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WARNING

THE REMAINING PORTIONS OF THIS TABLE OF CONTENTS LISTS THE SERVICING INSTRUCTIONS. THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED SERVICE PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK OR OTHER PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT DESCRIBED IN THE OPERATOR'S INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

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OPERATING INSTRUCTIONS

To operate the 7934 effectively, the user must become familiar with its operation and capabilities. This section describes how to use the front- and rear-panel controls and connectors.

For detailed operating information on specific plug-in units used with the 7934, refer to the manual for that unit.

WARNING

To avoid electric-shock hazard, see installation in the General Information section of this manual before operating this instrument.

PLUG-IN UNITS

The 7934 accepts up to four Tektronix 7000-Series plug-in units. This feature allows selection of bandwidth, sensitivity, display mode, etc., and provides for future expansion of the system.

The overall capabilities of the system are mainly determined by the characteristics of the selected plug-ins. Some typical combinations are given under Applications in this section. For information on other plug-in units, refer to the current Tektronix Products Catalog.

Installation of Plug-In Units

CAUTION

To prevent instrument damage, plug-in units should not be installed or removed without first turning the instrument power off.

To install a plug-in unit into a compartment, align the slots in the top and bottom of the plug-in unit with the associated guide rails in the plug-in compartment. Insert the plug-in unit into the compartment until it locks into place. To remove a plug-in unit, pull outward on the release latch to disengage the plug-in. To meet the EMC (electromagnetic compatibility) specifications, cover all unused plug-in compartments with an EMC shielded blank plug-in panel, Tektronix Part 016-0155-00.

The gain of the 7934 vertical and horizontal systems has been normalized to allow plug-in units to be interchanged among plug-in compartments without readjustment of the system. The basic calibration of the plug-in units should be checked when installed to verify their accuracy (refer to the operating instructions in the plug-in manual).

CONTROLS AND CONNECTORS

The 7934 front and rear panels are shown in Figure 2-1 and Figure 2-2. A brief, functional description of each control and connector is included in these illustrations. Refer to Detailed Operating Information for additional information.

Front-Panel Color Coding

The 7934 front panel is color coded to define areas by function. Blue identifies controls that affect the display mode; green identifies triggering controls.

