer actuator arms in the slots of the aligner (locator) combs. The actuator arms are individually aligned by forming with three-prong pliers to fully clear the adjacent tines of the associated aligner comb. For this adjustment, the arms are formed just below the heavy section, at least 1/2 inch (1,27 cm) away from the associated aligner comb as shown in Figure 3-10. While aligning an actuator arm, take care to minimize twisting of the arm against its pivot pin to avoid the possibility of damaging the bushing in the arm.

3.5.1.3.3 Actuator and Print Hammer Adjustment (Reference IPB Figures 52 and 55)

Figure 3-11 illustrates the proper method of aligning the hammer actuator arms with the print hammers. The actuator arms are individually aligned by forming with three-prong pliers to center the tips of the arms on the end of the associated print hammers. For this adjustment, the arms are formed in the section between the actuator and its associated aligner comb, as close to the aligner comb as the tool will allow as shown in Figure 3-11. [Note — This and the preceding Actuator and Aligner Comb adjustment interact.]

CAUTION

DO NOT attempt to form the tips of the actuator arms in the area between the aligner combs. The tips are hardened and may be damaged if forced.

3.5.1.3.4 Hammer Bank Replacement (Reference IPB Figures 52 and 53)

To replace the hammer bank assembly, proceed as follows (refer to Figure 3-9):

1. With the "U"-shaped hammer channel facing up, place the hammer bank assembly between the two set screws on both the left-hand and right-hand platen support/hammer bank mounting brackets.
2. Position the hammer bank assembly so that the keyway in the right-hand end of the hammer bar and bumper assembly is engaged with the eccentric locating stud on the underside of the top leg of the right-hand platen support/hammer mounting brackets.
3. While holding the hammer bank assembly in position, manually pull the hammers forward, then release them, to allow the hammers to reset in a normal position. Check that the hammer actuator tips are *not* positioned between hammers.
4. Insert the two (2) socket-head mounting screws ["A"] and plain washers into the holes at the ends of the hammer bank assembly and tighten.
5. Check the over-all alignment of the hammer bank assembly with the hammer actuators and readjust as required (refer to paragraph 3.5.1.5 for procedures).
6. After the hammer bank assembly has been properly aligned, replace the platen (refer to paragraph 3.5.1.5 for procedure).

3.5.1.4 Print Timing Adjustments

The procedures that follow pertain to the adjustment of the Fire Pulse amplitude and duration, the Phasing Control, the Phase Clock timing and Hammer Flight timing.

The procedures that follow require that the printer be operated in the LOCAL, internal test mode and, in some cases, with the printer yoke in the open position. To operate the printer in the LOCAL mode with the yoke open, place the Yoke Latch lever in the "Closed", or latched, position and pull out the actuator on the Yoke Interlock switch to the Maintenance Override position. Always check that the actuator is returned to the normal position before returning the unit to service. For detail instructions for operating the printer in the LOCAL mode, refer to the "Operating Instructions" manual for the particular CHAINTRAIN Line Printer model under consideration.

3.5.1.4.1 Phase Clock Timing Adjustment (Reference IPB Figure 77 and CD Figure 3.0.1)

The Phase Clock logic electronics times the print operations to occur in synchronism with the alignment of characters on the moving chaintrain with the print hammers. The Phase Clock must be adjusted to provide four (4) Phase Scans which are uniformly spaced between successive Character Strobe pulses to ensure proper horizontal registration of characters printed in print positions 2, 3 and 4; 6, 7 and 8; 10, 11 and 12, etc.

To adjust the Phase Clock timing, proceed as follows:

1. With the printer yoke in the open position, turn the printer ON in the LOCAL mode and check the Character Strobe Pulse at the Test Point 1 on the H.S. Print Timing Generator PCB (Logic Electronics Bay position 6) for an interval of 1.21 MS. If the interval between successive Character Strobe pulses is considerably greater than 1.21 MS or is erratic, readjust the chaintrain drive system as indicated in paragraph 3.5.1.2.

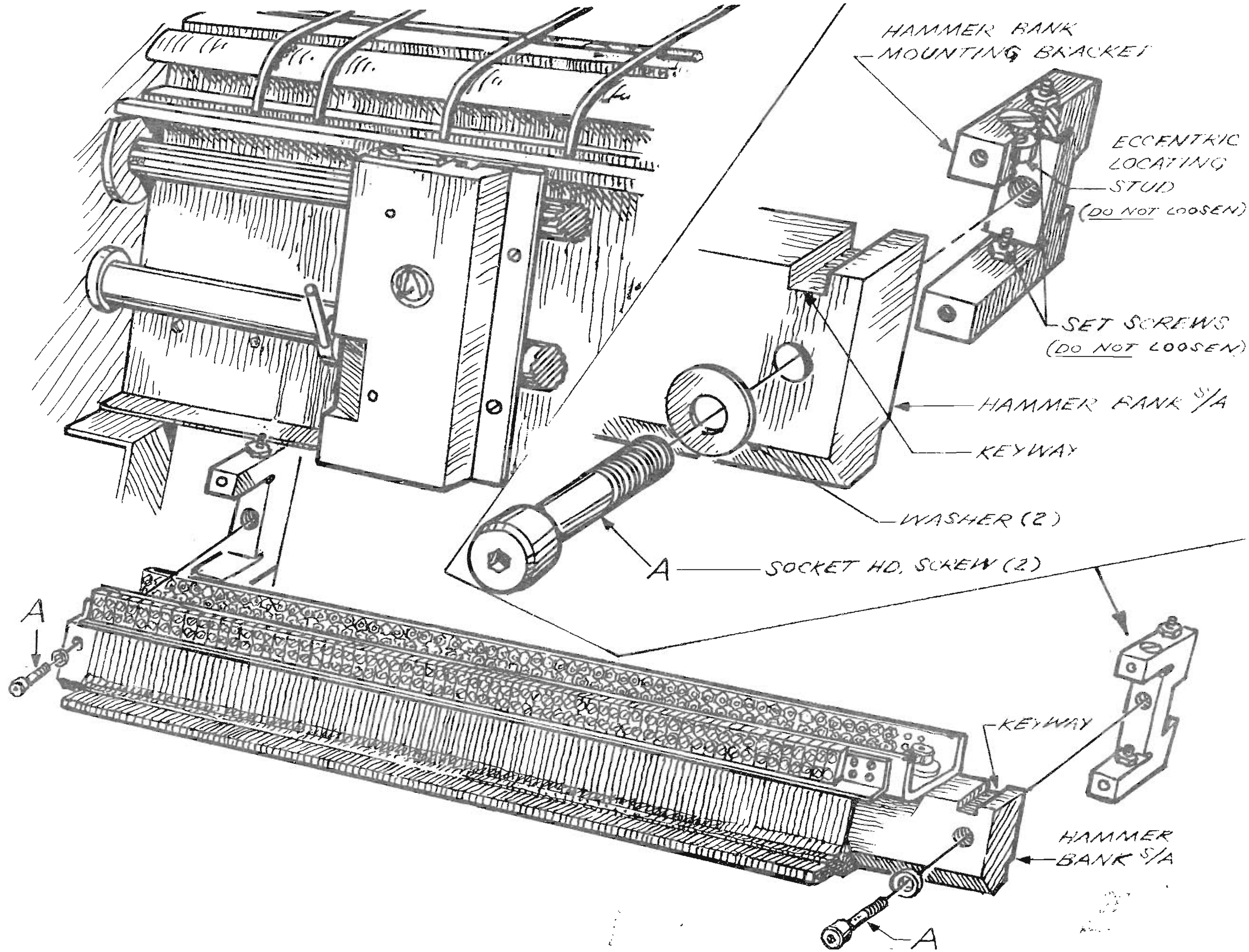
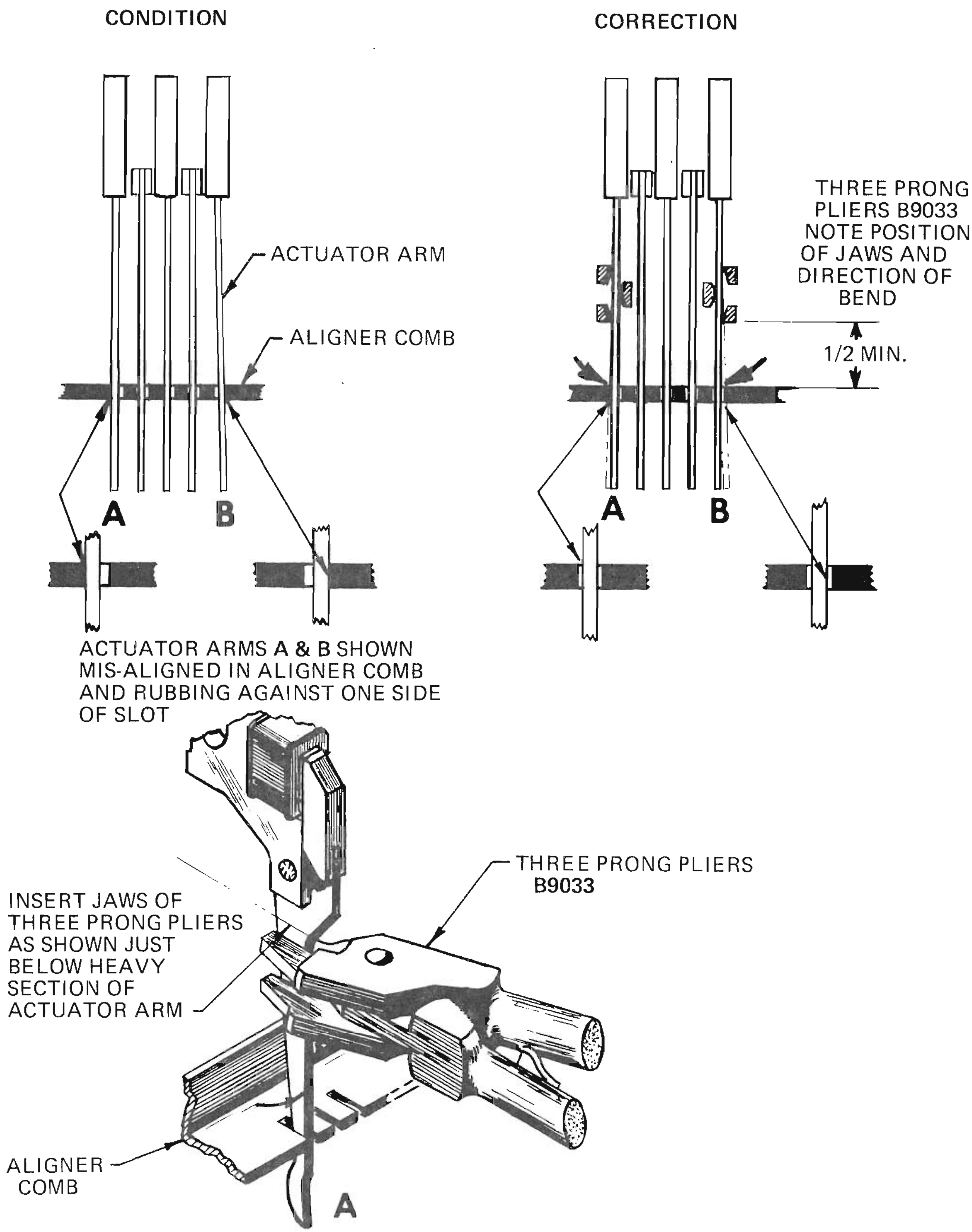


Figure 3-9. Removal Procedure, Hammer Bank Assembly



NOTE: HAMMER BANK MUST BE REMOVED FOR ACCESS TO ALL ACTUATOR ARMS.

Figure 3-10. Actuator and Aligner Comb Adjustment

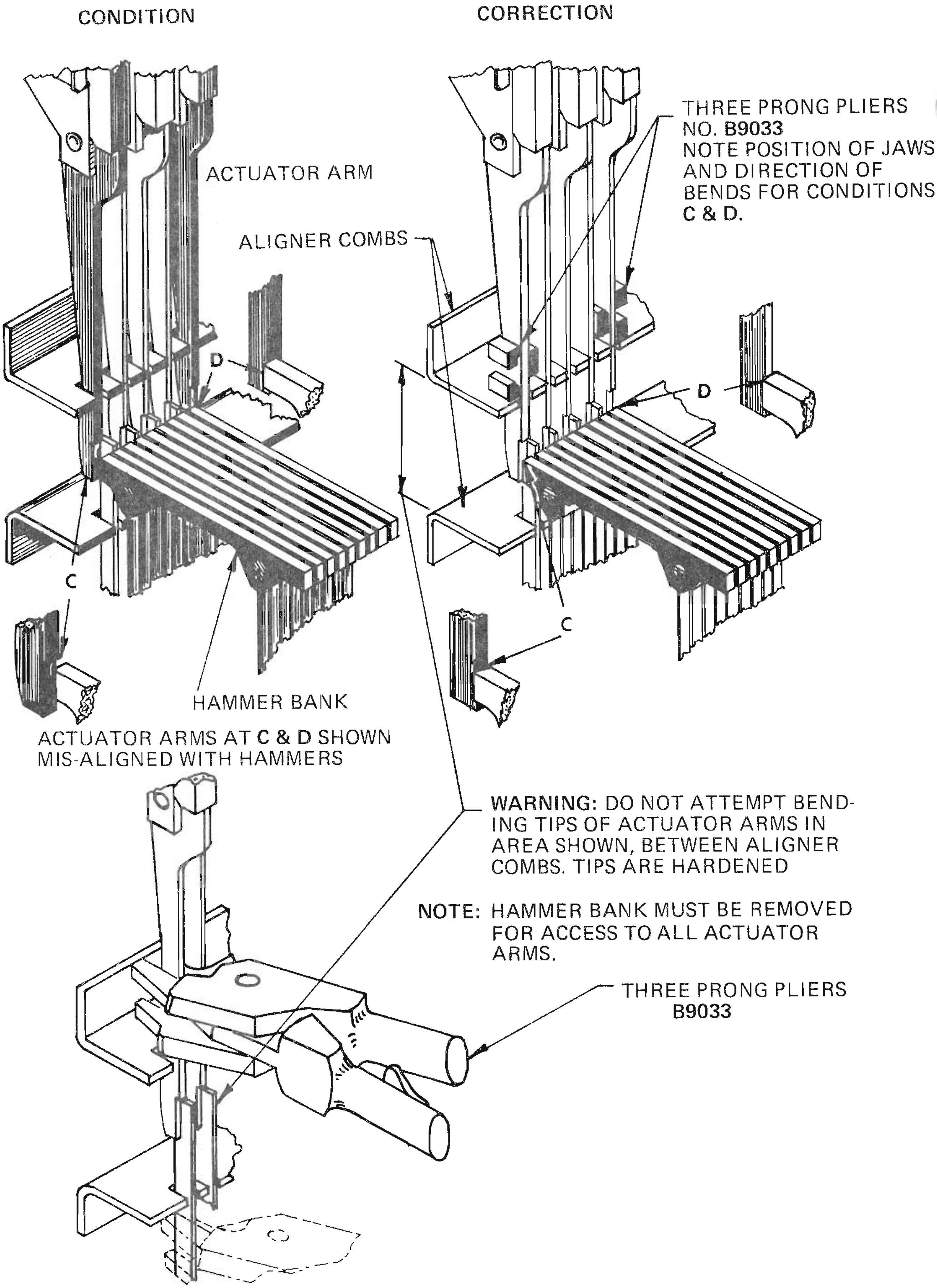


Figure 3-11. Actuator and Print Hammer Adjustment

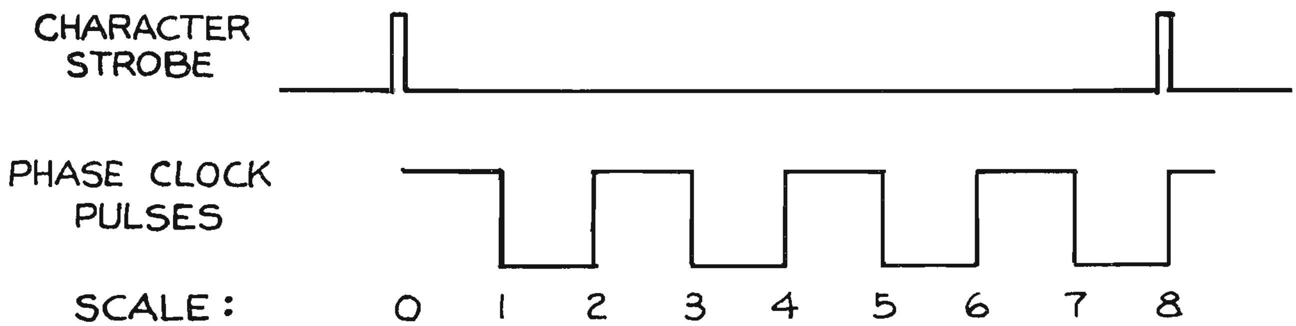


Figure 3-12. Timing Adjustment Waveforms, Phase Clock

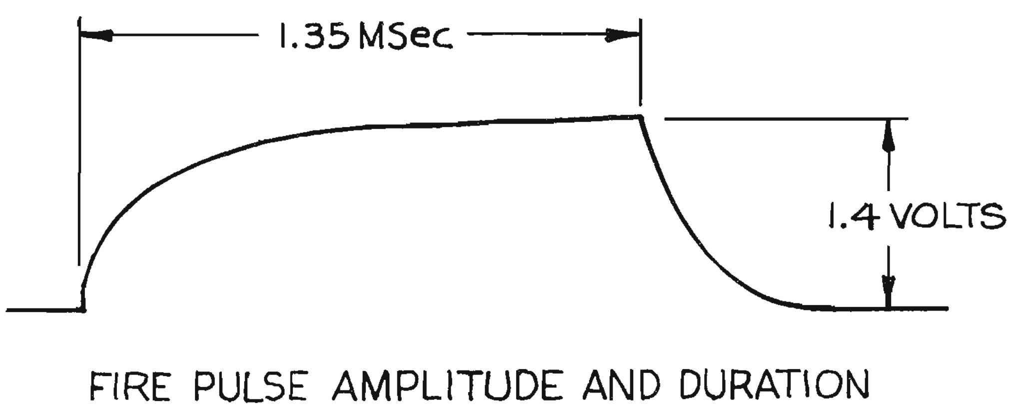


Figure 3-13. Amplitude and Duration Waveform, Hammer Driver Output

2. Set the oscilloscope to trigger on Character Strobe pulses and adjust the time base to display two (2) Character Strobe pulses at convenient reticle divisions (i.e.; at the zero [0] and eight [8] cm divisions, for example).
3. With the oscilloscope triggering on Character Strobe pulses, check the Phase Clock signal at the Test Point 3 on the Print Timing Generator PCB.
4. Adjust the Phase Clock potentiometer R12 on the Print Timing Generator PCB so that the Phase Clock pulses are uniformly spaced between successive Character Strobe pulses as shown in Figure 3-12 (i.e.; the leading edge of pulses 1, 2 and 3 occurs at the 2, 4 and 6 cm divisions, respectively).

3.5.1.4.2 "Fire" Pulse Amplitude and Duration Adjustments (Reference IPB Figures 74, 77 and 78, and CD Figures 3.0.4, 4.0.1 and 7.0.1)

The amplitude and duration of the output pulses of the hammer driver circuits must be correctly adjusted to ensure proper operation of the hammer actuators and print hammers. To adjust the amplitude and duration of the hammer driver output pulses, proceed as follows:

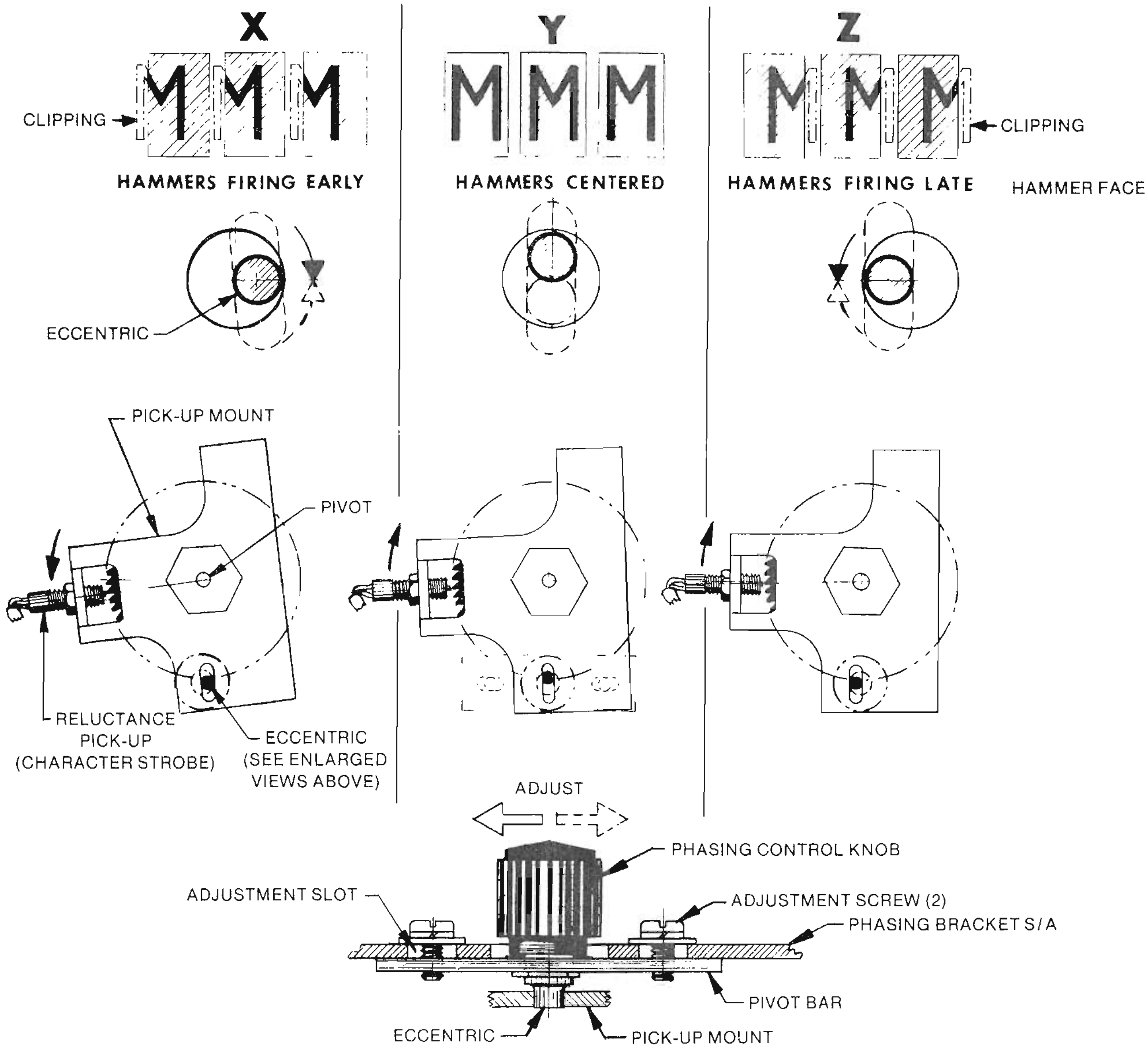
1. With the printer yoke in the open position, turn the printer ON in the LOCAL mode and check the hammer driver output pulses at Test Point 1 on the Hammer Driver PCB in position 11 with an oscilloscope.
2. Adjust the Fire Level potentiometer R9 on the Print Control (or ROM Print Control) PCB in position 5 to provide a hammer driver output pulse amplitude of 1.4 Volts [2.8 Amp.] as shown in Figure 3-13.
3. Adjust the Fire Pulse Clock Potentiometer R19 on the H.S. Print Timing Generator PCB in position 6 to provide a hammer driver output pulse duration of 1.35 MS as shown in Figure 3-13.
4. Check the output pulses at Test Point 1 on the remaining Hammer Driver PCB's in positions 7 through 10, and 12 through 14 for the proper waveshape.

