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CHRISTIE

INCORPORATED

35/70
Automated Electronic Film Projector

Maintenance and Service Manual

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INTRODUCTION

Contents of the Manual

This manual contains operation, maintenance, and service information for the 35/70 Automated Film Projector. The material covered includes:

- general description
- operating the projector
- theory of operation
- electronic adjustments
- periodic maintenance
- troubleshooting guide.

Who Should Use the Manual?

This manual provides levels of detail that are suitable for various purposes. For operators, and for general information, see:

- *Section 2: General Description*
- *Section 3: Operating the Projector*
- *Section 4: Periodic Maintenance.*
- *Section 8: Electronic Circuit Information.*

For a more detailed understanding of the projection system, see:

- *Section 5: Theory of Operation*
- *Section 8: Electronic Circuit Information.*

Before performing adjustments and periodic maintenance during normal operation, see:

- *Section 6: Mechanical and Electronic Adjustments*
- *Section 7: Troubleshooting Guide*
- *Section 8: Electronic Circuit Information.*

Additional reference information is contained in the appendices.

GENERAL DESCRIPTION

The 35/70 Automated Film Projector is a state-of-the-art projector designed for the demanding requirements of high-reality motion picture projection. Full microprocessor control results in a system that combines excellent image stability with high-speed motion, both forward and reverse, and complete external RS-232 computer control. Using advanced servomechanisms augmented by microprocessor control, the projector handles film so precisely that print life is greatly extended. Quality projected image, full external control, and the reliability to operate day after day, month after month, are the marks of the 35/70 projector.

The 35/70 Automated Film Projector can be used stand alone, interlocked, or used with a compatible show controller. The operation of the show controller, except as it interfaces directly with the 35/70 projection system, is not covered in this manual.

The projector can operate at speeds of 24, 25, 30, 48, or 60 frames per second and can be configured to use 35-millimeter or 70-millimeter film. The projector is a single unit that attaches to a lamphouse for its support. The projector's power supply, and keypad are located outside the projector head in separate enclosures. External connections are provided for BI-PHASE, RS-232, SYNC. and external douser interfaces.

Built into the 35/70 projector is the capability to accommodate 35millimeter DTS, 70 millimeter DTS and 70 millimeter Magnetic sound head equipment.

The projector can operate at 50 Hz or 60 Hz line frequency, and can be configured for 120- or 240-volt operation. The projector can also operate in precise synchronization with other film equipment, via 10 pulse per frame bi-phase, or NTSC, PAL, or SECAM video equipment. Through the use of the interlock provision on the 35/70 projector, two projectors can run in a Master/Slave configuration, with or without shutter phasing, to accommodate the showing of 3-D films.

Installation and Unpacking

This section provides unpacking information, installation data, and external connection data for the 35/70 Projector. For physical and electrical installation of the lamphouse, refer to the lamphouse manual.

The lamphouse is not part of the projector system.

Unpacking

Upon receipt of the projector at the final destination, unpack as follows:

1. Examine shipping crate or carton for visible shipping damage prior to removing the projector. Note any damage.
2. Carefully remove the shipping crate or carton from the unit.
3. Inspect the projector for shipping damage. Notify the carrier if such damage exists.
4. Remove rear panels of cabinet, and remove all packing material and restraints. Remove any package accessories, connectors, cables, power supply, keypad, etc. Check all items against packing list.

Installation

1. Prepare the floor area required for projector installation. The selected floor area should be of extremely solid construction to minimize transmission of floor vibration to projection equipment.
2. When the projector is supplied without a lamphouse, attach the projector with the four bolts supplied to the lamphouse base. Refer to the lamphouse manual for physical mounting instructions for the lamphouse.
3. Electrical connection for the 35/70 Projector consists of the following connections and cables[1]:
   - Power cable from power supply to projector head (P/N EC00215-39)
   - Communications cable from control keypad to projector head (P/N EC00215-41)
   - AC Power cables for blower motor and power supply (P/N EC00215-35, 37)
   - Douser relay connection via P15.
   - RS-232 communication connections via P18 and J25.
   - BI-Phase input connections via P17.
   - BI-Phase output connections via J13.
   - SYNC input via J11.

[1] Refer to interconnect diagrams in Section 8 for proper cable connections.

Refer to Section 6.8 for correct voltage strapping of power supply transformers prior to connection.

Control Ports

The projector has two serial control ports. In normal operation, they carry commands from a show controller or master projector. For debugging purposes, the ports can be connected to a service terminal. Commands can also be input from the projector control panel.
The serial communications protocol is set to 9600 baud; No Parity; 8 Data Bits, and 1 Stop Bit (9600/N/8/1). During normal operation all commands sent to the projector will be echoed back, except when the projector is used in the SLAVE mode of operation

Film and Shows

The reeling system holds approximately 2000' of film. The recommended type of film to use on the 35/70 projector is a polyester based film. A film reel may contain from one to six different shows of varying length; the projector assumes there is one show on a reel, unless a greater value is programmed (see Section 0). Each show is given a unique show number from one (1) to six (6). Show numbers can be designated with reflective tape. Where possible, low-inertia reels with core sizes of 4 inches or greater are recommended to minimize the stress applied to the reeling system.
Shows may be played in any order. The projector keeps track of the number of the show that is currently being played, called current show, and the number of the show that is to be played next, called next show.
The projector has sensors that detect the reflective tape used to indicate the show number, beginning-of-film (BOF), and end-of-film (EOF) markers. To reduce the possibility of mis reading film cues, film should be spliced with either clear splice tape or an ultrasonic film splicer.
When splicing film on 35/70 projectors, running in the Master/Slave mode, insure that the film length on both projectors remain the same to maintain film sync.

Programming Beginning and End of Shows

The BOF and EOF marks can be programmed by the 35/70 Projector in several ways:

- **DEFAULT Mode**
  The projector programs itself as shows are played in the course of operation. After all shows have been shown once, the projector logs all BOF and EOF cues.
- **MEMORY Mode**
  The optional battery backup on the CPU card enables the projector to remember all cue points from the last programming mode, even if the projector has been turned off in the meantime.
- **AUTO LOG Mode**
  This mode of operation enables the projector to automatically log the positions of all the cues. (See Section 0).
- **MANUAL LOG Mode**
  This mode of operation allows the operator to manually enter all cue points into the projector's memory. (See Section 0).
- **SHOW CONTROLLER Mode**
  This mode of operation allows the projector to accept cue points from a show controller through its serial communications port.

Procedures for programming the projector using these modes are described in detail in the command descriptions in Section 0.

Film Position

Two counters are stored in the projector memory space to track the position of the film. These are referred to as the reel counter and the film counter. The reel counter tracks timing for an entire reel of film, whereas the frame counter tracks the timing within an individual show. Both counters are expressed as a composite measure of time and frame position in the form *hh:mm:ss:ff*, where:

hh = hours (**0 - 99**)
mm = minutes (**0 - 59**)
ss = seconds (**0 - 59**)
ff = frame count within the second, called frame number (**0 - 29**).

The frame counter begins counting at the beginning of each show, and measures 30 frames for each second. By convention, each show's starting time is set to one hour and zero frames. This is displayed as **01:00:00:00**.
The reel counter begins counting at the beginning of the reel. It also measures 30 frames for each second, and is initially set to **01:00:00:00**. However, unlike the frame counter, the reel counter is not reinitialized at the start of a new show. The value of the reel counter is the cumulative, or elapsed, time-and-frame from the start of the reel.

The frame counter display on the control panel (see Section 0) normally shows the frame counter. See Sections 0 and 0 for discussions of changing this display to and from the reel counter value.
An example of reel and frame positions is shown in Table 2.1. For simplification, it is assumed that the BOF for Show #1 and the start of the reel are at the same position. Using the figures from that example, if the reel counter and frame counter were compared at the point that is 2 minutes, 37 seconds, and 15 frames into Show #2, their values would be:

Reel Counter: **01:06:55:19** ***(3:52:14 + 0:16:20 + 2:37:15)***
Frame Counter: **01:02:37:15**

Reel Contents	Length	Reel Counter Start/End	Frame Counter Start/End
Show #1	00:03:52.14 (*hh:mm:ss.ff)*	01:00:00:00 01:03:52:14	01:00:00:00 01:03:52:14
Separation between shows *(from EOF #1 to BOF #2)*	500 frames *(00:00:16:20)*	01:03:52:14 01:04:09:04	01:03:52:14 01:04:09:04
Show #2:	00:04:27.02 (*hh:mm:ss.ff)*	01:04:09:24 01:08:36:26	01:00:00:00 01:04:27:02

Table 2.1: Reel Counter and Frame Counter

Normal Operation

When operating normally, the projector is a completely automatic unit; once loaded with film and initially framed, it requires no operator. The projector automatically sets the loop size, reframes the film in the gate, cues to at the head of the desired show, and waits for a command that will cause the projector to play the show. When that command is received, the projector accelerates the film to cine speed in a smooth linear manner, synchronizes the pulldown with the shutter, and looks for the first frame of the show. When the first frame is found, the douser is enabled, and the projector signals the show controller that play is beginning. The douser open command may now be issued or, if the AUTO DOUSER function is enabled, the douser will open automatically 3 seconds into the film.
The douser closes automatically when it reaches the end of the current show. If the next show has not already been identified to the projector, the film decelerates to a stop in a smooth linear manner, and waits for a command that sets the next show. When the next show is identified, the projector moves at two times the normal speed (120 fps), cues to the

desired show, and waits for the command that will start play. This motion may be either forward or reverse depending on the position of the next show relative to the current show.
Certain commands input from the keypad or the remote interface (the show controller or a service terminal) suspend normal operation and allow the user to examine system state or modify constants for troubleshooting. In this mode, all film motion and other projector functions may be controlled manually.

Monitoring Projector Performance

Film advances through the projector in one of two ways. In *cine motion*, when a show is playing, the projector jerks, or pulls a film frame into position, synchronized with the closed portion of the shutter. Each advance of the film is called a pulldown. In *slew motion*, when advancing or rewinding to a new cue position, the film moves smoothly, and the douser prevents image projection.
Picture quality is maintained by several automatic systems, which function without operator assistance.
Proper framing of the film in the gate is monitored during every pulldown. If an out-of-frame condition is detected, the projector determines the number of perforations in error and corrects the error during the next pulldown by pulling either more or less film, as appropriate. The pulldown is automatically synchronized with the shutter as the running frame rate is reached. This automatic process maintains a “ghost-free” picture. The shutter action is adjusted during the manufacturing process; shutter adjustments are not normally required.
Another automatic system maintains a jitter-free picture by positioning the film in the gate in a manner that corrects for temperature changes, film type, gate pressure, and other conditions that would otherwise require operator adjustments.
The projector has been designed with built-in safety features to protect the film in case of malfunction. One such feature is the douser interlock relay, a solid-state relay that allows the douser to open only if the film is moving forward. This prevents the possibility of film burns due to an electronic malfunction. In addition, latching LED indicators help in troubleshoot problems if they occur.
The constant-velocity drive sprocket, pulldown, and shutter motor systems are controlled by a microprocessor that normally phase-locks all rates to the line frequency. When the system powers up, the processor determines whether the line is at 60 or 50 Hz, and sets the proper multiplier to maintain the system clock at 192 KHz. Crystal operation may be selected by a jumper plug on the Central Processing Unit/Main Logic card.

The Control Panel

The operation of the projector can be monitored by viewing the information displayed on the keypad with its associated LED display strip as shown in Figure 2.1.
The keypad LED display strip normally indicates the frame counter for the current show. However, this display strip may also display other command-specific information, as explained in the descriptions of the individual commands in Section 0. LEDs on the keys associated with projector commands toggle on to indicate projector action. For example, if the projector is stopped, the light on the <STOP> key is on.

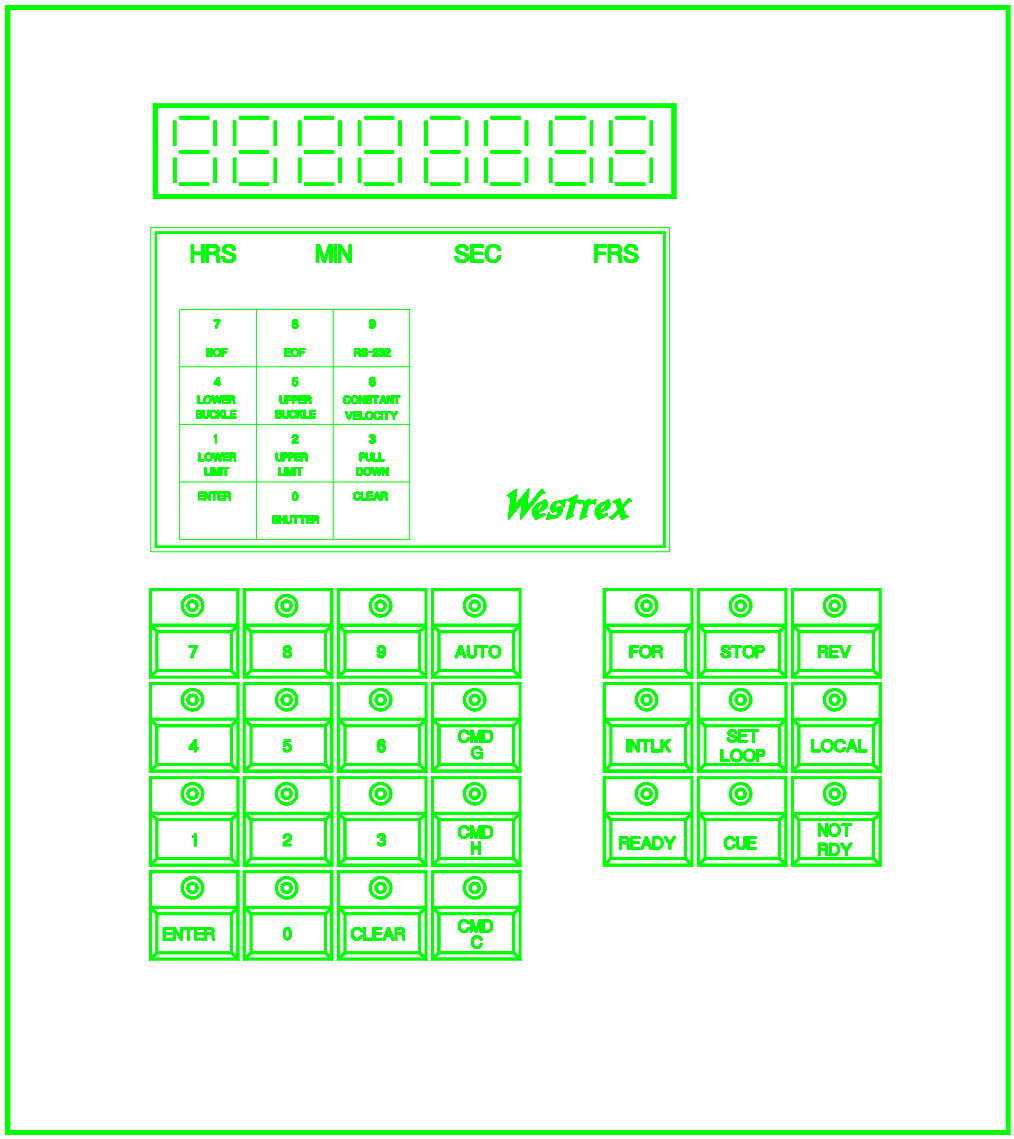


Figure 2.1: Control Panel

Keypad Input

The control panel contains two keypad areas that can be used to communicate to the projector: a 4X4 numeric keypad area on the left, which contains numeric and some function keys, and a 3X3 command keypad area in the center, which contains keys that execute the most commonly used functions. The numeric area can also be used for some commands. In addition, hexadecimal representations above 9 (A - F) can be entered from the numeric keypad area, as shown in Table 2.2. These keys are used to enter values in base-16 notation.

Hex Value	Key
A	CLEAR
B	ENTER
C	CMD C
D	CMD H
E	CMD G
F	AUTO

Table 2.2 Keypad Functions for Entering Hex Values

Keypad LED Indicators

The LEDs associated with the keypad provide an indication of projector status. Table 2.3 contains a list of the keypad LEDs and their indications.
Upon detection of a malfunction that causes a NOT READY condition, one of the <0> – <6> LEDs or the <CLEAR> LED will latch on, indicating the cause of the fault. These indicator LEDs can be reset once the <NOT RDY> button has been pressed and the cause of the malfunction has been corrected.

Frame Counter Display

The frame counter is normally displayed here. As explained in Section 0, this is a composite measure of elapsed time (hours + minutes + seconds) and frame count within a second, expressed in the standard counter format *hh:mm:ss:ff*. Some of the 35/70 projector operating and diagnostic commands use positions on the frame counter LED display to display values or echo input for verification. Refer to the individual command write-ups in Section 0 for detailed explanations of these instances.

Keypad LED	Indication
0	The CPU detected an error in the shutter speed.
1	The Lower Torque arm activated the limit switch.
2	The Upper Torque arm activated the limit switch.
3	The CPU detected that there is no film in the gate or there was a pulldown malfunction.
4	The Lower Buckle arm is out of position.
5	The Upper Buckle arm is out of position.
6	The CPU detected a constant velocity fault.
7	There is BOF sensor tape in the gate.
8	There is EOF sensor tape in the gate.
9	Keypad control is enabled.
CLEAR	
AUTO	The projector is in the CYCLE TEST mode.
G	The projector is receiving or performing one of the **G** function commands.
H	The projector is receiving or performing one of the **H** function commands.
C	The projector is receiving or performing one of the **C** function commands.
FOR	The projector is running forward.
STOP	The projector is stopped.
REV	The projector is running in reverse.
INTERLOCK	The projector is in INTERLOCK mode.
LOCAL	The projector is in the LOCAL mode.
SET LOOP	The projector is performing a loop set function.
READY	The projector is in READY mode.
CUE	The projector is performing a CUE function.
NOT RDY	The projector is in the NOT READY mode.

Table 2.3: Keypad LED Indicators

System Status

The system status identifies the show being played and the current action of the projector. This value is displayed in the rightmost two positions of the frame counter LED. The current show is the rightmost character of the two-character value, and the status is the leftmost character. The status identifies the type of operation the projector is executing. Valid status values and their meanings are shown in Table 2.4.

System Status	Meaning
8	Searching for Cue
A	Parked at Cue Point
0	Stopped
1	Moving Forward at or approaching Cine Speed, Douser Closed
3	Moving Forward at Cine Speed, Douser Open
B	Not Ready

Table 2.4: System Status Values

Thus, a value of **A2** indicates that the projector is parked at the cue point for Show #2.
The system status is output over the RS-232 interface in response to an **OUTPUT STATUS** command (see Section 0). Normally, the show controller receives the system status. When the system is operating in DEBUG mode, the system status is displayed on the service terminal.

The 35/70 Command Set

Projector commands are encoded in a hexadecimal character format. They are sent to the projector by the show controller, by a service terminal, or from the keypad. Some common commands have been assigned to specific keys on the command area of the keypad. When operating the 35/70 projector in a MASTER/SLAVE configuration, the serial communications port on the SLAVE projector connected to the MASTER will lock out certain commands from the MASTER projector. When in the SLAVE mode, the SLAVE projector will not echo any commands or provide prompts. In order to accomplish full duplex communications for a MASTER/SLAVE configuration to a show controller, the show controller will require two separate serial ports.
There are two types of command: *operational* and *diagnostic*. Operational codes are those commands used by the show controller or an operator during normal projector use. Diagnostic commands are used for debugging or service adjustment, for setup, and for other special operations. Some diagnostic commands may be used to enable features not currently implemented on the 35/70 Projector. Appendix A summarizes the entire system command set.
The following information is provided for each command:

- command name
- command type (operational: **OP** or diagnostic: **DX**)
- lock out condition for SLAVE projector commands (**L**)

- brief description of the command
- key sequence to trigger command
- RS-232 code for command
- data input description and format, where applicable
- resulting projector actions
- status changes as a result of the command.

When a projector command is referenced, it is written in bold, upper-case typeface. When a value that is stored in a memory register and tracked by the projector is referenced, it is written in lower case and underlined. Thus, **OUTPUT STATUS** is a command, and status refers to the status value itself. When a key entry or LED is described, the key's identity is enclosed in brackets, as <STOP>. If more than one key must be hit, keystrokes are separated by a comma (,).

C0: The STOP Command [OP,L]

This operational command causes the film to stop. The douser automatically closes before the projector stops. The douser cannot be opened if the film is at a stop.

ENTRY: <STOP>

CODE: C0

ACTIONS:
1. Ramp to a stop if film is in motion.
2. Advance one frame when film is at stop.
3. When operating in a MASTER/SLAVE configuration a C4 <CLOSE DOUSER> command will be sent to the SLAVE prior to the C0.

STATUS: Set to 0.

C1: The FORWARD Command [OP,L]

This operational command causes the projection system to play the current show and then return to the head of the film. When running the projector in a Master/Slave configuration use the PLAY CURRENT SHOW

command (See Section 2.8.18). Using the FORWARD command will cause the projectors to loose sync with each other.

ENTRY: <FOR>

CODE: C1

ACTIONS:
1. Accelerate to cine speed.
2. Enable douser at or about first frame, so that the **OPEN DOUSER** command will be accepted. If the **AUTO DOUSER** command has been entered the douser will automatically open after 3 seconds.
3. Play current show.
4. Stop at EOF marker.
5. Rewind to head of show.

STATUS: Set to **1** while advancing with douser closed;
set to **3** while playing with douser open;
set to **0** when stopped at EOF marker;
set to **8** while moving to cue for next show;
set to **A** while parked at cue.

C2: The REVERSE Command [OP,L]

This operational command moves the film in a reverse direction to the start of the current show.

ENTRY: <REV>

CODE: C2

ACTIONS: Reverse to head of current show.

STATUS: Set to **8** while moving to cue for next show;
set to **A** while parked at cue.

C3: The OPEN DOUSER AND CINE Command [OP]

This operational command opens the douser. The film must be moving at cine speed for this command to take effect; if the projector status is not equal to **1**, the **OPEN DOUSER** command is ignored.

ENTRY: <CMD-C>, <3>

CODE: C3

ACTIONS: Open the douser and put projector into *cine* mode.

STATUS: Set to **3**.

C4: The CLOSE DOUSER AND SLEW Command [OP]

This operational command closes the douser. The douser also closes automatically when the EOF marker is detected. Since the douser is open only when the film is moving at cine speed, a **CLOSE DOUSER** command has no effect unless the status value is 3.

ENTRY: <CMD-C>, <4>

CODE: C4

ACTIONS: Close the douser and put the projector into *slew* mode.

STATUS: Set to **1**.

C5: The CLEAR CUES Command [OP]

This operational command is used to erase all previously programmed BOF and EOF cue points.

ENTRY: <CMD-C>, <5>

CODE: C5

ACTIONS: Erases pre-programmed cue points for all shows.

STATUS: Unchanged.

C6: The AUTO LOG Command [OP]

This operational command causes the projector to do a normal CUE and then high speed forward to the end of the reel, logging EOF and BOF tapes as it moves. The REEL TIMES are displayed, logged, and latched, so that they may be recorded manually if desired. If fewer than the maximum shows are to be programmed, the STOP button terminates the command.

To perform auto logging, the projector must be in the READY mode, and the film must be loaded in the projector so that the BOF tape for Show #1 is above the gate or on the supply reel. Then follow the command sequence described.

BOF and EOF tapes must be affixed to the film for all shows that are to be programmed.

ENTRY: <CMD-C>, <6>

CODE: C6

ACTIONS: Projector logs all BOF and EOF sensor tapes on the reel.

STATUS: Unchanged.

Table 2.5 illustrates the sequence of commands necessary for auto-logging. In this example, the number of shows is equal to five, and the first show to be shown after all cues have been logged is Show #2.

Command	Input	Result	Reference
(Load the film on the reel so that the BOF tape for Show #1 is above the gate or on the supply reel.)			Chapter 3
READY	<READY>	Puts projector into READY mode.	Section 0
SET MAX SHOWS = 5	<H> , <D> , <5>	Sets number of shows to 5.	Section 0
SET NEXT SHOW = 1	<H> , <8> , <1>	Sets Show #1 as next show.	Section 0
SET CURRENT SHOW = 1	<H> , <5> , <1>	Sets current show to 1.	Section 0
CUE	<CUE>	Projector cues on BOF of Show #1.	Section 0
AUTO LOG	<C> , <6>	Projector logs all BOF and EOF tapes on the reel.	Section 0
SET NEXT SHOW	<H> , <8> , <2>	Sets Show #2 as next show.	Section 0
CUE	<CUE>	Projector cues on BOF of Show #2.	Section 0

Table 2.5: Command Sequence for Auto Logging

C7: The OUTPUT STATUS Command [DX]

This diagnostic command requests an output of the current status. The rightmost character of the two-character display contains the number of the current show; the leftmost character contains the status. The status is output on the RS-232 port to the show controller or the service terminal.

ENTRY: <CMD-C>, <7>

CODE: C7

ACTIONS: Outputs status over RS-232 interface.

STATUS: Unchanged.

