3400 MAGNETIC TAPE UNITS

FIELD ENGINEERING MAINTENANCE MANUAL

PN 9043

STORAGE TECHNOLOGY CORPORATION

3400 MAGNETIC TAPE UNITS

FIELD ENGINEERING MAINTENANCE MANUAL

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PREFACE

The 3400 Magnetic Tape Units Field Engineering Maintenance Manual contains a description of the STC 3400 series tape units. The description covers general information, tape unit operation, explanation of the elements comprising the tape unit and the maintenance information.

It is intended for use in helping to train STC Field Engineers and to aid the Field Engineers in maintaining this equipment. Photographs, block diagrams, simplified logic, flow charts, tabular material and line art are included to support the text.

The material is organized into four chapters, generally flowing from the most basic to the more detailed information. Chapter I is General Information, Chapter II covers the Operational Description, Chapter III goes into more depth on the Functional Description and Chapter IV pertains to Maintenance. The first three chapters contain the support and background material necessary to understand and conduct the maintenance procedures included in Chapter IV.

Comments concerning the contents of this manual should be directed to the Publications Department, Storage Technology Corporation. A prepaid Reader's Comment Form is provided at the back of the manual. Reqeusts for additional copies of the manual should be directed to Machine Level Control, Storage Technology Corporation.

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CHAPTER I

GENERAL INFORMATION

INTRODUCTION

This manual is intended as a source of adjustment and alignment specifications for STC 3400 series tape units. It incorporates the theory of operation and field engineering practices and procedures.

Basic machine specifications are listed in Figure 1-1. Figure 1-2 shows the location of major components and assemblies and may be referred to throughout this manual.

SUBSYSTEM OPERATION

Figure 1-3 is an illustration of the magnetic tape subsystem showing how the optional features and the tape unit variations come together in a simplified form. The 3400 series tape units may interface with either a 3800-III or a 3800-IV tape control unit via a radial interface. This interface provides individual I/O and ac power cables to each tape unit, and consists of twenty-one output signal lines, one ground line and two dc voltage lines. The ac power cables are separate from the I/O cables.

TAPE CONTROL UNIT

The Tape Control Unit (TCU) controls and checks data coming from the channel to be written on tape and also controls and monitors operations performed by the tape unit.

The three main functions of the TCU are (1) channel interface, (2) tape unit control and (3) read detection. The TCU accepts up to sixteen data bytes from the channel while the tape unit is preparing to receive it; it also buffers data bytes coming from tape unit that are to be accepted by the channel. An illustration of a partial Data Processing System is shown in Figure 1-4.

Functions of the TCU, with respect to the tape unit are to, monitor error and status conditions, time operations, and select the tape unit for use. In addition, it controls the initiation and termination of tape movement and monitors the amplitude of read signals.

TAPE UNIT

Up to eight tape units can be attached to one TCU. The TCU provides write data and gating lines to the tape units. Error-checking circuits in the TCU verify the validity of information exchanged during a read or write operation. When connected to the TCU the tape unit will:

- Read tape (forward or backward).
- Write tape (forward only).
- Space forward or backward over sections of previously written tape.
- Erase a section of tape.
- Rewind tape to load point.
- Rewind and unload the tape.

The tape unit can also operate offline -- disconnected from the TCU and cabled to a tester -- under the control of a Field Tester (see Figure 1-5). The tester provides write data and gating lines allowing the Field Engineer to perform tape unit maintenance without tieing up the customer's entire system. The tester, however, does not perform a validity check of read/write data. The commands that the field tester can transmit to the tape unit are:

- Read tape.
- Write tape.
- Rewind to load point.
- Rewind and unload.
- Sense data.

With the tape unit switched offline (see the OFFLINE switch in Figure 1-2) but still cabled to the TCU, Channel Command Words may be entered into the FE buffer of the TCU. The TCU is then time-shared between the channel and the remainder of the tape units. Between channel operations, commands can be directed to the offline tape unit from the FE buffer.

The tape unit can also operate under the direction of the Subsystem Program for Analysis and Repair (SPAR), an STC patented diagnostic approach operated either online or offline by the TCU microprogram. All tape units within a subsystem can be tested from any TCU within the subsystem.

OPERATOR PANEL

A very important source of information and control for the Field Engineer is the tape unit operator panel. It is located at the top front of each tape unit and contains a row of indicators above a row of pushbuttons (see Figure 1-6).

The pushbuttons are used to manually operate the tape unit. The indicators provide information on the tape unit mode of operation and status.

PUSHBUTTON OPERATION

Pressing the pushbuttons results in the following actions:

- LOAD/REWIND

  Initiates the thread/load operation, provided the tape unit is NOT already loaded. If the tape unit is loaded, it initiates a rewind to load point. This pushbutton is operational only when the READY and MACHINE CHECK indicators are not lit.

- START

  Enables the tape unit to accept commands from the TCU (ready state) provided the tape unit is loaded. If the tape unit is in a thread/load operation when START is pressed, it will enter the ready state upon detection of load point.

- UNLOAD/REWIND

  Operative only when the READY and MACHINE CHECK indicators are not lit. If tape is present in the columns, a rewind to load point occurs. The tape continues winding onto the file reel until tape is no longer present in the columns. This conditions the power window, cartridge and hub to allow removal of the reel.

- RESET

  If the tape unit is not loaded, RESET prepares it for threading by latching the hub and closing the window. It can also be used to terminate a load operation by forcing a machine check.

FEATURE	3430	3440	3450	3470	3480
Tape Speed (ips)	75	100	125	200	250
Data Rate (KB)	120	160	240	320	400
Density (bpi)	1600/800 556/200	1600/800	1600/800 556/200	1600/800 556/200	1600
Recording Mode	PE/NRZI	PE/NRZI	PE/NRZI	PE/NRZI	PE
Start Time (ms)	3.5	3.0	2.7	2.1	2.3
Rew Time (sec)	55	55	55	45	45
Quantity of Tracks	7/9	9	7/9	7/9	9
Max Bit Spacing (usec)	8.30	6.25	5.0	3.13	2.50

ENVIRONMENTAL CAPABILITIES:

Operating temperature 60^{o} to 90^{o} F (16^{o} to 39^{o} C).

Operating relative humidity 20% to 80% at 78^{o} F.

(Condensation must not occur.)

Non-operating temperature 50^{o} to 110^{o} F (10^{o} to 43^{o} C).

Non-operating relative humidity 8% to 80% at 80^{o} F.

(Condensation must not occur.)

DIMENSIONS:

Height to base of operator panel: 60 in.

Width: 30 1/2 in.

Depth: 29 1/2 in.

PRIMARY VOLTAGES:

208/230 Vac ± 10 percent, 3-phase 60 ± 1 Hz

or 220/235 Vac ($\triangle$) 3-phase 50 ± 1 Hz

or 380/408 Vac (Y) 3-phase 50 ± 1 Hz

Figure 1-1. Basic Specifications

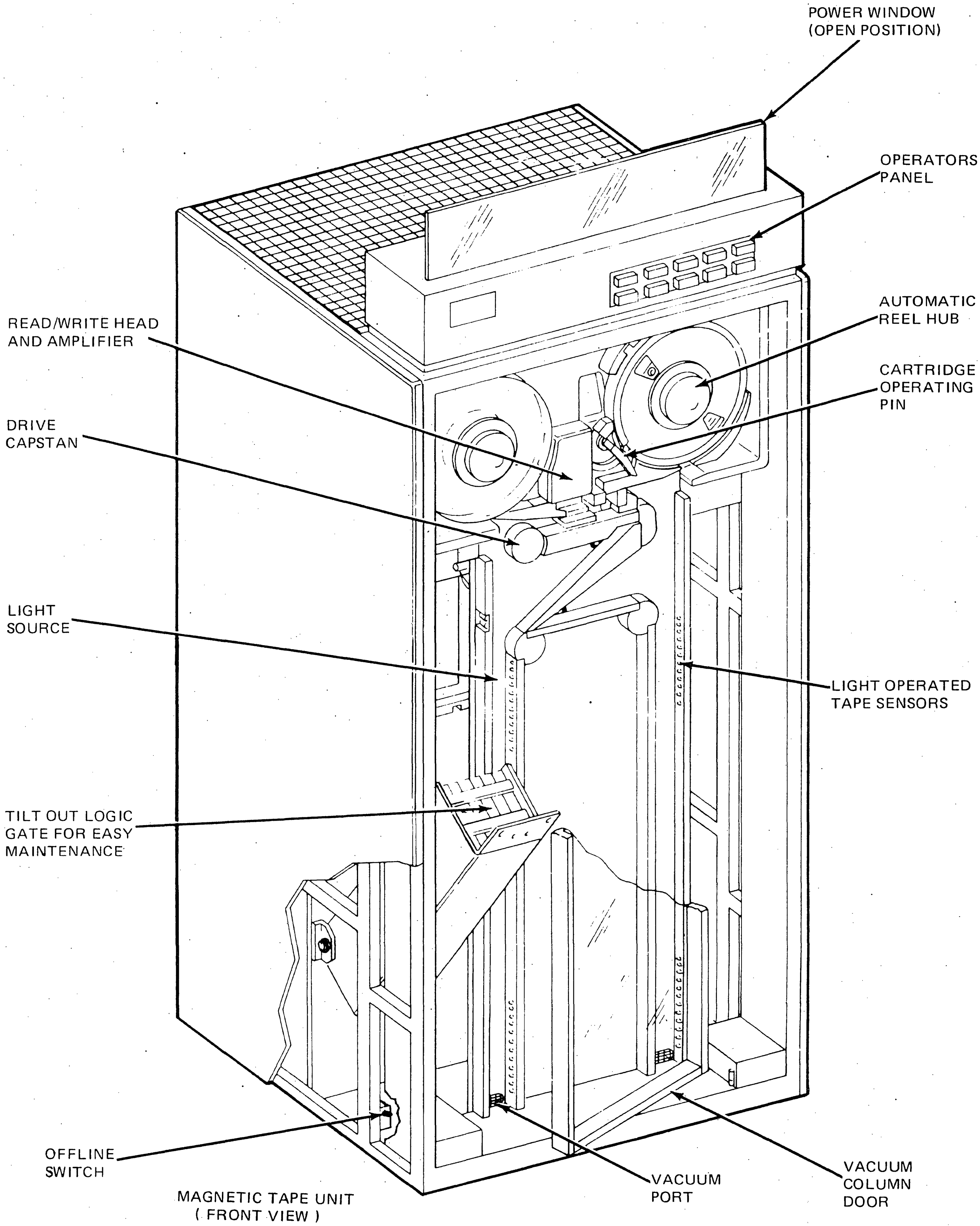


Figure 1-2. Major Components Location (Sheet 1 of 2)

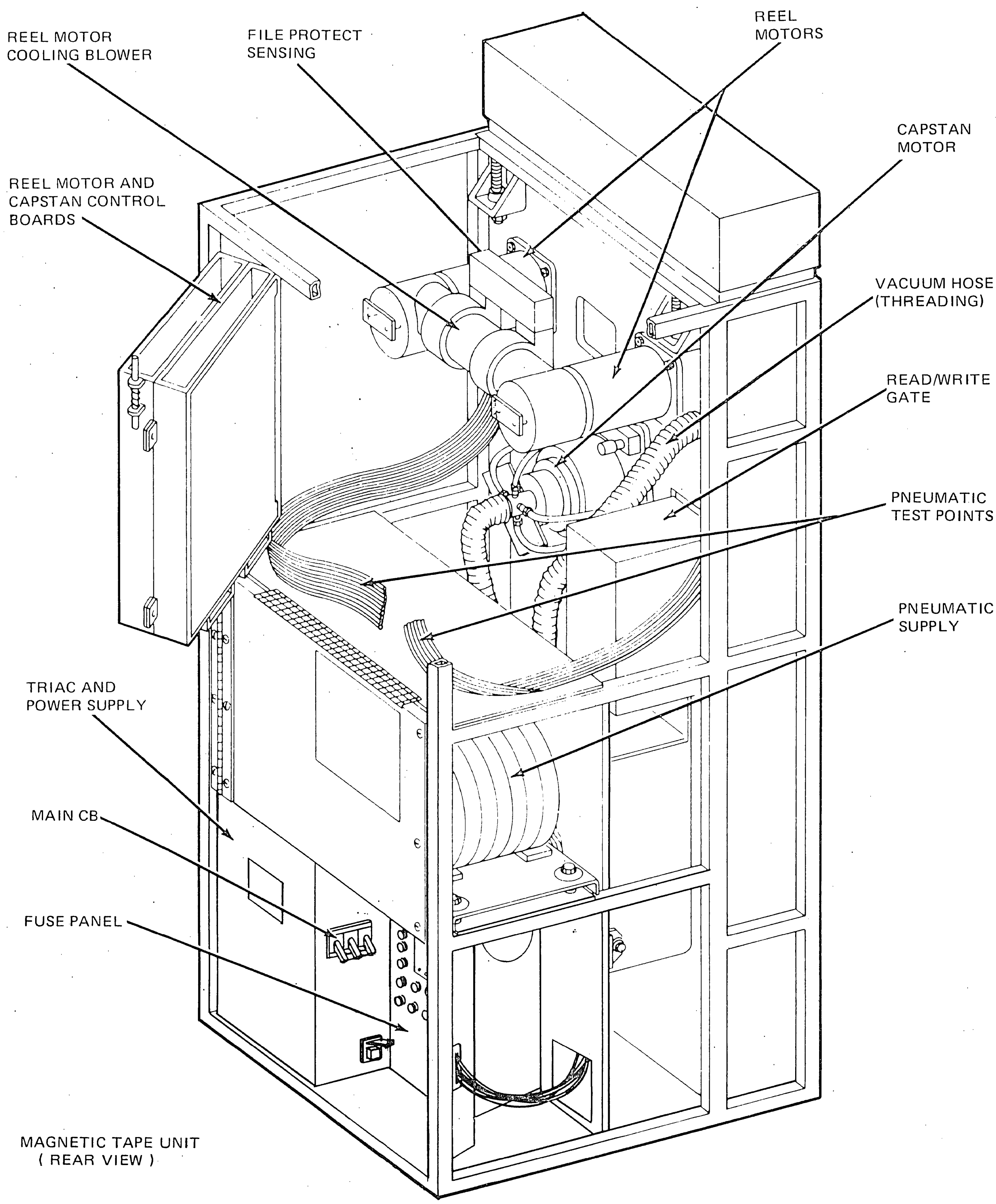


Figure 1-2. Major Components Location (Sheet 2 of 2)

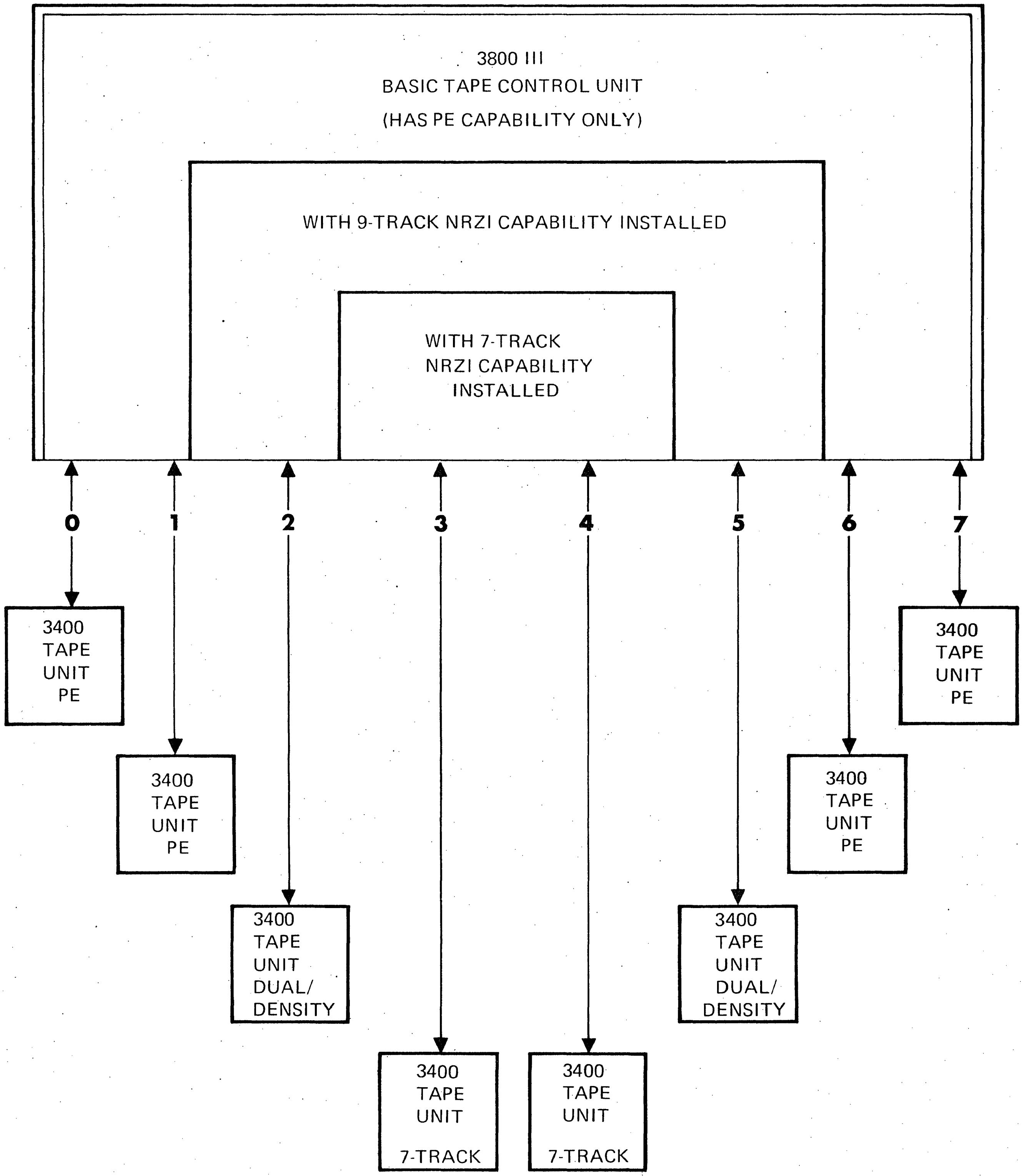


Figure 1-3. Magnetic Tape Subsystem

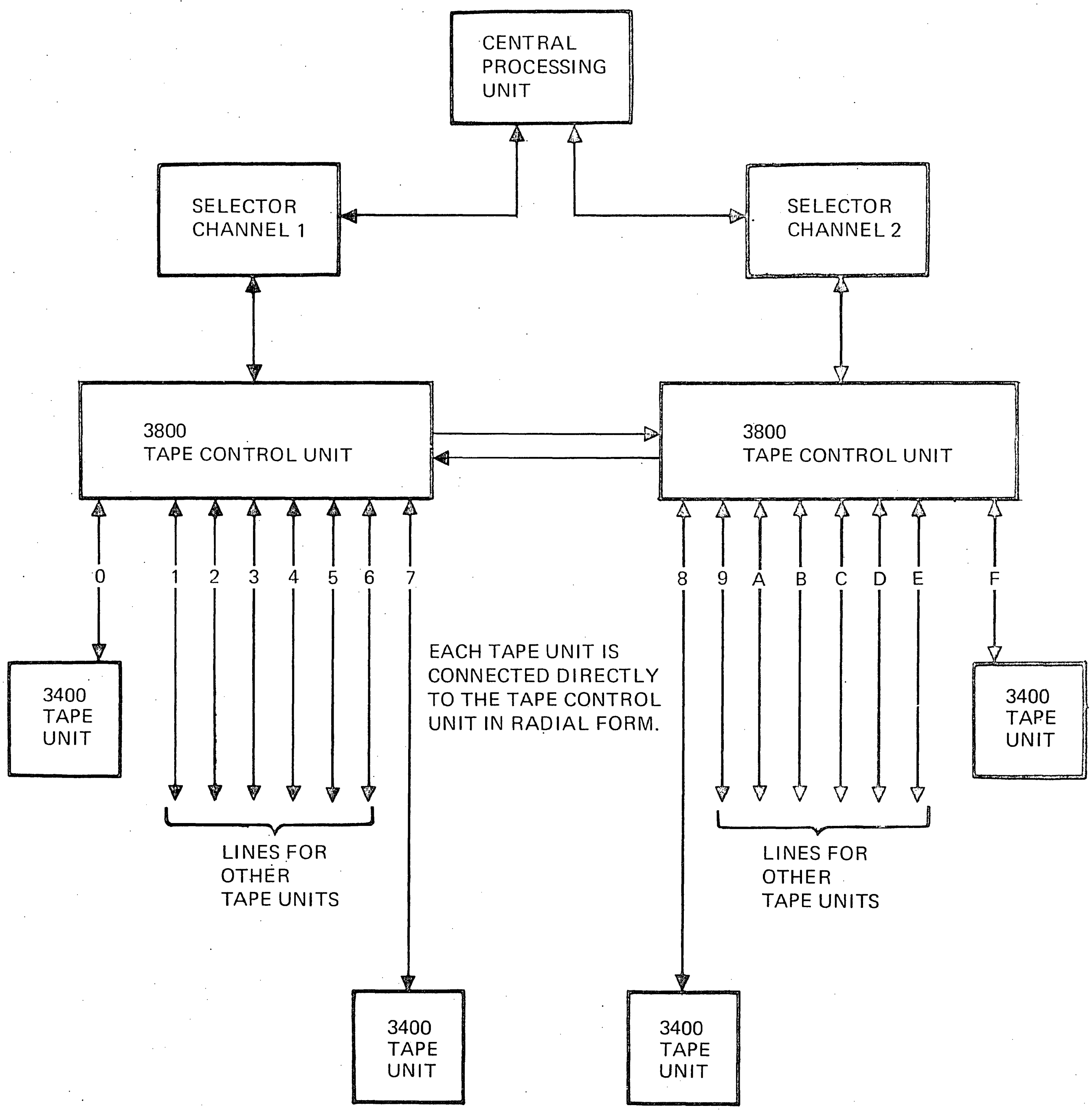
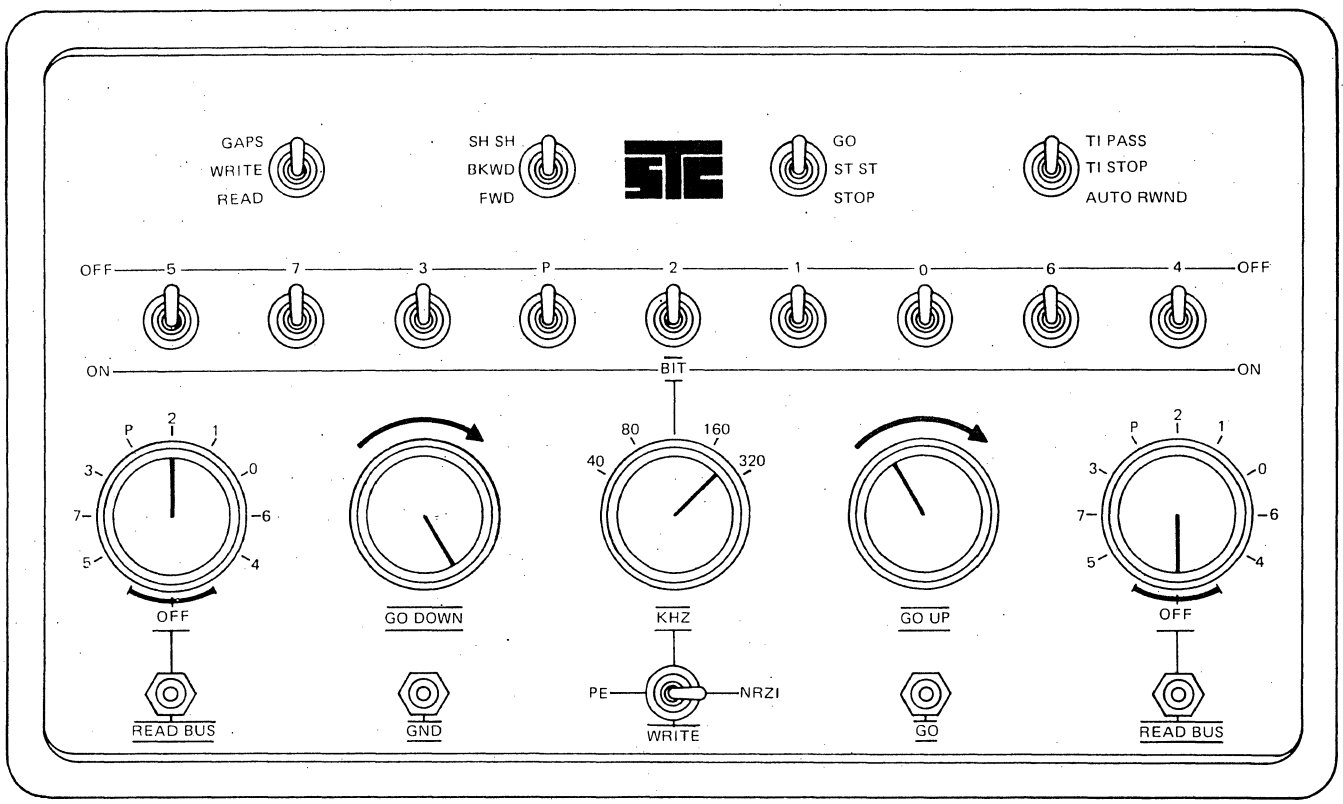
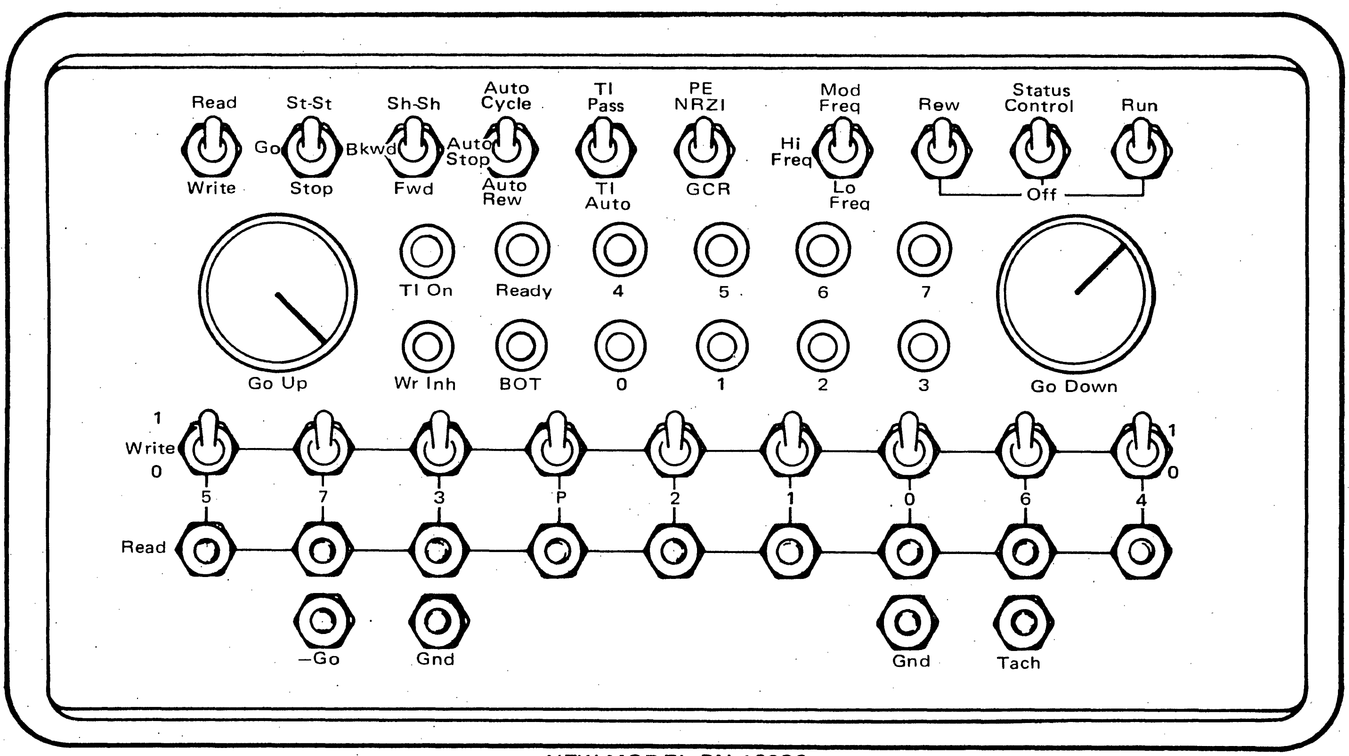


Figure 1-4. System Configuration



OLD MODEL PN 10489



NEW MODEL PN 16086

Figure 1-5. Tape Unit Field Testers

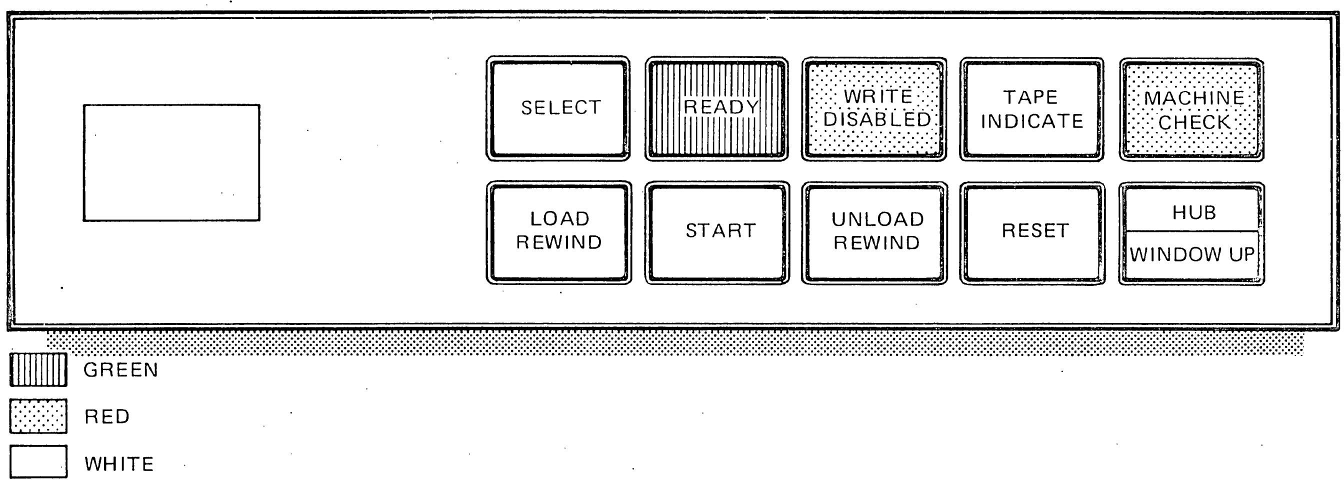


Figure 1-6. Tape Unit Operator Panel

A machine check is cleared by pressing RESET, if the condition causing it is no longer present. Pressing and releasing RESET slows a high-speed rewind to normal tape speed. Rewind stops completely if the pushbutton is held in or is pressed a second time. If it is pressed during a rewind/unload operation, it affects rewind as noted and keeps unload from occurring or halts it if already initiated.

Pressing RESET ends tape unit ready status, allowing use of the other operator panel pushbuttons.

- HUB/WINDOW UP

  Opens the power window if the tape unit is not in ready status. It also releases the file reel from the automatic hub if a machine check exists or if WINDOW OVERRIDE is active.

INDICATOR OPERATION

The indicators and the messages they provide are:

- SELECT (white)

  Indicates the tape unit has been selected for use and is under the direction of the TCU or the field tester (whichever is connected).

- READY (green)

  Indicates the tape unit is loaded with tape and is ready to accept commands from the TCU or the field tester (whichever is connected).

- WRITE DISABLED (red)

  Indicates that a write-enable ring is NOT in place on the file reel when the tape unit is ready.

- TAPE INDICATE (white)

  Lights when the End-of-Tape sensor detects the trailing edge of the End-of-Tape marker. It goes out when a rewind operation moves the marker back past the End-of-Tape sensor.

- MACHINE CHECK (red)

  (1) FLASHING light: Signals a Load Check which is operator correctable.

  (2) STEADY light: Machine failure requiring service by a Field Engineer, or a column check which may be reset by the operator.

TAPE UNIT DESIGN

The following design features are required to enable the tape unit to perform its function.

- Machine and file reel motors and associated servo system.
- Capstan motor and servo system.
- Read/write circuits.
- Control logic.
- Pneumatics supply.
- Cooling system.
- Input/output lines.
- Power supply.

The machine and file reels move tape, with the aid of the pneumatic supply, to accomplish the automatic thread/load operation. They do not move tape during normal operation, a function accomplished by the capstan.

As the capstan moves tape forward or backward, the reels take up or dump sufficient tape to maintain proper loop position in the columns. Loop position is monitored by sensors in each tape column.

The capstan moves tape across the write head in a forward direction during write. Write circuits then condition current through the write head to write on tape in response to control commands and WRITE BUS signals.

The capstan may move tape in either direction during a read operation. The read circuits process raw analog data from the tape and condition it to drive the READ BUS.

In addition to directing tape during the automatic load operation, the pneumatic supply provides pressure and vacuum for use during normal operation. The pressure and vacuum provide a cushion for tape to ride on, thus reducing tape drag on the capstan motor and reducing tape wear. It also aids the vacuum columns in buffering tape between the capstan and reels.

The cooling system keeps the tape unit and its components within the predetermined temperature parameters.

The input/output lines serve as the tie with the TCU, allowing the transfer of data, commands and other signals.

The power supply is comprised of an ac section and a dc section. It also houses the main power circuit breaker for the tape unit.

Detailed descriptions of these elements are found in Chapter III, Functional Description.

Shown in Figure 1-7 is an overall block diagram of the Tape Unit. The Tape Control Unit is included to show how it interfaces with the Tape Unit.

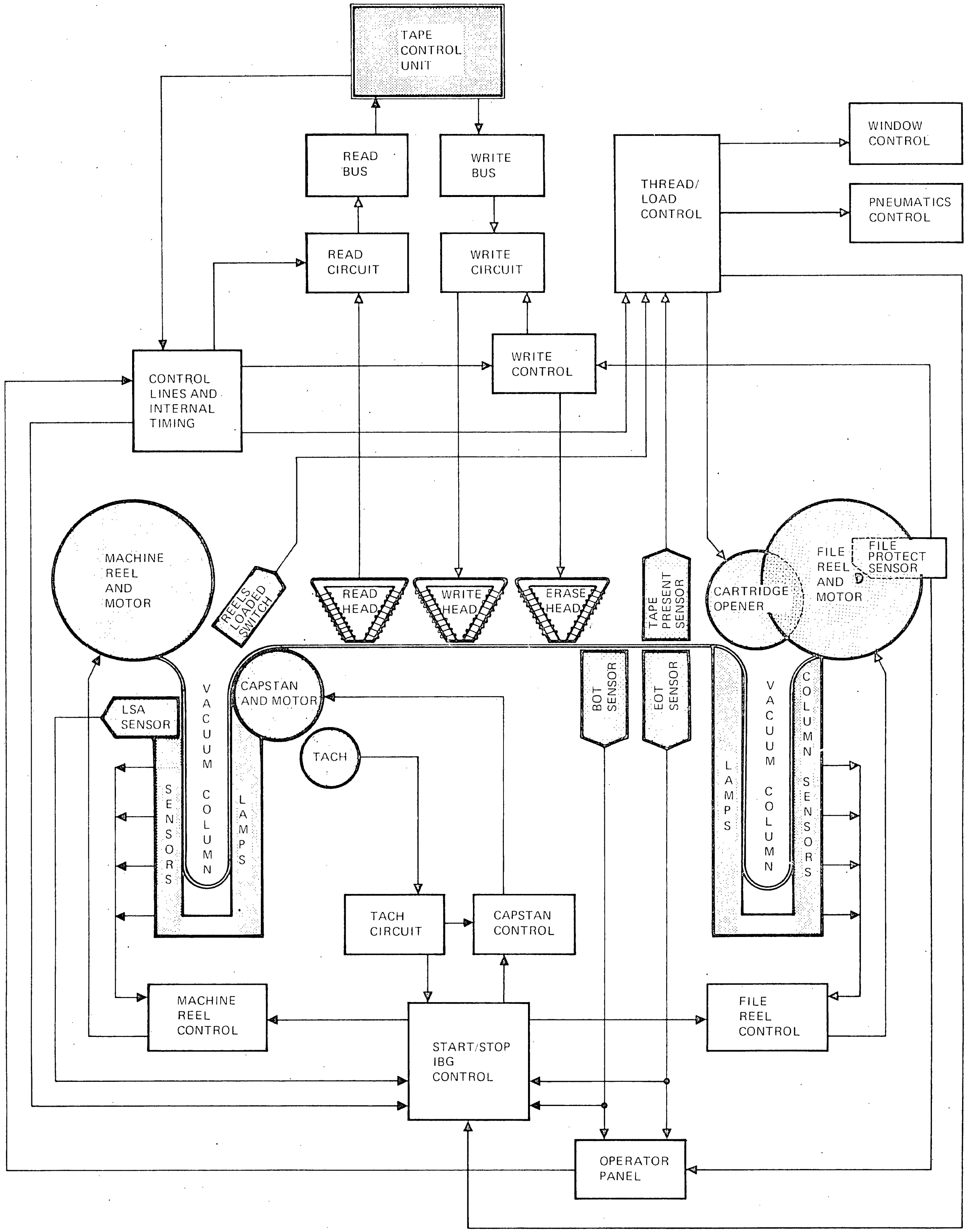


Figure 1-7. Tape Unit Block Diagram

CHAPTER II

OPERATIONAL DESCRIPTION

INTRODUCTION

The tape path incorporates air bearings that reduce friction and wear to a minimum. Tape movement is buffered by vacuum columns which virtually eliminate tape stress. After tape has been loaded all tape movement is the result of motion imparted to it by a single drive capstan.

These tasks require basic design features such as reel and capstan motor assemblies and logic. Sensors and switches located in the tape path control reel and capstan motion. Also in this Chapter is a description of the delay counter, which provides internal timing for the various operations.

In addition to the basic design features, STC tape units utilize an automatic thread/load feature to make the tape unit easier to use. The thread/load operation is covered in this chapter.

This chapter also covers the rewind operation and the unload operation. A more detailed description of the operation of the tape unit is found in Chapter III, Functional Description.

TAPE UNIT CONTROL

The tape unit operates in response to external commands, internal timing and sensing devices in the tape path. Tape unit operation is initiated by commands from the TCU or from pushbuttons on the operator panel.

Control is predominantly a function of the tape control unit. However, to accurately start, maintain the speed of, and stop tape without incurring damage requires considerable control and must be accomplished by the tape unit.

SENSORS

The types of sensing devices used in this control operation are phototransistors, a pressure switch and mechanical switches (see Figure 2-1). The sensing devices and their functions are:

- The Cartridge On Switch - detects the presence of a cartridge on the file reel.
- The Cartridge Open Switch - Signals that the cartridge on the file reel is open (if present).
- The Cartridge Closed Switch - Signals that the cartridge on the file reel is closed.
- The Window Open Switch - signals that the power window is open.
- The Window Closed Switch - signals the power window is closed.

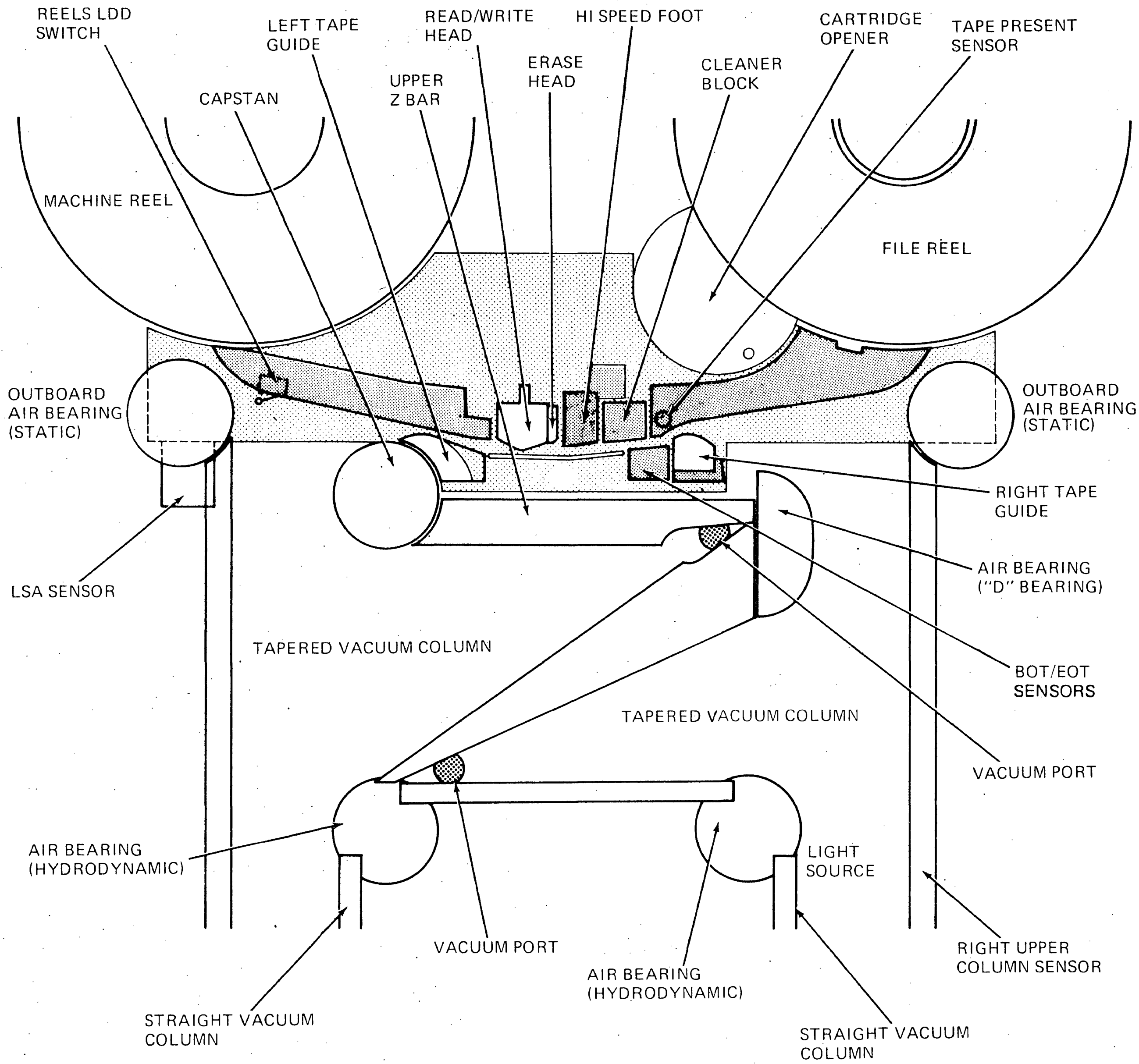


Figure 2-1. Tape Path

- The Reels Loaded Switch - signals the reels are loaded when tape draws taut during the thread operation.

- The File Protect Switch - A combination pneumatic pressure nozzle and back-pressure sensor that detects the presence of a write-enable ring on the file reel.

- The Override Switch - inhibits window operation to facilitate troubleshooting.

- The Tape-Present Sensor - signals when tape is present in the head area.

- The Low-Speed Area Sensor - detects the beginning-of-tape reflective marker during a rewind operation. Its output is used to signal the logic to step down from a high-speed rewind to nominal speed.

- The Beginning-of-Tape Sensor (BOT) - detects when the beginning-of-tape reflective marker on the outside edge of the tape is in the head area.

- The End-of-Tape Sensor (EOT) - detects when the end-of-tape reflective marker on the inside edge of the tape is in the head area.

- The Vacuum Column Phototransistors - detects the position and direction of movement of the tape loop in the column. They are an integral part of the reel control system.

The operator panel pushbuttons are described in the Operator Panel section of Chapter I. Once an operation starts, no other operation can interrupt until the first one is completed, or in some cases, the operation is aborted by pressing the RESET pushbutton. The INTERNAL READY signal raises when the tape unit is loaded. It can then accept commands from the TCU as soon as the START pushbutton is pressed.

DELAY COUNTER

The delay counter provides timing for all operations and checks during the operational sequences. The delay counter is normally started at the beginning of an operation and reset at the end. It is an eight-stage counter consisting of two four-stage counter modules (see Figure 2-2) that are advanced by the output of a single shot oscillator every 23 milliseconds.

The output of the delay counter is eight stages of timing pulses designated DC1, DC2, DC4, through DC128. The delay counter outputs are also ANDed to develop additional timing pulses necessary to tape unit operation (see Figure 2-2).

THREAD/LOAD OPERATION

The automatic thread/load operation on the STC tape units is a convenience feature. The thread sequence moves tape from the file reel, threads it through the tape channel and winds it onto the machine reel (see Figure 1-2). The load sequence dumps tape from the reels into the vacuum columns and then moves the tape to load point (the point at which the beginning-of-tape marker is sensed by the beginning-of-tape sensor).

To help supplement the text, a flow chart of the thread/load operation is provided in Figure 2-3. Reference to the figure will help organize the sequence in which the various functions occur. Figures 2-4 and 2-5 provide a thread sequence timing chart and a columns load sequence timing chart.

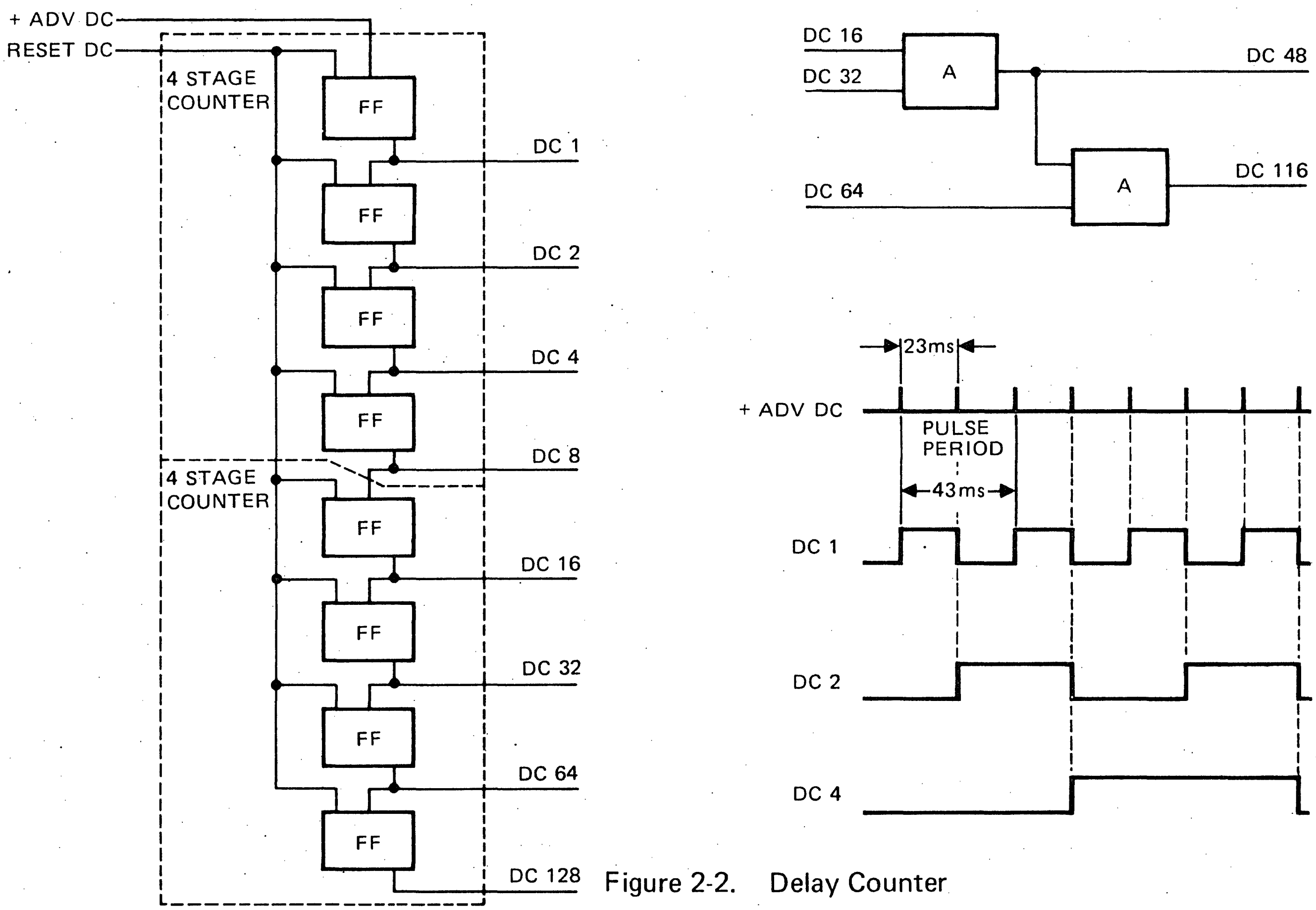


Figure 2-2. Delay Counter

To initiate the thread/load operation, the operator places the file reel on the hub and presses the LOAD/REWIND pushbutton. This locks the file reel to the automatic hub, closes the power window and sets both the Load Delay latch and the Load latch (see Figure 2-3).

Setting the Load latch results in the following actions:

- Power is applied to the pneumatic system.
- Pressure is transferred for threading.
- The cartridge opens.
- The delay counter starts.

Load Delay allows time for the pneumatic system to build pressure and vacuum up to proper operating levels, to transfer vacuum for threading and permits interrogation of the file protect switch. File protect is a feature designed to protect the data stored on a tape (keep it from being written over by mistake). If a write enable ring is detected by the file protect mechanism at delay count 32, the Not File Protected latch sets to enable writing on the tape. If no ring is present, the Not File Protected latch does NOT set and writing CANNOT occur. (If a write command is received, COMMAND REJECT is set in the TCU).

At delay count 116 load delay ends, the delay counter is reset and the Thread latch sets, activating file and machine reel motion. (For additional reel motion explanation, refer to the Reel Control Circuitry section of Chapter III.) Both reels begin moving clockwise with the file reel turning at 60 r/min and the machine reel turning at 140 r/min.