3.5.1.4.3 Character Phasing Adjustment (Reference IPB Figures 58, 65 and 68)

Rotation of the PHASING control advances or retards the timing of print hammer actuation ("firing") with respect to the position of the characters on the moving chaintrain as they pass in front of the print hammers. As shown in Figure 3-14, the control knob is coupled to the pickup mount subassembly by an eccentric which provides a reciprocating movement of character imprints when the knob is rotated in either direction. When properly adjusted, the control should provide an equal lateral displacement of character imprint to either side of a print hammer center when the knob is turned through a complete rotation. With the control properly centered, it is impossible, even at the extreme limits of the control, to phase-in on a full character which is to the left or right of the selected print character on the chaintrain.

The character phasing adjustment is depicted in Figure 3-14. To adjust the PHASING control, proceed as follows:

1. Install single-part, 15# paper, close and latch the printer yoke, and set the IMPRESSION control to "DARK" [most right-hand position].
2. Select the LOCAL mode of printer operation and program the printer to print the uppercase letter "M".
3. Print 2 or 3 lines and stop printing. Check the copy for indications of top or bottom clipping. If clipping is indicated, readjust the print hammer bank with respect to the type slugs before proceeding (see 3.5.1.5).
4. While printing, check for left and right side cutoff of the character imprints in Print Positions (Columns) 1 and 129 [or 133 if provided with the 136-Column option] as described in Step 3 of Figure 3-14.
5. Should side cutoff *not* occur at both sides of the character printed in Step 4, above, adjust the PHASING control as described in Step 4 of Figure 3-14 to properly center the adjustment range of the control.
6. With the PHASING control properly adjusted and the character imprints in Print Positions 1 and 129 [or 133] properly positioned as shown in diagram "Y" of Figure 3-14, check the lateral position of the character imprints in all remaining print positions.



PHASING ASSEMBLY

STEP 1 LOAD SINGLE PART 15# PAPER ON TRACTORS, CLOSE & LATCH YOKE ASSEMBLY. SET PENETRATION SLIDER WITH INDICATOR ON "DARK" POSITION.

STEP 2: PROGRAM THE PRINTER TO PRINT THE UPPER CASE LETTER "M" (REFER TO OPERATING INSTRUCTIONS MANUAL.

STEP 3: ROTATE PHASING CONTROL KNOB (CW or CCW) AND OBSERVE POINT AT WHICH CLIPPING BEGINS TO OCCUR AT LEFT SIDE OF CHARACTER IMPRINTS (X). ROTATE PHASING CONTROL KNOB IN OPPOSITE DIRECTION AND OBSERVE POINT AT WHICH CLIPPING BEGINS TO OCCUR AT RIGHT SIDE OF CHARACTER IMPRINTS (Z). ROTATE PHASING CONTROL KNOB TO A POSITION MIDWAY BETWEEN X & Z AS SHOWN IN (Y).

STEP 4: SHOULD SIDE CLIPPING NOT OCCUR AT BOTH SIDES OF THE CHARACTER IMPRINT IN STEP 3, ROTATE PHASING CONTROL KNOB IN ONE THEN THE OPPOSITE DIRECTION WHILE OBSERVING MAXIMUM DISPLACEMENT OF CHARACTER IMPRINTS. ROTATE PHASING CONTROL KNOB TO POSITION PICK-UP MOUNT MIDWAY BETWEEN MAXIMUM DISPLACEMENTS. LOOSEN (DO NOT REMOVE) ADJUSTMENT SCREWS (2 PLACES) AND SLIDE PHASING ASSEMBLY TO THE LEFT, THEN TO THE RIGHT, WHILE OBSERVING POINTS AT WHICH SIDE CLIPPING OF THE CHARACTER IMPRINTS BEGINS TO OCCUR. POSITION PHASING ASSEMBLY TO A MIDWAY POSITION AND TIGHTEN ADJUSTMENT SCREWS. REPEAT STEP 3.

Figure 3-14. Character Phasing Adjustment

7. Should the character imprints in Print Positions 2, 3 and 4; 6, 7 and 8; 10, 11 and 12; etc., *not* be properly positioned in Step 6, above, adjust the Phase Clock timing to correct (refer to 3.5.1.4.1 for procedure).
8. Should the character imprint in an individual print position *not* be properly positioned in Steps 6 and 7, above, adjust the flight timing of the corresponding print hammer to correct (refer to 3.5.1.4.4 for procedure).

3.5.1.4.4 Print Hammer Flight Timing Adjustment (Reference IPB Figures 55, 56 and 57)

Print hammer flight timing, and the corresponding horizontal registration of character imprints, are adjusted by means of an individual flight-time screw for each print position as shown in Figure 3-15. Each flight-time screw raises or lowers an individual rubber backstop located on the end of a spring finger (part of the stop comb) beneath each actuator arm. Turning the flight-time screw clockwise (cw) raises the backstop which, in turn, raises the rest position of the corresponding actuator arm and print hammer and, thereby, reduces the hammer flight time. With the flight time reduced, the printed character registration is laterally shifted to the left. Conversely, turning a flight-time screw counter-clockwise (ccw) lowers the back-stop which, in turn, lowers the rest position of the corresponding actuator arm and print hammer and, thereby, increases the hammer flight time. With the flight time increased, the printed character registration is laterally shifted to the right.

The print hammer flight-time adjusting screws are accessible from the rear of the printer mechanism and are conveniently arranged in two rows as shown in Figure 3-16. To facilitate locating the flight-time screws, the corresponding print hammer positions are marked on a label affixed to the Adjusting Screw Guide Plate subassembly.

Considerable care should be exercised when adjusting the flight-time screws. The nominal travel of the tip of an actuator arm is approximately 0.050 inch (1,27 mm). A single full turn of a flight-time screw is about 0.030 inch (0,76 mm). Accordingly, flight timing adjustments will require but a fraction of a turn. If it appears that more than a fraction of a turn is required to align the horizontal character registration, the unit should be carefully checked for binding conditions, improper seating, shorted leads, or some similar fault which would result in improper operation of the hammer actuator.

CAUTION

Excessive adjustment of the print hammer flight-time screws in either direction may result in parts failure. If the screw is turned-in beyond the free travel of the actuator arm, the arm will be bent and the stop spring finger may break. Conversely, if the screw is backed-off beyond the preload travel of the backstop spring finger, the finger will be unsupported and will quickly fatigue under normal operating conditions.

As a check for either of the foregoing conditions, the position of the adjusted print hammer should be compared with the position of adjacent print hammers. If the face end of the adjusted hammer protrudes beyond the adjacent hammers, the corresponding actuator arm should be checked for normal travel. If the face end of the adjusted hammer is recessed below the adjacent hammers, the hammer should be manually depressed to check that the backstop spring finger is supported by the flight-time screw.

3.5.1.5 Hammer Bank Assembly Adjustments

The procedures that follow pertain to the over-all adjustment of the print hammer bank assembly with respect to the hammer actuators and the type slugs, and to the alignment of the platen with the adjusted print hammer bank. These adjustments are closely related and must be followed through completely in the order presented.

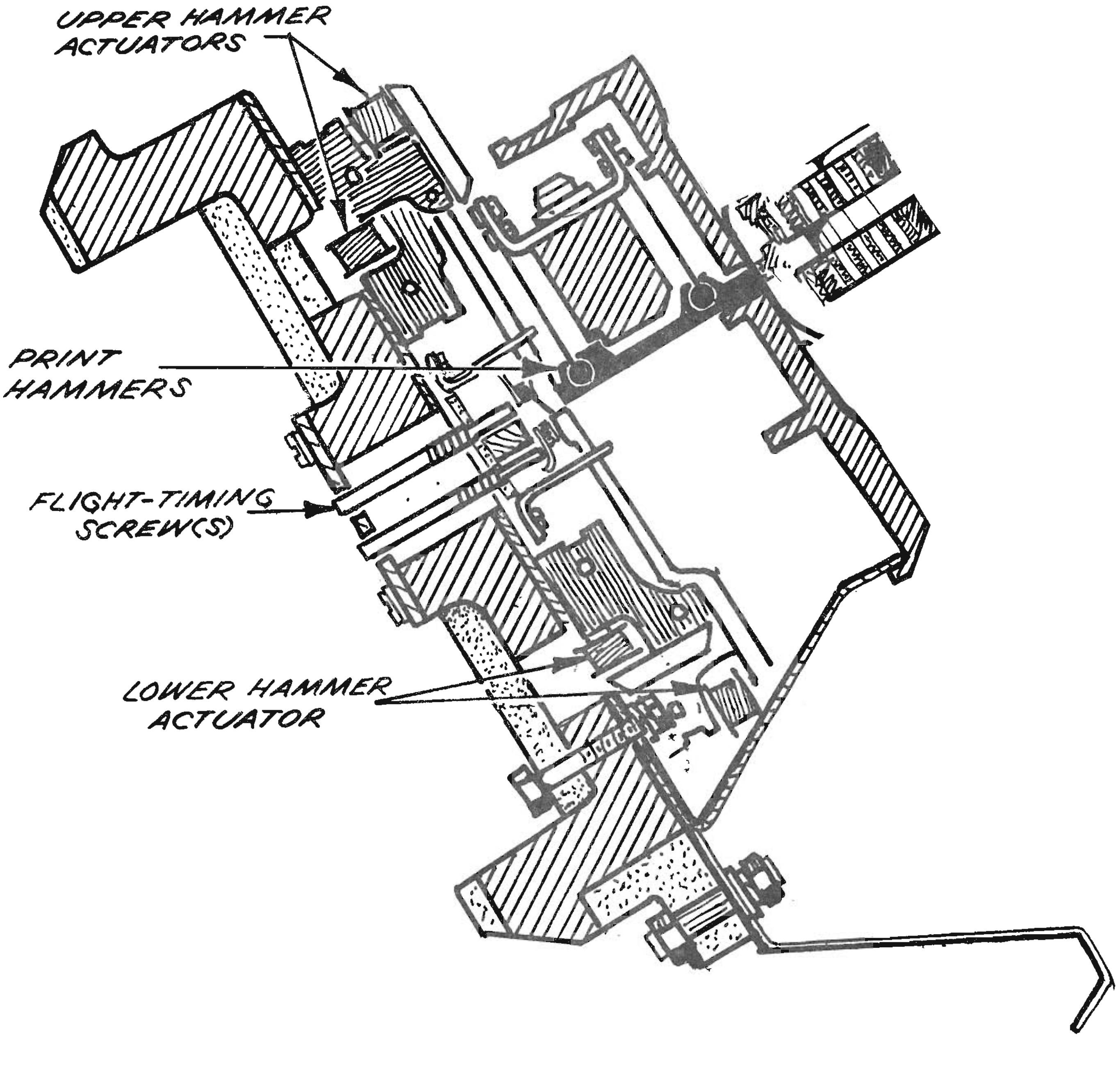


Figure 3-15. Print Hammer Flight Time Adjustment

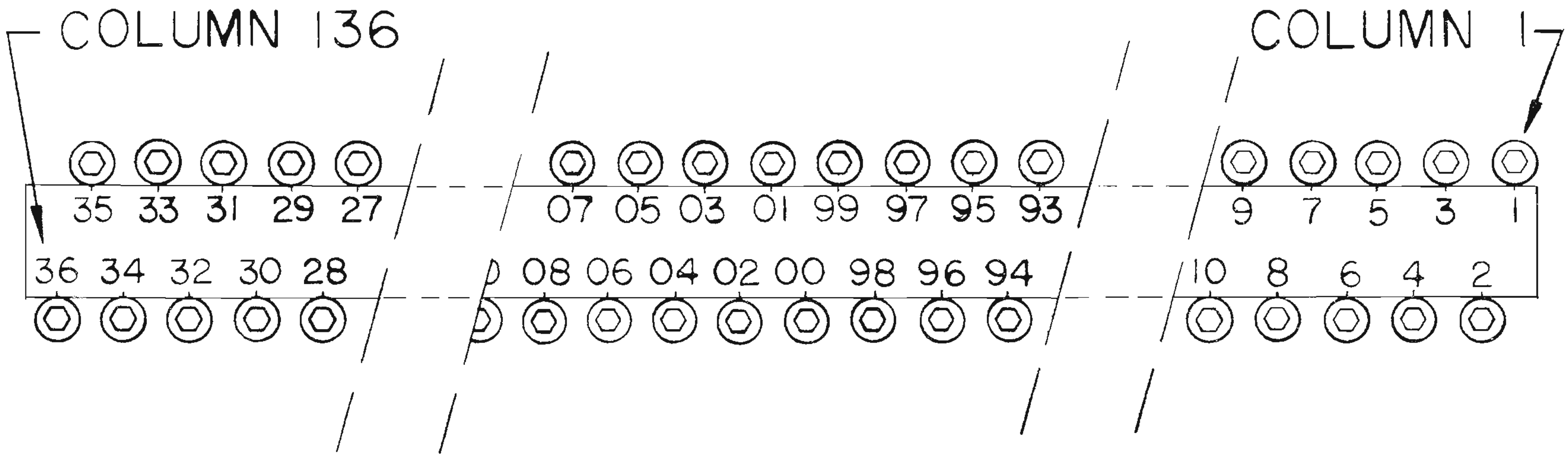


Figure 3-16. Print Hammer Flight Time Adjustment Screws

3.5.1.5.1 Hammer Bank and Actuator Adjustment (Reference IPB Figures 52 and 53)

The print hammer bank assembly must be adjusted horizontally so that the tip of every actuator arm is centered on the end of the respective print hammers. This adjustment is made by means of an eccentric stud located in the upper leg of the right-hand upper platen support/hammer bank mounting bracket. The proper alignment procedure is provided in Figure 3-17 which shows the details of hammer bank alignment with the actuator tips and the adjusting screws on the upper platen support/hammer bank mounting brackets.

It may be necessary to manually pull all of the print hammers forward, and then release them, to allow the hammers to reset to a normal position to make a final determination of the proper horizontal alignment of the hammer bank. After the hammer bank is properly positioned, check that the set screws ["C"] have been repositioned and their lock-nuts have been tightened, that the ecentric set-screw ["D"] has been tightened, and that the two (2) socket-head screws ["B"] that fasten the ends of the hammer bank assembly to the mounting brackets have been tightened. Any remaining mis-aligned actuator arms can be individually corrected by forming with three-prong pliers (refer to 3.5.1.5.3 for details).

3.5.1.5.2 Hammer Bank and Type Slug Adjustment (Reference IPB Figures 52, 53 and 59)

The print hammer bank assembly must be adjusted vertically so that the type faces on the chaintrain type-slugs are struck within the hammer faces at impact. This adjustment is made by means of vertical adjustment socket-head screws ["C" and "F"] located in the left and right-hand upper platen support/hammer bank mounting supports (see Figure 3-17).

The proper adjustment procedure is provided in Figure 3-18 which shows the details of alignment by means of characters printed on the hammer face: the locations of the adjustment screws used in this procedure are shown in Figure 3-17. For best results, the procedures pertaining to print timing should be completed before attempting to adjust the vertical position of the hammer bank assembly.

Minor variations, from hammer to hammer, in the horizontal position of the character imprints produced on the print hammer faces in this procedure is normal and should be disregarded. If the character imprints produced on all of the hammer faces are significantly off-center, the phasing adjustment should be checked (see 3.5.1.4.3 for procedure). If the character imprints produced on the faces of hammers in Print Positions 2, 3 and 4; 6, 7 and 8; 10, 11 and 12; etc., are significantly off-center laterally, the Phase Clock timing adjustment should be checked (see 3.5.1.4.1 for procedure). If the character imprint produced on the face of an individual hammer is significantly off-center laterally, that hammer's flight-timing adjustment should be checked (see 3.5.1.4.4 for procedure).

CAUTION

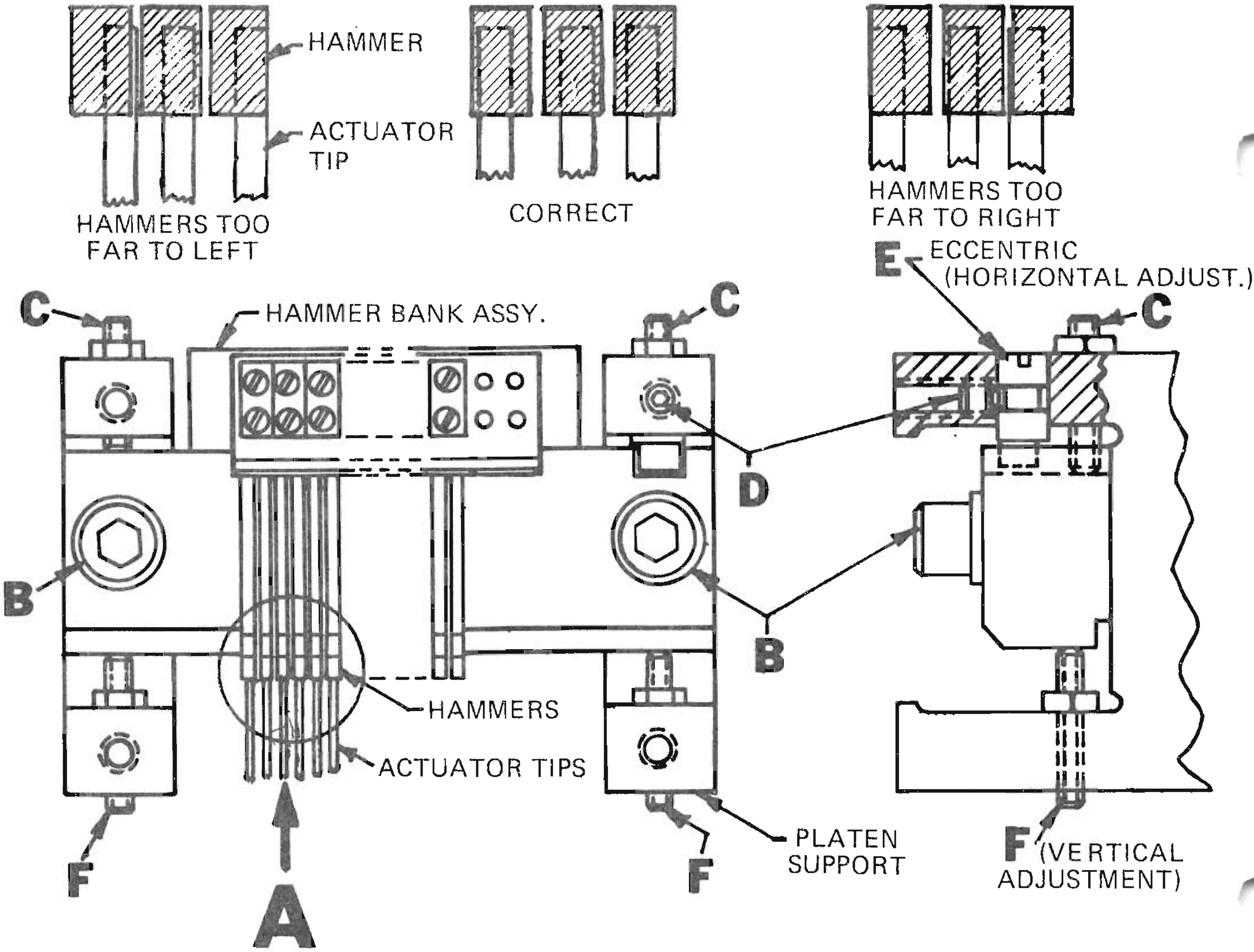
DO NOT attempt any timing adjustment while printing on the hammer faces. Continued operation and any misalignment of hammers with type faces while printing in this manner may damage the equipment.

After the hammer bank assembly is properly positioned, check that the setscrews ["C" and "F"] and their lock-nuts have been tightened, and that the two (2) socket-head screws ["B"] that fasten the ends of the hammer bank assembly to the mounting brackets have been tightened.

3.5.1.5.3 Platen Adjustment (Reference IPB Figure 52)

The platen must be properly aligned with the completely adjusted print hammer bank assembly so as to provide proper clearance for the print hammers to move through the slot in the platen.

Figure 3-19 illustrates the proper adjustment of the platen with the print hammer bank assembly. [Note — Prior to attempting to install and adjust the platen, check that the hammer bank assembly adjustments with the actuators and with the type slugs have been completed (refer to 3.5.1.5.1 and 3.5.1.5.2, above).]



ALIGNING HAMMERS & ACTUATOR ARMS

CAUTION: EXERCISE DUE CARE IN MAKING THIS ADJUSTMENT.

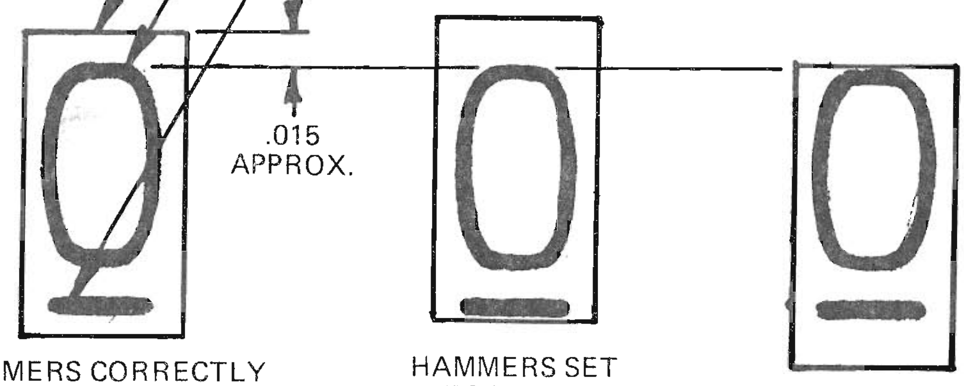
REMOVE UPPER PLATEN FOR ACCESS TO HAMMER BANK ASSEMBLY.
OBSERVE ALIGNMENT OF ACTUATOR TIPS WITH REAR END OF HAMMERS, LOOK UNDERNEATH AS INDICATED AT "A". NOTE AVERAGE OVER-ALL POSITION OF ALL HAMMERS TO DETERMINE IF HAMMER BANK SHOULD BE REPOSITIONED LEFT OR RIGHT FOR BETTER ALIGNMENT.

REPOSITION HAMMER BANK AS FOLLOWS:

1. LOOSEN SCREWS "**B**" APPROXIMATELY 1/2 TURN.
2. LOOSEN HEX NUTS AND BACK OFF 1/2 TURN ON 2 UPPER SET-SCREWS "**C**".
3. LOOSEN SET-SCREW "**D**" AND BACK OFF AT LEAST ONE FULL TURN.
4. INSERT SCREWDRIVER IN SLOT OF ECCENTRIC "**E**" AND SLOWLY ROTATE ECCENTRIC WHILE OBSERVING DIRECTION OF MOVEMENT. OBSERVE ALIGNMENT OF ACTUATOR TIPS & HAMMERS UNDERNEATH AT POINT "**A**". ADJUST ECCENTRIC UNTIL HAMMERS & ACTUATOR TIPS HAVE AN AVERAGE OVER-ALL ALIGNMENT AND THAT ACTUATOR TIPS ARE NOT POSITIONED BETWEEN HAMMERS. IT MAY BE NECESSARY TO MANUALLY PULL ALL HAMMERS UPWARD & RELEASE TO ALLOW HAMMERS TO RESET TO A NORMAL POSITION FOR FINAL DETERMINATION.
5. TIGHTEN ALL SCREWS, SET-SCREWS AND HEX-NUTS AND MAKE A FINAL OBSERVATION. REPEAT ADJUSTMENT IF NECESSARY.