An example of an output status return value is:

A2

where

A: Parked at Cue Point (see Table 2.4)
2: Show number 2.

C8: The CUE Command [OP,L]

This operational command causes the projector to position the film at the start of the first show encountered when the projector moves in a forward direction. The film advances in the slew mode. If the **CUE** command is entered after the BOF marker in a show has been passed, the projector will find the next show on the film; this may not be the next show in a programmed sequence. A **CUE** command must be issued prior to the first time a show is played after the system powers up; thereafter, the projector tracks the start point for every show on the film.

Do not enter a CUE command if the projector has already encountered the BOF marker of the last show on the film. If a CUE command is entered at this point, the projector will move forward until the film runs off the reel.

ENTRY: <CUE>

CODE: C8

ACTIONS:
1. Move forward in slew mode at 15 fps until BOF marker of the next show is located.
2. Update frame counter.
3. Park on BOF mark.

STATUS: Set to **8** while searching for next show;
set to **A** while parked at cue.

C9: The JAM Command [DX]

This diagnostic command resets the frame counter for a show. If a new frame counter was just loaded using the **SET FRAME COUNTER** command (see Section 0), that value is loaded; if no time has been set, the frame counter setting defaults to one hour, written as **01:00:00:00**. The **JAM** command is useful if there is a requirement to inspect the new value immediately or to set MASTER and SLAVE start times to the same value.

ENTRY: <CMD-C>, <9>

CODE: C9

ACTIONS: Reset the frame counter.

STATUS: Unchanged.

CA: The READY Command [OP]

This operational command initiates the READY sequence.

When the projector is in READY mode, if the <READY> key is pressed again, the LED display strip displays the reel counter. To return the show counter to the display, enter a G1 (DISPLAY COUNTER) command.

ENTRY: <READY>

CODE: CA

ACTIONS:
1. Apply power to motor systems.
2. Check all limit switches.
3. Check the CV, Pulldown, and Shutter motor systems.
4. Set loop.
5. Execute single frame advance and stop.

STATUS: Set to **0**.

CB: The NOT READY Command [OP]

This operational command places the system in a NOT READY state. When in this state, the projector will not accept any commands that require film motion.

ENTRY: <NOT RDY>

CODE: CB

ACTIONS:
1. Remove power from motor systems.
2. Reinitialize software values and turns the AUTO DOUSER command off .
3. Reset LED error indicators.

STATUS: Set to **B**.

CD: The MANUAL LOG Command [OP]

This operational command enables manual entry of reel time values for shows marked with BOF tape at the head of each show. The command sequence is repeated for each show on the film.

All reel times must be entered in the standard format, where the hours value defaults to *01*. These values represent points on the film, rather than elapsed times.

ENTRY: <C> , <D>

CODE: CD

INPUT:
1. Show number. *Example: CD1*
2. Reel time for BOF/EOF of selected show, followed by <ENTER>.[2]
   Example: 01:00:20:04

ACTIONS:
1. Displays the entered BOF or EOF value on the LED display.
2. Stores the entered BOF or EOF value.

STATUS: Unchanged.

Before beginning the manual logging process, it is necessary to create a log sheet, such as the one shown in Figure 2.2.

SHOW #	SHOW NAME	START TIME	STOP TIME
1	Cowboy-1	01:00:00:00	01:04:43:16
2	Cowboy-2	01:05:00:00	01:09:17:10
3	Desert-1	01:09:21:26	01:13:55:08
4	Cactus	01:14:00:22	01:16:34:00
5	none	—	—
6	none	—	—

Figure 2.2: Sample Log Sheet

If a mistake is made, the <CLEAR> key erases the last entry made. When the BOF time is correctly displayed, press <ENTER>.
Table 2.6 illustrates the sequence of commands to program the shows from the Sample Log Sheet in Figure 2.2.

[2] If a mistake is made, press <CLEAR> to re-enter. When the displayed value is correct, press <ENTER>.

	Input	Result
1	CD1	Specify Show *Cowboy-1*
2	01 00 00 00	BOF time for *Cowboy-1*
3	<ENTER>	Accept displayed value
4	01 04 43 16	EOF time for *Cowboy-1*
5	<ENTER>	Accept displayed value
6	01 05 00 00	BOF time for *Cowboy-2*
7	<ENTER>	Accept displayed value
8	01 09 17 10	EOF time for *Cowboy-2*
9	<ENTER>	Accept displayed value
10	01 09 21 26	BOF time for *Desert*
11	<ENTER>	Accept displayed value
12	01 13 55 09	EOF time for *Desert* ***(Incorrect!)***
13	<CLEAR>	Reject incorrect value
14	01 13 55 0**8**	***Correct*** EOF time for *Desert*
15	<ENTER>	Accept corrected value
16	01 14 00 22	BOF time for *Cactus*
17	<ENTER>	Accept displayed value
18	01 16 34 00	EOF time for *Cactus*
19	<ENTER>	Accept displayed value
20	<CLEAR>	Signify end of film and exit command sequence; display shows current film position.

Table 2.6: Sample Command Sequence for Manual Logging

The **MANUAL LOG** command can also be used to display and check the show lengths that have been entered. Enter the <**C**> <**D**> command, followed by a ***1*** to indicate Show #1; then press <ENTER> to step through the entire set of BOF and EOF reel times. BOF and EOF values are **not** changed.

CD: The SHOW CONTROLLER LOG Command [DX]

The function of this diagnostic command is the same as the **MANUAL LOG** command, except that it is issued through the serial port via a show controller. The format of the **SHOW CONTROLLER LOG** command from the show controller differs from keypad operation in that the **CLEAR** command is replaced with a hex ***3A*** (or the ASCII symbol "***:***"), and the **ENTER** command is replaced with a hex ***3B*** (or the ASCII symbol "***;***"). Also, leading zeroes may be omitted when data is entered from the show controller.
The entry from a show controller over the serial port for the example shown in Figure 2.2 and Table 2.6 would be:

CD11010000;1044316;1020000;1025000;1030000;1035000:

CE: The SET REEL COUNTER Command [DX]

This diagnostic command allows the user to manually change the value of the reel counter.

ENTRY: <C> , <E>

CODE: CE

INPUT: Desired reel counter value in the counter format *hh:mm:ss:ff* (see Section 0).

ACTIONS: Sets the reel counter to the new value.

STATUS: Unchanged.

CF: The CYCLE TEST Command [DX]

This diagnostic command initiates a CYCLE test for the projection system. When in the CYCLE mode, the projector plays all programmed shows on the current reel of film in cine mode, then reverses to the beginning of Show #1 and repeats the sequence. If the **AUTO DOUSER** command (See Section 2.8.37) has been entered prior to the **CYCLE TEST** command, then the projector will automatically open the douser for each showing. The number of cycled shows is equal to the value set with the **SET MAXIMUM SHOWS** command (see Section 0).
This sequence repeats until the projector is told to perform some other type of movement. The test ends when a second **CYCLE TEST** command is entered. The current cycle completes, and the system returns to the start point of the first show. A **STOP** command pauses the cycle; a **FORWARD** or **REVERSE** command resumes operation.

ENTRY: <AUTO>

CODE: CF

ACTIONS:
1. Play the show in cine mode.
2. Cue to the next show in sequence.
3. Park.

Repeats actions 1 - 3 until interrupted.

STATUS: Set to **A** while parked at cue point;
set to **1** while moving to first frame;
set to **3** while playing;
set to **0** when stopped at end of show;
set to **8** while searching for BOF marker.
(The above status sequence repeats until the cycle ends.)

H0: The CUE/ADVANCE Command [OP,L]

This operational command is identical to the **CUE** sequence described in Section 0, except that film advances in the cine mode.

ENTRY: <CMD-H>, <0>

CODE: H0

ACTIONS:
1. Move forward at 15 fps in cine mode until BOF marker is located.
2. Update frame counter.
3. Park at BOF mark.

STATUS: Set to **8** while searching for BOF marker;
set to **A** while parked at cue point.

H1: The PLAY CURRENT SHOW Command [OP,L]

This operational command causes the system to play the current show. The command should be issued from a cue point. Use this command instead of the **FORWARD** command to operate projectors configured for MASTER/SLAVE operation.

ENTRY: <CMD-H>, <1>

CODE: H1

ACTIONS:
1. Play current show.
2. Stop at tail of show.
3. Wait for **SET NEXT SHOW** command (see Section 0).

STATUS: Set to **1** while moving to first frame.
Set to **3** while playing (douser open).
Set to **0** when stopped at end of show.

H2: The SET GOTO Command [DX]

This diagnostic command allows the user to enter a goto point for a subsequent **GOTO** action. The goto point must be a frame counter value in the current show. This command is used for motion programming, and is not a normal part of system operations.

ENTRY: <CMD-H>, <2>

CODE: H2

INPUT:
1. Enter the desired goto point with the numeric portion of the keypad. This is entered in the counter format *hh:mm:ss:ff* (see Section 0).
2. Hit the <ENTER> key.

ACTIONS: Load the goto point value.

STATUS: Unchanged.

H3: The FAST FORWARD Command [DX,L]

This diagnostic command moves the film in a forward direction at a rate of 120 fps. The douser is closed.

This command must be followed by a STOP command, or the film will run off the reel.

ENTRY: <CMD-H>, <3>

CODE: H3

ACTIONS: Move film forward at 120 fps.

STATUS: Set to **8**.

H4: The SET FRAME COUNTER Command [DX]

This diagnostic command allows the user to load a new value into the frame counter. The command should only be used if there is a problem with the current value.

ENTRY: <CMD-H>, <4>

CODE: H4

INPUT:
1. Enter the new value for the frame counter in the counter format *hh:mm:ss:ff* (see Section 0).
2. Press <ENTER> .

ACTIONS: Set the frame counter.

STATUS: Unchanged.

H5: The SET CURRENT SHOW Command [OP]

This operational command causes a display of the current show and the next show in the two rightmost digits of the numeric display, respectively. The user may enter a new current show number, if desired. The new value must be a valid show number. The current show and next show values are displayed for one second before the numeric display reverts to the frame counter. The new current show value must be entered while the show values are displayed.

ENTRY: <CMD-H>, <5>

CODE: H5

ACTIONS:
1. Display current show in second-from-right position of numeric display.
2. Display next show in rightmost position of numeric display.

INPUT: Enter the number of the new current show, using the numeric portion of the keypad. The number entered cannot exceed the maximum shows, which is **3** by default but may be set as high as **6** with the **SET MAXIMUM NUMBER OF SHOWS** command (see Section 0).

ACTIONS: Load the new current show value.

STATUS: Unchanged.

H6: The GOTO FRAME Command [DX,L]

This diagnostic command triggers the projector to move the film to the point in the show that was previously set with the **SET GOTO** command (see Section 0).

ENTRY: <CMD-H>, <6>

CODE: H6

ACTIONS:
1. Move forward or backward at 120 fps until the goto point specified with the **SET GOTO** command is reached.
2. Update frame counter.
3. Park.

STATUS: Set to **8** while searching for goto point.

Set to **0** while stopped at goto point.

H7: The CUE NEXT Command [OP,L]

The **CUE NEXT** operational command differs from the **CUE** command (see Section 0) in the way the projector finds the show that is to be cued. **CUE NEXT** cues the projector in front of the next show in the pre-programmed series of shows on the film. The **CUE** command cues the projector to the next show located when moving the film in a forward direction.

ENTRY: <CMD-H>, <7>

CODE: H7

ACTIONS:
1. Move forward or backward at 120 fps until the BOF marker for the next show is located.
2. Update frame counter.
3. Park at BOF mark.

STATUS: Set to **8** while searching for BOF marker of next show.

Set to **A** while parked at cue point.

H8: The SET NEXT SHOW Command [OP]

This operational command causes a display of the current show and the next show, respectively, in the two rightmost digits of the numeric display. The user may enter a new next show number, if desired. The new value must be a valid show number. If **PLAY CURRENT SHOW** (see Section 0) was the most recent play command, the projector also cues to the next show. The current show and next show values are displayed for one second before the numeric display reverts to the frame counter. The new next show value must be entered while the show values are displayed.

ENTRY: <CMD-H>, <8>

CODE: H8

ACTIONS:
1. Display current show in second-from-right position of numeric display.
2. Display next show in rightmost position of numeric display.

INPUT: Enter the number of the new next show, using the numeric portion of the keypad. The entered value may not exceed maximum shows (see Section 0).

ACTIONS:
1. Load the new next show value.
2. If **PLAY CURRENT SHOW** is the most recent play command, cue to the next show.

STATUS: As indicated by necessary motion.

H9: The SET OPERATING FREQUENCY Command [DX]

This diagnostic command selects the synchronization frequency, or line frequency, between 50 Hz and 60 Hz[3]. The default value is 60Hz operation. The battery backup RAM on the CPU card will maintain the frequency setting, so this command should only be used once.

[3] As shown in the two leftmost digits of the keypad LED display strip.

ENTRY: <CMD-H>, <9>

CODE: H9

INPUT: 1. Enter a **6** from the keypad to select 60-Hz operation.

2. Enter a **5** from the keypad to select 50-Hz operation.

ACTIONS: The synchronization frequency is reset accordingly.

STATUS: Unchanged.

HA: The INTERLOCK Command [OP]

This command puts the projector into interlock mode. Interlock mode allows the projector to be interlocked via BI-PHASE to an external motion source or MASTER projector. Commanding the projector into INTERLOCK mode before a READY causes the projectors shutter to lock into a position 180 degrees out of phase. This mode is useful for applications that require shutter phasing for 3-D films.

To prevent film damage, enter this command only when the external motion source is idle.

ENTRY: <INTERLOCK>

CODE: HA

ACTIONS: The projector is set to interlock mode.

STATUS: Unchanged.

HB: The DISPLAY ERROR Command [DX]

This diagnostic command triggers a “Cause of Fault” message over the RS-232 interface. The message displays on a workstation that is connected to the RS-232.

ENTRY: <CMD-H>, <B>

CODE: HB

ACTIONS: Send error message, coded in ASCII, over RS-232.

STATUS: Unchanged.

HC *(READY)*: The PULLDOWN GAIN DISPLAY Command [DX]

This diagnostic command is used for calibration and setup. When the projector is in READY mode and has been given the command to cue cine forward, this command checks the gain value for VR1 on the CPU/Main Logic card and displays it in the rightmost two digits of the corresponding numeric displays on the operator control consoles. The projector must be in READY mode; if the projector is in NOT READY mode, this command will release the upper torque motor brake (see Section 0).

ENTRY: <CMD-H>, <CMD-C> *(READY mode)*

CODE: HC

ACTION: Displays pulldown gain.

STATUS: Not applicable.

HC *(NOT RDY)*: The BRAKE RELEASE Command [DX]

This diagnostic command is used to release the upper torque motor brake to allow for easier film threading. The projector must be in NOT READY mode, or this command will display the pulldown gain (see Section 0).

ENTRY: <CMD-H>, <CMD-C> *(NOT READY mode)*

CODE: HC

ACTIONS: Releases upper brake.

STATUS: Not applicable.

HD: The SET MAXIMUM NUMBER OF SHOWS Command [OP]

This operational command enables the user to program into the projector the maximum number of shows on the current reel of film. The command is used in conjunction with the commands **AUTO LOG** (See Section 0), **MANUAL LOG** (See Section 0), **CYCLE TEST** (See Section 0), **SET CURRENT SHOW** (See Section 0), and **SET NEXT SHOW** (See Section 0).

If this command is not used, the default maximum number of shows is set to 1.

ENTRY: <H> , <D>

CODE: HD

INPUT: Number of shows on reel (must be from **1 – 6**).

ACTIONS: Sets maximum number of shows on the current reel of film.

STATUS: Unchanged.

HE: The LOCAL MODE Command [DX]

This diagnostic command takes the projector out of *interlock* mode. Interlock mode allows the projector to be interlocked, via BI-Phase, to an external motion source or MASTER projector.

To prevent film damage, enter this command only when the external motion source is idle.

ENTRY: <LOCAL>

CODE: HE

ACTIONS: Take the projector out of interlock mode.

STATUS: Unchanged.

HF: The DISPLAY START Command [DX]

This diagnostic command displays the GOTO frame that was programmed using the **SET GOTO** command (see Section 0).

ENTRY: <H> , <F>

CODE: HF

ACTIONS: Displays the GOTO frame in the standard counter format of *hh:mm:ss:ff* (see Section 0).

STATUS: Unchanged.

G0: The MEMORY INSPECT Command [DX]

Altering the projector memory contents may damage the film and/or the projector! To protect against such damage, allow only qualified service personnel to use this command.

This powerful diagnostic command is used to view and update data in the memory of the projector CPU. **This command is *NOT* part of normal projector operation!**
The **MEMORY INSPECT** command can be used from the projector control console or from a serial communications service terminal. However, the input and command sequence differs somewhat.
From the projector control console, the sequence is:

All alphabetic characters terminal (hexadecimal digits) entered into the service terminal must be upper-case.

ENTRY: <G> , <0>

CODE: G0

INPUT: Enter the four-digit (hexadecimal) address that is to be updated. Press the <FOR> key to increment the address; press the <REV> key to decrement the address.

Example:

Entry:	***32AB***
<FOR>	***32AC***
<FOR>	***32AD***
<REV>	***32AC***

ACTIONS: Displays the two-digit (hexadecimal) data stored at the specified address in the two rightmost digits of the LED display.

INPUT: Enter the new two-digit (hex) value for the chosen address.

ACTIONS: Updates the address contents.

INPUT: To exit the **MEMORY INSPECT** command:

1. Press <STOP> to exit
2. Enter the ***G1*** command to return to the frame counter display.

STATUS: Unchanged.

The sequence of commands and inputs from a service terminal is shown in Table 2.7.

Input	Comment	Result
G9	Must be entered from console.	Activates the serial RS-232 communications port (see Section 0).
M xxxx	"M" followed by desired hexadecimal memory location (use upper case for alpha characters).	Data stored at the chosen address is shown to the right of that address on the terminal's display.
yy	New value for memory location (two hex digits).	Value at selected address is updated.
↑	Up-arrow cursor.	Increment memory location.
↓	Down-arrow cursor.	Decrement memory location.
<ENTER>		Exit **MEMORY INSPECT.**

Table 2.7: MEMORY INSPECT from a Service Terminal.

G1: The DISPLAY FRAME COUNTER Command [DX]

This diagnostic command causes the current frame counter value to be displayed on the LED strip.

ENTRY: <CMD-G>, <1>

CODE: G1

ACTIONS: Display the current frame counter value.

STATUS: Unchanged.

G2: The SELECT FRAME RATES Commands [DX]

This diagnostic command allows entry of the selected frame rate and the number of perfs per frame. Default values are 30 fps and 5 perforations unless specified otherwise. When using 35mm film select 5 perforations.

ENTRY: <CMD-G>, <2>

CODE: G2

INPUT:
1. Select the frame rate:
   - Enter a **2** from the keypad to select 24 frames per second
   - Enter a 5 from the keypad to select 25 frames per second
   - Enter a **3** from the keypad to select 30 frames per second
   - Enter a **4** from the keypad to select 48 frames per second
   - Enter a **6** from the keypad to select 60 frames per second.
2. Select the number of film perfs:
   - Enter a **5** from the keypad to select 5 perfs.
   - For models equipped with 8-perf capabilities, enter an **8** from the keypad to select 8 perfs.

ACTIONS:
1. Reset frame rate and number of perfs.
2. Display frame rate in the second- and third-last positions on the LED display, as shown in Figure 2.3.
3. Display number of perfs in the last position on the LED display, as shown in Figure 2.3.

STATUS: Unchanged.

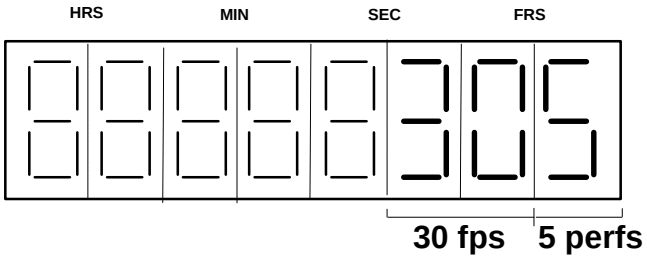


Figure 2.3: SELECT FRAME RATES LED Display

G3: The AUTO DOUSER Command [OP]

This operational command enables the projector to automatically open the douser 3 seconds into the film after the projector has been commanded to run FORWARD. This function is reset when the projector goes into a NOT READY condition.

ENTRY: <G> , <3>

CODE: G3

ACTIONS: Allows the douser to be automatically opened 3 seconds into the film.

STATUS: Unchanged.

G4: The LOAD REEL COUNTER Command [DX]

This diagnostic command loads the time code value of the frame counter register into the reel counter register. This command is used for motion programming, and is not a part of normal operation.

ENTRY: <G> , <4>

CODE: G4

ACTIONS: Sets the reel counter equal to the frame counter.

STATUS: Unchanged.

G5: The SET PLATTER MODE Commands [OP]

This operational command sets the projector to *platter* mode. This command is recognized only in the NOT READY state.

ENTRY: <CMD-G>, <5>

CODE: G5

ACTIONS: Disables upper and lower torque arm operation. Enter a **NOT READY** command to reset projector to the default *reel* mode.

STATUS: Unchanged.

G6: The OUTPUT CUE TAPES Command [DX]

This diagnostic command downloads the position of each BOF and EOF cue tape, as it has been loaded into the projector, to the show controller. The output data is in the format shown in Table 2.8.

ENTRY: <CMD-G>, <6>

CODE: G6

ACTIONS:
1. Outputs PROMPT followed by BOF for first show.
2. Outputs successive BOF and EOF positions, each preceded by a PROMPT.

STATUS: Unchanged.

Output	Meaning
<PROMPT>	<CR> <LF> *
hh:mm:ss:ff <PROMPT>	BOF for Show #1
hh:mm:ss:ff <PROMPT>	EOF for Show #1
hh:mm:ss:ff <PROMPT>	BOF for Show #2
hh:mm:ss:ff <PROMPT>	EOF for Show #2
. . .	repeated for additional shows

Table 2.8: OUTPUT CUE TAPES Data Format.

G7: The SHUTTER TEST Command [DX]

This diagnostic command is used to test the speed of the shutter. LED 0 on the control keypad is used as an indicator of this test's success or failure.

ENTRY: <CMD-G>, <7>

CODE: G7 (also HD, from remote interface only)

ACTIONS: LED 0 flashes and remains **OFF** if shutter speed is correct.
LED 0 flashes and remains **ON** if shutter speed is incorrect.

STATUS: Unchanged.

G8: The REVERSE TEST MODE Command [DX,L]

This diagnostic command is used to adjust the position of the torque arms and run the projector in *slew* mode at various speeds in the *forward* and *reverse* direction. The projector must be powered up and in the READY state.

ENTRY: <CMD-G>, <8>

CODE: G8

INPUT:
1. Enter a speed value of **10** on the keypad.
2. Hit the <ENTER> key.
3. Adjust R183 so that the upper torque arm sensor voltage (as measured from the top of R150) is 0 volts ± 1 volt. This adjusts *upper* torque arm position.
4. Adjust R136 so that the upper torque arm sensor voltage (as measured from the top of R149) is 0 volts ± 1 volt. This adjusts *lower* torque arm position.

Repeat Steps 1 – 4 with speed *value inputs of* **20**, **30**, **40** *and* 5**0**.

5. Enter a speed value of **00** to stop the projector.
6. Press the <STOP> key.
7. Enter **00** to change the projector direction to forward.
8. Press the <STOP> key.

STEPS: Repeat the above Input sequence, using R196 for the upper torque arm and R137 for the lower torque arm.

INPUT: Enter the **DISPLAY FRAME COUNTER** (<G> , <1>) command to return the display to normal.

STATUS: Not applicable.

Entering speed values greater than 50 can cause projector and film damage.

G9: The SHOW CONTROL ENABLE Command [OP]

This operational command toggles projector control between the right half of the control keypad and the RS232 communication port.

ENTRY: <CMD-G>, <9>

CODE: G9

ACTIONS:
1. If the **9** LED is *on*, RS232 communication port control is disabled and keypad control is enabled.
2. If the **9** LED is *off*, keypad control is disabled and RS232 communication port control is enabled.

STATUS: Unchanged.

GA: The OUTPUT LOG Command [DX]

This diagnostic command is used to report the last five commands sent to the projector over the RS-232 communication port. The status is output on the RS-232 port to the show controller or the service terminal. These commands are recorded only when the projector is in READY mode. The commands can be reported only when the projector is in the NOT READY mode.

ENTRY: <CMD-G>, <A>

CODE: GA

ACTIONS: The last five commands sent to the projector are output across the RS-232 communication port, provided that the projector is in NOT READY. The commands appear in the format *mm:ss:ff:<cmd>:<resp>*, where

mm	=	minutes
ss	=	seconds
ff	=	frame count within the second
<cmd>	=	command
<resp>	=	response

To illustrate this format:

03:57:14:H8:2

indicates that, at 3 minutes, 57 seconds, the 14th frame, the command **H8** was received, and the response **2** was made.

STATUS: Unchanged.