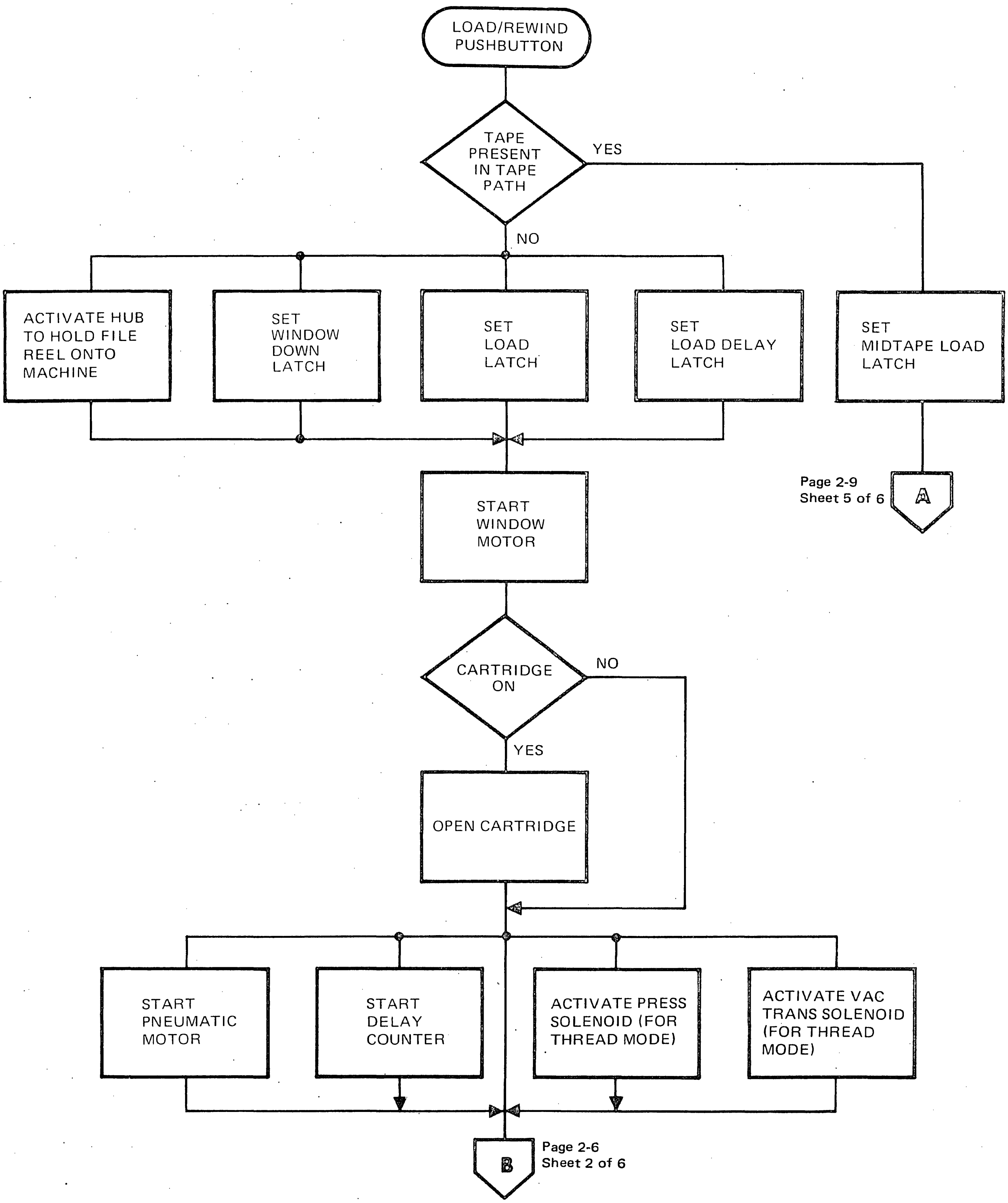


Figure 2-3. Thread/Load Flow Chart (Sheet 1 of 6)

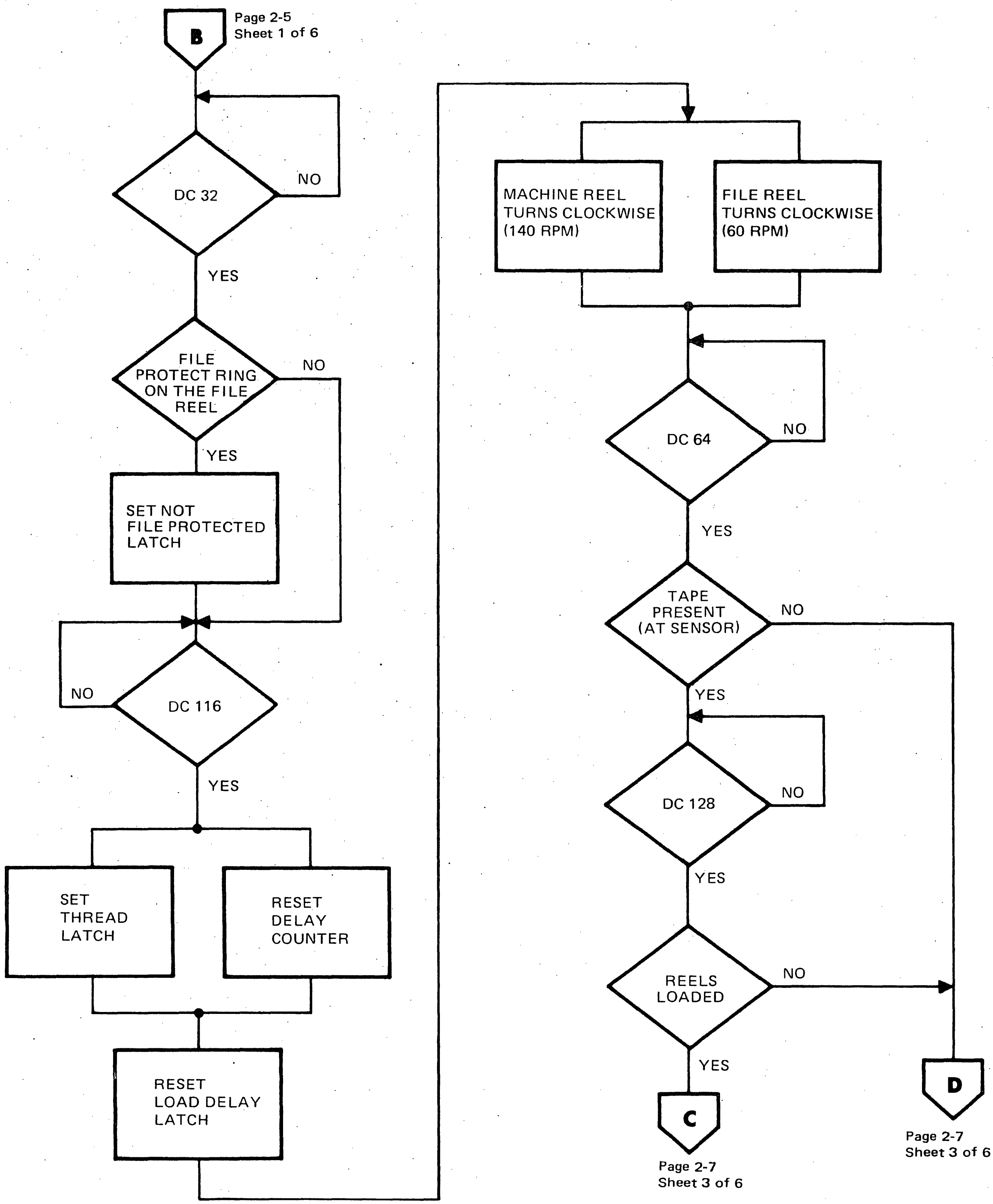


Figure 2-3. Thread/Load Flow Chart (Sheet 2 of 6)

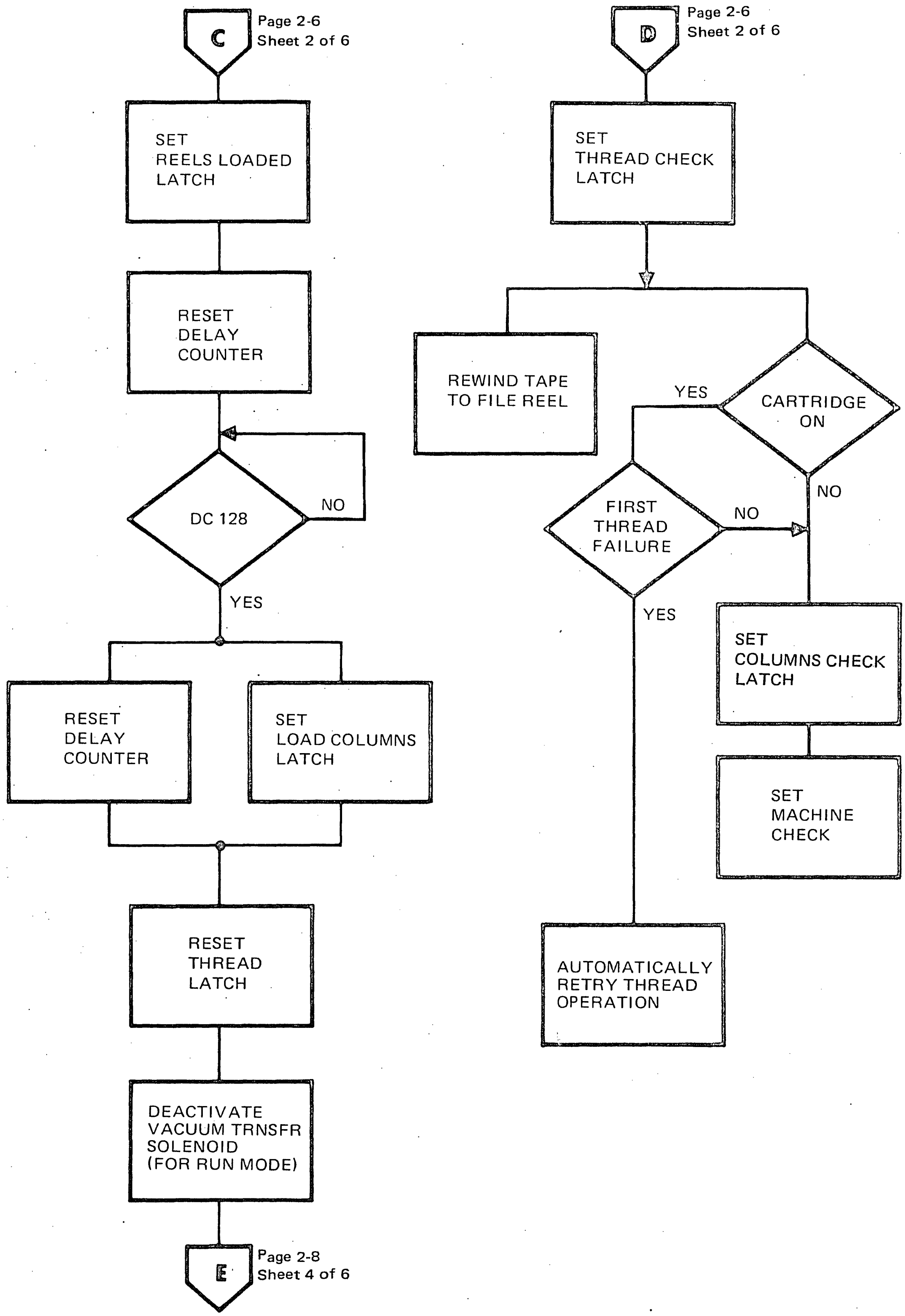


Figure 2-3. Thread/Load Flow Chart (Sheet 3 of 6)

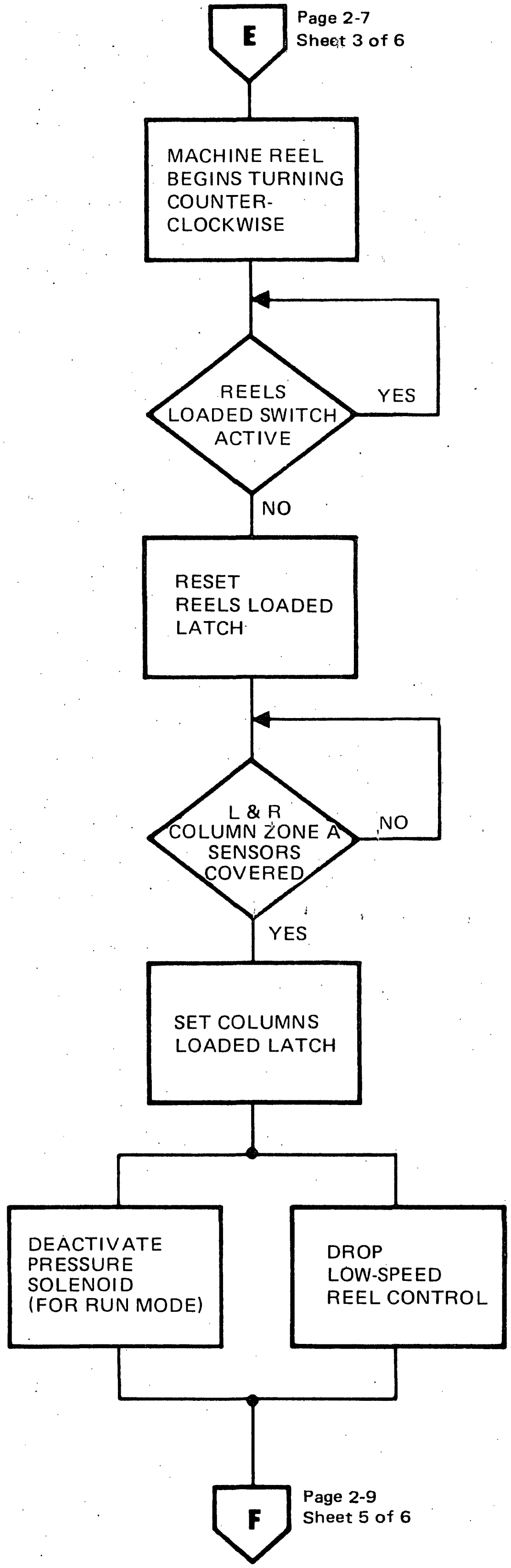


Figure 2-3. Thread/Load Flow Chart (Sheet 4 of 6)

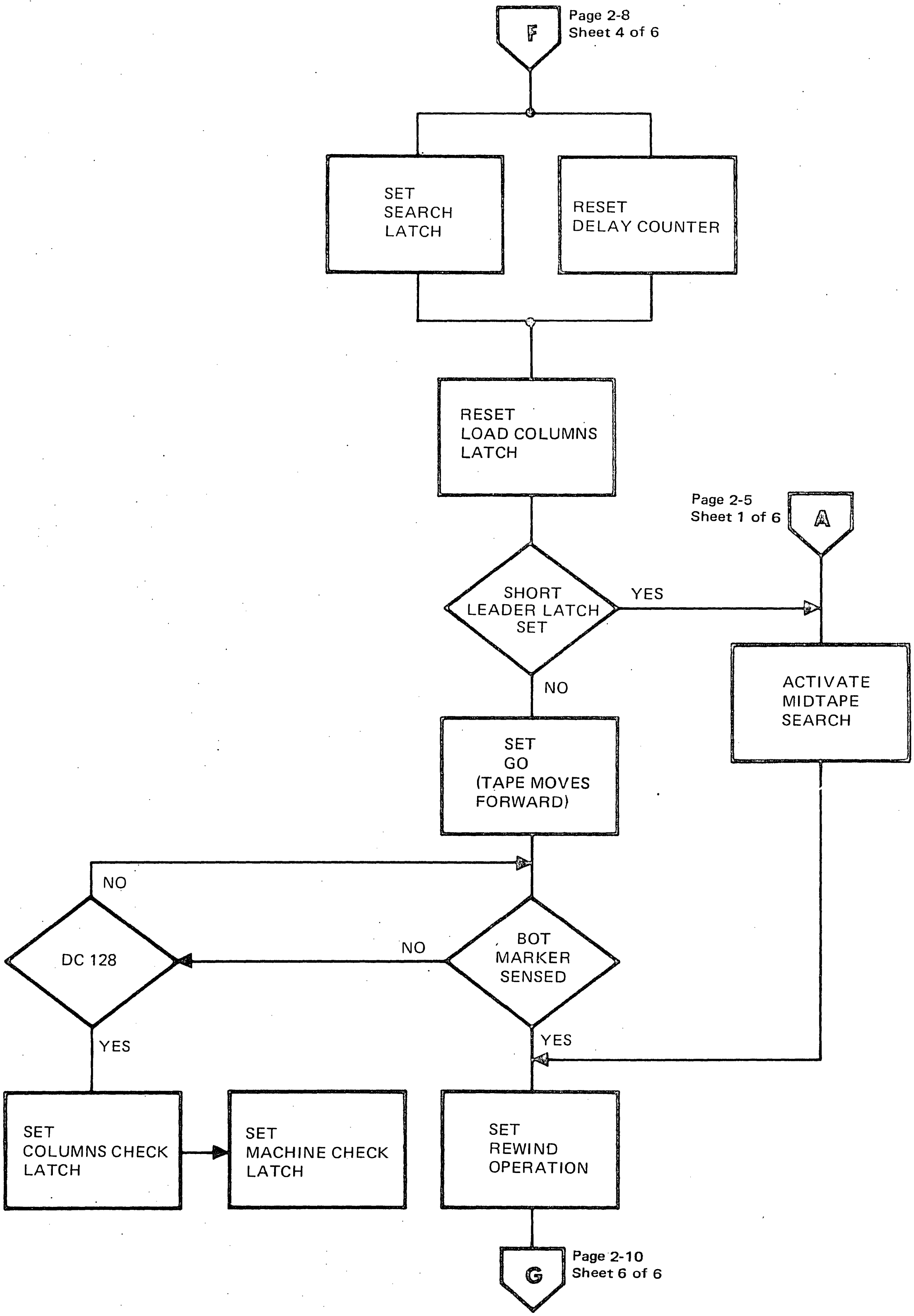


Figure 2-3. Thread/Load Flow Chart (Sheet 5 of 6)

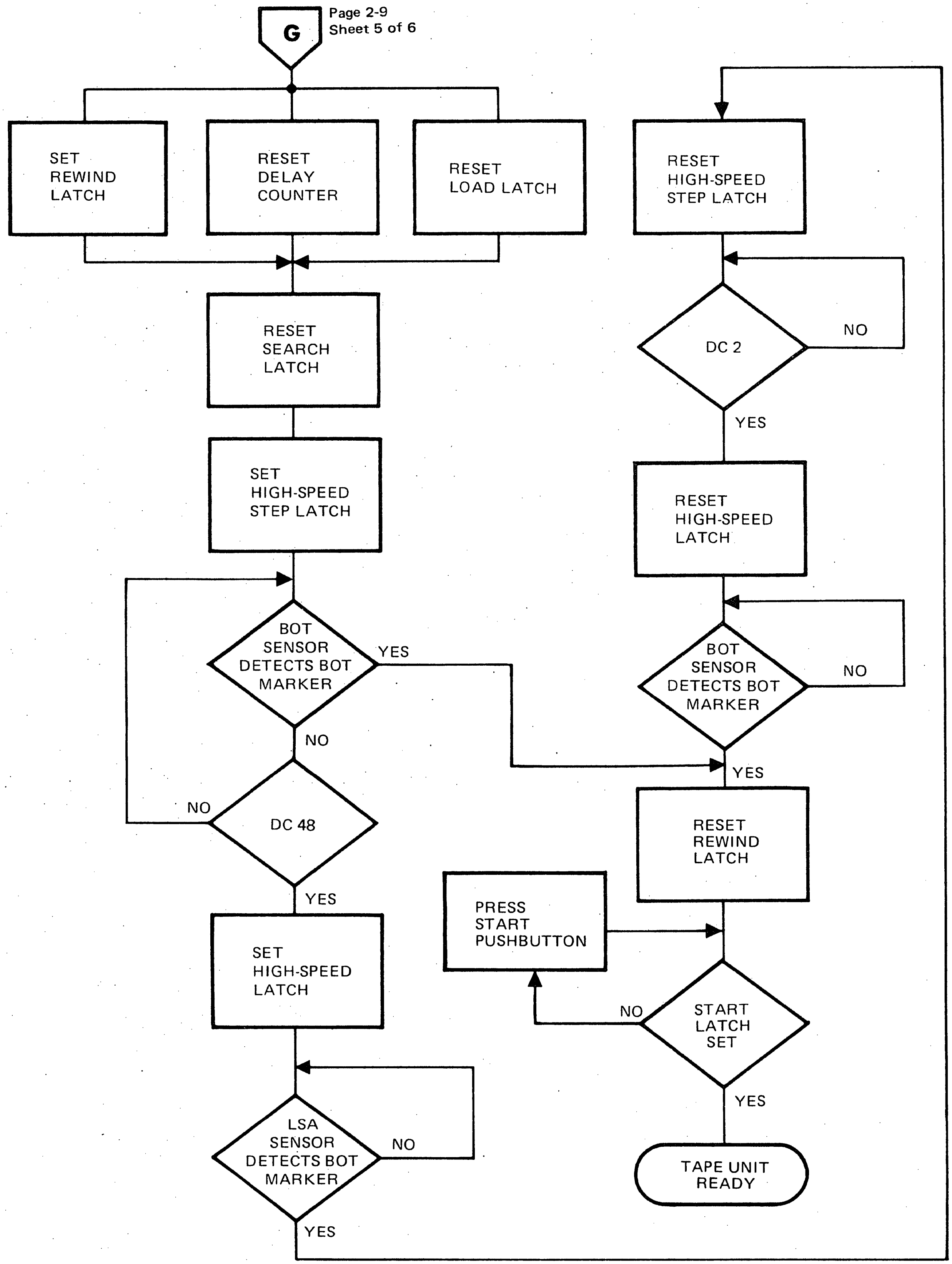


Figure 2-3. Thread/Load Flow Chart (Sheet 6 of 6)

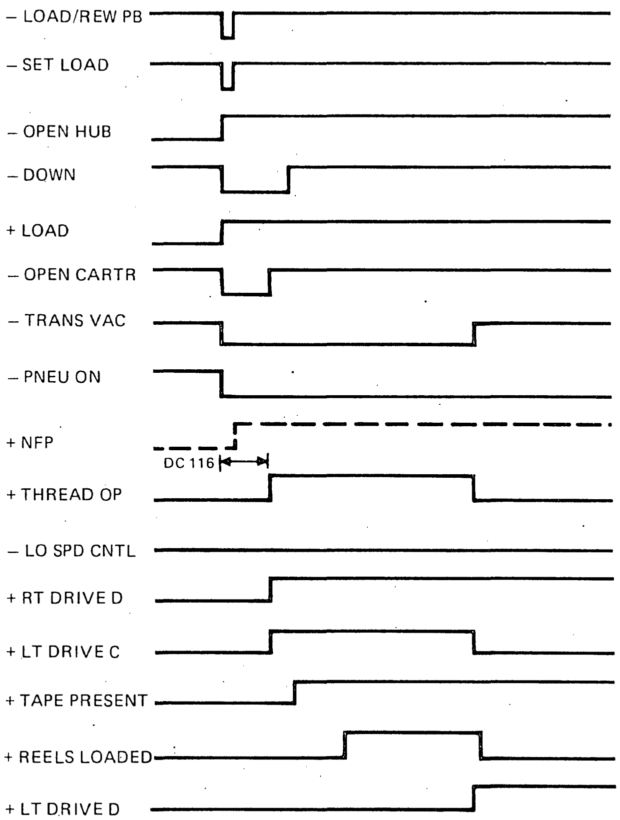


Figure 2-4. Thread Sequence Timing Chart

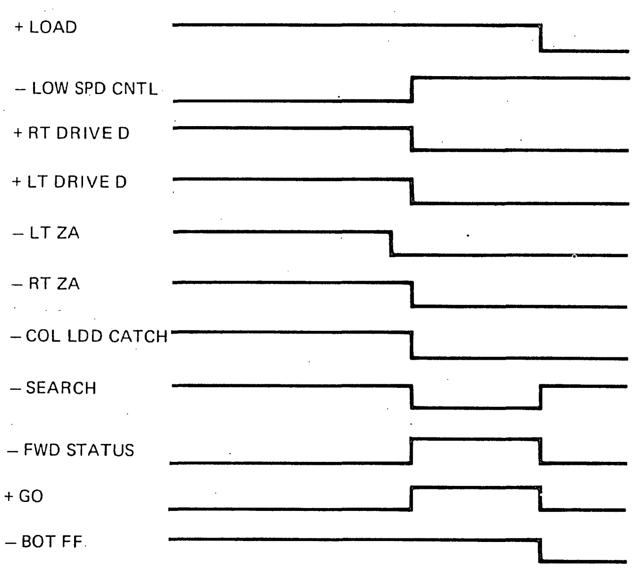


Figure 2-5. Colums Load Sequence Timing Chart

During the threading mode, pressure and vacuum guide tape from the file reel into the right threading channel, Tape entering the head area blocks light from the tape-present photosensor, activating +TAPE PRESENT. The tape-present sensing element is a phototransistor located in the tip of the right threading channel immediately adjacent to the tape cleaner block.

As tape movement continues, the tape floats up to the machine reel where it is pulled onto the reel hub by vacuum. The faster moving machine reel pulls the tape taut, which activates the Reels Loaded switch to set the Reels Loaded latch. The Reels Loaded latch then resets the delay counter. Both reels continue turning clockwise winding tape onto the machine reel until delay count 128 is reached. At this time the Thread latch, Reels Loaded latch and delay counter are reset and the Load Columns latch is set.

Resetting the Thread latch starts the machine reel turning counterclockwise, while the file reel continues turning clockwise. It also causes vacuum and pressure to be transferred from the threading channel to the vacuum columns. Reel movement unwinds tape from both reels and the vacuum draws it down into the columns. When tape filling the column reaches the appropriate position (zone B), the Columns Loaded latch is set.

Setting the Columns Loaded latch transfers reel control from low speed control to column control. Resetting low speed control resets the delay counter and the Load Columns latch and, in addition, it sets the Search latch. If beginning-of-tape has already been detected (due to a short leader), search is immediately aborted, rewind is set and a mid-tape search is begun (see Short Leader Load/Midtape Load).

With the tape unit in forward status, GO becomes active and is applied to the capstan control system. This starts the capstan motor, moving tape forward in search of the beginning-of-tape (BOT) marker. The BOT sensor located in the tape path detects the trailing edge of the BOT marker activating the BOT pulse. The BOT pulse is logically ANDed with the SEARCH signal to set rewind.

The High Speed Step latch then sets, but the tape unit remains at normal rewind speed until delay count 48. Normally the BOT marker is detected moving back across the sensor during the delay and high-speed rewind never occurs. If the BOT marker is not detected during the delay, the High Speed latch sets to put the tape unit into high-speed rewind.

NOTE

> A high-speed rewind is highly unusual during search, even though the logic exists for it.

When the low-speed area (LSA) sensor detects the BOT marker, the High Speed Step latch and High Speed latch reset. The tape unit returns to normal rewind speed until the BOT sensor detects the BOT marker and sends out a BOT pulse. This BOT pulse is ANDed with a BOT DELAYED pulse to set the BOT latch. GO becomes inactive and the rewind function ends.

This completes the thread/load operation. If the START pushbutton is or has been pressed, the tape unit is ready to accept commands from the tape control unit.

SHORT LEADER LOAD/MIDTAPE LOAD

The normal load operation as just described varies under two conditions -- short leader load and midtape load. Short leader load is a condition caused by the tape not having a leader of approximately 10.5 feet or more. (For a successful load operation, the leader must be at least 7.5 feet).

In the event that the mounted tape has a short leader, the thread operation begins as in a normal thread/load sequence. But because the leader is short, the BOT marker passes the BOT sensor during the thread operation. The sensor detects the early passing of the BOT marker and sets the Short Leader latch.

When the columns are loaded, the Short Leader latch activates midtape search. Midtape search causes the tape to rewind to load point -- there is no need to search forward for the BOT marker which has already been detected. When load point is reached short leader load ends and the tape unit is ready to accept commands from the tape control unit.

Midtape load occurs if the LOAD/REWIND pushbutton is pressed when tape is present in the head area. Pressing LOAD/REWIND sets the Midtape Load latch, which sets the Load Columns latch if the columns are NOT loaded. Tape is then dumped into the columns and the load operation proceeds in a normal fashion.

When the columns are loaded, setting the Midtape Load latch activates midtape search. As was the case in the short leader load, tape rewinds to loadpoint. The tape unit is once again ready to accept commands from the tape control unit.

LOAD OPERATION CHECKS

During the thread/load sequence, many checks are made of individual operations. If an error condition is detected during thread/load, either a retry operation or a machine check can result. Anytime the Machine Check latch is set, the MACHINE CHECK indicator (on the operator panel) is on. This in turn resets the operation in progress, turns off pneumatics and opens the power window.

One check, file protect, was mentioned in the Thread/Load section. The file protect switch senses the presence or absence of a write enable ring on the file reel (see Figure 2-6). Lack of a ring inhibits the write circuits.

File protect is keyed by a pressure sensitive switch. During the thread/load operation, the pneumatic system sends a blast of air through a port in the file protect assembly. If the air strikes a write enable ring, the air deflects back onto the pressure sensitive switch. This deactivates +FILE PROT SW and thus sets the Not File Protected latch. The loaded tape can then be written on.

If no ring is present on the file reel, there is no deflected back pressure onto the pressure sensitive switch. In this case +FILE PROT SW is active, keeping the Not File Protected latch from setting. When this occurs, the loaded tape cannot be written on.

The logic circuits, which sense the position of the file protect switch, are designed for fail-safe operation. Thus, if the switch fails such that it indicates a ring is present when in fact it is not, the logic detects the error. This occurs once tape is loaded into the columns. Pneumatics to the file protect assembly drop, removing back pressure from the switch. The switch should then return to its normal position causing +FILE PROT SW to become active.

If +FILE PROT SW remains inactive (due to a file protect failure) +READY INHIBIT stays active. Because ready status is not presented to the tape unit unless +READY INHIBIT is inactive, a device check results -- bringing the tape unit to a halt -- after a delay count of 48.

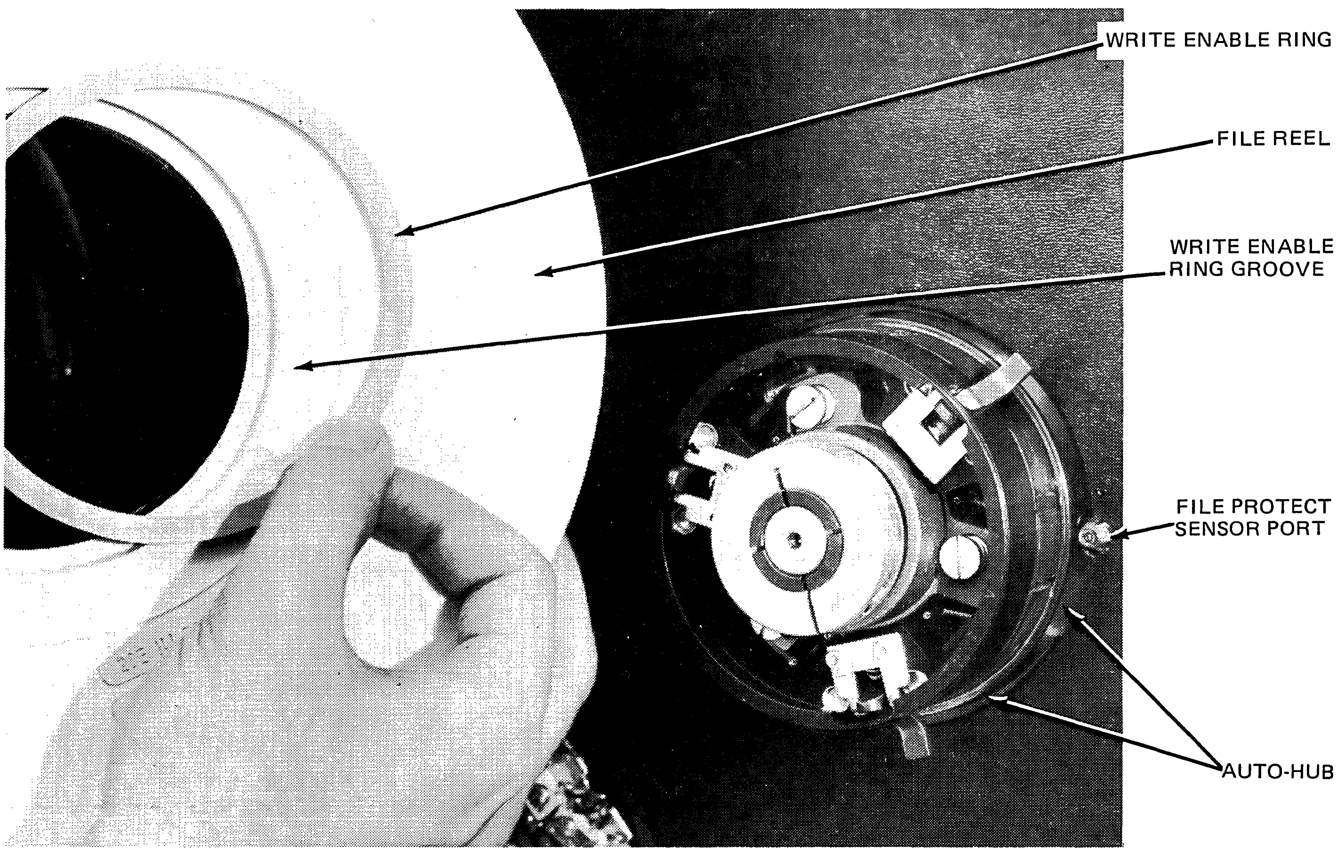


Figure 2-6. Write Enable Ring and File Protect Mechanism

Two checks are made during the load operation. At delay count 64 a check is made to see if the tape-present sensor detects tape. Then at delay count 128 the Reels Loaded latch is interrogated to determine if the reels are loaded. If either condition is not satisfied, the Thread Check latch is set and the delay counter is reset. If there is no cartridge on the machine, the Check latch is set which, in turn, sets machine check.

If a tape cartridge is in use, the thread operation is retried. The Thread Check latch causes +RT DRIVE C and +L DRIVE D to become active and the tape to be rewound into the cartridge. At delay count 208, the Thread Check latch and the delay counter are reset. The Retry latch sets, initiating another thread operation with the normal checks for tape present and reels loaded. If the thread operation fails the second time, the Thread Check latch is again set and tape is rewound onto the file reel. The thread operation halts when -COL CHK LTCH sets a machine check.

A missing BOT marker can also result in machine check. If during the search mode the BOT sensor has not detected the BOT marker by delay count 128, the two signals are ANDed to set a machine check.

A manually induced check -- pressing the RESET pushbutton -- can be used to halt machine operations during the load sequence. Pressing RESET results in the signals RESET 2 and LOAD LATCH being ANDed to set machine check. To restart the load operation, tape must be cleared from the tape present sensor by hand-winding the tape onto the file reel.

REWIND OPERATION

The signals that initiate a rewind operation can originate from any one of four possible sources -- two from the tape control unit, one from the tape unit operator panel and one that can be generated, under certain conditions, during the thread/load operation.

CONTROL SIGNALS

The -SET REWIND/UNLOAD signal (from TCU) or the -UNLOAD PB signal (from the REWIND/UNLOAD pushbutton on the tape unit operator panel) initiates the rewind operation by activating SET UNLOAD. Activating SET UNLOAD also conditions the unload operation, so that unload occurs following the completion of rewind (see the Unload Operation section of this chapter).

The third signal that can initiate rewind is -SET REWIND (from the TCU). Unlike the first two signals, activating -SET REWIND results only in a rewind to load point. The final signal capable of initiating rewind, -MIDTAPE SEARCH, is activated either by a short leader load during a thread/load operation (see the Thread/Load section of this chapter) or by pressing the LOAD/REWIND pushbutton on the tape unit operator panel. -MIDTAPE SEARCH also results only in a rewind to load point.

To aid in the understanding of rewind, Figure 2-7 provides a flow chart of the operation. Figure 2-8 is a series of rewind operation timing signals.

REWIND SEQUENCE

The -SET REWIND/UNLOAD signal and -UNLOAD PB signal are gated together, the output of which is -SET UNLOAD. -SET UNLOAD is then gated with -MIDTAPE SEARCH and -SET REWIND. If any of these three signals are active, a rewind operation is initiated when their gated output sets the Rewind latch (see Figure 2-9).

The Rewind latch sets backward status and activates GO, causing tape to move backward at normal speed. In addition, the High Speed Step latch sets (see Figure 2-9) and starts the delay counter.

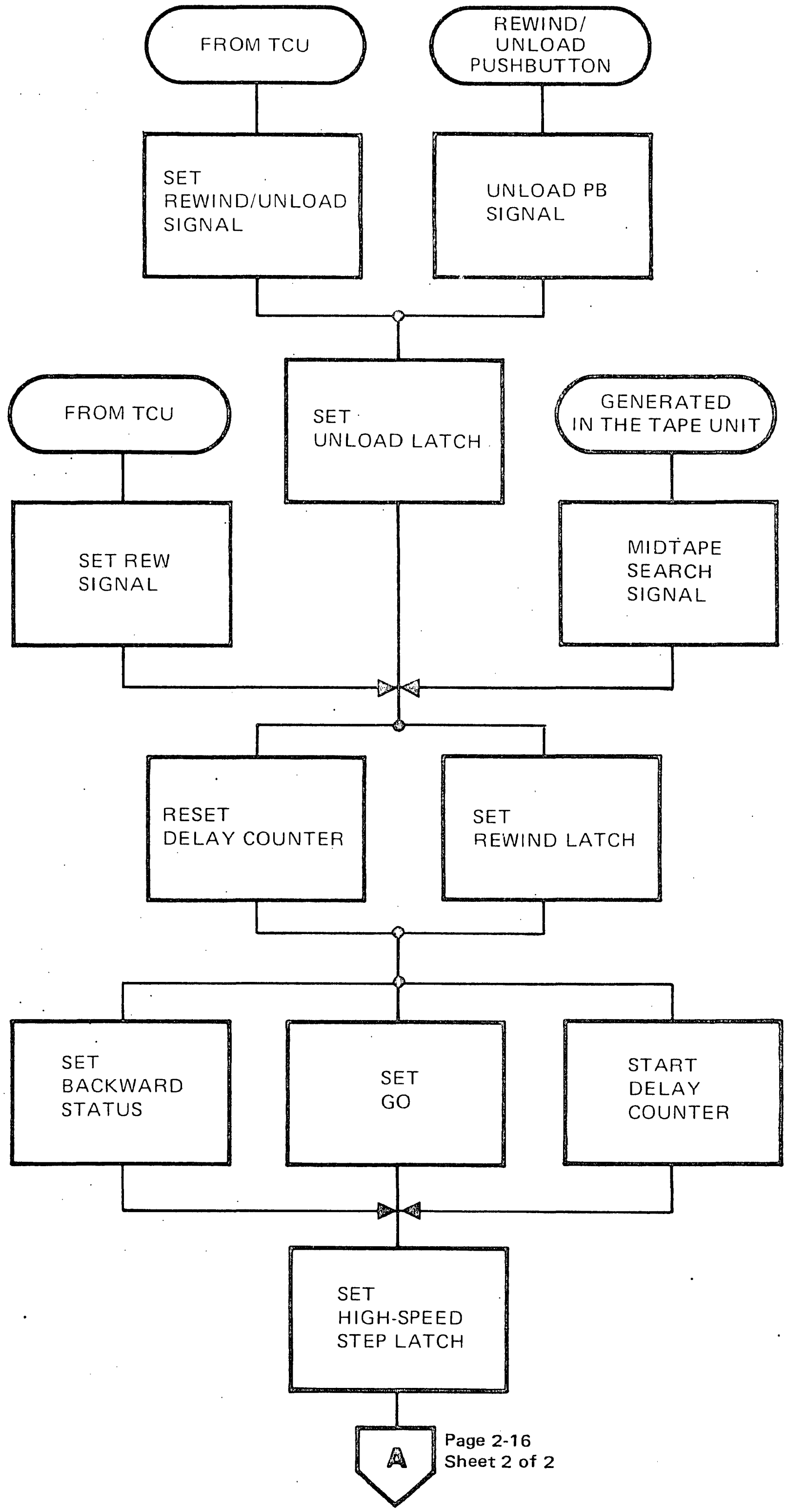


Figure 2-7. Rewind Operation Flow Chart (Sheet 1 of 2)

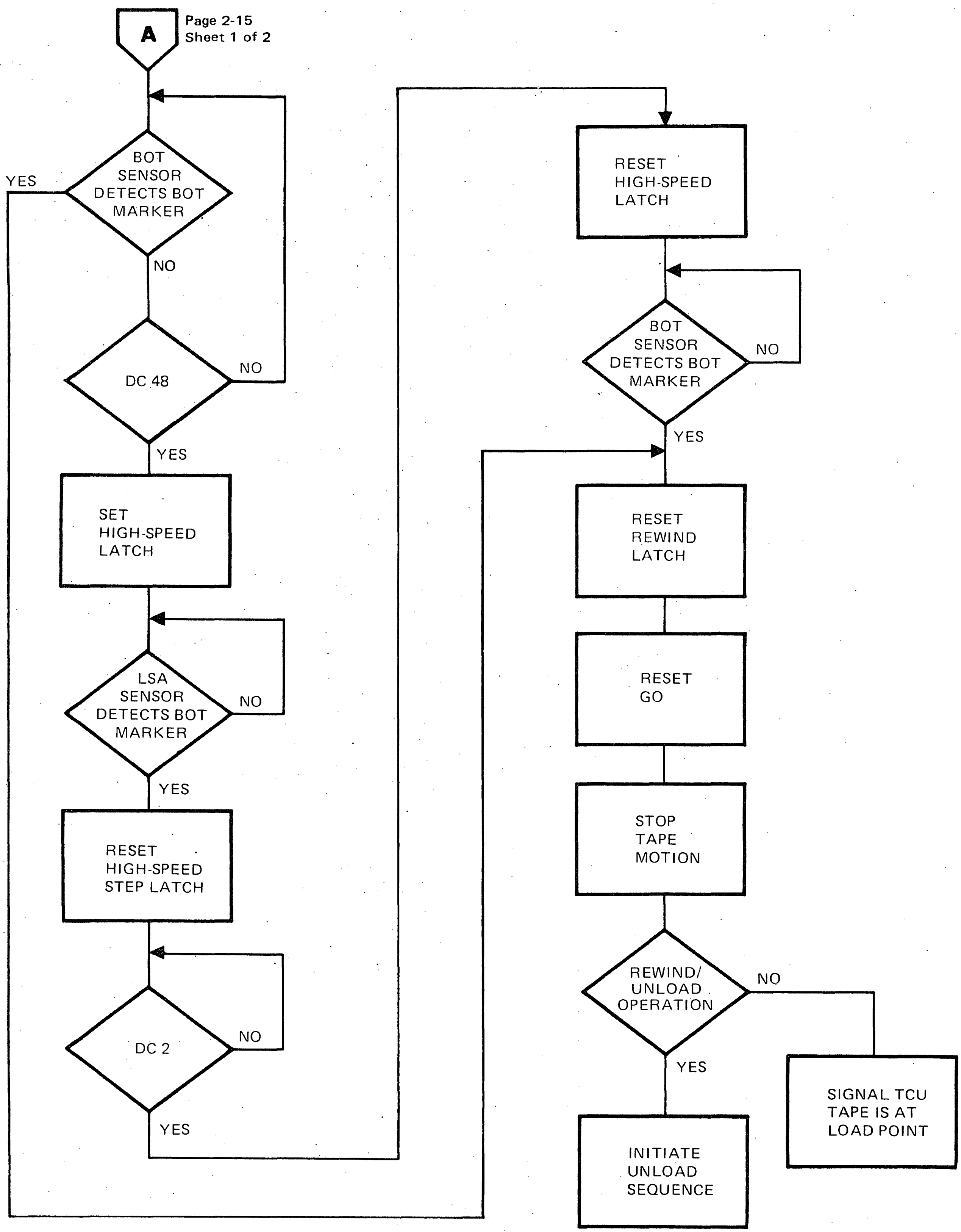


Figure 2-7. Rewind Operation Flow Chart (Sheet 2 of 2)

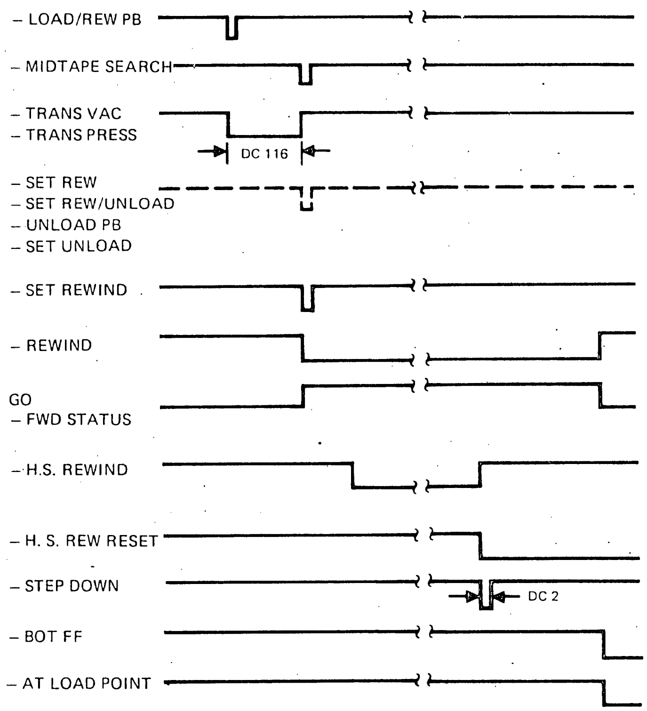


Figure 2-8. Rewind Operation Timing

After a delay count of 48, the High Speed latch is set. This starts the capstan motor ramping up to high-speed rewind, where it remains until the BOT marker activates the Low-Speed-Area sensor. The delay keeps the system at normal backward speed in case the BOT marker is between the low-speed-area sensor and the BOT sensor.

The delay is important because the BOT marker on the tape triggers the low-speed-area sensor, signaling rewind is nearly complete. Triggering the low-speed-area sensor generates -HS REWIND RESET, which inputs to the High Speed Step latch causing the High Speed latch to reset and -STEP DOWN to activate. -STEP DOWN signals the capstan to brake from high-speed rewind to normal backward speed. Tape movement then continues at normal backward speed until the BOT marker triggers the BOT sensor (load point), setting the BOT latch.

The BOT marker triggers the BOT sensor (load point), setting the BOT latch. The BOT latch resets the Rewind latch, deactivating GO and signaling the reel and capstan control logic to end tape movement. In addition, setting the BOT latch signals the TCU that the tape is at load point and ready.

UNLOAD OPERATION

The unload operation is initiated only after tape has been rewound to load point. It is activated by either of two signals, -SET REWIND/UNLOAD (from the TCU) or - UNLOAD PB (from the REWIND/UNLOAD pushbutton on the tape unit operator panel).

Figure 2-10 is a flow chart which illustrates the unload operation sequentially. A list of timing signals for the unload operation is found in Figure 2-11.

When either -SET REWIND/UNLOAD or -UNLOAD PB is active, the UNLOAD latch sets and a rewind operation is initiated (refer to the Rewind Operation section of this chapter). Once the unload latch sets, the unload operation remains inactive until the tape reaches load point.

When the BOT sensor detects the BOT marker, the BOT latch sets and the output is ANDed with the output of the Unload latch to activate UNLOAD (see Figure 2-12). UNLOAD starts the delay counter, deactivates pneumatics and returns the tape unit to low speed control.

In addition, UNLOAD controls reel motor motion during the unload operation. It activates +REEL DRIVE C to turn the file reel counterclockwise, pulling the tape out of the columns and winding it onto the reel. When tape tension transfers

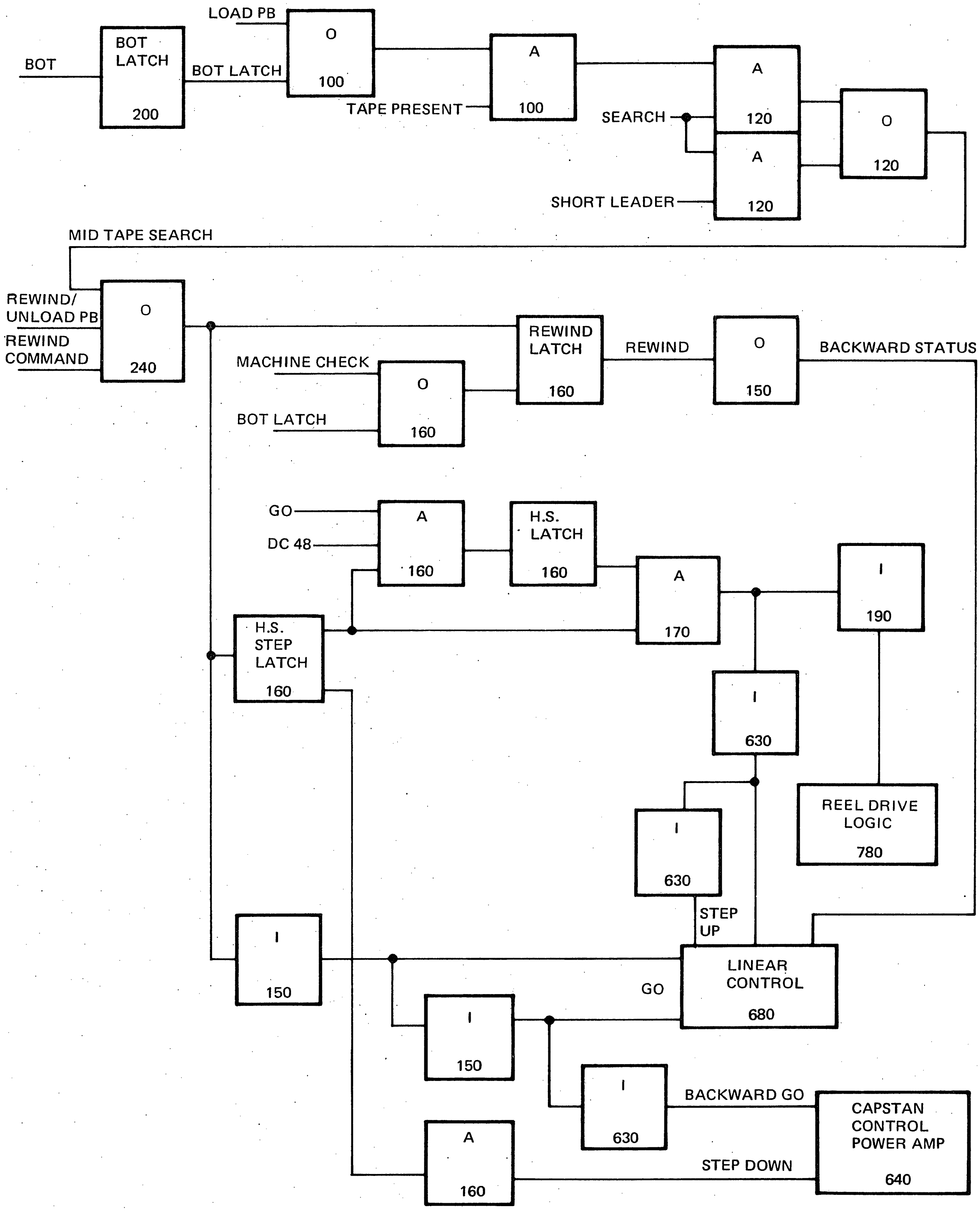


Figure 2-9. Rewind Operation Simplified Logic

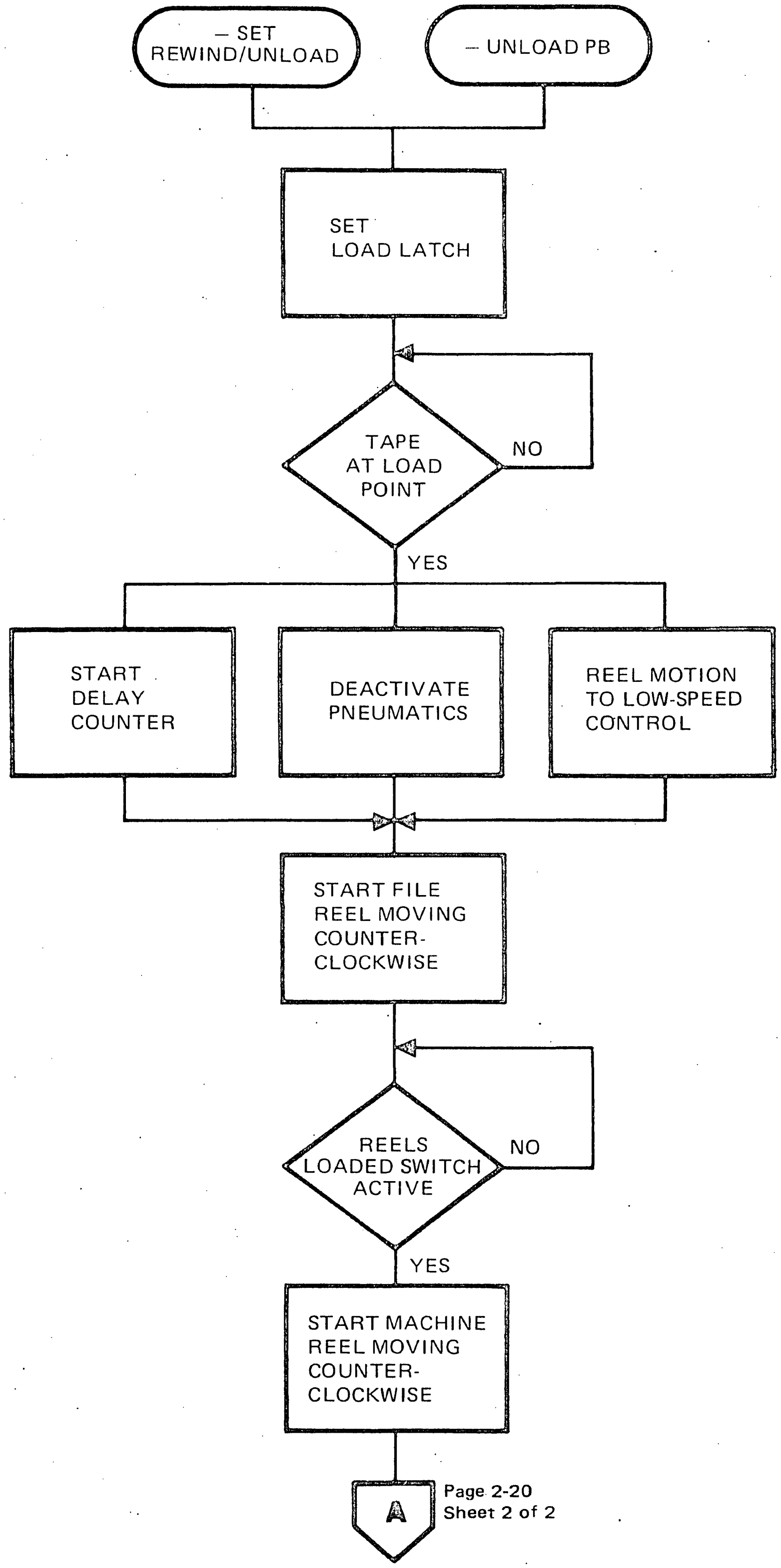


Figure 2-10. Unload Operation Flow Chart (Sheet 1 of 2)

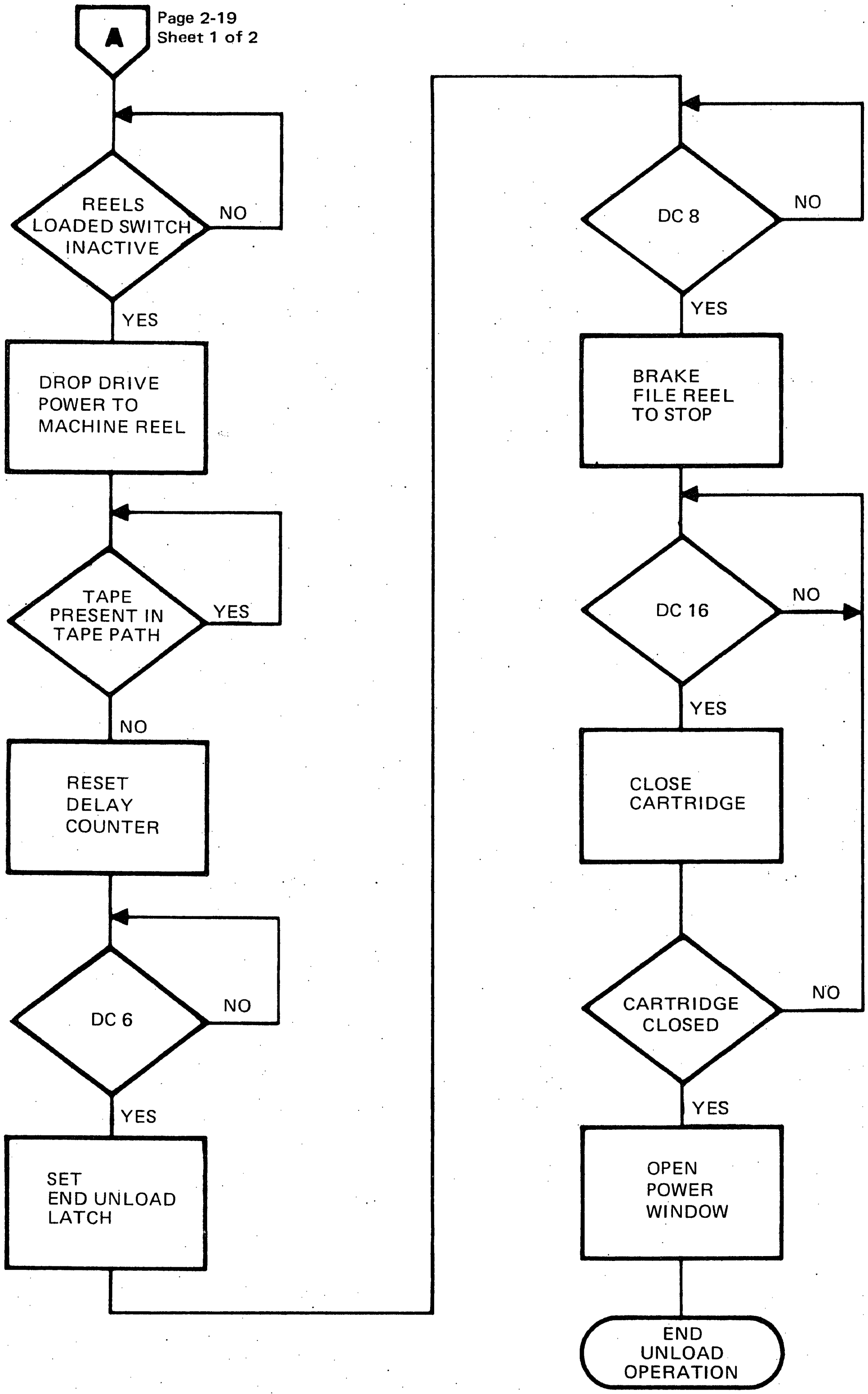


Figure 2-10. Unload Operation Flow Chart (Sheet 2 of 2)

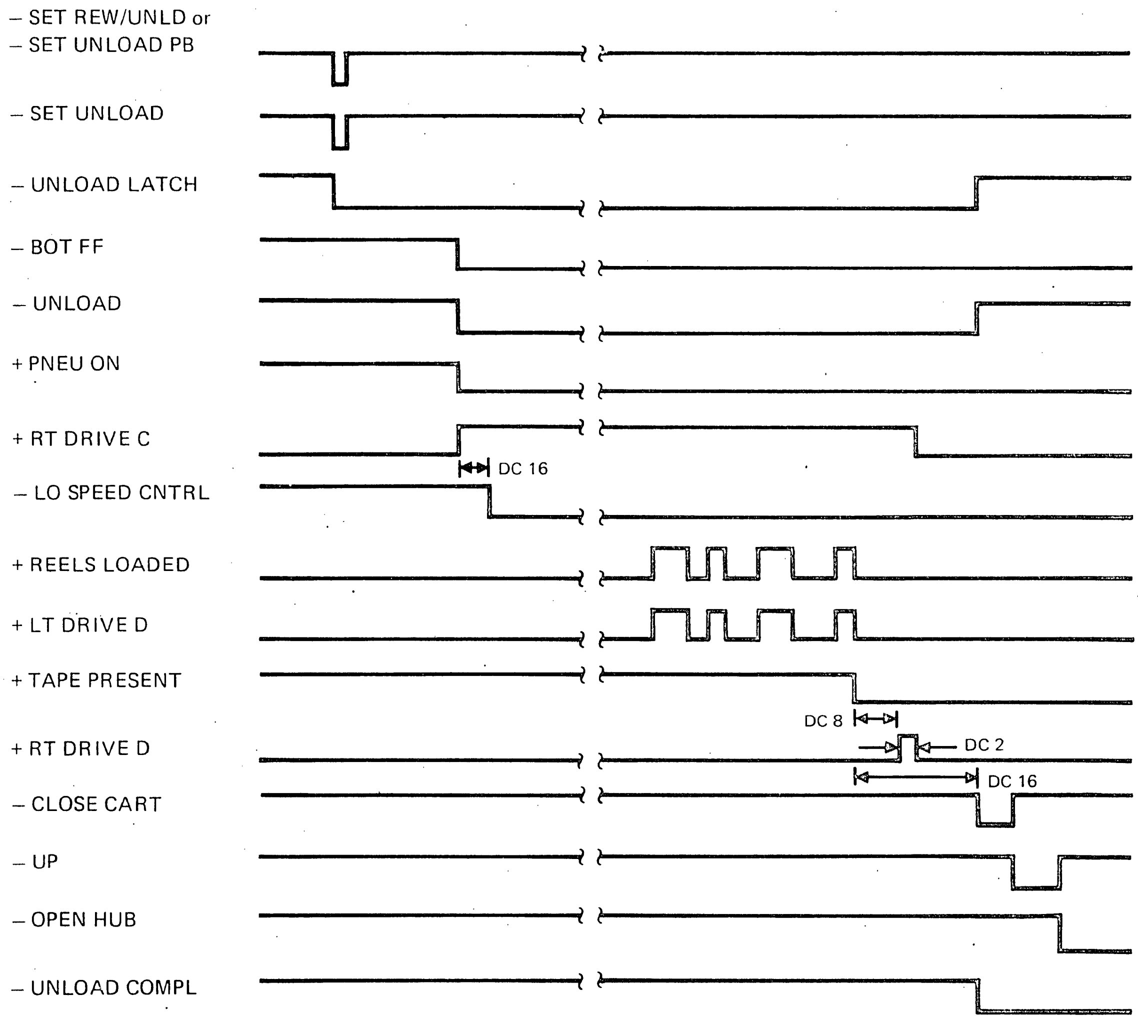


Figure 2-11. Unload Operation Timing

the reels loaded switch, activating REELS LOADED, +UNLOAD is gated through to activate +LEFT DRIVE D (see Figure 2-12). This turns the machine reel counterclockwise, dumping tape from it. When the machine reel is empty, the reels loaded switch deactivates and thus drops power to the machine reel.

The file reel continues turning, pulling the tape out of its path. When TAPE PRESENT goes inactive, the delay counter resets. At delay count six UNLOAD is gated to set the End Unload latch (see Figure 2-12), activating -END UNLOAD.

Activating -END UNLOAD results in the following actions:

- The file reel brakes to a stop.
- The cartridge closes.
- The power window opens.

The automatic hub releases the file reel and the unload operation is complete. The file reel may now be removed from the tape unit.

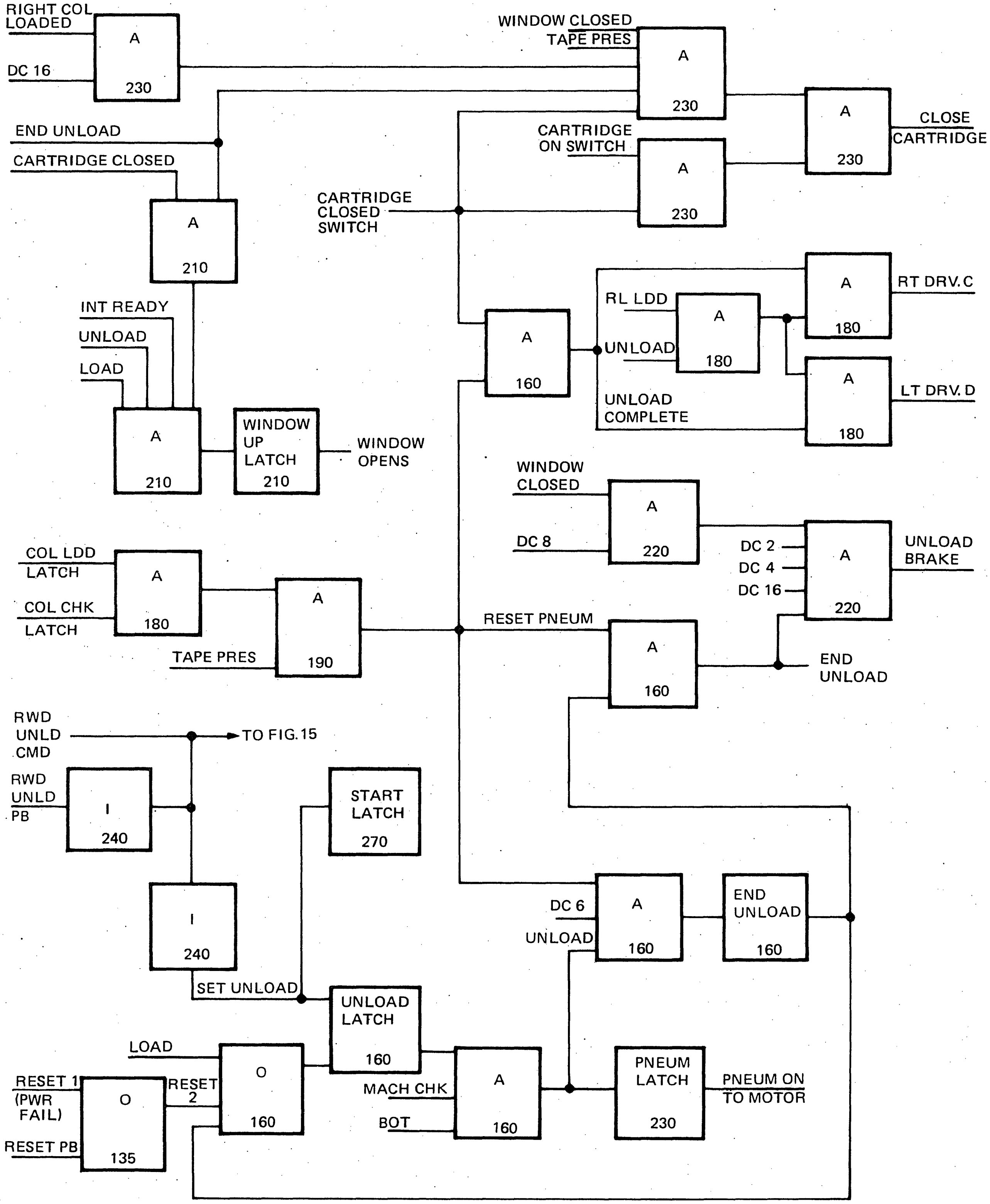


Figure 2-12. Unload Operation Simplified Logic

CHAPTER III

FUNCTIONAL DESCRIPTION

INTRODUCTION

The various assemblies and subassemblies which comprise the tape unit are described in this chapter. The subject matter covered is:

- Reel control system.
- Capstan control system.
- Read/write control.
- Input/output lines.
- Power supply.
- Pneumatics.
- Tape unit cooling.