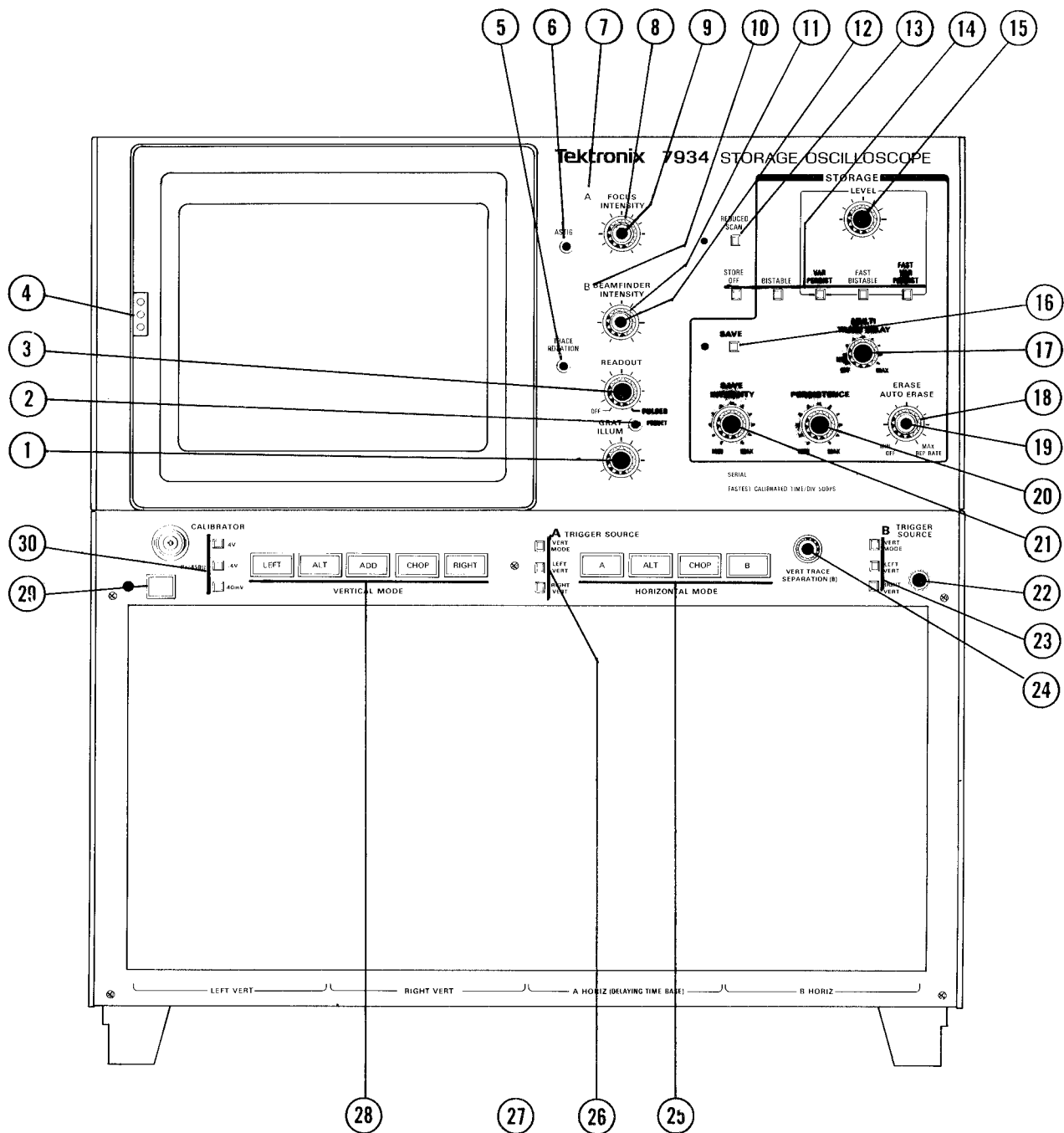
Other colors such as gray, orange, and yellow have no functional assignment, but indicate a relationship among controls and/or connectors.

OPERATOR'S CHECKOUT PROCEDURE

The Operator's Checkout Procedure may be used to verify proper operation of the controls and to get acquainted with the instrument. Only instrument functions (not measurement quantities or specifications) are checked in this procedure; therefore, a minimum amount of test equipment is required. If performing the Operator's Checkout Procedure reveals improper performance or instrument malfunction, first check the operation of associated equipment; then refer to qualified service personnel for repair or adjustment of the instrument.

Test Equipment Required

The following test equipment is required for the Operator's Checkout Procedure. Other test equipment which meets these requirements may be substituted. When other equipment is substituted, the control settings or setup may need to be altered.



NOTE
HORIZONTAL SELECTOR SWITCH
LOCATED AT THE REAR OF THE
A HORIZ COMPARTMENT.

5879-2

Fig. 2-1a. Front-panel controls, connectors and indicators.