GB: The TIMECODE INQUIRY Command [DX]

This diagnostic command is used to report the current timecode stored in the projector's internal buffer. The status is output on the RS-232 port to the show controller or the service terminal.

ENTRY: <CMD-G>, <B>

CODE: GB

ACTIONS: The current timecode is output across the RS-232 communication port in the counter format *hh:mm:ss:ff* (see Section 0).

STATUS: Unchanged.

GD: The PARK ON CUE Command [OP]

This command is used to park the BOF sensor tape in the gate. The use of this command is associated with operating the projector in the Master or Slave mode and can be issued after a CUE command (See Section 2.8.9) has been issued. By parking the BOF sensor tape in the gate proper frame synchronization between the Master and Slave projector is achieved.

ENTRY: <CMD-G>, <D>

CODE: GD

ACTIONS: Cues film forward and parks BOF sensor tape in gate.

STATUS: Set to A while parked at CUE point.

GE: The ENGAGE SOUND Command [OP]

This command is used to engage the sound head lifter solenoid. This command is mainly used when projectors are used in the Master/Slave configuration.

ENTRY: <CMD-G>, <E>

CODE: GE

ACTIONS: Engages sound head lifter solenoid.

STATUS: Unchanged.

GF: The SOFTWARE VERSION Command [DX]

This diagnostic command triggers the output of an ASCII string containing the software version number.

ENTRY: <CMD-G> , <F>

CODE: GF

ACTIONS: Returns software version number.

STATUS: Unchanged.

OPERATING THE PROJECTOR

Although film projection using the show controller requires no operator intervention, certain procedures must be followed to prepare the film and projector for playing shows. This section describes the setup and operating procedures.

Marking Shows on the Film

Reflective tape must be installed for each show on the film reel. Up to three pieces of tape per show are required:

- BOF indicator
- EOF indicator
- SHOW NUMBER indicator (optional).

Thus, if three shows are used, nine tape strips would be installed.

The BOF sensor is located next to the "inboard" (away from the user) film perforations, while the EOF sensor is next to the "outboard" (toward the user) film perforations.

Tape should be placed on the emulsion side of the film, as it might not be read through the film if it is positioned on the base side. When a start command is given, the film accelerates to cine speed before it encounters the BOF marker. The film decelerates to a stop after the projector detects the EOF marker.

The projector determines the show number by measuring the length of reflective tape, placed on the inboard side directly opposite the EOF tape, with the BOF sensor. The show number tape is measured in units of frame lengths. For example, show number two must have a tape length of two frames. The EOF tape opposite the show number tape must extend beyond both ends of the show number tape.

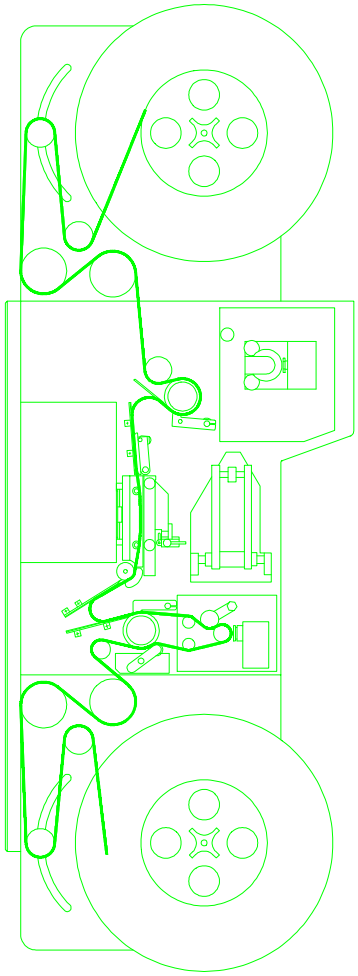
If the projector is to automatically open the douser, by use of the **AUTO DOUSER** command (See Section 2.8.37), the BOF marker on the film must be positioned so that it is 3 seconds before the first frame of picture. The placement of the BOF tape can be calculated by multiplying the frame rate by 3. This will give the number of frame position, before first frame of picture, for the BOF tape

Threading Film

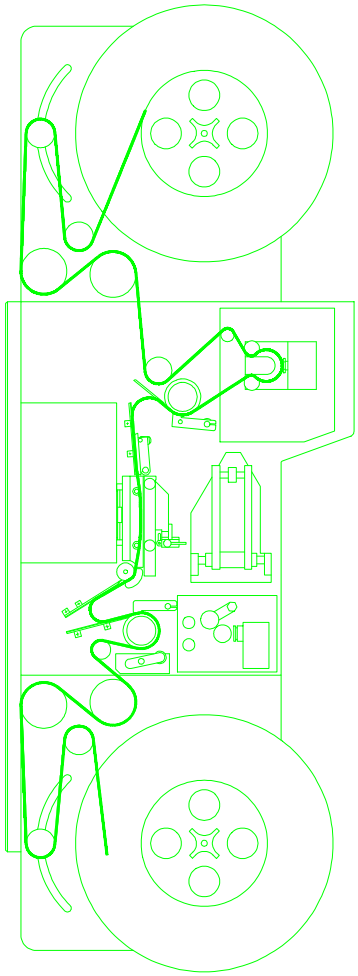
Consult the threading diagram in Figure 3.1, and thread the film as shown. The film must be threaded so that the emulsion side is toward the lamp. It is important that the right amount of film is in the gate area so that the projector can effect a proper loop set. For 70 millimeter film thread the film so that, when the top loop is pulled into the bottom, the total bottom loop guide is 75% full. For 35 millimeter film thread the film so that there are 20 frames, plus 1 frame for every 50 feet of projector to screen distance, of film between the aperture opening in the gate and the DTS sound head. Setting the loop correctly is important in order to maintain proper sound to picture synchronization. After the film has been threaded set upper and lower reel tension so the torque arms are approximately in their center positions.

Figure 3.1: EP-35/70 Projector Threading Diagrams

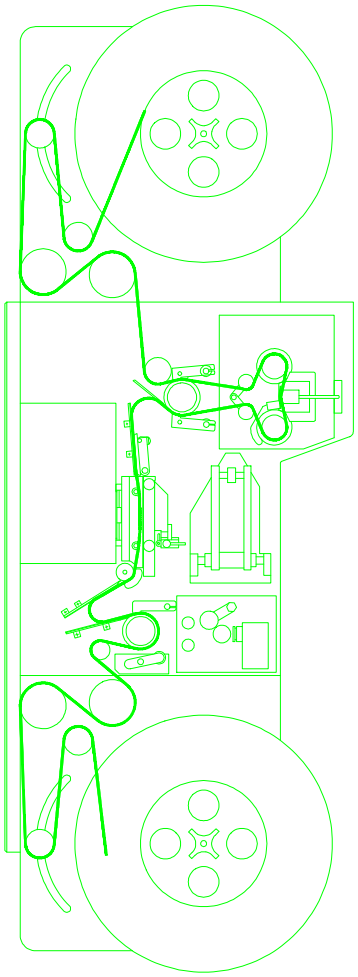
35mm Film Threading
With DTS head



70mm Film Threading
With DTS Head



70mm Film Threading
With Magnetic Head



Operating Instructions

Do not strike the lamp unless the projector is OFF or in the NOT READY state. Failure to comply with this procedure could result in damage to the projector or film.

Normal Operation

Apply power by positioning the PROJECTOR ON/OFF switch on the power supply switch panel to **ON**. The frame counter display should read **01:00:00:00** (one hour). The LED's on the <NOT RDY>, and <9> buttons should be on. The shutter will not be rotating at this time. Be sure film is properly mounted and threaded. Enter the film rate at which the projector is to operate (See Section 2.8.36). Press the <READY> key, and observe the following sequence:

(Refer to the operating commands outlined in Section 2.8.)

1. The projector performs a loop set and the Pulldown motor system is tested. The LED on the <SET LOOP> key will go on.
2. Simultaneously, the brake solenoids release, and the torque arms move into position.
3. The constant velocity sprocket advances one frame and the CV motor system is tested.
4. The shutter comes up to speed and is tested.
5. The <STOP> and <READY> LED's go on, and the <SET LOOP> LED goes off.
6. Enter a **CUE** (press <CUE>) command. The film moves forward in slew motion at 15 fps until the BOF tape is found.
7. Enter a **SET CURRENT SHOW** (<H>,<5>) command, and indicate which show the projector is cued to (The default show number is 1.). The projector is now ready for the first show.

If the film length, BOF/EOF markers, or shows have been changed, new show times must be entered into the projector. First, clear all stored time codes with the CLEAR CUES command (see Section 2.8.6). Then, enter new cue points by the AUTO LOG (see Section 2.8.7), MANUAL LOG (see Section 2.8.13), or SHOW CONTROLLER LOG (see Section 2.8.14) commands, or in DEFAULT LOG mode (Section 2.3.1).

Operation of the projector is automatic:

1. Enter a **FORWARD** command (press <FOR>) to start.
2. The douser can be opened by a show controller command by entering an **OPEN DOUSER AND CINE** (<C3>) command, or automatically if the **AUTO DOUSER** (<G3>) command has been entered.
3. When the EOF tape is detected, the douser automatically closes, and the film stops. The projector then automatically cue's the film so that it is ready for the next show. The projector will not pick up commands from the show controller until after a **SHOW CONTROL ENABLE** (<G9>) command is entered.

Master/Slave Operation

If the projector is to be used in a Master/Slave configuration, the following steps will need to be performed, in addition to steps 1 to 7 in Section 3.3.1.

1. Enter the **PARK ON CUE** (<GD>) command for both Master and Slave projectors.
2. Enter the **JAM** (<C9>) command for both projectors to reset the time display to 1:00:00:00 if desired.
3. Enter the **INTERLOCK** (press <INTLK> or enter <HA>) command for the Slave projector.
4. Enter the **SHOW CONTROL ENABLE** (<G9>) command for both projectors, if not already enabled.

Operation of the projector is automatic:

5. Enter a **PLAY CURRENT SHOW** (<H1>) command from the Master projector or show controller to start.
6. The douser can be opened by entering an **OPEN DOUSER AND CINE** (<C3>) command, or automatically if the **AUTO DOUSER** (<G3>) command has been entered.
7. When the EOF tape is detected on the Master, both dousers automatically close, and the film stops. The Master projector then automatically cue's both projectors so that they are ready for the next show.
8. Repeat steps 1 to 7 to play the next show.

Master Motion Controller Operation

If the projector is to be used in conjunction with a Master Motion Controller, the following steps will need to be performed, in addition to steps 1 to 7 in Section 3.3.1. Note that all commands starting with a "K" must be entered into the Master Motion Controller via the RS-232 communications port.

1. Enter the **CUE** (<C8> or <CUE>) command to cue the projector to the beginning of the show.
2. Enter the **PARK ON CUE** (<GD>) command to set the first frame of film in the gate .
3. Enter the **JAM** (<C9>) command to reset the time display to 1:00:00:00, if desired.
4. Enter the **INTERLOCK** (press <INTLK> or enter <HA>) command.
5. Enter the **SHOW CONTROL ENABLE** (<G9>) command, if not already enabled.

Operation of the projector is automatic:

5. Enter a **JAM** (<K9>) command into the Master Motion Controller to reset the timecode to 1:00:00:00.
6. Entering a **PLAY CURRENT SHOW** (<K1>) into the Master Motion Controller will start the show.
7. Sending a **OPEN DOUSER** (<C3>) command to the projector will project the picture, or it will occur automatically if the **AUTO DOUSER** (<G3>) command has been entered.

8. At the end of the show a **CLOSE DOUSER** (<C4>) command must be sent to the projector to close the douser and a **STOP** (<K0>) command must be sent to the Master Motion Controller to stop the projector.

9. From this point the projector must be taken out of interlock, with the **LOCAL MODE** (<HE>) command, and rewound to the start of the show by entering a **CUE NEXT** (<H7>) command into the projector.

10. Repeat steps 2 to 9 to play the next show.

Power Down Sequence

To turn off power to the projector, enter the following command key sequence:

(<G>,<9>) : Re-activate the projector keypad.

<STOP> : Stop the projector if it is in motion.

<NOT RDY> : Remove power from projector motors.

Power to the projector, lamphouse, and show controller may then be removed in any order.

PERIODIC MAINTENANCE

To properly maintain the **CHRISTIE** *35/70* Automatic Electronic Projector and avoid damage to the film, a certain amount of routine preventive maintenance is required. Proper maintenance aids in preventing untimely system breakdowns. This section describes the appropriate maintenance procedures.
Maintenance procedures are performed at daily, weekly, monthly, six-month (semiannual), or yearly (annual) intervals, as well as when the lamphouse bulb is replaced. Tables 4.2 through 4.7 list the periodic procedures. **CHRISTIE** recommends that these tables be photocopied and used as preventive maintenance checklists and logs.

Do not use any film lubricants on the *35/70* projector!

Equipment Required for Preventive Maintenance

Table 4.1 lists equipment that should be available in the projection booth. It should be easy and convenient for the projectionist to perform any required maintenance. If the proper tools are not at hand, it is unlikely that the maintenance will be performed as directed.

Allen Keys, Long-handled ball-end: 0.050–5/16"	Isopropyl alcohol (for cleaning purposes)
Desoldering Tool	Brush, soft camel hair
Nut Driver, 3/16"	Clean soft cloth
Pin Extractor, 0.063" MOLEX	Compressed air, can (no more than 15 PSI)
Pin Extractor, 0.093" MOLEX	Cotton swabs
Pliers, Needle-nosed	Lens Cleaning Tissues or Wipes
Pliers, Snap-ring	222 Loctite
Ruler, 6" Steel	Silicone Grease
Screwdrivers, Assorted Flat	Toothbrush (ordinary)
Screwdrivers, Assorted Phillips	Explosion Vest (for lamp replacement)
Side Cutters	Full-face Safety Mask (for lamp replacement)
Soldering Iron, 40W	Gloves (for handling lamphouse bulb)
Wire Strippers/Crimpers	Digital Multimeter
Wrench, Adjustable	Oscilloscope, Dual-trace Analog 20mhz
Wrench, ¼" Open-end	Vacuum Cleaner with Hose and Nozzle

Table 4.1: Commonly Used Maintenance Tools

CHRISTIE *35/70* Projector
Daily Preventive Maintenance Log Sheet

Action Required	Week Beginning: _____/_____/_____						
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Clean Particle Transfer Rollers							
Clean lens							
Clean rollers							
Clean gate							
Clean gate trap, guide rails							
Clean sensors							
General dusting							
Check buckle trips							
Check Sprockets							
Check torque arms							
Check picture quality							

Table 4.2: Daily Preventive Maintenance Checklist/Log Sheet

CHRISTIE *35/70* Projector
Weekly Preventive Maintenance Log Sheet

Week Beginning (Day): _____ **Date:** _____ , 19 _____

Action Required	Date Performed
Brush off sprocket teeth	
Clean DTS head/ Magnetic head	
Vacuum circuit boards	
Clean surfaces at rear of projector	
Lubricate gate center pin	
Clean gate glass	
Check gate shoe spring tension	
Check all mechanical connections	

Table 4.3: Weekly Preventive Maintenance Checklist/Log Sheet

CHRISTIE *35/70* Projector **Monthly Preventive Maintenance Log Sheet**	
Month: _____	**Year: 19** _____
Action Required	**Date Performed**
Check belt tension	
Clean air filter	
Check all electrical connections	

Table 4.4: Monthly Preventive Maintenance Checklist/Log Sheet

CHRISTIE *35/70* Projector **Semiannual Preventive Maintenance Log Sheet**	
	Year: 19 _____
Action Required	**Date Performed**
Interval 1	
Check brushes on servo motors and Pulldown motor	
Check BOF/EOF sensor voltage	
Check CV Buckle shoes for wear	
Interval 2	
Check brushes on servo motors and Pulldown motor	
Check BOF/EOF sensor voltage	
Check CV Buckle shoes for wear	

Table 4.5: Semiannual Preventive Maintenance Checklist/Log Sheet

CHRISTIE *35/70* Projector
Annual Preventive Maintenance Log Sheet

Year: _____

Action Required	Date Performed
Check coupling between tacho roller and tacho generator	
Check power supply voltages	
Check reeling motor brakes	
Visual inspection (loose bolts, screws, damaged cables, etc.)	
Replace Particle Transfer Rollers	
Clean back of projector with vacuum	

Table 4.6: Annual Preventive Maintenance Checklist/Log Sheet

CHRISTIE *35/70* Projector
Lamphouse Preventive Maintenance Log Sheet
(Perform Every Time Lamphouse Bulb is Replaced)

Date: _____/_____/_____ **Lamphouse Hour Meter Reading:** _____

Action Required	Date Performed
Clean lamphouse mirror	
Vacuum lamphouse assembly	
Check lamp connectors	
Check douser assembly	
Check cooling blowers	

Table 4.7: Lamphouse Preventive Maintenance Checklist/Log Sheet

Projector Dusting Guidelines

The most important part of the maintenance program is cleaning. Dust on surfaces that the film touches can scratch the film and render it useless for future exhibition. Dust does not remain in one place, but migrates to all parts of the projector, causing film damage and possible bearing failure. Blowing dust off projector parts and surfaces with a high-pressure air hose is not recommended. This activity drives the dust into the mechanisms, where it can cause damage. The preferred approach for dusting the projector is to wipe surfaces with a soft cloth or brush them with a camel hair brush. Vacuuming is also acceptable. If a part does not contain moving parts or dust-trapping cavities, remove it, take it to a work area away from the projector, and blow it clean with high-pressure air. If desired, these parts can be cleaned on the machine with the soft cloth or camel hair brush.

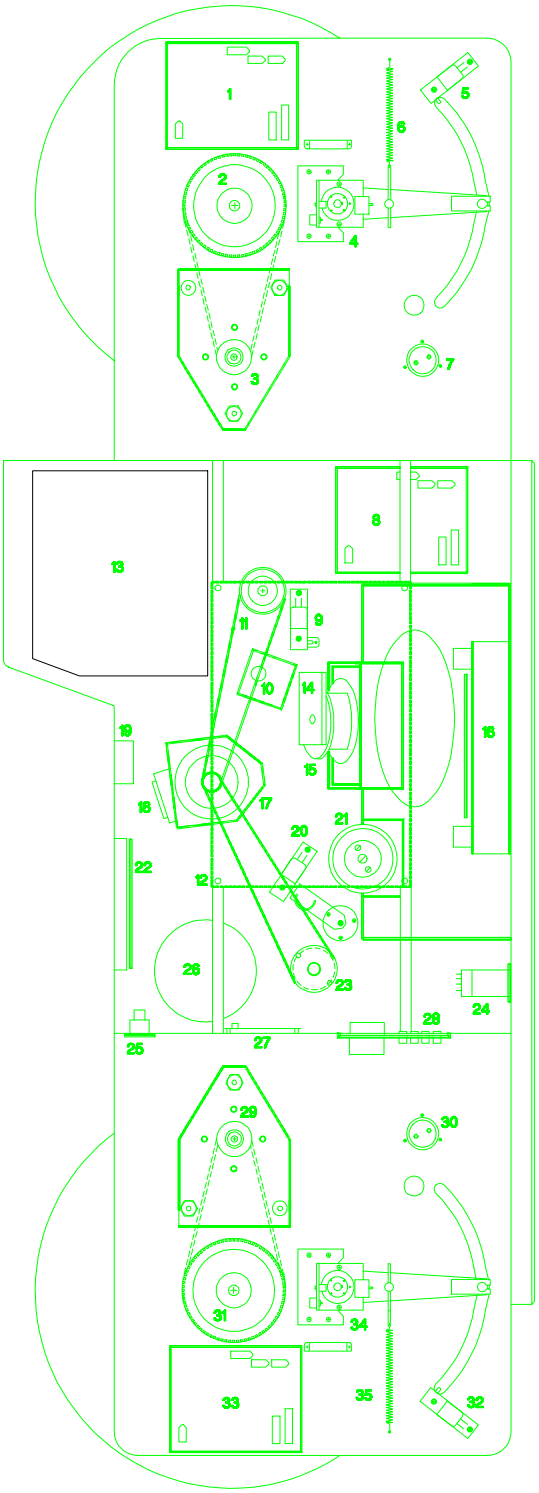
Daily Preventive Maintenance Requirements

Table 4.2 contains the daily preventive maintenance checklist/log sheet.

1. Remove all 4 particle transfer rollers from the projector and, using a damp cloth or cloth with mild soap and water, clean all debris from the rollers. Insure that the rollers are completely dry before re-installing.
2. If necessary, clean the projection lens using the lens cleaning kit.
3. Using the soft cloth, carefully wipe the guide rollers (see Figure 4.2)
4. Remove the gate (see Figure 4.2) and clean the rails on both the movable and stationary gate portions thoroughly with a soft cloth and isopropyl alcohol. If necessary, use a wooden or plastic scraping tool to remove heavy build-up.

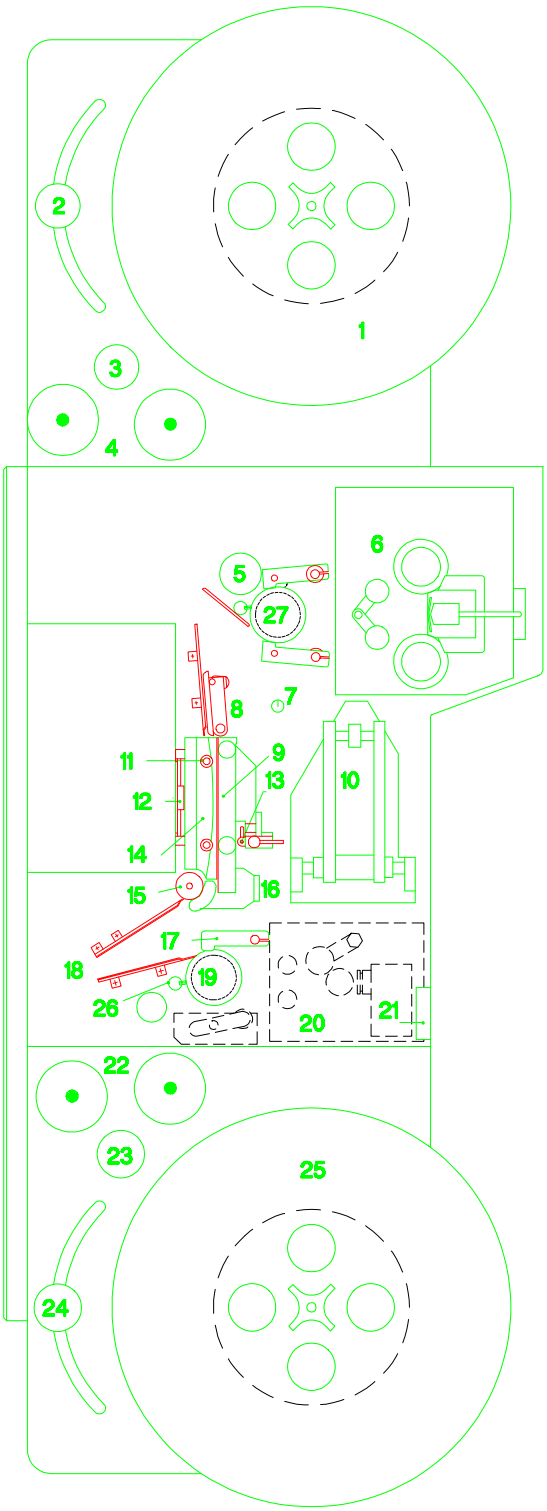
Avoid scratching the guide rails with metal objects. Scratches cause dirt to build up faster in the gate, degrading picture quality.

4. While the gate is out, clean the trap (see Figure 4.2) using the soft cloth. Avoid areas near the BOF and EOF sensors. As with the removable gate, keep dust and debris from entering the clearance spaces. Be certain that the guide rails are absolutely clean.
5. The BOF and EOF sensors are optical devices. Therefore, they must be cared for just as the rest of the optics. Due to their delicacy, they must be cleaned gently with a soft camel hair brush.
6. Dust and vacuum the film side of the projector to remove any film debris.
7. Check the two buckle trips in the film path (see Figure 4.2) for proper operation.
8. Check the sprockets (see Figure 4.2) or smooth movement. Since the two constant-velocity sprockets are driven together, turn either one to check them both. The pulldown sprocket (see Figure 4.2) is directly driven, and does not need to be checked.