This chapter is a prime source of information and provides a working knowledge of tape unit operation. The information is necessary when determining whether the tape unit is functioning properly. Thus during troubleshooting, the information aids in the progression from symptom to problem to solution.

REEL CONTROL SYSTEM

Two tape reels are used on each tape unit -- a file reel and a machine reel. A file reel is used for storage of tape, and therefore must be interchangeable. The machine reel is permanent and its only function is to take up tape during tape unit operation.

Neither reel is responsible for the movement of tape across the read/write heads -- an operation performed by the capstan. The reels, however, are responsible for maintaining proper tape loops in the vacuum columns during operation. The Reel Control system operates the reels in two basic modes during tape unit operation -- Low Speed Control and Column Control.

Low speed control is in effect during:

- Threading
- Loading
- Unloading

During these low speed operations, the reels function under the direction of signals from the Control Logic. Operations are initiated either by commands from the operator panel or from the interface. The operations are monitored and terminated by sensors in the tape threading path and tape columns. The reel motors are powered by -10 volt power during low speed operations.

Once tape is loaded in the columns, the reels operate under Column Control which constantly strives to keep the tape loops in zone B (see Figure 3-2).

Column Control is in effect during:

- Normal forward and backward operation.
- High-speed rewind.

During Column Control, the capstan may move tape across the read/write heads and when this occurs the reels take up or feed tape to maintain proper loop position in the tape columns. The reel motors are powered by -46 volt power, with sensors in the tape columns monitoring loop position, direction and velocity. When the tape is not moving, the loops are held in a quiescent state by -10 volt power.

Column control logic circuits and -46 volt power switching circuits are located on the Right (3A) and Left (3C) Reel boards of the power gate assembly. The Miscellaneous board (3D) contains the -10 volt power control, motor field control, Emergency Power Off (EPO) circuits and armature and field current-limiting resistors.

LOW SPEED REEL CONTROL

During threading, loading and unloading, the reel motors are driven by either Drive C or Drive D, with a path through a current limiting circuit to -10 volts. The current limiting circuits provide the correct amount of torque for the reels to operate in these modes.

All four of the -10 volt lines (two per motor) are normally enabled to and balanced across the motors. The file or right reel is supplied -10 volts by Q1 or Q2 being enabled. The machine or left reel is supplied -10 volts by Q3 and Q4 being enabled. To obtain current flow through the motors, either Q1 or Q2 and Q3 or Q4 must be disabled, which will in turn end the balanced condition of the voltages.

Figure 3-1 is a general schematic for the reel motor showing the power H configuration, -10 volt armature control, field control and EPO. The figure is valid for both reels. The difference being that driver C turns the machine reel clockwise (CW) and the file reel counterclockwise (CCW). Conversely, driver D turns the machine reel counterclockwise and the file reel clockwise.

During the thread sequence, low speed logic raises signals -LT DR C and -RT DR D. Left Driver C is turned on by -LT DR C, which also turns off Q4 creating a -10v current path through the machine reel motor. This turns the machine reel in a CW direction. -RT DR D turns on Right Driver D and turns off Q2 creating a -10v path through the file reel motor. This causes the file reel motor to turn in a CW direction.

File reel armature current is limited allowing the machine reel to turn faster (140 r/min) than the file reel (60 r/min). The faster moving machine reel draws tape taut signaling that threading is complete. Then, after a delay of about 3.2 seconds, -LT DR C is dropped and -LT DR D is raised to turn the machine reel CCW at about 110 r/min. With the machine reel turning CCW and the file reel moving CW, tape is fed into the columns until the loops cover the lower photosensors in zone A (see Figure 3-2). When the lower zone A sensors in both columns are covered -- signaling that the columns are loaded -- the system switches into column control.

If the tape unit is in the rewind/unload mode, reel operation enters low speed control at load point. Left Driver C and Right Driver C turn on, moving the machine reel CW and the file reel CCW with just enough torque to overcome column vacuum in pulling tape out of the columns. When tape clears both columns and becomes taut, (activating the reels loaded switch), Left Driver C turns off and Left Driver D turns on. Both reels are then turning CCW, with less current limiting in the file reel current path giving it greater torque. The file reel continues turning CCW until tape clears

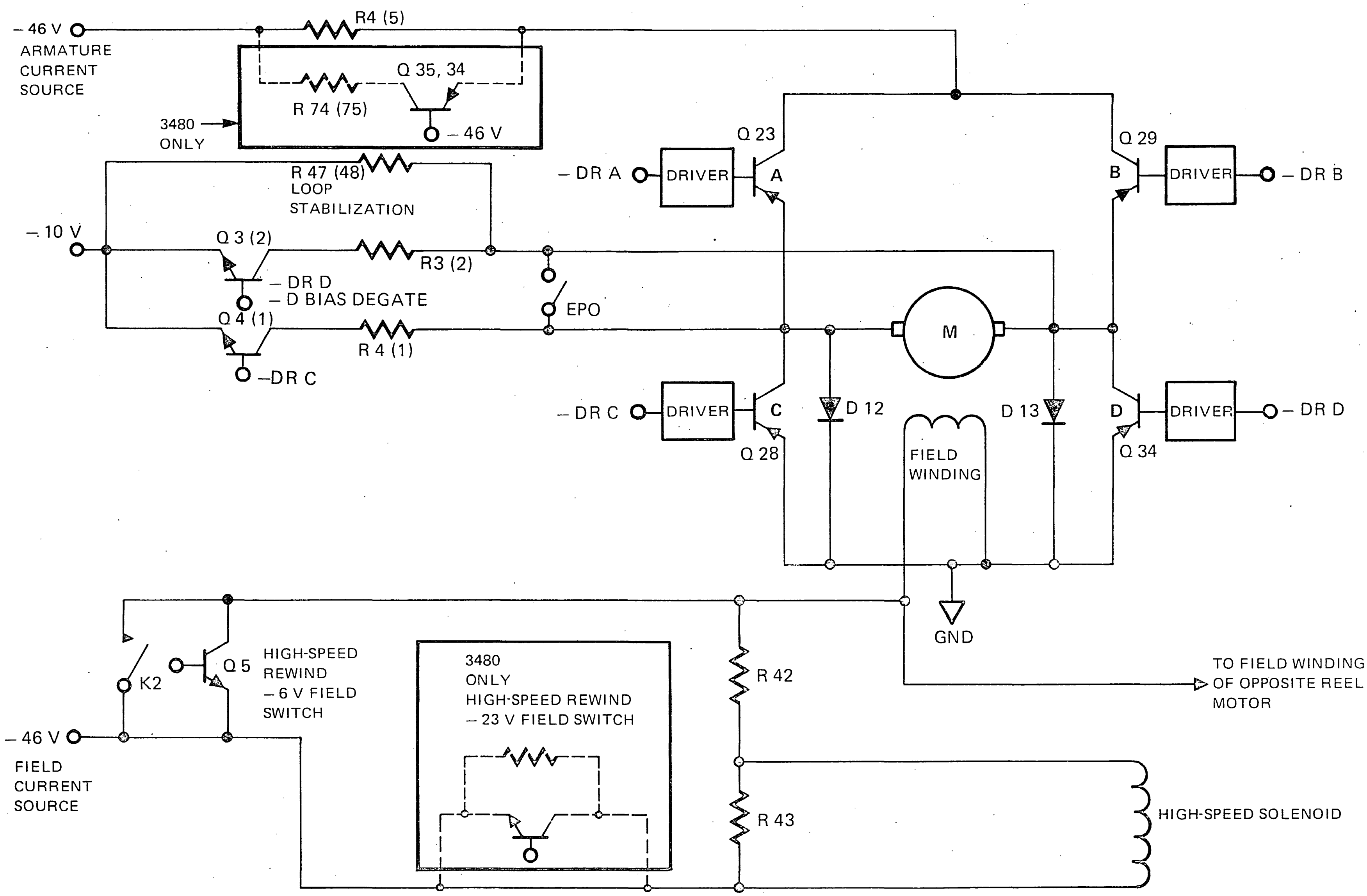


Figure 3-1. Reel System Simplified Schematic

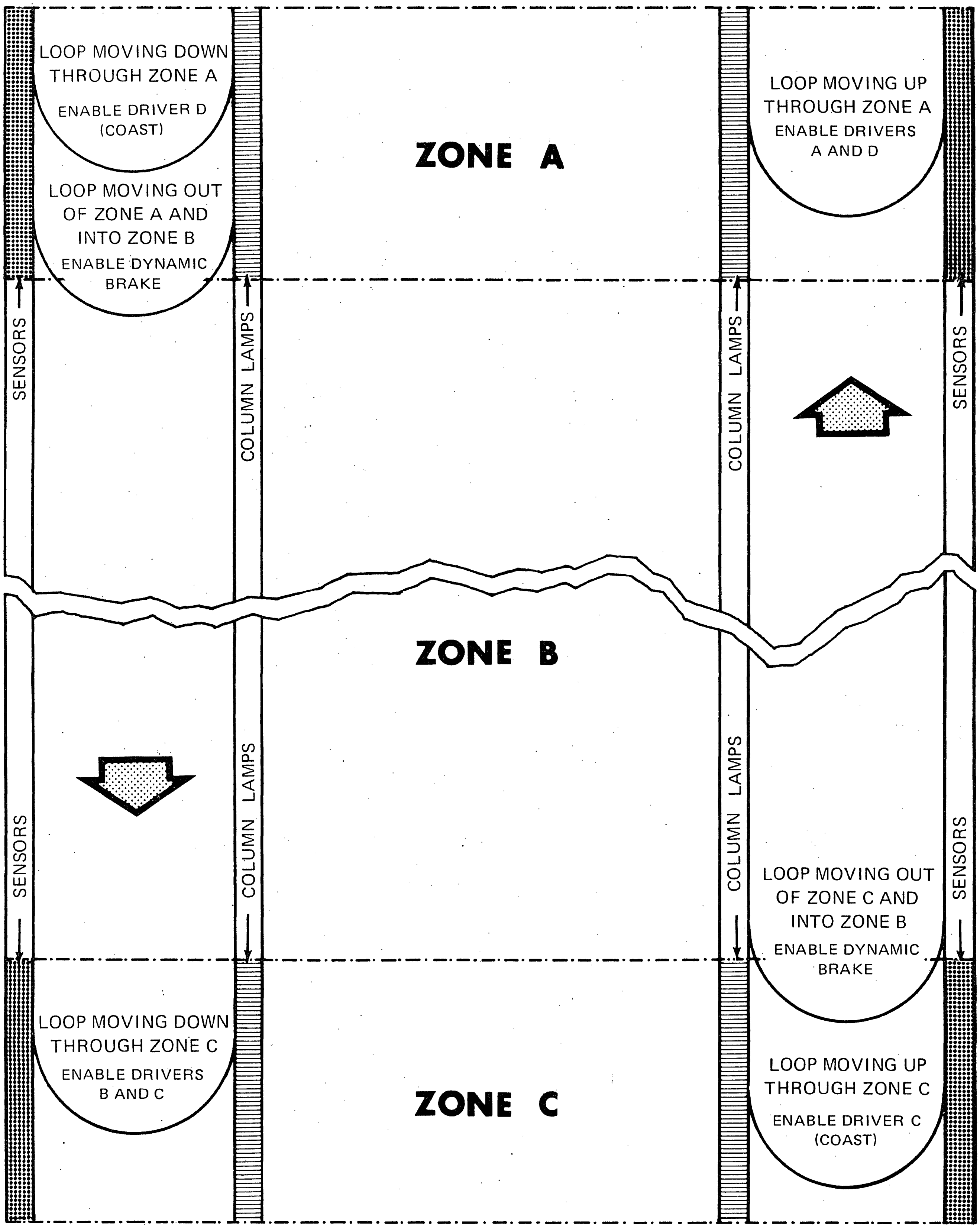


Figure 3-2. Column Sensors and Zones

the tape present sensor signaling that unload is complete.

COLUMN REEL CONTROL

Once tape is loaded in the columns, setting the Columns Loaded latch, the reels are under -46 volt column control. As the capstan moves tape, each reel control system feeds or pulls tape to maintain the loop in its tape column. While moving tape forward, loops are maintained in left column zone C and right column zone A. Conversely, the loops are maintained in left zone A and right zone C while moving tape backward.

FORWARD OPERATION - When the columns are first loaded, the tape loops are both maintained at zone B levels until the capstan receives a command to move tape forward. The forward motion pulls tape in the right column up into zone A and dumps it into the left column violating zone C. Tape sensed in right zone A turns on right drivers A and D to power the file reel motor in a CW direction (see Figure 3-3). This moves the tape loop back down in the right

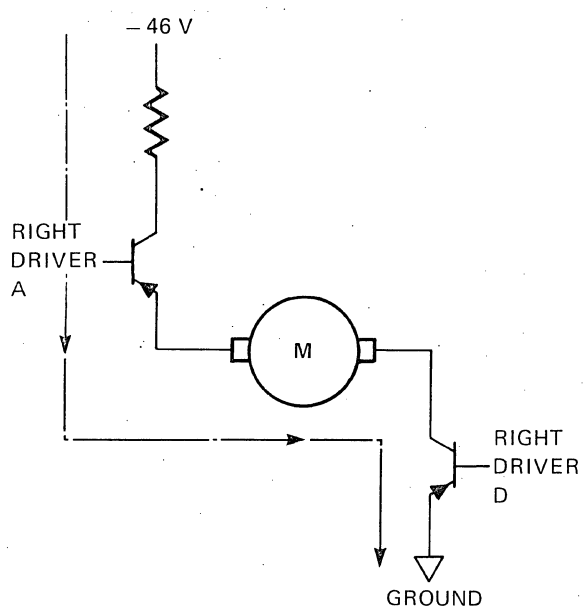


Figure 3-3. File Reel Current Path—Forward Motion Right Zone A Violation

column toward right zone B. Tape sensed in left zone C turns on left drivers B and C (see Figure 3-4). This powers the machine reel motor to turn in a CW direction, pulling tape up in the left column toward zone B.

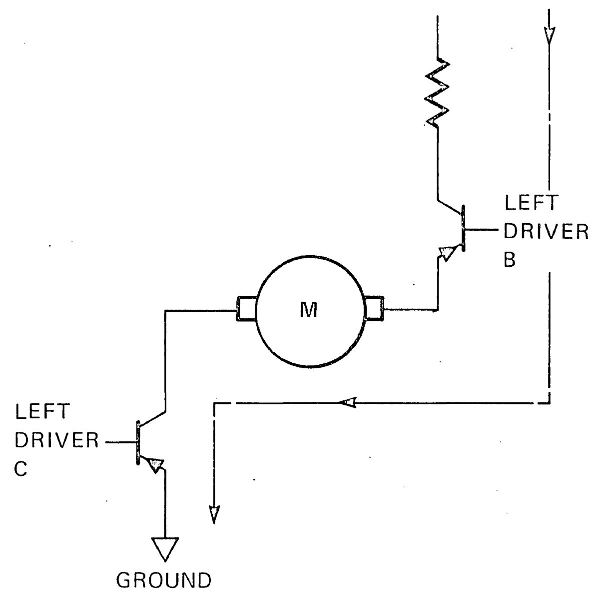


Figure 3-4. Machine Reel Current Path—Forward Motion Left Zone C Violation

Both reel motors continue to drive as long as the tape loops remain stationary in the violated zones or if the loops continue to move up in the violated right zone A or down in the violated left zone C. If downward tape motion (maintaining proper loop position) is sensed in right zone A, right driver A is turned off and the reel motor begins to coast. If upward tape motion (maintaining proper loop position) is sensed in left zone C, left driver B is turned off and the machine reel begins to coast.

The reel motors continue to coast if the tape loops continue to move toward zone B or until the loops move back into the zone B. When tape is sensed dropping from right zone A into right zone B, +RT BRAKE C turns off right drivers A and D and turns on right driver C. This applies a dynamic brake to the right reel motor by shorting the current from the armature back EMF to ground (see Figure 3-5). In the same way, if the tape loop is sensed moving up from left zone C into left zone B, +LT BRAKE D is activated to apply a dynamic brake to the machine reel motor through left driver D (see Figure 3-6). This protects against over-coasting in zone B.

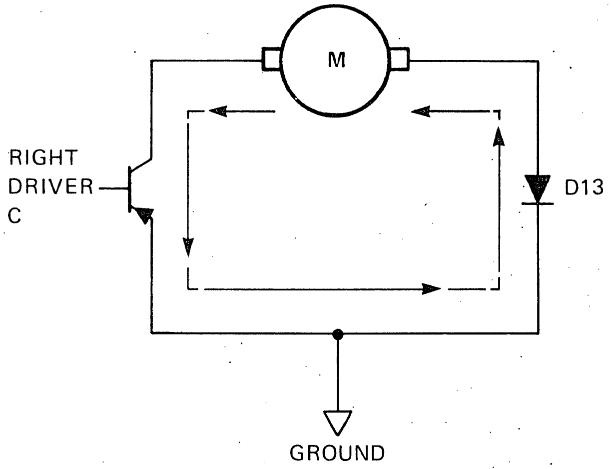


Figure 3-5. Dynamic Brake Current Path (CCW Rotation)

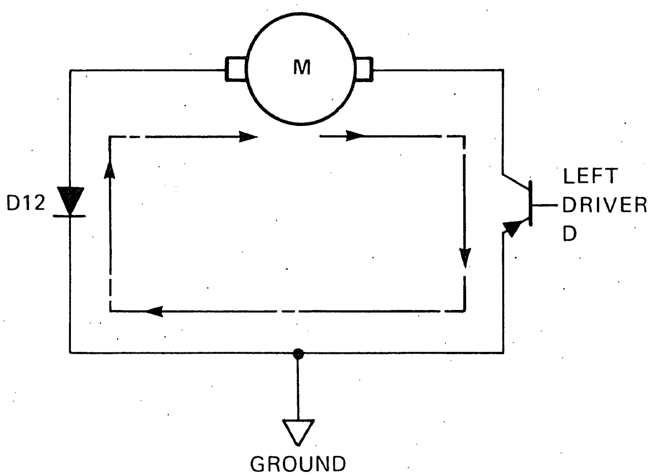


Figure 3-6. Dynamic Brake Current Path (CW Rotation)

BACKWARD OPERATION - Reel control during backward motion is the same as for forward motion, except the loop control is maintained by left zone A and right zone C.

Reel response of the 3480 tape unit is enhanced by reducing armature current-limiting when the power supply is most heavily burdened. This is accomplished by switching a second resistor in parallel with the normal armature current-limiting resistor to increase the current available. This occurs automatically if the armature supply voltage (normally -46 V) drops below -43 V (see Figure 3-1).

Anytime the tape loops drop far enough to cover the bottom sensors in either column, -RT COL BTMD or -LT COL BTMD is raised to set the Columns Check latch, set Machine Check and reset the Columns Loaded latch. This drops the system out of column control. Should the upper sensor in either column uncover, -LT COL LDD or -RT COL LDD drop and reset the Columns Loaded latch and set Column Check and Machine Check.

In the 3480 model tape unit, the reel motor field voltages are reduced allowing the reels to turn faster once the tape loops enter either the upper half of zone A or the lower half of zone C in either column. This is accomplished by switching a resistor in series with the motor field winding to reduce the field voltage from -46 volts to -23 volts. The switching is controlled by the midpoint sensors (PT A-4 and PT C-4) in each zone.

VELOCITY FEEDBACK CONTROL - Drive to the reel motors is controlled by velocity feedback. As described in the section on Column Reel Control, the reel motors are turned on in order to dump tape into or pull tape out of the columns, thus maintaining proper column tape loop. If the reel motors are over driving the loops (pulling or dumping excess tape), -DR A for the file reel and -DR B for the machine reel are inhibited by 20 millisecond pulses. The inhibit pulses are a function of the rate at which the 22 phototransistor arrays are covered and uncovered. A simplified diagram of velocity feedback control is shown in Figure 3-7.

The outputs of the zone A and zone C phototransistors for the individual columns are tied together and fed into summing amplifier OPA 1. The output of OPA 1 is shown in Figure 3-7 as V1, the function of tape loop position in the column. V1 is +8 volts when the tape loop covers all phototransistors in the columns and -8 volts when the tape loop covers none of the phototransistors in the columns (the uppermost portion of zone A). When the tape loop covers the phototransistors in zone A and none of those in zone C, the loop is in zone B and the summing amplifier output voltage is zero.

The output of summing amplifier OPA 1 is fed into differentiator OPA 2. If the tape loop is moving downward, V1 increases in positive steps, thus producing an output of negative 5v pulses (V2) from OPA 2. These negative pulses are then applied to the +DOWN single shot and produce a 20 millisecond positive pulse for each negative input pulse.

The +DOWN pulses are gated only for zone A and they inhibit -DR A, incrementally turning off driver A. The +UP pulses are gated only for zone C and they inhibit -DR B, incrementally turning off driver B. The faster the tape loop moves down in zone A, the shorter the period of +DOWN pulses and the more driver A is inhibited. If the period of the +DOWN pulses becomes less than 20 milliseconds, driver A remains off and the reel motor coasts. In the same way, the faster the tape loop moves up in zone C, the more driver B is inhibited until it remains off and the reel motor coasts.

A protective squelch circuit is included in addition to the normal velocity feedback signals +UP and +DOWN. If the opposite single-shot signal goes positive, the existing single-shot signal is squelched. For example, the +DOWN signal is in the middle of its 20 millisecond pulse. The tape loop suddenly reverses (goes up) and the output of the +UP single-shot becomes positive. The -UP signal immediately inhibits the +DOWN signal via the squelch circuit. On the other hand, if the +DOWN signal becomes positive while the +UP single-shot is in its 20 millisecond period, the output of the +UP single-shot is inhibited.

HIGH-SPEED REWIND REEL CONTROL - High-speed rewind differs very little from a normal forward or backward operation except that tape always moves backward during high-speed operation. During high-speed rewind, the field current in both reel motors is reduced to obtain a faster rewind speed. The capstan drive cuts out and reel coasting is inhibited if the tape loop moves above the middle sensor in left zone A or below the middle sensor in right zone C.

Field current is reduced by switching a resistor in series with the -46 volt supply common to both reel motor fields. This resistor is normally shorted out but during high-speed rewind it is switched in, thus reducing the voltage across each motor field to -6 volts. During high-speed rewind on the 3480 model, the field current reduction in upper zone A and lower zone C is inhibited.

Reel motor coast inhibit occurs when the tape loop moves up in left zone A uncovering the midpoint sensor or when the tape loop drops low enough to cover the midpoint sensor in right column zone C. Uncovering the left zone A midpoint sensor raises -LT CAP CUTOUT which inhibits the machine reel motor from coasting (coasting normally occurs when the loop begins to move downward in zone A) and cuts out capstan drive. Left driver A remains on causing the machine reel to dump tape into the

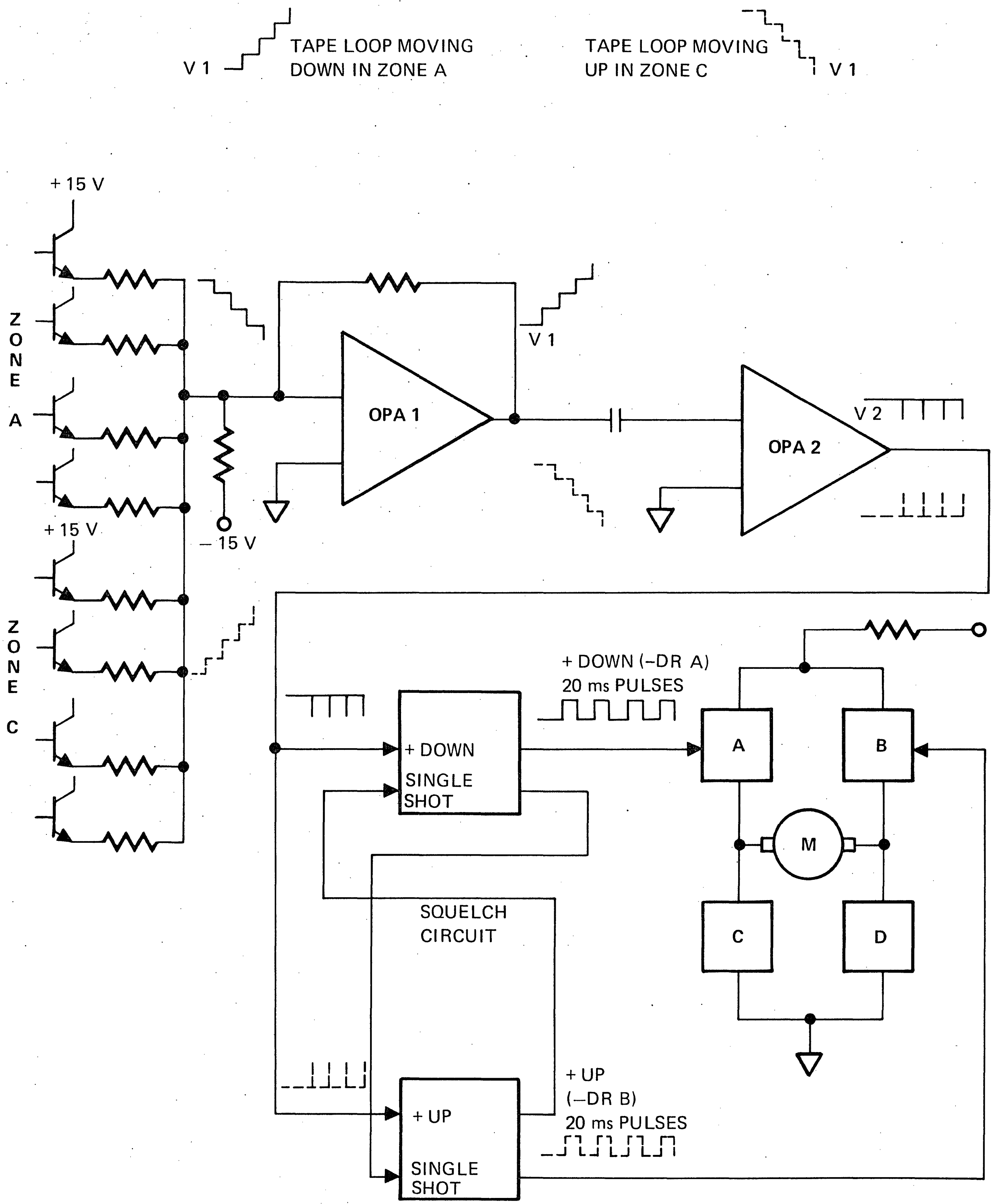


Figure 3-7. Velocity Feedback Control

column until the tape loop moves through zone A and into zone B. Capstan drive restarts when the left zone A midpoint sensor is covered. Coast inhibit drops when tape enters zone B.

Covering the midpoint sensor in right zone C produces much the same results as previously noted. The tape loop covers the midpoint sensor activating -RT CAP CUTOUT. It cuts out capstan drive and sets the latch which holds right driver B on. Holding driver B on inhibits coasting (coasting normally occurs when the loop begins to move upward in zone C) until the tape loop enters zone B. Capstan drive restarts when the right zone C midpoint sensor uncovers. Coast inhibit drops when the tape enters zone B.

LOOP STABILIZATION (ANTI-BOBBLE)
Whenever GO drops and the capstan stops, the reel motors begin to coast driving the loops into the zone B. Having tape enter zone B under these conditions activates +BRAKE C and +BRAKE D ending reel motion. Once the GO line drops, the delay counter counts to 8, at which time Driver D is deactivated and -DR C and -D BIAS DEGATE are raised. -D BIAS DEGATE disables the normal low-speed control paths for the C drivers. In this mode all normal low-speed armature paths are disabled. A small amount of current leaks through the 40-ohm resistors R47 and R48 (see Figure 3-1), allowing enough armature current through the C drivers to balance the tape loops in the vacuum columns against the pull of the vacuum in the column when there is no tape movement.

EMERGENCY POWER OFF (EPO)

A power failure could result in abnormal reel motor speeds and possible tape damage. To protect against such damage, an EPO relay shorts out the motor armatures during a power failure (see Figure 3-1). The EPO relay is normally energized through transistor Q9 which is controlled by the +10 volt, -10 volt and -46 volt power lines. If +10 volt, -10 volt or -46 volt power fails, the relay de-energizes shorting out the motor armatures and field current resistance.

CAPSTAN CONTROL

Tape movement across the read/write head is under the direction of the Capstan Control System. The control system comprises the capstan motor assembly and velocity control circuits.

The velocity control circuits are listed below.

- A tachometer which measures the rate of rotation.
- A crystal oscillator which is used as a time reference.
- A counter that accumulates oscillator pulses during each tach period.
- A digital-to-analog converter which converts the contents of the counter to an analog voltage proportional to capstan rotational velocity.
- A comparison circuit that compares the analog voltage with a predetermined voltage that is indicative of the desired rate of capstan rotation and thereby determines whether the actual rate is high, low or nominal.
- A driver circuit which, under the control of the comparitor, provides an appropriate current path to the capstan motor that will produce the proper rate of rotation.

The capstan motor assembly includes the capstan motor, the capstan and a digital tachometer assembly. A high torque, low inertia motor provides quick starting and stopping of the capstan. Due to the nature of the tape unit, the capstan motor is designed for intermittent high-current operation. All STC tape units use a single capstan constructed of a light-weight alloy.

POWER DRIVER

The capstan power driver operation is broken down into the following four functions:

- Direction Control

  This is accomplished by providing the appropriate current paths for the dc motor. Forward motion current path is through drivers A and D. Backward motion current path is through drivers B and C. Drivers A and B operate in increments between on and off. Drivers C and D operate as either on or off (see Figures 3-8, 3-9 and 3-10).

- Dynamic Braking

  Magnetic coupling is employed to provide dynamic braking. With dynamic braking no surfaces make contact, thus there is no wear. Braking is accomplished by enabling drivers C and D which, in conjunction with the adjacent diodes, provide a brake current path from one side of the armature to the other. In other words the armature is shorted. Braking is also in effect when the capstan is stopped. This prevents motion from occurring as a result of a disturbance in the tape path area (see Figure 3-11).

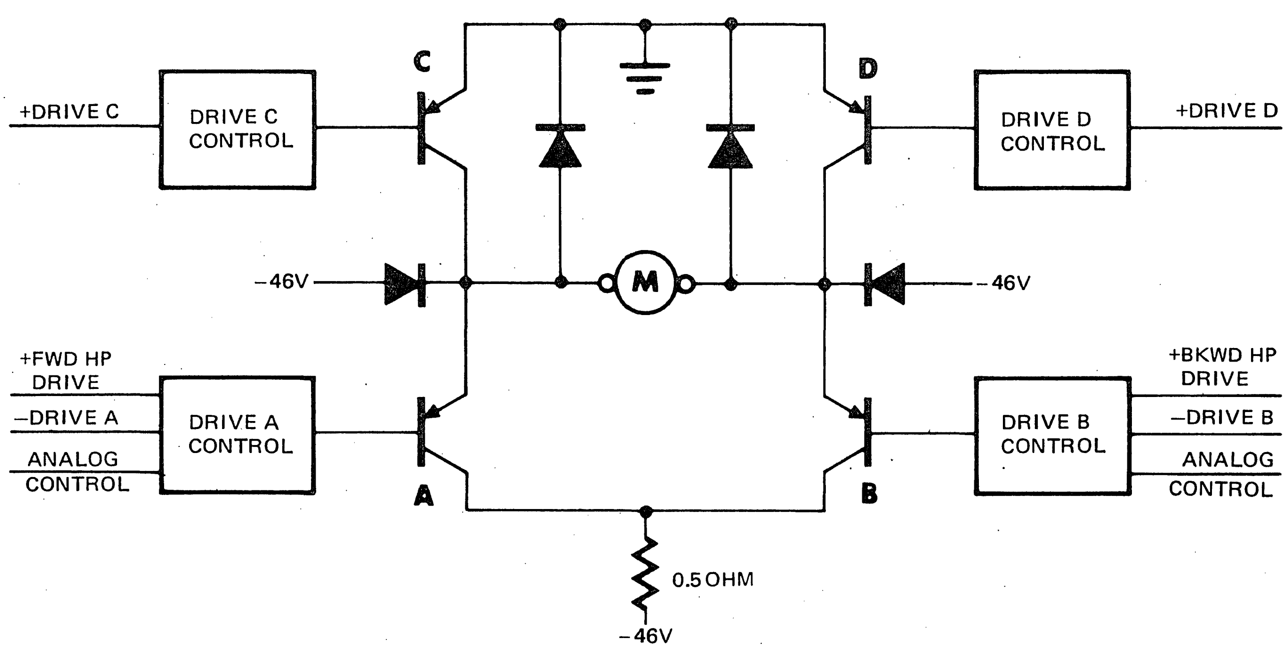


Figure 3-8. Capstan Power Amplifier

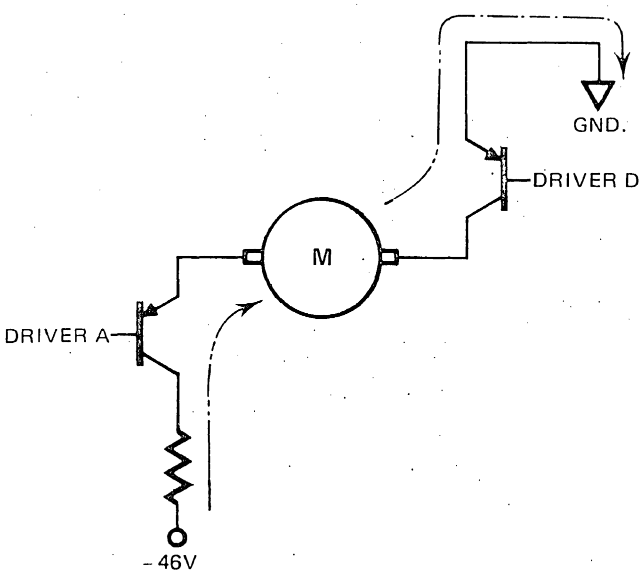


Figure 3-9. Capstan Motor Current Path (Forward Motion)

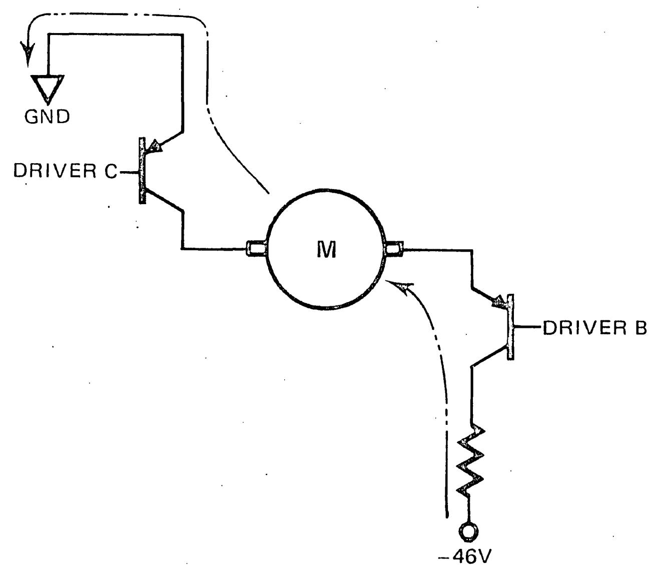


Figure 3-10. Capstan Motor Current Path (Backward Motion)

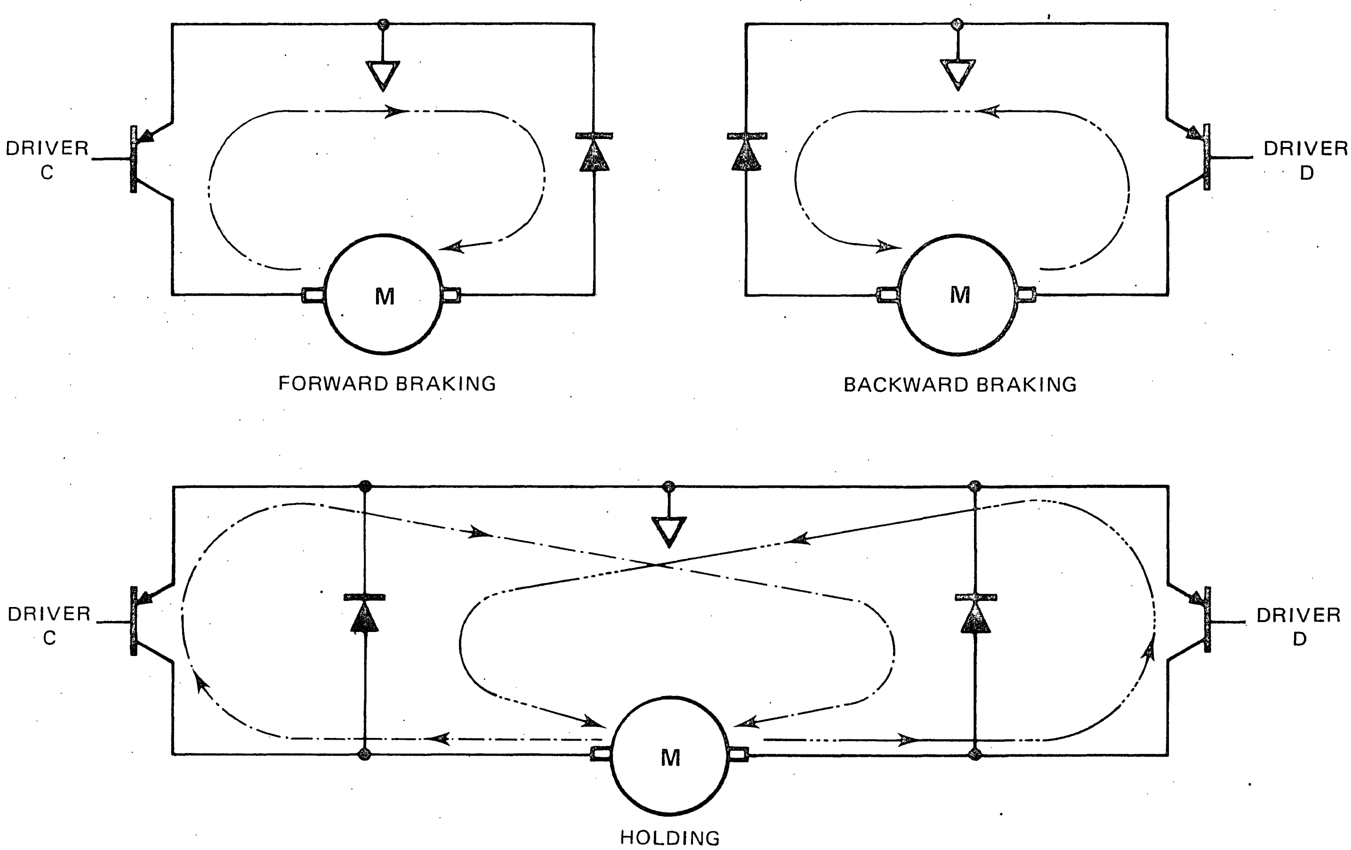


Figure 3-11. Capstan Dynamic Brake Current Paths

- High Power Drive

  Interblock gaps (IBG 0.6") between the individual records on tape require that the capstan be up to operational velocity within 20 degrees of rotation. This is accomplished by applying full supply power to the capstan motor until it reaches 88 percent of the desired steady state rotational velocity. After this is achieved, high power drive is terminated. The capstan motor is then powered by a signal referred to as linear control.

- Linear Control

  Once the capstan is operating at or very near the correct rotational velocity, it must be monitored and controlled to ensure that it remains within tolerance. To accomplish this, a signal proportional to the velocity error controls the capstan driver conduction. This in turn, controls the rotational velocity of the capstan motor. This signal is referred to as linear control.

The following description of forward tape motion illustrates the four driver functions in operation.

- Forward Motion Control

  Initially the capstan motor is in a dynamically braked condition. This means drivers C and D are enabled (see Figure 3-8). To initiate forward motion, the forward line must be active. When the GO line becomes active, due to the motion requirement of the operation to be performed, driver C disables. After 120 microseconds, driver A enables. This delay ensures that drivers A and C are not enabled at the same time. The high power drive line activates just prior to driver A being enabled. This provides a high-current path through driver A, the motor and driver D. As a result, the motor starts rapidly (see Figure 3-9).

  When the motor reaches approximately 88 percent of the desired steady state rotational velocity, the high power drive line becomes inactive. At this point in the sequence of events, linear control takes over. Linear control is a rotational velocity error signal used to keep the capstan motor rotating at the correct velocity. Upon completion of the operation, GO becomes inactive and disables drivers A and D. After a 120 microsecond delay, drivers B and C and backward high power drive are enabled. This provides a reverse current path to the motor which causes it to attempt reverse rotation. The net result is rapid deceleration.

  An adjustable single-shot governs the deceleration period by disabling driver B when it times out. Dynamic braking is applied 120 microseconds later by enabling driver D. This brings the capstan motor to a complete stop.

NOTE

There is a write single-shot and a read single-shot used for reverse current deceleration. They are adjustable to compensate for initial tolerances and to provide the correct stopping distance. Total write stop distance is 0.20 inches. Total read stop distance is 0.35 inches.

Shown in Figure 3-12 are the five modes of operation for the capstan drivers.

		FORWARD LINEAR DRIVE	FORWARD HIGH POWER DRIVE BACKWARD PLUG	BACKWARD LINEAR DRIVE	BACKWARD HIGH POWER DRIVE FORWARD PLUG	DYNAMIC BRAKE
– DRIVE A	STATUS	ACTIVE	ACTIVE	INACTIVE	INACTIVE	INACTIVE
	VOLTAGE	0V	0V	1.3V	1.3V	1.3V
	TOLERANCE	(0V TO 0.4V)	(0V TO 0.4V)	(1.2V TO 1.5V)	(1.2V TO 1.5V)	(1.2V TO 1.5V)
+ DRIVE D	STATUS	ACTIVE	ACTIVE	INACTIVE	INACTIVE	ACTIVE
	VOLTAGE	1.3V	1.3V	0V	0V	1.3V
	TOLERANCE	(1.2V TO 1.5V)	(1.2V TO 1.5V)	(0V TO 0.4V)	(0V TO 0.4V)	(1.2V TO 1.5V)
+ FORWARD HIGH POWER DRIVE	STATUS	INACTIVE	ACTIVE	INACTIVE	INACTIVE	INACTIVE
	VOLTAGE	0V	5V	0V	0V	0V
	TOLERANCE	(0V TO 0.4V)	(3.0 TO 5.00)	(0V TO 0.4V)	(0V TO 0.4V)	(0V TO 0.4V)
– DRIVE B	STATUS	INACTIVE	INACTIVE	ACTIVE	ACTIVE	INACTIVE
	VOLTAGE	1.3V	1.3V	0V	0V	1.3V
	TOLERANCE	(1.2V TO 1.5V)	(1.2V TO 1.5V)	(0V TO 0.4V)	(0V TO 0.4V)	(1.2V TO 1.5V)
+ DRIVE C	STATUS	INACTIVE	INACTIVE	ACTIVE	ACTIVE	ACTIVE
	VOLTAGE	0V	0V	1.3V	1.3V	1.3V
	TOLERANCE	(0V TO 0.4V)	(0V TO 0.4V)	(1.2V TO 1.5V)	(1.2V TO 1.5V)	(1.2V TO 1.5V)
+ BACKWARD HIGH POWER DRIVE	STATUS	INACTIVE	INACTIVE	INACTIVE	ACTIVE	INACTIVE
	VOLTAGE	0V	0V	0V	5V	0V
	TOLERANCE	(0V TO 0.4V)	(0V TO 0.4V)	(0V TO 0.4V)	(3.0V TO 5.0V)	(0V TO 0.4V)

Figure 3-12. Capstan Driver Voltages and Modes

VELOCITY CONTROL CIRCUITS

The velocity control system senses capstan speed as defined by the tachometer pulse time period. It then compares the speed to a fixed reference and generates an error signal to the power driver which varies the voltage to the capstan motor (see Figure 3-13). Oscillator pulses are counted during each tachometer period. The count is inversely proportional to the capstan velocity. The oscillator frequency is fixed for tape unit speed so that other capstan system constants are the same for all models.

- Digital Tachometer Assembly

  This consists of two phototransistor light pairs, an etched glass disk and a mask.

  The glass tachometer disk, mounted on the capstan motor shaft, has 500 etched radial lines. As shown in Figure 3-14, a light source is

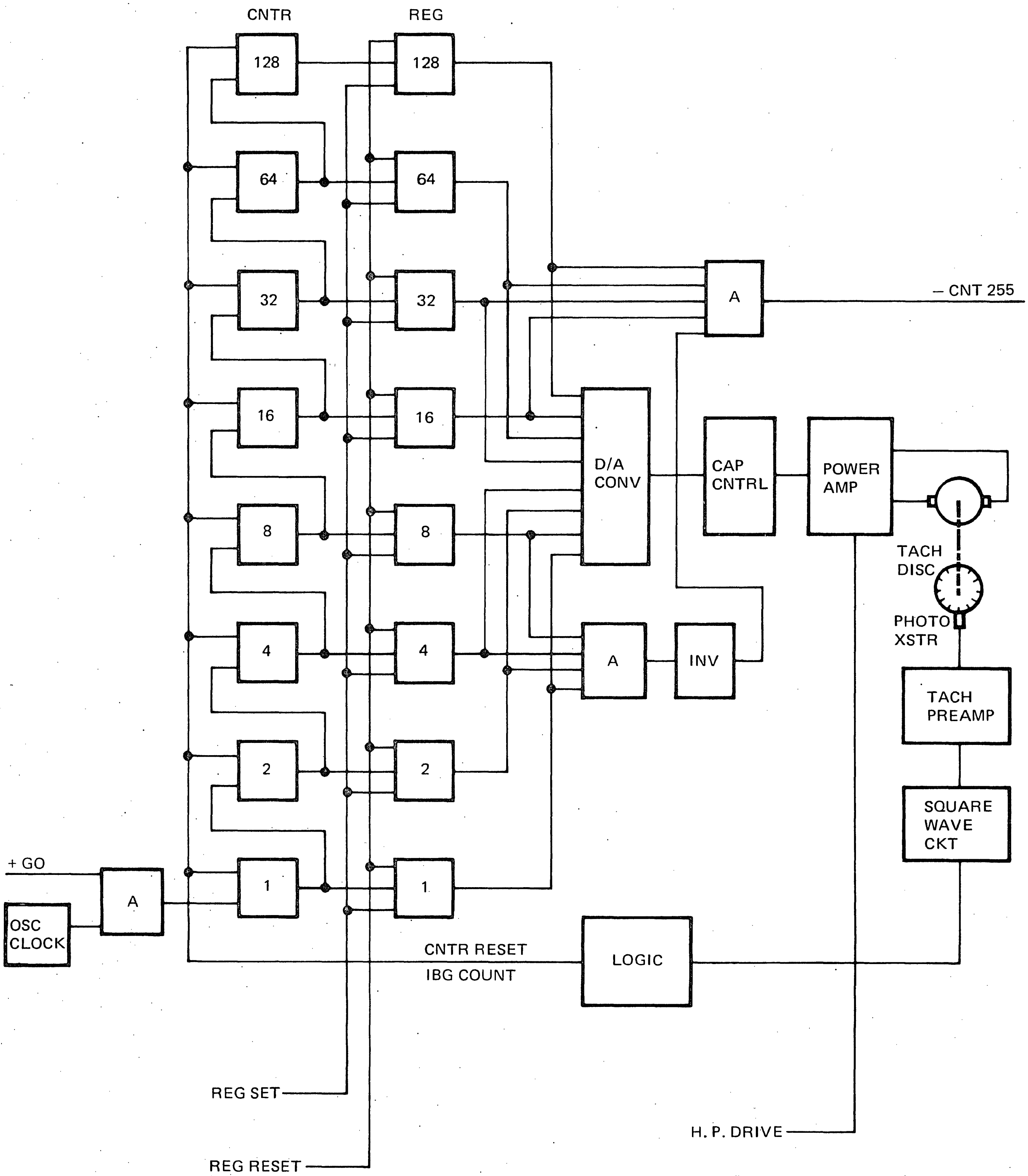


Figure 3-13. Capstan Velocity Control Block Diagram

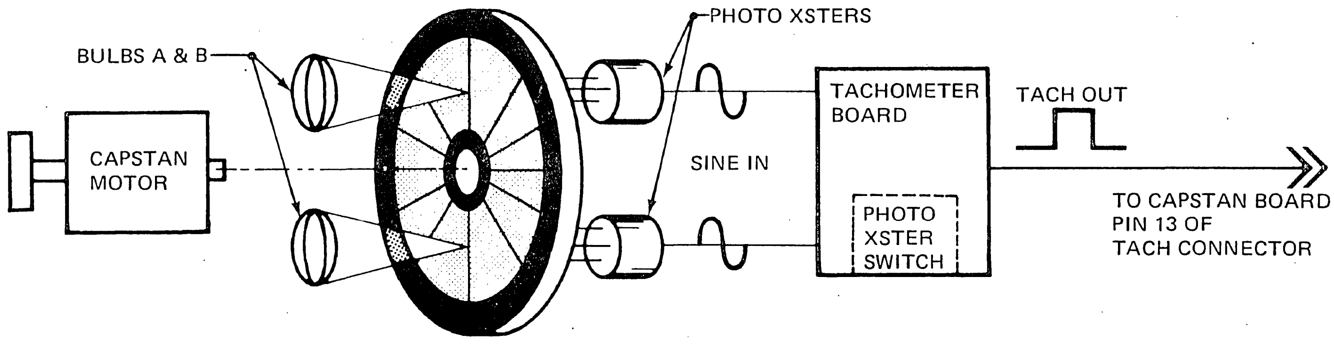


Figure 3-14. Digital Tachometer Configuration

mounted on one side of the disk and a phototransistor on the other. A stationary mask (not shown in Figure 3-14) confines the light and in conjunction with the disk produce a shutter action as the capstan rotates. The light which passes through the disk and mask flashes as a result of the shutter action at a rate proportional to capstan rotation. These light flashes strike the phototransistor causing it to alternately turn on and off thereby producing a sine wave output. The sine wave is shaped into a square wave which is used to monitor and control velocity and stop distance.

- Oscillator Pulse Counter

The previously mentioned tachometer pulses are not adequate in themselves to monitor rotation accurately. However, the tach pulse duration or tach period is indicative of capstan rotational velocity and, by counting fixed frequency pulses during these periods, a high degree of accuracy is obtained. A crystal controlled oscillator provides the fixed frequency pulses and they are counted by an eight stage counter. The oscillator, counter and associated circuitry are shown in a block diagram in Figure 3-13.

Due to the tach period being inversely proportional to the capstan's rotational velocity, the pulse count decreases as the capstans's rotational velocity increases. Also since the tach period is the quantity of time during which the pulse count is made, the pulse count is a digital indication of the capstan's rotational velocity. By sending the pulse count through a digital-to-analog converter, a rotational velocity analog is developed. This rotational velocity analog is compared to a fixed reference voltage which corresponds to the desired steady state rotational velocity.

The resultant difference produces a rotational velocity error signal used for linear control.

An additional function of the pulse counter is to terminate high power drive after start. This is accomplished by monitoring for a pulse count of less than 255 during two successive tach periods. When this situation exists, the 88 percent of steady state rotational velocity has been reached and high power drive is terminated.

CAPSTAN STARTING

During capstan start, the input to the D/A converter is held at a count of 192 by an inhibit gate. When -GO becomes active the power driver logic raises the high-power driver to override the analog control and start the capstan motor at maximum acceleration. As capstan speed increases, the tachometer pulse frequency increases and tachometer pulse width decreases. When the oscillator count within a tachometer period is less than 255 for two consecutive tach pulses the Linear Control latch sets. This signals the power driver logic to switch from high-power to linear control. It also removes the inhibit gate and puts the actual velocity count into the register and the D/A converter. The capstan motor continues to accelerate under linear control until steady state velocity is reached.

CAPSTAN STOPPING

To stop the capstan in the required distance, controlled plugging or dynamic braking must be applied. When GO becomes inactive, the capstan remains in linear control until Go Holdover logic, which provides proper stopping distance, allows GO 1 to become inactive. GO 1 becoming inactive applies dynamic braking to the capstan.

INTERBLOCK GAP CONTROL

The interblock gap (IBG) is created during the stopping and starting of tape motion on Write commands. This is accomplished by leaving the write and erase heads on (with no data). The length of the interblock gap is controlled by the IBG counter.

The IBG counter is a six stage binary counter (see Figure 3-15) which controls the write gap to approximately 0.6 of an inch. This is accomplished by counting the total number of tachometer pulses that occur during the stopping and starting of tape motion (see Figure 3-16).

When the GO line becomes inactive upon completion of a write operation, the IBG counter counts tach pulses while the capstan is coming to a stop. This tach count is indicative of the distance tape was moved while stopping and is retained for use on the next Write command.

When GO from the next Write command is received and the capstan starts to rotate, the counting is resumed and continues until a count of 31 is reached. At this time a check is made of the capstan control registers contents to determine if the capstan is at the correct operating speed. If the capstan is not at the correct speed, the contents of the IBG counter remain at 31 until it is.

When the capstan attains 95% of the proper velocity, the IBG counter is once more allowed to count. Two additional tach pulses are counted (33 total), which causes the +WR INH (write inhibit) signal to go negative (inactive). This causes "write condition" to become active in the TCU. This in turn allows the first byte of data to be transferred to the tape unit.

FORWARD CREEP - During a "Write-Backspace-Write" sequence of operations there is a possibility of producing a short IBG. This arises as a result of a possible difference between backward stopping distance and forward starting distance.

To prevent this situation from being a problem, all operations involving backward motion followed by a Write command are treated in the following manner (see Figure 3-17).