FRONT-PANEL CONTROLS, CONNECTORS, AND INDICATORS

- 1 **GRAT ILLUM** — Controls illumination of graticule lines.
- 2 **PRESET (Readout)** — Screwdriver adjustment to set PULSED Readout Mode intensity.
- 3 **READOUT** — Controls brightness of the readout display. Disables Readout System in counterclockwise OFF detent. Activates Pulsed Readout Mode in clockwise PULSED detent.
- 4 **Camera Power Connector (not labeled)** — Three-pin connector provides power for camera operation and receives single-sweep-reset signal.
- 5 **TRACE ROTATION** — Screwdriver adjustment to align trace(s) with graticule lines.
- 6 **ASTIG** — Screwdriver adjustment used with the FOCUS control to obtain a well-defined display.
- 7 **A INTENSITY (indicator)** — Illuminates when A HORIZ plug-in selected for display.
- 8 **A INTENSITY** — Controls brightness of trace produced by the plug-in installed in the A HORIZ compartment.
- 9 **FOCUS** — Optimizes crt trace definition.
- 10 **B INTENSITY (indicator)** — Illuminates when B HORIZ plug-in selected for display.
- 11 **B INTENSITY** — Controls brightness of trace produced by the plug-in installed in the B HORIZ compartment.
- 12 **BEAMFINDER** — When pressed, compresses and defocuses display within graticule area.
- 13 **REDUCED SCAN (switch and indicator)** — Calibrated area of crt is reduced to inner half-size graticule and stored writing speed is increased when indicator is on.
- 14 **Storage Mode Switch (not labeled)** — Selects one of four storage modes or the STORE OFF display mode.
- 15 **STORAGE LEVEL** — Varies writing speed of VAR PERSIST, FAST BISTABLE, and FAST VAR PERSIST storage modes.
- 16 **SAVE (control and indicator)** — Retains stored display in a noneraseable mode with continuously variable intensity when indicator is on.
- 17 **MULTI TRACE DELAY** — Controls time between successive sweeps when operating in FAST BISTABLE and FAST VAR PERSIST storage modes.
- 18 **AUTO ERASE** — Controls viewtime in automatic erase mode.
- 19 **ERASE** — Erases stored display.
- 20 **PERSISTENCE** — Controls rate of continuous erasure of VAR PERSIST and FAST VAR PERSIST storage display modes.
- 21 **SAVE INTENSITY** — Controls intensity of the SAVE display.
- 22 **Ground (not labeled)** — Binding post to establish common ground between associated equipment.
- 23 **B TRIGGER SOURCE** — Selects internal trigger source for B HORIZ plug-in unit.
- 24 **VERT TRACE SEPARATION (B)** — Vertically positions the B HORIZ trace with respect to the A HORIZ trace (dual-sweep modes only).
- 25 **HORIZONTAL MODE** — Selects source of horizontal signal and horizontal display mode.
- 26 **A TRIGGER SOURCE** — Selects internal trigger source for A HORIZ plug-in unit.
- 27 **Horizontal Selector (located at rear of A HORIZ compartment)** — Three position switch which over-rides the HORIZONTAL MODE switch to determine the source of the horizontal display signal.
- 28 **VERTICAL MODE** — Selects source of vertical input signal and vertical display mode.
- 29 **POWER (switch and indicator)** — Switch controls power to instrument; indicator illuminates when power is applied.
- 30 **CALIBRATOR** — Provides calibrated square-wave voltages at 1 kHz repetition rate at CALIBRATOR output connector.

Fig. 2-1b. Front-panel controls, connectors and indicators.