1. UPPER TOURQUE MOTOR AMPLIFIER
2. UPPER TORQUE MOTOR BRAKE AND PULLEY
3. UPPER TORQUE MOTOR
4. UPPER TORQUE ARM AND OPTICAL ASSEMBLY
5. UPPER ARM LIMIT SWITCH
6. UPPER ARM TENSION SPRING
7. UPPER TACHO GENERATOR
8. 2285 SHUTTER MOTOR AMPLIFIER
9. UPPER BUCKLE LIMIT SWITCH
10. 2276 FRAMING SWITCH
11. UPPER C.V. PULLEY AND BELT
12. 2293 MAIN CPU CARD
13. 70mm DTS/MAGNETIC HEAD MOUNTING AREA
14. 2269 SHUTTER ENCODER
15. SHUTTER MOTOR
16. 2275 PULL-DOWN AMPLIFIER
17. CONSTANT VELOCITY (C.V.) MOTOR
18. 2269 C.V. MOTOR ENCODER
19. DOUSER INTERLOCK RELAY
20. LOWER BUCKLE LIMIT SWITCH
21. PULL-DOWN MOTOR
22. 2285 C.V. MOTOR AMPLIFIER
23. LOWER C.V. PULLEY AND BELT
24. DOUSER RELAY
25. XLR AUDIO CONNECTOR
26. 35mm DTS MOUNTING AREA
27. 2273 BI-PHASE INTERFACE CARD
28. MAIN CONNECTOR PANEL
29. LOWERTORQUE MOTOR
30. LOWER TACHO GENERATOR
31. LOWER TORQUE MOTOR BRAKE AND PULLEY
32. LOWER ARM LIMIT SWITCH
33. 2285 LOWER TORQUE MOTOR AMPLIFIER
34. LOWER TORQUE ARM AND OPTICAL ASSEMBLY
35. LOWER ARM TENSION SPRING

Figure 4.1: Maintenance Locations on Projector Mechanical Side



1. UPPER REEL
2. UPPER TORQUE ARM ROLLER
3. UPPER TACHO GENERATOR
4. UPPER PARTICLE TRANSFER ROLLERS
5. ROLLER
6. 70mm MAGNETIC HEAD
7. FRAMING SWITCH
8. UPPER BUCKLE PLATE
9. MOVABLE GATE
10. LENS MOUNT
11. WEAVE GUIDES
12. GATE GLASS
13. GATE PIN
14. STATIONARY GATE
15. PULL-DOWN SPROCKET
16. 2268 PULL-DOWN SENSOR
17. LOWER C.V. BUCKLE PLATE
18. LOWER LOOP GUIDES
19. LOWER C.V. SPROCKET
20. 35mm OPTICAL HEAD
21. PRE-AMPLIFIER

LOWER PARTICLE TRANSFER ROLLERS

22. LOWER TACHO GENERATOR
23. LOWER TORQUE ARM ROLLER
24. LOWER REEL
25. LOWER FILM STRIPPER
26. UPPER C.V. SPROCKET

Figure 4.2: Maintenance Locations on Projector Film Side

9. Check both upper and lower torque arm trip switches (see Figure 4.1). Ensure that, when the arm is relaxed to within one inch of its resting position, the corresponding LED on the control panel goes on.

10. Check picture quality to ensure that ghosting, jitter, and weave are within acceptable limits. Refer to the troubleshooting guide (Chapter 7) if adjustments are necessary.

Weekly Preventive Maintenance Requirements

Table 4.3 contains the weekly preventive maintenance checklist/log sheet.

1. Using the ordinary toothbrush, brush off the teeth on all the sprockets. The sprockets are as shown in Figure 4.2.
2. Clean the DTS head or Magnetic head with a cotton swab dipped in isopropyl alcohol or using a soft brush.
3. Open the back of the projector and vacuum the circuit boards.
4. Generally clean all surfaces in the back of the projector. Be careful to wipe around bearings. Do not let dust or debris get into the bearings.
5. Lubricate the gate center pin with a small amount of silicone grease.
6. Remove and clean the gate glass (see Figure 4.2) with isopropyl alcohol and lens cleaning tissue.
7. Ensure that the Delrin shoes on the movable gate have adequate spring tension; adjust the tension if it is too weak.
8. Check all mechanical connections (screws, etc.) and tighten as needed.

Monthly Preventive Maintenance Requirements

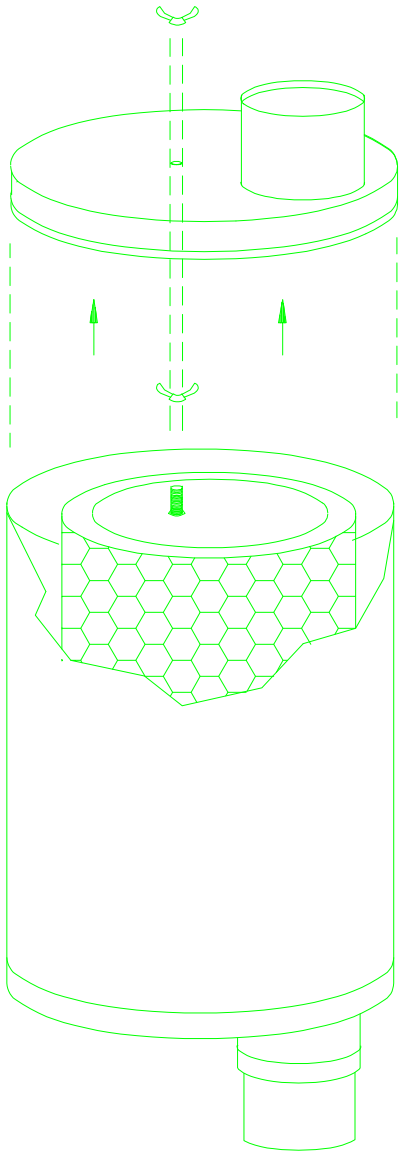


Figure 4.3: Air Filter Canisters

Table 4.4 contains the monthly preventive maintenance checklist/log sheet.

1. Check the belt tension on all four belts (see Figure 4.1). This check is accomplished by pushing the center of one side of the belt with moderate pressure and ensuring that the belt deflects approximately ¼" (6 mm).
2. Service the air filter canister:
   a. Remove the wing nut on top of the air filter canister. (See Figure 4.3.) It is not necessary to remove the hose clamp.
   b. Carefully lift off the top cover of the canister, taking care not to kink the flexible hose. Then slide the cylindrical shell of the canister up and set it aside.
   c. Unscrew the nut on top of the filter to free the filter from the threaded center post, and slide the filter off.
   d. If replacement is not necessary, clean the element:
      1) Blow dry compressed air (30 PSI or less) through the element from the clean side.
      2) If necessary, wash the element in warm (120° F or less) water solution with household detergent. Rinse thoroughly. Examine pleated media carefully to determine that the media has not been damaged.
   e. Reassemble the filter canister in reverse order, using a new filter.
3. Remove all four cleaner brushes with snap-ring pliers and clean the brushes with compressed air outside of the projection booth.
4. Visually inspect the entire projection system for loose connections.

Replace the element for ANY of the following reasons:

- **Pleated media is cut, torn, worn, or uncleanable.**
- **Metal end caps (if so equipped) are bent out of flat.**
- **Perforated metal bent into pleated media.**
- **Gasket is cut, deformed, or damaged in any manner.**

Semiannual Preventive Maintenance Requirements

Table 4.5 contains the semiannual preventive maintenance checklist/log sheet.

1. Check the brushes on all five servo motors.

- **When reinstalling old brushes for ANY motor, ensure that the brushes are installed in their original location and in the same direction.**
- **The installation of new pulldown motor brushes requires a burn-in period of at least 24 hours. The pulldown motor must be toggled between forward and reverse every hour to properly wear in the brushes and to prevent jitter. It is recommended that an external 12- or 15-VDC power supply be used to run the motor.**

2. Check EOF/BOF sensor voltage and adjust if necessary. (See Section 6.2.)
3. Inspect CV buckle shoes for excessive wear. Replace if necessary.

Yearly Preventive Maintenance Requirements

Table 4.6 contains the annual preventive maintenance checklist/log sheet.

1. Ensure that the coupling between the tacho roller and the tacho generator is secure and there is no slippage between the generator and the roller.
2. Check all power supply voltages: +5V, +15V, +34V, and +24V.
3. Ensure the reeling motor brakes are operating properly in the NOT READY mode and disengaging properly in the READY mode.
4. Visually inspect the entire projection system for loose bolts or screws and damaged cables.
5. Replace particle transfer rollers to maintain film cleaning effectiveness.
6. Clean the back of the projector with the vacuum.

Preventive Maintenance Requirements for Lamphouse

Table 4.7 contains the lamphouse preventive maintenance checklist/log sheet. The following steps should be performed with the lamp removed whenever the lamphouse bulb is replaced:

Always verify that the lamp is removed and power to the lamphouse is shut off. Failure to do so can result in severe injury!

1. Clean lamphouse mirror with tissue paper or optical wipes. Be very careful not to scratch the mirrored surface.
2. Clean the lamphouse assembly with the vacuum.
3. Check the lamp connectors for corrosion and security.
4. Check for any loose connectors.
5. Check douser limit bumpers for wear and replace if necessary.

Refer to the lamphouse manual for any other specific maintenance requirements.

THEORY OF OPERATION

This section describes the theory of operation for the 35/70 projector. The description introduces a general view at an overall block diagram level, and then details the function of each block in subsequent paragraphs. Circuit diagrams and component layouts for each card are found in Section 8 of this manual.
The projector is self-contained except for the power supply and control console. The projector houses most of the electronics, as well as the position encoders, power amplifiers, and motors.

Functional Description of the Projector

The overall block diagram of the projector is shown in Figure 5.1. Projector operation depends on five motor systems which deal with the shutter timing and film motion in both cine (also called pulldown) and slew (also called high-speed) modes.

- Shutter Control Circuit
- Constant Velocity Control Circuit
- Pulldown Motor Control Circuit
- Upper Torque Motor Control Circuit
- Lower Torque Motor Control Circuit.

The interrelationship and timing between these circuits is shown schematically in the film velocity diagram and the system timing diagram, both in Section 8.15 (Miscellaneous Diagrams).
The Shutter Control Circuit and the Constant Velocity Control Circuit are directly controlled in both cine and slew motion modes. The desired film speed is normally 30 frames per second in cine, and 120 frames per second in slew mode. The shutter rotation speed is normally 30 rotations per second. The microprocessor CPU generates signals which are used to precisely control these two motor speeds, which are locked to the line frequency using a phase locked loop.
The shutter has two openings, so the film frames are illuminated 60 times per second. In cine operation, the pulldown motor must move the film in such a way that a frame is stationary in the film gate during two illuminations, and then must move a new frame of film into the gate during the closed portion of the second shutter cycle. The shutter provides an index signal to the pulldown circuit which indicates the precise moment of shutter closure, and initiates the pulldown action. The next frame is pulled into place, and held in registration by monitoring an edge indication from the slots on the pulldown disk encoder.

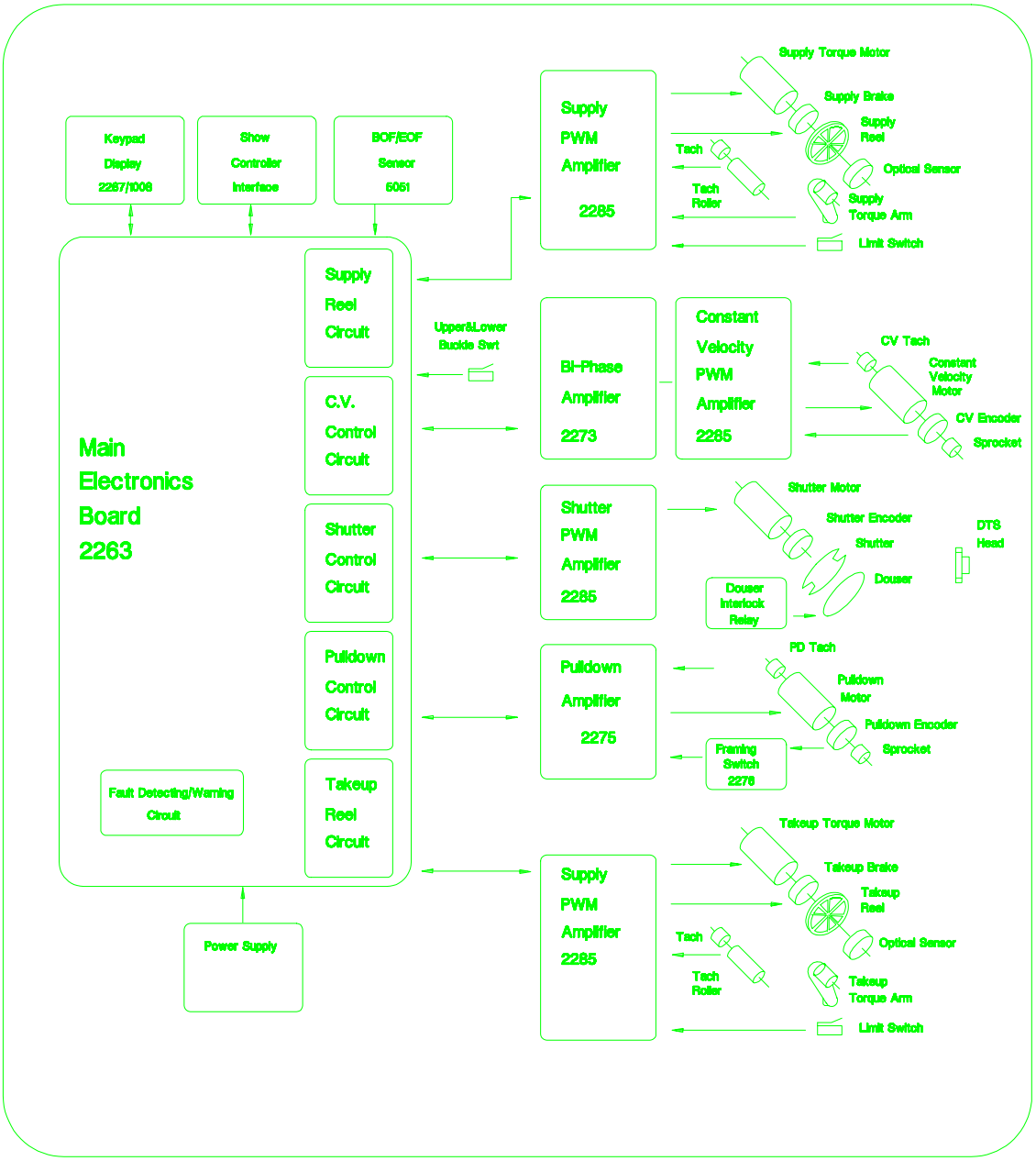


Figure 5.1: 35/70 Electronic Projector Block Diagram

The incremental motion of the film in the gate is taken up by the film loops maintained for this purpose. The upper and lower torque motors are controlled by the position of the respective torque arms, and operate to maintain the torque arms stationary, independently of the amount of film on the supply and take-up reels.

During slew operation the speed and direction of the constant velocity motor is controlled by the CPU. The pulldown motor is slaved to the constant velocity motor so film moves through the film gate smoothly. During slew operation, the douser blocks the illumination of the film.

In interlock operation, the CPU signal that controls the Constant Velocity motor is replaced by an external interlock signal. This interlock signal, when supplied from a Master projector, is derived from the pulses coming back from the C.V. motor of the Master projector. The remainder of the operation remains the same.

Additional functions such as beginning of show and end of show sensing and control of various projector elements are also provided by the CPU.

Actual operation of the control loops is somewhat more complex than the introductory description above, and will be discussed in detail in subsequent paragraphs.

Shutter Control Circuit

The primary mechanical elements of the shutter control circuit are the shutter, the shutter encoder, and the shutter motor, located on the shutter assembly. The shutter encoder provides 20 pulses per revolution of the shutter, and two index mark indications per revolution, corresponding to the two shutter apertures. The encoder pulses are used to control the speed of the shutter; the index pulses control frame pulldown in cine mode and are used a reference when shutter phasing is enabled. The electronic control portion consists of the Shutter PWM Amplifier, 2285, and the shutter control circuitry on the 2293 Main Electronics Board.

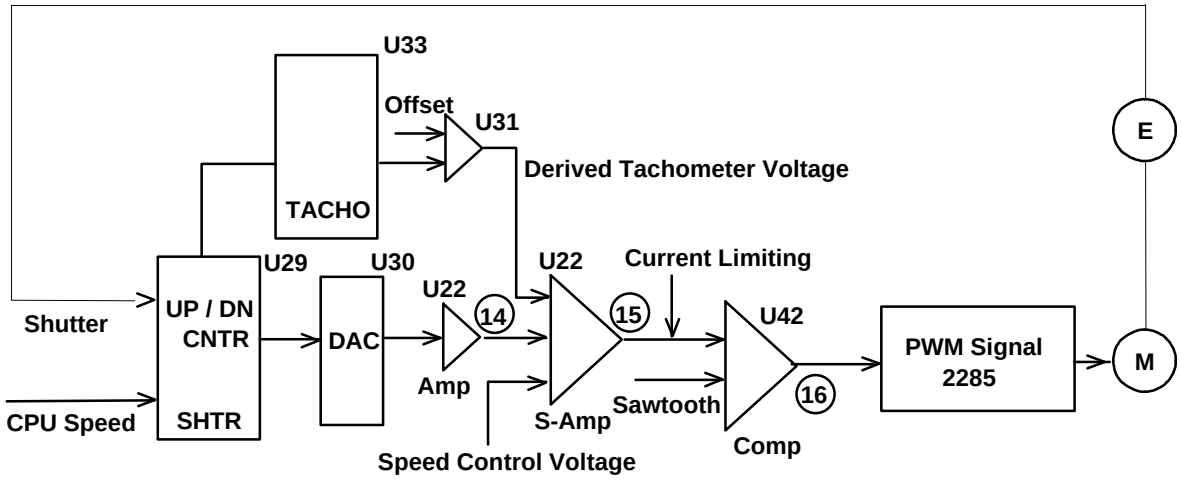


Figure 5.2: Shutter Motor Control

Shutter operation is diagrammed in Figure 5.2 above. When the shutter is rotating at correct speed, nominally 30 rps, about 600 pulses per second are sent to the Shutter EPLD, U29, by the 20 slot shutter encoder rotating on the same shaft as the shutter. Since the shutter is locked to the line frequency, this is either 10 times the 60 Hz rate or 12 times the 50 Hz rate. Within the EPLD, an edge detector produces a signal of four times this rate, which is sent to the Tacho EPLD U33. The Tacho circuit produces output signal pulses that can be converted into a tachometer signal. Integrating amplifier U31 produces this analog tachometer signal which is summed into amplifier U22. The speed control voltage into this amplifier is derived from the negative supply voltage. The output of the summing amplifier U22 is sent to comparator U42, where the error signal is converted into a pulse-width-modulated (PWM) signal by comparing with a sawtooth input. This output is sent through photocouplers to the PWM power amplifier, the 2285 card, which drives the shutter motor. The current-limiting signal from the Power Amplifier turns on the photocoupler, U43, which limits the voltage sent to the pulse width modulator, U42.

While the circuitry described so far would result in an accurate rate of shutter rotation, it is also desirable that the shutter rotation be held constant over the long term operation of the system. This requires that any rotational lag or lead that develops due to mechanical or circuit perturbations be zeroed out. To accomplish this, a positional correction has been incorporated. The pulses from the Shutter encoder are compared with the control rate by means of an up-down counter in the shutter EPLD U29. Each pulse from the control rate input causes the counter to count up, each pulse from the encoder causes the counter to count down. The eight-bit output of this counter is sent to a DAC, U30, where an analog voltage proportional to the number of pulses by which the shutter lags or leads the reference is generated. This voltage is amplified by U22 and applied to the summing amplifier U22, along with the control and velocity inputs. Having both the long term and short term rotational rates of the shutter precisely controlled allows the pulldown operation to be controlled by the shutter index pulse. Without this control, long term effects would eventually cause the pulldown to over-run the film loops and stop operation of the projector.

As a further refinement in support of telecine applications, a circuit has been incorporated which ensures the shutter is synchronized to the vertical blanking time of a video frame. EPLD U19 detects the relative occurrence of the shutter edge and the 60 Hz reference crossover, and adds or subtracts pulses from the 24 KHz reference to the Shutter EPLD to ensure synchronization. This also ensures exact frame-per-frame blanking correspondence for multiple projector applications.

Constant Velocity Motor Control

As seen in Figure 5.1, the main mechanical elements of the Constant Velocity Motor circuit are the Motor, encoder, tachometer and constant velocity drive sprocket contained on the constant velocity drive assembly. The electronic portion of the control circuit is the Constant Velocity PWM amplifier 2285 and the CV control circuit on the 2293 Main Electronics Board.

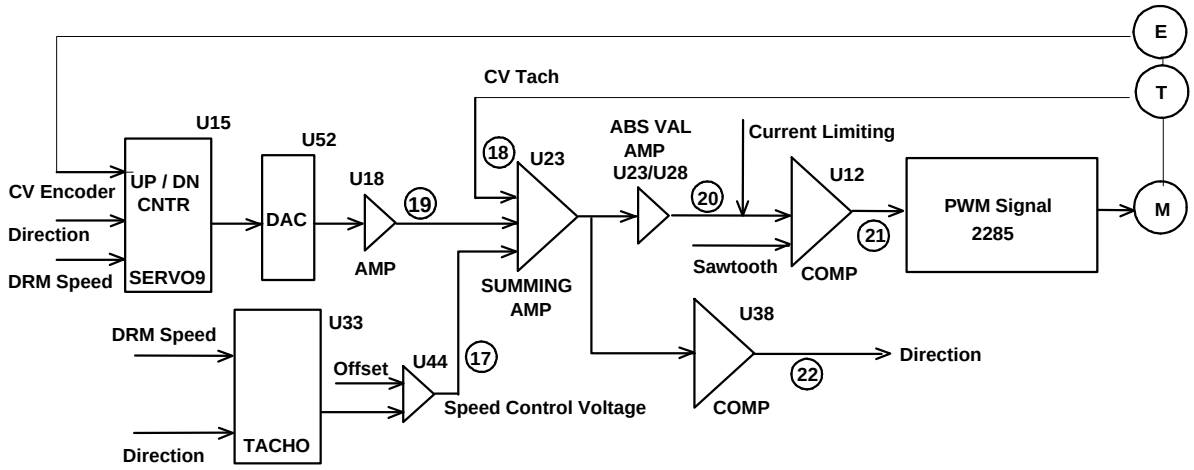


Figure 5.3: Constant Velocity Motor Control

Constant Velocity operation is diagrammed in Figure 5.3. A signal with frequency proportional to the desired film rates is generated by the Digital Rate Multiplier EPLD U14 and associated Programmable Timer Modules. The rates generated for various film speeds, in pulses per second, are given below in Table 5.4.

Frames per Second	Pulses per Second
24 FPS	240 PPS
30 FPS	300 PPS
48 FPS	480 PPS
60 FPS	600 PPS
120 FPS	1200 PPS

Table 5.4: Constant Velocity Rates for Film Speeds

A direction signal is also supplied by the CPU. These signals are processed by the Tacho EPLD U33, whose output is integrated by U44 into an analog speed control voltage. An offset derived from the plus voltage is also summed by U44. This speed control signal is compared to the CV tachometer signal by U23, and the absolute value of the error signal is derived by U23 in combination with U28. This unidirectional signal is converted to a PWM signal by comparator U12, and sent to the Constant Velocity PWM Amplifier 2285. Comparator U38 derives a direction signal which is also sent to the PWM Amplifier. The current-limiting signal from the power amplifier turns on the photocoupler, U11, which limits the voltage sent to the pulse width modulator, U12.

In a manner similar to the case of the shutter motor control, a signal representing the long-term position error is also summed into U23, along with the speed control voltage and the tachometer signal. This signal is derived from the CV encoder pulses and the DRM speed pulses, using the SERVO9 EPLD U15 as an up-down counter. The eight-bit output of this counter is converted into an analog voltage by DAC U52, and amplified by U18 before being summed into U23. To

ensure that the counter does not overflow and cause a sudden transient to the motor during rollover, pending overflow is detected and the CPU reduces motor speed so overflow does not occur.
Locking the Constant Velocity motor to the line frequency has advantages where line frequency variations are minor. Where excessive variation exists, crystal oscillator control may be selected by a jumper on the 2293 board.

Pulldown Control Circuit

The primary mechanical elements of the pulldown circuit are the pulldown motor, the pulldown disk sensor, the tachometer, and the pulldown sprocket, all located on the pulldown assembly. The major electronic assemblies are the Pulldown Amplifier 2275 and the associated pulldown circuitry on the 2293 Main Electronics Board.
The action of the pulldown circuit is different in slew and in cine mode. During slew operation, the pulldown motor must be locked to the constant-velocity motor so film moves smoothly through the film gate.
Figure 5.5 shows the pulldown circuit configured for slew operation. To lock the speed of the pulldown motor to the constant velocity motor, the two tachometer signals are fed into U21 as a differential amplifier. The bi-directional error output is amplified by U21 and sent to the Pulldown Amplifier Board 2275. On the amplifier board the signal is amplified by U1 and sent to the motor drive circuitry. To further ensure full synchronization between the two motors, the respective encoder signals are sent to EPLD U19 operating as an up-down counter. The eight-bit output of this counter is sent to the DAC U20, amplified by U55, and summed with the pulldown tachometer to provide precise positional control between the two motors.