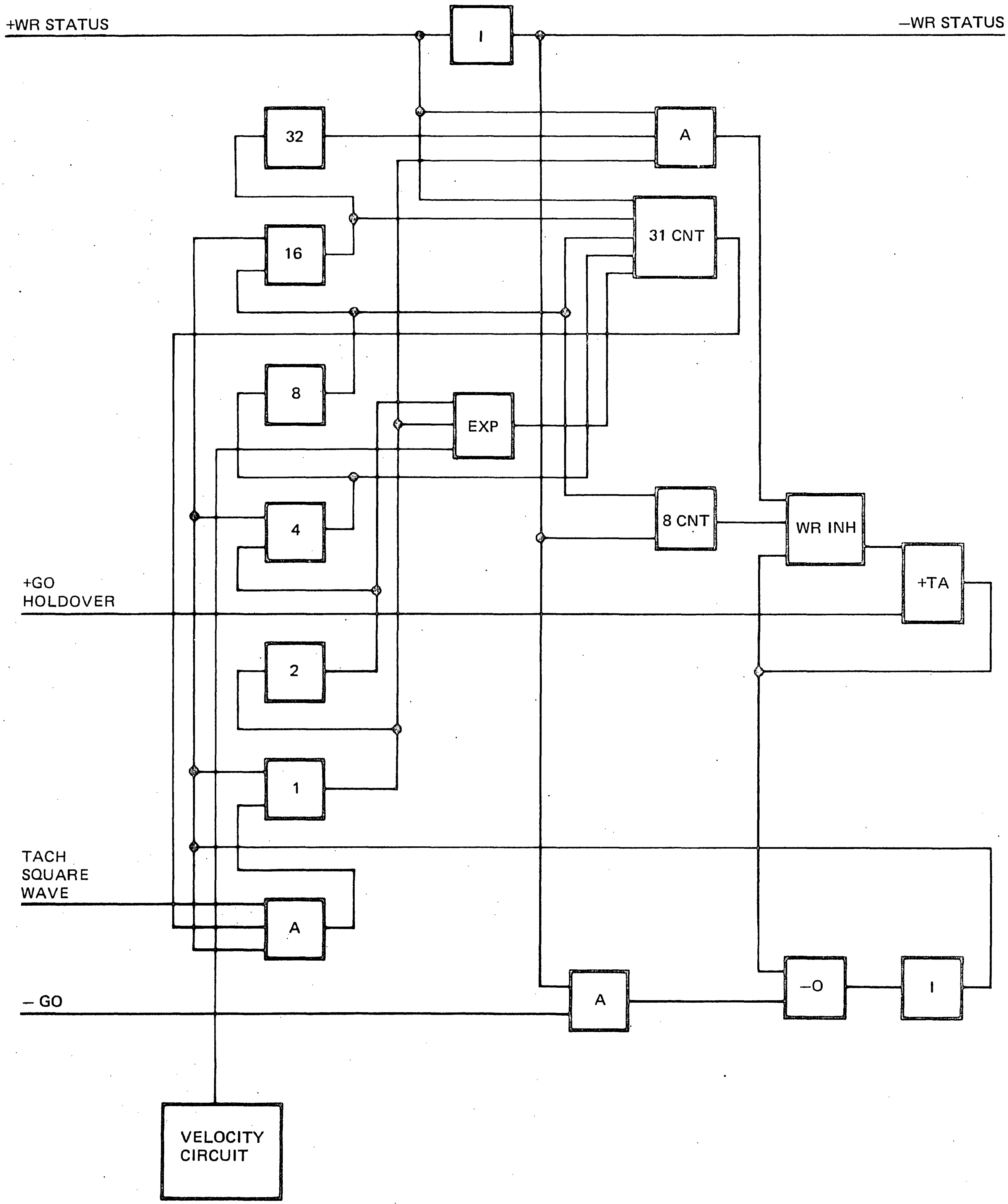


Figure 3-15. IBG Counter

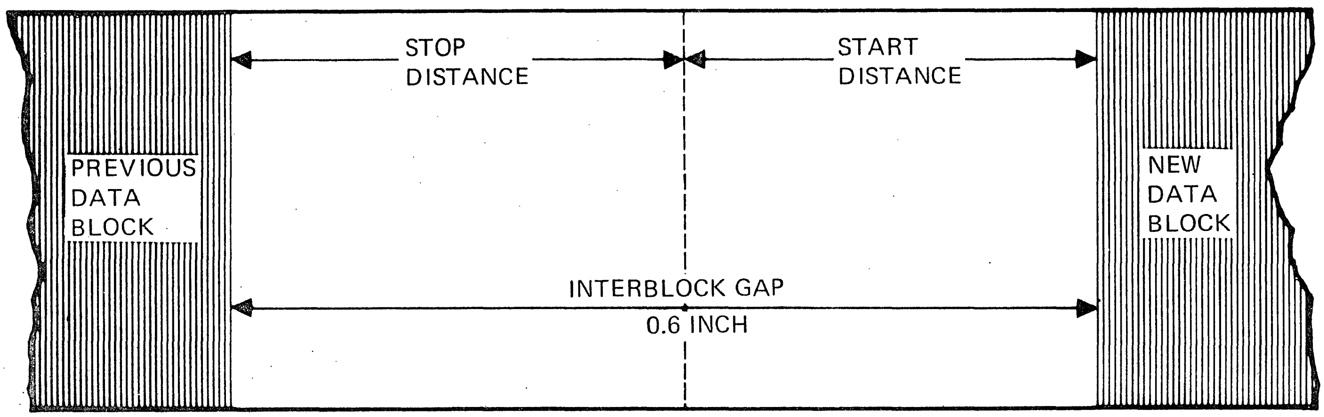


Figure 3-16. Interblock Gap Diagram

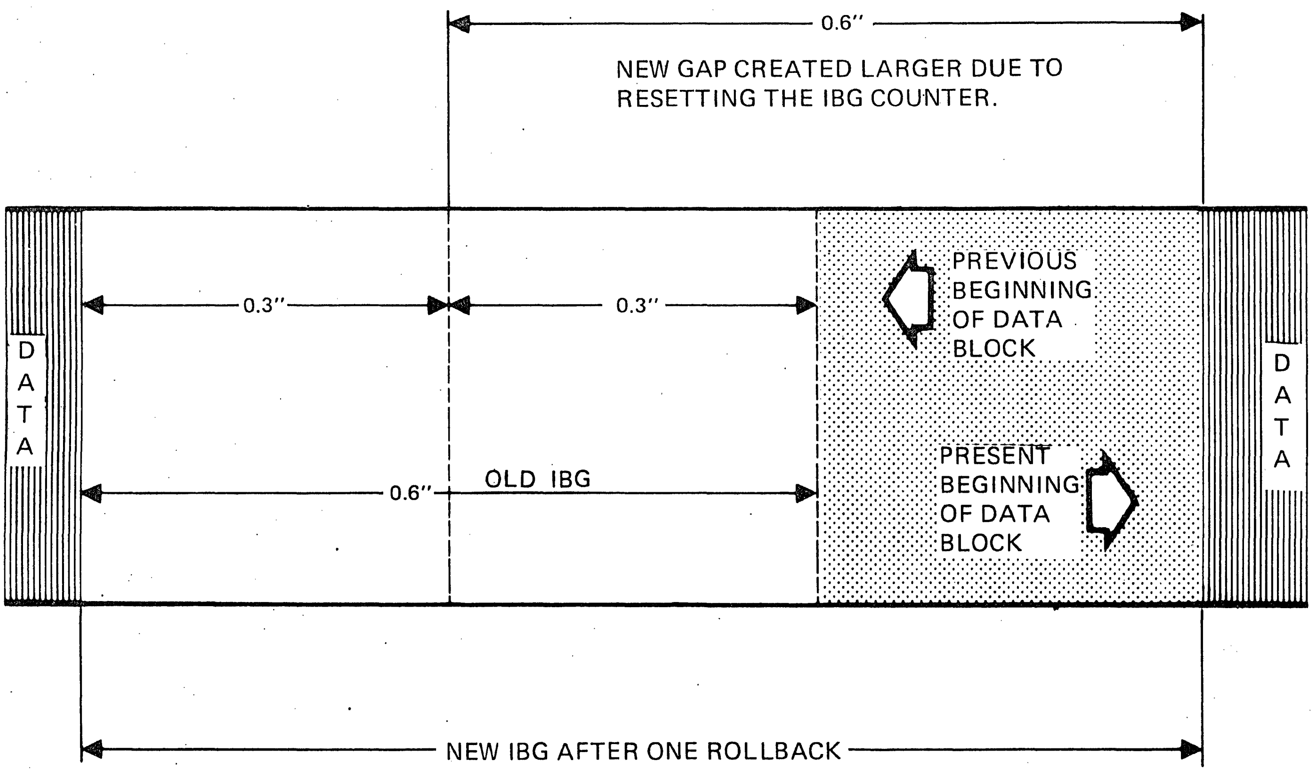


Figure 3-17. Forward Creep IBG

The IBG counter is reset to zero. Write Inhibit (WR INH) remains active until the thirty-third tach pulse is counted.

If consecutive "Write-Backspace-Write etc." commands, or rollbacks are performed, the tape will gradually creep forward due to a larger IBG being generated at the beginning of each write operation. This is referred to as Forward Creep.

READ/WRITE CONTROL

The read/write circuits are the heart of the tape unit. All other subsystem operations function to provide the support necessary for reading and writing to occur. Writing is accomplished by having a current driver connected to a write head which is triggered by the incoming one (1) bits of data. Each bit has its own busline, driver and track on tape. The tape moves under the write head and read head at a specific rate in that order. This allows the data that has just been written to be read and thereby checked for accuracy. The read head is much like the write head but the circuitry is different. Since the read signal is very weak, it must be amplified a considerable amount.

WRITE OPERATION

The write circuits are located in the R/W logic gate, and comprise the following cards: Write Status (1A3), Write Driver (1A4, 1A5, 1A6), and the Load Card (1A7) (see Figure 3-18). The write bus paddle is inserted at 1A1; the head connector plugs into 1A7. The logic-to-read/write gate paddle is inserted into 1A2. This cable contains all control

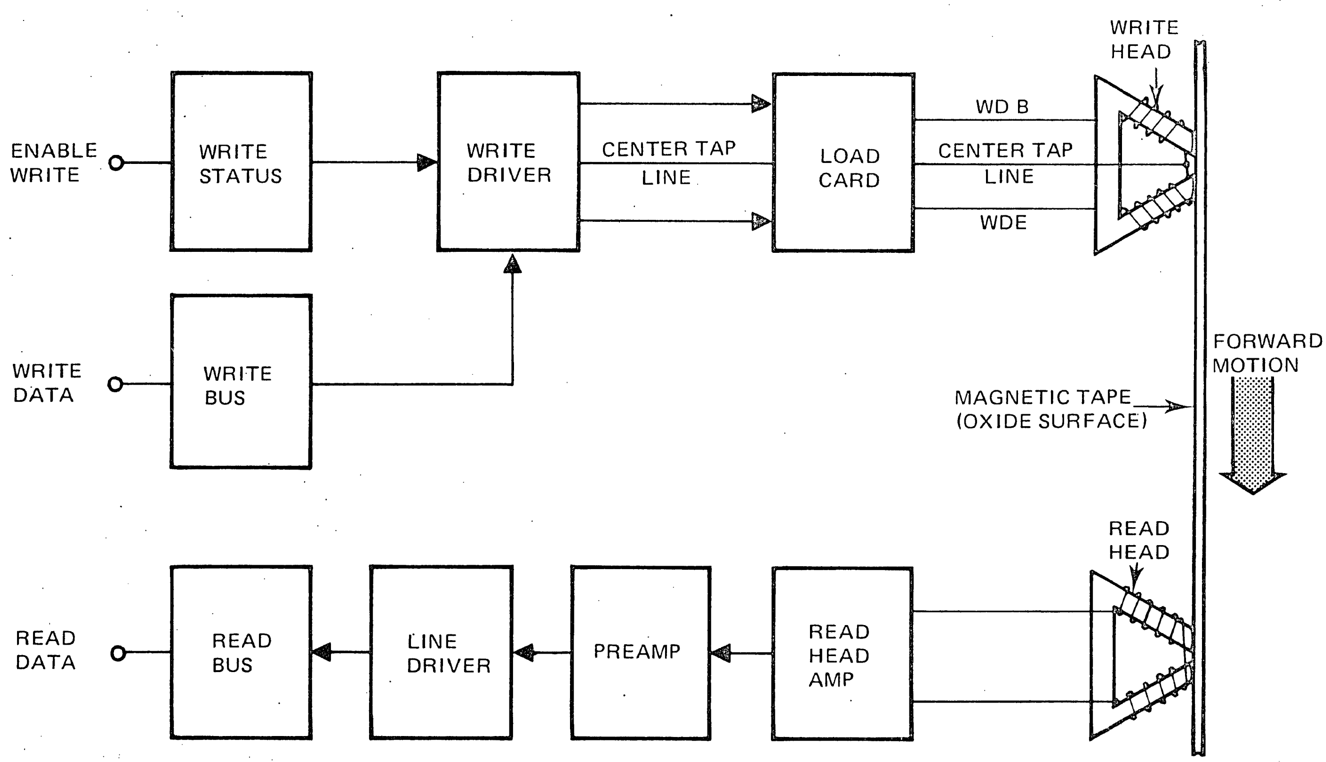


Figure 3-18. Read/Write Block Diagram

lines necessary to operate the read and write circuits. The resistor pack (mounted on a 14-pin, dual-in-line package) plugs into the Write Status card at 1A3. This pack is part of the head assembly, and establishes the write current for each track. However, the resistor pack is not required with a seven-track head.

The Write Status card causes the write drivers to operate in a high current mode during the initial write delay operation to aid in erasing tape. For a phase-encoded write operation, the high current mode ends when the data appears on the write bus. NRZI write operations require the high current. The Write Status card also originates an automatic head degaussing signal. This occurs when a write operation is followed by a read operation and the GO line is inactive.

The Write Driver card receives inputs from the Write Bus which control the driver action. The output is current limited by the load card and applied to the write head coils. Figure 3-19 is a simplified drawing of the Write Driver circuit.

READ OPERATION

The read operation occurs both to obtain data stored on the tape and to check the validity of data being written. Flux signals from the read head are routed through the head amplifier to the preamplifiers. The preamps output this signal to the line drivers for transmission to the TCU via the Read bus (see Figure 3-20).

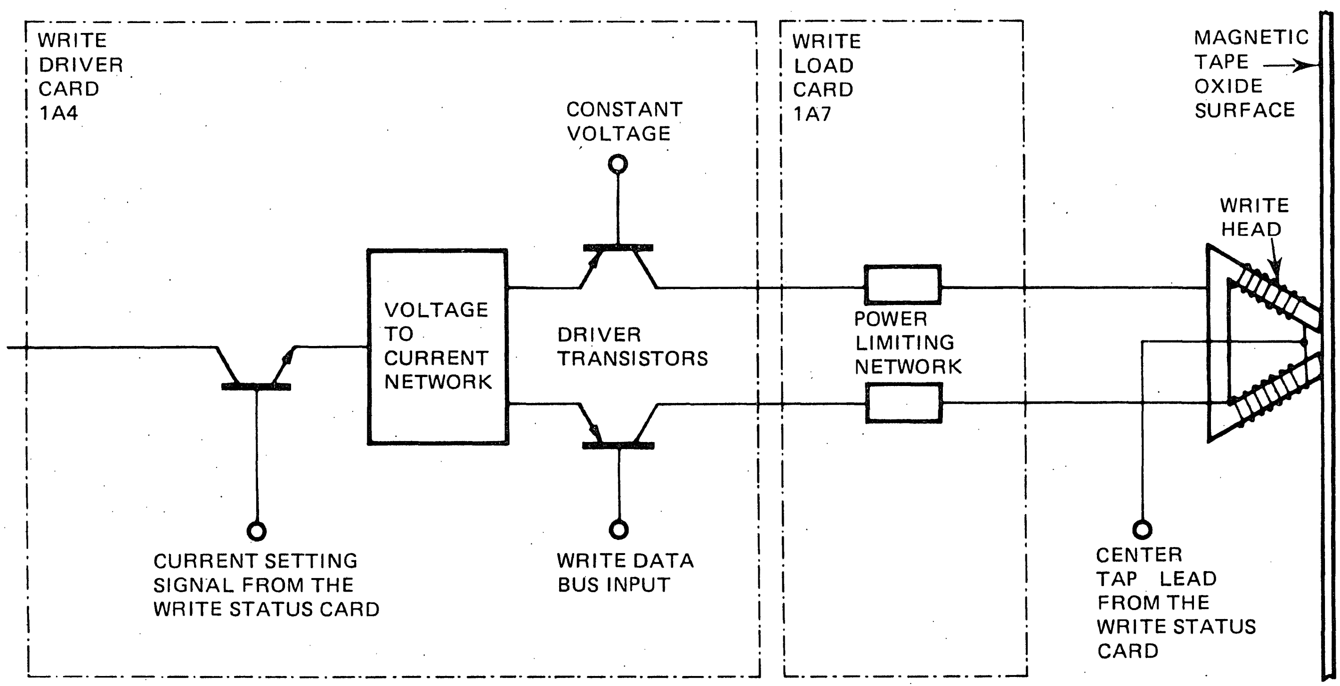


Figure 3-19. Write Driver Simplified

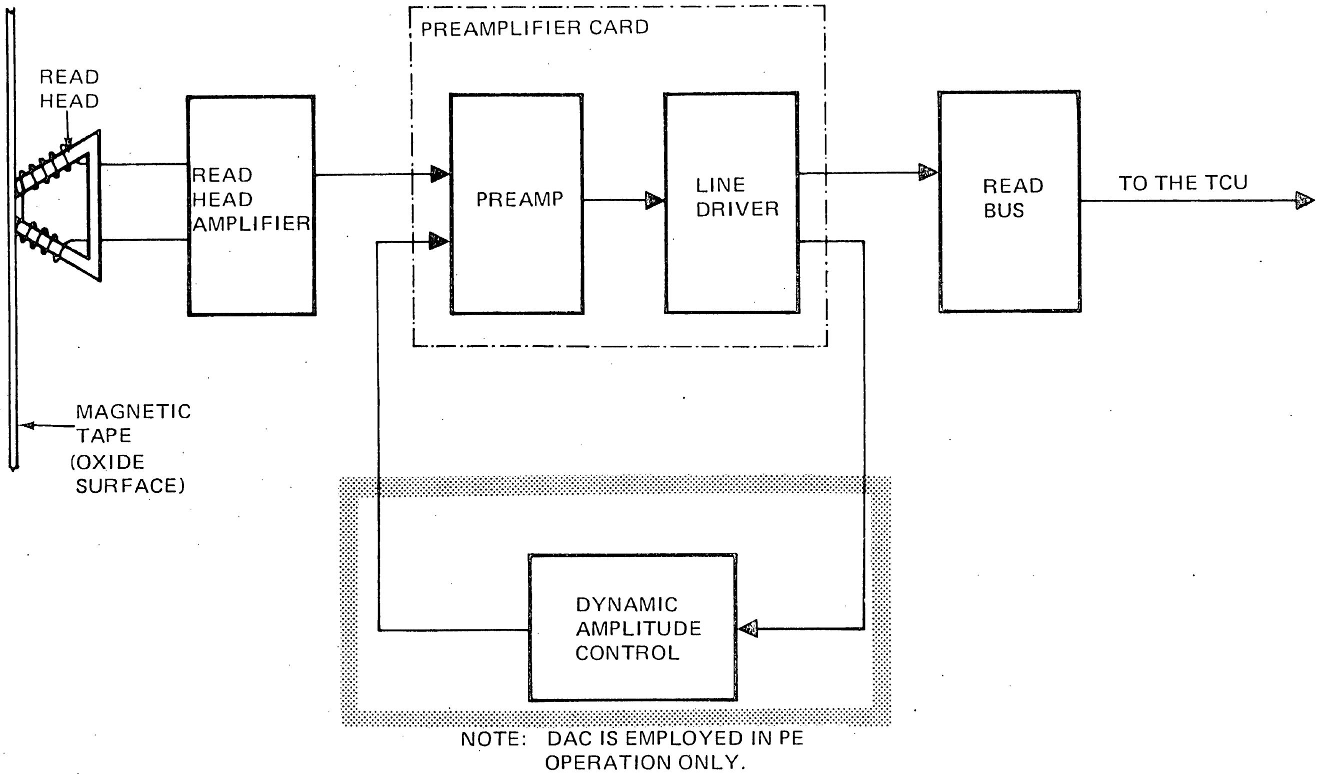


Figure 3-20. Read Circuit Simplified

HEAD AMPLIFIER

The R/W Head Amplifier card is shown in Figure 3-21. The head amplifier amplifies the signals from the read head before they are routed through the drive to the preamplifier. The output of the head amplifier is calibrated to be 440mv at 3200 flux reversals per inch at the speed appropriate for each model drive. The signals from the head enter this card at the solder terminals. Power and output signals travel to the Read/Write gate through the flat-shielded cable. Dual operational amplifiers in five IC modules (including an extra, unused amplifier) and associated components provide amplification.

PREAMPLIFIERS, NRZI

There are three preamplifier cards containing three preamps each. The combined total of the three cards is nine preamp channels which is the quantity necessary to handle a nine bit data byte. The preamplifier cards are in locations 1B5, 1B6, and 1B7 on the R/W logic board gate. Each preamp has a gain control for adjusting the Read bus amplitude, and a selectable tap type delay for adjusting read skew. The input signals come from the R/W head amplifier card via a flat cable which connects at location 1B4. The R/W motherboard distributes the input signals from 1B4 to the proper preamplifier channel. The output of preamplifier goes to a line driver located on the same card. The line driver outputs to the R/W termination card and to the Read bus.

PREAMPLIFIERS, PHASE ENCODED

There are two preamplifier cards containing five preamps each. The combined total of the two cards is ten preamp channels, nine of which are used for data. The remaining preamp is unused.

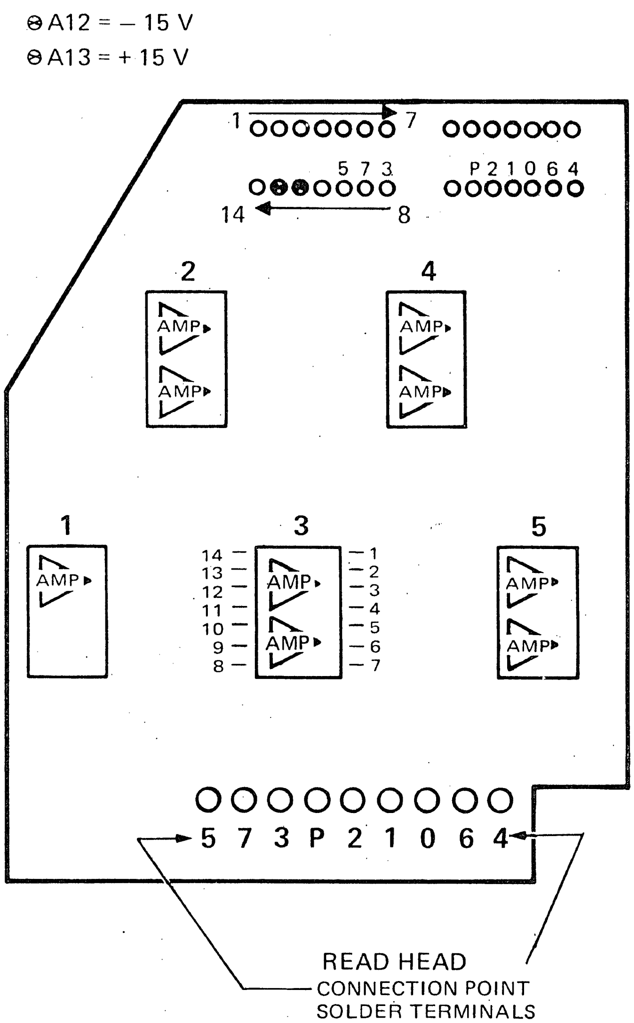


Figure 3-21. R/W Head Amplifier Card

The preamplifier cards are in locations 1B2 and 1B3 in the R/W gate. Their input signals come from the read head amplifier card via a flat cable which connects at location 1B4. The R/W motherboard distributes the input signals from 1B4 to the proper preamplifier channels. The basic amplification factor of the preamplifier is 1.5x, but due to DAC (Dynamic Amplitude Control) this varies. The output of the preamplifier goes to a line driver located on the same card. The line driver outputs to the R/W termination card and to the Read bus.

DYNAMIC AMPLITUDE CONTROL (DAC)

DAC is employed only during phase encoded read operations. It continually monitors tracks 2, 6 and 7 at the output of the line drivers. However, it makes no gain changes to alter the amplitude of the present record. Instead DAC records the amplitude levels of the present record to control the gain of the next record.

There are three signal levels which are gating factors for DAC; 300, 500 and 800mv. The DAC circuit introduces the following gain changes to the preamplifiers:

- DAC does not respond to signal levels that are less than 300 mV. (below 300 mV is considered noise)
- Signal levels greater than 300 mV but less than 500 mV are increased by stepping up the gain.
- Signal levels greater than 500 mV but less than 800 mV are within the acceptable gain of the preamps.
- Signal levels greater than 800 mV are considered too high and DAC will decrease the gain of the preamps.

Figure 3-22 is a block diagram of DAC. The line driver signals monitored by DAC are rectified to an average dc level, which is compared to a fixed reference voltage. The outputs of the three comparators condition the Step latches. The Step latch outputs are transferred to the binary counter (0-0-1) which biases the preamplifiers to a maximum gain.

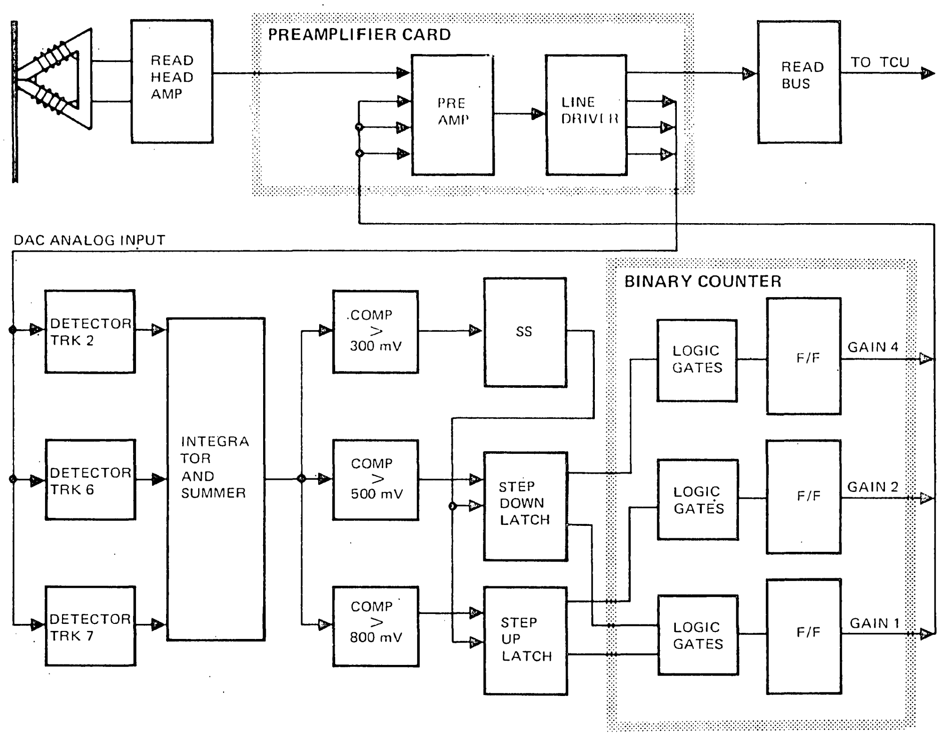


Figure 3-22. DAC Operational Block Diagram

The analog portion of DAC can best be explained with the aid of the waveforms shown in sketches A thru G of Figure 3-23. The 40 zeros burst is coupled into the first stage of the DAC board, which is a half wave rectifier. The input to this circuit is shown in sketch A and the output is shown in sketch B. The following stage integrates and averages the signal to form an output shown in sketch C. This signal is then coupled to three comparators, each of which has a different threshold level. The active state of the comparator indicates the different amplitude levels of the signal on the Read bus.

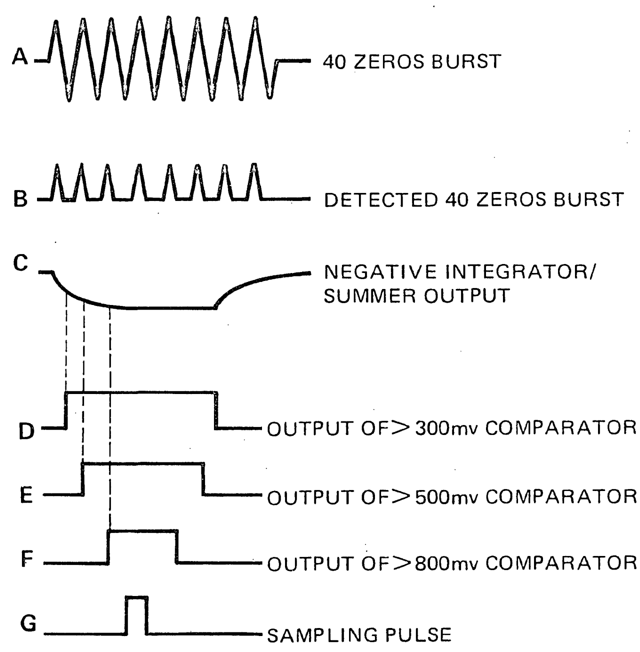


Figure 3-23. DAC Operation Waveforms

DAC is logically reset each time tape motion changes direction or when the tape unit is in write status.

INPUT LINES

All input lines have a maximum active (down) level of +0.7 volts dc, with a maximum noise of 0.5 volts; and a minimum inactive (up) level of +2.8 volts, with a maximum noise of 0.8 volts. Figure 3-24 shows the interface lines at the tape unit I/O connector.

- SELECT (B1v)

  The Select signal line "gates" the tape unit common to the line which allows it to transmit and receive subsequent signals to and from the control unit.

- GO (B1A)

  This line controls tape motion. It is conditioned after the status lines have been set, to establish the operation to be performed. The GO line must be active for all operations that move tape, except REWIND and REWIND-UNLOAD. During these times, tape motion is under internal logic control.

- SET BACKWARD (B1B)

  This line puts the TU in backward status. It remains in this status until the Set Read Status or Set Write Status lines are activated. Since the tape can be written forward only, Read Status is set by the BACKWARD line.

- SET READ STATUS (B1H)

  This line sets the tape unit in Read Status and degates the write circuits. The tape unit remains in Read Status until SET WRITE STATUS becomes active. SET READ STATUS assumes forward read, resetting Backward Status.

- SET WRITE STATUS (B1C)

  This line puts the tape unit in Write Status until SET READ STATUS.

  NOTE

  Since Write checking is accomplished by reading, Read circuits are conditioned during both read and write operations.

- WRITE BUS (B2u, B2x, B2f, B2a, B2j, B2k, B2m, B2n, B2w)

  The nine input signal lines (0-7 and P) "gate" data from the control unit directly to the write head drivers. Data sent by the control unit determines the time duration of write head flux reversals.

- SET NRZI (B1M)

  With the dual density 800/1600 bpi feature, and tape at load point, this line sets the NRZI latch for a write operation.

- REWIND (B1K)

  This input line causes the tape unit to perform a rewind operation (to load point).

- REWIND UNLOAD (B1P)

  This line also causes the tape to rewind to load point. In addition tape unloads and the power window opens so that reels may be changed.

- METERING OUT (B1R)

  This line enables the Elapsed Time Meter to run when the tape unit is ready and not at load point.

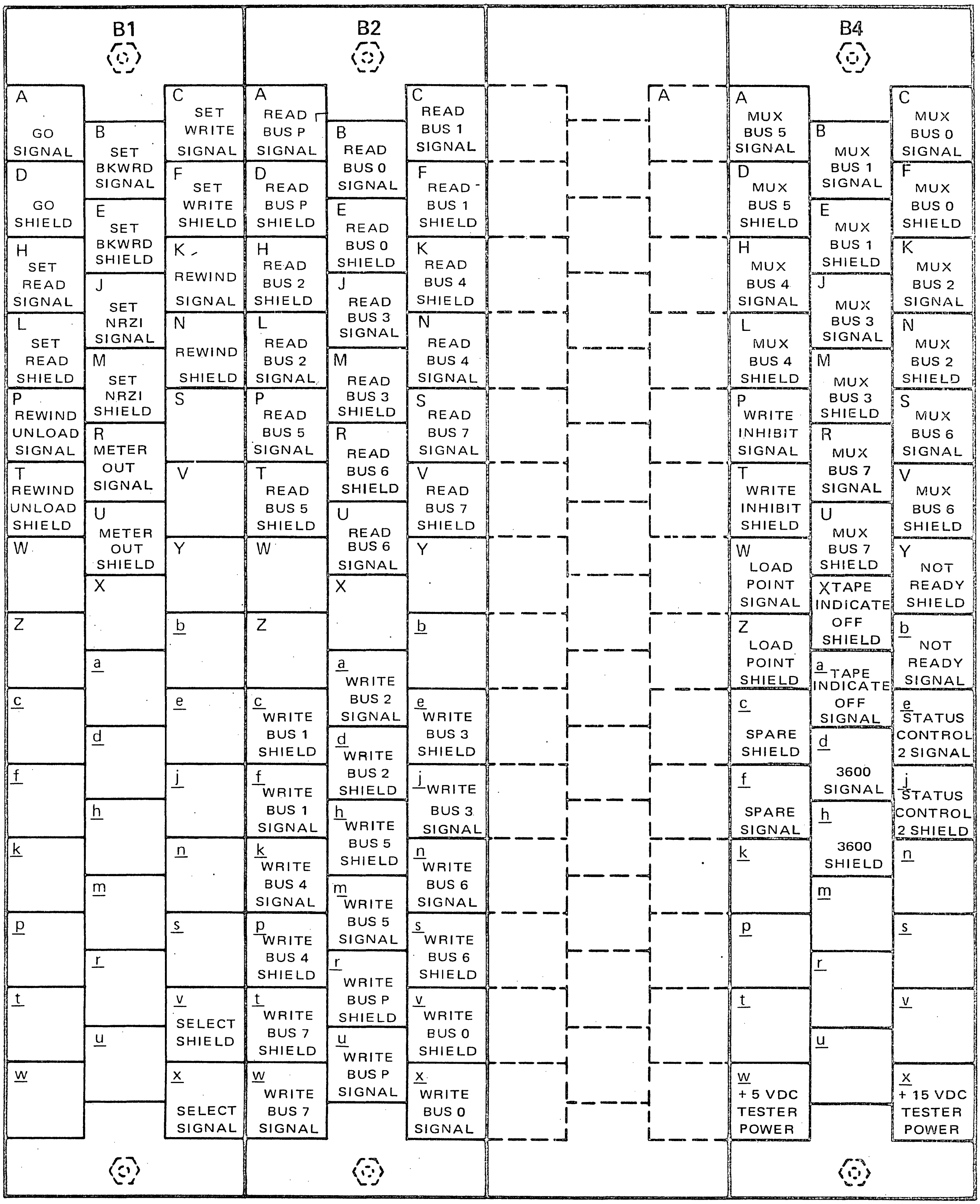


Figure 3-24. Tape Unit I/O Connector (Connector Side)

- STATUS CONTROL 1 (B4d)

  Not presently used.

- STATUS CONTROL 2 (B4e)

  The STATUS CONTROL 2 line conditions the eight status lines as follows:

STATUS CONTROL 2 ACTIVE	BIT	STATUS CONTROL 2 INACTIVE
Mod 4	0	Mod 4
Mod 2	1	Mod 2
Mod 1	2	Mod 1
NRZI	3	NRZI
Tach Pulse	4	Seven Track
Rd Status	5	Rd Status
Bwd Memory	6	Bwd Memory
NFP	7	NFP

- STATUS CONTROL 3 (B4f)

  Not presently used.

OUTPUT LINES

All output lines have a maximum down level of 0.4 volts and a minimum up level of 2.5 volts.

- MOD 1, 2, 4 (B,K)

  These lines indicate that the tape unit is selected and ready. A summary of the coding is as follows:

MOD Lines

4	2	1	
0	0	0	Not selected or not ready.
0	0	1	3480 (250 ips).
0	1	1	3430 (75 ips).
1	0	0	3440 (100 ips).
1	0	1	3450 (125 ips).
1	1	1	3470 (200 ips).

- NRZI (B4J)

  This line is active when:

  1. A tape unit which has the dual density feature (800/1600 bpi) installed is operating in 800 bpi NRZI mode.
  2. A tape unit which has the 7-Track feature installed is operating.

- SEVEN TRACK (B4H)

  When active, indicates that the 7-Track feature is installed.

- READ STATUS (B4A)

  When active, indicates that the selected tape unit is in read status; when inactive, indicates the selected tape unit is in write status.

- BACKWARD MEMORY (B4S)

  When active, indicates the selected tape unit is in backward status.

- NOT FILE PROTECTED (B4R)

  When active, indicates the selected tape unit may perform a write operation; that is, the file reel contains a write enable ring.

- WRITE INHIBIT (B4P)

  When active, and the selected tape unit is in write status, it indicates to the control unit that the proper amount of tape has not been passed for the IBG. When the tape unit IBG counter counts the proper number of tach pulses the WRITE INHIBIT line becomes inactive, thereby indicating to the TCU that it may commence writing.

When active, and the selected tape unit is in read status, it prevents the TCU from activating a read condition. After the proper number of tach pulses have been counted by the IBG counter, the WRITE INHIBIT line becomes inactive.

- LOAD POINT (B4W)

When active, indicates the selected tape unit is positioned at load point. The line is reset if the tape unit is unloaded or if the tape moves forward.

- TAPE INDICATE OFF (B4a)

When active, indicates that the tape unit has not reached the EOT marker. Tape indicate is set by sensing the light to dark transition of the trailing edge of the EOT marker while moving tape forward. It is reset by sensing the light to dark transition of the opposite edge of the reflective marker while moving tape backward.

- REW NOT READY (B4b)

When active, indicates the tape unit is physically connected but not ready. A tape unit is not ready if it is unloaded, in reset status, or rewinding. If the TCU has tape switching capability, it may also signify that the tape unit is operating with another TCU.

On a Rewind/Unload command, the tape unit drops the MOD 1, 2, and/or 4 lines before activating the NOT READY line.

- READ BUS (B2A, B, C, L, J, N, P, U, S)

These lines carry data read from tape to the control unit during a read operation. They are also used during a write operation to permit the checking of write data on tape.

POWER SUPPLY

The power supply consists of an ac section and a dc section. The ac section accepts ac power from a tape control unit and provides primary power to solenoids, motors, and the dc section of the power supply. The dc section feeds directly to the using functions within the drive (see Figures 3-25, 26 and 27 for parts location).

CAUTION

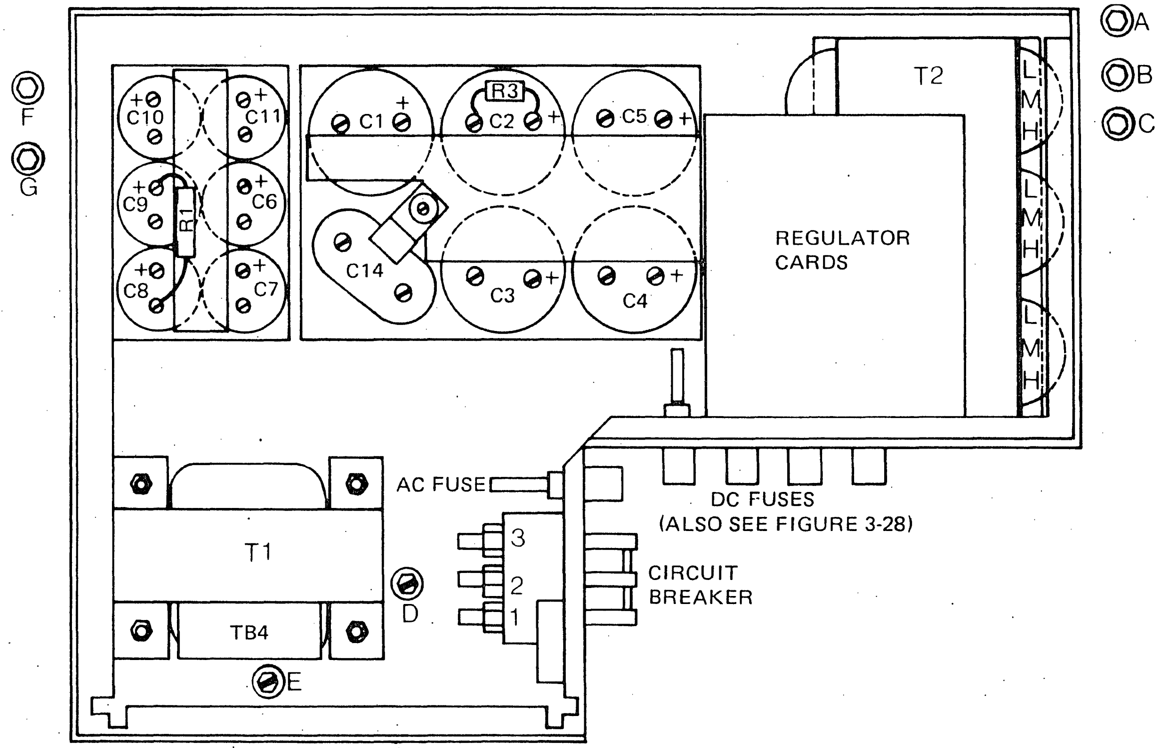
Do not disconnect all of the load from the regulated power supplies when troubleshooting power supply problems. Due to the type of regulators used in the tape unit, disconnecting all of the load will cause the fuse to blow and could damage the regulator card.

AC SECTION

The ac section consists of an input connector that furnishes ac power to a 3-phase circuit breaker. The circuit breaker functions as an overcurrent-limiting device to all ac loads within the tape unit. A triac board (solid state switches for ac power) located within the power supply, turns the motor and solenoids on or off. The 3-phase power from the circuit breaker is fed directly to the ac section.

DC SECTION

Power from the ac section is fed to terminal board 4, a tap change block, which feeds two transformers T1 and T2. This tap change block allows voltage selection from 208 volts to 230 volts to be made for proper operation of the constant voltage (T1) and 3-phase (T2) transformers. The 3-phase transformer feeds a 3-phase, full-wave rectifier.



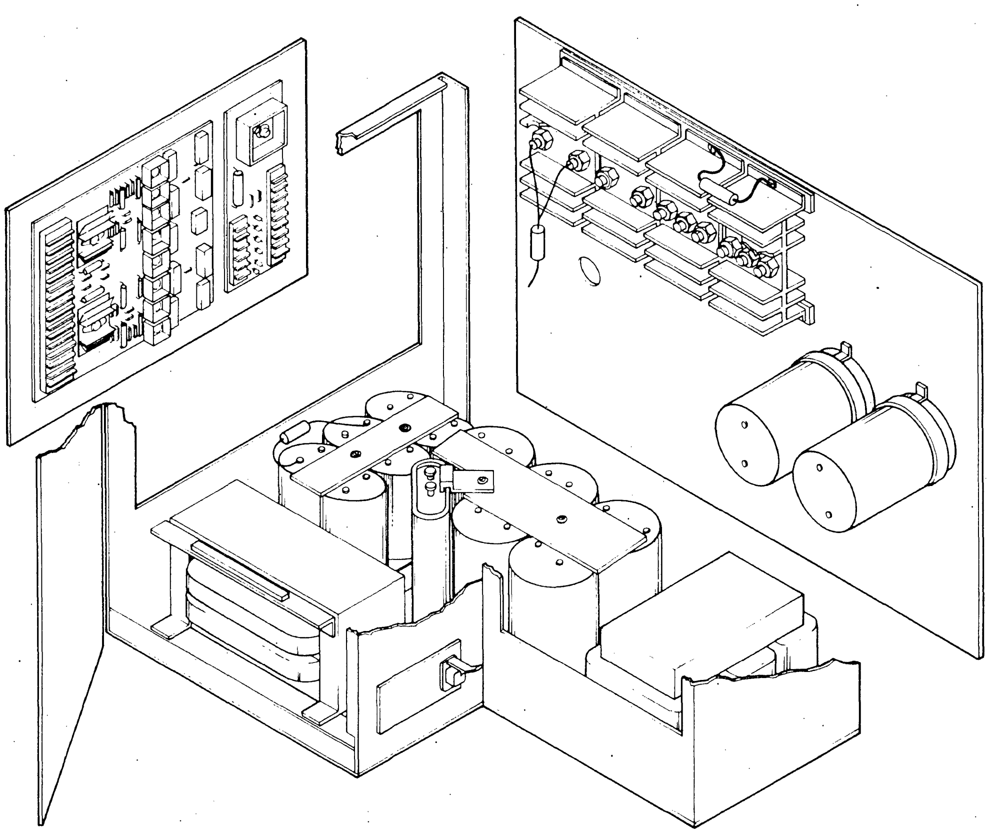


Figure 3-25. Power Supply (Top View)

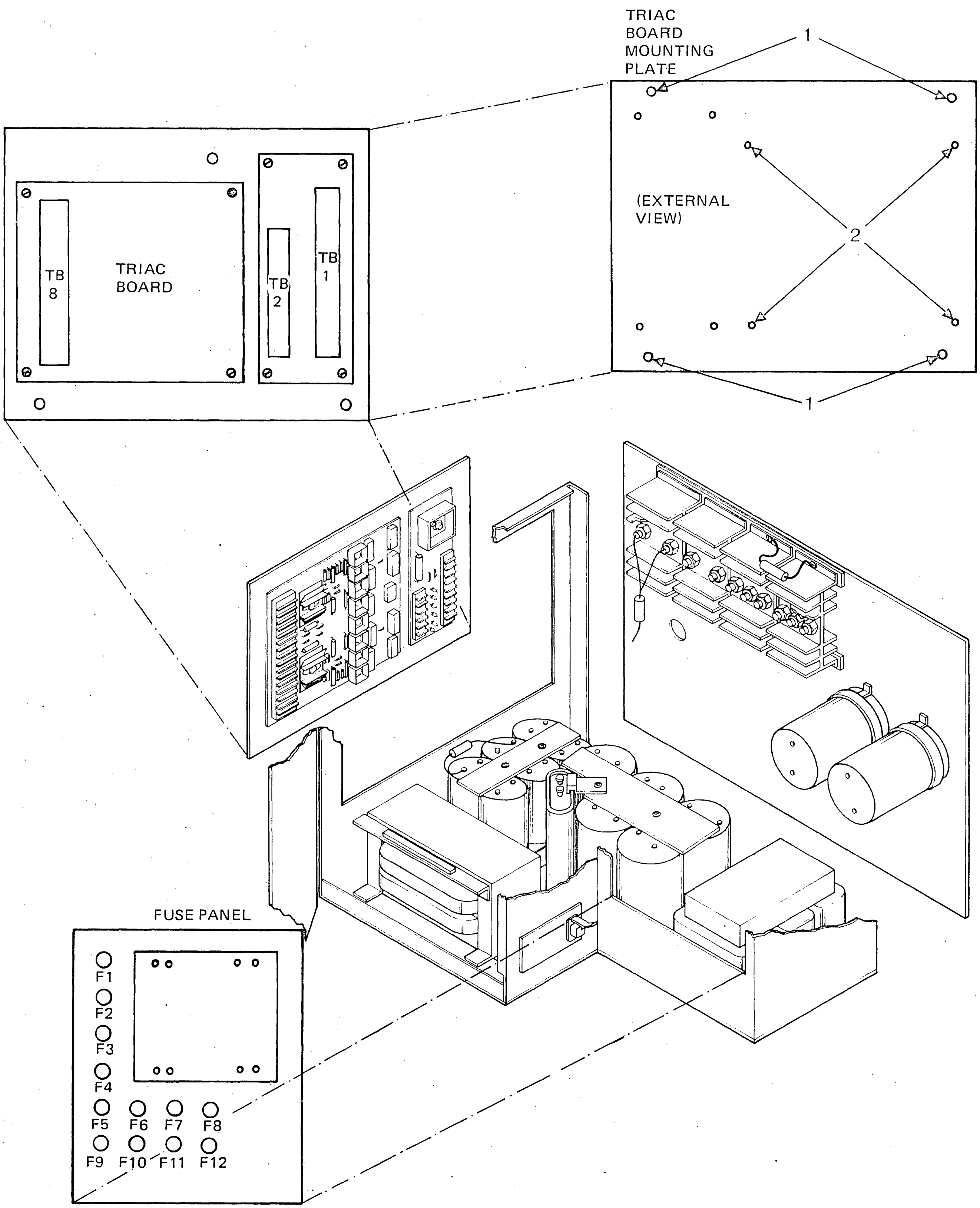


Figure 3-26. TRIAC Board and Fuse Panel

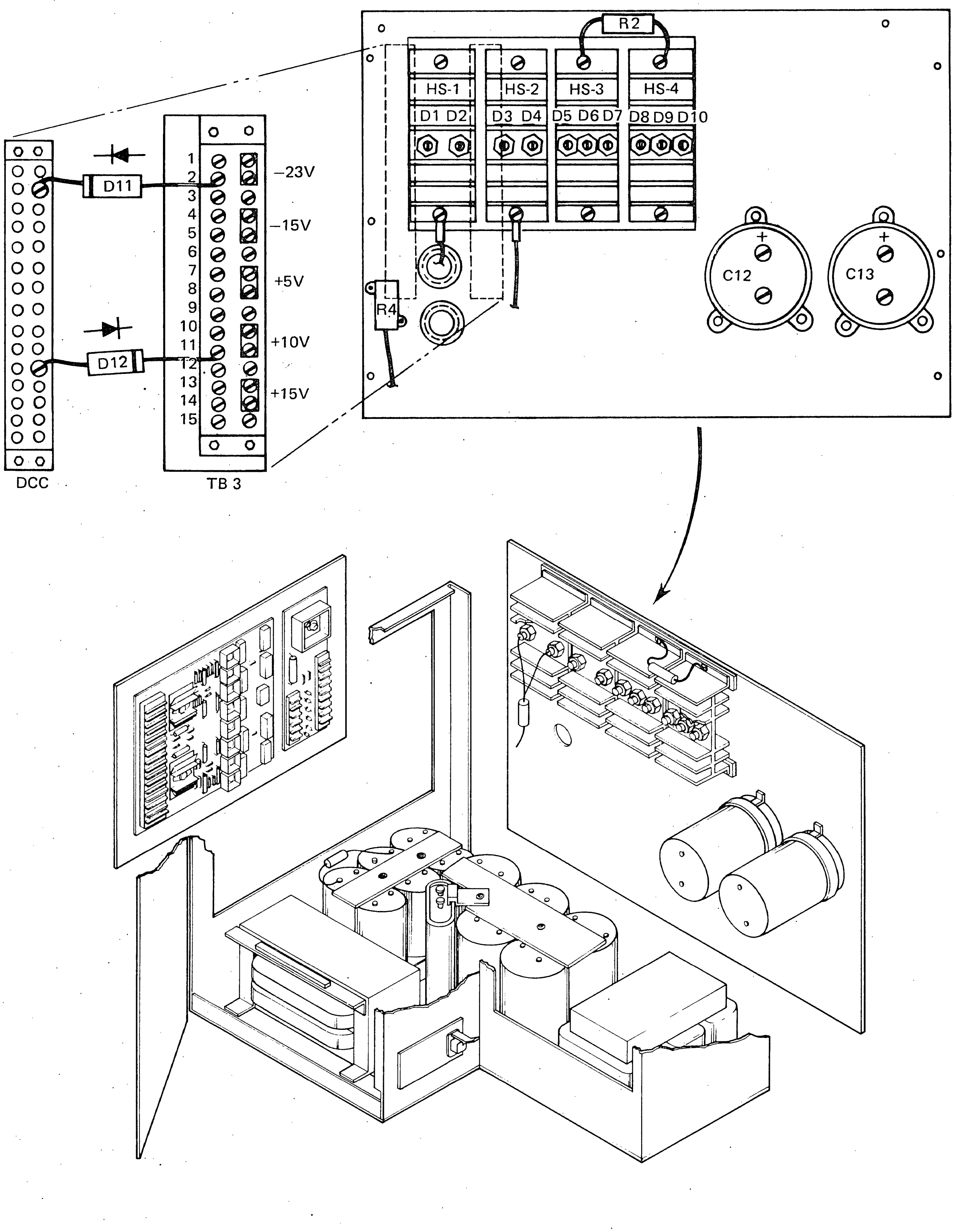


Figure 3-27. DC Distribution Terminals

The rectified output is fed into a large capacitance bank. The output of this capacitance bank is divided among the various -46 volt fuses (see Figure 3-28). From the fuses, the dc voltage is applied to the two reel boards, the capstan board, and the miscellaneous board.

POWER SUPPLY FUSES

F1	+ 15 V @ 3 A	3AG	F7	– 10 V @ 15 A	3AB
F2	+ 10 V @ 8 A	3AG	F8	– 10 V @ 15 A	3AB
F3	+ 5 V @ 2 A	3AG	F9	– 46 V @ 8 A	3AG
F4	– 15 V @ 2 A	3AG	F10	– 46 V @ 15 A	3AB
F5	– 23 V @ 2 A	3AG	F11	– 46 V @ 15 A	3AB
F6	– 10 V @ 15 A	3AB	F12	– 46 V @ 15 A	3AB
FAC	110 V ac @ 1A 3AG for Hub Solenoid				

Figure 3-28. Power Supply Fuse Values

The constant-voltage transformer provides all the remaining voltage levels within the machine. Its outputs are full-wave rectified and capacitor filtered. Three of these rectified voltages, +5, +15 and -15 are regulated. All are then channeled through the proper fuses, (see Figure 3-28) and outputted. The interchangeable regulator cards each contain overcurrent-limiting and overvoltage protection. A small potentiometer on each card allows adjustment of the regulated voltage as required.

For adjustment procedures refer to Adjustment and Alignment Procedures in Chapter four.

PNEUMATICS

The pneumatic system supplies the vacuum and pressure which guide the tape during thread mode, reduces friction between tape and machine components, and provides buffering between reels and capstan during run mode. The system utilizes a vacuum pump and a pressure pump to supply the pneumatics, with both flow restrictor and bleed valves to regulate vacuum and pressure levels. Pneumatics stabilize approximately 2.25 seconds after LOAD/REWIND is pressed.

PRESSURE AND VACUUM CONTROL

The vacuum and pressure transfer valves, as mentioned in the Thread/Load section, control the routing of the pneumatics. The controlling factor is whether the machine is in thread mode or run mode. See the Thread/Load Flowchart, Figure 2-3, for the vacuum and pressure transfer timing.

During threading, the pneumatic system supplies pressure and vacuum to the thread area (see Figure 2-1) at the following points:

- The left threading channel (pressure only).
- The right threading channel (vacuum and pressure).
- The upper and lower restraints around the file reel (pressure only).
- The machine reel hub (vacuum only).
- The air jets in the lower-left air bearing (pressure only).
- The file protect switch (pressure only).

The transition from thread mode to run mode is accomplished by the reels loaded switch closing and rerouting the pneumatics. Pressure functions primarily as a cushion on which the tape rides during operation. The air cusion reduces friction between the tape and machine surfaces which decreases drag on the capstan motor thereby increasing tape life.

During run mode, the pneumatic system supplies pressure to the following points:

- The lower left air bearing.
- The lower right air bearing.
- The upper right air bearing.
- The left tape guide.
- The right tape guide.

The components listed above are illustrated in Figure 2-1. During run mode, vacuum is applied to the tape columns to provide tape buffering. The vacuum ports are located at the bottom of each vacuum column and in the tapered columns formed by the Z bars.

PNEUMATICS GENERATION

Pressure is derived from a small air compressor. Vacuum is derived from a five stage turbine-like vacuum pump. This vacuum pump is similar to a home vacuum cleaner's air propelling mechanism. At higher altitudes it must rotate more rapidly than at sea level to move the same quantity of air. Since the vacuum pump is belt driven it employs pulleys. A change in the diameter of a pulley will provide the required change in rotational rate. There are only two pulleys involved, one for low altitude (below 2,000 feet) and one for high altitude (above 2,000 feet). High or low altitude is stamped on the pulleys. Functional diagrams

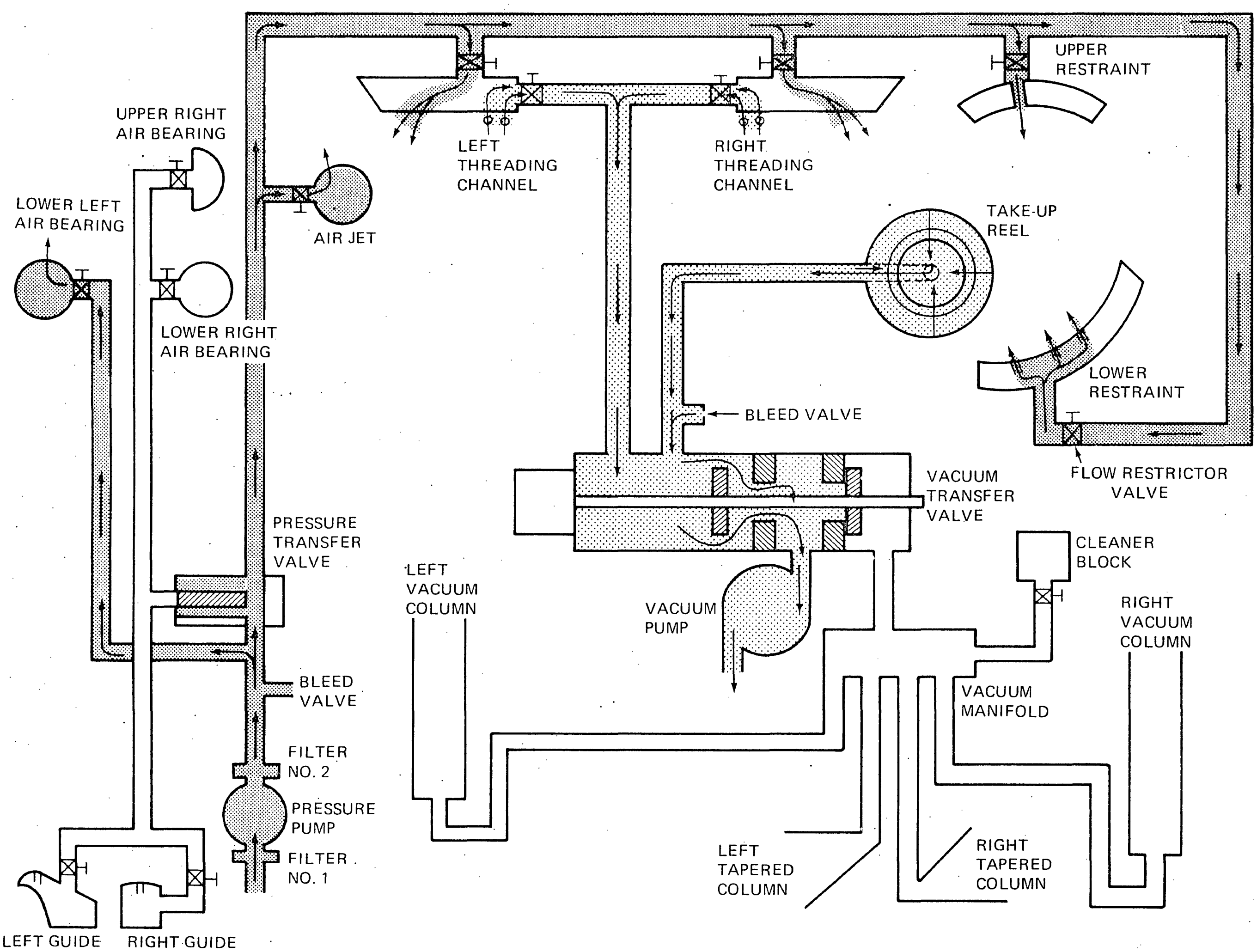


Figure 3-29. Pneumatics, Threading Mode

of the pneumatic system show air flow during both thread mode (Figure 3-29) and run mode (Figure 3-30).

COOLING SYSTEM

The importance of an adequate cooling system is reflected by the tape unit BTU output, ranging from 4,400 to 8,200 BTU (depending on the model). Tape unit cooling is obtained by directing cool air into some areas and by pulling hot air out of other areas. The system is non-adjustable and requires no servicing other than inspection and cleaning. Specific areas to be cooled are:

- The power resistor assembly.
- The reel motors.
- The capstan motor.
- The power supplies.
- The logic and power gates.
- The pneumatic supply area.