IMPORTANT: SEE INSTRUCTIONS ON FIGS. 5-19 & 5-20. THESE ADJUSTMENTS ARE CLOSELY RELATED AND **MUST** BE FOLLOWED THROUGH COMPLETELY.

Figure 3-17. Hammer Bank and Actuator Adjustment



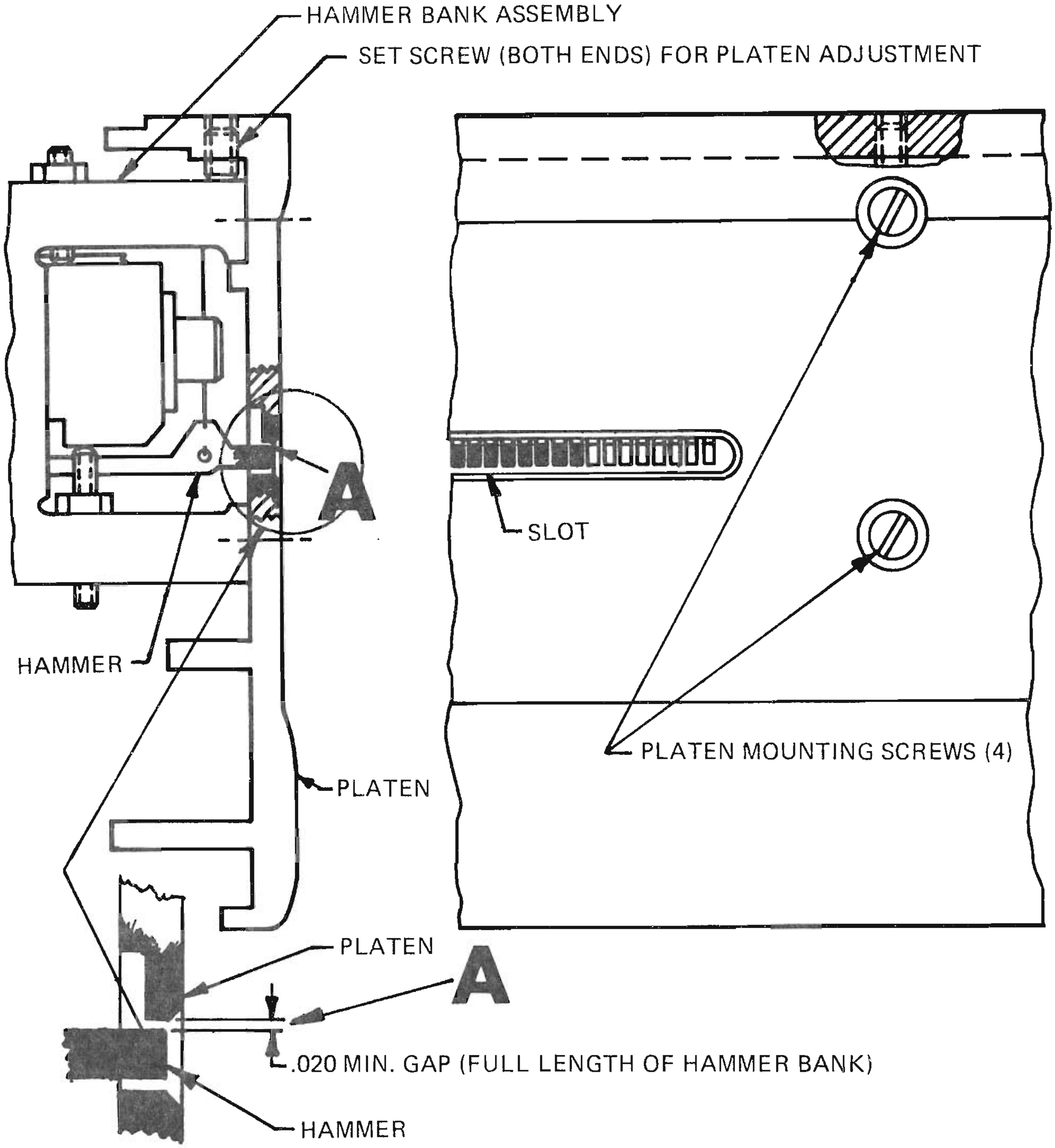
CAUTION: EXERCISE DUE CARE IN MAKING THIS ADJUSTMENT TO AVOID POSSIBLE DAMAGE TO CHAINTRAIN SLUGS.

ALIGNING HAMMER BANK TO CHAINTRAIN:

1. PROGRAM PRINTER TO PRINT "ZERO'S" FOR FULL LINE OF SOLID PRINT.
2. OPEN YOKE ASSEMBLY AND REMOVE RIBBON. REMOVE SINGLE SHEET OF CARBON PAPER FROM MULTIPLE PART FORMS AND PLACE CARBON FACE DOWN OVER PLATEN IN HAMMER BANK AREA. CLOSE YOKE, LATCH AND SET PENETRATION CONTROL ON "DARK" POSITION. RUN PRINTER FOR A VERY SHORT BURST BY OPERATING "RUN" & "STOP" BUTTONS ON CONTROL PANEL AND PRINTING ON HAMMER FACES.
3. PROGRAM PRINTER TO PRINT "UNDERLINE". NOTE: IF CHARACTER FONT DOES NOT INCLUDE "UNDERLINE" THEN POSITION "ZERO" AS SHOWN ABOVE AT LEFT. RUN PRINTER FOR A VERY SHORT BURST WITH CARBON IN PLACE OVER HAMMERS. OPEN YOKE & REMOVE CARBON PAPER. OBSERVE POSITION OF CHARACTERS ON HAMMER FACES & MAKE NECESSARY ADJUSTMENT AS FOLLOWS: REFER TO FIG.   ILLUSTRATIONS FOR THIS ADJUSTMENT.
4. LOOSEN SCREWS **"B"** APPROXIMATELY 1/2 TURN.
   TO **LOWER** HAMMER BANK, LOOSEN HEX NUTS ON 2 SET SCREWS **"F"** AND BACK OFF SET SCREWS. NOTE: 1/4 TURN OF SET SCREW IS EQUAL TO .008 MOVEMENT – COMPENSATE AS REQUIRED. TIGHTEN HEX NUTS. LOOSEN HEX NUTS ON 2 UPPER SET SCREWS **"C"** AND TIGHTEN SET SCREWS. TIGHTEN HEX NUTS.
   TO **RAISE** HAMMER BANK REVERSE PROCEDURE ABOVE AND START WITH SET SCREWS **"C"**. WHEN ADJUSTMENT IS COMPLETED TIGHTEN BOTH SCREWS **"B"**.
5. REPEAT ABOVE PROCEDURES 1 THRU 3 TO ENSURE HAMMER BANK HAS BEEN PROPERLY ADJUSTED.
6. PRIOR TO INSTALLING PLATEN SEE FIG. 5-20 FOR INSTRUCTIONS.

IMPORTANT: SEE INSTRUCTIONS OF FIGS. 5-18 & 5-20. THESE ADJUSTMENTS ARE CLOSELY RELATED AND **MUST** BE FOLLOWED THROUGH COMPLETELY.

Figure 3-18. Hammer Bank and Type Slug Adjustment



INSTALL PLATEN CAREFULLY WITH SLOT IN PLATEN ALIGNED OVER HAMMERS. CHECK CLEARANCE AT POINT "A" BETWEEN TOP OF SLOT IN PLATEN & TOP OF HAMMERS, FOR FULL LENGTH OF HAMMER BANK. HAMMERS SHOULD BE APPROXIMATELY CENTERED IN SLOT OR A MINIMUM OF .020 GAP ABOVE HAMMERS AS SHOWN ABOVE (THIS IS IN A STATIC POSITION).

USE .020 THICK PLASTIC SHIM STOCK (YELLOW) TO CHECK THIS GAP. ADJUST SET SCREWS IN TOP OF PLATEN TO RAISE OR LOWER SLOT AS REQUIRED, BUT MAKE CERTAIN THE PLATEN MOUNTING SCREWS HAVE BEEN FIRST LOOSENED.

IMPORTANT: PRIOR TO MAKING THIS ADJUSTMENT SEE FIG. 3-18 FOR ADJUSTING HAMMERS TO PRINT SLUGS (VERTICAL ALIGNMENT). THIS ADJUSTMENT MUST BE MADE PRIOR TO PLATEN ADJUSTMENT.

Figure 3-19 Platen Adjustment

3.5.1.6 Hammer Driver Overcurrent Alarm Adjustment (Reference IPB Figures 82 and 83, and CD Figure 10.0.2)

The Hammer Driver Overcurrent Alarm automatically turns-off printer power whenever current is sensed to be flowing in the +40 VDC hammer driver supply lead at any time other than during a *Print* cycle. The hammer driver current sensing circuit in the Sequencer PCB (chassis 400) must be correctly adjusted to ensure proper operation of the alarm and protection of the hammer actuator coils and driver circuits. This adjustment is made by simulating a hammer overcurrent condition and setting the circuit reference voltage, E_{ref}, for proper operation of the alarm.

To adjust the Hammer Driver overcurrent sensing circuit, proceed as follows:

1. Install paper in the printer, close and latch the printer yoke, and operate the printer in the LOCAL mode to check that printing occurs in all print positions (i.e.; that all hammer drivers are firing properly).
2. Turn off printer power and attach a 100 Ohm, 25 Watt resistor between DC Return and the +40 VDC Bus on the wiring side of the Logic Electronics Bay motherboard (chassis 200). [DC Return, or GND, is available at pins 1 through 18 of the connectors in positions B7 through B14. The +40 VDC Bus is available at pins 37 through 44 of the connectors in positions A7 through A14.]
3. Turn the printer ON:
   A. If the printer remains ON, proceed to Step 5, below.
   B. If the printer automatically turns OFF, turn the Reference Voltage potentiometer [R447] adjustment on the Sequencer PCB one-eighth (1/8th) turn clockwise.

WARNING

Primary and secondary AC voltages exist at certain terminals and at several points on the Sequencer PCB. Use caution when making adjustments on or in the area of this board; always turn OFF the Main Circuit breaker before attempting to service or remove the Sequencer PCB.

4. Repeat Step 3, above, until the printer remains ON.
5. Turn OFF printer power, remove the 100 Ohm resistor and attach a 75 Ohm, 25 Watt resistor between DC Return and the +40 VDC Bus on the motherboard.
6. Turn the printer ON:
   A. If the printer automatically turns OFF, the overcurrent sensing circuit is properly adjusted. Turn OFF printer power and remove the 75 Ohm resistor.
   B. If the printer remains ON, slowly turn the Reference Voltage potentiometer [R447] adjustment counter-clockwise (ccw) until the printer turns OFF. Repeat this procedure from Step 2, above.

3.5.2 Paperfeed Systems Adjustments

3.5.2.1 Paper Tractor Adjustments

3.5.2.1.1 Upper Tractor Pulley Alignment and Tensioning (Reference IPB Figures 43 and 44)

The upper and lower pulleys must be free of all end-play and the lower pulley must be adjusted to remove excess slack from the tractor belt on both the left-hand and right-hand paper tractor assemblies to ensure proper feeding of paper. Figure 3-20 shows the details of shimming the tractor pulleys and of adjusting the tension of the tractor belt. [Note — The tractor assemblies must be removed from the printer mechanism to align the upper pulley; refer to paragraph 3.6 for details.] Normally, the tractor pulley alignment adjustment is necessary only upon replacement of a paper tractor assembly.

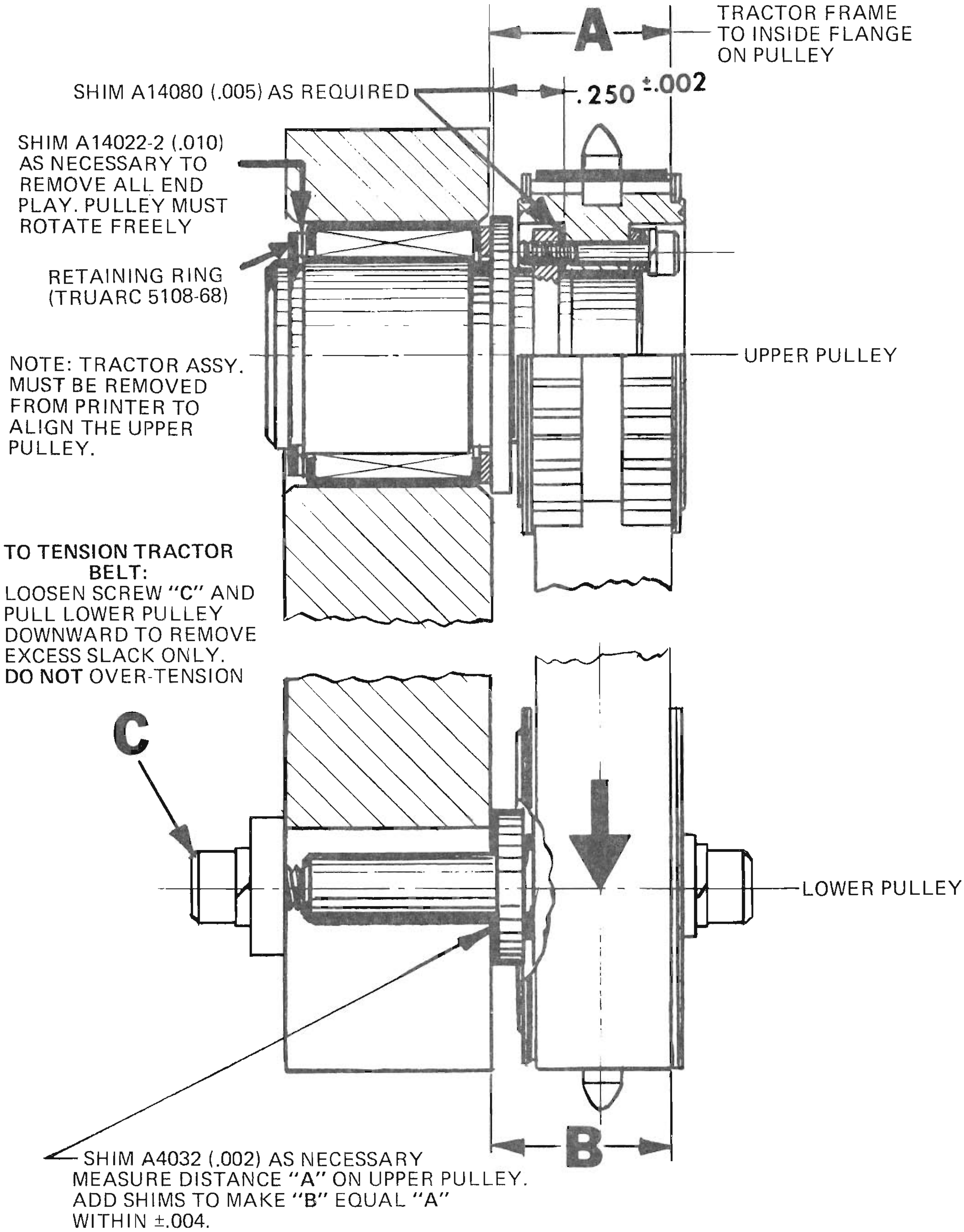


Figure 3-20. Pulley Alignment and Belt Tension Adjustments, Upper Paper Tractor

3.5.2.1.2 Upper Tractor Pin Alignment (Reference IPB Figures 41 through 44)

The alignment of the tractor pins is very important to forms feeding, particularly when slew-feeding forms. The pins must be aligned to work in unison in order to prevent plowing and/or elongating of the feed-holes in the form which can cause paper jamming. This adjustment is made by positioning the tractor belt of either or both tractors with a Tractor Pin Alignment Gauge (DPC Part No. A9110)[5] so that the corresponding pins on both tractors are in a line which is parallel to the tractor housing.

The details of tractor pin alignment are shown in Figure 3-21. To adjust the alignment of the tractor pins, refer to Figure 3-21 and proceed as follows:

1. Install paper in the printer, close and latch the yoke, and operate the printer in the LOCAL mode to print full lines of the upper-case letter "E".
2. Check the printout for parallelism between the printed lines and the top or bottom edges of the form. If the printed lines are not parallel to the edge of the form (see detail in Figure 3-21), the tractor belts are misaligned.
3. Correct any misalignment by raising either the right ["D"] or left ["E"] tractor belt as indicated in Figure 3-21. If additional adjustment is required, also lower the opposite tractor belt.

3.5.2.1.3 Upper Tractor Hold-Down Gap Setting (Reference IPB Figures 43 and 44)

The paper hold-down gap on each paper tractor must be properly adjusted to secure the paper on the feed pins while not exerting excessive drag on the forms. This adjustment is made by means of an eccentric on the tractor latch of each paper tractor. This adjustment sets the spacing between the opposing surfaces of the pin shield and the hinged pressure plate. By turning both the eccentric and its associated pan-head screw simultaneously, the tractor latch can be raised or lowered to provide the proper hold-down gap.

The details of the paper hold-down gap setting are shown in Figure 3-22.

3.5.2.1.4 Lower Paper Tractor Adjustments (Reference IPB Figure 51)

The lower paper tractors must be free of shaft end play and must be aligned with respect to the upper paper tractors to ensure proper feeding of paper. Figure 3-23 shows the details of properly setting the lower tractor shaft end play. The proper procedure for aligning both lower paper tractors with respect to the upper paper tractors is given in Figure 3-24 and is illustrated in Figure 3-25.

3.5.2.2 Paper Guides and Paper Tension Adjustments

3.5.2.2.1 Paper Guides Adjustment (Reference IPB Figure 67)

The paper path through the print area of the printer is designed to allow free passage of the forms. For proper paper feeding, the functional surfaces of the upper and lower paper guides must be parallel with each other throughout their length, and must be set so as to be approximately 0.010 inch (0,25 mm) above the type faces on the type slugs when the paper guide assembly is positioned against the printer yoke.

The paper guides are set at the time of manufacture and normally should not require maintenance attention for the life of the equipment. If the factory settings are disturbed, improper paper feeding might result. To check, or adjust the paper guide settings, refer to Figure 3-26.

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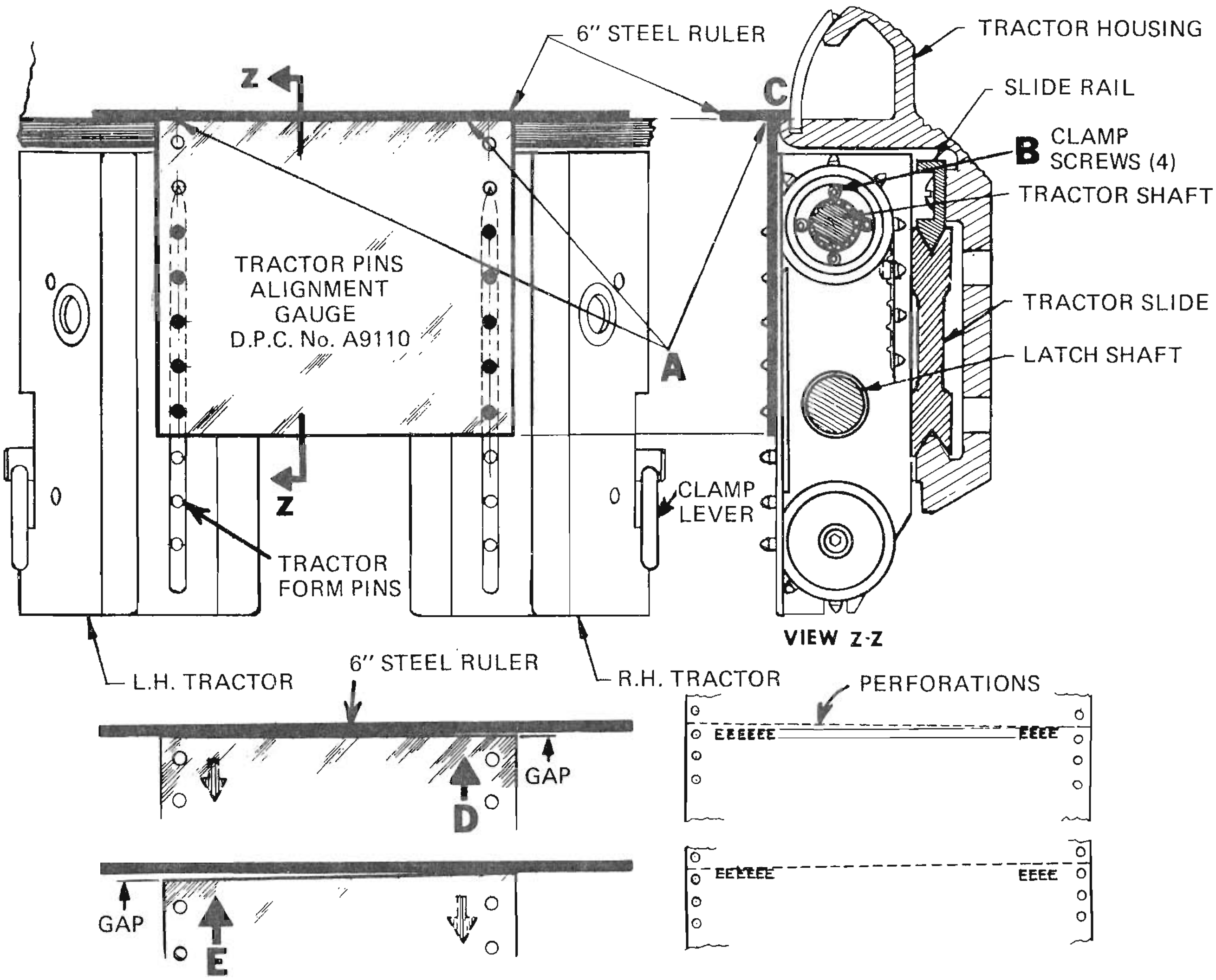
(5) As a field expedient, the pre-punched feed holes in a paper form may be used when the Tractor Pin Alignment Gauge is not available. When using a paper form, it is important to check the dimensional integrity of the punching by folding the form on its vertical centerline while aligning the feed holes in the right margin with the feed holes in the left margin, and checking that the top and bottom edges of the left and right halves of the form coincide exactly.



PERFORATION LINE LOW AT RIGHT, OR LEFT, SIDE OF FORM. TRACTOR FORM LINKS ARE MIS-ALIGNED.

CORRECT BY RAISING RIGHT (D), OR LEFT (E), TRACTOR FORM PINS. IF ADDITIONAL ADJUSTMENT IS REQUIRED, ALSO LOWER OPPOSITE TRACTOR FORM PINS.

LOOSEN 4 CLAMP SCREWS (B) ON UPPER TRACTOR PULLEY, ROTATE FORMS POSITIONING KNOB (TRACTOR SHAFT) COUNTER-CLOCKWISE UNTIL ALIGNMENT GAUGE IS IN FULL CONTACT WITH 6" STEEL RULER HELD DOWN AGAINST TOP EDGE OF TRACTOR HOUSING AS SHOWN (C) IN TOP VIEW. SECURE 4 CLAMP SCREWS (B) AND RE-CHECK GAUGE ALIGNMENT WITH RULER.