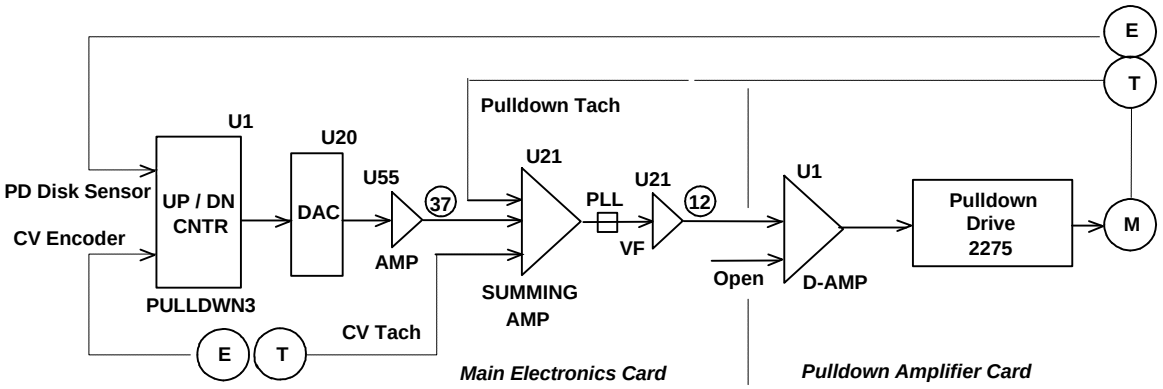


Figure 5.5: Slew Operation - Pulldown Circuit

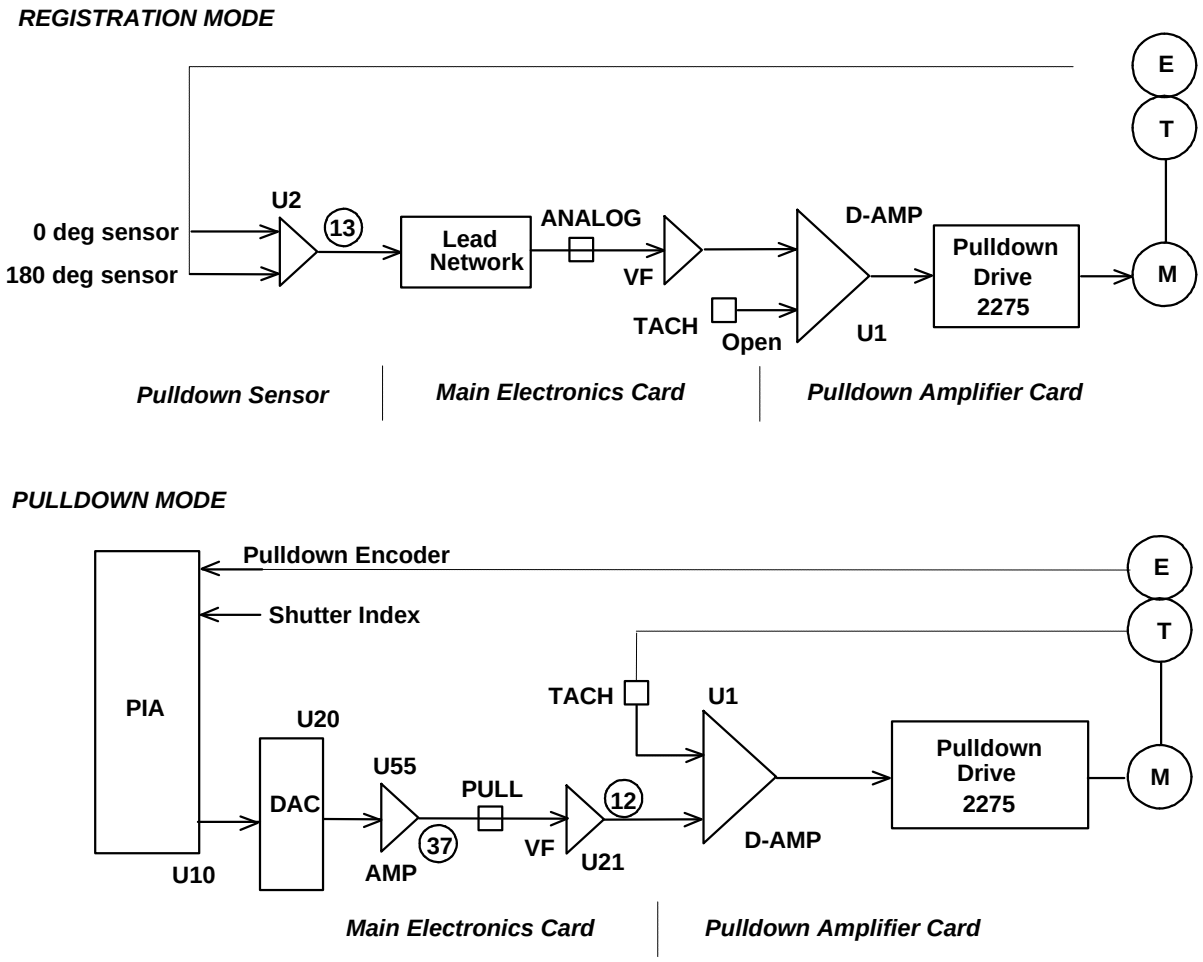


Figure 5.6: Cine Operation - Pulldown Circuit

The operation of the pulldown circuit during cine motion is shown in Figure 5.6. During registration mode, the Pulldown motor is used to maintain stationary registration by connecting the differential output of the zero and 180 degree sensors, each partially blocked by the edge of a disk slot, to the motor through amplifiers U21 and U1. Any motion of the disk edge across the face of the sensors creates a restoring signal to the motor. During pulldown operation, the CPU maintains direct control of the Pulldown motor. PIA U10 provides an eight-bit control signal to DAC U20. The analog control voltage is amplified by U55, U21 and U1 on the Pulldown Amplifier Card, driving the Pulldown motor.
Figure 5.7 shows the timing relationships during the pulldown action. Prior to time 0 on the diagram, the film is in registration and is being illuminated by the shutter. At time 0 a shutter index pulse signals the CPU to initiate a pulldown. The CPU opens the TACH AND ANALOG switch U27 and closes the PULL switch U47. A signal is sent through the PIA and DAC to command the pulldown motor to full speed. The CPU monitors the signal from the pulldown disk sensor, which has been squared up by comparator U2 on the sensor board. When the fourth slot on the five slots-per-frame sensor is in the sensor area, which is to say the seventh edge has passed the sensor, the CPU initiates a positive voltage to the motor to achieve the desired braking. As the motor comes to a stop, the shutter tachometer signal is summed into U1 on the pulldown amplifier board by closing the TACH analog switch portion of U27. This provides damping. The circuit is placed into registration mode and the trailing edge of the fifth slot is used to resume registration for the next frame of the film. An automatic circuit detects any incorrect registration, such as might be caused by a change in motor characteristics. If registration is not correct, the correction voltage used on the next pulldown is changed to ensure correct registration.

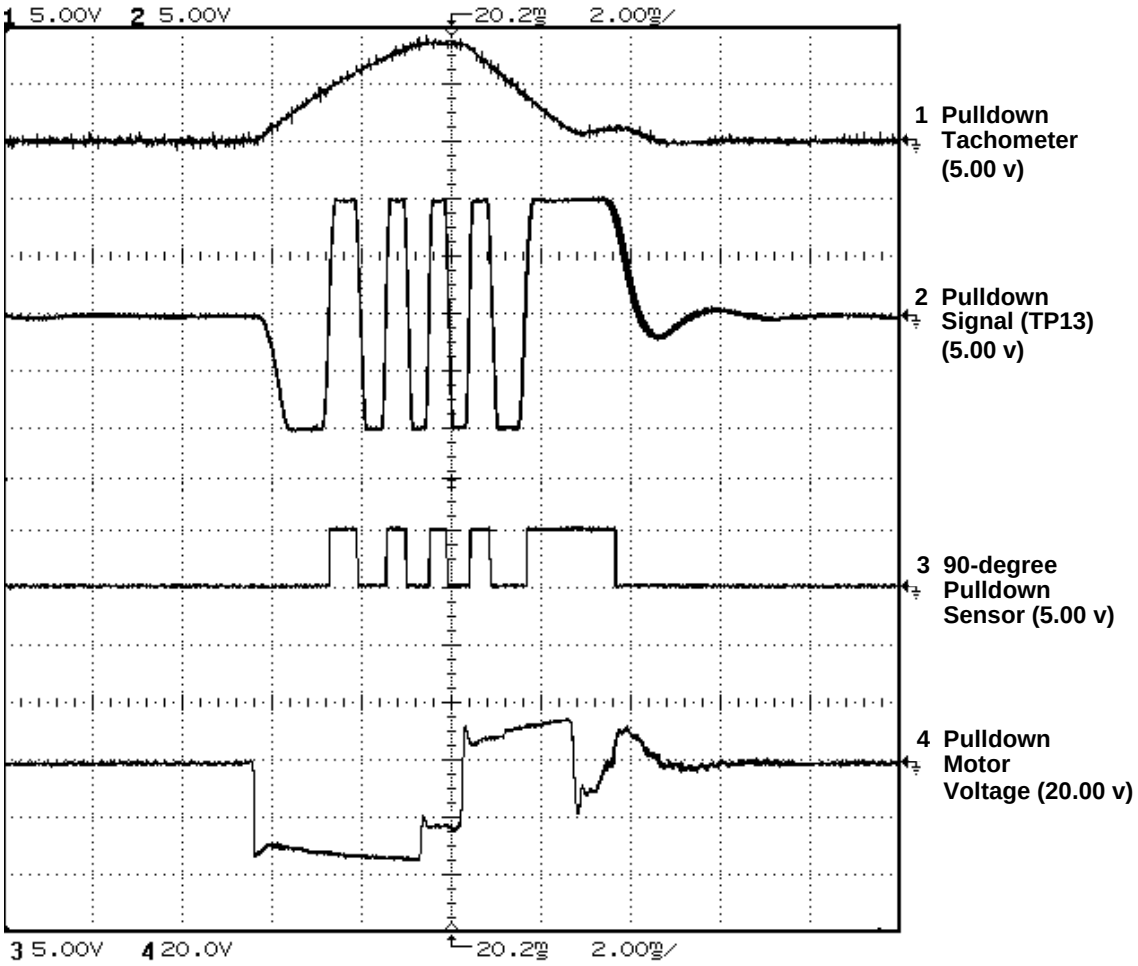


Figure 5.7: Pulldown Circuit Timing for 60FPS

The pulldown circuit also performs the Automatic Loopset function. Under CPU control, the pulldown sprocket is turned slowly until the film speed drops below a set value. The CPU rewinds four and one-half frames and stops in registration. A two-second timeout stops the pulldown motor if there is no film in the projector and illuminates LED <3> on the keypad.

A framing switch has been incorporated to aid the operator in proper framing. The five positions of the framing switch allow the relationship between the encoder slot selected for registration and the indexing slot to be changed in increments of 1 film perforation, for 70mm film. For 35mm film the increments equal 1/5 of the 4 perforation film frame. This avoids the need to relocate the film on the sprocket if the film is not framed.

The Reeling System Circuitry

The major components of the upper reeling circuit are the upper reel motor and brake, the tacho-roller, and the upper torque arm with its optical potentiometer. The major electronic components are the Supply PWM Amplifier (2285) and the Supply Reel Control circuitry on the Main Electronics Board. (See Figure 5.8.)

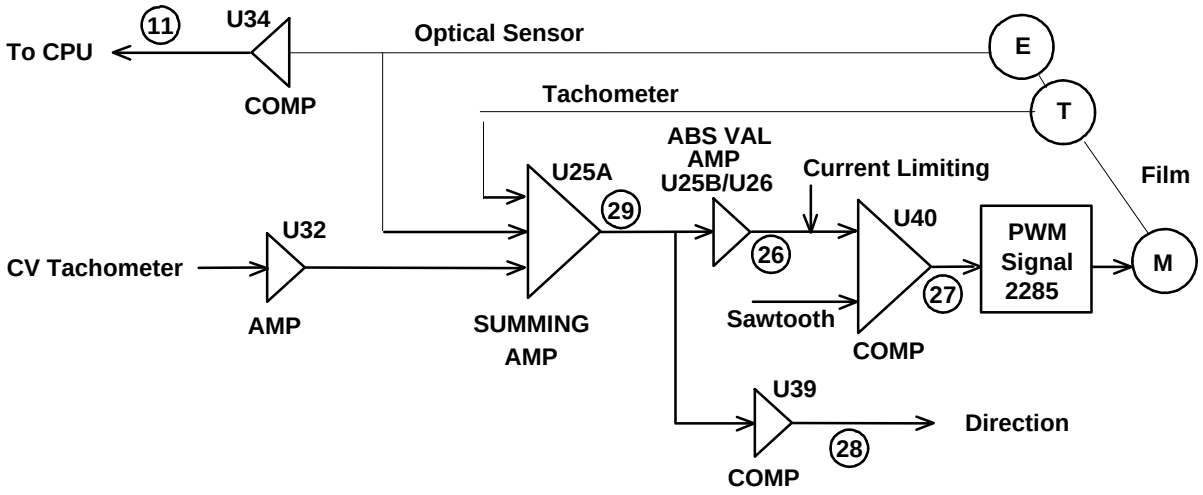


Figure 5.8: Upper Reel Motor Control Circuit

The reel motor control is accomplished by comparing the speed of a film-driven Tacho-roller with the voltage from the constant-velocity tachometer using summing amplifier U25A. In addition, the upper torque arm position, sensed by an optical pot, feeds into the summing amplifier. As the voltage becomes more negative, more torque is applied in the take-up direction. The circuit is biased in such a manner that the input signal from the optical pot will be zero volts when the torque arm is at normal position, independent of speed.

The output of U25A goes to an absolute value circuit, formed by U25B and U26, where it is converted to a PWM signal by U40. U40 compares the analog voltage to the output of the sawtooth generator, as is done by U42 for the shutter. U25A also goes to a comparator, U39, which determines the polarity of U25A and outputs a direction signal to the upper torque power amplifier. The current limiting signal from the power amplifier turn on the photocoupler, U41, which limits the voltage sent to the pulse width modulator, U40.

The Optical Sensor is also monitored by the CPU using comparator U34. Transistor Q9 turns off the drive to the reel motor in the Platter mode of operation.

The lower torque circuit is similar to the upper. The major components of the lower reeling circuit are the lower reel motor and brake, the tacho-roller, and the lower torque arm with its optical potentiometer. The major electronic components are the PWM Amplifier and the Reel Control circuitry on the Main Electronics Board. (See Figure 5.9.)

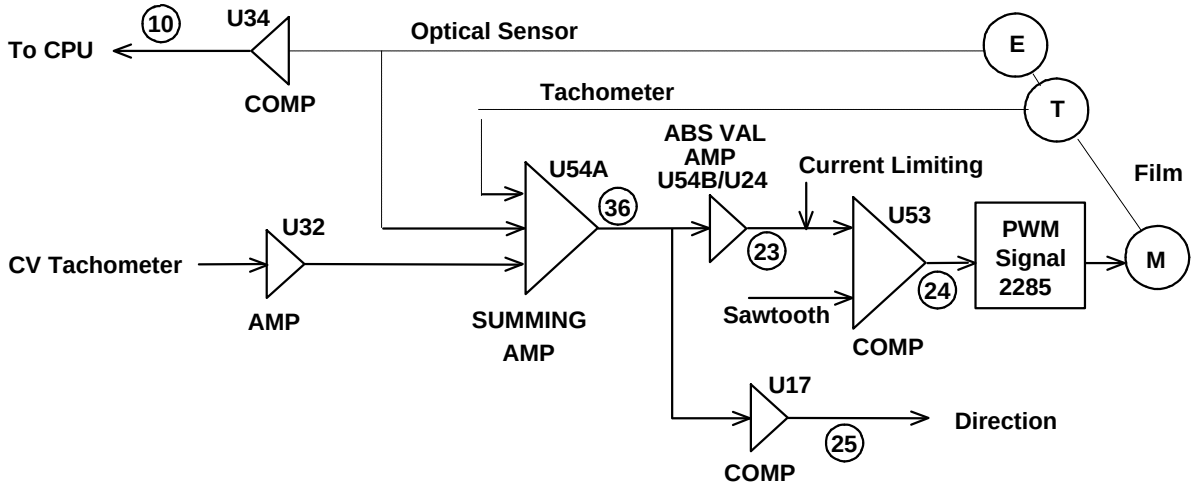


Figure 5.9: Lower Reel Motor Control Circuit

The lower reel motor controls summing amplifier U54A. The absolute-value circuit is formed by U54B and U24; the PWM conversion is done by U53. U17 determines the polarity and outputs a direction signal to the lower torque power amplifier. The current-limiting signal from the power amplifier turns on the photocoupler, U45, which limits the voltage sent to the pulse width modulator, U53. The Optical Sensor is monitored using comparator U34. Transistor Q10 disables the PWM output in the Platter mode of operation.

The Sync Separator Card (0300)

The Sync Separator card (see Section 8.2) is used to extract vertical sync timing information from a composite NTSC, PAL, or SECAM video input signal. This card is also used to select the type of reference signal being supplied to the projector. The jumper settings on the board control 50/60Hz line frequency, external 60Hz, vertical video synchronization, and internal synchronization (See Table 5.10). When operating the 35/70 projector in the Master/Slave mode it is important the both projectors are receiving their sync from the same source.

Signal Type	JP1	JP2	JP1 (2293)
Video Sync	1&2	1&2	1&2
External	2&3	2&3	1&2
50/60Hz Line	N/A	N/A	1&2
Crystal[4]	N/A	N/A	2&3

Table 5.10: Sync Separator Card Jumper Settings

[4] This setting is not recommended for use with Master/Slave projector configurations.

The CPU/Main Logic Card (2293)

The CPU/Main Logic card (card 2293) contains:

- the 6809 microprocessor (CPU)
- parallel interface adapters (PIAs)
- the control read-only memory (ROM) that contains the program
- the RS-232 asynchronous communication interface adapter (ACIA) chip for serial communication
- the programmable timer module (PTM) chip that generates the clock rates for the ACIA and motor circuits
- the scratch pad random access memory (RAM)
- the digital-to-analog converters (DACs) that allow the CPU to generate motor drive voltages
- Erasable Programmable Logic Devices (EPLDs) that contain complementary metallic oxide semiconductor (CMOS) logic elements, such as gates and flip-flops.
- Control Circuitry, much of which is described in Section 5.1.

The CPU Section

The CPU section of card 2293, illustrated in Section 8.7, uses a 6809 processor with a built-in crystal oscillator. The CPU section is shown in the diagram of Figure 5.11. The computer program resides in a single 27128 EPROM, designated U2 in the circuit diagram. U1 is an 8192-byte RAM. U4, U10, and U37 are PIAs, used to communicate with the EPLDs and DACs, and for sensing and controlling bilevel inputs and outputs. U7 is the ACIA, which communicates with the show controller, or with the terminal for troubleshooting, across the RS-232 interface. U9 shifts the 0- to 5-volt output of the ACIA to ±15 volts, as required for an RS-232 interface. U8 shifts incoming 12-volt levels to 0 - 5 volts for the ACIA. The PTM divides the CPU clock to 153.6 KHz, as required for the ACIA, and scales other rates for motor drive circuits. The ACIA communicates at 9600 baud.

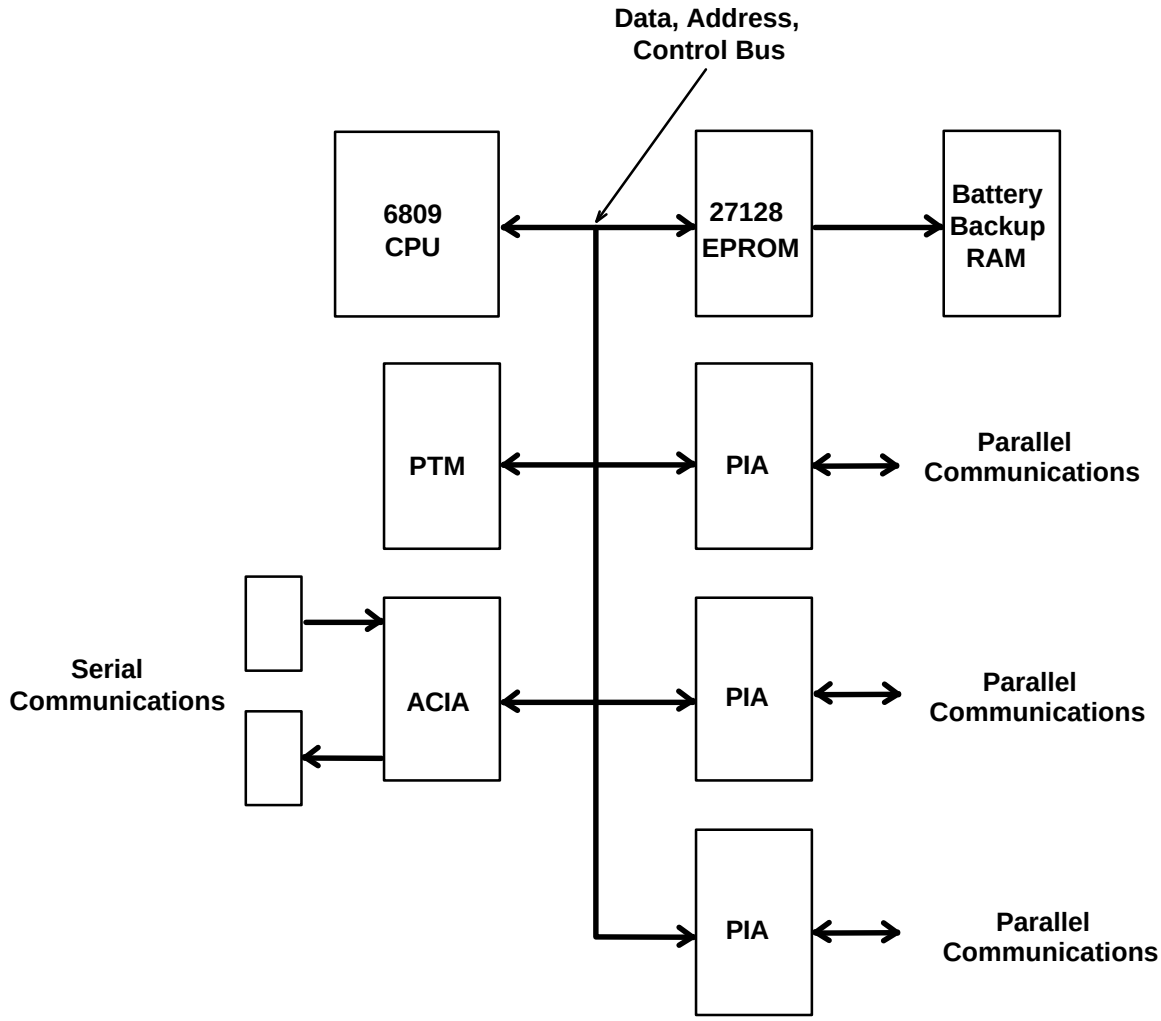


Figure 5.11: CPU Circuits

The CPU section operation is typical of any microcomputer:

1. The restart logic applies a **RESET** command to the processor when power is applied.
2. The processor then begins to execute the program stored at the **RESET** address, which is located in the EPROM.
3. After the **RESET** routines have been executed, the processor executes the normal operating program. This program monitors the PIAs and the ACIA, and controls the PTM. Based on the information received, the processor sends the necessary control signals to the PIAs to operate the pulldown, constant-velocity, and shutter motors.

A phase-locked loop, located on this card, locks the internal signals to an external 50- or 60-Hz source. The phase-locked oscillator is U16. The PTM divides the oscillator output of 192 KHz to 60 Hz, and provides a 50% duty cycle to the comparator of the phase-locked loop. The PTM divider is under software control, and can be adjusted to divide to 50 Hz operation. U14, an EPLD, is a DRM that uses the phase-locked oscillator's output.

The 192 KHz signal input to the DRM can be multiplied by any value from .00 to .99. This function provides a precise set of frequencies that are stepped from one value to another to ramp motors up and down in speed with linear and consistent accelerations.

Interlock Operation

The 35/70 Projector has the capability to be directly controlled by an external input in a manner quite different from the normal Show Controller interface. This feature, called interlock, is normally used when the 35/70 projector is operated in a Master/Slave configuration or is being driven by an external bi-phase source.
As noted above, the motion of film in the projector is directly controlled in both cine and slew modes by speed control pulses commanded by the CPU and generated from the DRM. These pulses control the shutter speed, as shown in Figure 5.2, and the Constant Velocity Motor, as shown in Figure 5.3. In each case, signals are sent to U33, the Tacho circuit, to generate a speed control voltage, and to an up/down counter to provide precise positional control. Pulldown in cine mode is synchronized by the shutter index pulses, and in slew mode the pulldown motor follows the Constant Velocity Motor. The torque arms operate the reel motors with the help of the CV Tach. To operate in interlock mode, the signals generated by the CPU to the constant velocity circuit are replaced by pulses sent from an external biphase source, which is referenced to the line frequency or some other reference source which is common to all the machines being controlled. Interlock operation is selected by giving the CPU the appropriate command. Interlock signals are input at connector J11 on the Main Electronics Card.