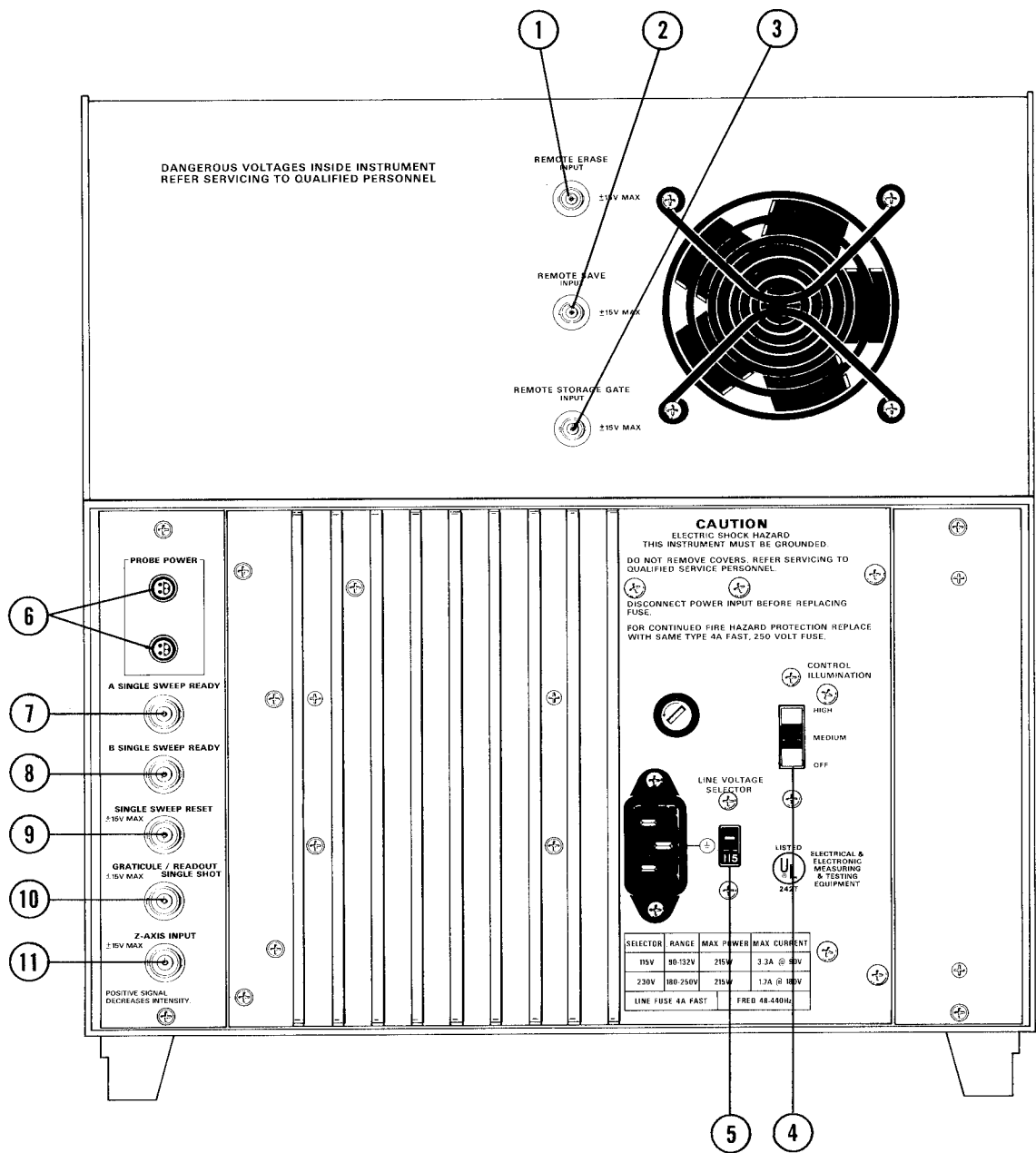


Fig. 2-2a. Rear-panel controls and connectors.

REAR-PANEL CONTROLS AND CONNECTORS

- ① **REMOTE ERASE INPUT** — Allows external operation of the ERASE function.
- ② **REMOTE SAVE INPUT** — Allows external operation of the SAVE function.
- ③ **REMOTE STORAGE GATE INPUT** — Allows external operation of the transfer function (FAST BISTABLE and FAST VAR PERSIST only).
- ④ **CONTROL ILLUMINATION** — Sets illumination level of the indicators and the lighted pushbutton switches on the 7934 front panel and the associated plug-in units.
- ⑤ **LINE VOLTAGE SELECTOR** — Sets instrument to 115-volt or 230-volt nominal line operation.
- ⑥ **PROBE POWER (two connectors)** — Provides power to active probe system.
- ⑦ **Z-AXIS INPUT** — Input for external intensity modulation of the crt display.
- ⑧ **VERT SIG OUT** — Output signal derived from vertical signal as selected by the B TRIGGER SOURCE switch.
- ⑨ **+SAWTOOTH OUT** — Sawtooth output signal derived from the A or B time-base unit.
- ⑩ **+GATE OUT** — Output signal derived from the A Gate, B Gate, or the A Delay'd Gate.
- ⑪ **REMOTE RESET IN** — Allows external single-sweep reset of time-base unit(s).

Fig. 2-2b. Rear-panel controls and connectors.

1. Amplifier Unit (two required)

Description: Compatible with 7934 Oscilloscope. One dual-trace unit required to completely check vertical readout fields.

Type: Any compatible 7A-series units. Refer to Table 1-8 in the General Information Section for suitable units.

2. Time-Base Unit (two required)

Description: Compatible with 7934 Oscilloscope. One dual time-base or delaying time-base required to completely check horizontal readout fields.

Type: Any compatible 7B-series units. Refer to Table 1-9 in the General Information section for suitable units.

3. Sine-Wave Generator

Description: Frequency range, 250 kilohertz to 1 megahertz; output amplitude, two volts peak-to-peak into 50 ohms; waveform, sine wave.