Figure 3-21. Tractor Pin Alignment, Upper Paper Tractor

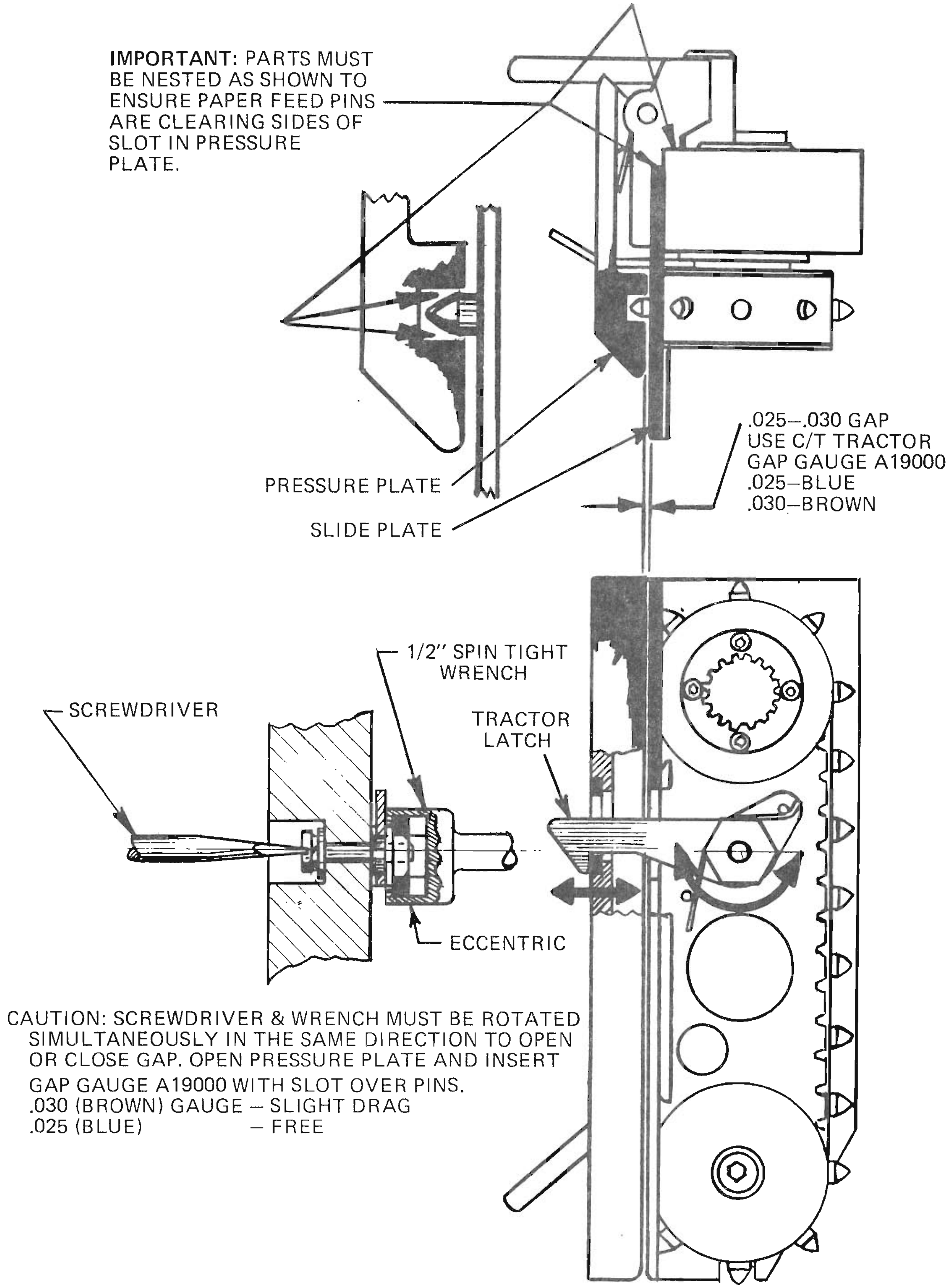
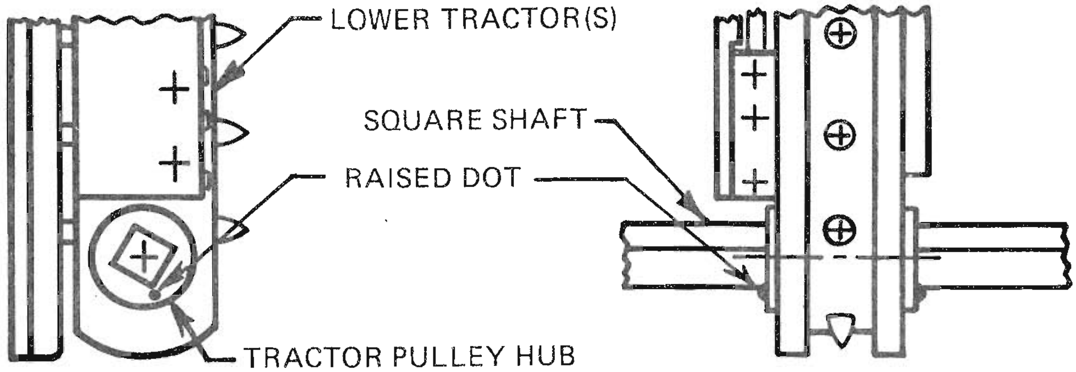
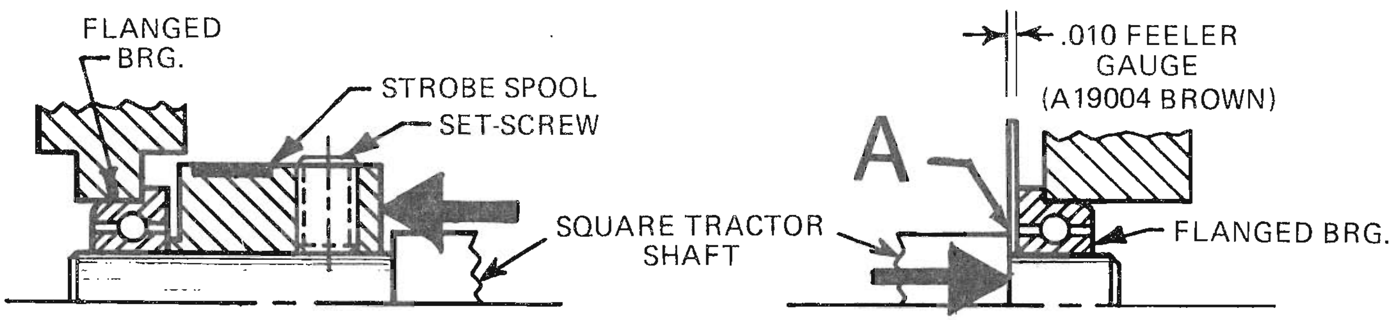


Figure 3-22. Paper Hold-Down Gap Setting, Upper Paper Tractor



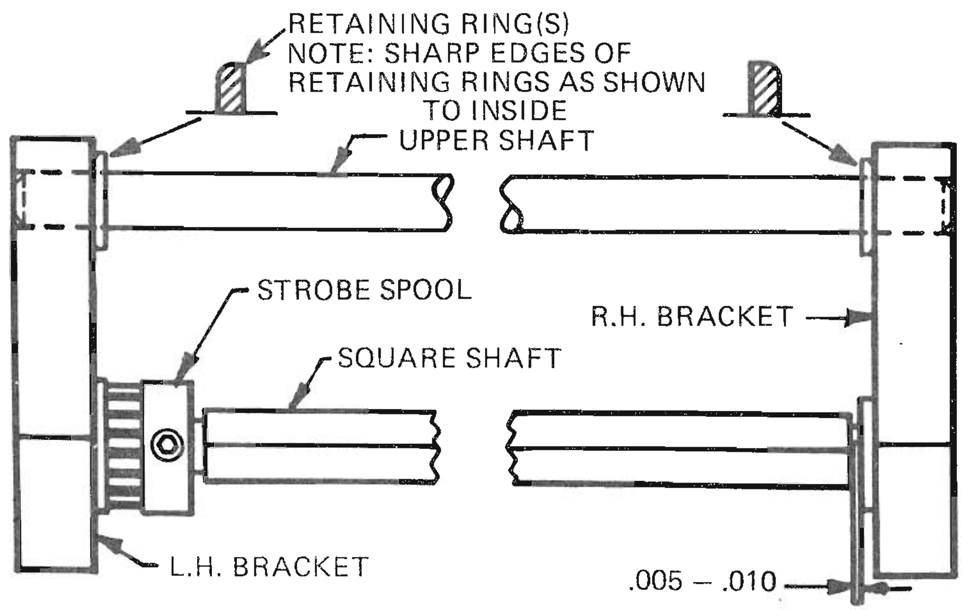
ALIGNING LOWER TRACTORS

IMPORTANT: LOWER TRACTORS MUST BE ASSEMBLED ON SQUARE SHAFT WITH IDENTIFICATION MARKS (RAISED DOTS) ON TRACTOR PULLEY HUBS IN LINE WITH ONE CORNER OF SQUARE SHAFT.



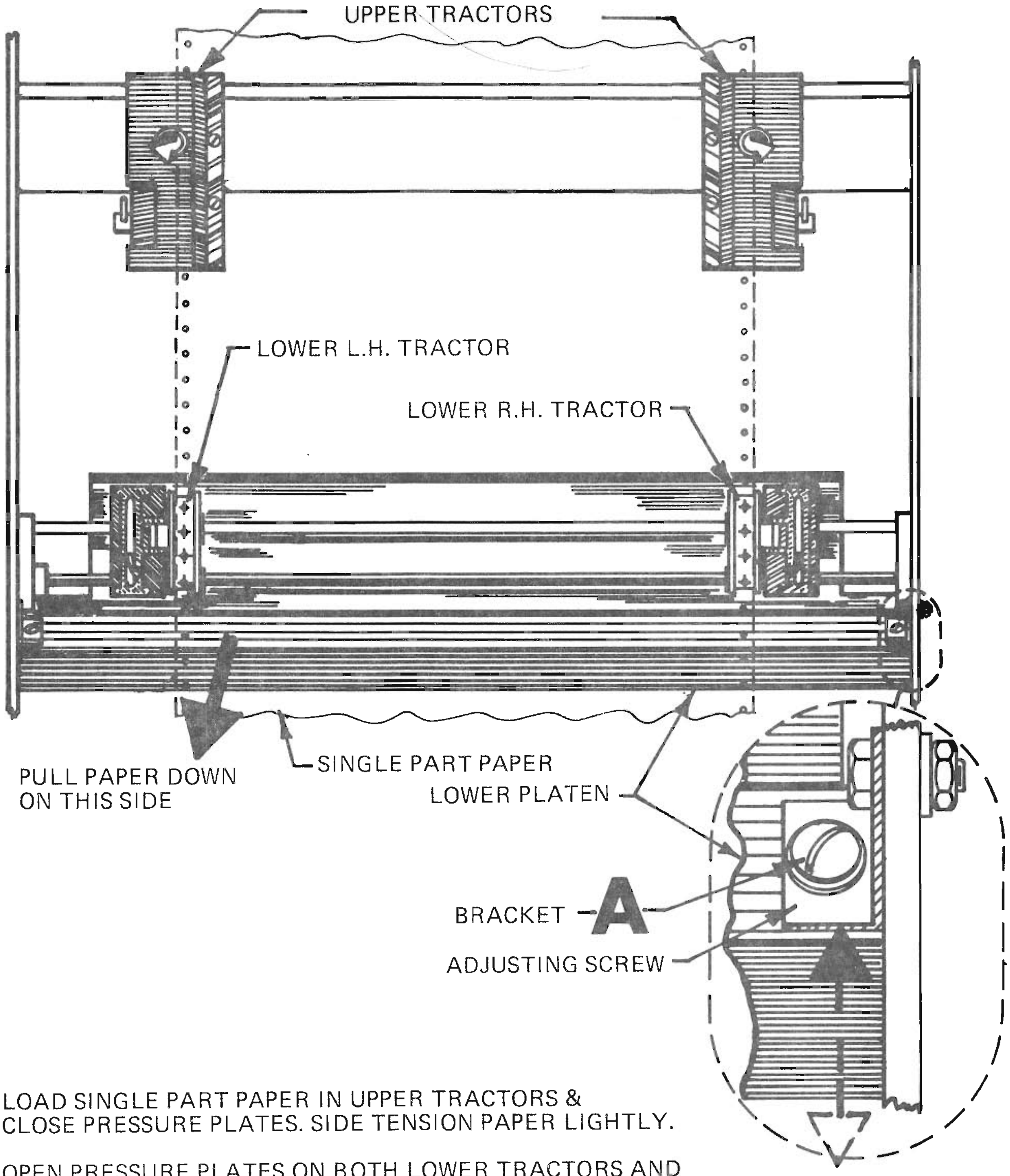
SETTING SHAFT END-PLAY

LOOSEN SET SCREW IN STROBE SPOOL AT L.H. END OF LOWER TRACTOR SHAFT. INSERT .010 FEELER GAUGE BETWEEN SQUARE SHAFT SHOULDER & FLANGED BEARING AT R.H. END OF ASSEMBLY (POINT A).
PUSH SHAFT AGAINST FEELER GAUGE AND STROBE SPOOL AGAINST FLANGED BEARING AT LEFT AS SHOWN AND TIGHTEN SET SCREW.



IMPORTANT: RETAINING RINGS ON UPPER SHAFT MUST BE POSITIONED AGAINST THEIR ADJACENT BRACKETS (SHARP EDGES OF RETAINING RINGS FACING AWAY FROM BRACKET). THERE MUST BE .005 - .010 END PLAY.

Figure 3-23. End Play Adjustment, Lower Paper Tractor



STEP 1. LOAD SINGLE PART PAPER IN UPPER TRACTORS & CLOSE PRESSURE PLATES. SIDE TENSION PAPER LIGHTLY.

STEP 2. OPEN PRESSURE PLATES ON BOTH LOWER TRACTORS AND LOAD PAPER OVER FEED PINS IN L.H. TRACTOR ONLY, PULLING PAPER DOWNWARD TO LIGHTLY TENSION PAPER. ROTATE SQUARE TRACTOR SHAFT UPWARD SO THAT THE FEED PINS ARE TOUCHING THE UPPER EDGE OF HOLES IN PAPER AS SHOWN IN FIG. DO NOT CLOSE PRESSURE PLATES ON LOWER TRACTORS. ALLOW PAPER TO REST ON PINS ON LOWER R.H. TRACTOR & OBSERVE POSITION OF HOLES OVER PINS. (SEE FIG. 3-25)

STEP 3. LOOSEN ADJUSTING SCREW A AT LOWER R.H. CORNER BRACKET AND MOVE LOWER PLATEN UP OR DOWN UNTIL FEED PINS ENTER PAPER FEED HOLES AND PINS ARE TOUCHING UPPER EDGES OF HOLES. TIGHTEN SCREW A. CHECK PAPER BOTH SIDES TO ENSURE PINS ARE UNIFORMLY ENGAGED ON BOTH TRACTORS. REFER TO FIG. 3-25 .

Figure 3-24. Alignment Adjustment, Lower Paper Tractors

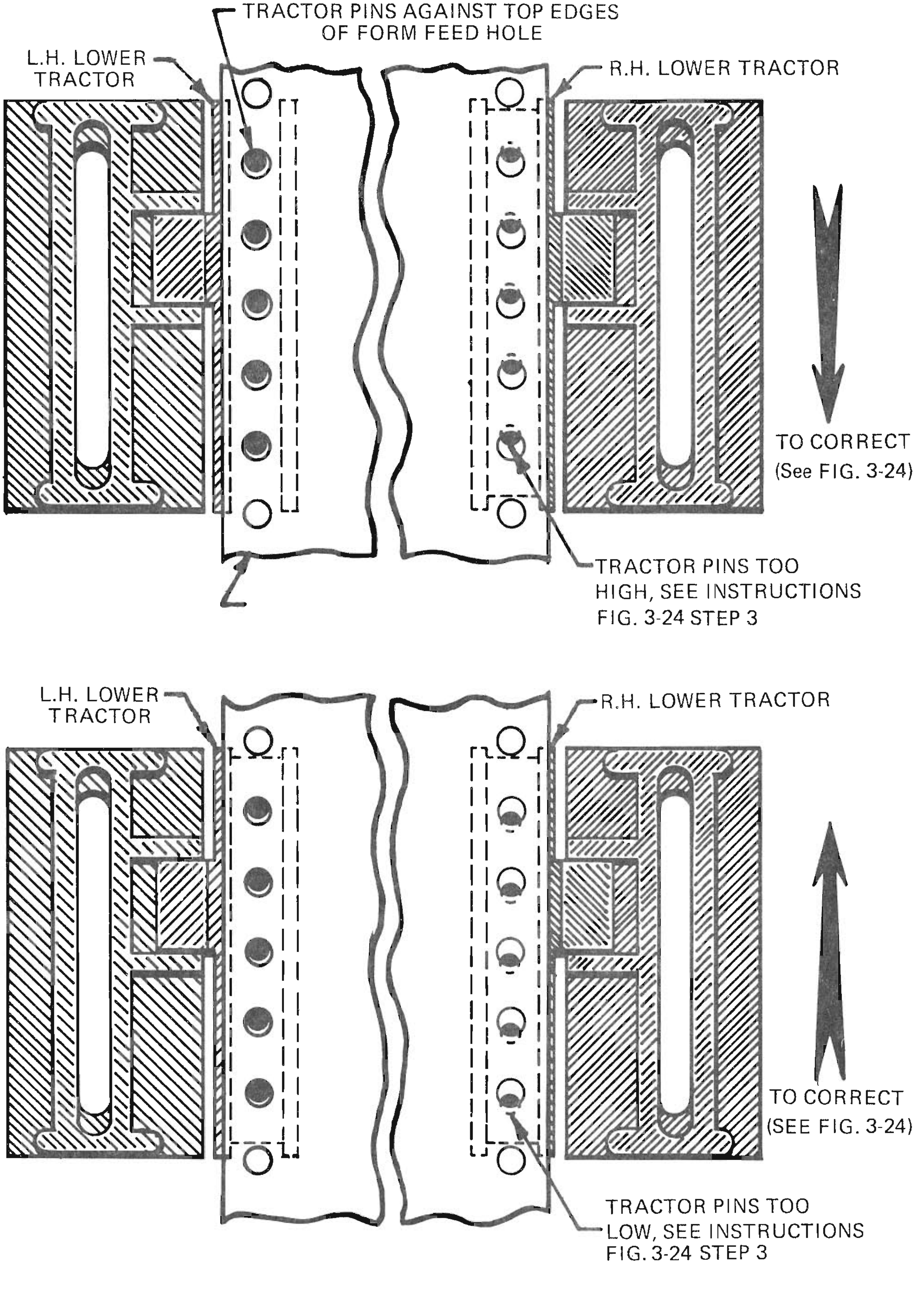
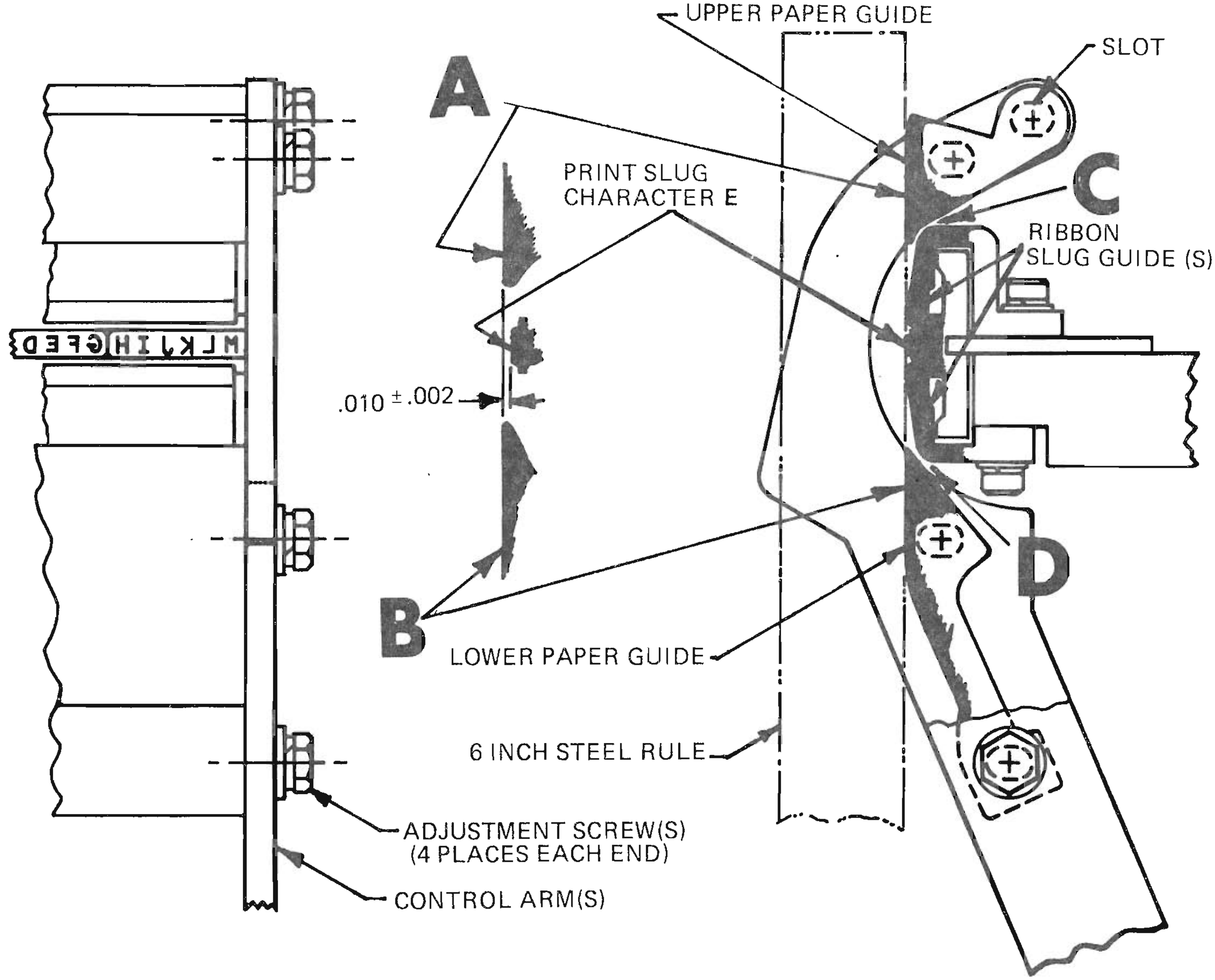


Figure 3-25. Alignment Illustration, Lower Paper Tractor Alignment



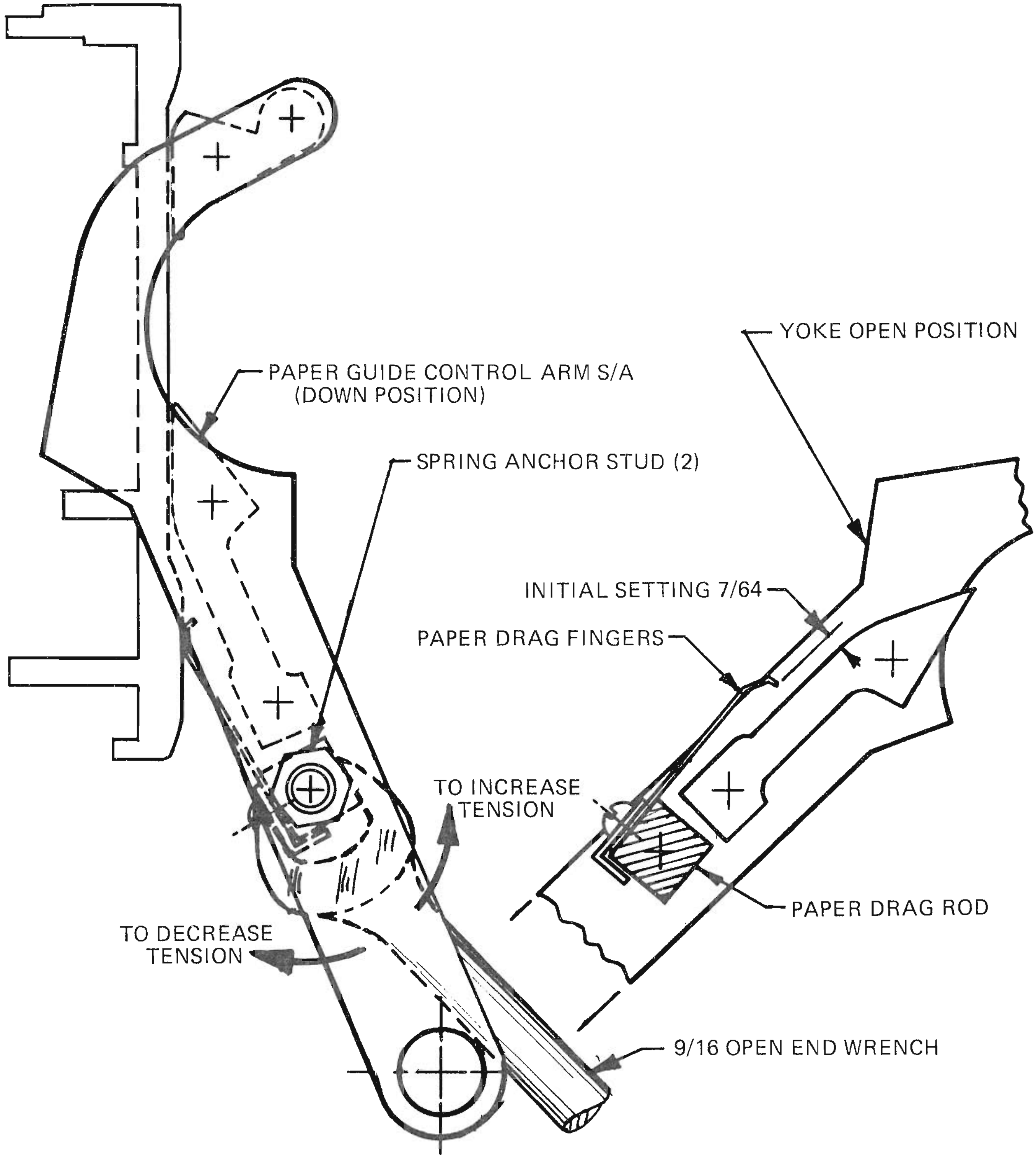
STEP 1: REMOVE RIBBON. USING A 6 INCH STEEL POCKET SCALE WITH EDGE HELD FLAT AGAINST UPPER & LOWER PAPER GUIDES, CHECK FOR PARALLELISM OF SURFACES **A & B** IN THE PRINT AREA (OPPOSITE PRINT HAMMERS). PAPER GUIDES MAY BE ADJUSTED BY LOOSENING ADJUSTMENT SCREWS AT BOTH ENDS OF CONTROL ARMS AND MOVING PAPER GUIDES IN OR OUT AS REQUIRED. PAPER GUIDES MUST BE ABOVE PRINT SLUG CHARACTER FACES APPROXIMATELY .010 AS SHOWN IN ENLARGED VIEW ABOVE. USE FULL CHARACTER "E" FOR THIS SETTING.