Three small cooling fans, located directly above the air filter in the base of the tape unit frame, draw air into

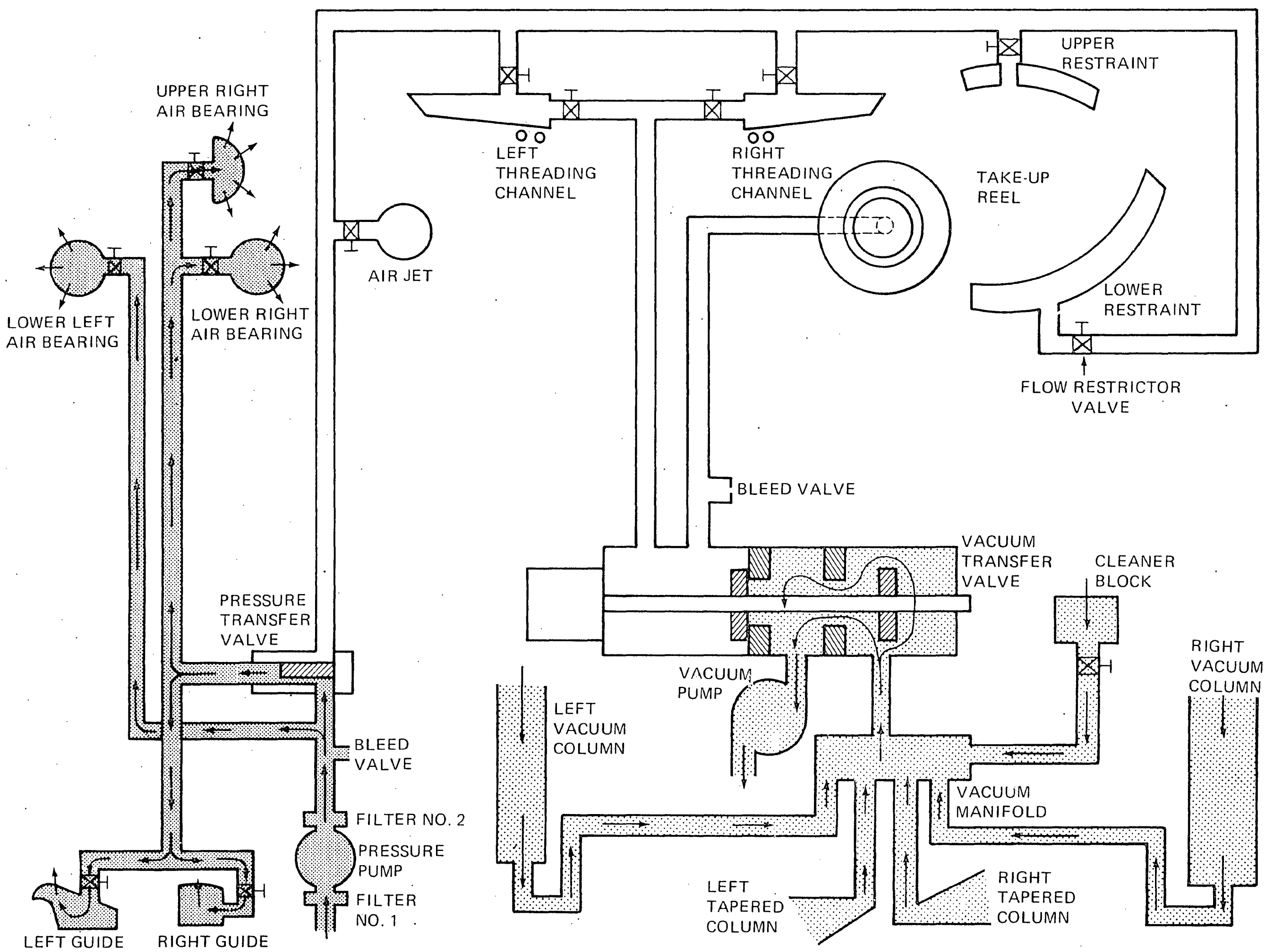


Figure 3-30. Pneumatics, Running Mode

and direct it through the general box area. This air cools the pressure pump, then circulates through the pneumatic supply before exiting through a duct in the rear.

A fan, located at the bottom of the logic gate, provides cooling by directing air upward through the gate. Two additional fans, located on the bottom of the power gate, cool the capstan, reel and miscellaneous boards in a similar fashion.

The power supply is cooled by a single fan located on the right side of the power supply enclosure. The same fan cools the regulator card.

A twin squirrel-cage blower, set between the two reel motors, draws air through the reel motors from vents in the front of the motor housings. The capstan motor uses a different method of cooling. A vacuum hose, connected to the rear of the housing, draws fresh air through the motor.

CHAPTER IV

MAINTENANCE PROCEDURES

INTRODUCTION

The importance of equipment maintenance is obvious. To help the Field Engineer perform the maintenance function, this chapter provides information on the following topics:

- Field tester.
- Preventive maintenance.
- Adjustment and alignment procedures.
- Replacement procedures.

The section on the field tester describes the testers capabilities and the function of each switch. The preventive maintenance section includes information on the tasks to be performed and the specific intervals for performing them. If the tape unit does not perform within specifications, it is necessary to proceed with the adjustments and alignments which are also covered in this chapter. Should the problem be a defective part or assembly, the information in the section on replacement procedures will be an aid in changing the defective part.

FIELD TESTERS

The field tester is a portable unit designed to allow the testing of tape units when they are disconnected from the TCU. The field tester is housed in a black, molded plastic case using an aluminum bracket to mount it to the top of the tape unit.

There are currently two types of field testers designed for STC tape units. The older model (PN 10489) is for use only with 3400 tape units. The newer model (PN 16086) may be used with both 3400 and 3600 tape units.

FIELD TESTER (PN 10489)

To operate the older model, the tape unit must be OFFLINE and not in ready status. The power and command cables connect at location 2A6 in the logic gate.

The significant features of this field tester are as follows:

- Performs Read forward and backward operations.
- Performs write operations.
- Has an auto-cycle which allows continuous operation of tape unit for long periods of time.
- Enables the tape drive to Write at normal PE frequencies, 1/2 normal PE frequencies, and normal NRZI frequencies.
- Manual control of Go-up, Go-down times (2 ms to 2 sec).
- On/Off control of write lines.
- Test points for all nine tracks.
- Logic ground test point.

FIELD TESTER CONTROLS (PN 10489)

NOTE

When using the tester in the TI PASS MODE, the EOT latch is set when EOT marker is detected. If stopped at this point and rewind is initiated, tape goes back to BOT, stops momentarily, then rewinds off the left reel. Since this is a procedure problem in the use of the Field Tester, there is no fix in process. This information is furnished to advise the field of what will happen in TI PASS MODE.

The following list of switches and potentiometers are used to operate the tape unit (see Figure 1-5).

NOTE

Engineering recommends that this Field Tester (PN 10489) not be used for the following:

1. To write valid data, because the frequencies are inaccurate.

2. To set skew during NRZI setup.

3. To check feedthrough or cross talk.

4. To check amplitudes, even on prewritten tapes.

All these steps must be checked using a Tape Control Unit.

- GO Control

This is a three-position switch marked GO/ST-ST/STOP. With the switch in the Stop position, the GO line to the tape unit is inactive. When it is in the ST-ST position, the drive operates in a Start-Stop mode. (See paragraph on GO UP/GO DOWN potentiometers below.) The GO position causes a continuously active GO line in the tape unit.

- Direction Control

This is a three-position toggle switch marked SH-SH/FWD/BKWD. It is functional only when GO is active. The FWD position causes forward tape motion. The BKWD position causes backward tape motion. The SH-SH position causes alternating forward/backward tape motion with a 16 ms. turn-around delay (see paragraphs on GO UP/GO DOWN and Auto Functions below).

- Read/Write Control

This three-position toggle switch is marked GAPS/WRITE/READ. When the switch is in the WRITE position, the Write Status line is active in the tape unit. If a write enable ring has been installed, and the GO line is active, the tape unit will write on tape (see following paragraphs on Bit Switches). When the switch is in the READ position, the tape unit will reset Write Status. This allows a read operation to take place if the GO line is active.

When in the GAPS position with the GO control in the ST-ST position, blocks of data will be written on tape. The length of the IBG will be controlled by the tape units Write Inhibit line feeding into the tester.

- End-of-Tape Control

This three-position toggle switch is marked TI PASS/TI STOP/AUTO RWND.

It determines tape unit operation when the end-of-tape (EOT) reflective marker (Tape Indicate) is sensed. The AUTO RWND position causes a Rewind Status in the drive when EOT is sensed. The tape unit then rewinds to BOT in normal high speed rewind. The TI STOP position de-activates the GO line when EOT is sensed; the tape unit remains in this status until a rewind or a backward operation is initiated. The TI PASS position allows the GO line to remain active after EOT is sensed.

NOTE

GO will remain active until the tape comes off the file reel.

- Recording Format

This is a two position switch marked PE/NRZI that sets the tape unit to the desired recording format. With tape units having the Dual Density feature, setting the switch to the NRZI position sets NRZI Status in the tape unit. The switch also channels NRZI read bus to the read bus test points. With the switch in the PE position, the PE read bus is channeled to the test points. Once the tape unit has been set to NRZI Status it cannot be reset until the tape is back to BOT. The format switch must be used in conjunction with the Rotary Frequency switch.

- Rotary Frequency

This switch selects the correct write frequency for the operation to be performed.

Format Sw.	Rotary Sw.	Results in:
NRZI	80	NRZI (800 BPI)
PE	160	PE (800 BPI)
PE	320	PE (1600 BPI)

- Bit Switches

There are nine two-position bit switches that allow a choice of tracks where data can be written. When a bit switch is in the OFF position, no data can be written in the corresponding track during a write operation initiated by the tester; previously written data is erased.

- Rotary Read Bus Switches

CAUTION

Do not ground the scope at any other place.

The two rotary read bus switches channel the read signal from the track to which they are set to the read bus test point located directly below the rotary switch. When scoping the read bus test points, use the ground test point for the scope ground.

NOTE

The Field Tester read bus amplitudes are usually lower than the online read bus. This is due, in part, to the differences between the write frequencies of the Control Unit and that of the Field Tester.

The GO test point may be used for scope trigger when a read envelope is being observed.

- GO UP/GO DOWN Potentiometers

These two potentiometers vary the time periods for an active and inactive GO line. They are used in conjunction with the ST-ST and GO position of the direction control.

FIELD TESTER (PN 16086)

A ten-foot cable connects the tester to the same receptacle that the TCU I/O cable connects to. Control switches located on the field tester allow manual operation of the tape unit to check out its operation. The light emitting diode (LED) readouts provide direct read-out of the tape unit sense lines (see Figure 1-5).

FUNCTIONS AND CONTROLS

Typical functions of the field tester are:

- To provide a means of manually duplicating machine operation to isolate errors.
- To provide a means for manually operating the tape unit while performing checks and adjustments.
- To provide a means of continually cycling the tape unit manually to ensure reliability.

Field Tester controls and displays are divided into three groups:

- Motion Controls -- control the movement of tape.
- Read/write controls and test points.
- Status controls and status line readouts.

OPERATING CONSIDERATIONS

To use the field tester, the tape unit must be taken offline and all TCU operator panel switches on all TCU's for the tape unit under test must be turned off. The I/O connector should be checked for bent or unseated pins.

When reconnecting the TCU to the tape unit, check again that the pins are not bent or unseated. Once the TCU is reconnected to the tape unit, restore the TCU operator panel switches for the particular tape unit to the ON position. Also, notify operations that the tape unit is again available for online operation.

FIELD TESTER SWITCHES (PN 16086)

The Field Tester switches and their settings are:

- READ/WRITE SWITCH

  The Read/Write switch is of the two-position toggle design. Placing the switch in the WRITE position activates the Write Status in the tape unit. If a write enable ring is installed on the file reel, the tape unit will write on tape (for additional material refer to the paragraphs on the Bit switches). When the switch is in the READ position, the tape unit resets Write Status allowing a read operation to take place.

- ST-ST/GO/STOP SWITCH

  The field tester GO line is controlled by this switch (the -GO signal can be monitored at the test point labled -GO). Placing the switch in the STOP position inhibits the -GO, SET READ, SET WRITE and BACKWARD signals. Setting the switch to the GO position enables -GO continuously to the tape unit, except for a delay when the tape is changing direction. When the switch is placed in the ST-ST position, the -GO signal falls under the control of the GO UP and GO DWN potentiometers. The tape unit operates in a start/stop mode when the switch is in the ST-ST position.

- SH-SH/BKWD/FWD SWITCH

When under the control of the field tester, tape movement is dictated by the position of the SH-SH/BKWD/FWD switch on the tester. Placing the switch in the FWD position drops the BACKWARD line, allowing tape to move forward whenever GO is raised. (Any time this switch is toggled between the FWD and the BKWD position, GO is interrupted by the turnaround delay.)

At the SH-SH position switch setting, the BACKWARD line raises on alternate active GO signals. GO is under the control of the GO UP and GO DWN potentiometers in what is called a shoe-shine operation. The result is an alternating forward/backward tape motion with a 16 millisecond turnaround delay. (GO is interrupted by the turnaround delay.)

- AUTO CYCLE/AUTO STOP/AUTO REW SWITCH

This switch is a convenience device that operates properly ONLY if the TI switch is in the TI AUTO position. When the AUTO CYCLE/AUTO STOP/AUTO REW switch is in the AUTO CYCLE position, the operating mode (forward or backward) reverses every time either EOT or BOT is reached. This allows for continuous motion between EOT and BOT without a high speed rewind. In the AUTO STOP position, GO is dropped whenever either EOT or BOT is detected. Setting the switch in the AUTO REW position sets the tape unit to automatically rewind anytime it reaches EOT.

- TI PASS/TI AUTO SWITCH

This switch sets the tape unit to either pass the EOT marker in the TI PASS position or to enable the AUTO CYCLE/AUTO STOP/AUTO REW switch (as mentioned above) in the TI AUTO position.

- PE/NRZI/GCR SWITCH

This switch in conjunction with the MED FREQ/HI FREQ/LO FREQ switch, determines the write frequency.

- MED FREQ/HI FREQ/LO FREQ SWITCH

The tester decodes the MOD lines to determine at what write frequency the tape unit is operating. The only frequency control available to the Field Engineer is through the MED FREQ/HI FREQ/LO FREQ switch. Placing the switch in the HIGH FREQ position sets the tape unit for normal PE write frequency. The MED FREQ setting places the tape unit at one-half the normal PE write frequency. The LO FREQ position is used only for NRZI operations.

- STATUS CONTROL 2

When STATUS CONTROL 2 is inactive or a zero (0), the Status byte is on the Bus lines. When STATUS CONTROL 2 is active or a one (1), bit 4 of the Status byte is modified. Bit 4 normally contains Seven Track information, but with STATUS CONTROL 2 active, it is connected to the Tach Pulse output.

- WRITE SWITCHES AND READ TEST POINTS

Nine two-position WRITE BIT switches feed the write bus and thereby allow a choice of what is to be written. When a WRITE BIT switch is in the "zero" position, zeros are written on tape in the designated track. When a WRITE BIT switch is in the "one" position, ones are written on tape in the designated track.

Each of the READ BUS terminals is individually terminated. The termination is internally controlled for the PE mode. The Read test points allow each of the nine tracks to be monitored.

- GO UP AND GO DOWN POTENTIOMETERS

  The GO UP and GO DOWN potentiometers vary the time periods for active and inactive GO. The potentiometers are operational when the ST-ST/GO/STOP switch is in the ST-ST position and when the SH-SH/BKWD/FWD switch is ~~in the SH-SH position.~~

- REW SWITCH

  The Rew switch causes the tape to rewind and unload.

- RUN SWITCH

  The Run switch causes the tape to rewind and unload.

PREVENTIVE MAINTENANCE

Preventive maintenance encompasses those activities which must be performed at regular intervals to prevent conditions from arising that could lead to costly down-time of the equipment. Minimizing down-time and avoiding conditions that jeopardize equipment performance are necessary in building good customer relations.

Preventive maintenance activities may be classified into the following categories:

- Visual Inspection

  This requires only minimum training -- e.g., what conditions to look for and how to remove protective covers so that the equipment can be viewed (operator and Field Engineer responsibility).

- Regular Cleaning

  Certain portions of the equipment will not function properly if they are not kept clean.

- Lubrication

  Moving parts must be properly lubricated to maintain optimum operation and to avoid excess wear (Field Engineer responsibility).

- ~~Complex Maintenance~~

  Complex maintenance involves periodic performance checks, adjustments or replacement of components and assemblies (Field Engineer responsibility).

Regular preventive maintenance time periods are listed in Figure 4-1. Additional preventive maintenance is recommended for performance at random intervals, based on whether subsystem operation permits placing one or more tape units offline. When the preventive maintenance activity is the obligation of the customer, the Field Engineer need not be present. Such maintenance is intended for the customers employee to perform as needed and required.

ACTIVITY	CODE	SCHEDULE
Inspection at Random	(both)	
Tape Transport Cleaning	*	Each 8-Hour Shift
Limited Cleaning	*	Monthly
General Cleaning	**	Quarterly
Adjustment	**	Semiannual
Parts Replacement	**	Annual
* Customer Obligation ** FE Responsibility		

Figure 4-1. Preventive Maintenance Schedule

MAINTENANCE EQUIPMENT

To perform preventive maintenance, the following equipment is necessary:

- Cleaning kit (PN 6164)

  The cleaning kit is necessary for all tape unit cleaning. The kit includes a LINT-FREE cloth for dusting and wiping and FOAM-tipped applicators for small cavaties and hard to reach areas.

- Field testers (PNs 16086 new model and 10489 old model)

  The field tester permits offline testing of the tape unit as described in the front of this chapter under Field Tester.

- Tool kit (PN 4019)

  The tool kit contains the tools necessary to remove the covers and to repair and replace the subassemblies.

- STC Hub Cleaner (PN 12120)

  The hub cleaner is the only cleaning fluid to be used on the automatic hub. Other materials, especially tape transport cleaner, may cause reel slippage.

- Tape-transport cleaner fluid (PN 6167)

  The tape transport cleaner is used for general cleaning and degreasing.

In addition to the listed equipment, there are a number of consumable or disposable items, such as air filters, which are required as part of the preventive maintenance effort.

INSPECTION

Inspection of the tape units should be conducted no less than once a week. For best results, remove the cabinet panels and other protective covers and check the following:

- Verify that all column lights are lit.
- Be sure that all the indicators on the operator panel light.
- Check the physical condition of the indicators and pushbutton switches on the operator panel.
- Listen for unusual noises in the pneumatic system which may imply undue wear or misalignment.
- Check operating tape units for reel response and proper distribution of tape loops in the vacuum columns.
- Remove bits of tape or other foreign material from the vacuum columns.
- Be sure that all cooling fans within the tape unit are fully operational.
- Verify that the inspection lamp for the read/write head is operational.
- Check for unusual capstan wear which might indicate capstan contact with the column door or tape path contaminants.

The listed items do not exhaust the possibilities for visual inspection and should be used only as a starting point.

TAPE TRANSPORT CLEANING (Each 8-hour shift)

The tape transport should be cleaned at least once each eight hour shift. Prior to cleaning the tape transport, be sure the tape unit is unloaded and the file reel is removed, then:

- Clean the read/write head and the tape cleaner block using a lint-free cloth moistened with tape-transport cleaner fluid (PN 6167). To clean the slots in the read/write head of oxide particles, use the sharp corner of a data processing card. Check to be sure the tape cleaner block is free of oxide. (Sponge-tipped applicators should be used when necessary in this cleaning process.)

- Clean the threading channels, tape guides and air bearings with a lint free cloth moistened with tape-transport cleaner fluid. Also, inspect and clean the ceramic flanges of the tape guides. (Sponge-tipped applicators should be used when necessary in this cleaning process.)

- Clean the capstan by wrapping a lint-free cloth, moistened (not saturated) with tape-transport cleaning fluid, around the index finger. Then, while rotating the capstan with the free hand (slowly turning it two turns), apply the cloth draped finger to the capstan. Use the upper Z-bar as a partial support to avoid too much direct pressure on the capstan itself.

CAUTION

Do NOT touch the surface of the capstan with the bare hand, as it is sensative to contamination. Also, care should be exercised NOT to clean the capstan excessively--two revolutions during the cleaning process is generally sufficient.

- Wipe the light sensor with a dry, lint-free cloth.

- Clean the vacuum columns and the door glass using a lint-free cloth moistened with water. Oxide build-up in the corners can be cleaned with the corner of a folded data processing card. Remove bits of dirt and tape from the vacuum columns.

- Check for and remove any bits of tape present on the stubby column screens.

- Clean the rubber surfaces of the automatic hub using a lint-free cloth moistened with STC Hub Cleaner (PN 12120).

CAUTION

Do not use any other cleaning fluid.

LIMITED CLEANING/INSPECTION (Monthly)

Clean and adjust the following on a monthly basis:

- Inspect the grommet on the upper cartridge restraint for damage and replace if necessary.

- Run the tape unit SPAR kernels.

- Check for stagger wrap on the reels after a high-speed rewind operation.

- Check the power window alignment and verify that the window position switches are properly adjusted -- no binds or bounce as it stops at either end (see the Adjustments section of this chapter).

- Check the thread/load operation. Be sure that tape threads smoothly off the chute on the lower restraints, does not hang-up in the tape path and threads onto the machine reel properly.

GENERAL CLEANING/ADJUSTMENT (Quarterly)

Clean and adjust the following on a quarterly basis:

- Inspect for cartridge-on switch position and operation.

- Remove and clean the base air filter. The filter should be vacuumed clean or rotated 180° and re-used (replace when no longer serviceable).

  To remove filter:

  1. Remove the tape unit front kick plate.

  2. Kneeling and facing the front of the machine, push back on the filter finger ring and then pull down on it.

- To ensure proper vacuum sealing, check for loose vacuum-door glass and nicks on the column bar edges and the air bearing surfaces (replace or repair defective parts as necessary).

- Check the vacuum door hinge pins and screws. Check the inside of the door for contact with the capstan and align the door as necessary (see the Adjustments section). Also, check the center guide to see if it is bent out of alignment, causing binding. Check that it clears the tape path components when the vacuum column door is closed.

- Check the vacuum door seal by placing a strip of magnetic tape between the vacuum-column door and the column assembly. Close the door and pull the tape out -- a drag should be felt as the tape is withdrawn. This check should be made at various points around the perimeter of the vacuum-column door.

- In addition to the daily cleaning of the automatic hub, the toggles should be cleaned and checked to be sure that they retract sufficiently. To lubricate the hub proceed as follows (hub lubrication frequency is determined by account needs):

  1. Remove the file reel hub cover and loosen the allen screw securing the hub collar and remove the hub.

  2. Remove the screws that hold the toggle. Remove the toggle and then remove the pivot pin from the toggle itself.

  3. Place a small amount of Molykote on a small screwdriver. Use the screwdriver to put the Molykote into the pin opening on the toggle.

  4. Place the pivot pin back in the toggle and wipe off the excess Molykote from the ends of the pin.

  5. Place the toggle back into the hub assembly and secure in place with the holding screws.

  6. Install the hub assembly back on the tape unit and tighten the hub collar allen screw.

  CAUTION

  Be sure all excess Molykote is wiped off the hub before installation.

- Check the cleanliness of the tape path and clean as required. If the tape path is excessively dirty, instruct the operators on proper cleaning methods and schedules.

- Check the belts on the vacuum and pressure pumps for tension, alignment, and wear. Replace as necessary (see the belt tension adjustments and pulley alignments in this chapter).

- Check the cooling fans for proper ~~operation and replace if necessary.~~

NOTE

Special attention should be given to the reel cooling blower to see if binding exists. It is possible that the blower will slow if excess tension is applied by the reel motor shrouds. If this binding does exist, try loosening up the shroud mounting screws to allow repositioning of the shroud. Once binding is corrected, retighten the mounting screws.

- Check the operation of the High Speed Rewind Foot for complete extension and retraction.

- Remove the door cover and test the high-speed rewind for proper operation -- be sure it does not bind.

- Remove the tape cleaner block and flush it clean using tape-transport cleaning fluid. Replace worn or damaged blocks as necessary. After reinstalling the cleaner block, be sure that vacuum holds the tape against the cleaner blade.

- Check for proper pneumatic values (see the Adjustment section) and/or possible restrictions.

- Check the high-speed rewind time and monitor the tachometer waterfall.

- Check the tape unit reliability and performance using standalone diagnostics or OLTS if possible.

CLEANING/ADJUSTMENTS/REPLACEMENT
(Semiannual)

Perform the following cleaning, adjustments on a semiannual basis:

- Remove and clean the tape/guides and ceramic flanges.

- Replace the pneumatic line filters. There are two such filters on the pressure pump -- one intake and one exhaust. The intake filter element can be removed by unscrewing the jar and popping the clip plate holding it in. The filter is then replaced by a clean filter. The dirty filter is washed with soap and water and put up to dry. The exhaust filter is a throw-away canister type and is to be replaced every six months.

- Check the tape path for wear.

- Check the file protect mechanism for proper operation with and without a cartridge.

- Check tape tracking (see Tape Tracking Adjustments in this chapter).

- Check skew (see skew adjustments in this chapter).

- Check tape unit operating voltages using a digital voltmenter (see Voltage Adjustments in this chapter).

- Check the read/write head by testing all tracks for forward to backward amplitude ratio at the head amplifier outputs listed in figure 4-8.

The backward read amplitude must be 85% of the forward amplitude as the possibility of a worn head or tracking error exists.

- Check the capstan start times (see Capstan Specifications in this chapter).

INSPECTION/REPLACEMENT (Annual)

Inspect the following on an annual basis:

- Check for proper capstan stop distances and ensure that the interblock gap is within the tolerances specified in Figures 4-4 and 4-5.

  Also check to see that the trace meets the requirements shown in Figure 4-6.

- Check the capstan start times by monitoring the output of the Velocity D/A Converter. Refer to Figure 4-6 to verify that the times and voltages are within tolerances.

- Check the READ BUS to ensure that the waveshapes are within specified tolerances (see Figures 4-13 and 4-14).

ADJUSTMENT/ALIGNMENT PROCEDURES

The adjustments and alignments necessary for proper operation of the tape unit and the steps to complete them are described in this section. These adjustments and alignments are an extremely important facet of the maintenance function. Some of the procedures must be performed whenever the assembly or component is removed or replaced. Other adjustments must be performed whenever preventative maintenance checks reveal problems or indicate various parts of the tape unit do not meet specifications.

To make this section easier to use, the adjustments and alignments are listed in alphabetical sequence.

AUTOMATIC-HUB POSITIONING COLLAR ADJUSTMENT

1. Remove the file reel hub cover and loosen the allen screw securing the collar clamp and slide the hub and collar off the shaft.

2. Remove the screws (2) holding the pivot plate. Do not lose the spacer on each screw.

3. Remove the hub actuator assembly.

4. Loosen the allen screw securing the positioning collar.

5. Place the positioning collar alignment tool (PN 4632) on the motor shaft until it rests against the transport plate (purple plate). Move the positioning collar forward until it rests against the alignment tool and tighten the allen screw.

6. Replace the pivot plate. Make sure the spacers are in place (the grooves on the plate must align over the actuator lever).

7. Slide the hub onto the reel motor shaft until it rests against the collar.

8. Slide the collar clamp over the hub and align the splits in the collar with the splits in the motor shaft. Tighten the collar clamp allen screw.

9. Alternately press the LOAD/REWIND and RESET pushbuttons to check hub operation.

AUTO-HUB SOLENOID CHECK AND ADJUSTMENT

1. Activate the hub solenoid by pressing the LOAD/REWIND pushutton.

2. Remove the hub (see Automatic Hub Replacement procedure).

3. Slide the positioning-collar alignment tool onto the reel motor shaft until it is flush against the pivot plate (resting over the screws securing the plate).

4. Measure from the rear edge of the alignment-tool shaft to the positioning collar. The measurement must be .268 $\pm$ .007 inch.

5. If the measurement does not meet specifications, remove the grill cover from the top of the tape unit.

WARNING

> When power is applied to the tape unit, 208 Vac is present on the reel-latch solenoid. PROCEED WITH CARE.

6. Loosen the screws (4) securing the solenoid to its mounting bracket.

7. Adjust the solenoid for the correct measurement as stated in step 4. and tighten the screws (4) securing the solenoid.

8. Remove the positioning-collar alignment tool and re-install the hub.

9. Check the hub for proper operation by alternately pressing the LOAD/REWIND and the RESET pushbuttons. The hub should not clatter as it activates and deactivates.

10. Re-install the grill cover on the top of the tape unit.

BELT TENSION ADJUSTMENTS

- VACUUM PUMP

  1. Loosen the pump mounting screws (4) (see Figure 4-11).

  2. Place the tensiometer (PN 0157) on the belt as shown in Figure ~~4-2. Then shift the pump until~~ the tensiometer reads high altitude 10-13, or low altitude 6-10 pounds.

  3. Re-tighten the pump mounting screws (4) when correct tension is obtained.

- PRESSURE PUMP

  1. Remove the upper screws (3) and loosen the lower screws (3) to remove the pneumatic-supply left side cover.

  2. Loosen the pressure pump mounting nuts (4).

  3. Place the tensiometer (PN 0156) on the belt as shown in Figure 4-2. Then shift the pressure pump until the tensiometer reads 9.5-11 pounds.

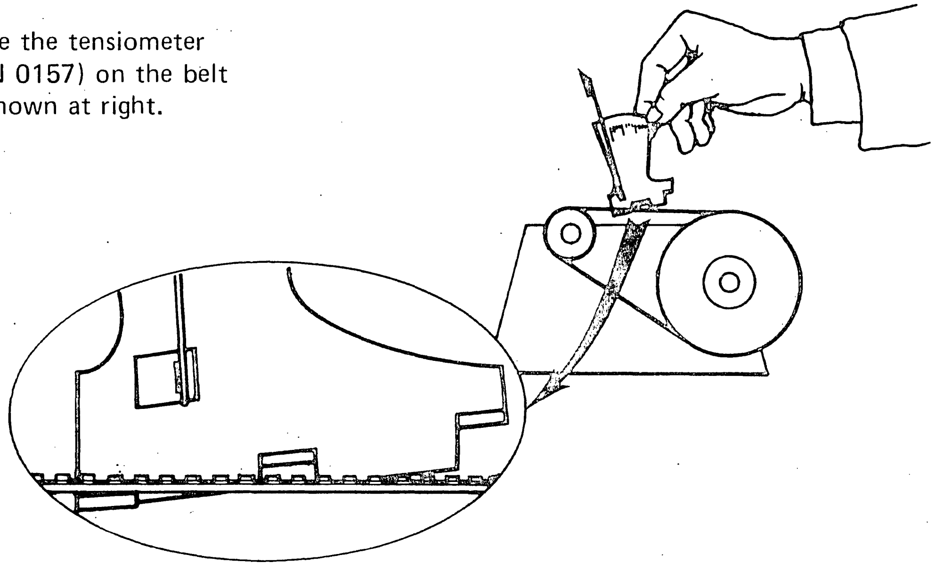
  4. When correct tension is obtained, tighten the mounting nuts (4).

CAPSTAN ALIGNMENT (Tracking)

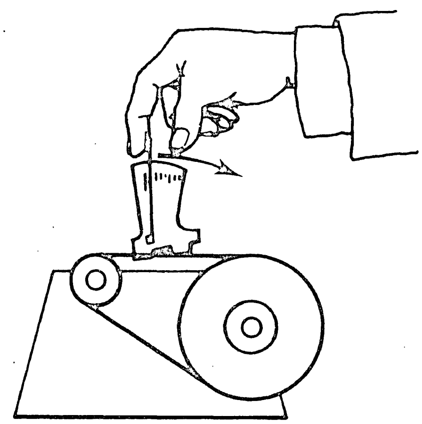
Correct alignment of the capstan assembly ensures that the tape will track in the center of the left tape guide. There should be no distortion of tape channel from tape creeping up the front or rear tape-guide flanges. The capstan alignment procedure is:

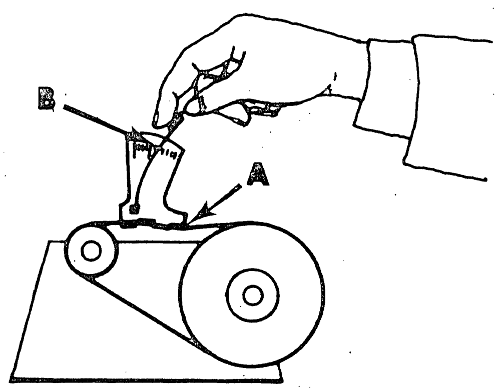
1. Loosen the locknuts on adjustment screws #1 and #3 approximately two

1. Place the tensiometer (P/N 0157) on the belt as shown at right.



2. With the forefinger on the spring tip, pull the spring in the direction shown at right.





3. When the right hand tab of the Tensiometer just touches the top of the belt (A), read the belt tension (on the left edge of the spring) in pounds on the scale (B).

Figure 4-2. Tensiometer Operation

turns (see Figure 4-3). Ensure that the vacuum column back plate is 17/32 $\pm$ 1/64 inch from the front edge of the capstan (check at three points around the circumference of the capstan). See CAUTION note in step five of this procedure.

2. Remove the outside guide flange from the left tape guide then re-insert the screw to hold the tape guide in place. Remove the decorative metal cover from the vacuum column door.

3. Loosen the screws (2) holding the upper Z-bar in place and slide it away from the capstan until the gap is approximately the width of two punched cards. Re-tighten the screws.

CAUTION

DO NOT exceed this width, as it may allow tape to wrap around the capstan and damage both the tape and capstan motor.

4. Load a good work tape on the tape unit.

5. Using the field tester, perform forward and backward continuous read operations to check the tape tracking. For any tracking corrections, use the adjustment screws shown in Figure 4-3.

CAUTION

Adjust screw #2 ONLY WHEN NECESSARY to meet the capstan measurement covered in step one of this procedure. When adjusting screw #2, turn all three of the adjustment screws a like amount in the same direction. USE EXTREME CARE.

For component location, see Chapter 2, Figure 2-1. Tape tracking conditions and necessary adjustments are:

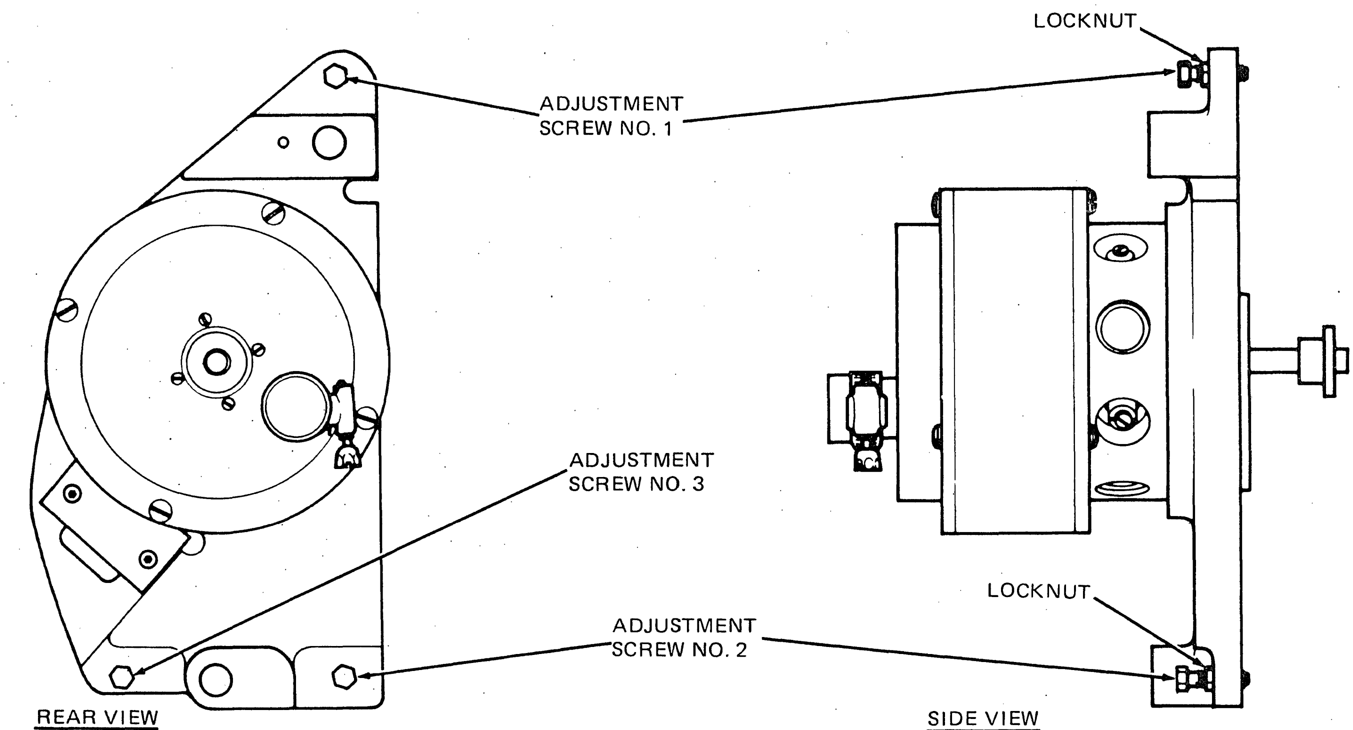


Figure 4-3. Capstan Motor Assembly

a. The tape tracks over the front edge of the left guide during both forward and backward operation. To correct, turn adjustment screw #3 counterclockwise in 60° intervals.

b. The tape tracks over the front edge of the left guide during forward operation. To correct, turn adjustment screw #1 counterclockwise in 60° intervals. Too much contact with the rear of the left guide causes tape to creep up the guide during forward operation. To correct, turn adjustment screw #1 clockwise in 60° intervals.

c. The tape tracks over the front edge of the left tape guide during backward operation. To correct, turn adjustment screw #1 clockwise 60°.

NOTE

Visual setting of tracking is satisfactory when NO flutter or side-to-side tape movement is observed. Excessive flutter is often the result of excess air pressure on the right tape guide and can be checked by referring to Pneumatic Adjustments.

6. Unload the tape unit and install the front tape-guide flange on the left tape guide. Then, re-install the decorative metal cover on the vacuum column door.

7. Loosen the screws (2) holding the upper Z-bar in place and slide it toward the capstan until the gap is approximately equal to the thickness of one data processing card. Re-tighten the screws.

8. Rotate the capstan checking to be sure it is not touching anything (DO NOT touch the capstan surface with the bare hand).

9. Once tracking is visually set, mechanical skew should be checked (see Mechanical Skew Adjustment).

CAPSTAN SPECIFICATIONS

Shown in Figures 4-4 and 4-5 are the tach pulse quantities involved in go holdover and stopping distances for the various tape unit models.

MODEL	WRITE	READ
3430	8	20
3440	0	16
3450	0	16
3470	0	8
3480	0	0

Figure 4-4. Go Holdover Distance in Tach Pulses

The actual stopping distance of the capstan must be controlled rather than the time period during which it stops.

Voltage relationships relative to start stop timing are given in Figure 4-6.

CARTRIDGE OPENER SWITCH ADJUSTMENT

Before adjusting the switches in the cartridge opener (see Figure 4-7), be sure the switch plate is secure and then adjust the switches as follows:

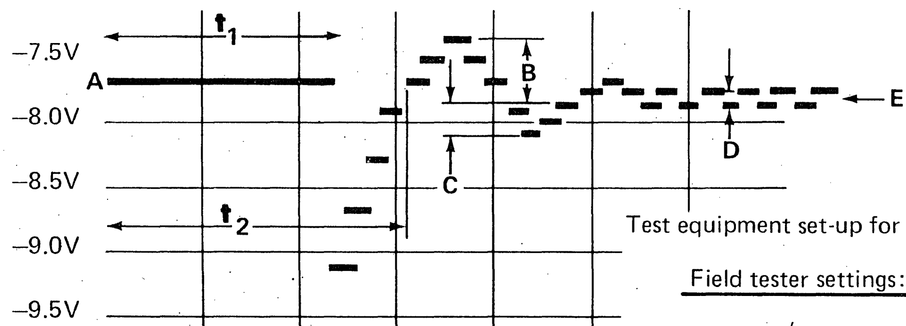
1. Loosen the screws (2 each) on the two switches:

CAUTION

Do not turn the screws more than one complete revolution. Further loosening will result in the nut plate (on the backside) falling out of place.

DRIVE	READ STOP – TACH LINES		WRITE STOP – TACH LINES	
	PRE EC 1066	AFTER EC 1066	PRE EC 1066	AFTER EC 1066
3430	. . . .	+ 1 27 – 1	. . . .	+ 1 15 – 1
3440	. . . .	+ 1 26 – 1	+ 2 14 – 6	+ 2 14 – 6
3450	+ 6 21 – 6	+ 1 26 – 1	+ 1 15 – 5	+ 1 15 – 5
3460	. . . .	+ 1 26 – 1	+ 1 15 – 1	+ 1 15 – 1
3470	+ 1 26 – 10	+ 1 26 – 1	+ 1 15 – 1	+ 1 15 – 1
3480	+ 1 20 – 1	+ 1 20 – 1	+ 1 16 – 1	+ 1 16 – 1

Figure 4-5. Stop Distance Including Go Holdover in Tach Pulses

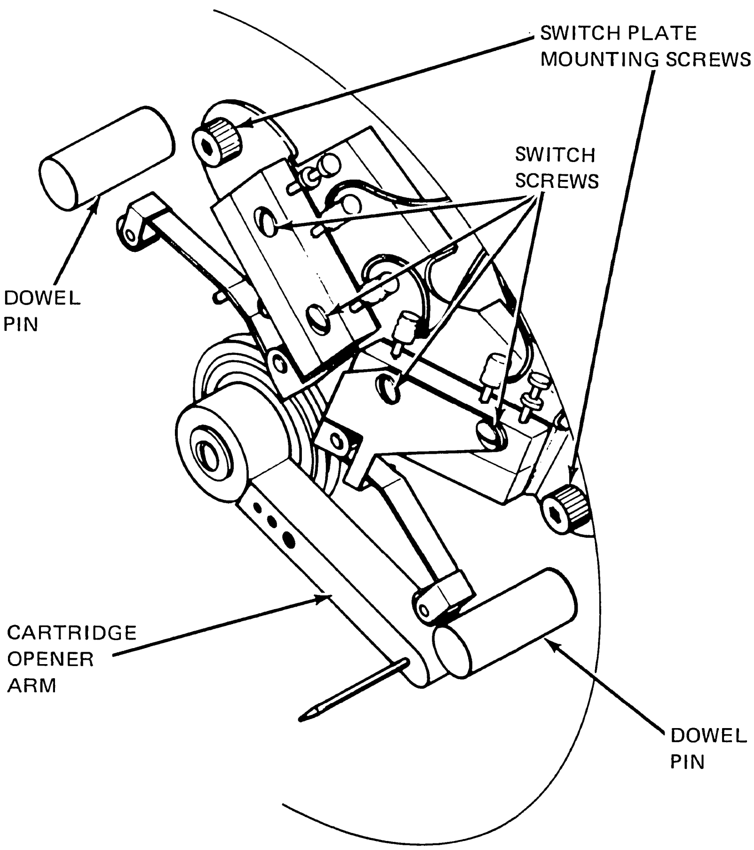


Test equipment set-up for monitoring this waveshape.

Field tester settings:	Scope settings:
start/stop on	horizontal sweep .5 ms/cm
go up 15 ms	vertical gain 2 V/cm
go down 100 ms	sync on GO

TU TYPE	MILLISECONDS				VOLTS								
	T_1			T_2	A			B	C	D	E		
	MIN	NOM	MAX	MAX	MIN	NOM	MAX	MAX	MAX	MAX	MIN	NOM	MAX
3430	2.2	2.95	3.85	4.35	–7.95	–7.65	–7.50	0.50	0.40	0.20	–8.1	–7.85	–7.4
(After EC 1066)	1.6	2.25	3.1	3.6									
3440	1.4	2.1	2.7	3.2									
3450	1.65	2.4	3.0	3.5									
3470	1.05	1.55	2.1	2.3									
3480	1.1	1.7	2.35	2.65	–7.95	–7.65	–7.50	0.50	0.40	0.20	–8.1	–7.85	–7.4

Figure 4-6. Start Stop Timing



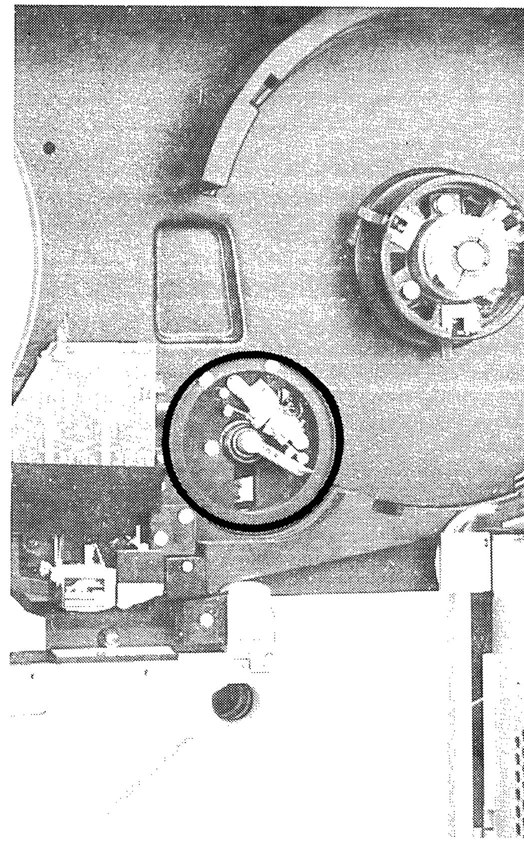


Figure 4-7. Cartridge Opener

2. Place a 0.007-.008 feeler gauge (about the thickness of one data processing card) against the dowel pin without interferring with the switch actuator. Rotate the cartridge opener arm so that it holds the feeler gauge in place.

3. Move the switch toward the cartridge opener arm until the switch JUST transfers. Then, re-tighten the switch screws.

4. Remove the shim and ensure that the switch transfers before the arm hits the dowel pin.

DELAY COUNTER CHECK AND ADJUSTMENT

If there is insufficient tape being loaded on the machine reel to allow proper column loading, or machine checks recur during loading and unloading sequences, the delay counter period should be checked and adjusted as follows:

1. With no file reel installed on the tape unit, cover the tape present sensor and press the LOAD/REWIND pushbutton. This forces a machine check and keeps the delay counter running.

2. Monitor delay count 1 and verify that the pulse period is 46 milliseconds.

3. If the delay count period is incorrect, adjust (P1) on 2A4.

4. Once the correct pulse period is attained, remove cover from tape present sensor and press the RESET pushbutton to clear the machine check.

DOOR LATCH ADJUSTMENT

1. Loosen the screws (2) securing the nylon latch to the vacuum column backplate (white plate).

2. Close the door until the spring catch on the door touches the nylon latch.

3. Raise or lower the nylon latch until it centers on the spring catch. Holding the nylon latch in that position, open the door and tighten the screws on the nylon latch.

4. Repeat this procedure for the bottom latch.

5. Once both nylon latches have been adjusted, open and close the vacuum column door to check the latch alignment.

ERASE HEAD CHECK

To verify that the erase head is functioning:

1. Mount a scratch tape, write all "ones" on it for a suitable distance then rewind to BOT.

2. Unplug the write drivers.

3. Initiate a continuous Write operation from either the TCU or the field tester.

4. Rewind to BOT and scope any read bus line (Figure 4-8). The peak-to-peak amplitude of the signal left after erasure should be less than 30 mv.

5. Connect write drivers.

To verify erase head polarity, scope any bus line listed in Figure 4-8 while writing a record. If the pulse circled in Figure 4-9 is observed, the erase head polarity is incorrect--correct polarity will not produce a pulse. Polarity can be changed by reversing the wires at the erase head. There is no other adjustment for the erase head.

TRACK	4	6	0	1	2	3	P	7	5
PIN	B09	B10	B11	B12	B08	B09	B10	B11	B12
CARD	1B3				1B2				

Figure 4-8. Read Bus Pin Location

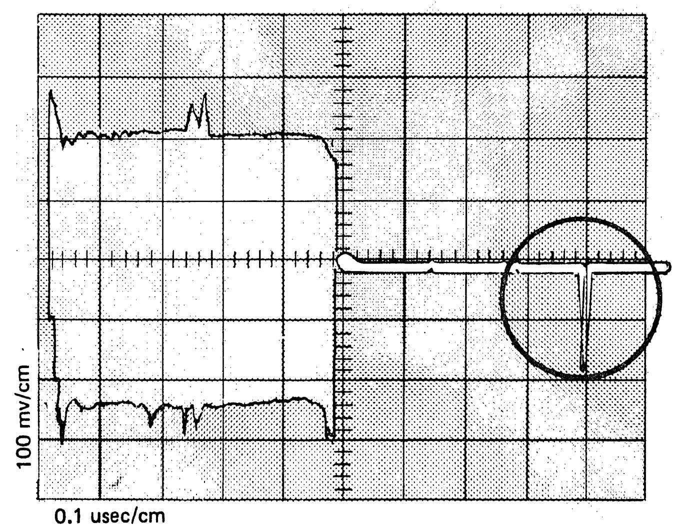


Figure 4-9. Erase Head Polarity Pulse

HIGH-SPEED REWIND ADJUSTMENT

The high-speed rewind adjustment is accomplished with the aid of the field tester.

1. Once the field tester is attached, move tape forward until it reaches the EOT marker and then stop.

2. Monitor the tachometer square wave with an oscilloscope. Set the scope at 2 volts per division and 5 seconds per division.

3. Press the LOAD/REWIND pushbutton.

4. Adjust the high-speed rewind potentiometer on the tachometer card for the following duration tachometer periods:

TAPE UNIT MODEL	TACH PERIOD IN MICRO-SECONDS
3430	32
3450	27
3470	22
3480	22

5. Disconnect the field tester and reconnect the tape unit to the control unit.

PNEUMATIC CHECKS AND ADJUSTMENTS

Proper pressure settings are very important to tape unit operation. Each pressure and vacuum point has an individual pneumatic output. Thus, it is necessary to test and adjust these points.

One pressure adjustment can affect the other pressure settings and, likewise, one vacuum adjustment can affect the other vacuum settings. As a result, ALL pneumatic adjustments must be checked, adjusted, rechecked, and possibly, re-adjusted. Vacuum and pressure readings may be taken with a magnehelic type gauge (0-100" H_20).

NOTE

> For elevations above 2,000 feet, use the high altitude pulley (PN 6868--High Altitude is stamped on the pulley) on the vacuum pump. Below 2,000 feet, use the low altitude pulley (PN 6867--Low Altitude is stamped on the pulley).

The color reference noted in each test refers to the color of the pneumatic test tube serving that point. These test points listed in Figure 4-10, are located on the left and right sides of the tape unit (and are so designated) as the viewer faces it from the rear. The pneumatic adjustment procedure is:

1. Check the vacuum-column door seal by placing a strip of magnetic tape between the door and the column assembly. Close the door and pull tape out--a drag should be felt as the tape is withdrawn. This check should be made at various points around the perimeter of the vacuum column door. If the seal is bad the door hinges and or latches must be adjusted.

2. Load a tape and allow the tape unit to run for about 15 minutes before continuing with the pneumatic checks and adjustments.

3. Open the bleed valve located on the high speed foot solenoid one turn from fully closed.

4. Adjust RUN Pressures to the values listed in Figure 4-10.

   - If RUN Pressures are easily obtained, open the bleed valve a little more and readjust the pressures.

   - If unable to obtain proper RUN Pressures, close the bleed valve a little, then adjust the pressures.

NOTE

> The purpose of the bleed valve is to prevent the pump from overheating and subsequent life degeneration.

5. Adjust RUN Vacuums to the values listed in Figure 4-10.

RUN MODE SETTINGS

Item to be Adjusted	Tube Asm. & Color	MACHINE TYPE AND PRESSURE/VACUUM SETTINGS				
		D. D. & 7-Track 2430, 2445, 2460 3430, 3440, 3450	P. E. 2445, 2450, 2460, 3430, 3440 & 3450 Only	P. E. 2470 & 3470 Only	D. D. & 7-Track 3470 Only	P. E. 3480 Only
Columns Vacuum	6 Purple	33" – 35"	33" – 35"	33" – 35"	34" – 35"	30" – 35" Try to get Max.
Rt Upper Air Bearing Pressure	10 Pink	48" – 50"	48" – 53"	48" – 53"	48" – 53"	48" – 53"
Right Guide Pressure	10 Green	40" – 60"	60" – 70"	60" – 70"	44" – 48"	60" – 70"
Tape Cleaner Block Vacuum	10 Black	Adjust the vacuum level on the tape cleaner block so that the tape seals the perforated cleaner blade. Start at 5" H20 and increase to a maximum of 8" H20. When tape seals the blade, put machine into moderate shoeshine mode to ensure tape does not part from the perforated blade. The intent is to use as little vacuum as possible (about 5" H20) to meet spec parameters. The door cover must be removed for this setting.				
Left Guide Pressure	10 Brown	40" – 60"	60" – 70"	Valve Closed	40" – 60"	Valve Closed
Right Lower Air Bearing Pressure	10 Clear	48" – 53"	48" – 53"	48" – 53"	48" – 53"	48" – 53"
Left Lower Air Bearing Pressure	6 Green	40" – 42"	40" – 42"	40" – 42"	40" – 42"	40" – 42"

THREAD MODE SETTINGS

Lower Restraint Pressure Metal	10 Red	5" – 6"	5" – 6"	5" – 6"	5" – 6"	5" – 6"
Plastic		10" – 12"	10" – 12"	10" – 12"	10" – 12"	10" – 12"
Upper Restraint Pressure	10 Blue	16" – 20"	16" – 20"	16" – 20"	16" – 20"	16" – 20"
Rt Thd Chan Pressure	10 Yellow	4.5" – 6.5"	7" – 8"	7" – 8"	4.5" – 6.5"	7" – 8"
Rt Thd Chan Vacuum	10 Purple	3" – 4"	3" – 4"	3" – 4"	3" – 4"	3" – 4"
Lt Thd Chan Vacuum	10 Orange	8" – 10"	3.5" – 4.5"	3.5" – 4.5"	8" – 10"	3.5" – 4.5"
Lt Thd Chan Pressure	6 Yellow	8" – 10"	8" – 10"	8" – 10"	8" – 10"	8" – 10"

Figure 4-10. Pneumatic Specifications (Sheet 1 of 2)

Item to be Adjusted	Tube Asm. & Color	D. D. & 7-Track 2430, 2445, 2460 3430, 3440, 3450	P. E. 2445, 2450, 2460, 3430, 3440 & 3450 Only	P. E. 2470 & 3470 Only	D. D. & 7-Track 3470 Only	P. E. 3480 Only
Vacuum Reel Vacuum	6 Red	21" – 23"	21" – 23"	21" – 23"	21" – 23"	21" – 23"
Air Jet Lt Upper A.B. Pressure	6 Blue	15" Min	15" Min	15" Min	15" Min	15" Min

These are the thread pneumatic specifications for drives only with the "Easy Load II" cartridge feature (Slim line). This is in addition to the current drive settings and is not meant as a replacement for all drives. Do not use these specifications on drives not having slim line restraints installed.

THREAD PNEUMATICS SPECIFICATIONS – EASY LOAD II, HIGH AND LOW ALTITUDE

Thread Pneumatics Specifications – Easy Load II

Item to be Adjusted	Tube Asm. Color	Machine Type All
Lower Restraint Pressure	10 Red	3 – 5
Upper Restraint Pressure	10 Blue	16 Min. Note 2 Note 3
Right Thd Channel Vacuum	10 Purple	30
Left Thd Channel Vacuum	10 Orange	N. A.
Left Thd Channel Pressure	6 Yellow	30 Note 2
Vacuum Reel Vacuum	6 Red	19 – 21
Air Jet Left Upper A.B. Pressure	6 Blue	15 – 17

NOTES:

1. No low altitude presets.
2. Most important settings are threading channels. Adjust upper restraint for as much pressure as possible.
3. If reworked metal upper restraint is installed, this setting is 23.

Figure 4-10. Pneumatic Specifications (Sheet 2 of 2)

6. Unload the tape unit and install a file reel with the Easy Load II Cartridge. Then jumper pin 2A2 B07 to logic ground and press the LOAD/ REWIND pushbutton (located on the tape unit operator panel). The tape unit is now set to allow adjustment of the thread mode pneumatics.

7. Adjust the THREAD Pressures and Vacuums to the values listed in Figure 4-10.

NOTE

The Pressures and Vacuums should be adjusted to the specified minimum with the exception of the AIR JET in the upper left air bearing. This should be adjusted to a minimum plus value (a little more than minimum). When the tape reaches the air jet it should shoot up towards the machine reel hub with a minimum of flutter. The Thread operation can be simulated to ensure that the adjustments are correct. This is done by grasping the file reel with the right hand and rotating it clockwise at the approximate speed of a thread operation (remove reel divider while performing this operation). The tape should move smoothly out of the cartridge and be picked up by the right threading channel. It should glide along smoothly through the head area and the channels. Upon reaching the upper left air bearing, it should be deflected up towards the machine reel by the air pressure. The vacuum on the machine reel should then catch and hold the tape. If tape flutters severely while threading, it usually means that threading channel pressure is too high or the vacuum level is too low.

PULLEY ALIGNMENT—PNEUMATIC SUPPLY

There are three pneumatic-supply pulleys which require periodic checks: the pneumatic motor pulley, the vacuum pump pulley and the pressure-pump pulley. The pulley alignments must be accomplished in the following sequence:

- Pneumatic-Motor Pulley

  1. Check to see that the distance from the motor support bracket to the backside of the motor pulley is .68 ± .03 inch (see Figure 4-11).

  2. If the pulley is out of specification, loosen the pulley setscrews (2) and adjust the pulley to proper tolerances.

  3. Re-tighten the pulley setscrews (2).

- Vacuum Pump Pulley

  1. Place a straightedge across the front flange of the motor pulley -- not the pulley hub -- so that it extends across the front of the vacuum pump pulley. (The straightedge must extend to the farthest edge of both pulleys -- see Figure 4-11).

  2. If the vacuum pump pulley is not flush with the straightedge that is resting on the motor pulley, loosen the setscrews (2) securing the vacuum pump pulley.

  3. Shift the vacuum pulley until it does align with the straightedge that is resting on the motor pulley.

  4. Re-tighten the vacuum pump pulley setscrews.

- Pressure-Pump Pulley

  1. Place a straightedge across the rear surface of the motor and pressure pump pulleys (the

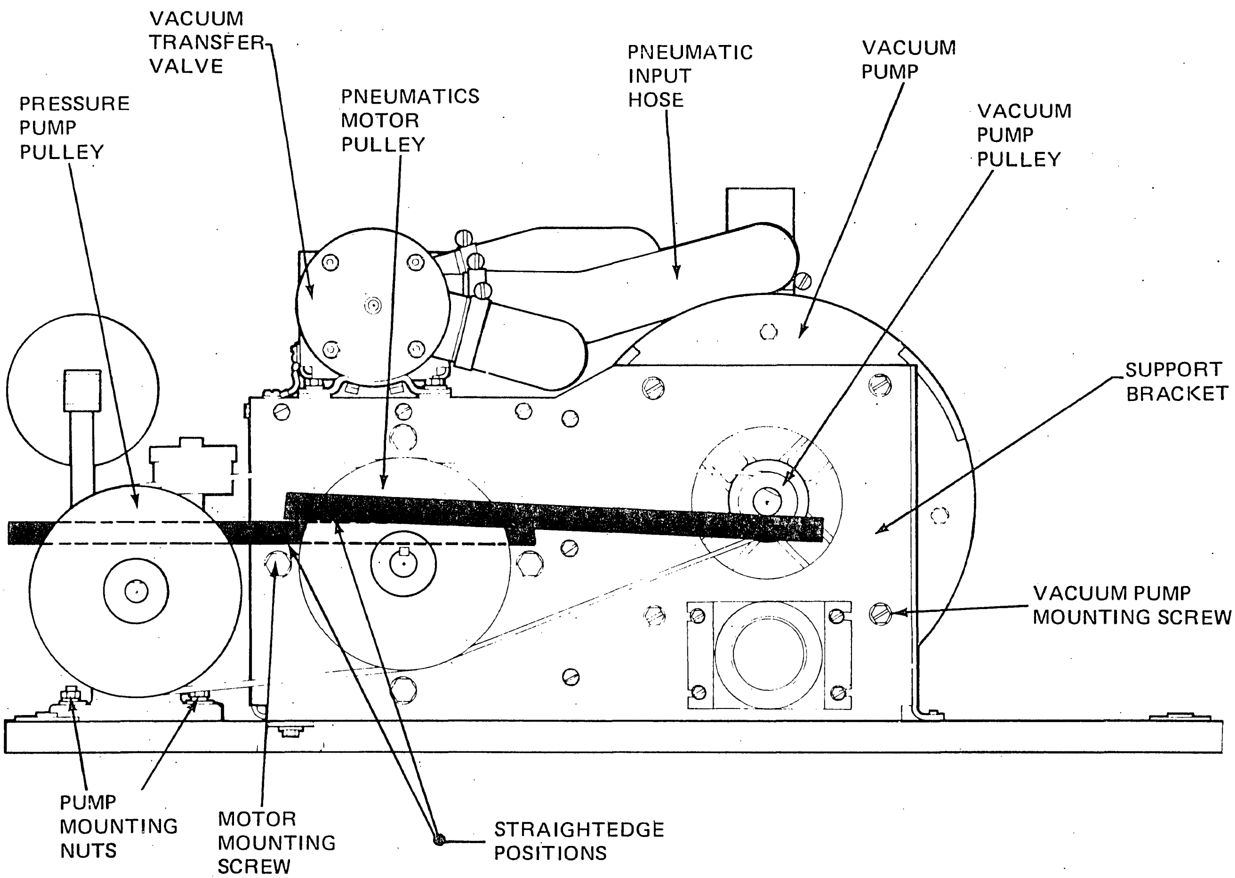


Figure 4-11. Pneumatic Supply Assembly (Front View)

straightedge must extend to the farthest edge of both pulleys--see Figure 4-11). The pressure-pump pulley should align flush with the straightedge (using the motor pulley as the guide).