Type: Tektronix SG 503 (requires TM 500 power module).

4. Cables (two required)

Description: Length, 42 inches; connectors, BNC.

Type: RG-58/U, 50-ohm coaxial, Tektronix Part 012-0057-01.

5. BNC T Connector

Description: Connectors, two BNC female, one BNC male.

Type: BNC "T" connector, Tektronix Part 103-0300-00.

6. Adapter

Description: Connectors, BNC female to BNC female.

Type: BNC female to BNC female adapter, Tektronix part 103-0028-00.

Preliminary Set Up

1. Set the front-panel controls as follows:

A INTENSITY	Counterclockwise
FOCUS	Midrange
B INTENSITY	Counterclockwise
READOUT	OFF
GRAT ILLUM	Counterclockwise
REDUCED SCAN	Button out
STORE OFF	Button in
POWER	Button out
CALIBRATOR	4 V
VERTICAL MODE	LEFT
A TRIGGER SOURCE	VERT MODE
HORIZONTAL MODE	A
VERT TRACE SEPARATION (B)	Midrange
B TRIGGER SOURCE	VERT MODE
Horizontal Selector (at rear of A HORIZ compartment)	Norm

2. Connect the 7934 to a power source that meets the voltage and frequency requirements. If the available line voltage is outside the limits of the LINE VOLTAGE SELECTOR switch setting (on rear panel), see Operating Power Information under Installation (General Information Section).

3. Install Tektronix 7A-Series amplifier units in the LEFT VERT and RIGHT VERT compartments. Install Tektronix 7B-Series time-base units in the A HORIZ and B HORIZ compartments.

4. Press the POWER switch to the on position (button in).

5. Set both time-base units to 1 millisecond/division and triggering to auto mode with ac coupling from the internal source.

6. Rotate the A INTENSITY control until the trace is at a desirable viewing level (near midrange). Position the trace as necessary for an on-screen display.

7. Connect the CALIBRATOR output to the input of the left amplifier unit with a 42-inch BNC cable.

8. Set the left amplifier unit deflection factor to display a signal amplitude of two divisions centered on the screen.

9. Set the A horizontal time-base triggering for a stable display.

Display Focus

10. Rotate the FOCUS control and observe the square-wave display. Notice that the thickness of the trace varies as the FOCUS control is rotated. Set the FOCUS control for a well-defined trace. If a well-defined trace cannot be obtained, adjust the ASTIG screwdriver adjustment along with the FOCUS control for the best trace.

Trace Alignment

11. Disconnect the input signal. Use the left amplifier unit position control to align the trace with the center horizontal graticule line. If necessary set the TRACE ROTATION adjustment so the trace is parallel to the center graticule line.

Graticule Illumination

12. Rotate the GRAT ILLUM control throughout its range and notice that the graticule lines are illuminated as the control is turned clockwise.

Control Illumination

13. Set the rear-panel CONTROL ILLUMINATION switch to HIGH. Notice that the A INTENSITY indicator and the lighted pushbutton switches are illuminated. Sequentially press all of the HORIZONTAL MODE switch positions and notice the A and B INTENSITY lights; these lights indicate which intensity control is active. Set the CONTROL ILLUMINATION switch to the MEDIUM position. Observe that the selected intensity indicator and the lighted pushbutton switches on the plug-in units are dimmed. Set the CONTROL ILLUMINATION switch to OFF and notice that the selected intensity indicator and pushbutton switches are extinguished.

14. Set the rear-panel CONTROL ILLUMINATION switch to the HIGH position. Return the HORIZONTAL MODE switch to A.

Vertical Deflection System

15. Connect the 4 V CALIBRATOR output to the input connectors of both amplifier units with two 42-inch BNC cables and a BNC T connector. Set the deflection factor of the left amplifier unit to display about two divisions of signal on the screen.

16. Notice that the position control of only the left amplifier unit affects the vertical position of the displayed trace. Position the trace to the upper half of the graticule.

17. Set the VERTICAL MODE switch to RIGHT. Set the deflection factor of the right amplifier unit to display about two divisions of signal on the screen.

18. Notice that the position control of only the right amplifier unit affects the vertical position of the displayed trace. Position the trace to the lower half of the graticule.