STEP 2: ENSURE THAT THERE IS ADEQUATE CLEARANCE FOR RIBBON BETWEEN PAPER GUIDES & RIBBON/SLUG GUIDES (POINTS **"C" & "D"**) CHECK OPENINGS IN THESE AREAS WITH 2 THICKNESSES OF .005 SHIM STOCK (LIGHT BLUE COLOR) ALONG THE 3 CENTER SECTIONS OF RIBBON/SLUG GUIDES.

STEP 3: TIGHTEN ALL SCREWS AND RE-CHECK FOR PARALLELISM & CLEARANCES PER STEP 1 & STEP 2.

STEP 4: LOOSEN TRACTOR CLAMPS & MOVE ALL TRACTORS OUT TOWARD SIDE FRAMES. HOLD 6 PART PAPER FORMS CENTERED ON PRINT STATION AND CLOSE YOKE & LATCH. SET PENETRATION CONTROL ON "DARK" POSITION. PULL 6 PART PAPER THROUGH. IF PAPER IS CLAMPED TIGHT THE LOWER PAPER GUIDE MAY BE TILTED IN TOO CLOSE TO PLATEN. REPEAT STEPS 1 THROUGH 4 AS REQUIRED.

Figure 3-26. Upper and Lower Paper Guides Setting



TO ADJUST PAPER TENSION: OPEN YOKE ASSEMBLY & SWING PAPER GUIDE CONTROL ARM SUB-ASSEMBLY TO DOWN POSITION AS SHOWN. USING A 9/16 OPEN END WRENCH ENGAGED ON CENTER OF PAPER DRAG AS SHOWN, PULL WRENCH UPWARD TO INCREASE PAPER TENSION OR DOWNWARD TO DECREASE PAPER TENSION. SEE FIG. 3-28 FOR METHOD OF CHECKING PAPER TENSION. MAKE CERTAIN SPRING ANCHOR STUDS AT BOTH ENDS OF PAPER DRAG ROD ARE TIGHTENED.

Figure 3-27. Paper Tension Adjustment

3.5.2.2.2 Paper Drag Fingers Adjustment (Reference IPB Figure 67)

The paper drag fingers located below the lower paper guide must be properly set to provide a paper tension of 260 ± 20 grams on single-part, 15 lb paper as the paper is steadily pulled upward through the print area. This adjustment is made simply by positioning the drag rod as indicated in Figure 3-27 for the proper paper tension. The drag rod is maintained in position by spring anchor studs at either end of the paper drag/guide assembly.

A convenient method of measuring paper tension is shown in Figure 3-28.

3.5.2.3 Paperfeed Drive Adjustments

The following procedures pertain to the adjustment of the paperfeed drive system, namely; the Form Position Control, the Paperfeed Drive Belt, and the Paperfeed Drive Stepping Motor.

3.5.2.3.1 Form Position Control Adjustment (Reference IPB Figure 36)

The Form Position Control must be adjusted to remove any perceptable end-play, yet permit free rotation while its pulley is held stationary with the cam lever in the release position. This adjustment is achieved by shim washers installed between the two (2) sets of Bellville washers located behind the control knob. This is a critical adjustment and must be performed carefully.

To ensure continued proper operation of the Form Position Control, a very light film of Auto-Moly grease should be applied to the cone clutch surfaces to prevent seizing, yet permit full mating engagement.

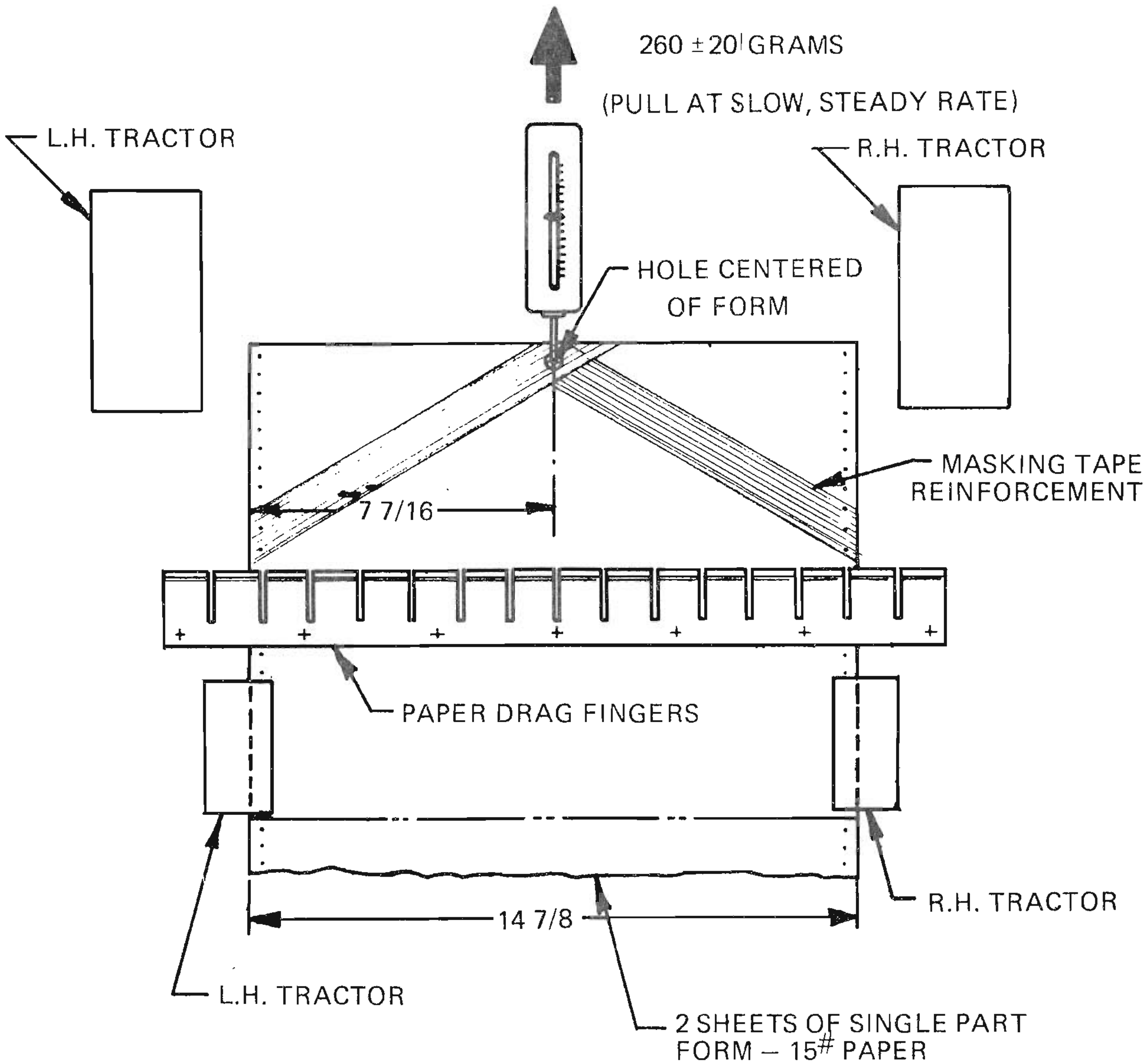
Figure 3-29 shows the details of this adjustment. To adjust, also refer to IPB Figure 36 and proceed as follows:

1. Turn OFF power to the printer and place the Form Position Control cam lever in the release position [“A”].
2. Remove the retaining ring from the left-hand end of the tractor shaft and carefully slide the shaft about 3/8 inch (9, 52 mm) to the left as shown in the lower diagram of Figure 3-29 to relieve the compression force on the control. [Note — With the compression force relieved, the dowel pin which secures the cam lever on the end of the tractor shaft will be free to drop out. Take care not to lose it.]
3. Dis-assemble the Form Position Control assembly down to the outer cone (refer to IPB Figure 36 for details).
4. Slide the outer cone and the pulley along the tractor shaft far enough to expose the cone clutch surfaces.
5. Apply a very light film of Auto-Moly grease to the cone clutch surfaces. Wipe off any excess grease and restore the outer cone and pulley to their original positions.
6. Re-assemble the control assembly with the appropriate shim washers installed between the two (2) sets of Bellville washers as shown in Figure 3-29.
7. Push the tractor shaft to the right and install the retaining ring with the burr, or flat side facing away from the left-hand side frame as shown in Figure 3-29.
8. Check the control for any perceptable end-play and for free rotation of the tractor shaft while the pulley is held stationary with the cam lever in the release position. If any end-play is evident, or the shaft does not rotate freely, repeat the adjustment, adding or deleting shim washers as required.

3.5.2.3.2 Paperfeed Drive Belt Adjustment (Reference IPB Figures 33 and 34)

Drive from the Paperfeed Drive Stepping Motor [B104] is coupled to the tractor shaft through pulleys and a single timing belt as shown in Figure 3-30. The Paperfeed Drive Belt tension must be properly adjusted to ensure proper operation of the paperfeed system. This adjustment is made by rotating the position of the Paperfeed Drive Stepping Motor about a pivot screw.

Figure 3-30 shows the details of adjusting the Paperfeed Drive Belt tension.



PREPARE SINGLE PART FORM – 15# PAPER, AS SHOWN ABOVE, TO CHECK PAPER TENSION. USE STANDARD 14 7/8 WIDE FORM. REINFORCE PAPER WITH MASKING TAPE AND PUNCTURE HOLE AT TOP AND CENTER OF FORM. FOR THIS MEASUREMENT USE A CHATILLON INSTRUMENT PUSH-PULL UTILITY GAUGE NO. 516-1000 (2 LB. x 1/2 OZ./DIVISION & 1000 GRAMS X 10G/DIV.) OR EQUIV. OPEN YOKE ASSEMBLY AND MOVE UPPER TRACTORS OUTBOARD AS SHOWN. PLACE PAPER IN POSITION, CENTERED IN PRINT STATION, AND LOAD PAPER IN LOWER TRACTORS. CLOSE YOKE ASSEMBLY AND LATCH. SET PENETRATION CONTROL ON "DARK" POSITION. INSERT HOOK OF MEASUREMENT GAGE INTO HOLE AT TOP OF PAPER FORM. PULL UP ON GUAGE SLOWLY & STEADILY, PULLING IN LINE WITH PAPER. SET INITIALLY FOR 240 TO 280 GRAMS BY ADJUSTING PAPER DRAG FINGERS. SEE PAPER TENSIONING ADJUSTMENT FIG. 3-27. REMOVE TEST FORM & REPLACE WITH CONTINUOUS, SINGLE PART, 15# FORMS. PROGRAM PRINTER TO PRINT **"M"s** OR OTHER FULL CHARACTER. OBSERVE FORMS FEED HOLES ABOVE UPPER TRACTORS (**TOP EDGE** OF HOLES) FOR PLOWING OR DISTORTION OF HOLES AND CHECK FOR UNIFORM LINE SPACING OF PRINT-OUT (VERTICAL REGISTRATION OF CHARACTERS). FOR EXCESSIVE PLOWING OF FORMS FEED HOLES DECREASE TENSION ON PAPER DRAG FINGERS TO POINT WHERE VERTICAL REGISTRATION OF CHARACTERS & LINE SPACING IS UNIFORM.

Figure 3-28. Paper Tension Measurement

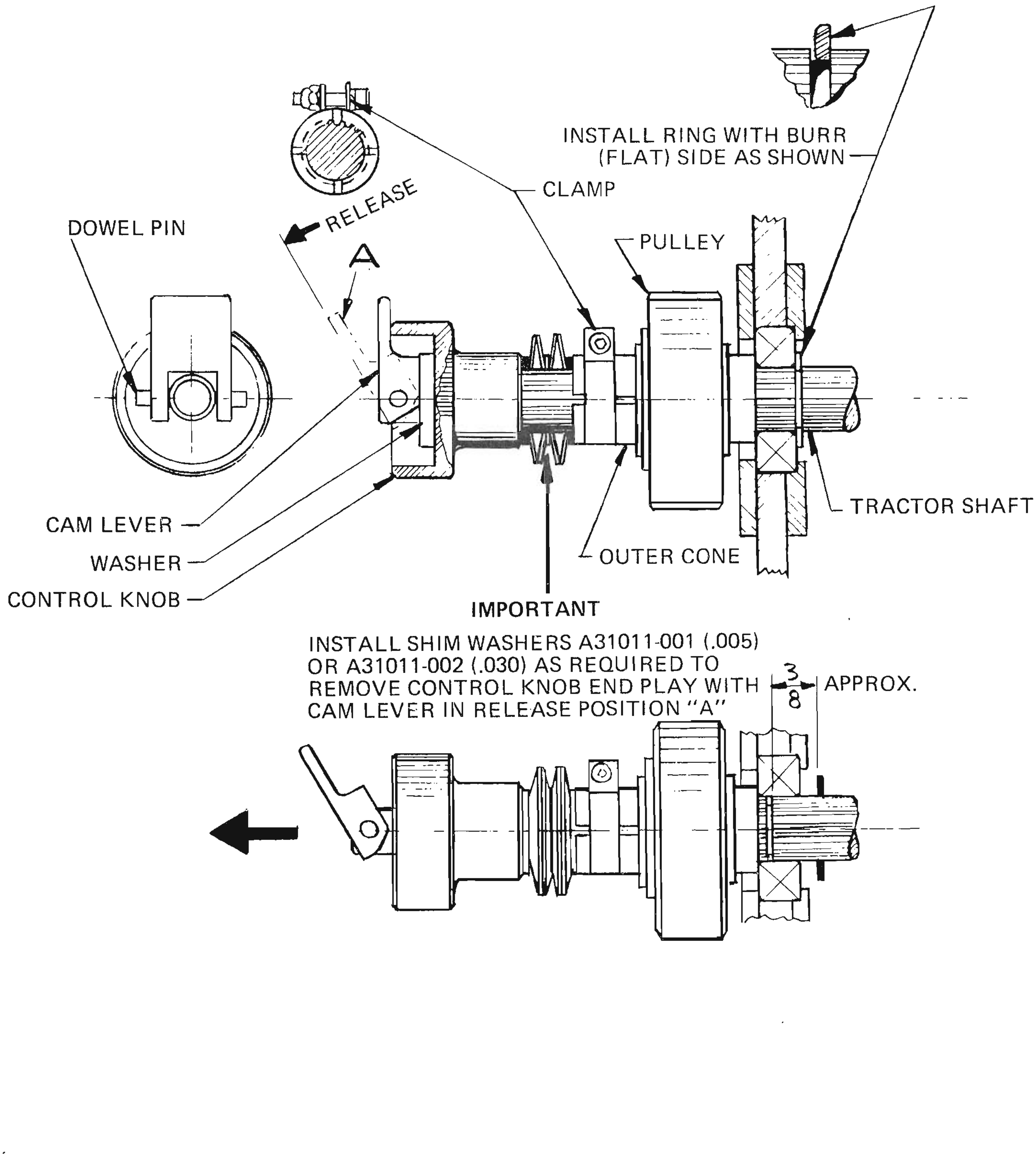
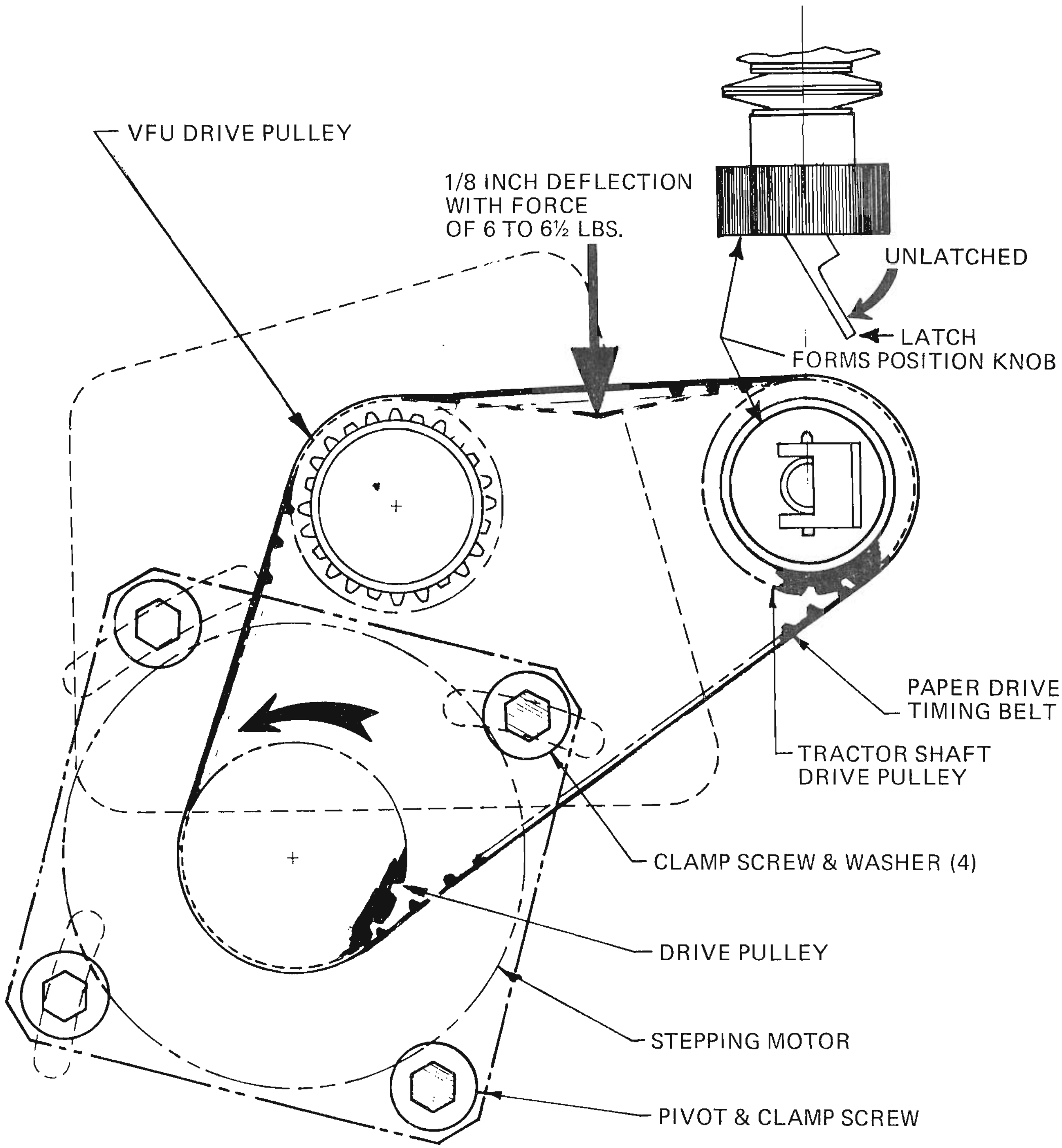


Figure 3-29. Form Position Control Adjustment

CAUTION: EXERCISE CARE WHEN LOOSENING & TIGHTENING STEPPING MOTOR CLAMP SCREWS TO AVOID DAMAGING STROBE DISCS.



NOTE: TO PROPERLY TENSION TIMING BELT, LOOSEN 4 CLAMP SCREWS ON STEPPING MOTOR, SWING STEPPING MOTOR IN DIRECTION SHOWN AND HOLD WHILE TIGHTENING CLAMP SCREWS. BELT MUST NOT BE OVERLY TIGHT SO THE FORMS POSITIONING CONTROL WILL NOT FUNCTION PROPERLY. AT THE PROPER TENSION THE FORMS POSITION KNOB IN THE UNLATCHED POSITION WILL ROTATE EASILY WHILE HOLDING THE TRACTOR SHAFT DRIVE PULLEY STATIONARY.

Figure 3-30. Paperfeed Drive Belt Tension Adjustment

3.5.2.3.3 Paperfeed Stepping Motor Adjustment (Reference IPB Figures 33, 34 and 79, and CD Figures 5.0.1, 5.0.5 and 13.0.1)

The Paperfeed Drive Stepping Motor [B104] is operated in a synchronous manner from synchronizing Step Strobe pulses fed-back from the Step Stobe Generator [at Channel 1 of the Line Feed Strobe Sensor A101[6]]. The phase relationship of the Step Strobe pulses, and the amplitude and duration of the stepping motor Phase Winding drive pulses, must be carefully adjusted to provide optimum synchronous operation of the stepping motor, and to provide a smooth deceleration of the moving forms when a paper advance operation is stopped. The stepping motor is self-lubricated, and should require no maintenance attention throughout its life.

To adjust the operation of the Paperfeed Drive Stepping Motor, proceed as follows, performing each step in the sequence listed. [Note — Steps 2 through 4, below, may be omitted when performing a preventive maintenance check of the stepping motor operation.]