2. If the pressure-pump pulley is not flush with the straightedge that is resting on the motor pulley, loosen the setscrews (2) securing the pressure-pump pulley.

3. Shift the pressure-pump pulley until it does align with the straightedge that is resting on the motor pulley.

4. Re-tighten the pressure-pump pulley setscrews (2).

5. Check for proper belt tension adjustment.

READ AMPLITUDE ADJUSTMENT (NRZI)

See WRITE AMPLITUDE (NRZI)

READ/WRITE DATA VERIFICATION

The information contained herein verifies the accuracy of the tape unit data handling capabilities. Due to the immense variation of problems that may be encountered, there is no sequence to accomplish this verification. Therefore only the information necessary for verification is provided.

READ AMPLITUDE

The operating range of the tape unit bus is defined as the peak-to-peak read bus amplitude measured at the tape control unit.

- Phase Encoded (all ones @ 3200 frpi, 500-900 mV.
- NRZI (all ones @ 800 frpi) 8-10 volts.

The PE preamplifiers are controlled by Dynamic Amplitude Control and have a nominal gain of 1.5. The NRZI preamplifiers have an adjustable amplitude control and must be adjusted.

The read backward amplitude should be within 15 percent of the read forward amplitude.

NOTE

> Do not remove the DAC card from the logic gate; this would leave a floating level on the base of the hex inverter transistors of the preamp which will adversely affect the read bus amplitudes.

BIT SPACING

The four paragraphs below are specifications for the instantaneous spacing between two transitions at the read bus.

- The spacing between successive 1600 frpi transitions must be between 88 and 105 percent of the instantaneous bit period.
- The spacing between successive 3200 frpi transitions must be between 47 and 59 percent of the instantaneous bit period.
- The spacing between alternate 3200 frpi transitions must be between 95 and 109 percent of the instantaneous bit period.
- The instantaneous bit period is measured by averaging 5 bit periods about the bit spacing measurement in question.

NOISE

Noise at the read bus can be caused by any of three independent factors discussed below.

- Feedthrough: This is noise coupled from the write head to the read head while writing. To measure feedthrough write 3200 frpi on all tracks. (Use field tester: Do not move tape.) Take measurements at read bus test points. Peak-to-valley readings in this mode should be less than 8 percent of full amplitude at the test point.
- Crosstalk: This is noise coupled between tracks. To measure:
  1. Turn field tester Write Switch to OFF for the track under test.
  2. Write all ones in all other tracks.
  3. Read forward measuring peak-to-valley amplitude at the read bus test point on the test track. The reading should be less than 3 percent of full amplitude at the test point while reading 3200 frpi.
- Random noise:

This noise is the hash line seen on the oscilloscope when measuring the read bus test points; it can be seen by exercising the machine with erased tapes. The hash should be less than 10 percent of full amplitude at the read bus test point while reading 3200 frpi (see Figure 4-12).

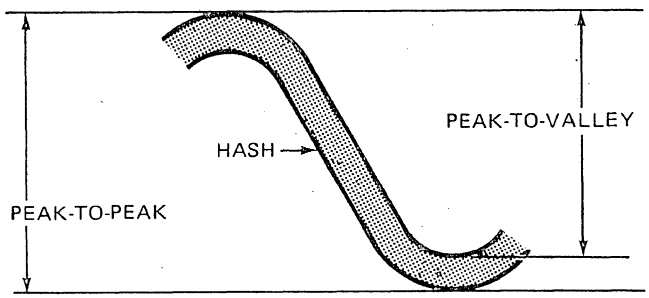


Figure 4-12. Expanded Read Bus Signal

Output missing from only one track may indicate either a bad track or a malfunctioning operational amplifier. The track output should be at least 5 mV. Check for breaks in the cable between the head amplifier and Read/Write gate. Output missing from two tracks, but fed through the same operational amplifier indicates a malfunctioning operational amplifier. Oscillations are usually caused by a loose component in that track.

READ PROBLEMS

Problems in the read area may be caused by the following:

- No output from any amplifier.
- Output missing from one head amplifier of the same IC module.
- Output missing from two head amplifiers of the IC module.
- Oscillation in an output line.

When there is no output from any preamplifier, a mechanical check should determine if the cards are inserted properly in the read gate. Check for correct voltage at the IC modules as follows:

NOTE

These voltages pertain to the R/W Head amplifier modules only.

Location	Voltage
Pin 14	+15 volts
Pin 7	-15 volts
Head Output	+ 5 mv minimum

CAUTION

Do not attempt to disconnect head while power is on; this could result in damage to the circuits.

DATA WAVEFORMS

Figures 4-13 and 4-14 illustrate the transformation a signal undergoes from the time it leaves the WRITE BUS until it is received in the TCU after a read operation.

- PHASE ENCODED -- See Figure 4-13

  Line 1 shows a WRITE BUS signal and line 2 depicts the same signal as it appears as a tape flux waveform. Line 3 is the waveform produced when that signal is differentiated by the read head and after amplification by the head amplifier. The original transition point on the WRITE BUS is now a peak at the read head output. In order to convert this peak back to a transition, the preamplifier differientiates the waveform. It then appears on the READ BUS as shown in line 4. The TCU limits the READ BUS and the resulting waveform (LIMITED DATA, line 5) looks like the original WRITE BUS signal. At this point the data is ready for decoding by the read circuits in the TCU.

- NRZI -- See Figure 4-14

  Line 1 shows a WRITE BUS signal and line 2 depicts that same signal as it appears as a tape flux waveform. Line 3 is the waveform produced when that signal is differientiated by the read head and after amplifica-

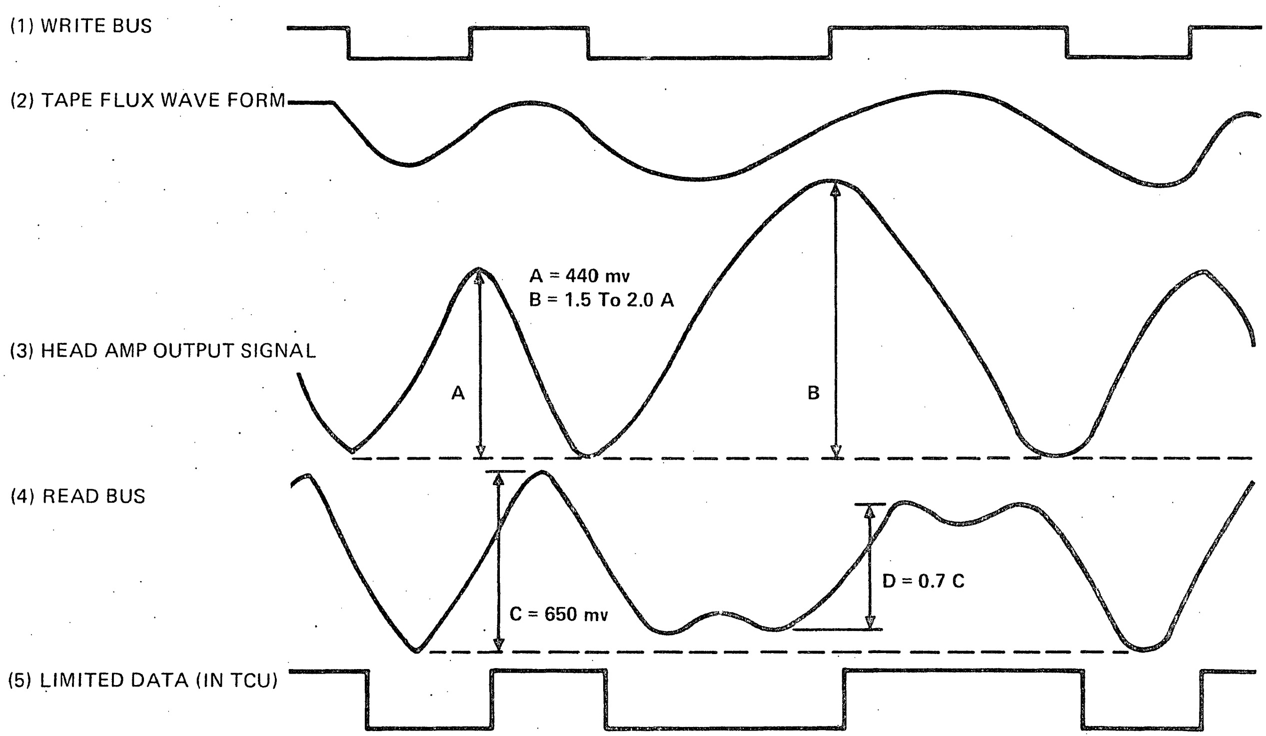


Figure 4-13. Phase Encoded Read Signal Waveforms

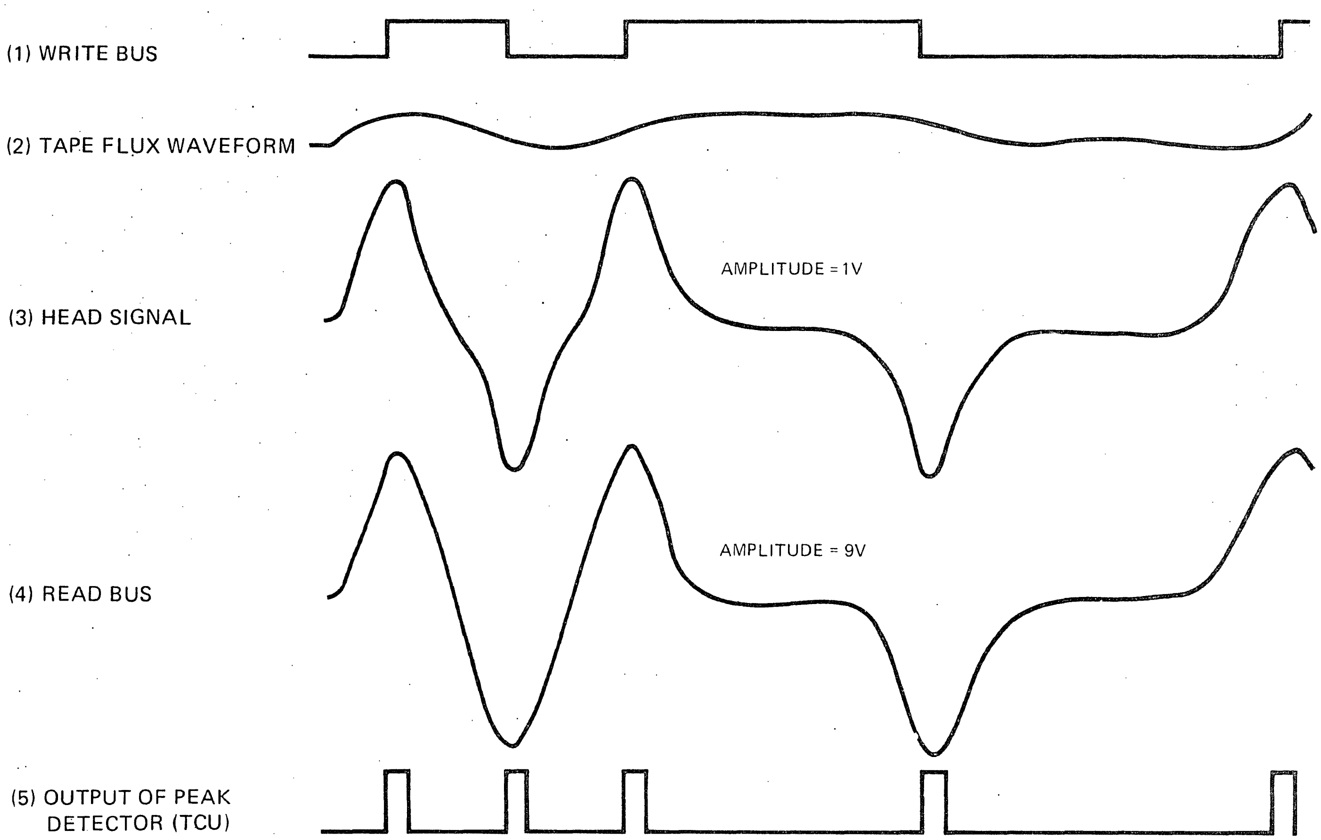


Figure 4-14. NRZI Read Signal Waveforms

tion by the head amplifier. The original transition point on the WRITE BUS is now a peak at the read head output. In order to convert this peak to a transition, the pre-amplifier differientiates the wave-form. It then appears on the READ BUS as shown in line 4. Line 5 shows the signal after peak detection in the TCU.

o READ FORMATS

Figure 4-15 illustrates the formats for both PE and NRZI recorded data as displayed on an oscilloscope.

Example "A" is a phase encoded eight character record of all ones data. The record is bordered by all ones markers which in turn are bordered by the preamble and postamble all zeros bursts.

Example "B" is an expansion of example "A" showing the all ones markers clearly.

Example "C" is a NRZI record consisting of all ones, a CRC character and an LRC character. Notice the three bit spaces on each side of the CRC character.

WRITE WAVEFORMS

To ensure that the write operation is being performed correctly requires that certain voltage levels and time references exist. To verify that the proper voltage and time conditions exist necessitates the use of a scope and reference information. This reference information is provided in Figures 4-16 and 4-17 which are drawings of the waveforms as they must appear.

Other write specifications are contained in the skew check and adjustment procedure.

RESTRAINT ALIGNMENT

1. Place the restraint alignment tool (PN 11146) on the automatic hub in the same manner a file reel is mounted. The two ears set farthest apart must border the upper restraint. The two ears set closest together must border on the lower restraint.

2. Loosen the screws (3) securing the upper restraint and the screws (3) securing the lower restraint.

3. Remove the pressure adjustment screw from the upper restraint pressure valve.

4. Insert the pressure port alignment pin in the pressure valve opening and align the valve and the port.

5. Set the upper restraint against the restraint alignment tool and tighten the restraint securing screws.

6. Lift the lower restraint until it touches the alignment tool and tighten the restraint securing screws.

7. Remove the alignment pin from the pressure valve and reinstall the pressure adjustment screw. Check and adjust the pressure according to the Pneumatic Adjustments in this section.

8. Remove the restraint alignment tool.

SENSOR ADJUSTMENTS

This procedure ensures that the tape unit recognizes EOT, BOT and tape present. The tape unit must be loaded for fifteen minutes to allow for heat drift stabilization in the sensors before making any adjustments. All

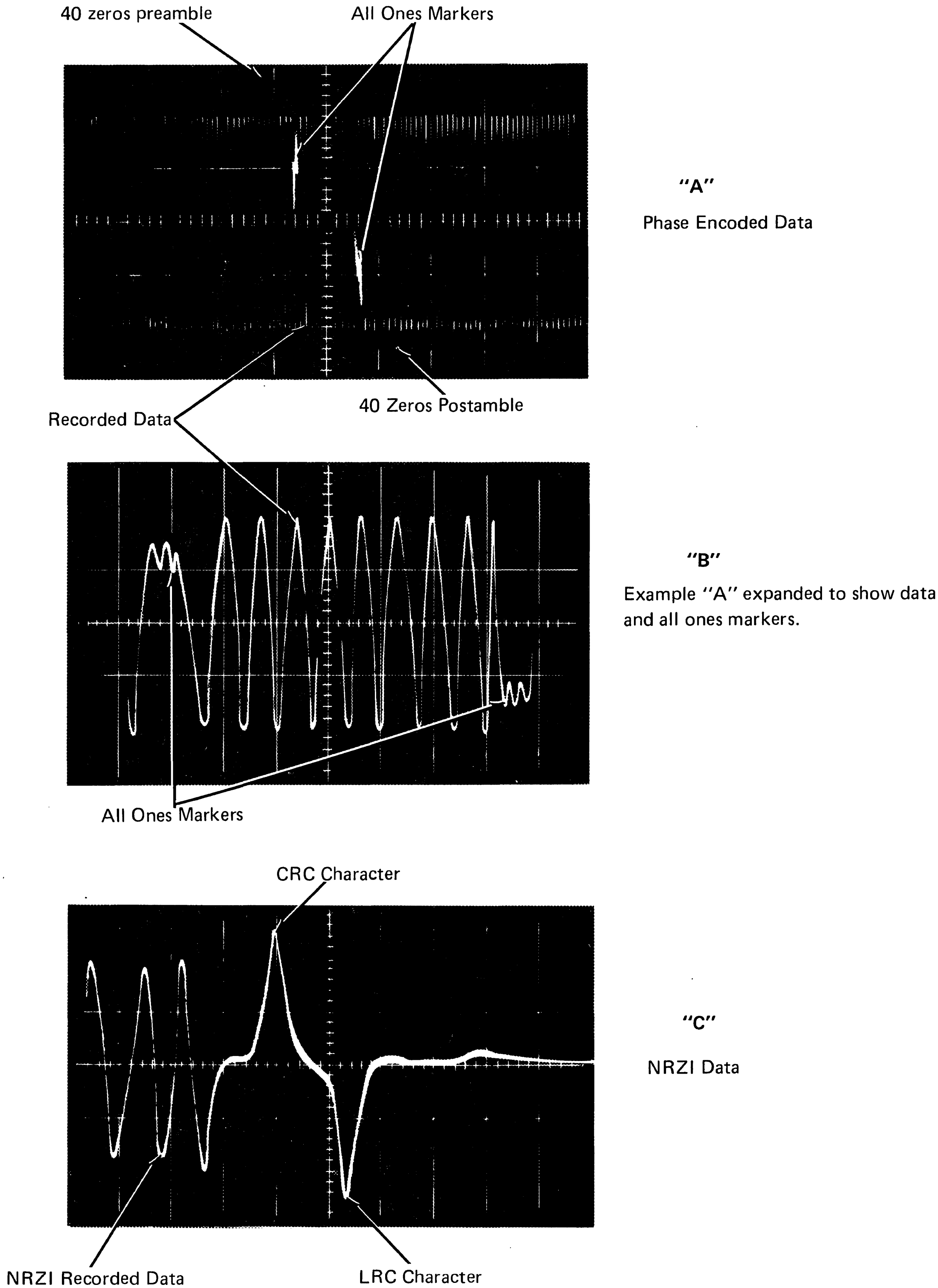


Figure 4-15. Scope View of Recorded Data

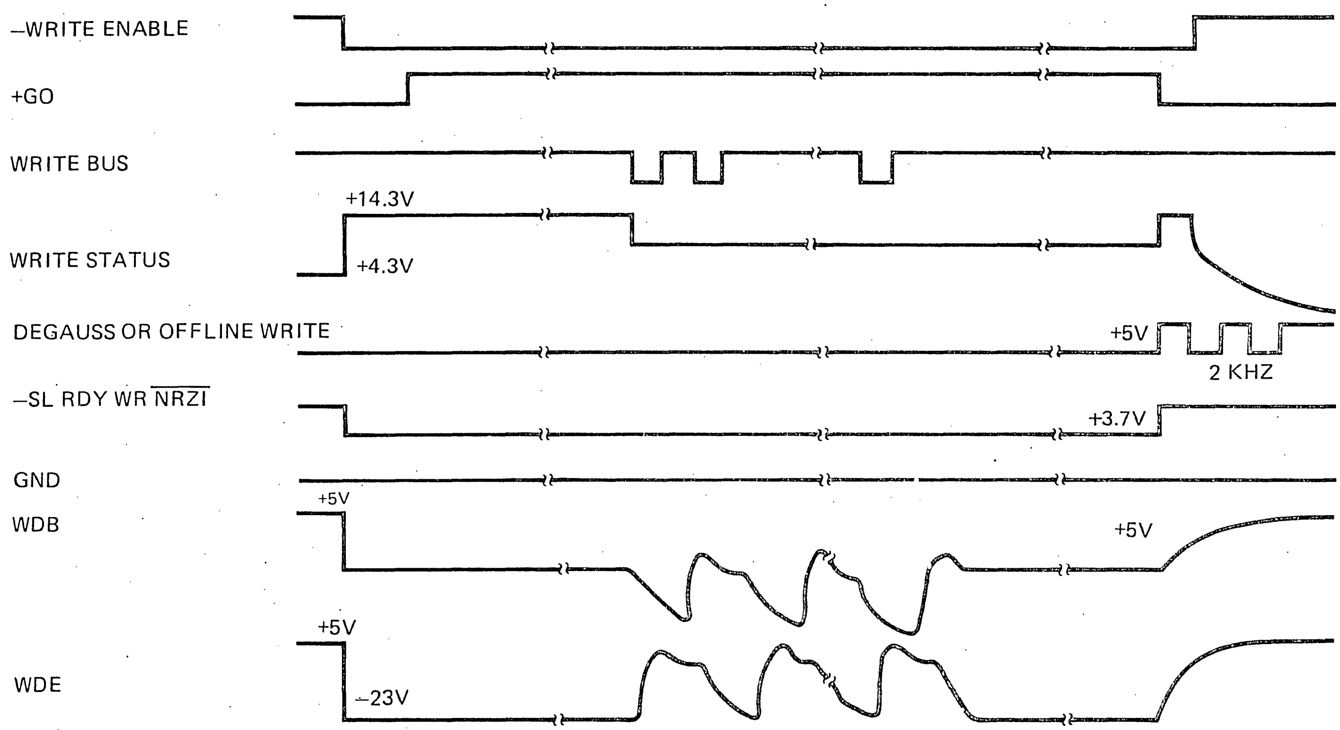


Figure 4-16. Phase Encoded, Write Operation

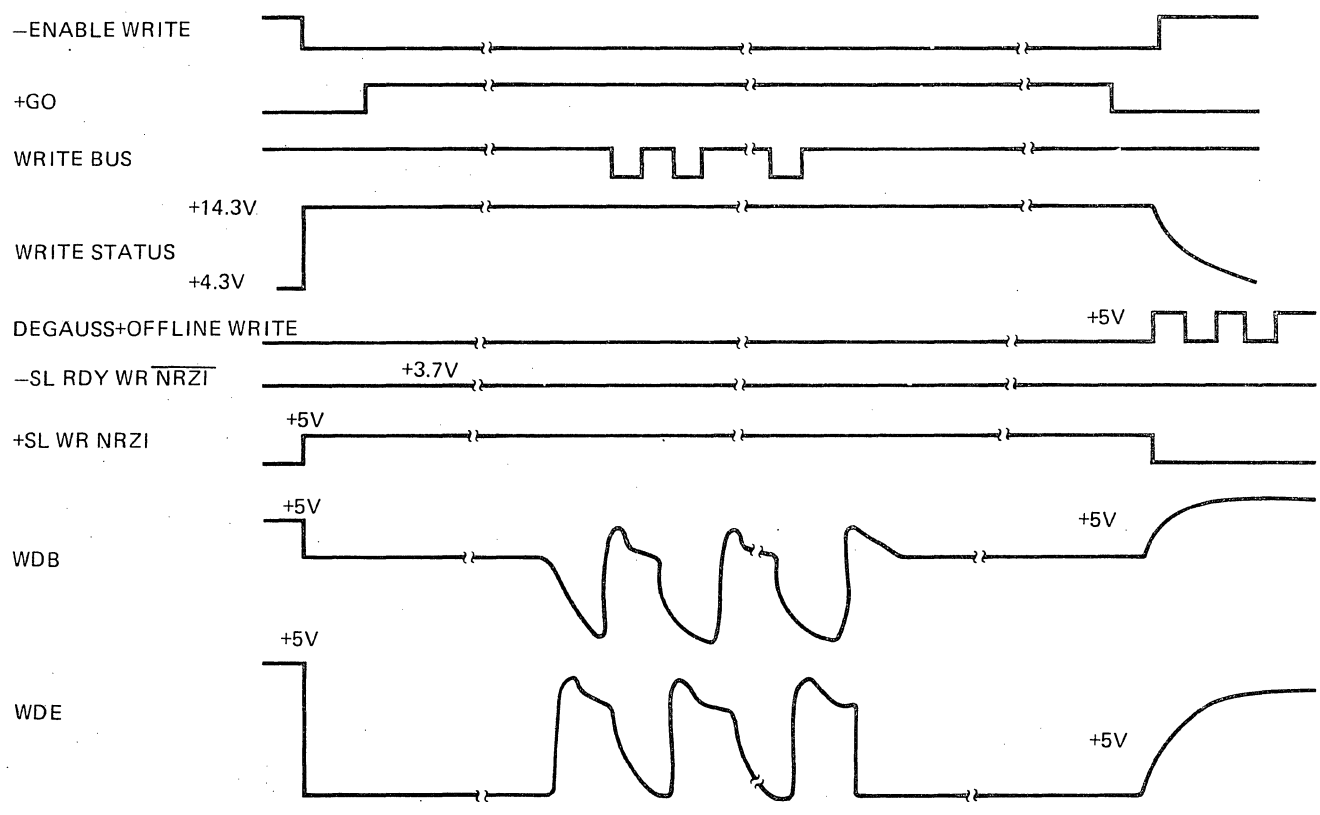


Figure 4-17. NRZI, Write Operation

adjustments must be made with an insulated tool to avoid shorting test points to voltages.

NOTE

When replacing the 2C1 card, turn all potentiometers to maximum resistance (full clockwise) before inserting card.

- EQUIPMENT SET-UP

1. Load drive with a reel of tape which has EOT marker located approximately 7 feet from BOT.

2. Connect the Field Tester, adjust it to AUTO-REWIND and allow the tape unit to autocycle.

- BOT

1. Scope 2C1 B09, Sync Positive.

2. Adjust down level for +1.5 V (P2) or maximum if less than +1.5 V.

3. The up level should be greater than +7.5 V.

4. Stop tape motion with reflective marker away from the EOT/BOT block. Press and release H. S. foot a number of times and assure dc level never goes above 3 V. If level goes above 3 V, adjust P2 for 3 V and recheck normal tape motion settings for less than 1.5 V and greater than 7.5 V.

- EOT

Scope 2C1 B08 and repeat BOT steps 2, 3 and 4. Adjust (P1) if necessary.

- LSA

1. Scope 2C1 B18.

2. Adjust (P4) for down level of +2.0 V.

3. Check and ensure that up level is greater than 8.0 V.

- TAPE PRESENT

1. Scope 2C1 B17.

2. Adjust (P3) for a signal greater than +4.0 V with tape present.

3. With no tape present less than (more negative) -.4 V.

NOTE

If the tape indicate light assembly on the operator's panel has an incorrect bulb or no bulb installed, highly intermittent EOT failures will occur. The EOT is sensed going forward and the latch is set. If the tape is then moved backwards and the EOT marker is positioned over the sensor, the latch will reset on the following forward operation. Such a condition could exist if the last record had an error and retry is attempted. The correct bulb is type 349, and the incorrect bulb is type 330. The cold resistance of a 349 bulb is 3.4 ohms. The 330 bulbs have 17 to 19 ohms. The incorrect bulbs are easily noticed as they glow more dimly than the correct ones.

SKEW CHECK AND ADJUSTMENT (MECHANICAL)

The purpose of this procedure is to ensure that the data bytes are written within a specified space. A portion of this space is called a "bit cell". The purpose of this adjustment is to align all nine bit cells perpendicular to the tape edge.

TAPE GUIDES

Before skew is adjusted, the NRZI guide must be checked, and adjusted if necessary. The NRZI guide tension is adjustable and must be between 40 - 44 grams on the left guide and 60 - 65 grams on the right guide. Measurement is made by monitoring the tension of the spring loaded portion of the guide at the first movement of compression. These adjustments are obtained by placing shims, PN 6041 (.003, green) and PN 6042 (.004, tan) behind the guide springs. If the guide springs have too much tension, and there are no shims to remove, file the button behind the springs. A Gram Gauge, PN 4015, can be ordered.

o DESCRIPTION

There is a difference between PE and NRZI Right Guides. Three different guides are used depending on the feature and model as shown below. They are as follows: Figure 4-18 - PE only, Figure 4-19 - Dual Density (3470 only), Figure 4-20 - All other models (except 3470).

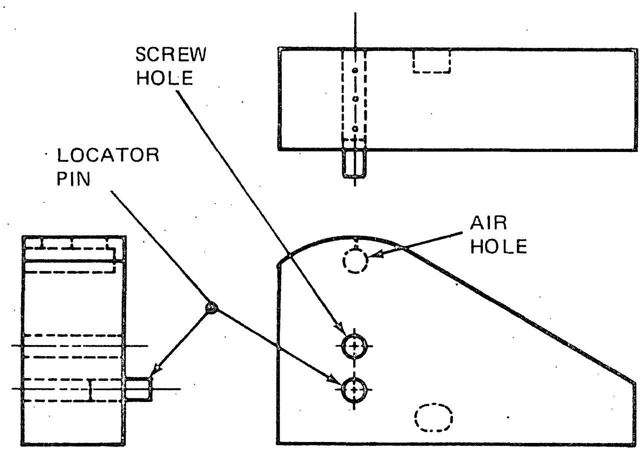


Figure 4-18. Right Guide Assembly PE Only

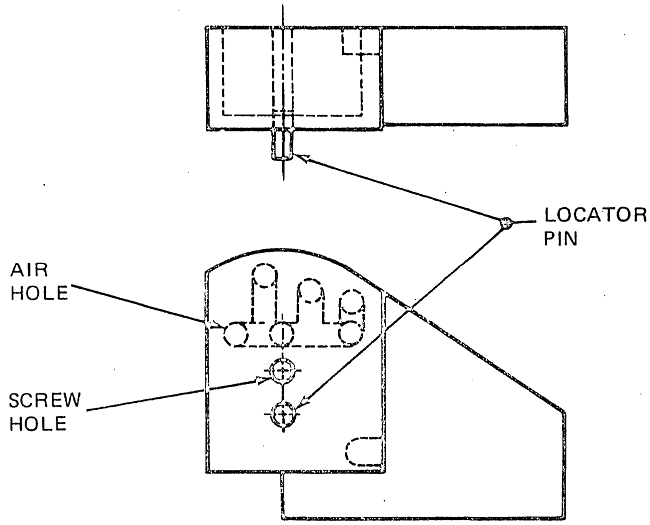


Figure 4-19. Right Guide Assembly 3470 DD Only

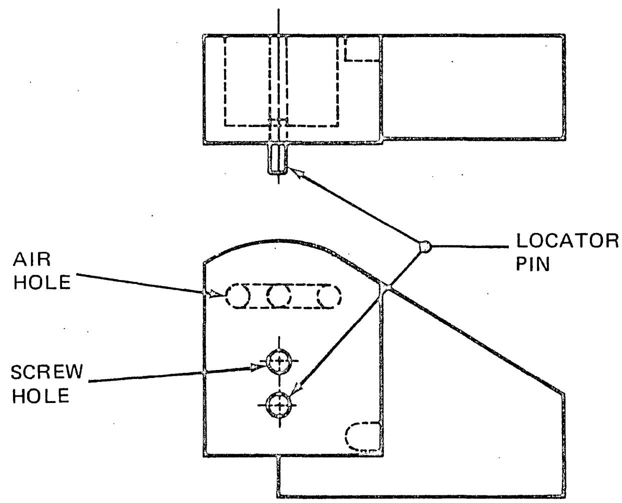


Figure 4-20. Right Guide Assembly (all DD except 3470)

o INSTALLATION INFORMATION

All NRZI machines must have the top air hole in the RED PLATE blocked with a set screw. This set screw can be seen by removing the right guide and looking through the upper hole. This screw must be slightly recessed into the red plate. Note also that this screw must be removed for PE Only machines, so that it matches the air hole in the guide.

MECHANICAL SKEW

Mechanical skew is checked and adjusted with the aid of the field tester. After the tester has been connected, load a master skew tape (STC PN 6013) onto the tape unit under test. Then proceed as follows:

1. Set the field tester Read/Write switch to the Read position, the Sh-Sh/Bkwd/Fwd switch to the forward position and the Auto Cycle/Auto Stop/Auto Rew switch to the Auto Stop position.

   NOTE

   If the tape unit has the NRZI feature, the skew delay taps listed in Figure 4-21 must be set to zero.

2. Trigger an oscilloscope on the negative slope of track 4. (Use the READ BUS test points on the field tester.)

3. Monitor track 5 and check to see if the negative slopes of tracks 4 and 5 coincide. Figure 4-22 illustrates what must be avoided and accomplished.

   NOTE

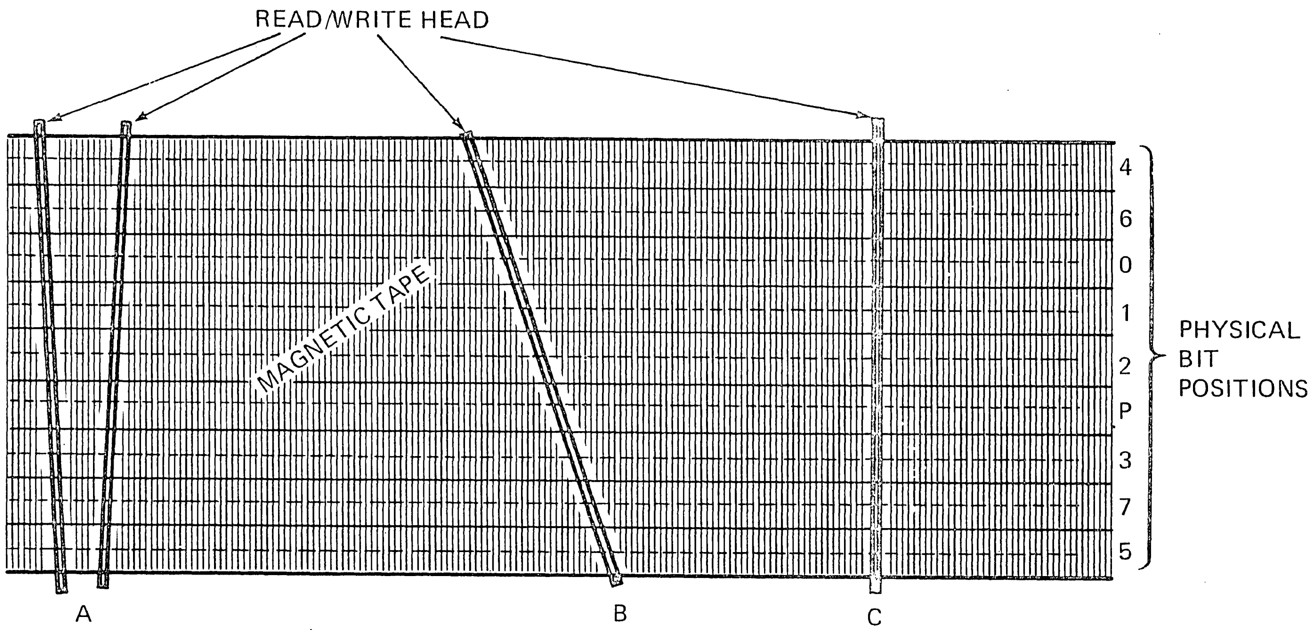
   The values given in steps 4, 6 and 7 are maximum acceptable limits. Skew should be adjusted to a minimum as near zero as possible.

4. Verify that skew, the time between the slopes, does not exceed these limits:

Model	Skew Limit
3430	2.3 microseconds
3450	1.4 microseconds
3470	0.9 microseconds
3480	0.7 microseconds

TRACK	BIT	DELAY CARD	DELAY TAPS	FWD AMP PIN	BKWD AMP PIN
1	5	1B7	B16, B17, B18, B19, B20, B21	A16	A17
2	7	1B7	B09, B10, B11, B12, B13, B14	A09	A10
3	3	1B7	B01, B02, B03, B04, B05, B06	A01	A02
4	P	1B6	B16, B17, B18, B19, B20, B21	A16	A17
5	2	1B6	B09, B10, B11, B12, B13, B14	A09	A10
6	1	1B6	B01, B02, B03, B04, B05, B06	A01	A02
7	0	1B5	B16, B17, B18, B19, B20, B21	A16	A17
8	6	1B5	B09, B10, B11, B12, B13, B14	A09	A10
9	4	1B5	B01, B02, B03, B04, B05, BC6	A01	A02

Figure 4-21. NRZI Skew Delay Taps



A. Shows the head cocked across the tape causing bit 4 to be read from one byte and bit 5 from an adjacent byte.

B. Shows the head cocked across tape to an extreme, thus each bit is taken from a different byte. However, the amplitude will appear weak.

C. Shows the head aligned straight across the tape which is the correct mechanical skew alignment.

Figure 4-22. Mechanical Skew Alignment

5. If skew does exceed the limits of step 4, turn the adjustment screw at the right front of the skew block to achieve minimum skew. Recheck to be sure skew is below the limit specified in Step 4.

6. Measure the time between the negative slope of track 4 and the negative slope of the other eight tracks to be sure the head is not misadjusted by 1 bit or more. The maximum time between the negative slope of track 4 and the other eight tracks must not exceed:

Model	Time Limit
3430	3.1 microseconds
3450	3.2 microseconds
3470	2.0 microseconds
3480	1.6 microseconds

7. Leaving the field tester Read/Write switch in the read position, set the Sh-Sh/Bkwd/Fwd switch to the backward position. Repeat the skew measurement in step 4, syncing on the positive slope this time. Backward skew should not exceed forward skew by more than:

Model	Time
3430	3.1 microseconds
3450	1.9 microseconds
3470	1.2 microseconds
3480	1.0 microseconds

8. If the read/write-head output amplitudes are below the specified levels, it is possible mechanical skew is misaligned by exactly 9 bytes. This can be checked by reading very small records written on a known good tape unit.

SKEW CHECK AND ADJUSTMENT (ELECTRICAL) . . . NRZI

Mechanical skew must be correct before electrical skew compensation is accomplished. Otherwise electrical skew would compensate for a misaligned head rather than head imperfections as it is intended.

The skew adjustment will be easier if a systematic list of accomplishments is maintained, as it is difficult to remember the bits, tracks and times involved. For the purpose of illustrating what is needed, there is a chart in Figure 4-23.

TRACK									OPERATION BEING PERFORMED
1	2	3	4	5	6	7	8	9	LAGGING BIT LOCATION
1	2	3	4	5	6	7	8	9	READ FORWARD
1	2	3	4	5	6	7	8	9	READ BACKWARD
1	2	3	4	5	6	7	8	9	WRITE

Figure 4-23. NRZI Skew Chart

READ FORWARD SKEW (NRZI)

1. NRZI skew delay taps shown in Figure 4-21 must be set to zero.

2. Mechanical skew must be checked, and if necessary, adjusted.

3. Load a Master Skew tape (STC PN 6013).

4. Connect the field tester and set the Read/Write switch to the Read position, the Sh-Sh/Bkwd/Fwd switch to the Forward position and the Auto Cycle/Auto Step/Auto Rew switch to the Automatic Rewind position.

5. With a scope monitor the Read Bus test points on the field tester and find the "latest bit" track.

6. Connect the oscilloscope's negative sync input probe to the lagging bits test point.

7. Adjust all other tracks to coincide with this lagging bit by changing the delay taps listed in Figure 4-22. Delay tap incremental values are:

TAPE UNIT SPEED IN INCHES PER SECOND	DELAY VALUE BETWEEN TWO ADJACENT TAPS IN NANOSECONDS
200	150
125	250
112.5	280
75	420

NOTE

Since bits cannot be speeded up, the earlier ones are delayed and caused to occur in synchronization with the later ones as one byte on the Read Bus.

READ BACKWARD SKEW (NRZI)

To adjust skew during Read Backward, proceed as in Read Forward with the following exceptions:

1. Change switch positions on the Field Tester to accomplish a Read Backward operation.

2. Sync the oscilloscope on positive slope.

3. Align the positive peaks.

NOTE

Unload the Master Skew tape and load a good scratch tape.

WRITE SKEW (NRZI)

1. Turn the write skew delay potentiometers listed in Figure 4-24 fully counterclockwise. These are one turn pots and this provides a minimum bit delay.

2. Locate the "lagging bit" track; it is to be used as an adjustment reference.

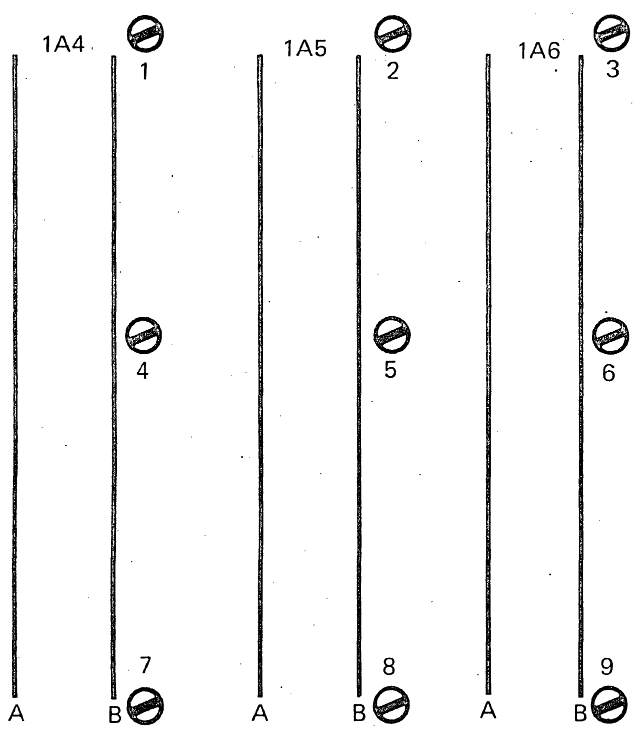
3. Sync the scope negative and connect the trigger input lead to the test point where the "lagging bit" was found.

4. Adjust all other bits to coincide with the "lagging bit" track.

There is no write skew tolerance because the write skew delay potentiometers provide for infinite adjustment.

WRITE AMPLITUDE (NRZI)

Adjust each track for 9.0 volts peak-to-peak on the read bus. This adjustment is to be made while writing all "ones" on a known good tape. The adjustment potentiometers are listed in Figure 4-25.



TRACK	1 2 3 4 5 6 7 8 9
BIT	5 7 3 P 2 1 0 6 4

Figure 4-24. NRZI Write Skew Delay Adjustment Potentiometers by Track Location

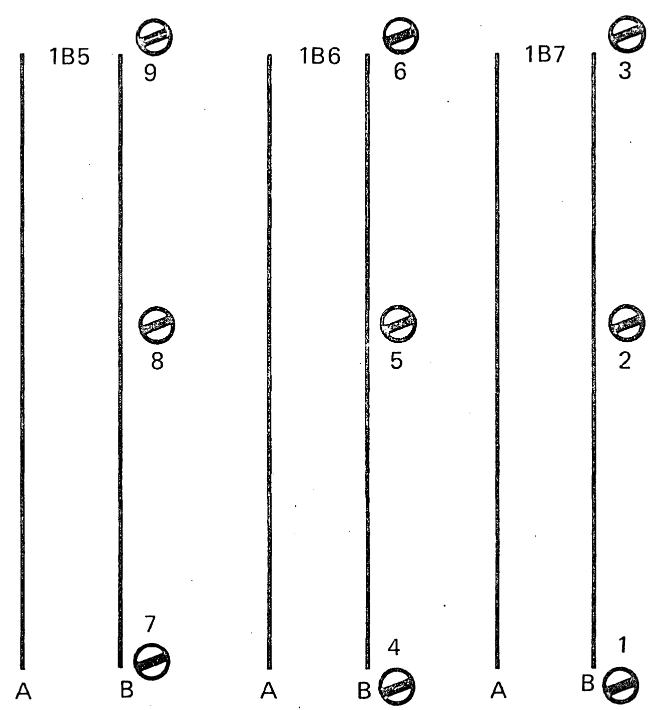


Figure 4-25. NRZI Write Amplitude Adjustment Potentiometers by Track Location

TACHOMETER CHECK AND ADJUSTMENT

The following procedure lists the steps required to set the dc level for the phototransistor and lamp assemblies.

1. Connect a field tester to and mount a scratch tape on the tape unit to be checked.

2. Move tape forward to the EOT marker and stop it.

3. Connect a scope to the sine output test point on the tach board shown in Figure 4-26.

4. Press the LOAD/REWIND pushbutton and adjust potentiometer P1 for a peak-to-peak signal of between 4 V and 6 V.

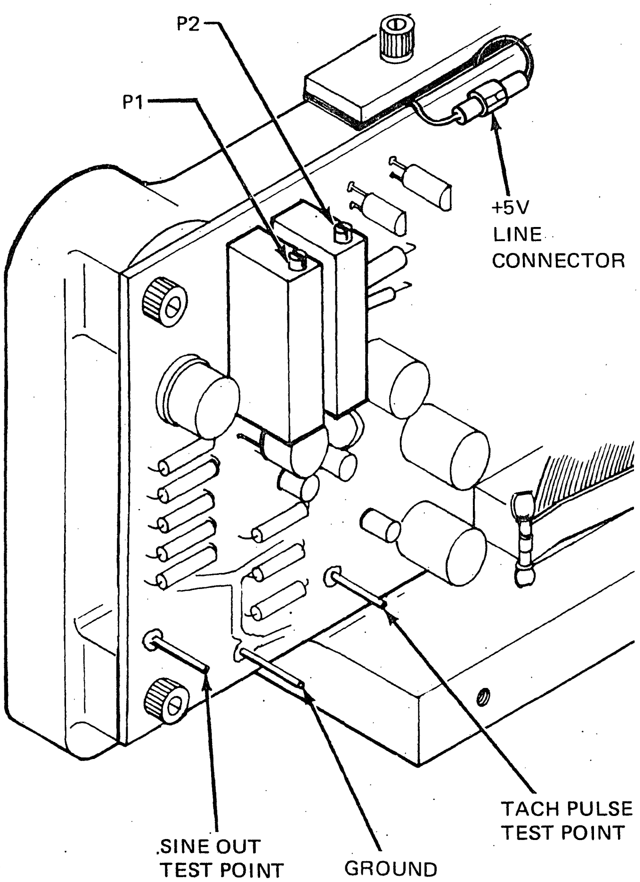


Figure 4-26. Tachometer Board

5. Stop tape motion and initiate a forward motion command.

6. Check to ensure a peak-to-peak signal of between 4 V and 9 V at the same test point previously used.

7. Allow tape to continue moving forward until it reaches EOT, then stop it.

8. Disconnect the +5 V line (small white plastic single wire connector between tach board and capstan tachometer assembly) from lamp A. This causes the circuit to automatically switch to assembly B.

9. Substitute potentiometer P1 with potentiometer P2 and repeat steps 4, 5, and 6.

10. Reconnect the +5 V line to the lamp A assembly.

VACUUM COLUMN DOOR ADJUSTMENT

The vacuum column door is correctly aligned when the door glass counterbore is centered on the capstan and the door swings freely on its hinges. It should maintain vacuum seal after a minimum of ten openings and closings. Check capstan and R/W head to door clearance before proceeding with the following adjustments:

- Vertical adjustment

  1. Loosen the hinge mounting screws on the rear of the vacuum-column back plate.

NOTE

DO NOT loosen both hinge mounting blocks simultaneously.

2. Adjust the lower hinge first, retighten the screws and then adjust the upper hinge.

- Horizontal adjustment

1. Loosen the hinge mounting screws on the side of the hinge mounting block.

NOTE

DO NOT loosen both hinges simultaneously.

2. Adjust the lower hinge first, retighten the screws and then adjust the upper hinge.

Once the vacuum door adjustments are completed, test the vacuum seal by placing a piece of magnetic tape between the door and the vacuum column bars. Close the door. A drag should be felt as the tape is pulled out. Check both the right and left sides for a good seal along the muffler plate and glass area. (See Door Catch section for further adjustments.) If a good seal cannot be accomplished, check for protruding air bearings and screws or for warped parts, burrs and foreign material.

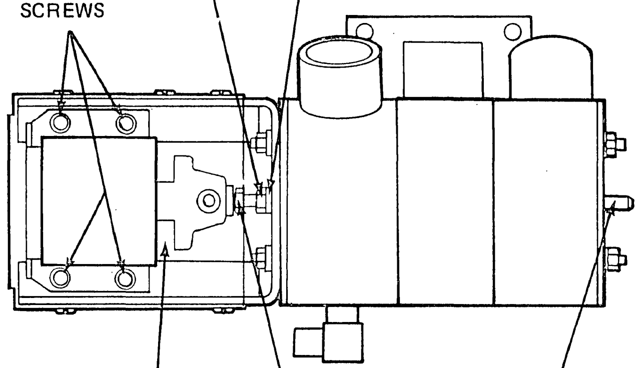


Figure 4-27. Vacuum Transfer Valve

VACUUM TRANSFER VALVE ADJUSTMENT

The vacuum transfer valve (see Figure 4-27) switches pneumatics from the thread mode vacuum ports to the run mode ports. To adjust the vacuum transfer valve:

1. Remove the top fire wall to obtain access to the transfer valve, and loosen the solenoid mounting screws (4).

2. Loosen the valve shaft nuts until maximum shaft movement is obtained. Then press the valve shaft-end with the thumb until the valve is fully seated. While still holding the shaft in, move the solenoid coil forward until it touches and is square with the plunger face (making contact on both sides).

3. Release the shaft and retighten the mounting screws (4).

4. Repeat this portion of the procedure if the plunger and coil do not seat when flush on both sides.

5. With the valve shaft in normal position (running mode), rotate the position nut (the nut closest to the valve assembly) until it makes contact with the end plate. Using two wrenches, lock the locknut against the position nut being careful not to disturb the setting of the position nut.

6. To complete the adjustment, press on the valve shaft-end until the valve seats. Then rotate the shaft in either direction to obtain .002 to .003 inch clearance between the solenoid plunger and the core. Tighten the solenoid locknut -- do not allow the shaft to rotate when tightening the locknut.

VOLTAGE ADJUSTMENTS

The +5, +15 and -15 volts must be adjusted to within ±4 percent of nominal.

+5 V ± 0.2 V
+15 V ± 0.6 V
-15 V ± 0.6 V

These voltages may be monitored on Terminal Board 3 (TB-3) shown in Figure 3-27. The nonadjustable voltages that may be monitored on TB-3 are -23 V and +10 V.

The remaining voltages are -10 V and -46 V. They are not adjustable and may be monitored on the back of the power gate.

WINDOW LIMIT SWITCHES ADJUSTMENT

The window-limit switches are located near the left end of the power-window drive shaft. The switch nearest the front of the machine senses the down position. The rear switch senses the up position (see Figures 4-28 and 4-29).

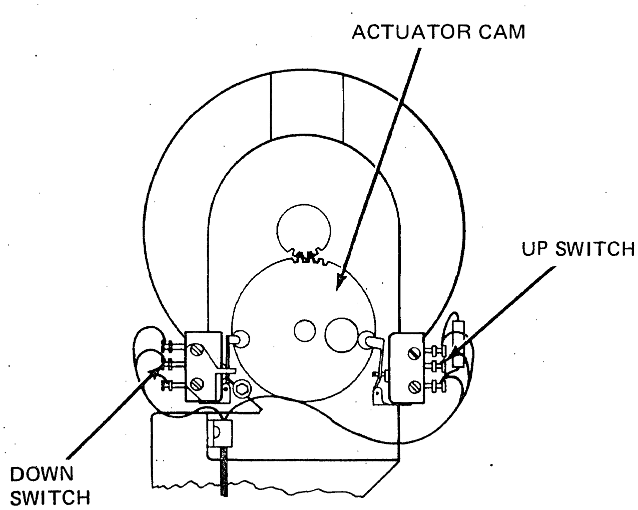


Figure 4-28. Power Window Switches

Limit switch adjustments are made with the window down as follows:

1. Loosen the two screws securing each switch.
2. Move the desired switch up or down with respect to the actuator cam.

Correct switch position is determined by trial and error according to the following guidelines:

- The down switch should be adjusted so that the window closes fully without bouncing.
- The up switch should be adjusted so that power is cut off just before the window reaches the stops.

WINDOW ADJUSTMENTS

HORIZONTAL ADJUSTMENT

The power window horizontal adjustment procedure is:

1. Loosen the two cap screws on each window guide (see Figure 4-30 for the cap screws location).
2. Align the guides to allow the window to swing out freely without interference or contact with the sides of the tape unit.
3. Retighten the cap screws.

VERTICAL ADJUSTMENT

The power-window vertical adjustment procedure is:

1. Loosen the two cap screws on the drive-shaft coupling (see Figure 4-29 for the cap screws location).
2. With the coupling loosened, close the window completely and then retighten the cap screws.

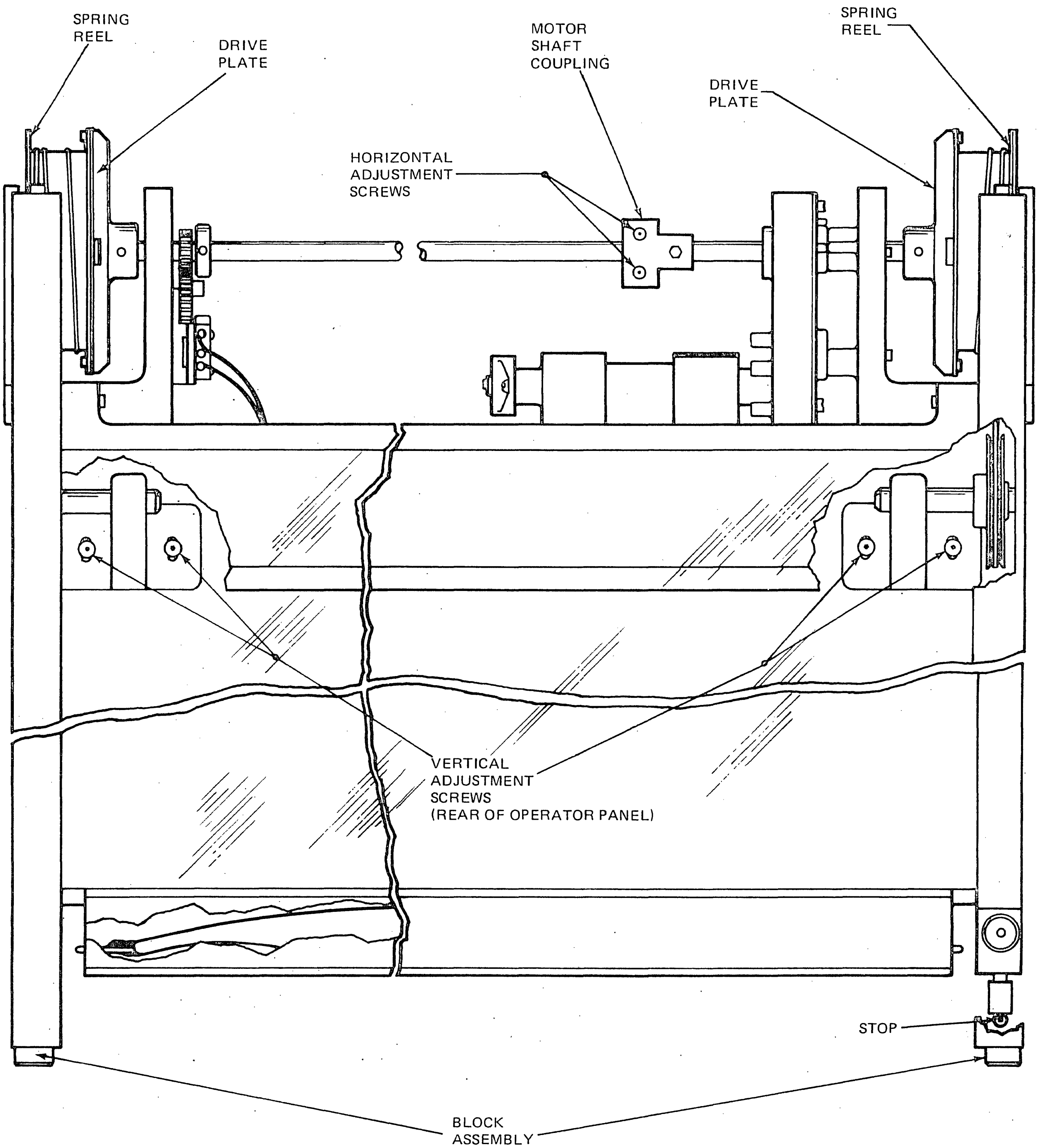


Figure 4-29. Power Window Adjustments

TENSION ADJUSTMENT

1. Remove the screws (6) holding the operator panel in place and set the panel back on the top of the tape unit.

2. Disconnect the cable from the spring reel by removing the screw securing it (see Figure 4-29).

3. Hold the spring reel in place and remove the allen screws attaching the reel to the drive plate.

CAUTION

Keep a firm hold on the spring reel once the screws are removed. Releasing the reel results in the reel unwinding until tension is removed. Should this happen, rewind the spring reel until proper tension is attained.

4. Rotate the spring reel either a quarter or half turn to adjust the tension. This is a trial-and-error adjustment.

5. Reinstall the screws (2) that hold the spring reel to the drive plate.

6. Reconnect the cable to the spring reel.

7. Follow this sequence for the second spring reel.

8. Test window operation.

9. Set the operator panel in position and secure in place with the allen screws (6). One of the screws also connects the ground wire.