19. Set the VERTICAL MODE switch to ALT. Notice that two traces are displayed on the screen. The top trace is produced by the left amplifier unit and the bottom trace is produced by the right amplifier unit; the sweep for both traces is produced by the A time-base unit. Set the sweep rate of the A time-base unit to 50 milliseconds/division; notice that the display alternates between the left and right amplifier plug-in units after each sweep. Turn the A time-base sweep rate switch throughout its range; notice that the display alternates between amplifier units at all sweep rates.

20. Set the VERTICAL MODE switch to CHOP. Turn the A time-base unit sweep rate switch throughout its range. Notice that a dual-trace display is presented at all sweep rates, and that both amplifier units are displayed by the A time-base unit on a time-sharing basis. Set the A time-base unit sweep rate switch to 0.5 millisecond/division.

21. Set the VERTICAL MODE switch to ADD. The display should be four divisions in amplitude. Notice that the position control of either amplifier unit moves the display. Set the VERTICAL MODE switch to LEFT.

Horizontal Deflection System

22. Notice that the position control of only the A time-base unit affects the horizontal position of the displayed trace. Position the start of the trace to the left graticule line with the A time-base unit position control.

23. Set the HORIZONTAL MODE switch to B. Advance the B INTENSITY control until the display becomes defocused. The defocused display indicates that the B INTENSITY control is set too high. Reduce the setting of the B INTENSITY control to obtain a bright, well-defined display.

24. Notice that only the B time-base unit position control affects the horizontal position of the displayed trace. Position the start of the trace to the left graticule line with the B time-base unit position control. Set the B time-base unit triggering controls for a stable display.

25. Set the HORIZONTAL MODE switch to ALT. Two traces should be presented on the screen. If the traces overlap, adjust the VERT TRACE SEPARATION (B) control to position one trace to the bottom of the graticule area. Turn the sweep rate switches of both time-base units throughout their range. Observe that each time-base unit controls one of the traces independently of the other time-base unit. Also notice that when one of the time-base units is set to a slow sweep rate (below about 50 milliseconds/division), sweep alternation is evident (only one of the traces is presented on the screen at a time). Set the sweep rates of both time-base units to 0.5 millisecond/division. Adjust the A INTENSITY control; notice that it changes the intensity of the trace produced by the A time-base unit only. Likewise, the B INTENSITY control changes the intensity of the trace produced by the B time-base unit only. Return both intensity controls to desirable levels.

26. Set the HORIZONTAL MODE switch to CHOP. Notice that two traces are displayed on the screen in a manner similar to that of the ALT display. Turn the sweep rate switches of both time-base units throughout their ranges. Observe that two traces are displayed on the screen at all sweep rates. Also notice that when both time-base units are set to a slow sweep rate (50 milliseconds/division or slower), both traces are visible on the screen at the same time. Return the sweep rate switches of both time-base units to 0.5 millisecond/division.

27. Set the CALIBRATOR switch to 0.4 V. Set the VERTICAL MODE switch to CHOP. Four traces should be displayed on the screen. If not, adjust the position controls of the amplifier units and the VERT TRACE SEPARATION (B) control to position the four traces into view. Set the position controls of the plug-in units to identify which trace is produced from each plug-in unit (if amplifier units have the identify feature, it can be used to identify the traces). Set the A time-base unit for a sweep rate of 1 millisecond/division. Notice that the left-amplifier unit is displayed at the sweep rate of both the A and B time-base units and that the right-amplifier unit is also displayed at the sweep rate of both time-base units.

28. Set the HORIZONTAL MODE switch to ALT. Observe that the display is very similar to that obtained in the previous step. The main difference in this display is that the traces are now displayed alternately (noticeable only at slow sweep rates).

29. Set the VERTICAL MODE switch to ALT. Set the CALIBRATOR switch to 4 V. Notice that the trace produced by the left amplifier unit is displayed at the sweep rate of the B time-base unit and the trace produced by the right amplifier unit is displayed at the A time-base unit sweep rate. This feature is called slaved-alternate operation and is obtained

only when the VERTICAL MODE switch is in the ALT position, the HORIZONTAL MODE switch is in either the ALT or the CHOP position, and the time-base units are in the independent mode.