1. Check that the Paper Tractors, Paper Guides, Form Position Control and Paperfeed Drive Belt are properly adjusted (for details, refer to 3.5.2.1, 3.5.2.2, 3.5.2.3.1 and 3.5.2.3.2 respectively).
2. With the printer power turned OFF, preset the four (4) potentiometers R2, R4, R6 and R38 on the Paper/Ribbon Control PCB [Logic Electronics Bay position 15] as follows:
   A. Turn the Phase Winding Current Control potentiometer, R38, counter-clockwise until it makes a faint "clicking" sound which indicates that the bottom limit has been reached.
   B. Turn the three (3), single-turn Deceleration Delay potentiometers R2, R4 and R6 to their maximum clockwise position.
3. Turn the printer ON and press the ONE LINE pushbutton switch on the front control panel to cause the printer's logic electronics to request paperfeed. [Note — With the Phase Winding Current Control potentiometer preset per Step 2, above, no current will be supplied to the stepping motor and no paperfeeding will occur; however, the printer's logic electronics will be requesting paperfeed and will continue to do so until the next step (4) is completed.]
4. With the printer's logic electronics requesting paperfeed, turn the Phase Winding Current Control potentiometer, R38, clockwise until the stepping motor starts moving; then continue turning in the clockwise direction for one (1) complete turn. At this point the stepping motor will be stopped and a distinct "whistling" sound will be heard in the vicinity of the stepping motor.
5. If the printer is equipped with the optional 6/8-LPI Linespacing Feature, check that the 6/8 LINES PER INCH switch [S110] on the VFU mounting plate is in the six (6) LPI position and that a format tape loop punched for 6-LPI is installed in the VFU.
6. Press the HOME pushbutton switch on the front control panel to advance the stepping motor to the next logically indexed stop position. [Note — Stepping motor Phase Windings 2 and 3 will be energized at a low, "holding" current level when the motor stops.]
7. With the motor stopped at a logically-indexed position, adjust the Phase Winding Current potentiometer, R38, to provide a phase winding "holding" level of 0.8 Volt DC (1.6 Amp.) 1.1V as shown in Figure 3-31 at the "Ø2" Test Point on the Paper/Ribbon Control PCB.
8. Carefully loosen (DO NOT REMOVE) the two (2) pan-head screws that lock the Line Feed Strobe sensor mounting bracket (see Figure 3-32).
9. Program the printer to operate in the LOCAL, PROGRAM FEED mode with a "space 63 lines" paperfeed command code [0 111 111].
10. Operate the printer with the yoke in the open position[7]. While the printer is paperfeeding, carefully adjust the angular position of the Line Feed Strobe sensor mounting bracket as shown in Figure 3-32 until the Step Strobe pulses appearing at the "STEP STROBE" Test Point on the Paper/Ribbon Control PCB occur at an interval of from 0.9 to 1.0 MS (see 1.1 ms Figure 3-33).

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(6)A dual-channel sensor is provided on units equipped with the standard 6-LPI Linespacing Feature: units equipped with the optional 6/8-LPI Linespacing Feature are provided with a single-channel sensor, A101.

(7)To operate the printer in the LOCAL mode with the yoke open, place the Yoke Latch lever in the "Closed" or latched position and pull out the actuator of the Yoke Interlock switch to the Maintenance Override position. Always check that the actuator of the Yoke Interlock switch is in the normal position before returning the printer to service.

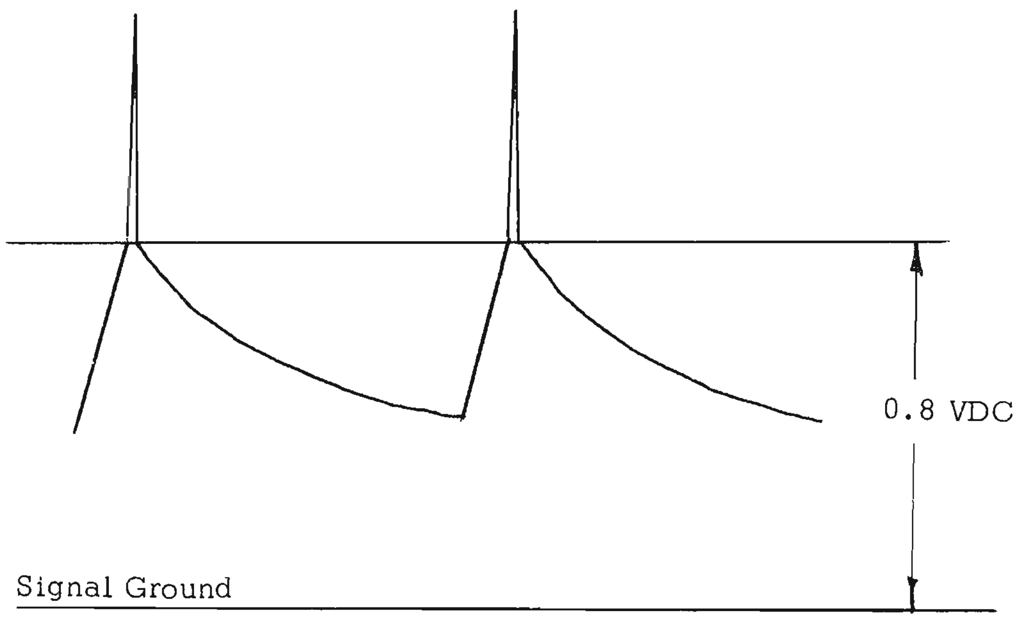

Figure 3-31. Stepping Motor Phase Winding "Hold" Current, Typical Waveform [Test Points Ø1, Ø2, Ø3 and Ø4]

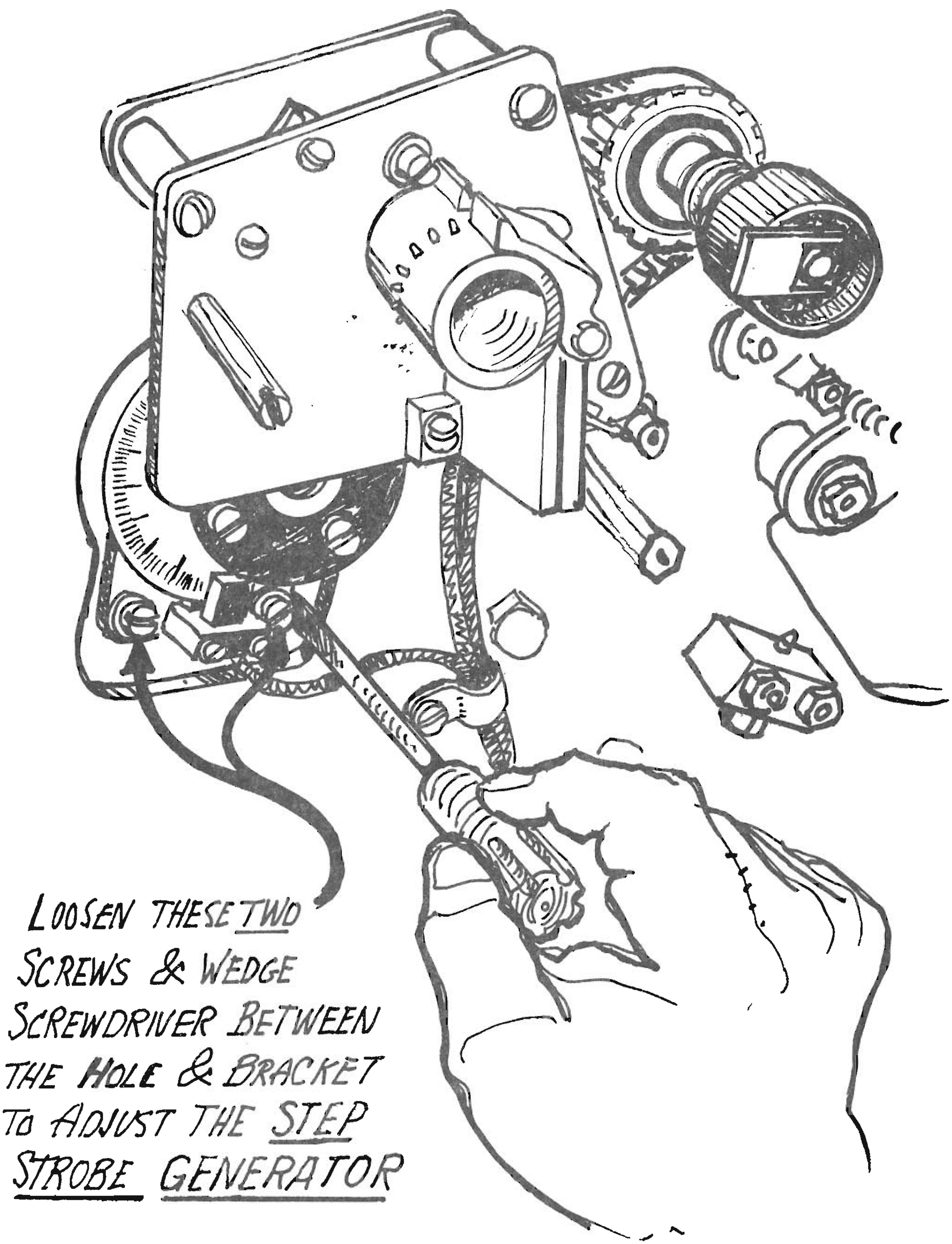

Figure 3-32. Line Feed Strobe Sensor Adjustment

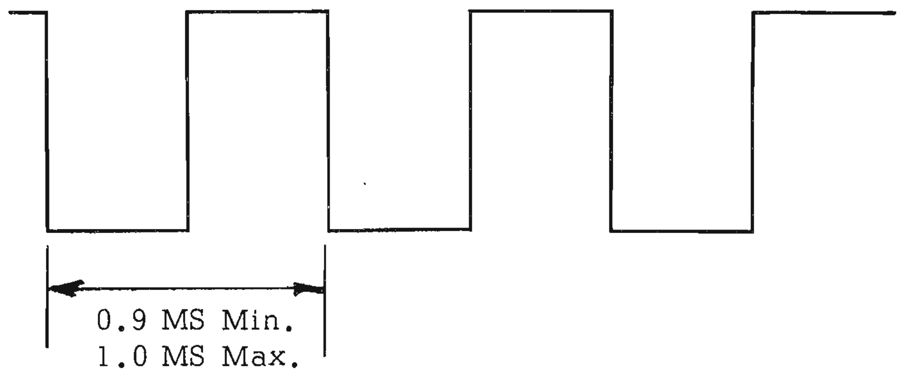

Figure 3-33. Step Strobe Pulse Waveform

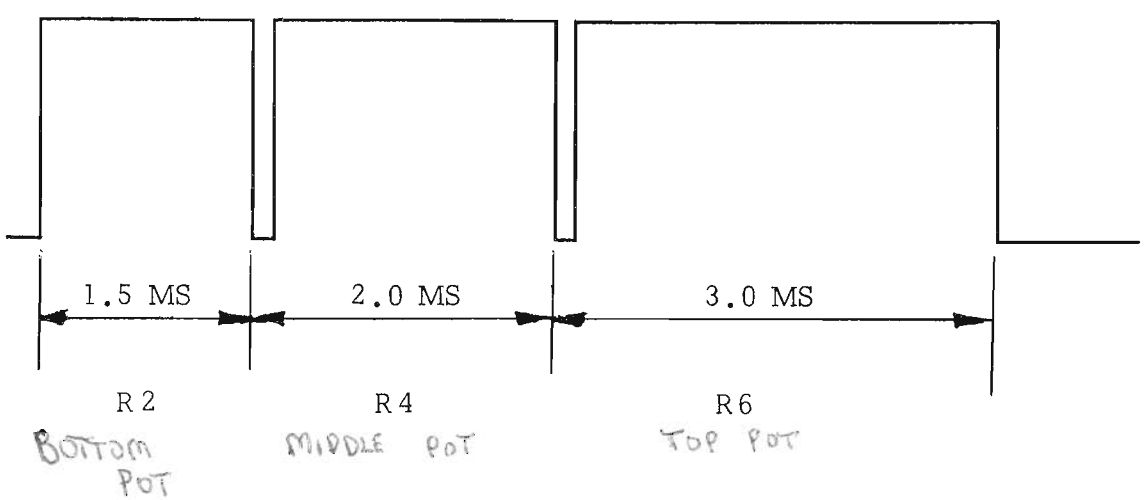

Figure 3-34. Waveform, Deceleration Delay Interval Sequence

CAUTION

Take particular care to avoid contact with the metal timing disc when adjusting the Line Feed Strobe sensor bracket. The disc is necessarily thin and may easily be damaged.

[Note — If the adjustment of the Line Feed Strobe sensor mounting bracket is not close to the proper setting, the paperfeed drive system may make a "growling" sound, and may occasionally stall. The printer can be restarted by pressing the STOP, then the RUN push-button switches on the front control panel.]

11. With the printer in the STOP mode, carefully tighten the two (2) screws that lock the Line Feed Strobe sensor mounting bracket in position. Operate the printer and check that the adjustment did not shift when the locking screws were tightened.
12. Program the printer to operate in the LOCAL, SINGLE SPACE mode[8].
13. Operate the printer with the yoke in the open position. While the printer is operating, adjust the three (3) Deceleration Delay potentiometers R2, R4 and R6 to obtain a stream of three step strobe delay intervals at Test Point "D" on the Paper/Ribbon Control PCB as follows (see Figure 3-34):

R2; First of three delay intervals:	1.5 MS
R4; Second of three delay intervals:	2.0 MS
R6; Last of three delay intervals:	3.0 MS

14. Load paper into the printer, close the yoke and operate the printer in the LOCAL, SINGLE SPACE mode. While the printer is operating, make a "pencil scope" on the advancing paper by steadily drawing a pencil along the formscale as shown in Figure 3-35. Check the pencil scope for the conditions illustrated in Figure 3-36. If further adjustment is required, re-adjust the Deceleration Delay potentiometers R2, R4 and R6 proportionately; that is, so that the basic 1.5-to-2-to-3 ratio is maintained.

3.5.2.4 Paperfeed Strobe Adjustment

Operation of the Paperfeed Drive Stepping Motor is also synchronized with the paper tractors to permit paper motion to be stopped with the desired linespace accurately positioned opposite the bank of print hammers. This synchronization is accomplished by means of positioning strobe pulses fed-back from either of two different types of strobe generators depending upon the line-spacing feature provided. Units equipped with the standard 6-LPI Linespacing Feature are provided with a dual-channel Line Feed Strobe Sensor, A101, which provides a 6-LPI Strobe output at Channel 2 for paperfeed synchronization. On units equipped with the optional 6/8-LPI Line-spacing Feature, a single-channel (Channel 1 only) sensor is provided in place of the dual-channel sensor, and a seperate "1/2-Inch Strobe" sensor, A102, and associated timing disc are provided behind the VFU for paperfeed synchronization.

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(8) If desired, the firing of print hammers can be suppressed in this mode by also programming the appropriate input code for the "Space" character (bit pattern 0 100 000 if ASCII; bit pattern 1 000 000 if EBCDIC).

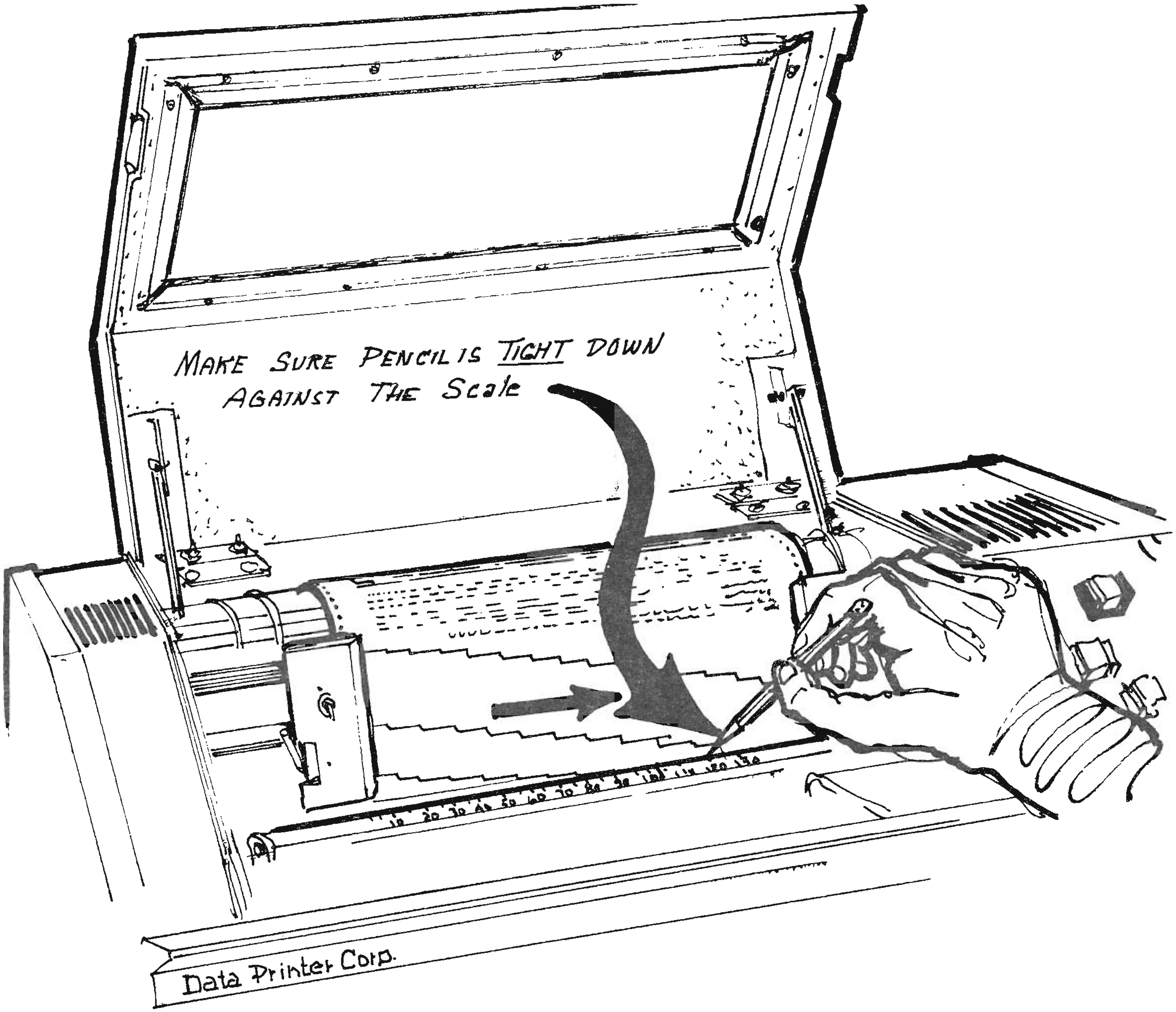
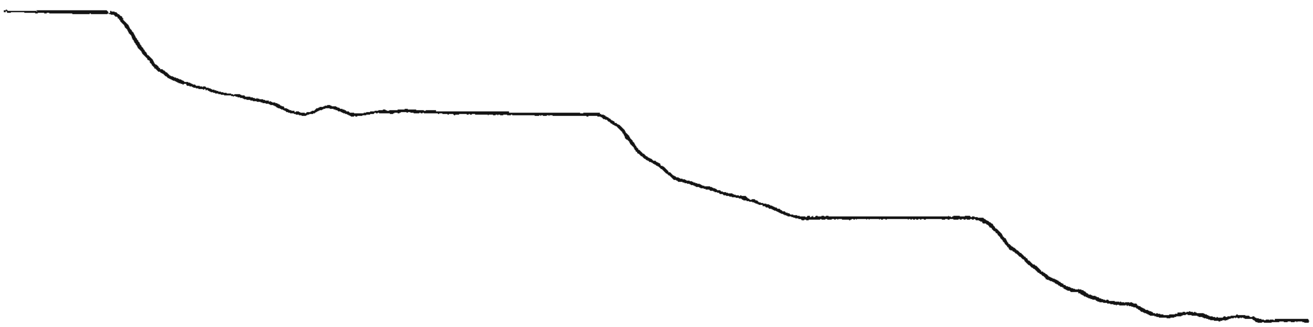
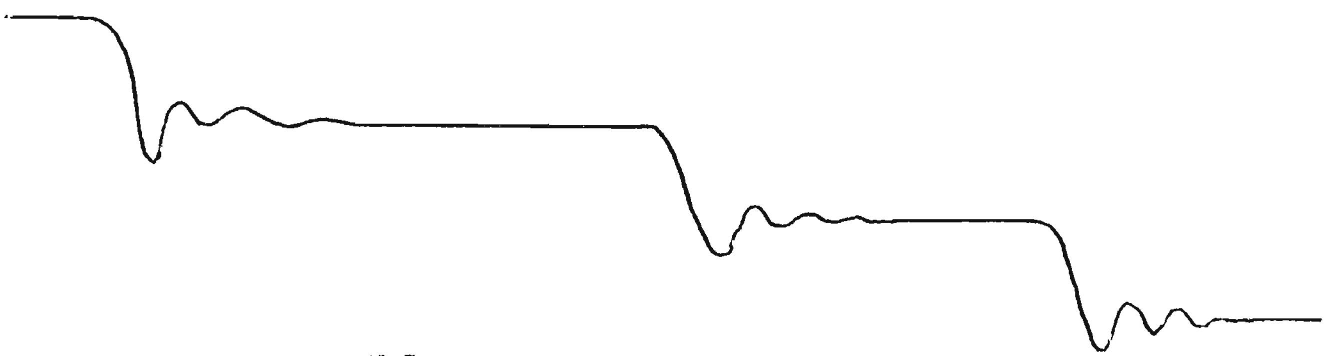


Figure 3-35. Pencil Strobe Technique

Correct Pencil Scope
No further adjustment required



Incorrect Pencil Scope
Note long slope from one line to the next
Paperfeed stopping time is too slow, proportionately adjust potentiometers R2, R4 and R6 in the counter-clockwise direction.



Incorrect Pencil Scope
Note over-travel from one line to the next
Paperfeed stopping time is too fast; proportionately adjust potentiometers R2, R4 and R6 in the clockwise direction.

Figure 3-36. Paperfeed Pencil-Scope Conditions

3.5.2.4.1 Six-LPI Paperfeed Strobe Adjustment (Reference IPB Figures 32, 39 and 79, and CD Figures 5.0.1 and 13.0.1)

NOTE

The following procedure applies only to units equipped with the standard 6-LPI Linespacing Feature. The procedure affects the position of the line-count timing disc and should be performed only if additional adjustment is required after having completed the Paperfeed Drive Stepping Motor adjustment procedure 3.5.2.3.3, above.

The feeding of paper by the printer is synchronized with the paper tractors from "6-LPI Strobe" pulses fed-back from the 6-LPI Strobe Generator [at Channel 2 of the Line Feed Strobe Sensor A101]. The timing relationship of the 6-LPI Strobe pulses and the stepping motor Phase Winding Drive pulses must be adjusted to ensure proper positioning of the form at the typeline. This adjustment is made by carefully rotating the linecount timing disc with respect to the stepping motor shaft position.

The sensor itself is preset at the time of manufacture and should require no maintenance attention throughout its life. To ensure satisfactory performance, the sensor's light source and optical switch should be cleaned periodically.

To adjust the timing of the 6-LPI Strobe pulses, proceed as follows:

1. Remove any forms that are in the printer.
2. Attach an oscilloscope to view and synchronize on the Phase 1 drive pulse at Test Point "Ø1", and to also view the 6-LPI Strobe pulse at terminal A37 of the Paper/Ribbon Control PCB [Logic Electronics Bay position 15].
3. Turn the printer ON and simultaneously press both the ONE LINE and HOME pushbutton switches on the front control panel to slew feed. While slew-feeding, check the timing relationship of the Phase 1 drive pulse and the 6-LPI Strobe pulse (refer to Figure 3-37). Note the direction and degree of correction required, if any.
4. Turn the printer OFF and carefully loosen [DO NOT REMOVE] the three (3) pan-head screws that secure the linecount timing disc to the drive pulley (refer to IPB Figure 39 for details).
5. With the linecount timing disc loosened, manually rotate it as required. [Note—Each 1.8°, or each space between apertures in the outer band, of the disc corresponds to one (1) MS at normal operating speed. Rotating the disc clockwise retards the 6-LPI Strobe pulse; rotating the disc counter-clockwise advances the 6-LPI Strobe pulse.]
6. Tighten the three (3) screws that secure the timing disc and repeat Step 3, above, to check the adjustment.
7. Since any adjustment of the linecount timing disc also affects the Step Strobe Generator, the Paperfeed Drive Stepping Motor adjustment should be rechecked, and re-adjusted as required (see 3.5.2.3.3, above, for details).