EOF and BOF Detection

The beginning-of-show (BOF) and end-of-show (EOF) signals are input into the main electronic card on connector J6. The circuitry is shown in the diagram of Figure 5.12. (See also Section 8.14.) The EOF tape is detected by comparator U35A. The output of U35A goes high while the tape is being detected; it is input to the CPU through a PIA. The BOF tape is processed in a similar manner by U35B. When a projector is operated in the Slave mode, the detection of EOF signals is disabled.

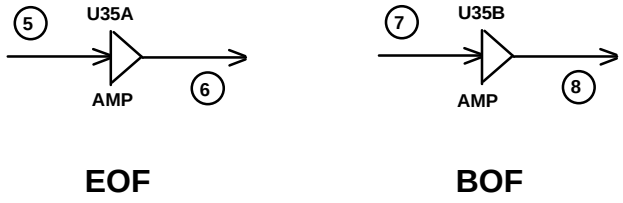


Figure 5.12: EOF and BOF Detection Circuits

PWM Sawtooth Ramp

The sawtooth ramp used to generate the PWM signals for motor controllers is generated by two sections of U34 and two of U36. The sawtooth is generated on capacitor C22, controlled by the charge and discharge rates of Q5 and Q6. The frequency is about 20 KHz.

Fault Indications

Indications of operating faults are input to the main electronics card in connector J5. Upper and lower film buckle switches are monitored by the CPU and also combined in EPLD U29 to provide a ready signal to send to motor control cards. This ensures the film comes to a smooth stop in the event of a problem, eliminating film breakage and sprocket hole damage.

The Pulldown Sensor Circuit (2268)

Signals from the zero-degree sensor and the 180-degree sensor of the disk sensor card feed into a differential amplifier, U1. (See the appropriate circuit diagram in Section 8.9.) The output of U1 is Pin 1 (at R6). The signal there is as shown in the second trace of Figure 5.7.
As the slotted disk on the pulldown shaft turns, the slots pass in front of the 180-degree sensor, causing amplifier U1B to move positive. Simultaneously, another web passes in front of the zero-degree sensor and causes U1A to go negative, in turn causing U1B to go more positive. The resulting pulses, as the disk continues to turn, are counted by the CPU. Comparator U2 squares up the signal and sends it to the computer over parallel bus PIA2-PB4. When four positive and three negative transitions have been counted, braking is applied to the pulldown motor. As the amplifier comes down

toward zero volts for the fifth time, the pulldown motor has nearly slowed to a stop. At this point both optical pickups are partially on, and registration begins.
The sensor circuit also has a 90-degree sensor and an index sensor. Their outputs are squared by U2 and sent to the Main Logic/CPU card, along with the zero-degree and 180-degree outputs.

The Pulldown Power Amplifier Circuit (2275)

The pulldown power amplifier circuit consists of a LM741 operational amplifier followed by an analog amplifier. (See the pulldown amplifier circuit diagram and component layout in Section 8.11.) During final braking and registration, the tach signal from the pulldown motor is summed with the pulldown signal to dampen oscillation. The overall voltage gain of the power amplifier is slightly over 12. The two circuits are identical in operation, differing primarily in their circuit board layout.

The Pulse-Width-Modulated Power Amplifier (2285)

The 2285 power amplifier (see Section 8.13) contains three LMD18200 integrated power switching amplifiers, U5, U6, and U7. Their outputs are coupled to the motor through filters formed by L1-L6 and C12-C13. The filters contain the 20KHz switching frequencies to the board and also isolate U5 – U7. Photocouplers U1-U4 isolate the power stages from the logic level circuits on the 2293 CPU Card. U1 inputs the Pulse Width Modulated signal to U5 – U7, while U2 inputs the direction signal. U3 and U4 activate bilevel drivers Q2 and Q3. Q1 is used to activate photocouplers on the 2293 card that limit current by decreasing the input pulse width. Q4 reduces and regulates the 24-volt supply to 5 volts as required by U1, U5, U6, and U7. This supply maintains isolation between signal and power level circuits.

PWA Amplifier	Circuit 1	Circuit 2
Shutter	Douser	N/U
Constant Velocity	Reverse Solenoid	N/U
Upper Torque Motor	Reel (brake)	N/U
Lower Torque Motor	Reel (brake)	READY Relay

Table 5.13: PWM Amplifier Bilevel Outputs

The DC Power Supplies

The projector power supply (see Section 8.4)has regulated outputs. The high power outputs are -34 volts and +24 volts. The voltages used by the pulldown motor are +24 volts and -34 volts; these are switched by the READY relay, which is part of the power supply. The constant-velocity, shutter, and torque motors use +24 volts. This voltage is switched by another READY relay contact.
The regulated low power supplies +5 volts, +15 volts, and -15 volts for the CPU and other logic devices.

The Keypad (2267)

The keypad consists of the keyboard card, card 2267. (See the keyboard component layout and circuit diagram in Section 8.8.) The keyboard card is a 4 x 8 switch matrix. The fifth column and the right-hand four keys of the bottom row are not used. The four rows of the matrix are scanned by strobes from multiplexer U46 on the CPU/Main Logic card. Each column is monitored for a switch closure by the PIA, U37, on the CPU/Main Logic card. Latches U1 through U4 control the LED indicators on each key.

The Frame Counter Display (1008)

The digits for the frame counter display are sent by means of a four-bit binary coded decimal (BCD) code and eight strobes, one for each digit. The strobe lines drive non-inverting buffers U9 and U10. U1 through U8 are "smart" seven-segment displays with internal latches and seven-segment decoders. When strobed, the BCD data on pins 3, 2, 13, and 12 are latched, decoded, and displayed. Refer to the frame counter diagram in Section 8.3.

Framing Board (2276)

The 2276 Framing Board (see also Section 8.12) selects consecutive phototransistors on the pulldown encoder to allow convenient picture framing by the operator.

System Software

This software theory of operation section offers a deeper appreciation of the basic structure and features of the software. Some of the functions and features described here may not be pertinent to the current application of the electronic projector; however, future applications may make use of them. A fuller understanding of the software requires familiarity with the 6809 assembly language code.

The software that governs the electronic projector system controls the various hardware elements to produce the desired film motion while handling system communication and fault detection. The interweaving of event-driven and real-time interrupt routines with background routines for less time-critical functions provides the speed required for projector operation, along with the robustness of full command functionality. Fail-safe hardware mechanisms back up the software for those critical functions that protect the film and provide safe operation.

At system start-up, initialization routines set up the hardware and software registers, verify proper system operation, and begin execution of the basic film motion interrupt routine. A background program, which monitors the system fault status and the communication ports, is also started. The system is initially in a non-operating state, and must be placed into a ready condition by specific operator commands. When the projector is in a ready state, it can receive commands either to affect the movement and projection of film or to change the system state.

The system state is a combination of hardware and software values that are shared among various software subroutines and store information about previous operations for later use. The selection of an alternate film speed is an example of a change to the system state. The 35/70 software system can support extensive modifications to projector operation to enable improvements or implement diverse applications. This flexibility does not compromise system performance. Software modifications have the additional advantage of eliminating the need for system hardware modifications.

Figure 5.14 provides a high-level flowchart of the system software. Major system variables are listed in Appendix C, the RAM Assignment Chart.

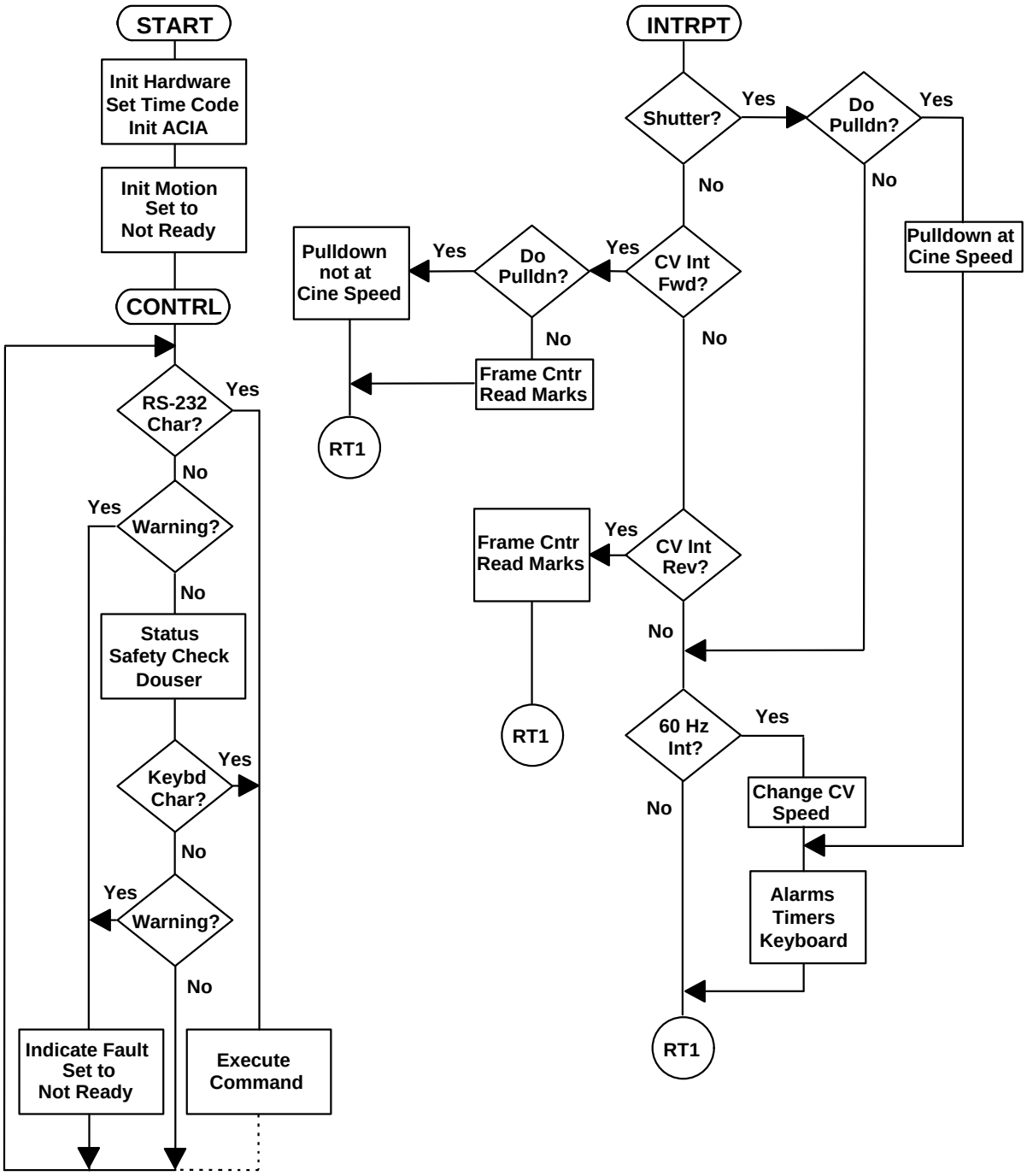


Figure 5.14: System Software Architecture

MECHANICAL AND ELECTRONIC ADJUSTMENTS

This section describes the overall mechanical configuration of the projector and details adjustments that may be required as the result of repair or parts replacement. All necessary mechanical and electronic adjustments are made before the projector is shipped from the factory.
Figures 4.1 and 4.2 illustrate the features of the film path side and the mechanical side, respectively, of the 35/70 Projector.

General Approach to Adjustments

The adjustments and replacement procedures described in this section are ordinarily performed individually as the result of a repair, or because a part has been accidentally disturbed. The order and grouping of the adjustments in this section represents the typical approach to the projector, and is related to the diagnostic approach embodied in the following chapter on troubleshooting.
The starting point is to ensure that the system will come into a READY state, and that the shutter and optical system are performing satisfactorily. Next, the constant velocity system and the film handling loops and gate are set up, and the film is correctly threaded on the machine. With the film handling in place, the reeling system is set up, allowing the film to be transported in slew modes. Finally, the pulldown system is set up to allow cine motion and the projection of the image. In many cases, the adjustment sequence must be repeated to obtain optimum performance. Coarse adjustments are first made to get the system operating; then finer adjustments are made, often by observing the projected image.

BOF and EOF Adjustments

The BOF and EOF sensors are VR7 and VR6, respectively, on the CPU/Main Logic card circuit diagram in Section 8.7. These sensors operate by detecting either the amount of light reflected from the film (non-active) or a piece of FORMLINE silver tape attached to the film (active). The tape should be 3/8 inch wide; it should be placed near the sprocket holes on the inboard side for the BOF sensor and on the outboard side for the EOF sensor. The sensors are located just above the pulldown sprocket in the gate area. Tape should be placed on the emulsion side of the film.

Tape may not be seen through the film if it is placed on the base side.

Film must be mounted on the projector to make adjustments to the BOF and EOF sensors. The film should be positioned in the projector so that the reflective tape is not in the area of the gate. The sensor adjustment is made based on the reflectivity of the film, rather than the reflectivity of the tape.

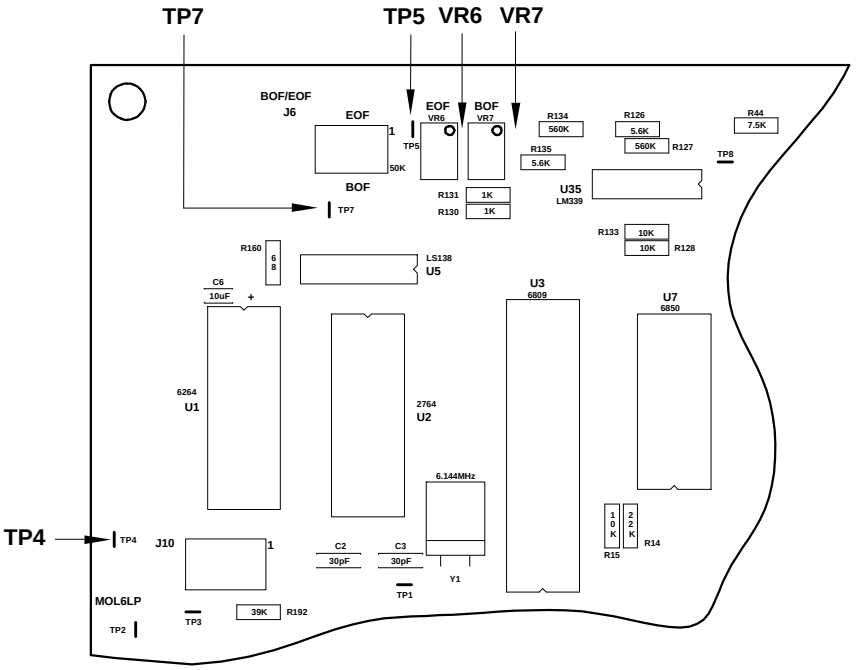


Figure 6.1: BOF and EOF Adjustments

1. Connect an oscilloscope or voltmeter to test point TP7, using TP4 as a ground reference. (See Figure 6.1.) If using an oscilloscope, set it for 1 millisecond per division horizontally and 1.0 volts per division vertically. Set the trigger to automatic. If using a voltmeter, set the scale to 20 Volts.
2. To adjust the BOF sensor voltage, adjust VR7 for a level of -2.0 Volts.
3. Move the test probe to TP5.
4. To adjust the EOF sensor voltage, adjust VR6 for a level of -2.0 Volts.
5. The trip point for the sensors is at +5 Volts. When the sensors see the reflection from the tape, the voltage is near +15 Volts, depending on the tape reflectivity.

Reeling System Adjustment

The torque arm position is monitored by an optical potentiometer consisting of an infrared LED and a phototransistor. A disk with an offset hole is mounted on the torque arm shaft. As the shaft rotates, the disk blocks more or less of the light beam. The disk is adjusted on the shaft so that the tension arm is at a center position, causing the film to be under tension. Both mechanical and electrical adjustments may be required. The mechanical procedures apply to both upper and lower reels, since they are identical in adjustment and operation. The electrical adjustments are carried out using the Reverse Test Mode command for the projector.

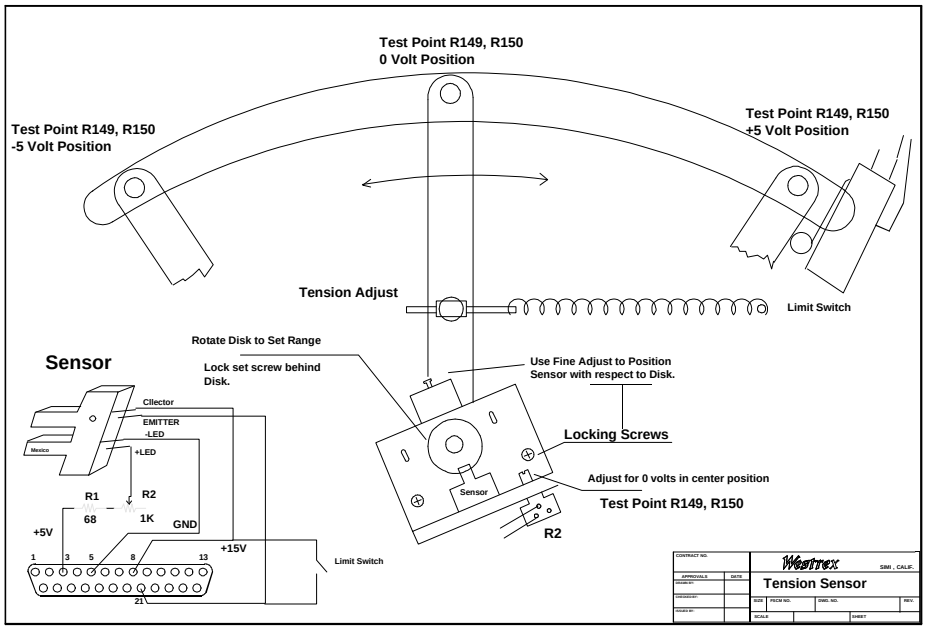


Figure 6.2: Tension Sensor Adjustment for Reeling System.

Mechanical Adjustments

1. Remove the back panel cover from the projector to access the tension sensor mechanism.
2. Apply power and keep the projector in NOT READY mode. In the relaxed position, the arm activates a limit switch, which will short the sensor output to the +15-volt supply. This switch should activate when the arm is relaxed to within one inch of the rubber stop.
3. Remove the disk sensor cover.
4. Loosen the locking screws so that the sensor assembly can be moved with respect to the disk. (See Figure 6.2.)
5. Loosen the set screw holding the disk to its shaft.
6. Turn R2 to the maximum counter-clockwise position; then turn it back a quarter-turn.
7. Hold the torque arm in its mid-travel position. The test point for the upper torque arm is at the top of R150 on the 2293 CPU/Main Logic card, and the test point for the lower torque arm is on the top of R149.

    a. Rotate the upper optical disk so that the widest part of the disk is pointed upwards, and secure the disk. Note that the widest portion of the disk corresponds to one of the four tapped set screw holes in the disk.

    b. Rotate the lower optical disk so that the widest part of the disk is pointed downwards, and secure the disk.

    c. Move the sensor bracket until a reading of 0 volts is obtained and secure the bracket.

    d. Verify that the voltage at R149 and R150 varies by approximately ±5V as the torque arm is moved to extremes. Minor adjustments to R2, the sensor bracket, and the sensor disk may be required to obtain the correct voltage fluctuations.

Do not allow the voltage fluctuation to exceed ±8V, as this may activate the torque arm limit circuit.

    e. Secure all set screws and install light cover.

f. Issue a **REVERSE TEST** MODE (<G>,<8>) command to set upper and lower Torque arm pots (See Section 0).

8. Use a spring scale to pull the torque arm to the center position. The scale should read 32 ounces for 70-mm film. Disconnect the spring from the torque arm. Use the tension adjustment screw to achieve the correct reading.

Do not allow the limit switch to be activated while making this adjustment.

9. Reattach the spring to the torque arm.
10. Replace the back panel of the projector.

Electrical Adjustments

The initial settings of pots R136, R137, R183, and R196 on the 2293 CPU card are set for 11½ turns clockwise after adjusting the pots completely counter-clockwise.

1. With the projector powered up and in READY, enter the **REVERSE TEST MODE (**<G>,<8>) command.
2. Enter a speed value of **10** on the keypad.
3. Adjust R183 so that the upper torque arm sensor voltage (as measured from the top of R150) is 0 volts ± 1 volt. This adjusts *upper* torque arm position.
4. Adjust R136 so that the upper torque arm sensor voltage (as measured from the top of R149) is 0 volts ± 1 volt. This adjusts *lower* torque arm position.
5. Repeat steps 3 - 5 with speed values of **20**, **30**, **40**, **50**, **60**, **70**, and **80**.
6. Enter a speed value of **00** to stop the projector.
7. Press the <STOP> button.
8. Enter **00** to change the projector direction to forward.
9. Press the <STOP> button.
10. Repeat steps 3 to 8, using R196 for the upper torque arm and R137 for the lower torque arm.
11. Enter the **DISPLAY FRAME COUNTER** (<G>,<1>) command to return the display to normal.

Shutter Timing Adjustment (2269 Encoder)

The shutter encoder outputs an index pulse each time the shutter blade completely blocks the light from the lamphouse. The index pulse must be adjusted so that the film stops before the shutter opens. The projector must be running for this adjustment.

Do not touch belts or other moving parts in the projector while making this adjustment.

1. Open the back cover and locate the shutter encoder at the back of the shutter motor.
2. Loosen the Phillips head screws holding the encoder mounting bracket to the back of the shutter motor.
3. Enter a **FORWARD** command (the <FOR> key).
4. Open the douser.
5. Rotate the encoder by hand until the picture is ghost-free.
6. Tighten the Phillips head screws.

This completes the shutter adjustment.

Pulldown Sensor Adjustment

The pulldown sensor provides position information to the CPU/Main Logic card. The sensor card has four infrared LED's and photo-transistor detectors. An encoder disk is mounted on the pulldown motor shaft next to the sprocket. Zero- and 180-degree signals are used to continuously adjust the drive to the pulldown motor to maintain a consistent jitter-free picture while running cine forward. Both a 90-degree and a zero-degree signal are used to form a biphase signal that locks the pulldown sprocket to the constant drive sprocket during slew motion in either direction. A fourth signal, an index pulse, is used by the CPU to keep the picture in frame.
The sensor card must be correctly positioned relative to the notched disk on the pulldown sprocket shaft. (See Figure 6.3.)

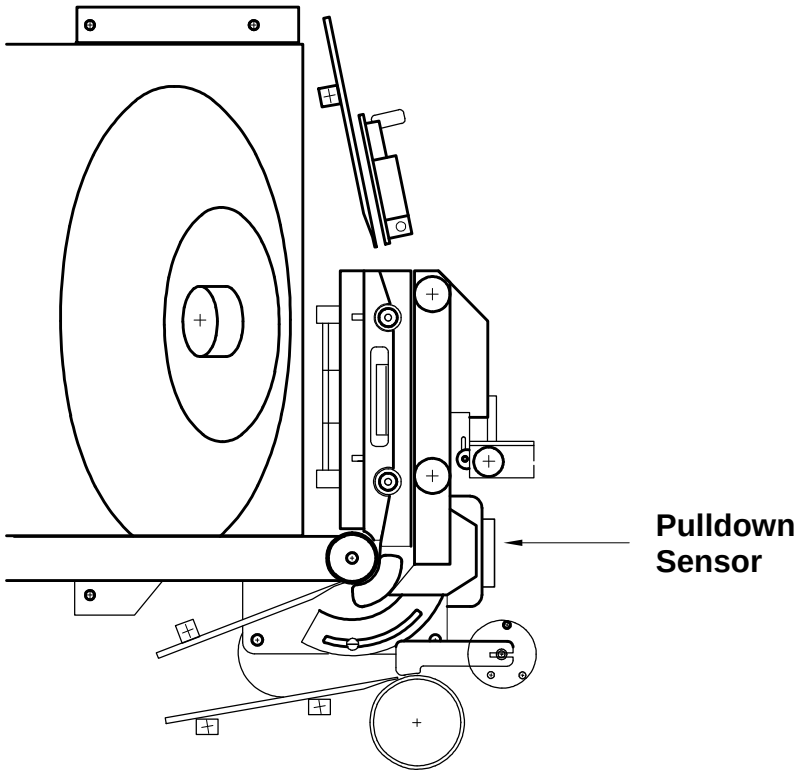


Figure 6.3: Pulldown Sensor Position

If the sensor card is adjusted improperly, the pulldown gain can be too low (Figure **6.4**-a), or too high (Figure **6.4**-b). Either situation can cause excessive jitter. The normal pulldown sensor signal is shown in Figure **6.4**-c.