Triggering

30. Set the VERTICAL MODE switch to LEFT and the HORIZONTAL MODE switch to A. Center the display on the screen with the left amplifier unit position control. Disconnect the input signal from the right amplifier unit input connector. Sequentially select all of the VERTICAL MODE switch positions. Notice that a stable display is obtained for all positions of the VERTICAL MODE switch (a straight line in RIGHT switch position).

31. Set the A TRIGGER SOURCE switch to LEFT VERT. Again, sequentially select all of the VERTICAL MODE switch positions. Notice that the display is again stable in all positions, as in the previous step, and that the LEFT VERT button is illuminated.

32. Set the A TRIGGER SOURCE switch to RIGHT VERT. Sequentially select all of the VERTICAL MODE switch positions and notice that a stable display cannot be obtained in any position (this is because there is no input signal connected to the right vertical unit). The RIGHT VERT button is illuminated. Return the A TRIGGER SOURCE switch to VERT MODE; notice that this button is illuminated.

33. The B TRIGGER SOURCE switch operates in a manner similar to the A TRIGGER SOURCE switch when the B time-base unit is selected to provide the display. Set the B TRIGGER SOURCE switch to VERT MODE, and the VERTICAL MODE switch to ALT.

34. Set the HORIZONTAL MODE switch to ALT or CHOP. Notice that this is the same display obtained in step 29 (slaved-alternate operation).

Readout

35. Turn the READOUT control clockwise until an alphanumeric display is visible within the top or bottom division of the screen. Change the deflection factor of the amplifier unit that is selected for display; notice that the readout display changes as the deflection factor is changed. Likewise, change the sweep rate of the time-base unit which is selected for display; notice that the readout display for the time-base unit changes as the sweep rate is changed.

36. Set the time-base unit for X10 magnification. Notice that the readout display changes to indicate the correct

magnified sweep rate. If a readout-coded 10X probe is available for use with the amplifier unit, install it on the input connector of the right amplifier plug-in unit. Notice that the deflection factor indicated by the readout is increased by 10 times when the probe is added. Return the time-base unit to normal sweep operation and disconnect the probe.

37. Sequentially select all of the VERTICAL MODE and HORIZONTAL MODE switch positions. Notice that the readout from a particular plug-in occupies a specific location on the display area. If either of the vertical plug-in units is a dual-trace unit, notice that the readout for channel 2 appears within the lower division of the screen. Return the VERTICAL MODE switch to LEFT and the HORIZONTAL MODE switch to A. Set the READOUT control to OFF.

Beamfinder

38. Set the deflection factor of the left amplifier unit to 0.1 volt/division. Notice that a square-wave display is not visible, since the deflection exceeds the scan area of the crt.

39. Press the BEAMFINDER button; notice that the display is returned to the viewing area in compressed form while the BEAMFINDER is pressed. Release the BEAMFINDER and notice that the display again disappears from the viewing area.

40. With the BEAMFINDER button pushed in, increase the amplifier-unit deflection factor until the display is reduced to about two divisions vertically. Adjust the position control of the displayed amplifier unit to position the compressed display near the center of the graticule. Release the BEAMFINDER and notice that the display remains within the viewing area.

Calibrator

41. Connect the CALIBRATOR output to both the left and right vertical units with two BNC cables and a BNC T connector. The display amplitude should be approximately two divisions. If not, adjust the deflection factor accordingly.

42. Press the different CALIBRATOR buttons (labeled 4 V, 0.4 V, and 40 mV) and notice that the displayed signal changes accordingly (CALIBRATOR output must be terminated into more than a 100-kilohm load for stated output). When the CALIBRATOR output is terminated into 50 ohms, the output is one-tenth of the stated output. Disconnect the CALIBRATOR signal.

Z-Axis Input

43. If an external signal is available (two volts peak-to-peak minimum), the function of the Z-AXIS INPUT can be demonstrated. Connect the external signal to both the input connector of the displayed amplifier unit and the rear-panel Z-AXIS INPUT connector. Set the sweep rate of the displayed time-base unit to display about five cycles of the signal. Set the amplitude of the signal generator until intensity modulation is visible on the display (change the amplifier unit deflection factor as necessary to produce an on-screen display). The positive peaks of the waveform should be blanked out and the negative peaks intensified. Notice that the setting of the intensity controls determines the amount of intensity modulation that is visible. Disconnect the cables.