3.5.2.4.2 Six/Eight-LPI Paperfeed Strobe Adjustment (Reference IPB Figures 28, 29 and 79, and CD Figures 5.0.1 and 13.0.1)

NOTE

The following procedure applies only to units equipped with the optional 6/8-LPI Linespacing Feature. On units so equipped, an additional timing disc and optical switch assembly are provided behind the VFU mounting plate at the upper left side of the printer mechanism. This procedure affects the position of that timing disc and should be performed only if additional adjustment is required after having completed the Paperfeed Drive Stepping Motor adjustment procedure 3.5.2.3.3, above.

The feeding of paper by the printer is synchronized with the paper tractors from "1/2-Inch Strobe" pulses fed-back from the 1/2-Inch Strobe Generator single-channel sensor A102. The timing relationship of the 1/2-Inch Strobe pulses and the stepping motor Phase Winding Drive pulses must be adjusted to ensure proper positioning of the form at the typeline. This adjustment is made by carefully rotating the single-channel sensor, A102, with respect to the associated timing disc.

The sensor itself is preset at the time of manufacture and should require no maintenance attention throughout its life. To ensure satisfactory performance, the sensor's light source and optical switch should be cleaned periodically.

To adjust the timing of the 1/2-Inch Strobe pulses, proceed as follows:

1. Remove any forms that are in the printer.
2. Attach an oscilloscope to view and synchronize on the Phase 1 drive pulse at Test Point "Ø1", and to also view the 1/2-Inch Strobe pulse at terminal A37 of the Paper/Ribbon Control PCB [Logic Electronics Bay position 15].
3. With the printer power turned OFF, carefully loosen [DO NOT REMOVE] the two (2) truss-head screws that fasten the sensor mounting block to the VFU mounting plate. The screws should be loosened only enough so that the mounting block will be held in place during adjustment.
4. Turn the printer ON and simultaneously press both the ONE LINE and HOME pushbutton switches on the front control panel to slew feed. While slew-feeding, carefully slide the 1/2-Inch Strobe sensor and mounting block to obtain the signal relationship shown in Figure 3-37. [Note—A 1/2-Inch Strobe pulse occurs once for every six (6) Phase 1 Winding drive pulses.]
5. Turn the printer OFF and tighten the two (2) screws that secure the 1/2-Inch Strobe sensor mounting block. Repeat Step 4, above, to check that the adjustment has not shifted while tightening the screws.

3.5.2.5 Vertical Format Unit Adjustments

The procedures that follow pertain to the alignment of the vertical format unit, the format tape hold-down gap adjustment, and the format tape sprocket positioning. Depending upon customer requirements, a printer can be provided with either a standard eight (8)-channel, or an optional twelve (12)-channel vertical format unit.

3.5.2.5.1 Eight-Channel VFU Adjustments (Reference IPB Figures 28 and 30)

Figure 3-38 shows the details of adjusting the axial position of the 8-Channel VFU tape sprocket and the tape hold-down to sprocket gap. The tape sprocket must be properly adjusted to align the punched holes in the format tape-loop with the VFU reader channels.

3.5.2.5.2 Twelve-Channel VFU Adjustments (Reference IPB Figures 28 and 29)

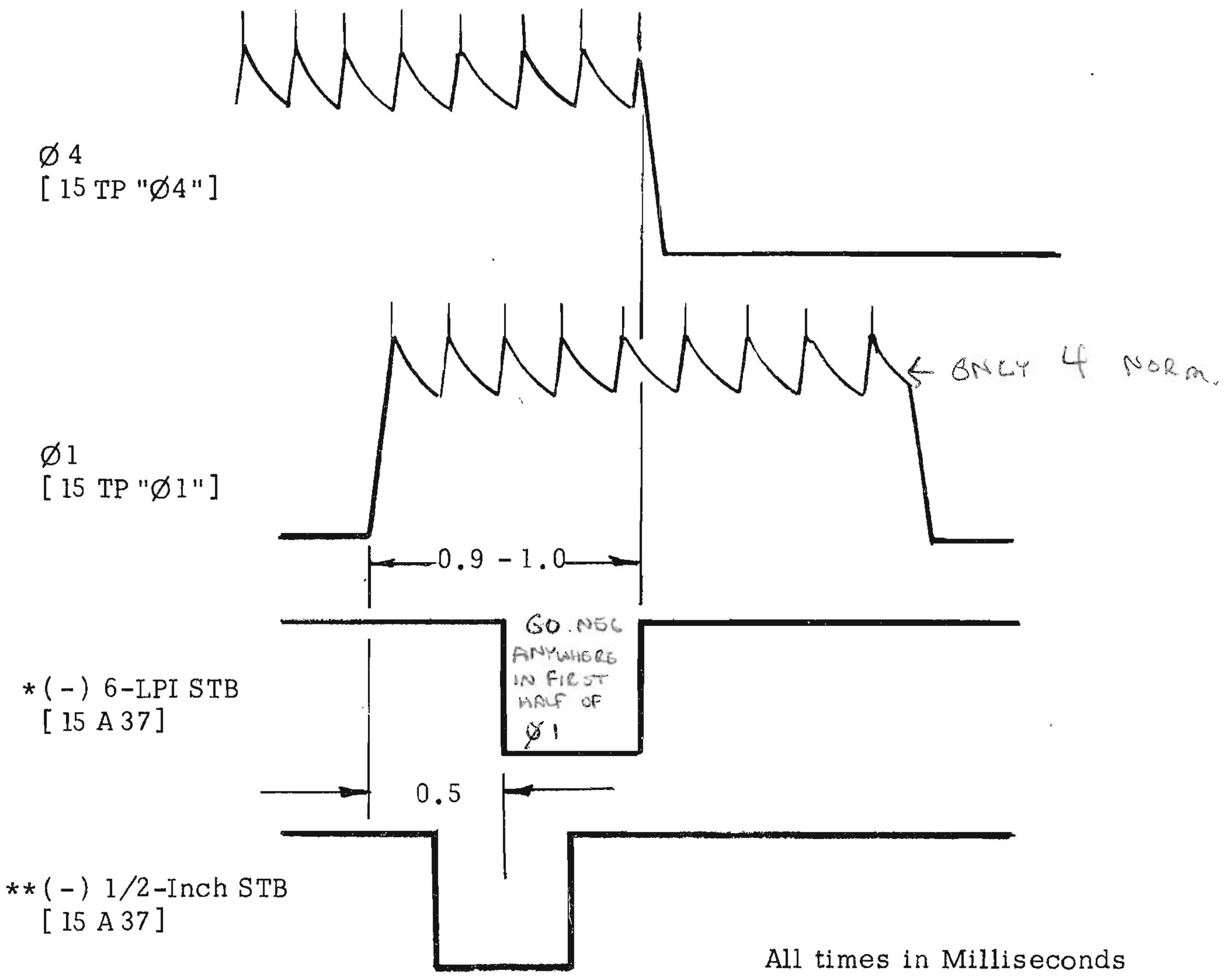
Figure 3-39 shows the details of the 12-Channel VFU tape hold-down and tape sprocket axial position adjustments. The tape hold-down must be adjusted axially to ensure that the slot in the hold-down properly clears the feed adjust pins on the tape sprocket, and the tape hold-down eccentric must be set to provide the proper hold-down-to-sprocket gap so that the hold-down clears the spliced section of the format tape-loop with a minimum of clearance. The tape sprocket must be adjusted axially to align the punched holes in the format tape-loop with the VFU channels.

3.5.2.5.3 VFU Timing Adjustment (Reference IPB Figures 28, 29 [12-Channel VFU], 30 [8-Channel VFU] and 79, and CD Figures 2.0.5, 5.0.1 and 13.0.1)

NOTE

> The following procedure applies to the tape sprocket of either the standard 8-Channel VFU or the optional 12-Channel VFU. The procedure affects the position of the tape-loop in the VFU reader and should be performed only after completion of the Paperfeed Drive Stepping Motor adjustment and, if required, the appropriate paperfeed strobe timing adjustment. All steps should be performed in the sequence listed.

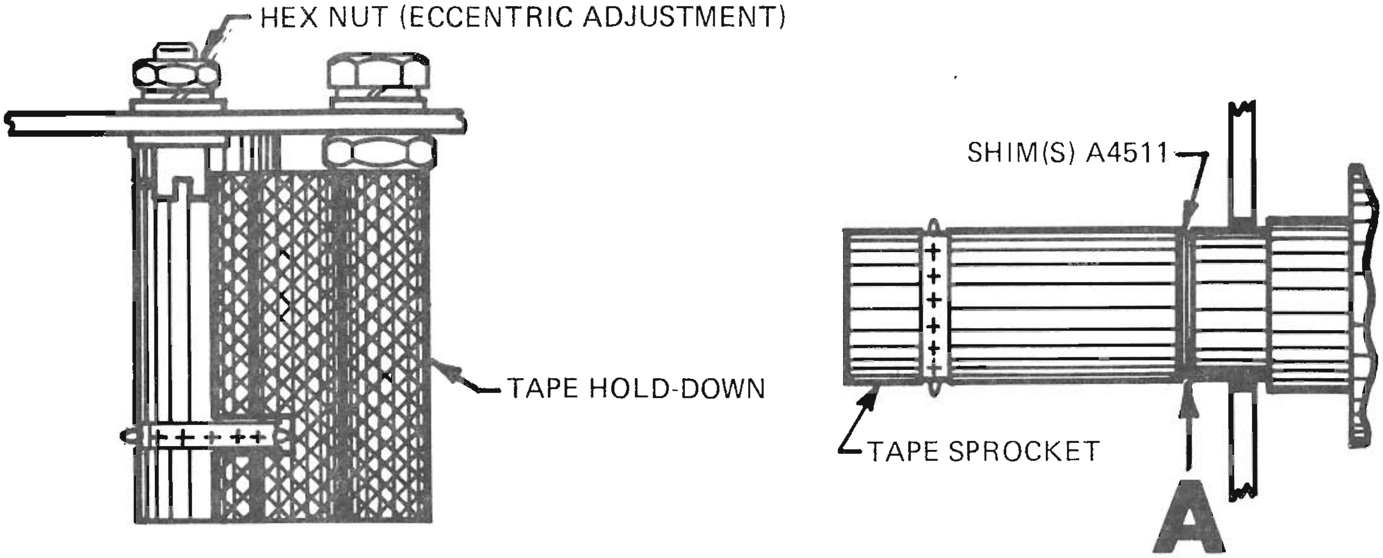
When the printer is paperfeeding under format tape control (i.e.; skipping), the termination of a paperfeed operation is controlled from "VFU Channel" signals fed-back from the VFU reader, A103, which correspond to the punched holes in the format tape. The VFU tape sprocket must be radially adjusted to provide the proper timing of the VFU Channel signals with the internally-generated paperfeed strobe.



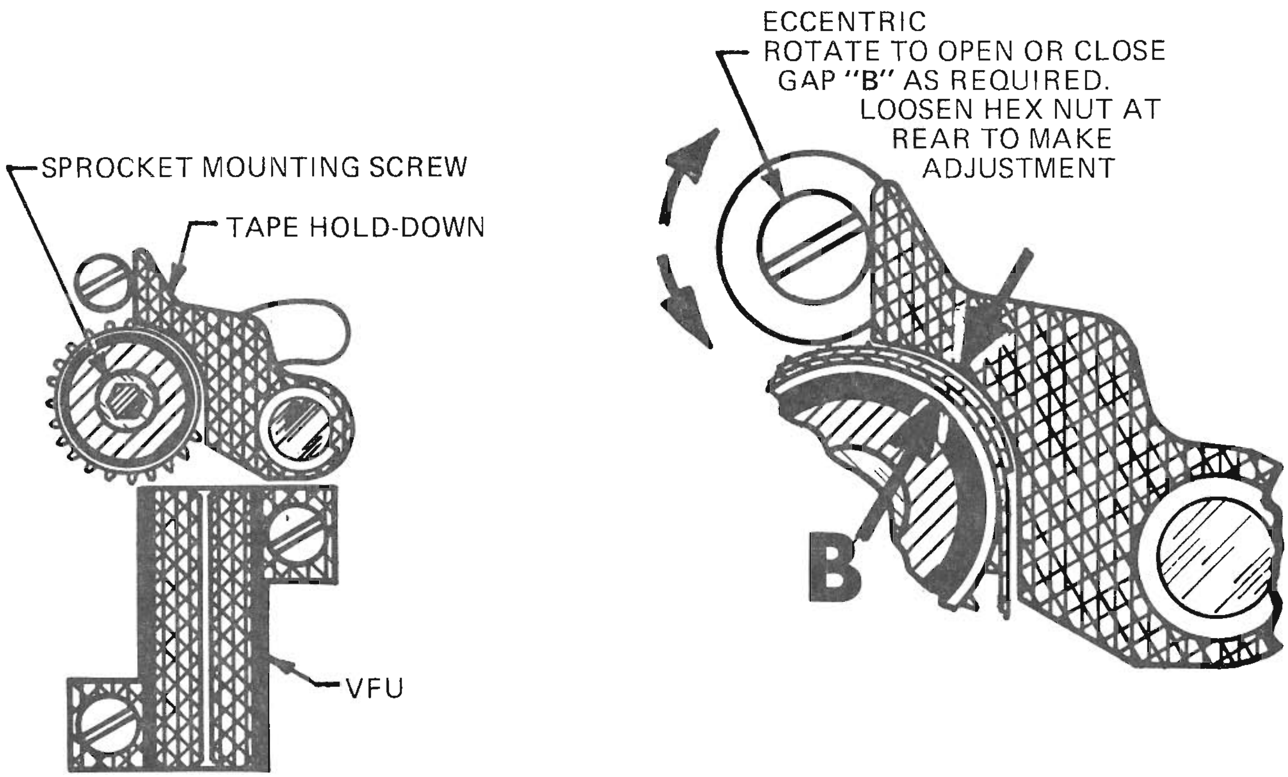
Notes: * Occurs once for every 2 Ø1 cycles, or every 8 Step Strobes; pulse is NOT adjustable with respect to phase-switching time since apertures are fixed on the Step Strobe/6-LPI timing disc.

** Occurs once for every 6 Ø 1 cycles, or every 24 Step Strobes; pulse IS adjustable with respect to phase-switching time by means of associated photosensor positioning.

Figure 3-37. Paperfeed Strobe Adjustment Waveforms (Idealized)



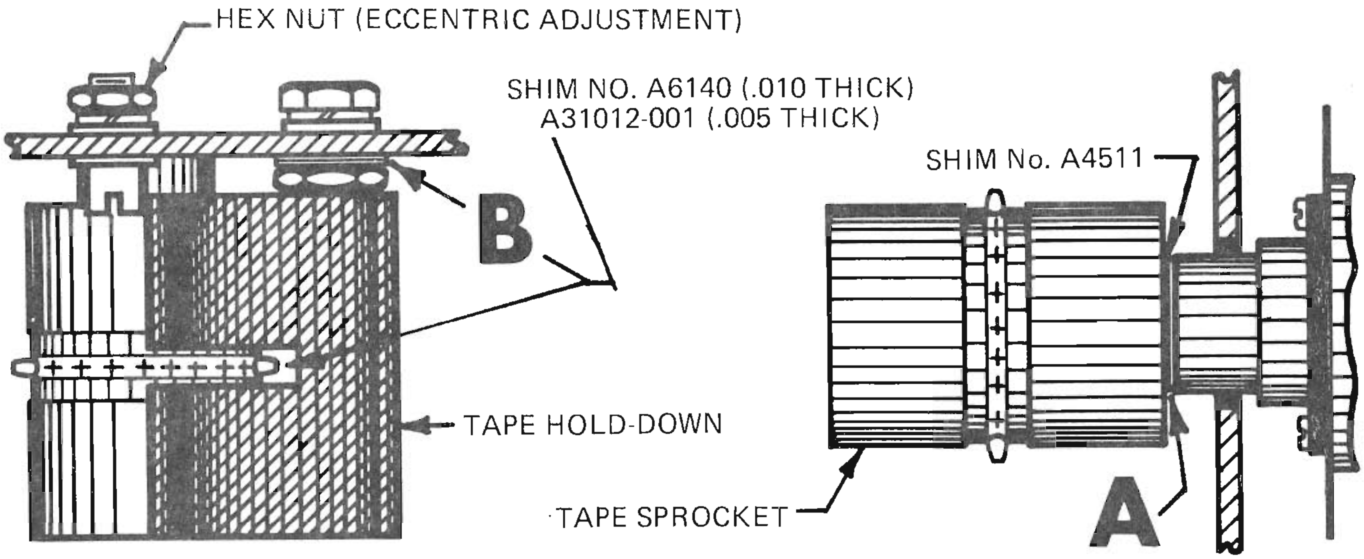
SHIM AT POINT "A" AS REQUIRED TO ALIGN PUNCHED HOLES IN FORMAT LOOP WITH VFU CHANNELS. REMOVE SPROCKET MOUNTING SCREW INSIDE OF TAPE SPROCKET, REMOVE SPROCKET AND INSERT SHIM(S) AS REQUIRED.



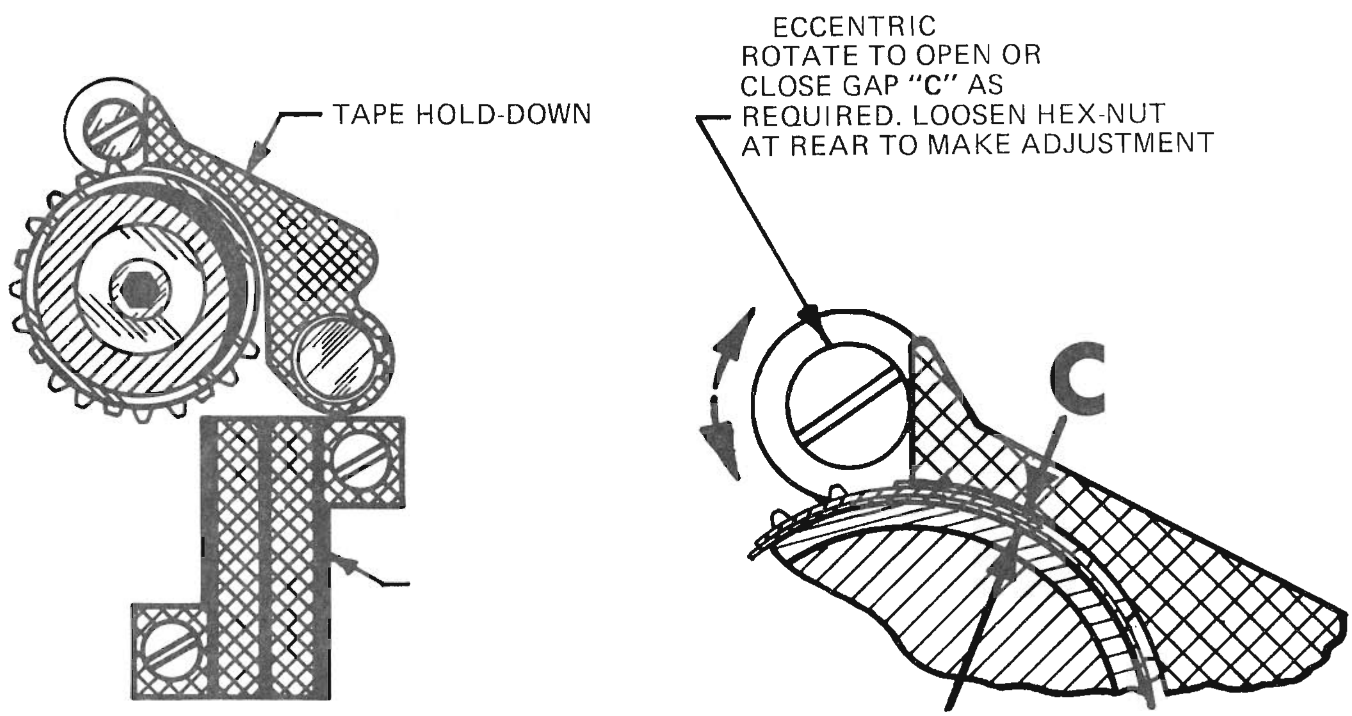
TO ADJUST GAP "B"

GAP MUST BE SET TO CLEAR SPLICED SECTION OF FORMAT LOOP WITH A MINIMUM OF CLEARANCE. USE 3 THICKNESSES OF .005 (TOTAL .015) LIGHT BLUE SHIM STOCK TO MAKE ADJUSTMENT. OPEN TAPE HOLD-DOWN AND WRAP SHIM STOCK AROUND TAPE SPROCKET. CLOSE TAPE HOLD-DOWN AND ADJUST ECCENTRIC UNTIL TAPE HOLD-DOWN RESTS ON SHIM STOCK. TIGHTEN NUT AT FAR END OF ECCENTRIC. REMOVE SHIM STOCK AND TEST FOR CLEARANCE OVER SPLICE ON FORMAT LOOP.

Figure 3-38. Eight-Channel VFU Adjustments



1. SHIM AT POINT "A" AS REQUIRED TO ALIGN PUNCHED HOLES IN FORMAT LOOP WITH VFU CHANNELS.
2. SHIM AT POINT "B" TO ENSURE SLOT IN TAPE HOLD DOWN CLEARS PINS IN TAPE SPROCKET.



TO ADJUST GAP "C"

GAP MUST BE SET TO CLEAR SPLICED SECTION OF FORMAT LOOP WITH A MINIMUM OF CLEARANCE. USE 3 THICKNESSES OF .005 (.015 TOTAL) LIGHT BLUE SHIM STOCK TO MAKE ADJUSTMENT. OPEN TAPE HOLD-DOWN & WRAP SHIM STOCK AROUND TAPE SPROCKET. CLOSE TAPE HOLD-DOWN & ADJUST ECCENTRIC UNTIL TAPE HOLD-DOWN RESTS ON SHIM STOCK. TIGHTEN NUT AT FAR END OF ECCENTRIC. REMOVE SHIM STOCK AND TEST FOR CLEARANCE OVER SPLICE ON FORMAT LOOP.