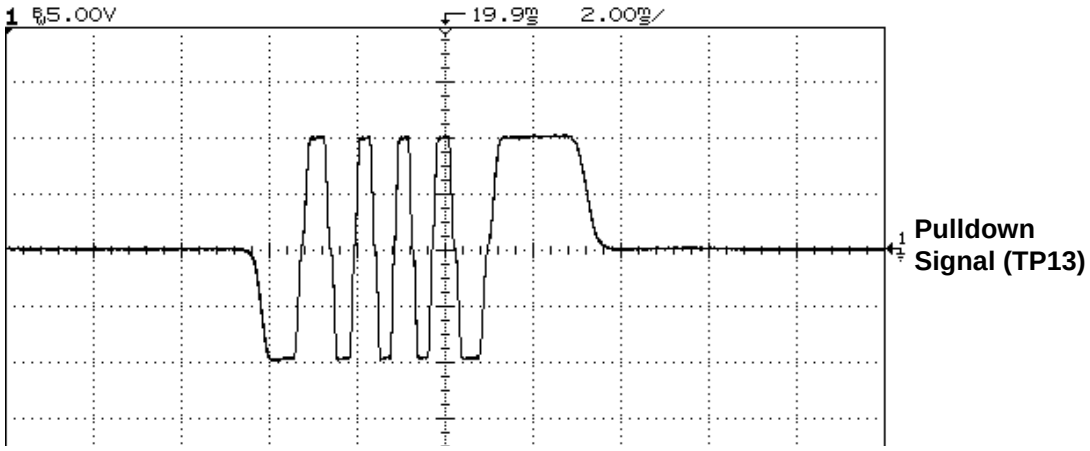


Figure 6.4-a: Pulldown Signal Gain Too Low

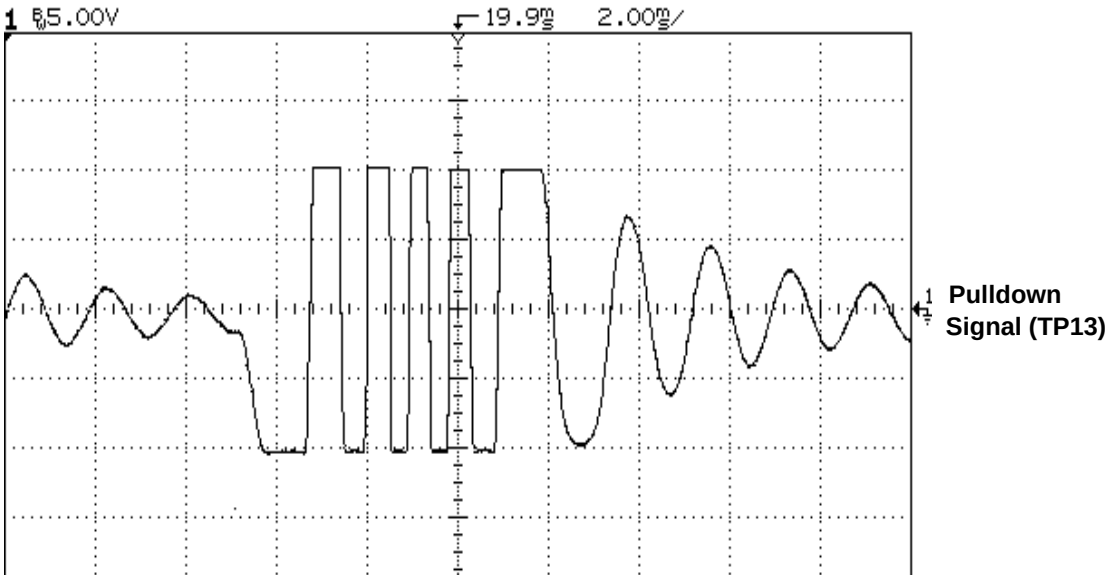


Figure 6.4-b: Pulldown Signal Gain Too High

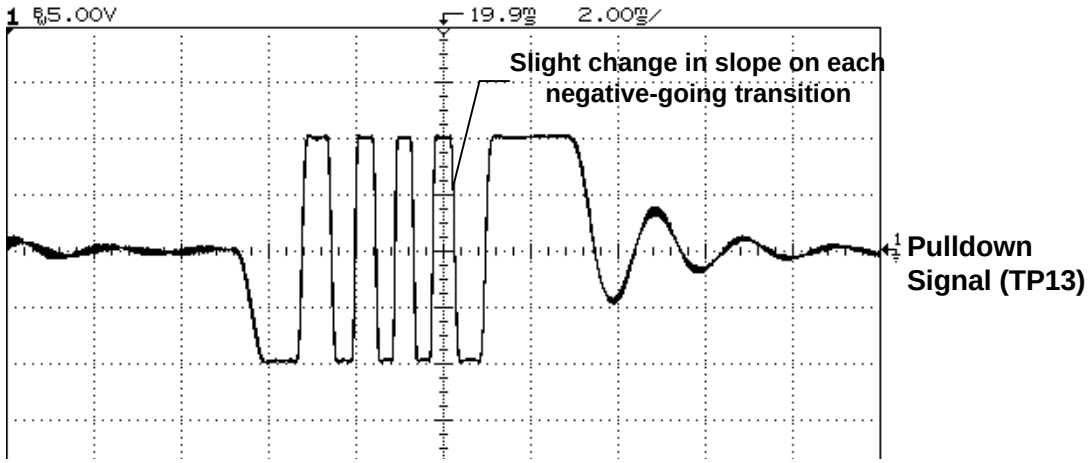


Figure 6.4-c: Pulldown Signal Normal Gain

The procedure for adjusting the pulldown is given below.

Film must be mounted for this adjustment.

1. Connect an oscilloscope to test point TP13 on the CPU/Main Logic card, card 2293. (See Figure **6.5**.) Set the vertical deflection to 5.0 volts per division, and the horizontal to 2 milliseconds per division.
2. Apply power to the lamphouse, strike the lamp, and power the projector. Enter a **READY** command (hit the READY key).
3. Slightly loosen the two screws securing the pulldown sensor card.
4. Enter a **FORWARD** command (the <FOR> key), and monitor the waveform on the scope.
5. If the waveform is as shown in Figure 6.4-a or 6.4-b, move the sensor card until the waveform more closely matches the one shown in Figure 6.4-c.

For this adjustment, the sensor card should be moved in a horizontal direction only.

6. When the waveform is correct, monitor the picture for jitter.

You may have to fine-tune the adjustment to minimize the jitter. The resultant scope waveform may not conform exactly to the waveform shown in Figure 6.4-c.

7. Tighten the two screws securing the sensor card.

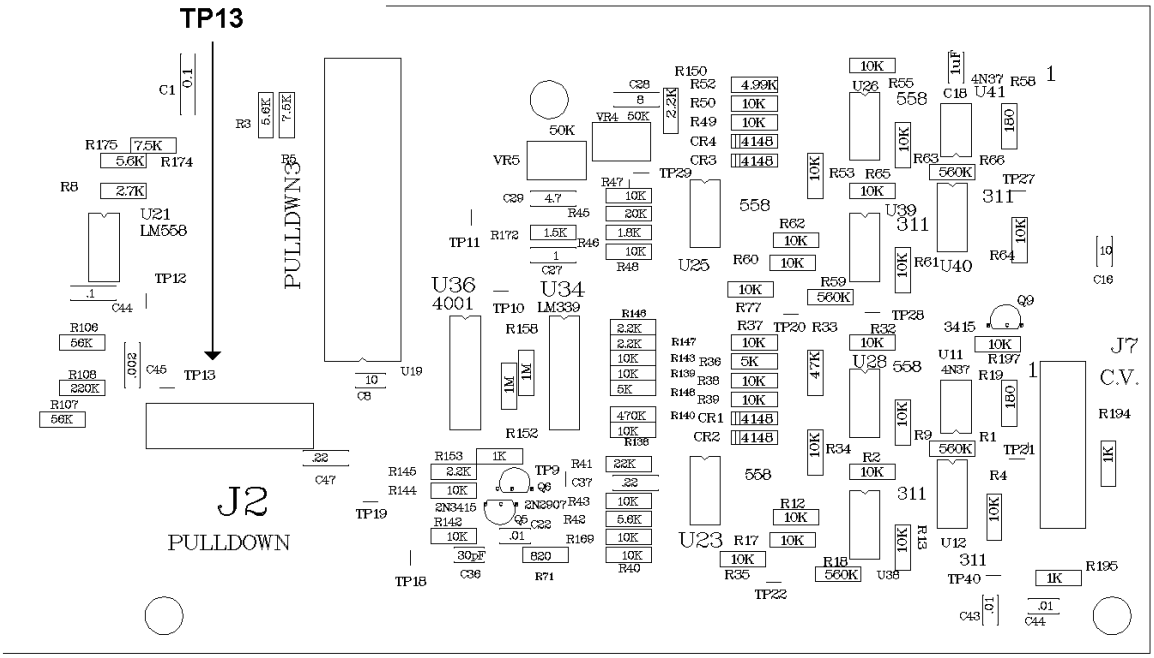


Figure 6.5: Pulldown Sensor Test Point

After completing the above adjustment, check the 90-degree output by connecting the second channel of the scope to pin 3 of U19. The phase relation should be about 90 degrees, as shown in Figure 6.6. The quadrature relationship is required when the projector executes high-speed slew motion operations. If adjustment is required the 2 screws securing the pull-down encoder to the framing ring can be loosened, and the encoder moved up or down to achieve correct quadrature.

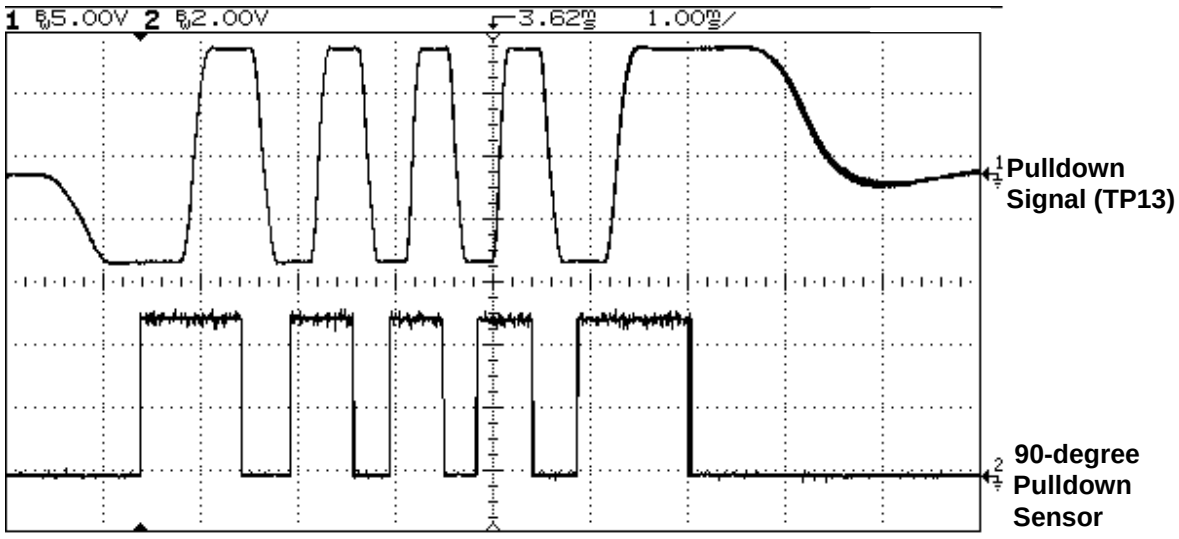


Figure 6.6: Phase Relationship of Pulldown Quadrature Signal

Line Voltage Selection

To locate jumpers and terminals, refer to the 35/70 Power Supply component layout in Section 8.4.

240-VAC Operation

To configure the 35/70 projector for 240-VAC operation:

1. Remove the jumper from terminals 1&3 and 2&4 on T1 and the jumper T1 terminals 2&3.

120-VAC Operation

To configure the 35/70 projector for 120-VAC operation:

1. Remove the jumper from terminals 2&3 on T1 and jumper terminals 1&3 and 2&4 on T1.

Pulldown Gain Adjustment

This adjustment is factory-set. This setup procedure should be performed only if VR1 is known to be out of adjustment.

1. After powering up the projector and putting it into READY mode, enter the **PULLDOWN GAIN DISPLAY** (<H>,<C>) command and note the gain value indicated by the two rightmost digits.
2. Run the projector in CINE FORWARD mode and adjust VR1 until the gain value is equal to the value noted in step (1). Note that this adjustment does not have to be precise in order for the projector to operate correctly.
3. Enter the **DISPLAY FRAME COUNTER** (<G>,<1>) command to return the display to normal.

Film Gate Adjustments

Pulldown Sprocket In–Out Adjustment

The adjustment of the pulldown sprocket has been preset during manufacturing. Slip the sprocket onto the shaft until it seats onto the Pulldown Encoder disc. The outer edge of the sprocket will be adjusted to within ±0.003 inches (±0.01 mm) from the outer edge of the rail on the fixed film gate.

Movable Gate Stop Adjustment

The gate stop can be moved in or out by first back-threading the ¼-20 socket cap screw, then adjusting the stop limit set screws for the desired gap. Verify that, when the adjustment is complete, the film is not being pinched in the gate, and the ¼-20 screw is tight.

Movable Gate Spring Tension Adjustment

This adjustment must be made while the projector is running.

1. Load the film and adjust the focus. Each gate shoe has two (2) 4-40 socket cap screws, with which the pressure on the film through the aperture can be adjusted.
2. Put the film in motion and observe the film image. Use as little pressure as possible while adjusting the cap screws to correct the image for jitter. Excessive pressure on the film causes poor projector performance and increased film wear.

Film Edge Guide Adjustment

1. Load the film and adjust the focus. Each edge guide has a socket cap screw with which the pressure on the film edge can be adjusted.
2. Put the film in motion and observe the film image. Use as little pressure as possible while adjusting the set screws to adjust picture weave. Too much pressure on the edge guides distorts the film path and causes uneven focus problems.

Focus Blower

The focus blower control valve controls the amount of air flow onto the film. This valve is adjusted so that the film frame in the aperture opening remains stable, thus reducing the effect of film breathing.

Film Format Conversion

The 35/70 projector is capable of being converted from a 35mm projector to a 70mm projector in a matter of 15 minutes. The conversion process for converting from 70mm to 35mm is as follows. (Refer to Figure 4.2 for part locations.)

1. Insure power is turned off to the projector.
2. Remove all 70mm reels and install 1 reel spacer on both the upper and lower reel shafts.
3. Remove the upper and lower C.V. sprocket pad shoes.
4. Loosen both the upper and lower C.V. sprocket film stripper posts.
5. Remove the upper and lower C.V. sprocket knobs and sprockets.
6. Install a C.V. shaft spacer, 35mm C.V. sprocket, and 35mm C.V. sprocket knob on both the upper and lower C.V. sprocket shafts. Insure that the allen set screws used to hold the sprockets and knobs are tightened against the flats on the shafts.
7. Install the 35mm C.V. sprocket pad shoes on the upper and lower C.V. sprockets. Insure that the gap between the Delron pad and the sprocket is approximately equal to the thickness of two pieces of film.
8. Rotate the upper and lower film stripper posts so that the stripping bar is pointed towards the sprocket and the post is not touching the sprocket teeth, Secure the post.
9. Remove the movable gate using the two thumb screws.
10. Disconnect the EOF/BOF sensor cable and remove the fixed gate.
11. Install the 35mm fixed gate threading the EOF/BOF sensor cable above the pull-down sprocket. Reconnect the cable and insure that the cable is not coming in contact with the sprocket.
12. Install the movable 35mm gate.
13. Remove the 70mm steel upper buckle plate and install the 35mm buckle plate. Secure the plate such that it does not interfere with the opening and closing of the gate.
14. Minor adjustments may need to be made to the gate assembly to minimize film pinching. (Refer to Section 6.8.)
15. To convert the projector from 35mm to 70mm, follow the above steps removing all spacers and using 70mm parts.

Sound Heads

The adjustments of sound heads is not covered as a part of this manual. Refer to head manufacturer for alignment procedures.

TROUBLESHOOTING GUIDE

Only technicians who are familiar with the detailed circuit descriptions in Section 5 and the adjustment procedures in Section 6 should attempt to troubleshoot or repair a problem.

This section provides information for diagnosing and troubleshooting operational problems with the 35/70 projector. The projector consists of hundreds of components. It is impossible to foresee all problems that might occur. However, the procedures outlined in this section should identify the problem area.
Checklists and troubleshooting tables are provided for the following areas:

- Visual Checklist
- Power-On Checklist and Diagnostic Table
- Ready Checklist and Diagnostic Table
- Slew Motion Checklist and Diagnostic Table
- Cine Motion Checklist and Diagnostic Table
- Image Quality Checklist and Diagnostic Table.

Use of the Troubleshooting Tables

This section presents a series of operational checklists and troubleshooting tables. They have been created to be used as part of a deliberate, organized approach to problem isolation. This approach consists of starting with the projector turned off, performing visual diagnostic checks, threading the projector with film, and performing operational checks. A turn-on and operating sequence requires the technician to observe a sequence of projector operations, continuing until an abnormal condition occurs. For each observed abnormal condition, an associated table isolates the particular failures or mis-adjustments that can cause the condition. Repair or adjustment is described to allow the technician to repeat the sequence, progressing to the next abnormal condition. This approach has the advantage of being effective in the case of multiple failures and of making the most basic corrections first in the sequence.
The tables have been arranged to be used as a checklist and data table. While experienced technicians will often attempt to short-cut the procedure or perform it by memory, the most effective approach is to copy this section of the manual and use it as a checklist for troubleshooting, and then retain it as part of the failure history of the projector, at least until sufficient proper operation shows that the repair is truly verified.
These checklists should be performed as part of the technician's training on machines that are known to be operating correctly. Familiarity with the visual conditions, the amount of play in mechanical systems, and the proper speed of operations is essential to the diagnostic process.
In a case where multiple failures are suspected, remove the four fuses associated with the drive motor systems (fuses 1 to 4). See Table 7.1 for fuse block identification. Start through the checklist and bring one system back on line at a time, starting with the Lower Torque. Follow with the Shutter, the Upper Torque, the Constant Velocity, and finally the Pulldown, replacing the required fuses as you progress. After the Lower Torque system is on line, the READY state must be achieved before the next four systems can become operational. Verify that all buckle and limit switches are inactive, or the projector will not go into READY state.

Fuse	Voltage	Amps	Controls	Type
1	SW -34 VDC	8A	Pulldown Amp	Fast Blow
2	SW +24 VDC	8A	C.V., Torque	Fast Blow
3	SW +24 VDC	8A	Pulldown Amp	Fast Blow
4	+24 VDC	4A	C.V., Torque, Shutter	Fast Blow
5	110 VAC	5A	Main	Fast Blow

Table 7.1: 35/70 Fuse Block Identification

The corrective procedures in the checklist allow for recalibration of various electronic cards. This should be necessary only in cases where cards have been replaced or unnecessary adjustments have previously been made. All electrical adjustments are factory-set; additional adjustment should not be required, especially on a projector that has been operating.

This troubleshooting procedure goes only to the card level. Defective cards should be returned to **CHRISTIE** for repair.

General Description of the Troubleshooting Approach

Step 1: This step is described in Section 0. With power turned off and no film on the machine, perform the *General Visual Checklists* designed to identify any open connectors, loose film guides, failed bearings, broken belts, etc. (See Tables 7.2, 7.3, and 7.4.) Correct any deficiencies found in the visual check.

Step 2: This step is described in Section 0. Load film on the machine. Apply power and check the *Power-On Checklist* (Table 7.5) to verify the machine is ready to be commanded into the READY condition. Correct any deficiencies pointed to on the *Power-On Checklist Diagnostic Table* (Table 7.6).

Step 3: This step is described in Section 0. Command the system into a READY condition and perform the *Ready Checklist* (Table 7.7). If the READY condition is not achieved, refer to the *Ready Checklist Diagnostic Table* (Table 7.8) and take corrective action.

Step 4: This step is described in Section 0. Perform the *Slew Motion Checklist* (Table 7.9). Correct deficiencies pointed to by the *Slew Motion Checklist Diagnostic Table* (Table 7.10).

Step 5: This step is described in Section 0. Perform the *Cine Motion Checklist* (Table 7.11). Correct deficiencies pointed to by the *Cine Motion Checklist Diagnostic Table* (Table 7.12).

Step 6: This step is described in Section 0. Perform the *Image Quality Checklist* (Table 7.13). Correct deficiencies pointed to by the *Image Quality Checklist Diagnostic Table* (Table 7.14).

Visual Checklist

Perform the following steps. In each case, corrective action is self-evident, so a diagnostic table is not included. Refer to Chapter 6, *Mechanical and Electronic Adjustments*, for instructions on adjustment and component replacement.

VISUAL CHECKLIST		
A	***At the film path side, with film not mounted*** *(Numbers in parentheses refer to details in Figure 4.2.)*	
Checklist Item	***Step Description***	***Completed***
A1	*Check that the Upper and Lower Torque Arms (2, 24) move freely and smoothly. The click from the limit switch should be audible near the relaxed end of the arm motion.*	
A2	*Verify that all Guide Rollers rotate freely with a minimum of lateral play. Note that the Torque-Arm Rollers (2, 24) rotate freely and have a wide range of lateral motion.*	
A3	*Verify Upper Constant Velocity Sprocket (27) rotates properly and associated CV pad shoes have minimal end-play.*	
A4	*Verify Upper and Lower Loop Chutes are positioned correctly and are not loose.*	
A5	*Verify Upper and Lower Feed Sprocket Shoes (8, 17) move freely. Buckle switch operation click should be heard close to the engaged position.*	
A6	*Verify Lower Constant Velocity Sprocket (19) moves freely without lateral play. Verify that Upper and Lower Sprockets move in unison.*	

Table 7.2: Visual Checklist, Part A (Projector Film Side)

VISUAL CHECKLIST		
B	***At the projector head*** *(Numbers in parentheses refer to details in Figure 4.1)*	
Checklist Item	***Step Description***	***Completed***
B1	*Verify that connectors to all boards are tight.*	
B2	*Gently verify Upper Torque Arm Sensor and Disk (4) are tight.*	
B3	*Gently verify Lower Torque Sensor and Disk (34) are tight.*	
B4	*Verify that the four belts are undamaged and properly tensioned.*	
B5	*Verify Upper and Lower Brakes (2, 31) are engaged and that there is no play between brake and shaft.*	
B6	*Verify that all cooling hoses are in place.*	

Table 7.3: Visual Checklist, Part B (Head and Reeling Cabinet)

VISUAL CHECKLIST		
C	***At the power supply area***	
Checklist Item	***Step Description***	***Completed***
C1	*Verify connectors are secured.*	
C2	*Verify Interlock Relay is tight in its socket.*	

Table 7.4: Visual Checklist, Part C (Power Supply Area)

Power-On Checklist and Diagnostic Table

Thread the projector with film that has the proper BOF and EOF markers installed. Perform the checklist in Table 7.5. Refer to the accompanying diagnostic table, Table 7.6, for corrective action.

POWER-ON CHECKLIST		
	Turn projector power on	
Checklist Item	***Step Description***	***Completed***
1	*Visually verify that the LED on the <NOT RDY> button on the control panel comes on.*	
2	*Visually verify that the Frame Counter reads one hour (01:00:00:00).*	

Table 7.5: Power-On Checklist

POWER-ON DIAGNOSTIC TABLE		
1	**None of the control lights comes on.**	
Step	**Diagnostic**	**Result**
1	Verify +5-volt supply is correct at J1 of the 2267 card in the control panel head. If not, determine fault and repair.	
2	Verify that the ribbon cable to the 2267 card is not damaged and is properly inserted. If not, properly insert or replace cable.	
3	Verify that the 25 conductor cable between the projector and control panel is not damaged and is properly inserted.	
2	**Frame counter does not function.**	
Step	**Diagnostic**	**Result**
1	Verify +5 volt supply at pin 14 of U9 of the 1008 card in the control head. If not correct, determine fault and correct.	
2.	Verify that the ribbon cable is not damaged and is properly inserted between the 2267 and the 1008 cards. If not, properly insert or replace cable.	
3	If failure remains, replace the 1008 card.	

Table 7.6: Power-On Diagnostic Table

Ready Checklist and Diagnostic Table

Perform the checklist in Table 7.7. Refer to the diagnostic table, Table 7.8, for corrective action.

READY CHECKLIST		
	Turn projector power on	
Checklist Item	***Step Description***	***Completed***
1	*Visually verify that LED #4 (Lower Buckle), LED #5 (Upper Buckle), LED #1 (Lower Arm Limit), LED #2 (Upper Arm Limit) are off.*	
2	*Push the <READY> button and verify that the READY LED illuminates and the READY relay activates.*	
3	*Visually verify that the Upper and Lower Torque Arms move to centered position and that the reel brakes are released. Verify that system is stable; reels do not oscillate.*	
4	*Visually verify that the projector performs a loop set. The loop set should be accomplished in about one to two seconds, and the upper buckle switch should not trip.*	
5	*Verify that the Constant Velocity sprocket advances film one frame and locks. When locked, the sprocket should resist motion in either direction.*	
6	*Verify that the Pulldown also advances film one frame and locks. Pulling the film loops or turning the pulldown sprocket by hand will verify the pulldown is locked.*	
7	*Verify that the shutter comes up to speed.*	

Table 7.7: READY Checklist

READY DIAGNOSTIC TABLE		
1-1	**LED is on – CONDITION 1: LED #4 is on.**	
Step	**Diagnostic**	**Result**
1	If LED #4 is illuminated, close the Lower Buckle arm, press the NOT RDY button, and ensure that the LED goes out. If the LED remains lit, proceed to Step 2.	
2	Check the buckle switch and associated wiring. If the LED still remains lit, proceed to Step 3.	
3	The 2267 keypad or the 2293 CPU/Main Logic card could be defective. Repair or replace as necessary.	
1-2	**LED is on – CONDITION 2: LED #5 is on.**	
Step	**Diagnostic**	**Result**
1	If LED #5 is illuminated, close the Upper Buckle plate, press the NOT RDY button, and ensure that the LED goes out. If the LED remains lit, proceed to Step 2.	
2	Check the buckle switch and associated wiring. If the LED still remains lit, proceed to Step 3.	
3	The 2267 keypad or the 2293 CPU/Main Logic card could be defective. Repair or replace as necessary.	