NOTE

The cable to the operator panel runs between the left spring reel and the panel. Do not pinch the cable and be sure it does not interfere with the proper window operation.

REPLACEMENT PROCEDURES

This section incorporates the replacement procedure for tape unit assemblies and individual parts. In many cases, removing an assembly may result in the need for adjustment and alignment of the assembly. The adjustment information is described in the Adjustment/Alignment Procedures section of this chapter. As an aid to locating a particular replacement procedure, they are arranged in alphabetical sequence.

AUTOMATIC HUB REPLACEMENT

1. Loosen the allen screw securing the collar clamp and slide the hub off the shaft.

2. Slide the new hub onto the reel motor shaft until it rests against the hub locating collar.

3. Slide the collar clamp over the hub splits and align the splits in the clamp with the splits in the hub assembly.

4. Tighten the collar clamp allen screw.

5. Alternately press the LOAD/REWIND and RESET pushbuttons to be sure the new hub is working.

6. If the hub chatters, perform the Hub Actuator Adjustment.

CAUTION

DO NOT change the hub position on the motor shaft, as it may result in tape damage.

AUTO-HUB COVER REPLACEMENT

1. Pull the cover straight off. Pry between the cover and hub with a screwdriver if necessary.

2. To install the new reel-hub cover, position it with the notch down and then insert the cover pin in the notch.

3. Rotate the cover clockwise around the cover pin until the two springs on the left slip into the hub.

4. Rotate the cover counterclockwise around the cover pin until the two springs on the left slip into the hub.

5. Rotate the cover counterclockwise until it is concentric with the hub.

6. Use a screwdriver to insert the third spring under the cover and then push the cover on.

7. Check to be sure that all three hub latch clamps are in up position.

AUTO-HUB SOLENOID REPLACEMENT

CAUTION

208 VAC present

1. Disconnect all wires to the solenoid (note their locations).

2. Remove the hex-head screws (2) used to fasten the solenoid retaining bracket to the main transport.

3. Pull the linkage pin from the solenoid arm and remove the solenoid assembly from the tape unit.

4. Remove the screws (2) holding the old solenoid to the retaining bracket.

5. Secure the new solenoid to the retaining bracket.

6. Install the linkage pin in the solenoid arm while holding the solenoid assembly in the tape unit.

7. Attach the solenoid retaining bracket to the transport plate.

8. Connect the wires to their appropriate connectors on the solenoid.

9. Apply power to check hub operation and adjust the solenoid as necessary (see the Adjustment section of this chapter).

BELT REPLACEMENTS

CAUTION

DO NOT roll the new belt onto the pulleys as it will permanently damage the belt.

VACUUM PUMP

1. Loosen the vacuum pump mounting screws (4) and slide the pump toward the pneumatic motor (see Figure 4-30).

2. Replace the old belt with a new one. Then slide the pump away from pneumatic motor to take up slack in the belt.

3. Check belt tension and pulley alignment.

PRESSURE PUMP

1. Mark the pressure pump position on the pneumatic supply frame.

2. Loosen the pressure pump mounting nuts (4) and slide the pressure pump assembly toward the pneumatics motor (see Figure 4-30).

3. Replace the old belt with a new one. Then slide the pressure pump assembly away from the pneumatics motor to take up the excess slack in the belt.

4. Check belt tension and pulley alignment.

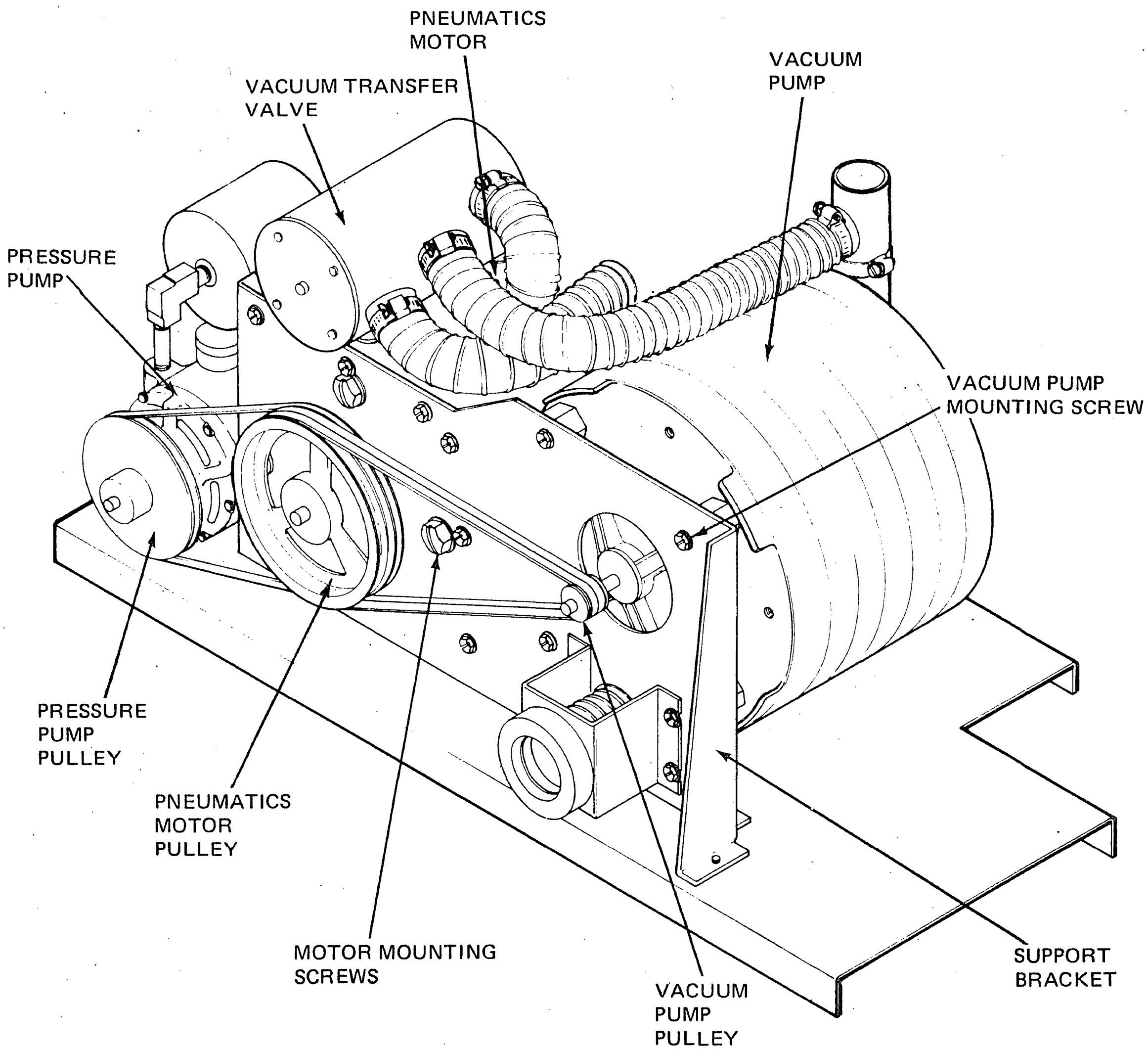


Figure 4-30. Pneumatic Supply Assembly

CAPSTAN MOTOR REPLACEMENT

The capstan motor assembly is removed or installed from the rear of the tape unit. To remove the capstan motor assembly:

1. Remove the screws (3) that hold the capstan in place on the motor shaft and remove the capstan.

CAUTION

DO NOT touch the capstan surface with the bare hand.

2. Disconnect the following wires and cables (noting their orientation to aid in the subsequent motor replacement):

   - Capstan power cables (2) from TB15.
   - Frame ground wire (color coded green and yellow) by removing the screw attaching it to the motor.
   - Tachometer cable, which is colored grey and clamped to the tachometer board.

3. Remove the 1-1/4 inch flexible cooling hose that connects the capstan motor to the vacuum pump.

4. Tighten the spacer guides (2) against the motor casting. This helps prevent cocking the assembly during removal (see Figure 4-31).

5. Remove the motor mounting nuts (2) and both mounting sleeves.

6. Remove the washers by sliding them off the mounting shaft and onto a screwdriver to maintain proper washer arrangement.

7. Withdraw the motor assembly by pulling it straight toward the rear of the tape unit. If the assembly is cocked, gently pull and push on both sides of the motor to free it.

To install the capstan motor:

1. Be sure the capstan is removed from the motor to be installed, then place the motor assembly on the mounting studs.

2. Tighten the spacer guides (2) while taking care to keep the motor assembly squarley aligned on the mounting studs.

3. Slide the motor forward until the adjustment screws touch the main transport plate (purple plate). Be sure that no cables or pneumatic tubes are between the motor assembly and the transport plate.

4. Replace the 20 belleville washers onto each of the mounting studs (these are the washers that were placed on a screwdriver to maintain proper arrangement).

5. Install the mounting sleeve and nut on each mounting stud and lock them down snugly.

6. Loosen the spacer-guide locking screws one full turn.

7. Connect the capstan motor wires and cables as follows:

   o Capstan power cables (2) to TB15.

   o Frame ground wire (color coded green and yellow).

   o Tachometer cable.

   o Ensure that other connections in the same area have not been accidently disconnected.

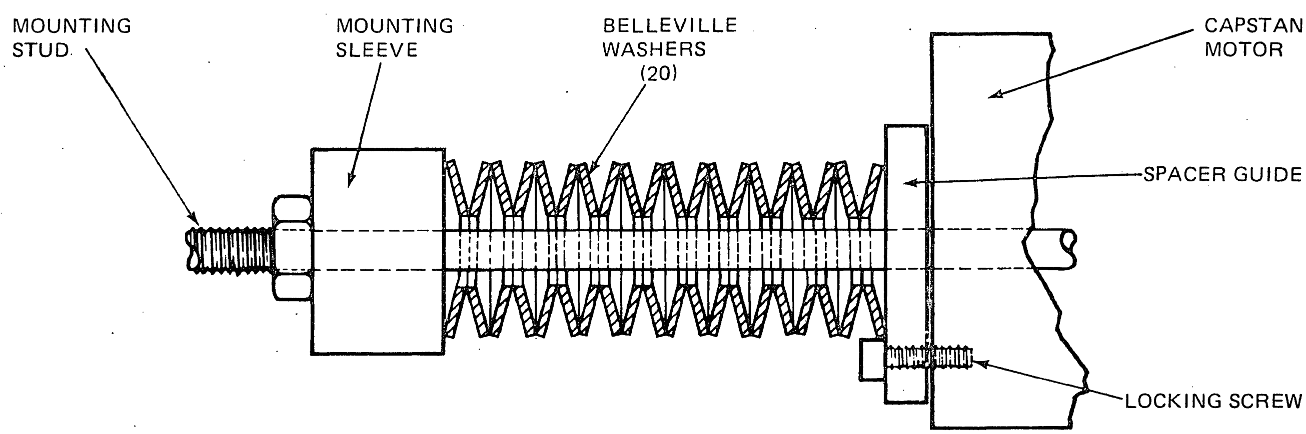


Figure 4-31. Capstan Mounting Assembly

8. Connect the 1-1/4 inch cooling hose to the capstan motor.

9. Carefully, and without touching its surface with the bare hands, install the capstan on the motor shaft (from the front of the tape unit). Be sure that the upper Z-bar does not interfere with capstan movement.

10. Loosen the allen screws (2) on the upper Z-bar and adjust the Z-bar until it is .006 inches (one data processing card thickness) from the capstan.

11. The final step is to perform capstan tracking and mechanical skew adjustments according to the procedures in the Adjustments section of this chapter.

CAUTION

Before mounting a tape, check the capstan for possible "run away" condition. The check is accomplished by simulating a mid-tape load and monitoring capstan speed. If the condition does exist, the excessive speed can force tape into the space between the capstan and the upper Z-bar locking-up tape motion. Not only does this damage the tape but it will ruin the motor. Check wiring if "run away" exists.

FILE PROTECT ASSEMBLY REPLACEMENT

To remove the defective file-protect assembly:

1. Remove the file reel and then pull the file-protect pneumatic supply hose free from its connector (pull straight back) with one hand, while holding the file-protect assembly with the other.

2. Disconnect the file-protect cable.

3. Remove the two mounting screws that hold the file-protect assembly in place.

4. Work the file-protect assembly carefully to the rear and left for removal from the tape unit.

To install the new file-protect assembly:

1. Place the new file-protect assembly in the tape unit making sure that the nozzle is not being pushed against the rear of the hub.

2. Insert and lightly tighten the mounting screws (2) -- the file-protect assembly should still be moveable.

3. Adjust the nozzle so that the distance from it to the hub assembly (gap B in Figure 4-32) is approximately the depth of one data processing card. Also verify that the flange of the hub assembly extends 0.05-0.09 inch beyond the nozzle of the file-protect assembly (gap B in Figure 4-32).

4. Tighten the mounting screws and then recheck the dimensions at points A and B.

5. If dimension A is incorrect, the mounting surface of the file-protect assembly can be filed down to reduce the gap. Shims (use card stock) can be added between the assembly and the main transport casting to increase the gap.

NOTE

Be sure to check for correct position and adjustment of the file-reel latch.

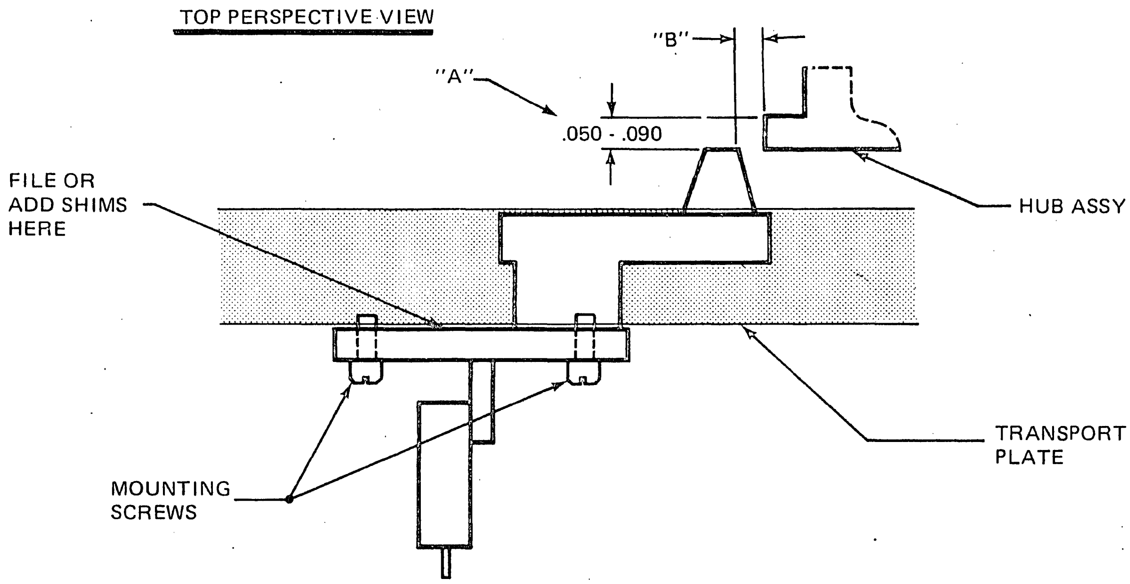


Figure 4-32. File Protect Assembly Mounting

6. Reconnect the pneumatic supply hose to the rear of the file-protect assembly.

7. Connect the file-protect cable, then check for proper operation of the file-protect mechanism with and without a file-protect ring. Repeat the check with a cartridge in place.

HIGH SPEED FOOT REPLACEMENT

1. Remove the screws (2) securing the foot to the main transport plate.

2. Remove the high speed foot and disconnect the pneumatic hose.

3. Connect the new foot to the pneumatic hose.

4. Align the pins on the foot in the guide groove and reinstall the retaining screws (do not tighten down).

5. Load a tape.

6. Adjust the foot to obtain approximately 0.06 inch gap between the foot and the tape in the tape path. Tighten the screws.

7. Manually actuate the foot assembly by pressing and holding the button on top of the high speed foot solenoid. The foot should hold tape clear of the read/write head without hitting on the center guide. If tape does not clear the head, increase the gap between the foot (when inactive) and the tape -- the foot must not touch the tape at this time. Manually actuate the foot again to see if it holds tape off the read/write head.

MACHINE REEL REPLACEMENT

1. Remove the hub cover.

2. Loosen the screw-in clamp which holds the reel in place, then remove the clamp and reel from the motor shaft.

3. Place the new reel on the machine-reel motor shaft so that the flanges are centered on the threading channel.

4. Position the screw-in clamp so that the slot in the clamp matches the slot in the hub. Then tighten the screw to secure the assembly in place.

5. Reinstall the hub cover.

6. Recheck to be sure that the mounted tape does not rub the reel flanges at any point.

PHOTOTRANSISTOR COLUMN BAR ASSEMBLY REPLACEMENT

1. Disconnect the electrical leads at the connector.

2. Remove the allen-head screws (2) attaching the column bar assembly to the tape unit and withdraw the assembly.

3. Thread the wires of the new phototransistor column bar assembly through the same holes the old ones were removed from.

4. Attach the assembly with the allen-head screws (2), obtain the correct vertical alignment of the column bar and then tighten the screws.

5. Connect electrical leads.

PNEUMATICS MOTOR REPLACEMENT

NOTE

Before starting the pneumatics motor replacement procedure, complete the Vacuum Transfer Valve Assembly Replacement section (removal).

Proceed as follows to remove the pneumatics motor:

1. Loosen the pressure pump nuts (4) and the vacuum pump mounting screws (4), slide the pumps toward the motor and remove the belts (see Figure 4-33).

2. Loosen the set screws (2) on the pneumatics motor triple-grooved pulley and remove the pulley, using a wheel puller if necessary.

3. Disconnect the motor mounting screws (4) and lift the pneumatics motor out of the tape unit.

To install the new pneumatics motor, reverse this sequence and then perform the vacuum transfer valve replacement (installation).

POWER SUPPLY REMOVAL AND REPLACEMENT

This procedure ensures an orderly removal of the power supply. Follow the steps in reverse order for installation.

1. Remove primary power cables and I/O connectors from tape unit.

2. Remove machine covers.

3. Remove ground strap located below vacuum pump by removing slot screw from base of tape unit.

4. Open rear hinged panel and remove two slotted hex screws (nuts are located beneath the tape unit), they are labeled D and E in Figure 3-25.

5. Loosen three allen-head cap screws on the left side and two on the right side of the power supply. These five screws are shown in Figure 3-25 and are labeled A, B, C, F, G.

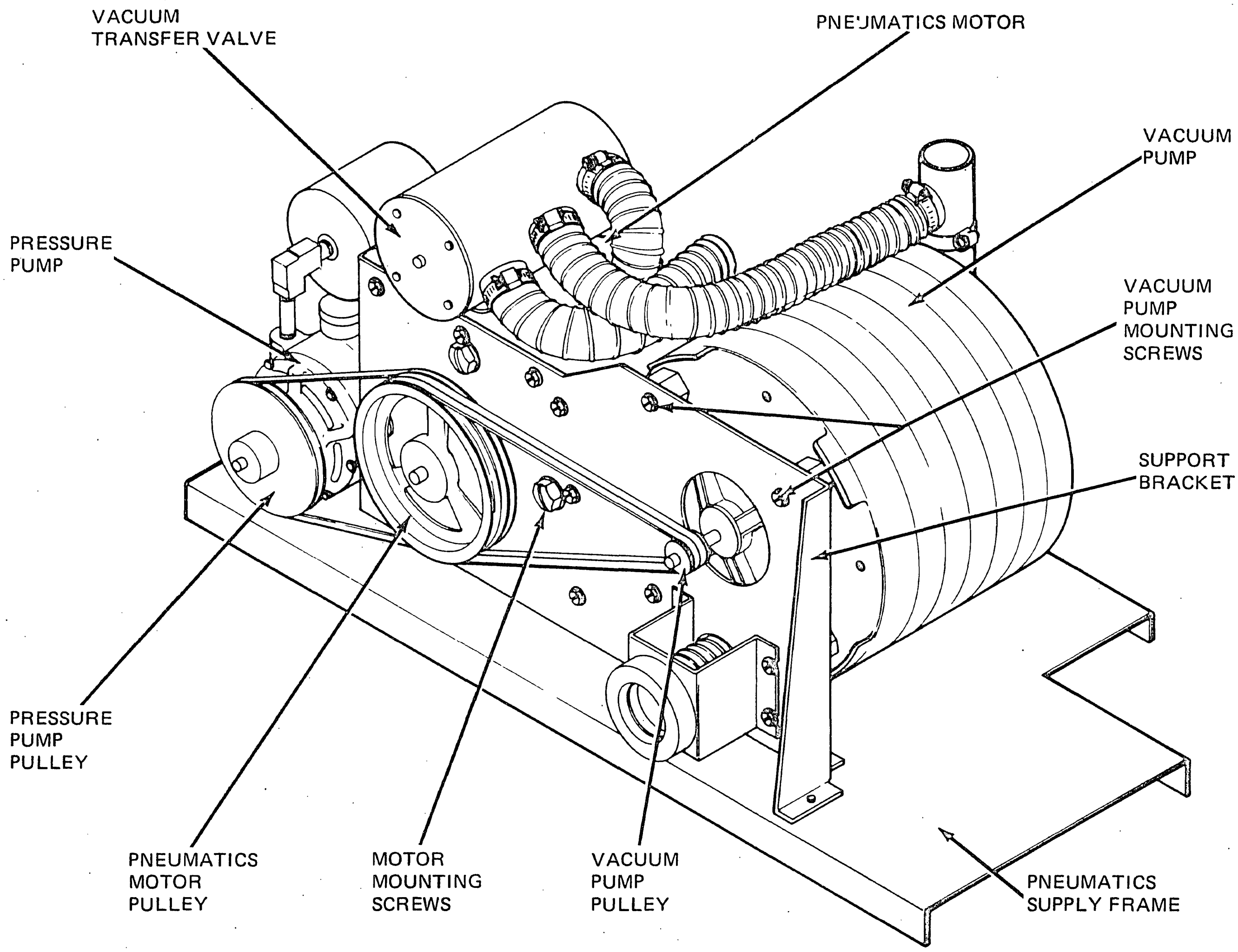


Figure 4-33. Pneumatic Supply Assembly

6. Remove and LABEL the external cables connected to TB-3 and the DCC bus bar on the front of the power supply.

7. Remove the voltage distribution cable from the power gate in the rear of the machine. (LABEL CAREFULLY) Note the groups of 4-3-3-1 wire breakout and the exact board on which they are located.

8. Remove the flat cable and external ac distribution cables from the triac board. (LABEL CAREFULLY FOR TB LOCATION).

9. Remove power supply assembly by sliding straight out from rear of machine.

WARNING

Sliding the power supply is physically a two-man requirement. A 4x4 block on which to slide the power supply helps prevent crushing of toes. Gross weight of the power supply is 149 pounds.

POWER-WINDOW GLASS REPLACEMENT

1. Remove the allen screws (2) securing the block assemblies (see Figure 4-29).

2. Lower the window until the stops on the cable ends are clear.

3. Place a 1/2 inch wrench on the motor shaft coupling and lift the window glass until it rests on the muffler door. The wrench thus holds tension off the cable, allowing the stops to hang free.

4. Remove the stops, tilt the window out at the bottom then slide the glass down and out.

5. Insert the new glass and follow the above steps in reverse sequence.

PRESSURE PUMP REPLACEMENT

1. Remove the right, pneumatic-supply side cover (as viewed from the front of the machine).

2. Disconnect the pneumatic line can filter (see Figure 4-30).

3. Mark the pressure pump position on its mounting plate.

4. Remove the nuts (4) holding the pressure pump in place.

5. Slide the pressure pump toward the pneumatics motor and then remove the belt from the pressure-pump pulley.

6. Withdraw the pressure pump through the opening in the side of the tape unit.

7. Remove the pressure pump pulley (2 set screws) from the pump shaft and place it on the new pressure pump.

8. Reverse the first seven steps of this procedure to replace the pressure pump.

READ/WRITE HEAD REPLACEMENT

Read/write head replacement is performed with the tape unit powered down.

CAUTION

Connecting or disconnecting the read/write cables with power ON may result in damage to the internal coils of the head or damage of the tape.

Place a cover similar to a bandaid over the read/write head surface to protect it.

1. Remove the allen screws (3) -- two on the right and one on the left -- securing the read/write head decorative cover.

2. Remove the high speed foot assembly.

3. Remove the cable ground strap from the Read Head Amplifier card (see Figure 3-21).

4. Unplug the read cables from the Read Head Amplifier card.

5. Unplug the resistor pack from the Write Driver (TL) card. Because the resistor packs are matched to the read/write heads, a new resistor pack will be supplied with the replacement read/write head. Return the old resistor pack to the factory with the defective read/write head.

6. Carefully pull the read/write head forward and off, rocking it slightly to loosen binding locator pins. Keep a cover on the read/write head when it is out of the tape unit.

7. Installation of the new read/write head and resistor pack is accomplished by reversing the removal sequence (steps 1-7).

8. After the new head is installed, adjust mechanical skew and check tracking following the procedures in the Mechanical Skew Adjustment and Capstan Alignment section of this chapter.

REEL-MOTOR COOLING ASSEMBLY REPLACEMENT

The reel-motor cooling assembly uses two squirrel-cage fans to draw cool air through the reel motor. The assembly rests between the two reel motors and is replaced as follows:

1. Disconnect the cooling motor input power cable.
2. Disconnect the reel motor wires at the terminal blocks located on the rear of the two reel motors (see Figure 4-34).
3. Detach the covers from the rear of the reel motors. This allows the removal of the covers and the cooling assembly as a unit. (It is necessary to pull the reel motor wires through the grommets on the rear of the reel-motor covers.)
4. Remove the screws (3 each) that hold the blower collars to the reel-motor covers and detach the reel-motor covers from the old cooling assembly.
5. Remount the reel-motor covers on the new cooling assembly. Fasten the cooling assembly in place with the screws (3 each) that hold the blower collars to the reel-motor covers.
6. Place the reel-motor covers and the cooling assembly back in the tape unit, being sure to draw the reel motor wires through the grommets on the covers.
7. Attach the reel-motor covers in place and then reconnect the reel motor wires to the terminal boards.
8. Reconnect the input power cable to the cooling motor.

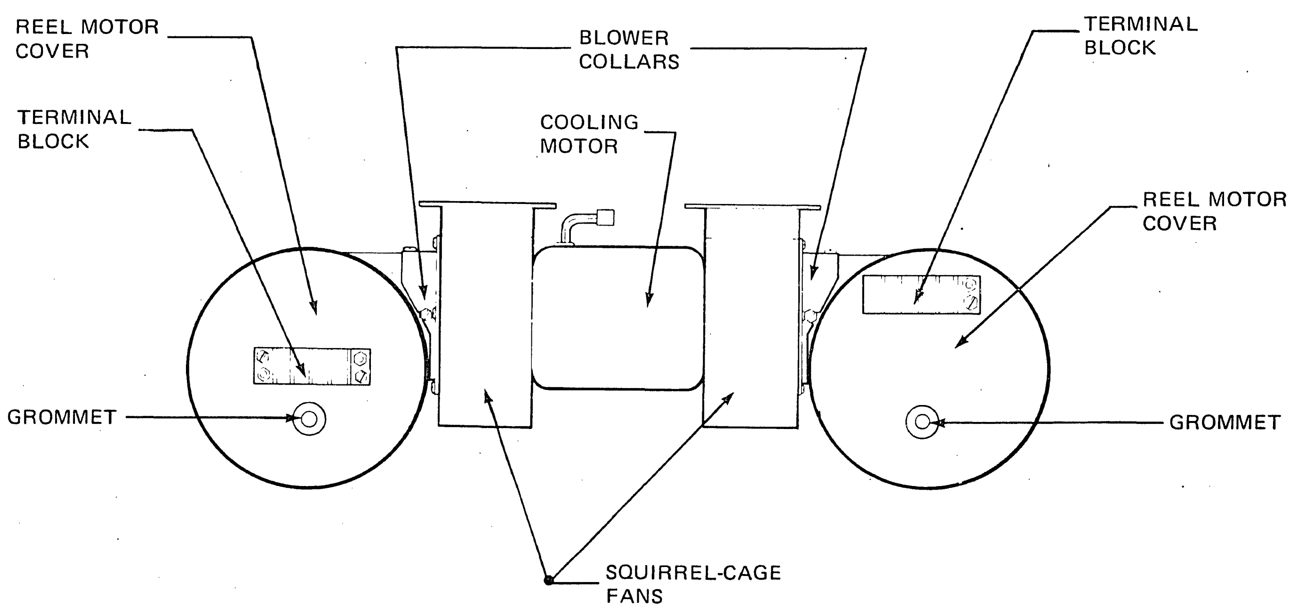


Figure 4-34. Reel Motor Cooling Assembly

TAPE CLEANER BLOCK REPLACEMENT

The tape cleaner block is located adjacent to the right threading channel just above the BOT/EOT sensors. To remove the cleaner block:

1. Remove the single allen-head screw holding the block in place.
2. Pull the cleaner block forward with slight side motion to disengage the locating pins and remove.
3. Check the vacuum port for obstructions.
4. Push the new cleaner block into place and secure it with the allen-head screw.
5. Check to be sure cleaner block vacuum holds the tape against the block during both forward and backward operation.

TRIAC BOARD REPLACEMENT

1. Disconnect the ac power connector from the tape unit.
2. Remove the wheel chocks under the tape unit and move it forward or backward so access to the right side cover panel can be gained.
3. Remove the right side cover panel from the tape unit.
4. Remove the four (4) screws labeled 1 in Figure 3-26 from the triac board plate at the bottom of the tape unit.
5. Carefully fold down the triac board mounting plate while feeding the small grey cable in from the front to allow for the movement.
6. Label and disconnect the cable and terminal connections from the triac board.
7. Carefully remove the four (4) screws labeled 2 in Figure 3-26 and remove the triac board.
8. Replace the old triac board with a new one and reverse this procedure for installation.

VACUUM-COLUMN-BAR LAMP ASSEMBLY REPLACEMENT

1. Disconnect the assembly input line on the back-side of the vacuum column back-plate.
2. Remove the allen-head cap screws holding the assembly to the vacuum-column back-plate (the lower column bars are held by hex-head machine screws) and withdraw the column-bar lamp assembly from the tape unit.
3. Remove the binding-head screws that hold the lamp circuit board to the column bar and detach the old circuit board (retain the spacers).
4. Attach the new lamp circuit board to the column bar (be sure to insert the spacers). The lamps on the circuit board should face the holes in the column bar.
5. Attach the column-bar lamp assembly to the vacuum-column back-plate with the allen-head cap screws.
6. Vertically align the column-bar lamp assembly and tighten in place.
7. Connect the vacuum-column-bar lamp assembly input line.

VACUUM PUMP REPLACEMENT

1. Loosen the vacuum pump mounting screws (4), slide it toward the pneumatics motor and remove the two belts (see Figure 4-33).

2. Loosen the set screws (2) on the vacuum pump double pulley and remove the pulley.

3. Disconnect the flexible pneumatic hose on the input side of the vacuum pump.

4. Remove the mounting screws (4) and lift the vacuum pump out of the tape unit.

To install the vacuum pump, reverse this sequence. Be sure to check belt alignment and tension.

VACUUM TRANSFER VALVE REPLACEMENT

Viewing the tape unit from the rear, the vacuum transfer valve is located to the left of the vacuum pump (see Figures 4-30 and 4-33). To replace the vacuum transfer valve:

1. Power down the tape unit.

2. Disconnect the signal and power cables.

3. Remove the tape unit back and side covers.

4. Remove the sheet metal screws (2) that attach the fuse bracket to the top firewall.

5. Remove the machine screws (9) that attach the top firewall to the tape unit frame and move the fuse bracket to one side.

CAUTION

Extreme stress on the cable may break the fuse holders.

6. Disconnect the vacuum hoses where they pass through the firewall.

7. Carefully remove the top firewall from the tape unit.

8. Remove the three flexible hoses on the transfer valve assembly and disconnect the rigid hose running between the transfer valve and the bulkhead.

9. Remove the plastic, safety shield on the solenoid and disconnect the two wires.

10. Remove the hex-head screws (7) that secure the transfer valve mounting plate to the vertical support.

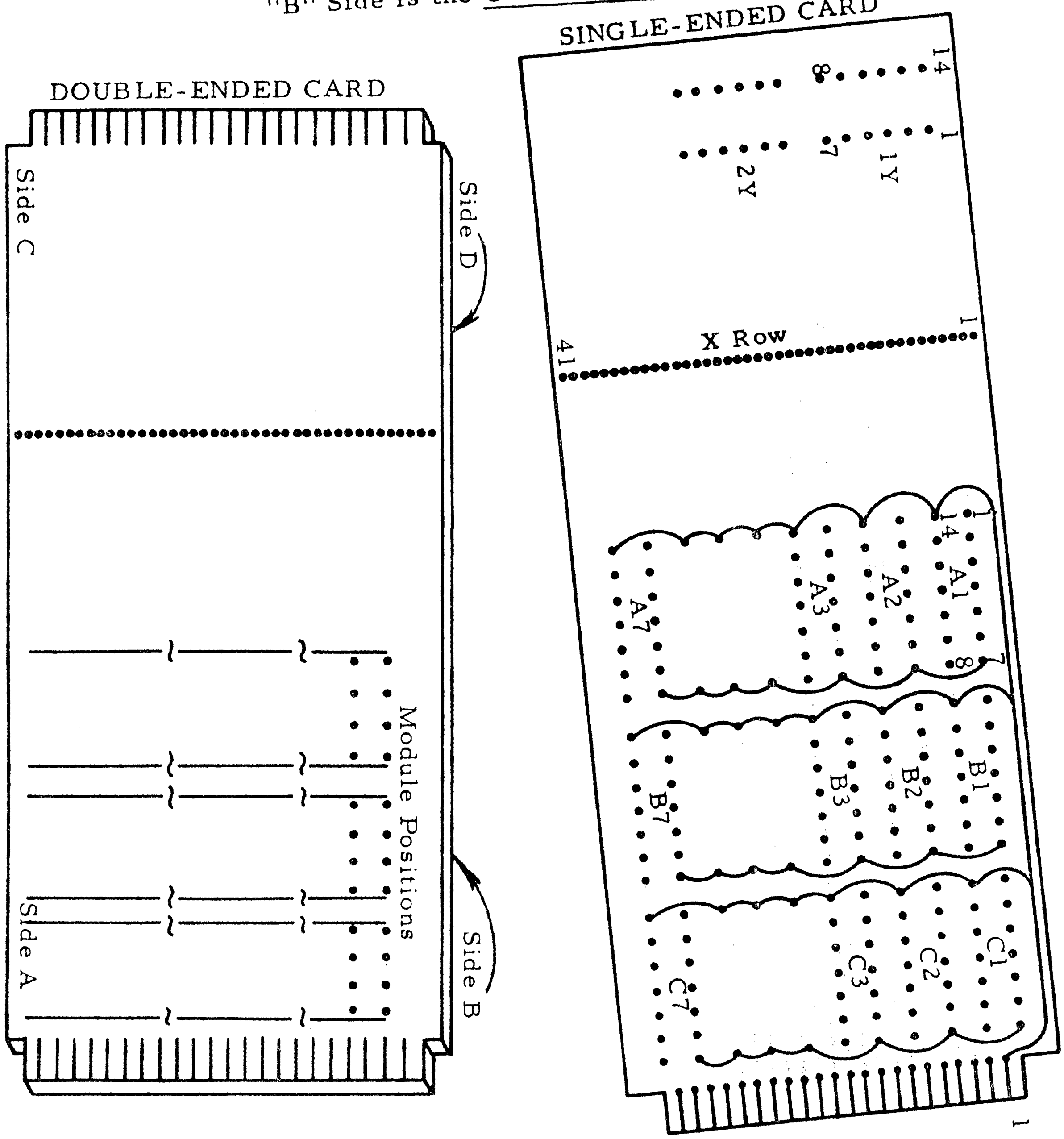
11. Remove the old vacuum transfer valve.

12. To install the new transfer valve assembly, follow the above steps in reverse sequence.

6.0.0.0 REFERENCES

6.1.0.0 STC Logic Card Configuration

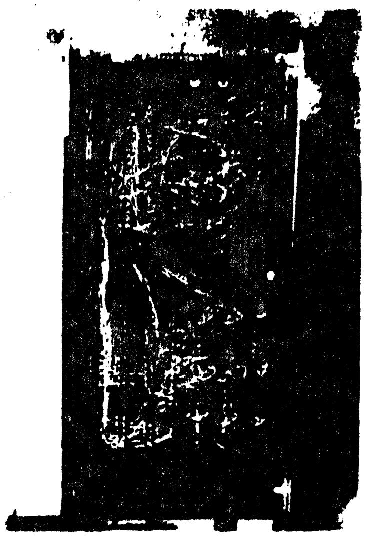
NOTE: "A" Side is the PIN side
"B" Side is the COMPONENT side



Pin 14 of all modules is +5v

Pin 7 of all modules is ground

6.2.0.0 Tape Unit Logic Gates



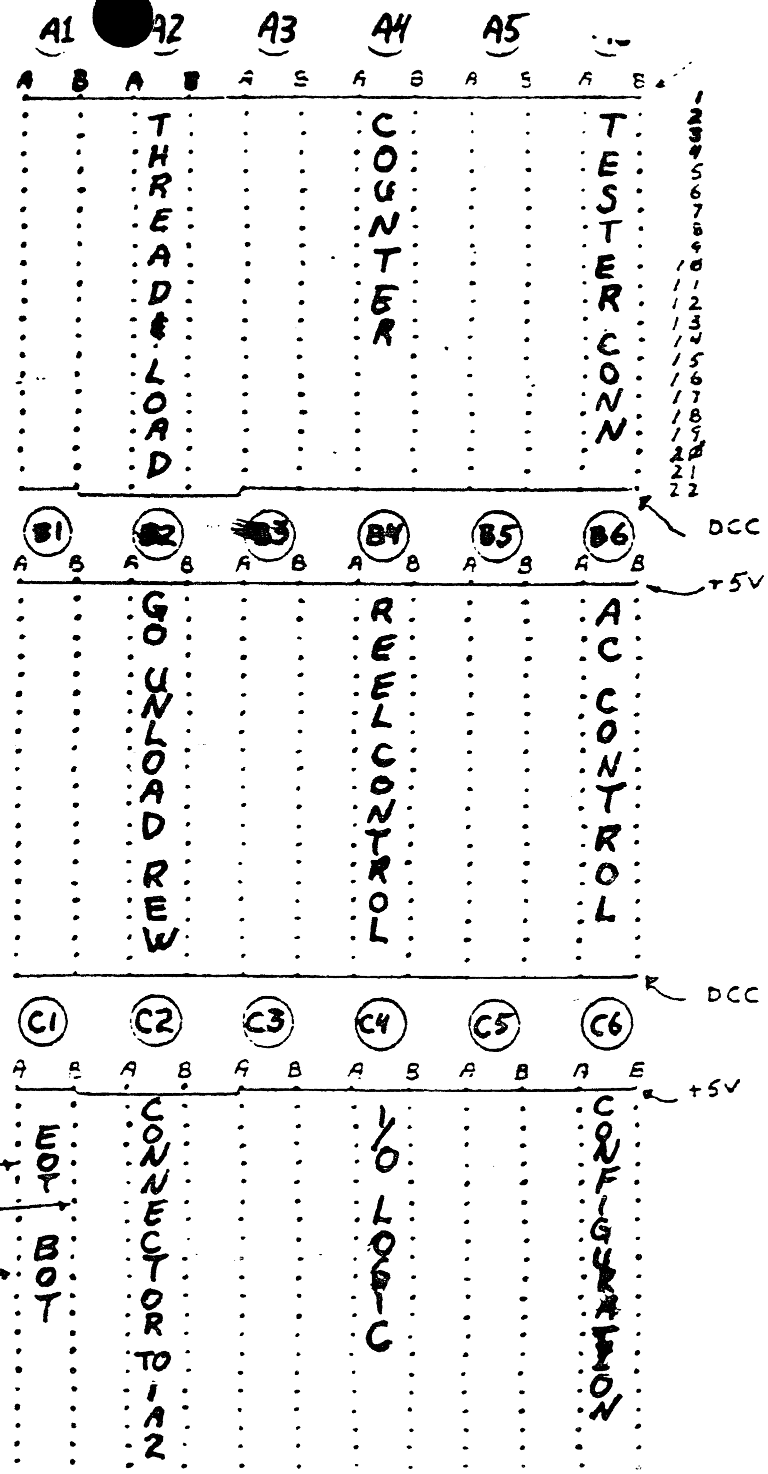
Read/Write Gate (1)

Logic Gate (2)

Refer to logic page TU 930 for voltage distribution information.

1411

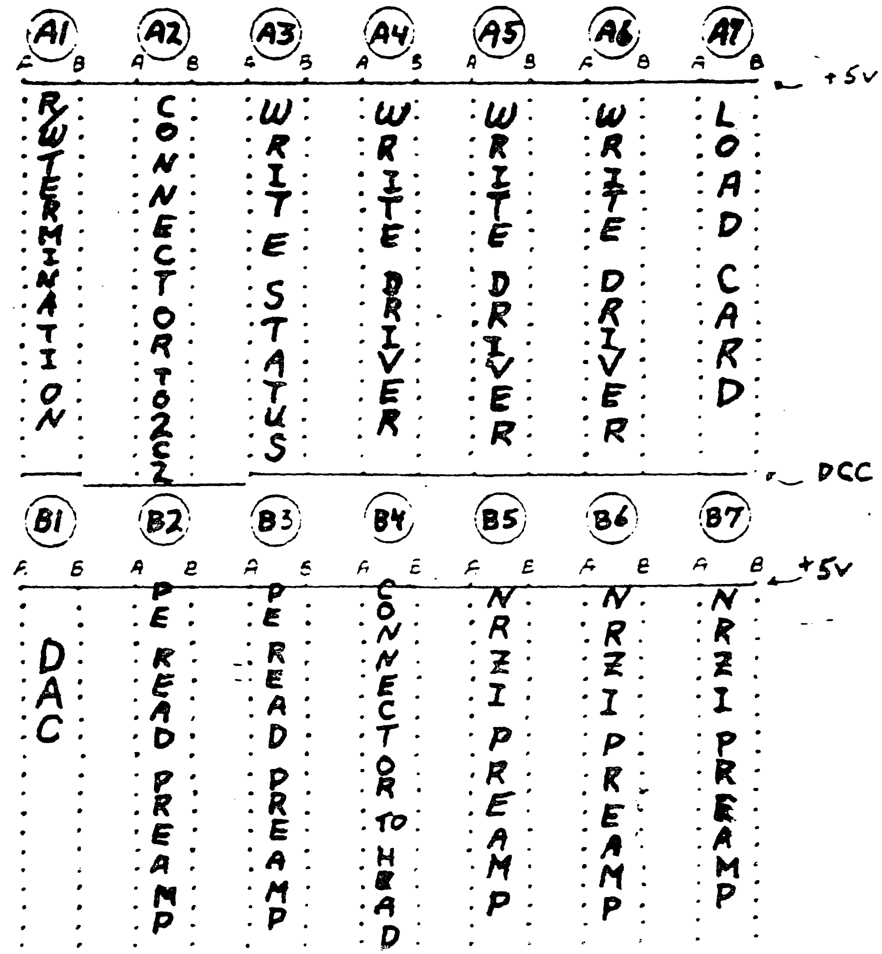
GATE "2"

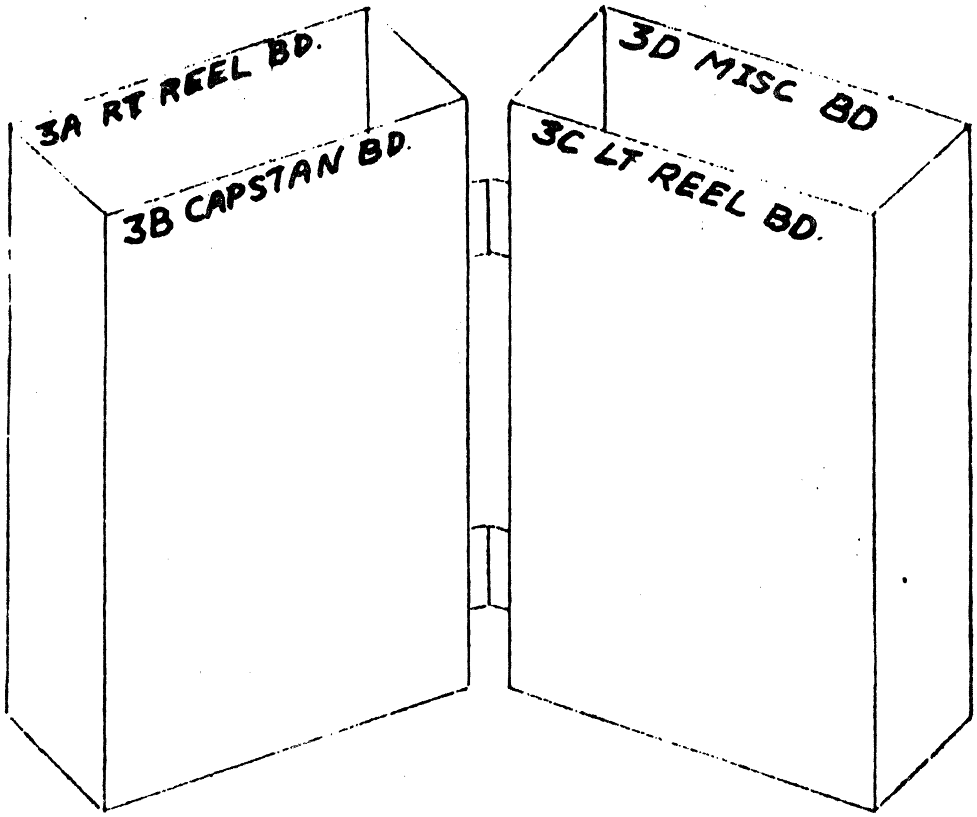


PIN LOCATION

2	A2	B	09
GATE	CARD	ROW	PIN

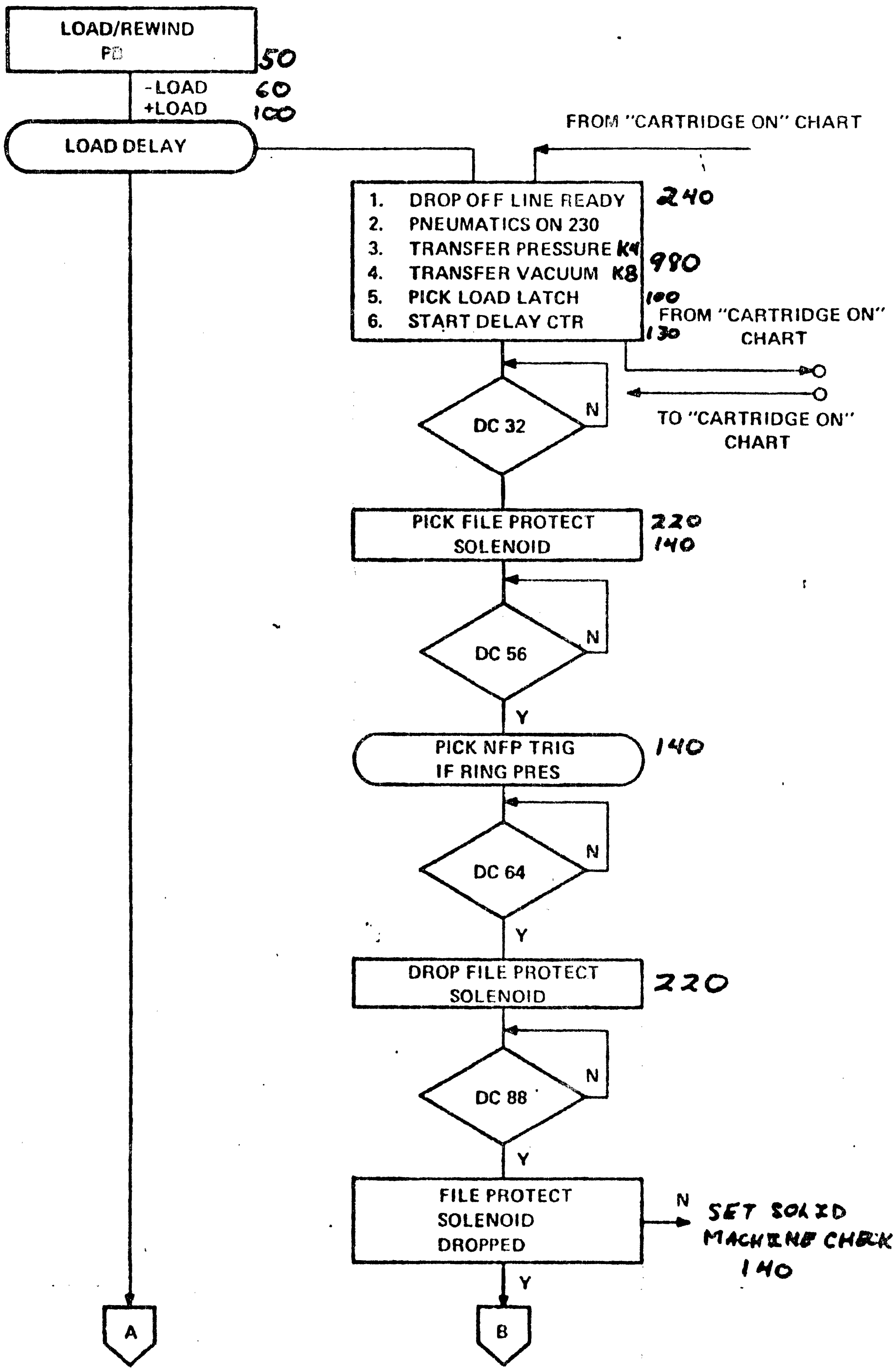
GATE "1"