Figure 3-39. Twelve-Channel VFU Adjustments

To adjust the VFU timing, proceed as follows:

1. Prepare a format tape-loop for the appropriate VFU configuration with a single (1) punch in Channel 1. The Channel 1 punch should be in alignment with a prepunched feed hole in the format tape.[9]
2. Mount the tape-loop in the VFU[10]. On units equipped with the optional 6/8-LPI Linespacing Feature, the tape-loop should be mounted such that the feed hole which is in alignment with the Channel 1 punch is engaged on a truncated (i.e.; flattened top) feed pin on the tape drive sprocket.
3. On units equipped with the optional 6/8-LPI Linespacing Feature, place the 6/8 LINES PER INCH switch, located on the VFU mounting plate, in the six (6) LPI position.
4. Remove any forms that are in the printer.
5. Attach an oscilloscope to view and synchronize on the "VFU Channel 1" output signal at terminal B22 of the Paperfeed Control PCB [Logic Electronics Bay position 3], and to also view the "Gated 1/2-Inch Strobe" signal at the "1/2-Inch Strobe" Test Point[11] on the Paper/Ribbon Control PCB [Logic Electronics Bay position 15].
6. Turn the printer ON and simultaneously press both the ONE LINE and HOME push-button switches on the front control panel to slew feed. While the printer is slew-feeding, check the relationship between the VFU Channel 1 output signal and the Gated 1/2-Inch Strobe signal (refer to Figure 3-40). Note the direction and the degree of correction required, if any.
7. Turn the printer OFF and carefully loosen [DO NOT REMOVE] the socket-head screw in the center of the tape drive sprocket (refer to IPB Figure 29, or 30, for details).
8. With the tape drive sprocket loosened, manually rotate it as required. Rotating the sprocket clockwise (as viewed from the open end of the sprocket) retards the VFU Channel output signals (i.e.; an apparent shift to the right as shown in Figure 3-40): rotating the sprocket counter-clockwise advances the VFU output signals (i.e.; an apparent shift to the left as shown in Figure 3-40). Each 15°, or each space between feed pins, on the tape drive sprocket corresponds to approximately twenty (20) MS when slew-feeding.
9. Tighten the socket-head screw that secures the tape drive sprocket and repeat Step 6, above, to check that the adjustment has not shifted while tightening the screw.
10. On units equipped with the optional 6/8-LPI Linespacing Feature, place the 6/8 LINES PER INCH switch in the eight (8) LPI position and repeat Step 6, above, for proper adjustment.
11. Remove the test format tape-loop.

3.5.2.6 Paper Low Switch Adjustment (Reference IPB Figures 31 and 51, and CD Figures 2.0.3 and 13.0.1)

The Paper Low Switch [SW 109], located on the L.H. Lower Paper Tractor, must be properly adjusted to avoid erroneous Paper Low alarm indications which would interfere with normal printer operation. As shown in Figure 3-41, the Paper Low Switch is actuated by paper in the printer which holds the switch contacts in the closed position when paper is between the tractor belt and paper hold-down plate. When paper is moved out from between the belt and hold-down, the switch actuator arm is freed to spring into the mating slot in the paper hold-down, permitting the NO switch contacts to open.

Figure 3-41 shows the details of adjusting the actuator arm of the Paper Low Switch. The arm is adjusted simply by forming with pliers. When forming the actuator arm, take care to prevent any bending motion from being transferred to the actuator arm pivot point. Operation of the Paper Low Switch can be checked either with an ohmmeter or, with printer power turned ON, by observing the voltage level at terminal 3 B 9 of the Logic Electronics Bay.

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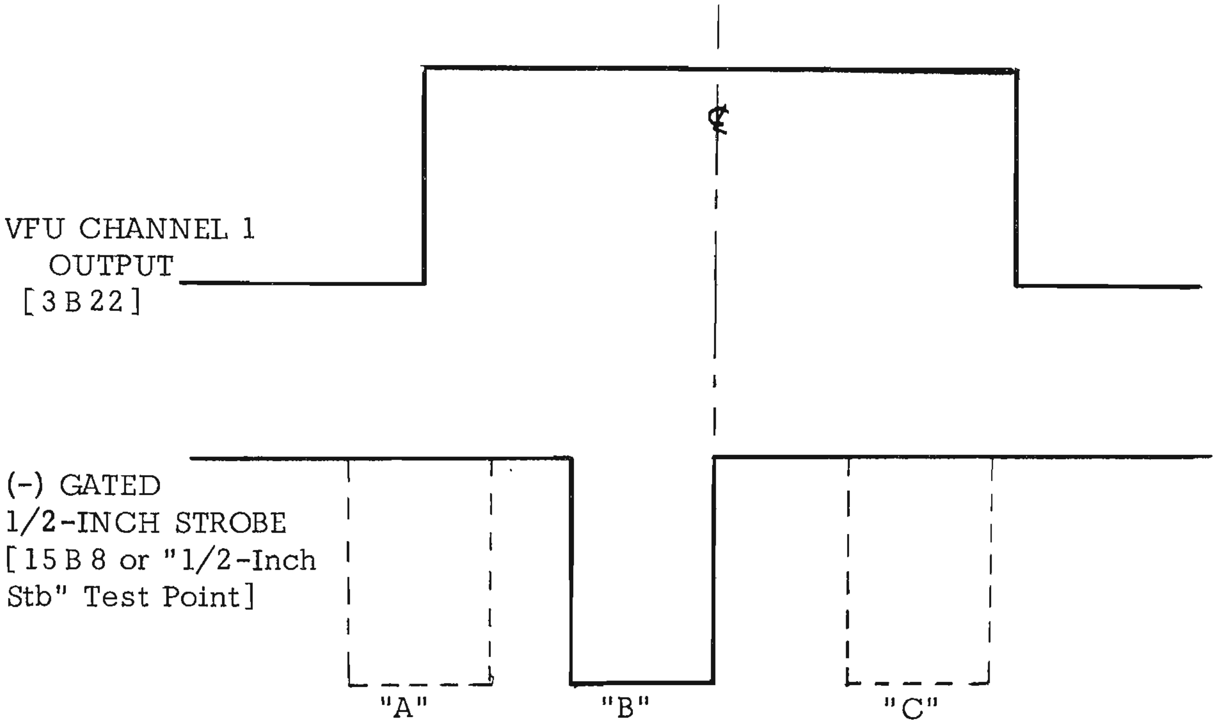
(9) For complete format tape-loop preparation instructions, refer to the "Operating Instructions" manual for the model printer under consideration.

(10) On an 8-Channel VFU, Channel 1 is outermost. On a 12-Channel VFU, Channel 1 is innermost.

(11) The "Gated 1/2-Inch Strobe" signal is also available at terminal B 8 of the Paper/Ribbon Control PCB.



ADJUST THE VFU TAPE DRIVE SPROCKET TO CENTER THE VFU CHANNEL OUTPUT SIGNAL ON THE TRAILING EDGE OF THE (-) GATED 1/2-INCH STROBE PULSE AS SHOWN AT "B" ABOVE.

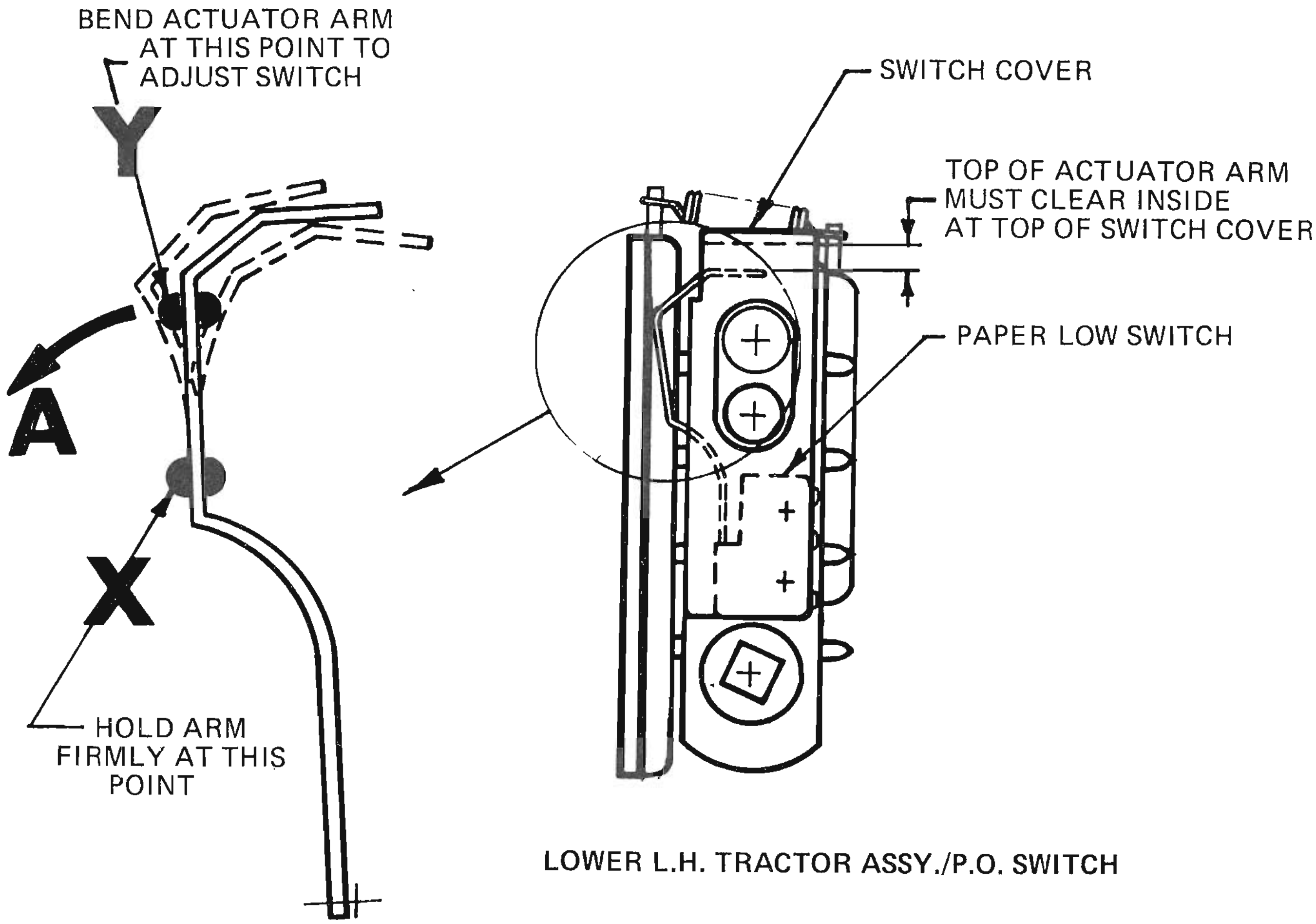
IF THE (-) GATED 1/2-INCH STROBE PULSE IS TO THE LEFT OF THE CENTER OF THE VFU CHANNEL OUTPUT AS SHOWN AT "A" ABOVE, ROTATE THE VFU TAPE DRIVE SPROCKET COUNTER-CLOCKWISE TO ADVANCE THE VFU OUTPUT.

IF THE (-) GATED 1/2-INCH STROBE PULSE IS TO THE RIGHT OF THE CENTER OF THE VFU CHANNEL OUTPUT AS SHOWN AT "C" ABOVE, ROTATE THE VFU TAPE DRIVE SPROCKET CLOCKWISE TO RETARD THE VFU CHANNEL OUTPUT.

TO ADJUST THE VFU TIMING, TURN THE PRINTER OFF AND LOOSEN [DO NOT REMOVE] THE SCREW IN THE CENTER OF THE TAPE DRIVE SPROCKET. ROTATE THE TAPE DRIVE SPROCKET AS REQUIRED AND TIGHTEN SCREW. CHECK THAT THE ADJUSTMENT IS CORRECT AND REPEAT ADJUSTMENT IF REQUIRED.

NOTE - ON UNITS EQUIPPED WITH THE OPTIONAL 6/8-LPI LINESPACING FEATURE, CHECK THAT THE CHANNEL ONE (1) PUNCH IS ALIGNED WITH A TAPE FEED HOLE WHICH, IN TURN, IS ENGAGED ON A TRUNCATED FEED PIN ON THE TAPE DRIVE SPROCKET.

Figure 3-40. VFU Timing Adjustment



TO CHECK & ADJUST PAPER LOW SWITCH:

STEP 1: REMOVE PAPER FROM PRINTER. DEPRESS "**HOME**" SWITCH BUTTON ON CONTROL PANEL FOR "**TOP OF FORM**" CONDITION, OR UNTIL "**PAPER-OUT**" ALARM INDICATOR LIGHT ILLUMINATES.

STEP 2: LOAD 15# SINGLE PART PAPER IN PRINTER. ALARM LIGHT SHOULD NOT BE LIT IN THIS CONDITION. IF NECESSARY, ADJUST SWITCH BY CAREFULLY BENDING ACTUATOR ARM UPWARD IN DIRECTION "A" AS INDICATED. USE 2 SETS OF NEEDLE NOSE PLIERS TO BEND ACTUATOR ARM.

CAUTION

LOWER END OF ACTUATOR ARM MUST BE HELD FIRMLY AT POINT "X" WHILE BENDING ARM AT POINT "Y" TO AVOID DAMAGING SWITCH.

STEP 3: REPEAT STEP 2 TO ENSURE THAT SWITCH HAS BEEN PROPERLY ADJUSTED AND THAT SWITCH "**CLOSES**" WITH PAPER LOADED IN TRACTORS AND "**OPENS**" WHEN THERE IS NO PAPER.

Figure 3-41. Paper Low Switch Adjustment

3.5.2.7. Paper Motion Sensor Adjustment (Reference IPB Figures 31 and 51, and CD Figures 4.0.6 and 13.0.1)

The reflective Paper Motion Sensor [A 106], located on the L.H. Lower Tractor Bracket, must be properly adjusted to avoid erroneous Paper Jam alarm indications which would interfere with normal printer operation. As shown in Figure 3-42, the sensor is actuated by light, from a self-contained source, reflected off the light bands which alternate with dark bands about the periphery of the Strobe Spool. As paper is pulled through the print area, the lower paper tractors turn the strobe spool which alternately turns the Paper Motion Sensor on and off.

The Paper Motion Sensor is adjusted simply by positioning it closer to, or farther from, the strobe spool as shown in Figure 3-42. Operation of the sensor can be checked with printer power turned ON at terminal 5 A 21 using either a voltmeter or oscilloscope.

3.5.3 Ribbonfeed System Adjustments

3.5.3.1 Ribbon Drive Motor and Ribbon Drive Assembly (Reference IPB Figures 58 and 60)

The upper and lower Ribbon Drive Motors [B102 and B103, respectively] and the corresponding Ribbon Drive Assemblies are pre-adjusted at the time of manufacture. The motors and drive assemblies have no adjustments and should require no maintenance attention throughout their life.

3.5.3.2 Ribbon Edge Sensors (Reference IPB Figure 58)

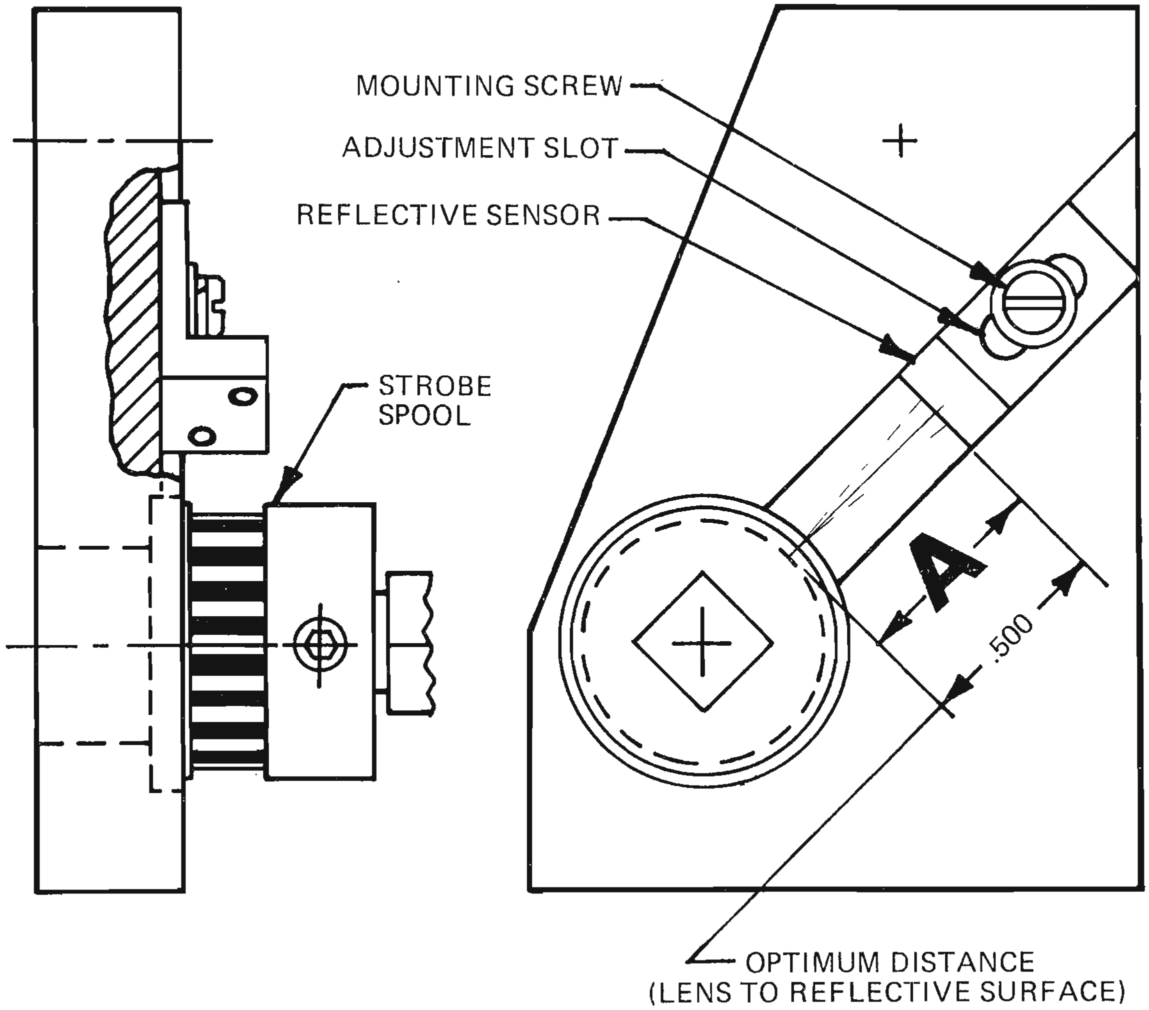
The Ribbon Edge Sensors [A104 and A105] are pre-adjusted at the time of manufacture. The sensors have no adjustments and should require no maintenance attention throughout their life.

To ensure satisfactory operation of the ribbonfeed system, both the upper and lower Ribbon Edge Sensors should be cleaned on a routine basis, preferrably with each ribbon change while ribbon is removed from the printer. The ribbon sensors can be cleaned either with a soft, lint-free cloth or with the impregnated hand-cleaning cloth supplied with each DPC ribbon. To clean a sensor, fold the cloth into a strip and insert the folded edge of the strip into the slot of the ribbon sensor assembly. Gently pull the cloth strip through the sensor slot, from back-to-front, to wipe the sensor devices. Repeat this process several times while exerting a slight downward pressure on the cloth to wipe the sensing device on one side of the assembly, and several times while exerting a slight upward pull on the cloth to wipe the sensing devices on the opposite side of the assembly.

3.5.3.3 Ribbon Tracking Adjustment (Reference IPB Figures 58 and 64)

The Ribbon Skew Mechanism Assembly must be properly adjusted as indicated by Figure 3-43 to ensure that the ribbon properly tracks at the typeline at all times. As indicated by the lower diagram, ribbon tracking is accomplished by skewing the right-hand end of both ribbon mandrels. This is performed by displacing the right-hand end of each ribbon mandrel an equal distance but in opposite directions, depending upon the direction of ribbon tracking required. The Ribbon Skew Mechanism is adjusted by properly positioning the two (2) Skew Solenoids [L101 and L102] so that the solenoid plungers ride freely in their respective solenoids, and so that each plunger fully bottoms when the ribbon skew arm is in the appropriate position.

To adjust a ribbon skew solenoid, loosen [DO NOT REMOVE] the two socket-head screws that fasten the solenoid to the skew bracket. Adjust the position of the solenoid as required and tighten the fastening screws.



LOCATION: L.H. SIDE OF LOWER TRACTOR ASSEMBLY

USING SCOPE OR VOLTMETER, ADJUST DISTANCE "A" SO THAT THE OUTPUT FROM THE SENSOR (LOGIC BAY PIN 5A-21) IS MAX. 2.0 VOLTS WHEN ON **LIGHT** SURFACE, AND MIN. 4.0 VOLTS WHEN ON **DARK** SURFACE. ROTATE SHAFT OR STROBE SPOOL MANUALLY.

Figure 3-42. Sensor Adjustment, Paper Motion Detector

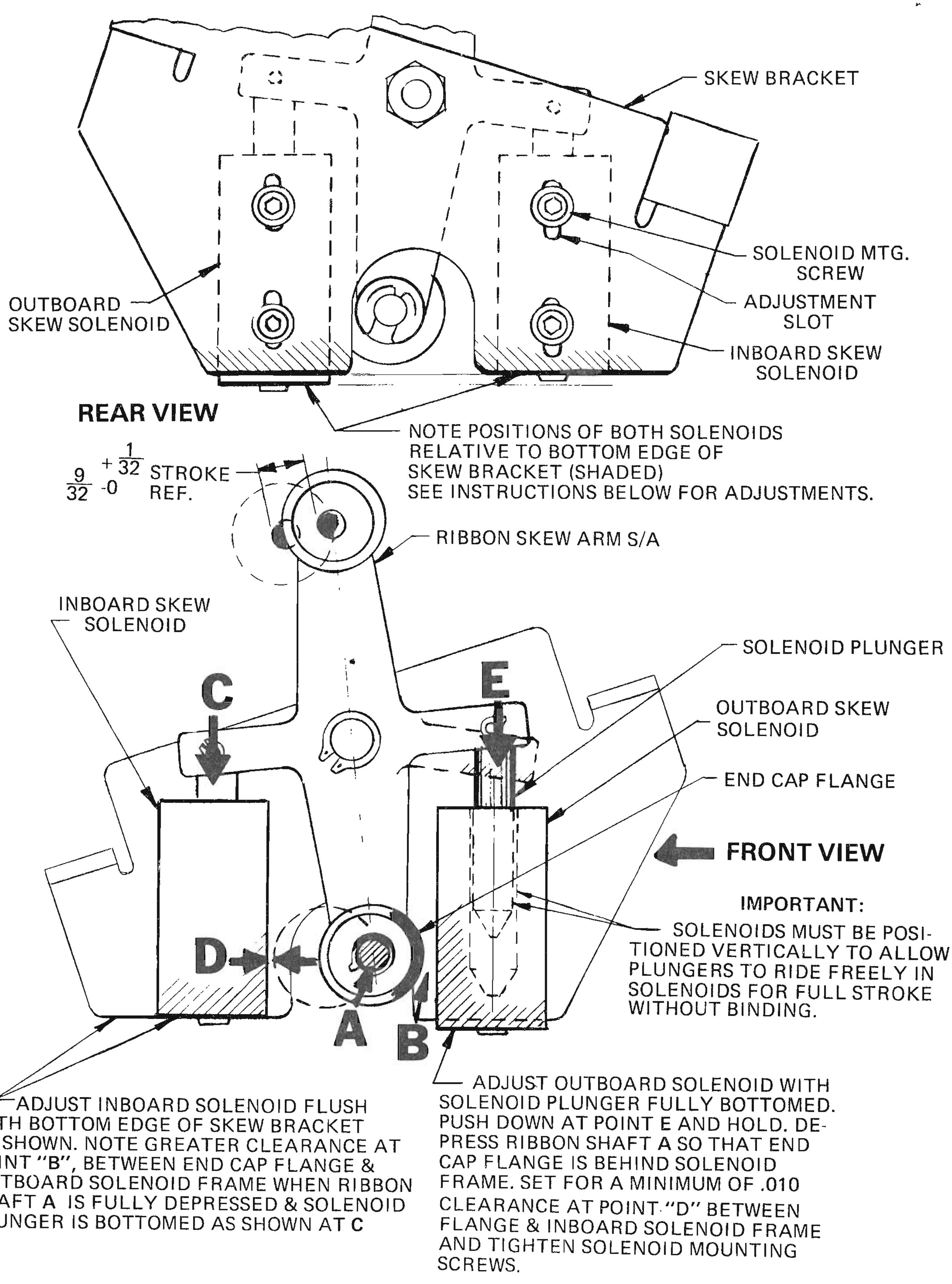


Figure 3-43. Ribbon Tracking Adjustment

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