Table 7.8: READY Diagnostic Table

READY DIAGNOSTIC TABLE		
1-3	**LED is on – CONDITION 3: LED #1 is on.**	
Step	**Diagnostic**	**Result**
1	If LED #1 is illuminated, center the Lower Torque Arm, press the NOT RDY button, and ensure that the LED goes out. If the LED remains lit, proceed to Step 2.	
2	Check the limit switch and associated wiring. If the LED is still lit, proceed to Step 3.	
3	Monitor output voltage from the optical pot. Verify range of +5 to -5 volts as arm is moved to its extremes; zero volts should be near the center of travel. Readjust if necessary.	
4	Measure the output voltage from the lower tacho generator. This should be approximately +3.0 volts with the projector running in REWIND. Replace generator if necessary.	
5	If the LED still remains lit, the 2267 keypad or the 2293 CPU/Main Logic card could be defective. Repair or replace as necessary.	
1-4	**LED is on – CONDITION 4: LED #2 is on.**	
Step	**Diagnostic**	**Result**
1	If LED #2 is illuminated, center the Upper Torque Arm, press the NOT RDY button, and ensure that the LED goes out. If the LED remains lit, proceed to Step 2.	
2	Check the limit switch and associated wiring. If the LED is still lit, proceed to Step 3.	
3	Monitor output voltage from the optical pot. Verify range of +5 to -5 volts as arm is moved to its extremes; zero volts should be near the center of travel. Readjust if necessary.	
4	Measure the output voltage from the upper tacho generator. This should be approximately -3. volts with the projector running in REWIND. Replace generator if necessary.	
5	If the LED still remains lit, the 2267 keypad or the 2293 CPU/Main Logic card could be defective. Repair or replace as necessary.	

Table 7.8: READY Diagnostic Table (Continued)

READY DIAGNOSTIC TABLE		
1.5	**READY relay does not activate or READY LED does not go on.**	
Step	**Diagnostic**	**Result**
1	If the READY relay does not pull in, check to see if there is +24VDC present at J3-3 on the lower torque 2285 amplifier. If not correct, determine the fault and correct.	
2	Verify that all cables going to the lower torque 2285 amplifier card and READY relay are not damaged and are correctly plugged in.	
3	Verify that the time delay relay contacts on K2, in the power supply, are closing approximately 3 seconds after power up. If not, re-adjust or replace relay.	
4	Verify that the collector of Q3 on the 2293 CPU/Main Logic card goes low when READY is commanded. If the signal is present, replace the lower torque 2285 card or READY relay. If the signal is not present, the problem could be with either the 2293 CPU/Main Logic card or the 2267 keypad card. Repair or replace as necessary.	

Table 7.8: READY Diagnostic Table (Continued)

READY DIAGNOSTIC TABLE		
3-1	**Failure of Upper or Lower Torque System – CONDITION 1: Upper or lower torque arm does not center.**	
Step	**Diagnostic**	**Result**
1	Verify that the brake associated with the defective system comes off while in **READY**. The reel should move freely if the brake is off.	
2	Monitor output voltage from the optical pot at the 2293 CPU/Main Logic card. Verify range of approximately +5 to -5 volts as arm is moved to its extremes; zero volts should be near the center of travel. Readjust if necessary.	
3	Monitor supply voltage at the plus (+) side of the 2285 card as the READY button is pushed. This signal will remain for at least one second even if the READY condition does not hold. If voltage is not found, determine failure point: faulty fuse, relay, power supply, or wiring. Repair or replace.	
4	Measure motor resistance to determine if the associated wiring or the motor is open. The resistance of the motor (pins 3 and 4) should be about 10 ohms	
5	If problem is not resolved after steps 1 through 4, replace the 2285 card associated with the faulty system.	

Table 7.8: READY Diagnostic Table (Continued)

READY DIAGNOSTIC TABLE		
3-2	**Failure of Upper or Lower Torque System –** **CONDITION 2: The system is not stable; reel and torque arm oscillate.**	
Step	**Diagnostic**	**Result**
1	Verify that the locking nut that holds the reel to the shaft is tight. Also check for a loose belt or loose set screws that hold pulleys to their shaft. Any mechanical play between the Torque motor and the reel will result in oscillations. Tighten as required.	
2	Verify that the mechanical adjustments to the Torque Arm assembly are correct. The spring tension adjustment should be checked and corrected if necessary. (See Section 6.3.)	
3	Oscillation could indicate worn brushes in the Torque motor or tacho generator assembly. Replace brushes or motor/tach assembly.	
4-1	**Loop set does not function, Pulldown System –** **CONDITION 1: Film is moved from the upper loop to the lower loop but does not move back up.**	
Step	**Diagnostic**	**Result**
1	Check the 8-amp fuse (fuse 3) associated with the +24 volt supply of the pulldown system; replace if defective.	
2	Verify that the signal from the 2293 card, at TP12 on the 2293 card, first goes positive as film moves down to the lower loop and then goes negative. If not correct, replace the 2293 card; if voltage is correct, replace the 2275 card.	

Table 7.8: READY Diagnostic Table (Continued)

READY DIAGNOSTIC TABLE		
4-2	**Loop set does not function, Pulldown System –** **CONDITION 2: Film is moved from the upper loop to the lower loop and then back to the upper loop but does not stop.**	
Step	**Diagnostic**	**Result**
	Verify that the index and the 90-degree signal from the Pulldown Sensor do pass though the 2276 card and reach U10 pin 11 and U19 pin 3 on the 2293 card. Isolate problem to the sensor, the 2276 card, or the wiring. If not any of these, replace the 2293 card.	
4-3	**Loop set does not function, Pulldown System –** **CONDITION 3: Film does not move until after 2 seconds and then only moves from the lower loop to the upper loop.**	
Step	**Diagnostic**	**Result**
1	Check the 8-amp fuse (fuse 1) associated with the -34 volt supply of the Pulldown system. Verify that the -34 volt supply does reach the 2275 card.	
2	Verify that the input to the 2275 card, at R102, or at TP12 on the 2293, goes positive for the first 2 seconds and then goes negative as film moves up. If the voltage is not correct replace the 2293 card. If the voltage is correct, replace the 2275 card.	
4-4	**Loop set does not function, Pulldown System –** **CONDITION 4: The Pulldown sprocket turns with enough force or speed to trip the buckle switch or damage film.**	
Step	**Diagnostic**	**Result**
	Replace the 2275 card.	
4-5	**Loop set does not function, Pulldown System –** **CONDITION 5: The Pulldown sprocket starts a Loop Set operation, but stops part way. Loop Set will continue or complete if film loop is restarted with assist by hand.**	
Step	**Diagnostic**	**Result**
	This indicates worn brushes in the Pulldown motor. Replace brushes or motor.	

Table 7.8: READY Diagnostic Table (Continued)

READY DIAGNOSTIC TABLE		
5-1	**The Constant Velocity sprocket will not advance film one frame and lock –** **CONDITION 1: The constant velocity sprocket advances film forward, but does not stop after one frame.**	
Step	**Diagnostic**	**Result**
	This condition is caused by a failure of the Pulldown system. The Constant Velocity system will continue to move film forward until the CPU receives the zero-degree and index signals from the Pulldown Sensor. Repair as indicated.	
5-2	**The Constant Velocity sprocket will not advance film one frame and lock –** **CONDITION 2: The constant velocity sprocket turns with enough force or speed to trip the buckle switch or damage film.**	
Step	**Diagnostic**	**Result**
	Replace the 2285 card.	
5-3	**The Constant Velocity sprocket will not advance film one frame and lock –** **CONDITION 3: The constant velocity sprocket does not advance film and can be turned by hand, at least in one direction.**	
Step	**Diagnostic**	**Result**
1	If it resists in one direction but not the other, replace the 2285 card; otherwise, continue to Step 2.	
2	While in the READY mode, verify that there is a +34-volt supply voltage at the positive end of C8 on the 2285 card. If not, check the fuse (fuse 2), wiring, ready relay, and power supply associated with the Constant Velocity system. Repair if problem is found.	

Table 7.8: READY Diagnostic Table (Continued)

READY DIAGNOSTIC TABLE		
5-4	**The Constant Velocity sprocket will not advance film one frame and lock –** **CONDITION 4: The constant velocity motor starts to move film, but stops part way. Motion continues or completes if CV sprocket is restarted with assist by hand.**	
Step	**Diagnostic**	**Result**
	This indicates worn brushes in the Constant Velocity motor. Replace brushes or motor.	
6-1	**The Pulldown System has performed a proper Loop Set, but failed to advance film and lock. Since a Loop Set was performed in Section 3 of this table, those checks need not be repeated.** **CONDITION 1: Pulldown sprocket offers no resistance to movement by hand.**	
Step	**Diagnostic**	**Result**
1	Replace 2275 card.	
2	If problem still exists, replace 2293 card.	
6-2	**The Pulldown System has performed a proper Loop Set, but failed to advance film and lock.** **CONDITION 2: Pulldown sprocket is not stable; oscillation produces audible sound. This is caused by a fault in tach circuit.**	
Step	**Diagnostic**	**Result**
1	The fault could be associated with the tach circuit on the 2293 card. Replace 2293 card.	
2	The brushes associated with the tach on the Pulldown motor assembly could be worn. Replace brushes or motor assembly.	

Table 7.8: READY Diagnostic Table (Continued)

READY DIAGNOSTIC TABLE		
7-1	**Shutter Failure –** **CONDITION 1: Shutter is at speed when phase A and phase B are measured to be 600 Hz at U29 pins 23 and 24 of the 2293 card. The shutter index pulse at U37 pin 18 of the 2293 card should measure 60 Hz. (Note: speed referenced to 60FPS operation.) If this is not the case:**	
Step	**Diagnostic**	**Result**
1	Verify that the low voltage power supply, +5 volt, is present at the regulator Q4 of the 2285 card. If not, determine fault and repair.	
2	Verify supply voltage of +24 volts at plus (+) side of C8 of the 2285 card. If not, determine fault and repair.	
3	Verify quadrature of the shutter encoder's phase A and phase B outputs: a. If shutter is moving, connect dual trace oscilloscope to pins 23 and 24 of U29 on the 2293 card and verify quadrature. If signals are not present or are not in quadrature, determine wiring fault or defective encoder and repair or replace. b. If shutter is not moving, continue to step 4.	
4	Verify the reference frequency at TP33 of the 2293 card. This square wave should have a frequency of 192 KHz. If not, determine wiring fault or defective 2293 card; repair or replace.	
5	Disconnect J2 from the 2285 card and measure the resistance from J2 pin 4 to J2 pin 3. This should be the shutter motor armature, and should measure about one ohm. Reconnect J2. Determine wiring fault or defective motor; repair or replace.	

Table 7.8: READY Diagnostic Table (Continued)

READY DIAGNOSTIC TABLE		
7-2	**Shutter Failure –** **CONDITION 2: The Shutter movement is erratic; a sound is heard that indicates the Shutter is hunting.**	
Step	**Diagnostic**	**Result**
1	This may indicate worn brushes in the Shutter motor. Replace brushes or motor.	
2	Erratic Shutter movement may also be caused by an unstable 192-KHz reference from the 2293 card. If required, adjust R20, the phase-locked loop circuit, on the 2293 card. Note that this adjustment will have no effect if running in crystal lock mode.	

Table 7.8: READY Diagnostic Table (Continued)

Slew Motion Checklist and Diagnostic Table

Perform the checklist in Table 7.9. Refer to the diagnostic table in Table 7.10 for corrective action.

SLEW MOTION CHECKLIST		
A	***Command the projector to high speed forward by pushing the button sequence <CMD-H>, <3>.***	
Checklist Item	***Step Description***	***Completed***
	Verify that the film accelerates to 120 frames per second in a smooth and linear motion.	
B	***Push the <STOP> button and, after film motion stops, push the <REV> button. After film reaches 120 frames per second in the reverse direction, push the <STOP> button.***	
Checklist Item	***Step Description***	***Completed***
	Verify that the film accelerates to 120 frames per second in the reverse direction in a smooth and linear motion.	

Table 7.9**: Slew Motion Checklist**

SLEW MOTION DIAGNOSTIC TABLE		
A-1	**Film does not ramp smoothly to 120 frames per second –** **CONDITION 1: Film ramps up smoothly to near maximum speed, then becomes unstable.**	
Step	**Diagnostic**	**Result**
	Verify that the +24VDC voltage at the positive end of C8 of the 2285 card is at the proper value. If not, repair.	
A-2	**Film does not ramp smoothly to 120 frames per second –** **CONDITION 2: Film ramps up smoothly to maximum speed but upper loop is lost while going forward.**	
Step	**Diagnostic**	**Result**
1	Verify that the Constant Velocity Tach voltage reaches the 2293 card. If not, repair wiring.	
2	If condition remains, replace the 2293 card.	
A-3	**Film does not ramp smoothly to 120 frames per second –** **CONDITION 3: Film ramps up smoothly to near maximum speed, but then upper or lower limit switch trips system to NOT READY.**	
Step	**Diagnostic**	**Result**
1	Verify that the +24VDC voltage to the associated 2285 card is at the proper value. If not, repair.	
2	If condition remains, replace the 2285 card associated with the defective system.	

Table 7.10: Slew Motion Diagnostic Table

SLEW MOTION DIAGNOSTIC TABLE		
A-4	**Film does not ramp smoothly to 120 frames per second – CONDITION 4: Film ramps up to maximum speed, but motion is not smooth.**	
Step	**Diagnostic**	**Result**
1	This may indicate worn brushes in the Constant Velocity Tach. Replace brushes or motor/tach assembly.	
2	If condition continues, check for a loose belt or loose set screws that hold pulleys to their shaft. Any mechanical play between the CV motor and the sprockets will result in irregular motion. Tighten as required.	
3	Verify the spring tension of the Upper and Lower Torque Arm assemblies are equal and at their proper value. An imbalance puts excessive load on the Constant Velocity system. Readjust if necessary. (See Section 6.3.)	
A-5	**Film does not ramp smoothly to 120 frames per second – CONDITION 5: Film ramps up to maximum speed, then ramps down to a stop with the #6 LED illuminated.**	
Step	**Diagnostic**	**Result**
1	Verify all power supply voltages to CV 2285 card. Repair connections or power supply as necessary.	
2	Determine problem to be either defective 2285 amplifier card or defective 2293 CPU/Main Logic card. Repair or replace.	
B	**Film does not ramp to 120 frames per second in the reverse direction in a smooth and linear motion.**	
Step	**Diagnostic**	**Result**
	Repeat the steps described in A-1 through A-4 of this table, using the <REV> button to initiate film motion..	

Table 7.10: Slew Motion Diagnostic Table (Continued)

Cine Motion Checklist and Diagnostic Table

This procedure requires the film to be **CUED** at the beginning of a show.
Perform the checklist in Table 7.11. Refer to the diagnostic table, Table 7.12, for corrective action.

CINE MOTION CHECKLIST		
	Push the <FOR> button. After film speed stabilizes, enter the <C>,<3> command to cause the douser to open.	
Checklist Item	***Step Description***	***Completed***
1	*Verify that the film accelerates to the pre-programmed film rate in a smooth and linear motion and performs pulldowns without losing either the upper or lower loop of film above and below the film gate.*	
2	*Verify that the douser opens when commanded and closes as the EOF tape is detected.*	
3	*Verify that the projector responds properly to the BOF and EOF tapes as they pass though the sensors.*	

Table 7.11: Cine Motion Checklist

CINE MOTION DIAGNOSTIC TABLE		
1	**Loop is lost as projector does Pulldowns.**	
Step	**Diagnostic**	**Result**
1	Verify proper adjustment of VR1 on the 2293 card. Adjust if necessary. (See Section 6.7.)	
2	It is possible for a Pulldown amplifier to have defective output transistors and function in all modes except Pulldown. Replace 2275 card.	
2	**Douser does not function.**	
Step	**Diagnostic**	**Result**
1	Douser has been found to be mechanically free, and relays are secure in their sockets. Verify that the douser relay does function. Determine bad solenoid or wiring fault, and repair or replace.	
2	If relay does not function, determine if fault is the driver on the 2285 shutter card, the solid-state douser interlock relay, the relay itself, the control signal from the 2293 card, or a wiring fault. Replace or repair.	
3	**Projector does not respond to the EOF or BOF.**	
Step	**Diagnostic**	**Result**
1	Verify adjustment procedures for EOF and BOF sensors have been properly executed. Adjust if necessary. (See Section 6.2.)	
2	If adjustment procedure is not successful, determine the fault to be associated with the EOF/BOF sensors or the circuits on the 2293 card. Replace as required.	

Table 7.12: Cine Motion Diagnostic Table

Image Quality Checklist and Diagnostic Table

This procedure requires the lamp house to be on with suitable lens and screen setup.
Perform the checklist in Table 7.13. Refer to the associated diagnostic table, Table 7.14, for corrective action.

IMAGE QUALITY CHECKLIST		
	Push the <FOR> button and after film speed stabilizes enter the <C>,<3> command to cause the douser to open.	
Checklist Item	***Step Description***	***Completed***
	Verify that the projected picture does not have excessive jitter, side weave, or ghosting.	

Table 7.13: Image Quality Checklist

IMAGE QUALITY DIAGNOSTIC TABLE		
1	**Poor Image Quality –** **CONDITION 1: Frame line jumps in and out of picture area on the screen, resulting in jitter one perf high. This condition is the result of a missing pulldown index pulse or one that comes at the wrong time due to mis-adjustment of the pulldown sensor.**	
Step	**Diagnostic**	**Result**
1	Verify index pulse at U10, pin 11, of the 2293 card. Connect oscilloscope to this point. Move pulldown sprocket at least one quarter turn to produce one high-going pulse. If pulse is not present, trace to the 2276 card and finally to the pulldown sensor to determine failure point. Repair wiring fault or replace 2276 card or 2268 card, as required.	
2	If the pulse is present, connect dual trace oscilloscope to TP13 of the 2293 card and pin 11 of U10, also on the 2293 card. The signal at TP13 is the analog registration error signal; the signal at U10 is the index signal. Rotate the pulldown sprocket clockwise. Note that the analog signal moves between +10 volts and -10 volts five times for every index pulse. Rotate the pulldown sprocket clockwise until just before the index pulse goes positive (0- to +5-volt signal). Verify that, as the sprocket continues in a clockwise direction, the index pulse is high at least from the time the analog voltage goes from +5 volts to -5 volts. This is required so that the CPU can determine if the projector is in frame; otherwise it will do 4-perf and then 6-perf pulldowns, trying to bring the picture in frame. If necessary, recalibrate the pulldown sensor assembly, the 2268 card. (See Section 6.5.)	
3	This condition can also occur due to worn brushes on the pulldown motor. Replace brushes or motor assembly as required.	

Table 7.14: Image Quality Diagnostic Table

IMAGE QUALITY DIAGNOSTIC TABLE		
2	**Poor Image Quality –** **CONDITION 2: Projected picture has vertical jitter in excess of 0.15%.**	
Step	**Diagnostic**	**Result**
1	Verify that both the fixed and movable sections of gate area are free of emulsion buildup. Clean if necessary.	
2	Verify there is proper spring tension on the movable portion of the gate. Adjust if necessary. (See Section 6.8)	
3	Verify proper right/left adjustment of pulldown sensor by following procedure in calibration section. Adjust if necessary. (See Section 6.5.)	
4	It is possible for a Pulldown amplifier to have defective output transistors and function in all modes except Pulldown. Replace 2275 card.	
5	It is possible for one of the fuses associated with the Pulldown system to appear good, but have too high a resistance to do a proper Pulldown. Replace fuses 1 and 3.	
6	Verify the edge guides are adjusted properly and do not interfere with the film path. Adjust if necessary. (See Section 6.8.4.)	
7	Verify the Pulldown sprocket is properly aligned to the gate. Realign if necessary. (See Section 6.8.1.)	
8	Verify that the inner and outer race of the pulldown sprocket are not damaged and have less than 0.001" run-out. Realign or replace sprocket as necessary.	

Table 7.14: Image Quality Diagnostic Table (Continued)

IMAGE QUALITY DIAGNOSTIC TABLE		
3	**Poor Image Quality –** **CONDITION 3: Projected picture has side weave in excess of 0.15%.**	
Step	**Diagnostic**	**Result**
	Verify the edge guides are adjusted properly and have the proper spring tension. Adjust if necessary. (See Section 6.8.4.)	
4	**Poor Image Quality –** **CONDITION 4: Projected picture exhibits ghosting.**	
Step	**Diagnostic**	**Result**
1	Rotate shutter encoder assembly to eliminate ghosting. This is a one time factory adjustment and should not be necessary unless parts associated with the shutter system have been replaced.	
2	If the shutter ghosting adjustment must be made on a regular basis, verify that all mechanical parts are properly tightened. A loose coupling or set screw could allow the shutter blade to slip on its shaft and alter the shutter timing.	
3	Ghosting can also be caused by a failure of the Pulldown system to pull down and register in the allowed time. Check the Pulldown system fuses (fuses 1 and 3).	
4	Verify that the +24-volt and -34-volt supplies are correct while the projector is moving forward in cine mode.	
5	Verify that the connections associated with the Pulldown motor are good.	
6	Replace the 2275 card.	
7	Check the brushes in the Pulldown motor.	

Table 7.14: Image Quality Diagnostic Table (Continued)

ELECTRONIC CIRCUIT INFORMATION

This section contains current data for the electronic circuits used in the 35/70 Automated Film Projector. For each circuit, the following information is included:

- Parts List
- Circuit Diagram (optional)
- Component Layout (optional).

The following circuits are described in this section:

- 0207 Torque Arm Optical Pot Assembly
- 0208 Optical Sensor Assembly
- 0300 Sync Separator
- 1008 Frame Counter Display
- 1034 Power Supply Assembly
- 2262 Bi-Level Interface
- 2267 Keypad
- 2268 Pulldown Sensor
- 2269 Shutter and CV Encoder
- 2273 Pulse Drive Amplifier
- 2275 Pulldown Amplifier
- 2276 Framing Control
- 2293 Central Processing Unit
- 2285 PWM Amplifier
- 5051 70mm BOF/EOF Sensor
- 5052 35mm BOF/EOF Sensor

In addition, miscellaneous diagrams and parts lists that are not necessarily associated with a specific card are grouped at the end of this chapter:

- 35/70 System Interconnect Diagrams
- Film Velocity Diagram
- 35/70 Timing Diagram
- Master/Slave Interconnect Diagram

35/70 COMMAND SUMMARY

ENTRY	COMMAND
STOP C0	STOP
FORWARD C1	FORWARD
REVERSE C2	REVERSE
C3	OPEN DOUSER & CINE
C4	CLOSE DOUSER & SLEW
C5	CLEAR CUES
SET LOOP C6	SET LOOP
C7	OUTPUT STATUS
CUE C8	CUE
C9	JAM
READY CA	READY (NOT READY)
READY CA	DISPLAY REEL COUNTER (READY)
NOT RDY CB	NOT READY
CC	*Not used*
CD	MANUAL/SHOW CONTROLLER LOG
CE	SET REEL COUNTER
AUTO CF	CYCLE TEST
H0	CUE/ADVANCE
H1	PLAY CURRENT SHOW
H2	SET GOTO
H3	FAST FORWARD
H4	SET FRAME COUNTER

H5	SET CURRENT SHOW
H6	GOTO FRAME
H7	CUE NEXT
H8	SET NEXT SHOW
H9	SET FREQUENCY
HA	INTERLOCK
HB	DISPLAY ERROR
HC	PULLDOWN GAIN DISPLAY (READY)
HC	BRAKE RELEASE (NOT READY)
HD	SET MAX SHOWS
HE	LOCAL MODE
HF	DISPLAY START
G0	MEMORY INSPECT
G1	DISPLAY FRAME COUNTER
G2	SELECT FRAME RATES
G3	AUTO DOUSER
G4	LOAD REEL COUNTER
G5	PLATTER MODE
G6	OUTPUT CUE TAPES
G7	SHUTTER TEST
G8	REVERSE TEST MODE
G9	SHOW CONTROL ENABLE
GA	OUTPUT LOG
GB	TIMECODE INQUIRY
GC	*Not used*
GD	PARK ON CUE
GE	ENGAGE SOUND
GF	SOFTWARE VERSION