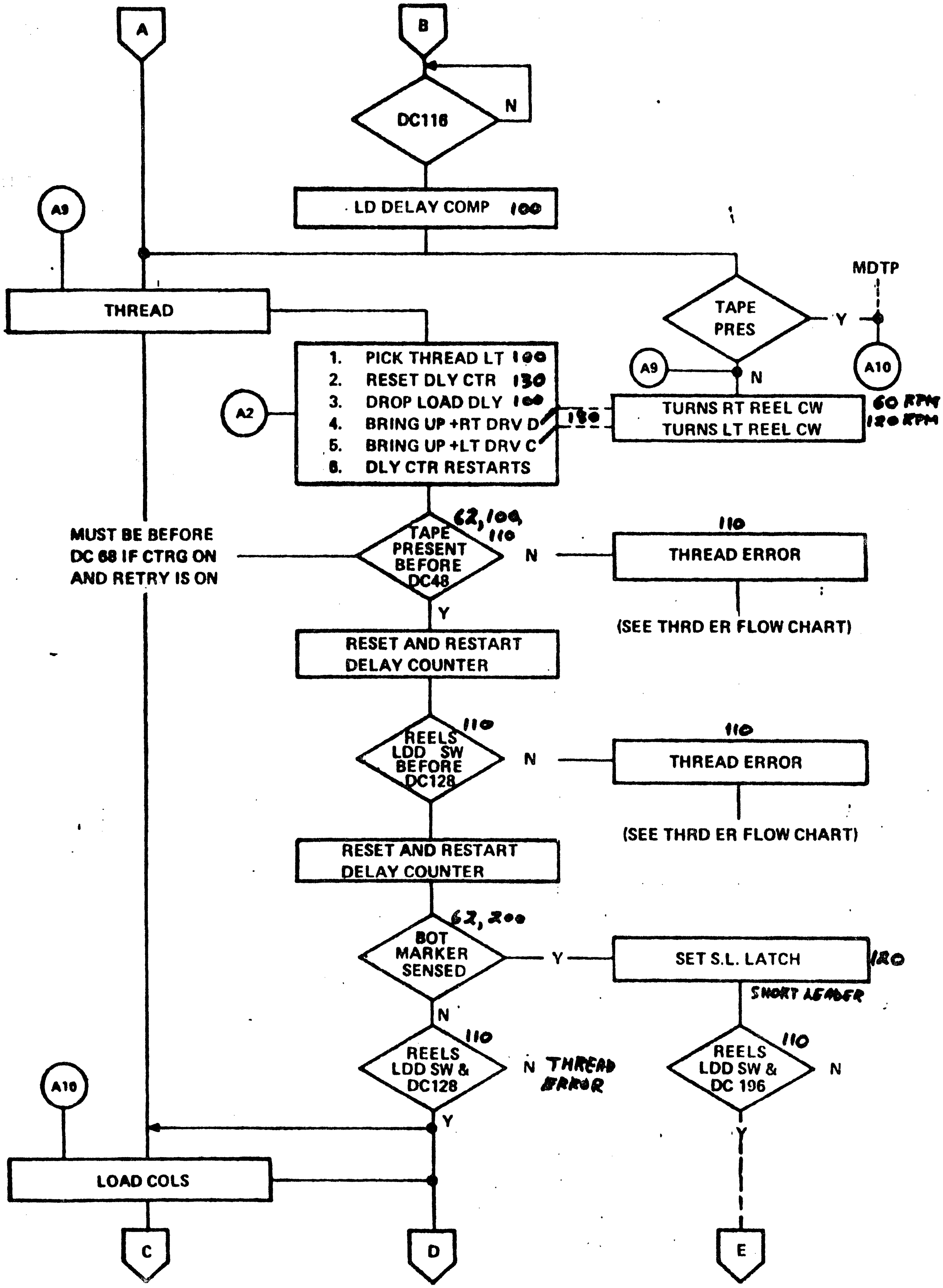


GATE 3

LOAD/REWIND SEQUENCE FLOW CHART



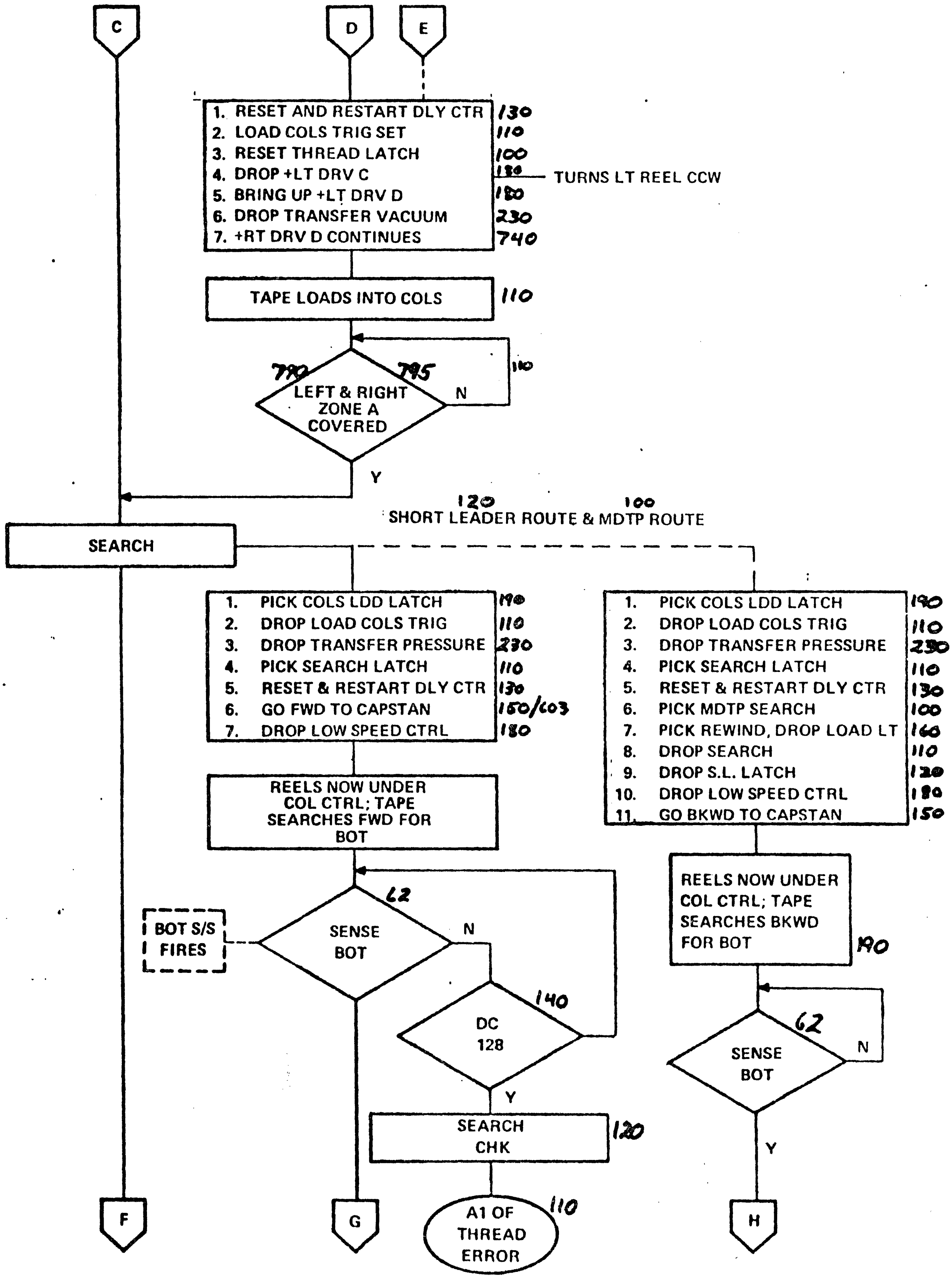
LOAD/REWIND SEQUENCE FLOW CHART

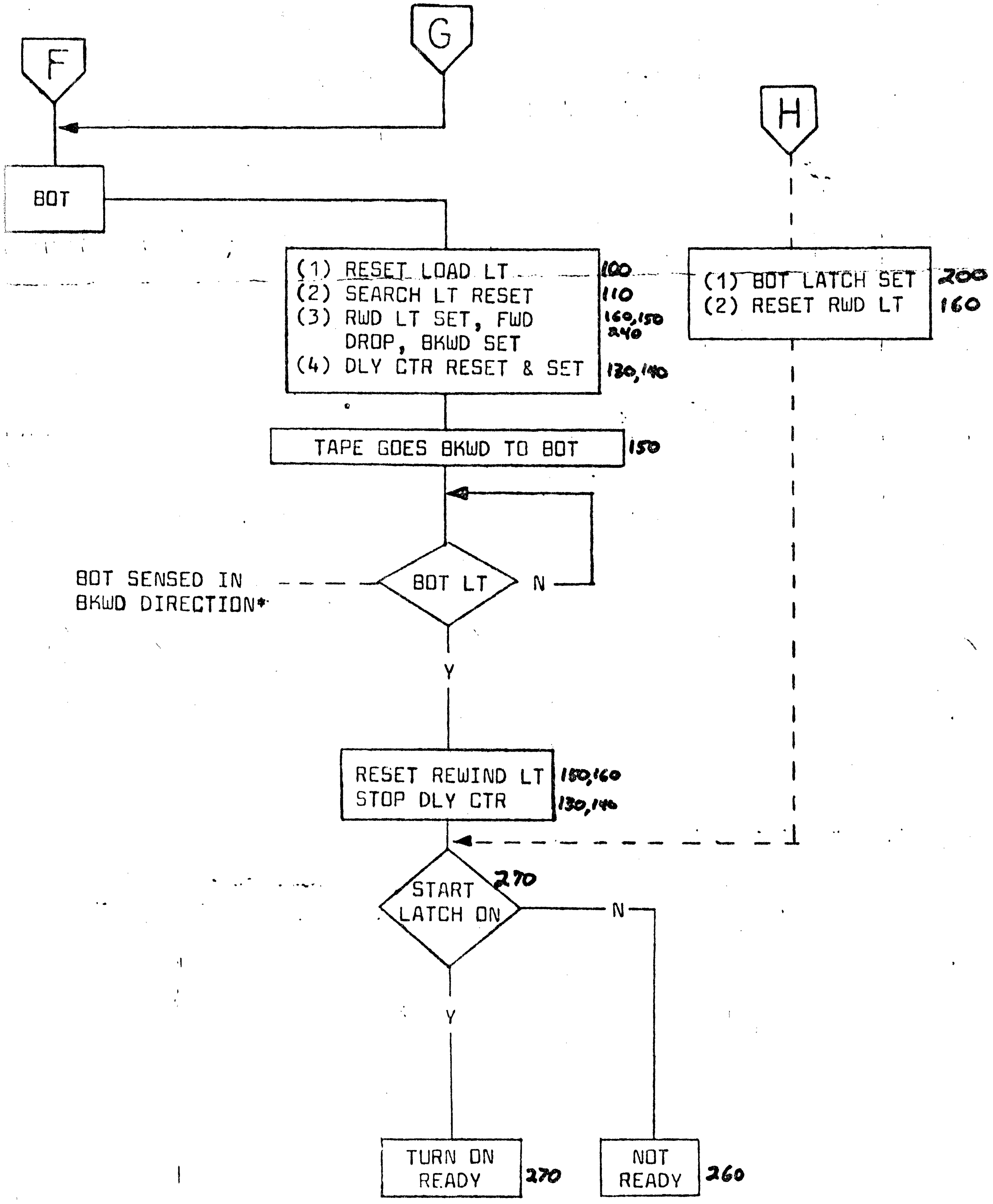


7-2

2 of 4

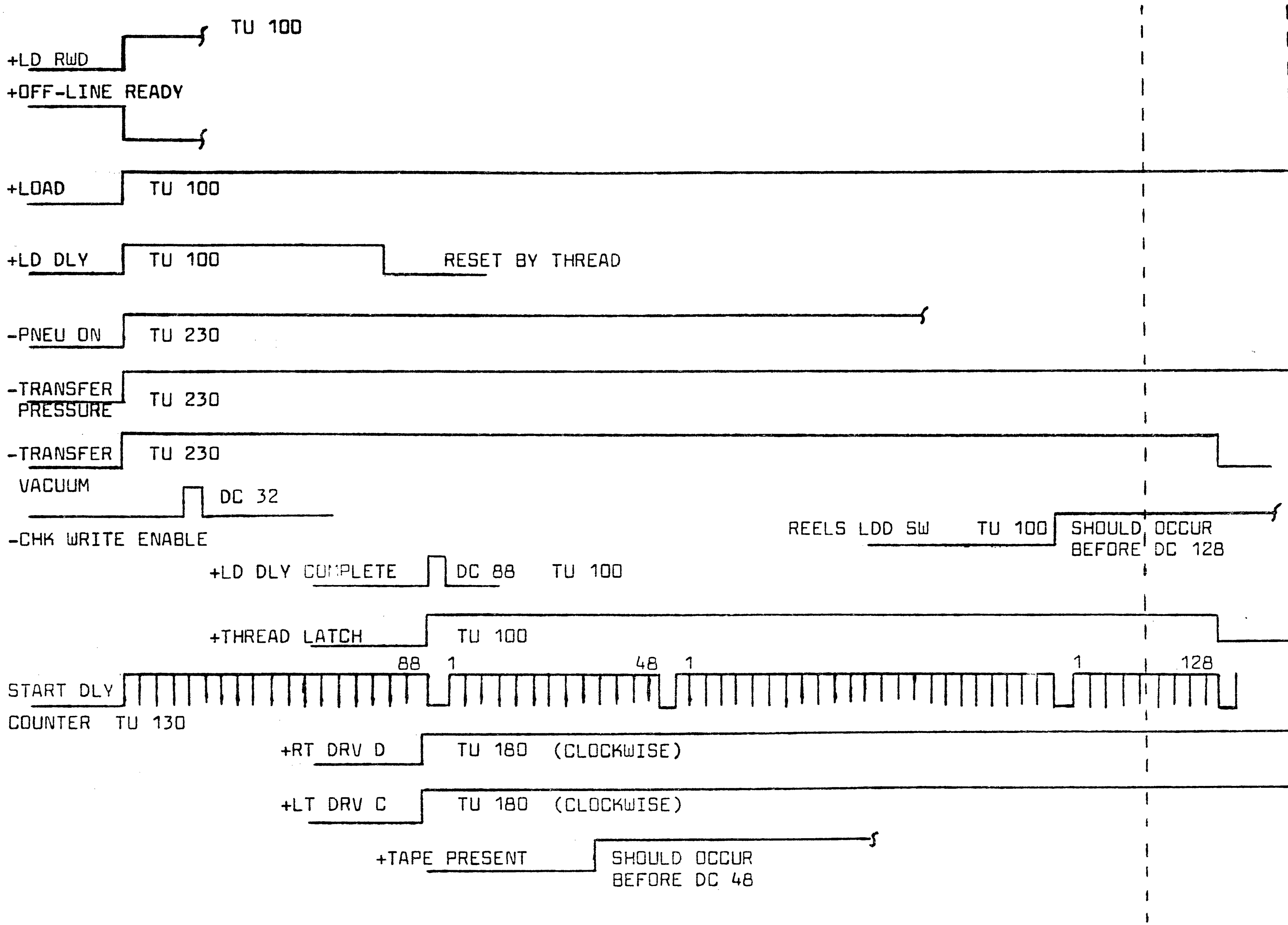
LOAD/REWIND SEQUENCE FLOW CHART

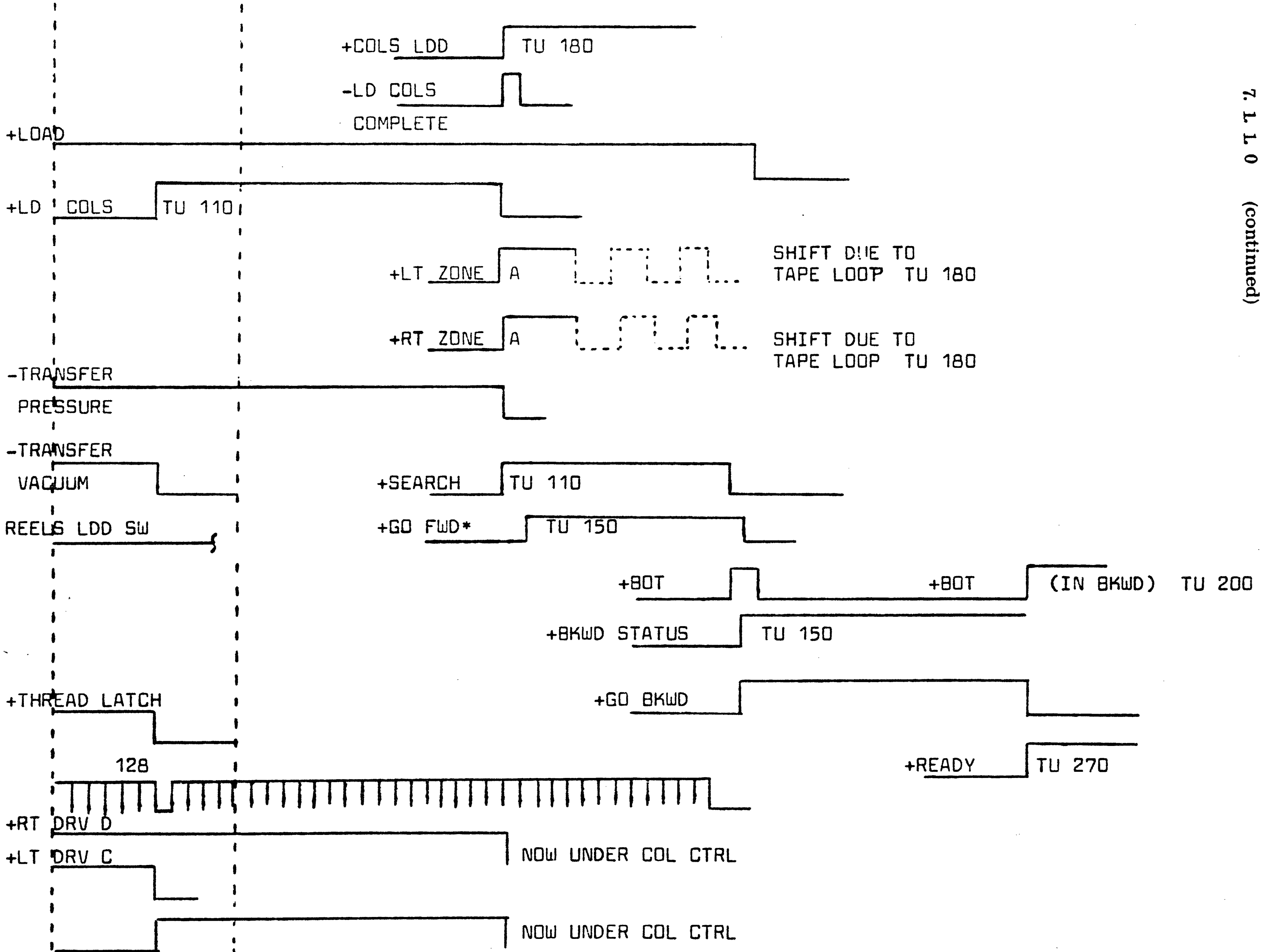




* TU-70 WILL SENSE THE TRAILING EDGE OF THE BOT STICKER AND LOCATE WITH ALL OF THE STICKER TO THE RIGHT OF THE BOT BLOCK.

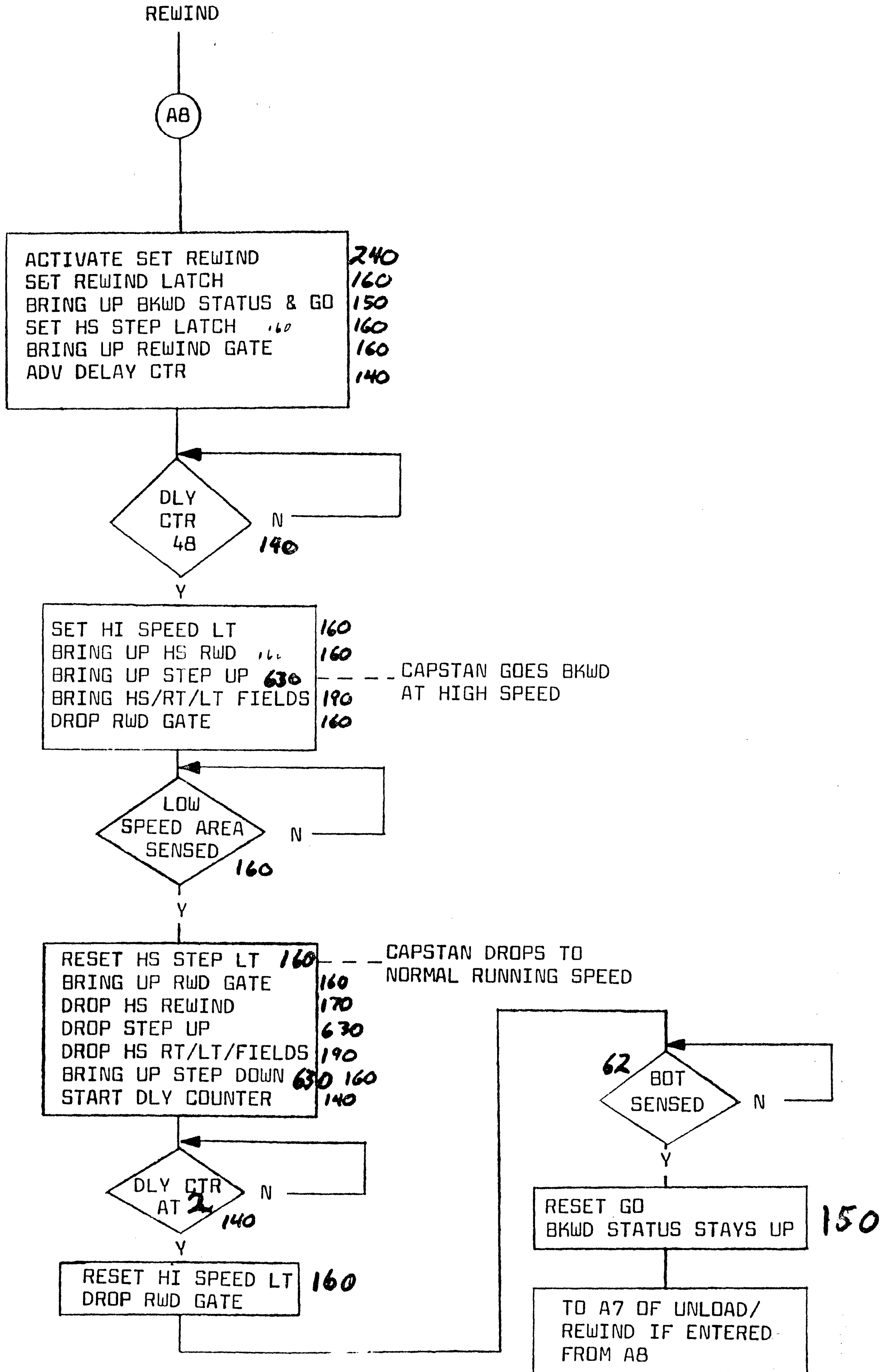
7.1.1.0 Thread and Load Timing Chart

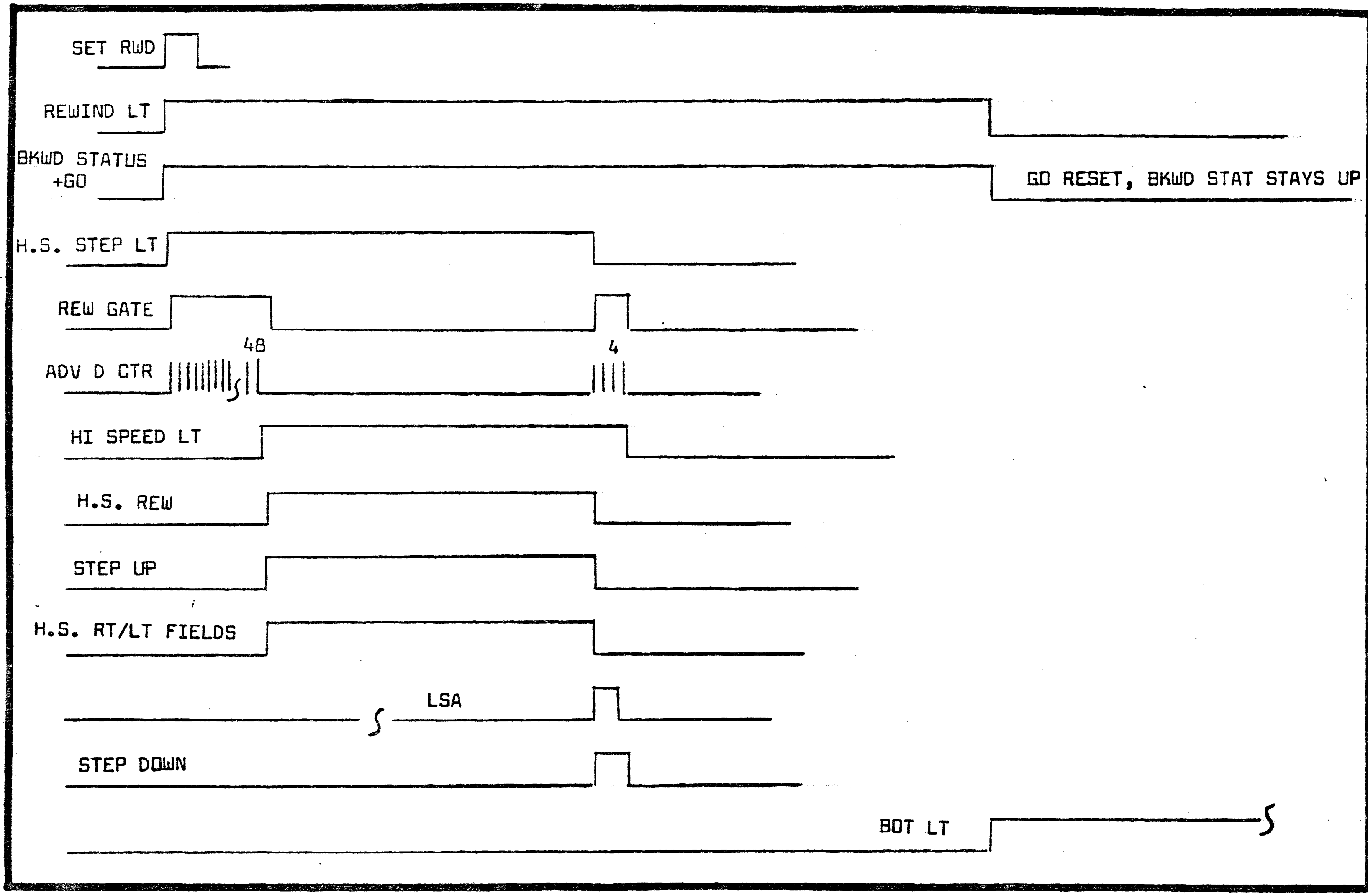




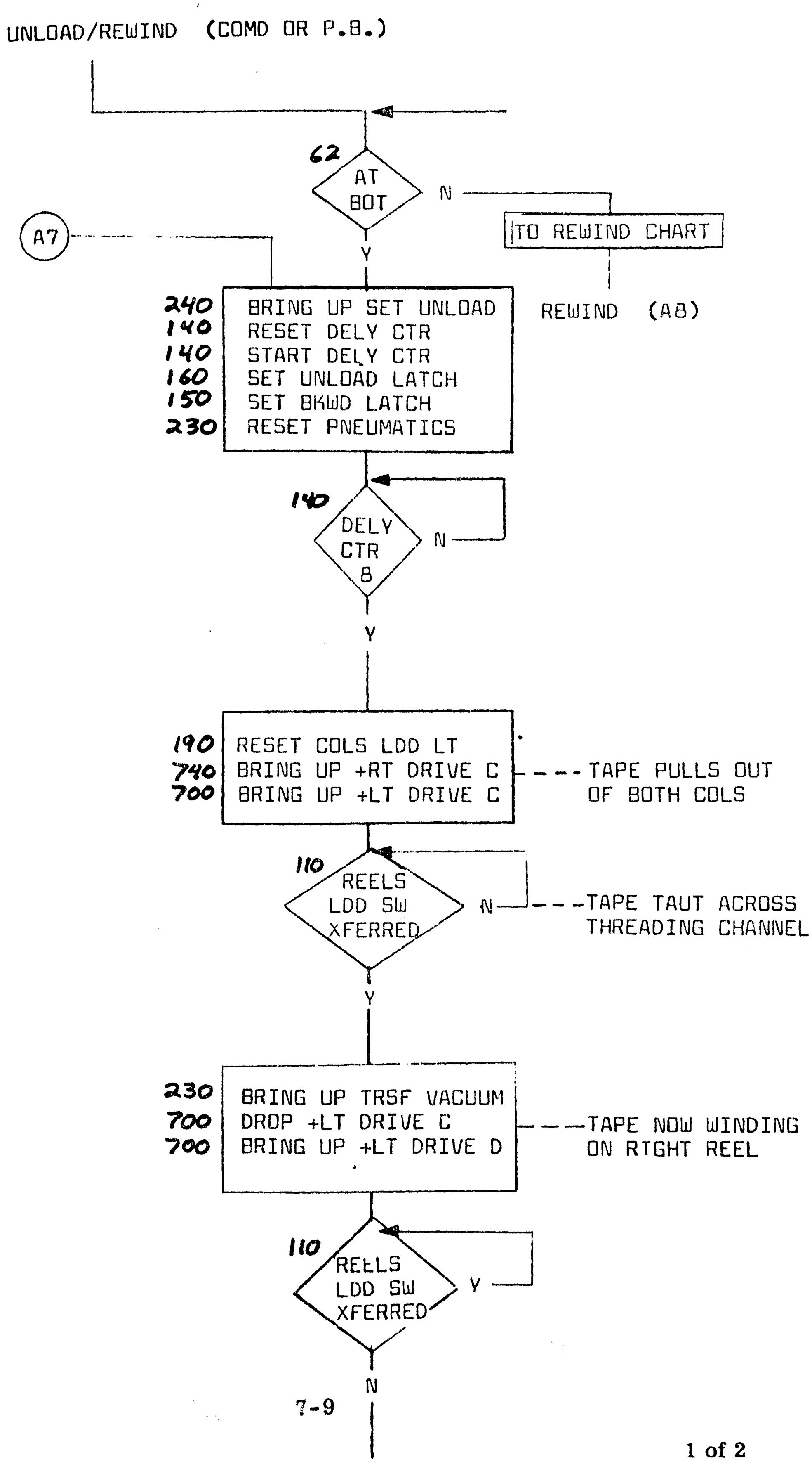
* GO FWD delayed by count of 16.

7.2.0.0 Rewind Flow Chart

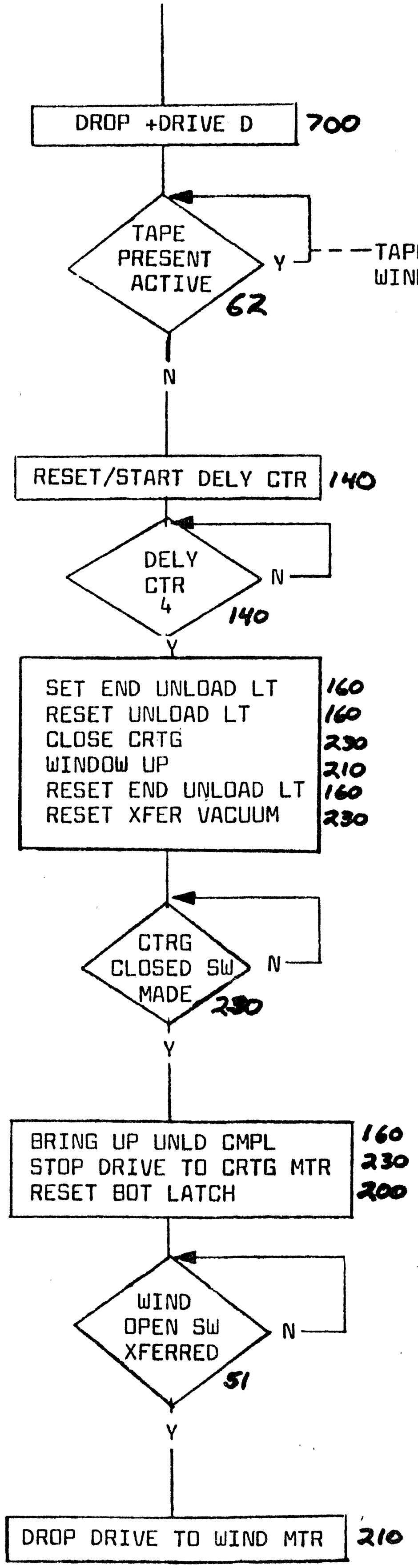


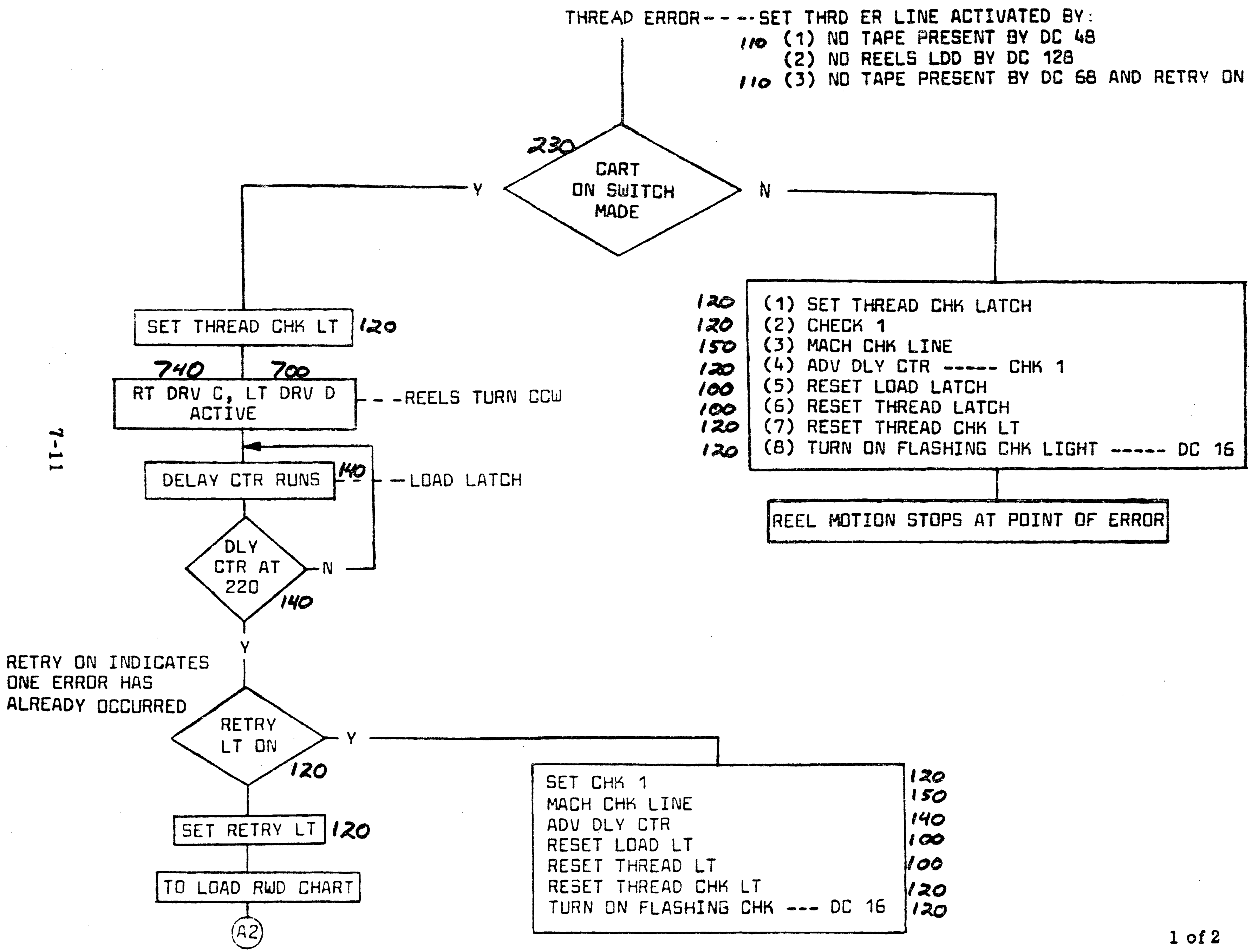

SET RWD
REWIND LT
BKWD STATUS
+GO
GO RESET, BKWD STAT STAYS UP
H.S. STEP LT
REW GATE
48
4
ADV D CTR
HI SPEED LT
H.S. REW
STEP UP
H.S. RT/LT FIELDS
LSA
STEP DOWN
BOT LT

LOAD/REWIND


UNLOAD/REWIND (COMD OR P.B.)
62
AT BOT
N
TO REWIND CHART
REWIND (A8)
Y
A7
240 BRING UP SET UNLOAD
140 RESET DELY CTR
140 START DELY CTR
160 SET UNLOAD LATCH
150 SET BKWD LATCH
230 RESET PNEUMATICS
140
DELY CTR 8
N
Y
190 RESET COLS LDD LT
740 BRING UP +RT DRIVE C
700 BRING UP +LT DRIVE C
TAPE PULLS OUT OF BOTH COLS
110
REELS LDD SW XFERRED
N
TAPE TAUT ACROSS THREADING CHANNEL
Y
230 BRING UP TRSF VACUUM
700 DROP +LT DRIVE C
700 BRING UP +LT DRIVE D
TAPE NOW WINDING ON RIGHT REEL
110
REELS LDD SW XFERRED
Y
N

7.3.0.0 [continued]




THREAD ERROR - - - -SET THRD ER LINE ACTIVATED BY:
110 (1) NO TAPE PRESENT BY DC 48
(2) NO REELS LDD BY DC 128
110 (3) NO TAPE PRESENT BY DC 68 AND RETRY ON
230
CART ON SWITCH MADE
Y
N
SET THREAD CHK LT 120
740 700
RT DRV C, LT DRV D ACTIVE
- - -REELS TURN CCW
DELAY CTR RUNS 140
- - -LOAD LATCH
DLY CTR AT 220
140
N
Y
RETRY ON INDICATES ONE ERROR HAS ALREADY OCCURRED
RETRY LT ON
120
Y
SET RETRY LT 120
TO LOAD RWD CHART
A2
120 (1) SET THREAD CHK LATCH
120 (2) CHECK 1
150 (3) MACH CHK LINE
120 (4) ADV DLY CTR ----- CHK 1
100 (5) RESET LOAD LATCH
100 (6) RESET THREAD LATCH
120 (7) RESET THREAD CHK LT
120 (8) TURN ON FLASHING CHK LIGHT ----- DC 16
REEL MOTION STOPS AT POINT OF ERROR
SET CHK 1 120
MACH CHK LINE 150
ADV DLY CTR 140
RESET LOAD LT 100
RESET THREAD LT 100
RESET THREAD CHK LT 120
TURN ON FLASHING CHK --- DC 16 120

FROM SEARCH CHK - FROM LOAD/REWIND CHART

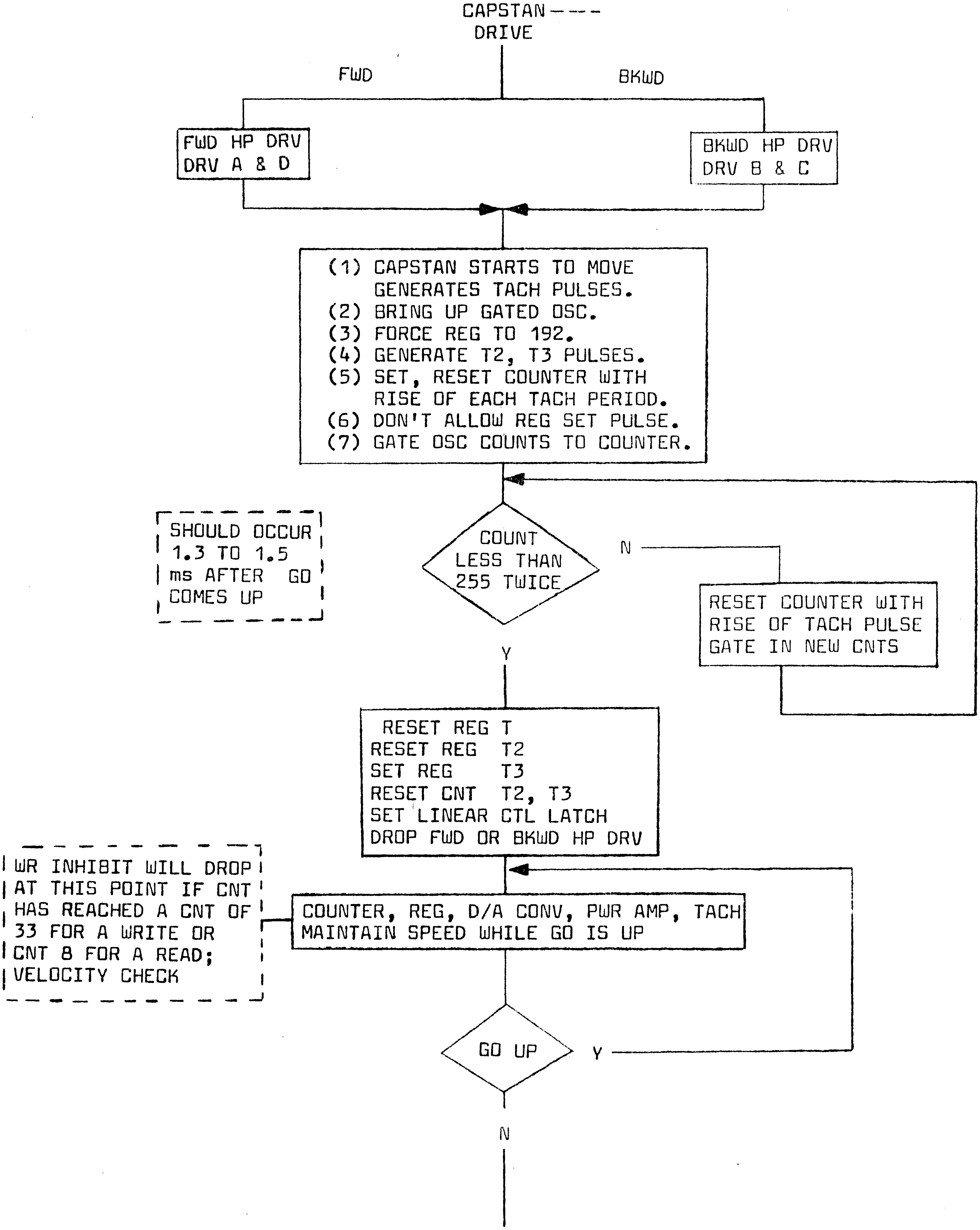
A1

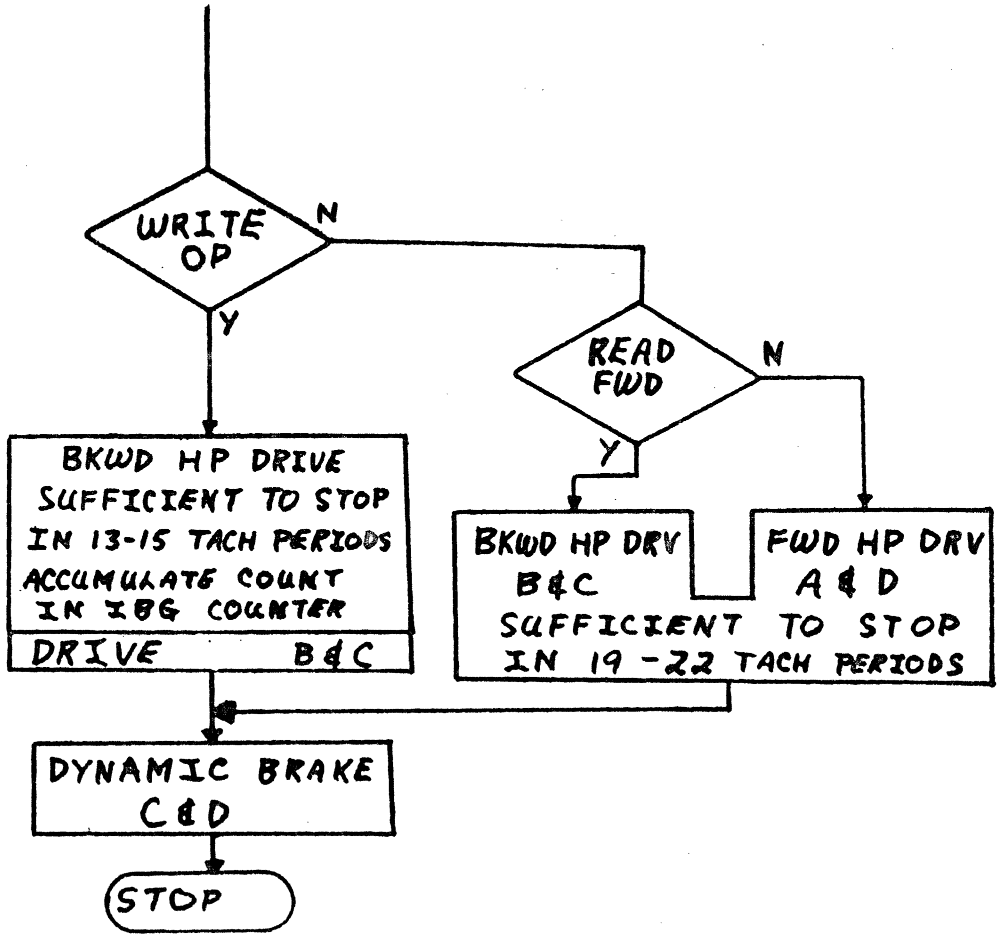
SET CHK 2 120

BOT LATCH 1 200
START DLY CTR 140
RESET LOAD LT 100
TURN ON FLASHING CHK LT 120

REEL MOTION STOPS AT POINT OF ERROR

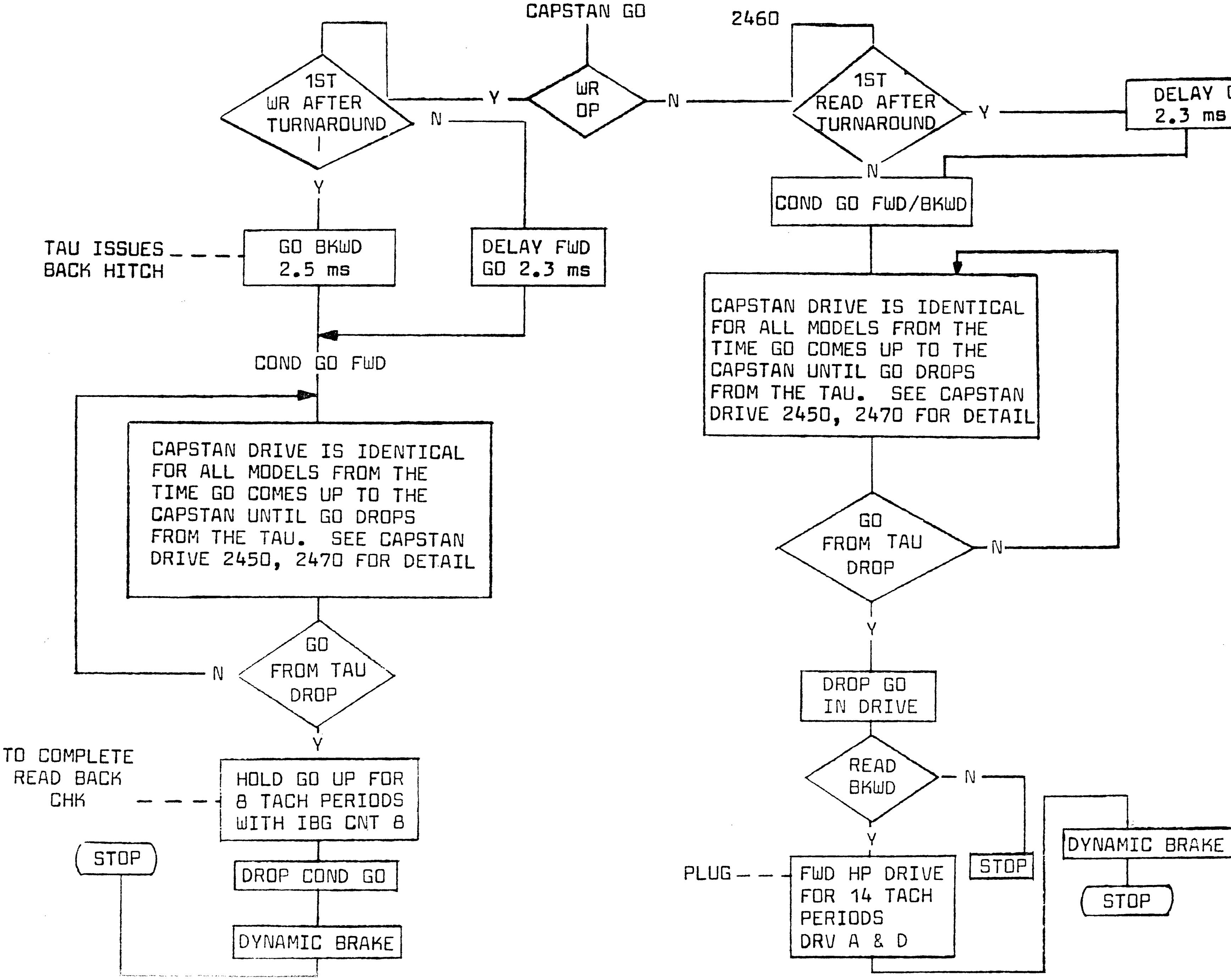
7.5.0.0 **Capstan Operation -**





WRITE OP
N
Y
READ FWD
N
Y
BKWD HP DRIVE SUFFICIENT TO STOP IN 13-15 TACH PERIODS ACCUMULATE COUNT IN IBG COUNTER
DRIVE B & C
BKWD HP DRV B & C
FWD HP DRV A & D
SUFFICIENT TO STOP IN 19-22 TACH PERIODS
DYNAMIC BRAKE C & D
STOP

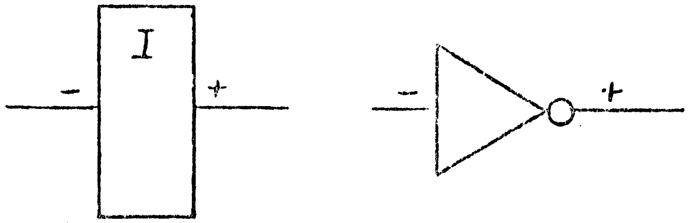
150



CAPSTAN GO
WR OP
Y
N
1ST WR AFTER TURNAROUND
N
Y
TAU ISSUES BACK HITCH
GO BKWD 2.5 ms
DELAY FWD GO 2.3 ms
COND GO FWD
CAPSTAN DRIVE IS IDENTICAL FOR ALL MODELS FROM THE TIME GO COMES UP TO THE CAPSTAN UNTIL GO DROPS FROM THE TAU. SEE CAPSTAN DRIVE 2450, 2470 FOR DETAIL
GO FROM TAU DROP
N
Y
TO COMPLETE READ BACK CHK
HOLD GO UP FOR 8 TACH PERIODS WITH IBG CNT 8
STOP
DROP COND GO
DYNAMIC BRAKE
2460
1ST READ AFTER TURNAROUND
Y
DELAY GO 2.3 ms
N
COND GO FWD/BKWD
CAPSTAN DRIVE IS IDENTICAL FOR ALL MODELS FROM THE TIME GO COMES UP TO THE CAPSTAN UNTIL GO DROPS FROM THE TAU. SEE CAPSTAN DRIVE 2450, 2470 FOR DETAIL
GO FROM TAU DROP
N
Y
DROP GO IN DRIVE
READ BKWD
N
Y
PLUG
FWD HP DRIVE FOR 14 TACH PERIODS DRV A & D
STOP
DYNAMIC BRAKE
STOP

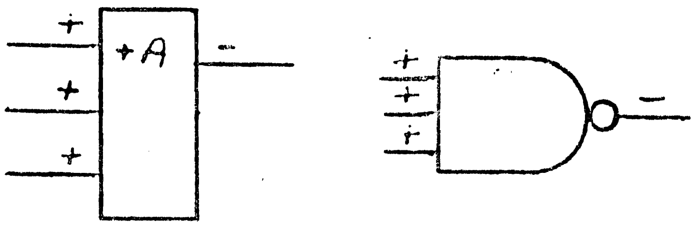
DTμL LOGIC USED WITH SIC TAPE DRIVES

INVERTER

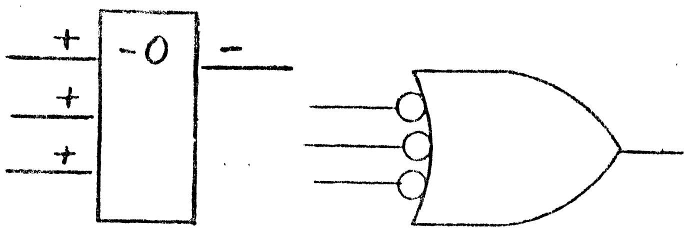


Any DTμL logic level can be tied to ground for troubleshooting

+AND



−Or



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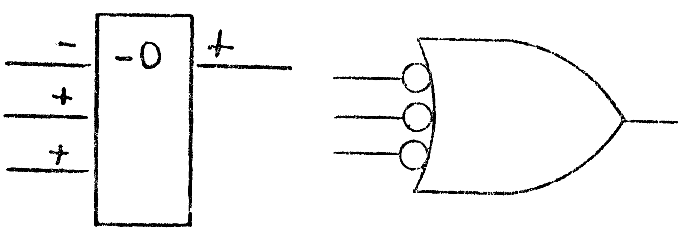
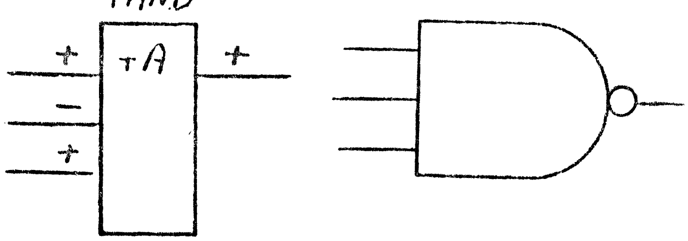
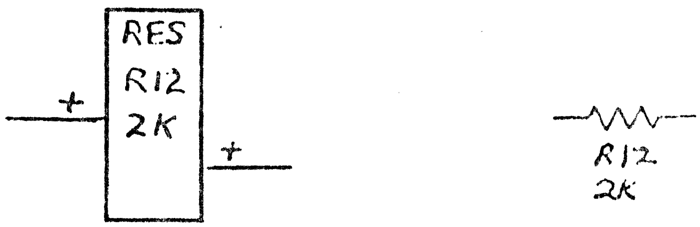


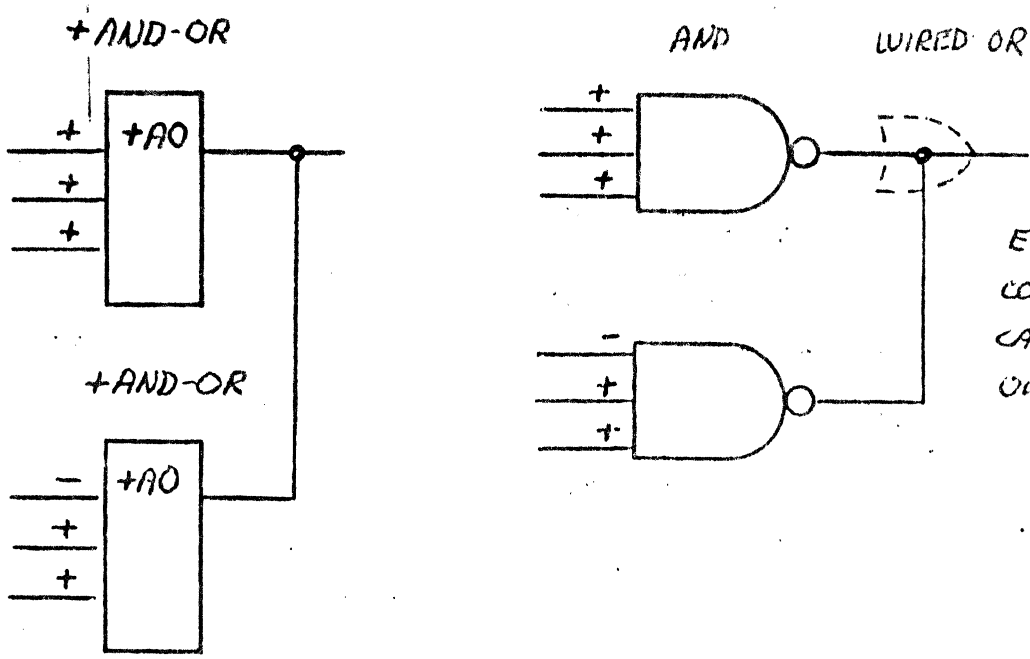
+AND



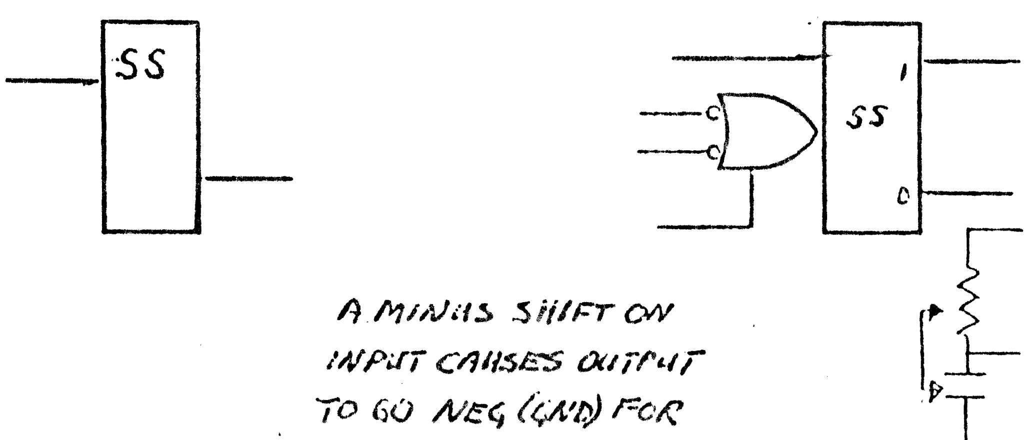
- DTµL Logic Used With STC TAPE DRIVES



NOTE: Line from lower half of Block means Non-Inversion of input.

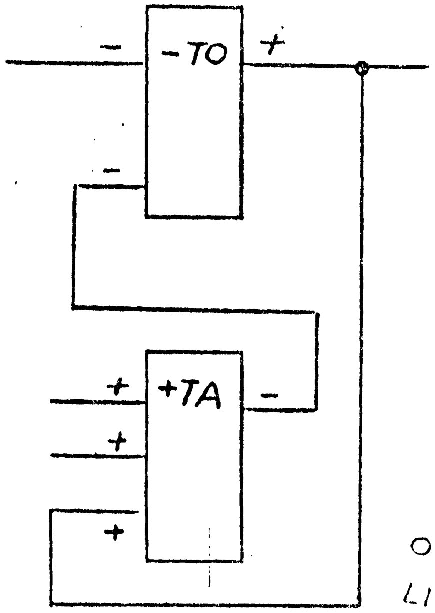


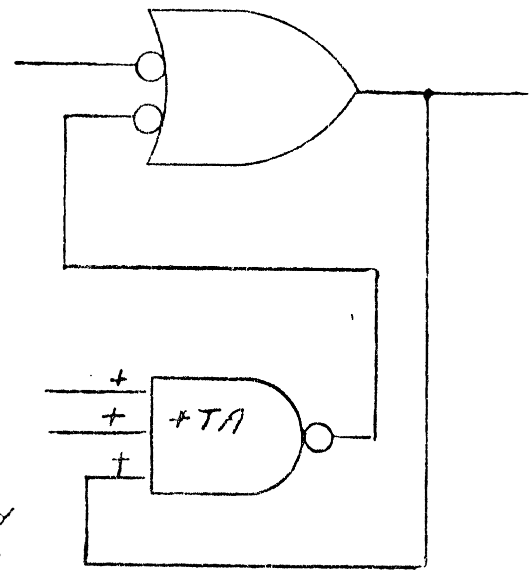
EITHER +AO CONDITIONED CAUSES SATISFIED OUTPUT



A MINUS SHIFT ON INPUT CAUSES OUTPUT TO GO NEG (GND) FOR DURATION OF SS TIMEOUT THEN RETURNS POSITIVE

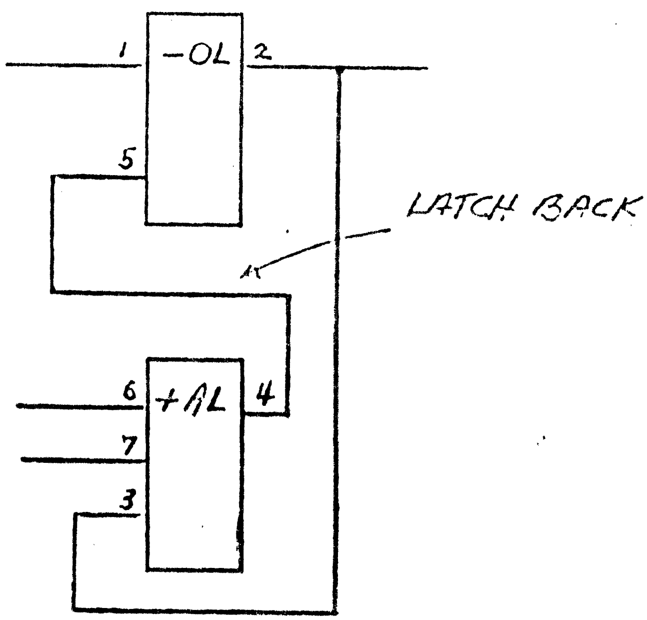
TRIGGER OR LATCH

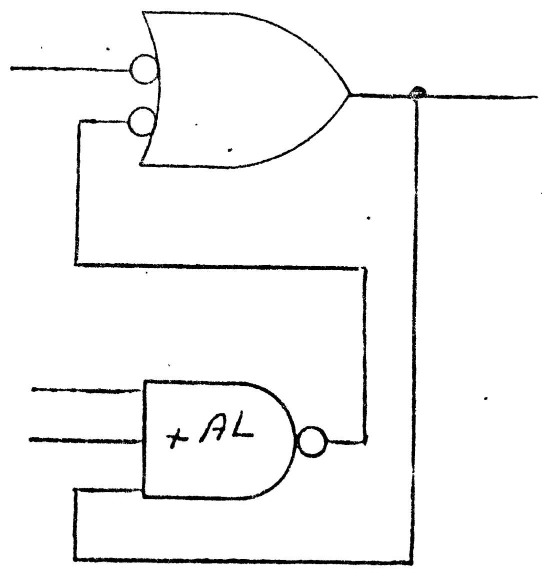




OPERATES EXACTLY LIKE A-OR LATCH AND IS USED IN THE SAME MANNER

OR LATCH

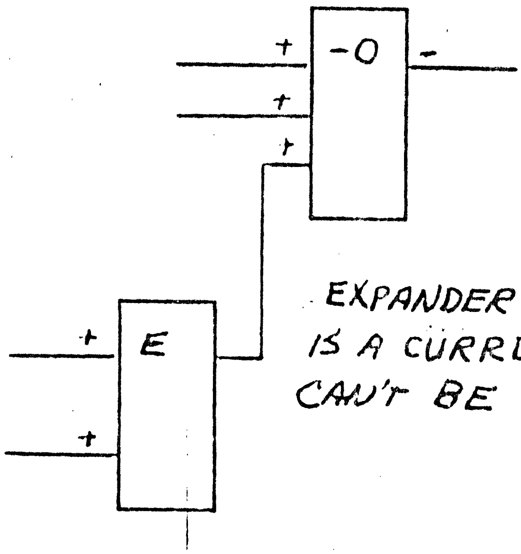




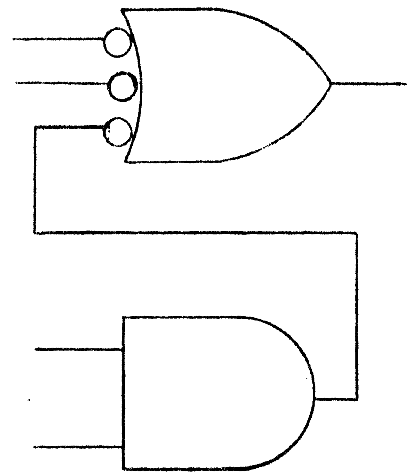
A NEGATIVE GOING SHIFT INTO PIN 1 WILL CAUSE PIN 2 & 3 TO GO POSITIVE. ASSUMING 6 & 7 ARE +, THE "LATCH BACK" AT PINS 4 & 5 GO MINUS. THIS HOLDS THE LATCH CONDITIONED (PIN 2 +, PIN 4 -) UNTIL PIN 6 or 7 GOES MINUS.

DRV — Driver

-OR WITH EXPANDER

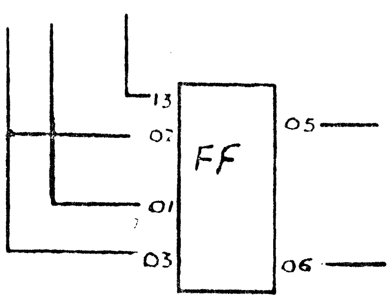


EXPANDER OUTPUT
IS A CURRENT LEVEL,
CAN'T BE SCOPE.

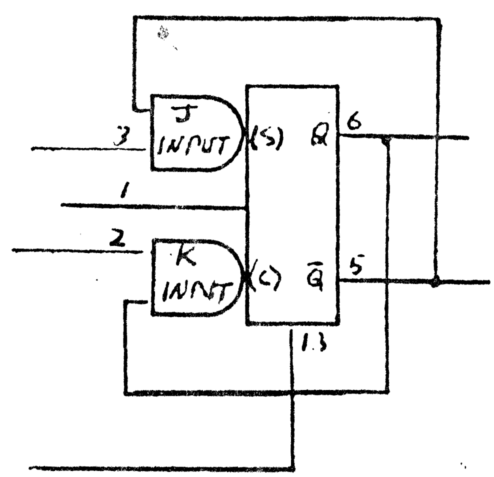


GNDING: A LOGIC LEVEL IS ALWAYS
ACCEPTABLE

FLOATING: A PIN USUALLY ACTS
AS A + INPUT



GND on pin 13
resets Latch



A + To – shift on pin 1 will
cause the flip flop to
change it's polarity. IF
on, it would go off... and
if off, it will turn on.

PNEUMATIC ADJUSTMENTS

NOTE: Adjust in run mode first (If possible).

RUN MODE - When tape is ready at load point.

THREAD MODE - When pin 2A2 B07 is jumpered to gnd. Press load/rewind.

HOSE SEQUENCE

LEFT SIDE

CLEAR	BROWN	BLACK	ORANGE	GREEN	PINK	PURPLE	YELLOW	BLUE	RED

RIGHT SIDE

GREEN	PINK	PURPLE	YELLOW	BLUE	RED

INDEX

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