Storage Operation

44. Connect the CALIBRATOR output to the input connector of the left amplifier unit, press the 4 V button, and set the vertical deflection factor for a two-division display. Set the time-base unit triggering mode to single sweep and set the sweep rate for 0.5 millisecond/division.

45. Press the BISTABLE button and set the AUTO ERASE control fully counterclockwise into the detent position.

46. Press the ERASE button. The calibrator signal should be stored on the screen. If not, increase the A INTENSITY control slightly and press the ERASE button again. Repeat this sequence until a stored display is obtained.

47. Press the SAVE button. The signal stored in the previous step should remain on the screen; it may be necessary to adjust the SAVE INTENSITY control to view the display. Turn the SAVE INTENSITY control throughout its range and observe the effect on the display.

48. Press the ERASE button. Notice that the display cannot be erased (the SAVE mode inhibits the erase function). Press and release the SAVE button.

49. Set the STORAGE LEVEL and the PERSISTENCE controls fully counterclockwise. Press the VAR PERSIST button. Observe that an erase cycle and sweep occurs (when switching between the BISTABLE and VAR PERSIST modes) and that the screen goes dark except for the stored display.

Operating Instructions—7934 Service

50. Slowly turn the PERSISTENCE control clockwise and notice that the stored display fades into the background (background lighting will be observed as the PERSISTENCE control is advanced clockwise). The PERSISTENCE control determines the time interval during which the stored display is retained in the VAR PERSIST mode. Set the PERSISTENCE control fully counterclockwise.

51. Press the ERASE button, then set the PERSISTENCE control to midrange just long enough for the display to fade out. Quickly turn the PERSISTENCE control fully counterclockwise. Slowly increase the STORAGE LEVEL (clockwise) and notice that the faded display again becomes visible, against the background.

52. Turn the PERSISTENCE, STORAGE LEVEL, and A INTENSITY controls fully counterclockwise and set the time-base unit for auto triggering at a sweep rate of 0.5 second/division.

53. Set the PERSISTENCE control to midrange and slowly increase the A INTENSITY (clockwise) until the trace appears. Vary the PERSISTENCE control setting and notice that the trace can be made to build up or fade more quickly, depending on the control setting. Varying the A INTENSITY control also affects the display in the same manner. Return the PERSISTENCE control to midrange and slowly decrease the A INTENSITY control to the point where the trace is just extinguished; then set the STORAGE LEVEL control fully clockwise and notice that the trace becomes visible again.

54. Turn the PERSISTENCE, STORAGE LEVEL, and A INTENSITY controls fully counterclockwise and set the time-base unit for auto triggering at a sweep rate of 0.5 millisecond/division.

55. Press the FAST BISTABLE button.

56. Press the ERASE button and notice that the screen background appears to alternate between bright and dim. This indicates that the sweep and transfer functions are operating.

57. Set the MULTI TRACE DELAY control fully clockwise; then, slowly increase the A INTENSITY control (clockwise) until the display stores. Notice that each sweep is stored without erasing the previously stored sweep. This is easily observed if the vertical position control is varied between sweeps.

58. Press the ERASE button and notice that the display is erased.

59. Set the time-base unit for single sweep and press the ERASE button. Notice that only one sweep is stored (trigger time-base unit if necessary).

60. Change the setting of the vertical position control and initiate another sweep by pressing the reset button on the time-base unit. Notice that the new sweep is stored along with the one stored in the previous step.

61. Alternately press the ERASE button and reduce the A INTENSITY control to the point where the display just fails to store.

62. Alternately increase the STORAGE LEVEL (clockwise) and press the ERASE button. Notice that as the STORAGE LEVEL is increased, the display begins to store.

63. The FAST VAR PERSIST mode operates as outlined for the VAR PERSIST mode except that the sweep and transfer functions are operative as described for FAST BISTABLE operation.

64. Press the BISTABLE button. Set the time-base unit for auto triggering.

65. Set the A INTENSITY control to the one o'clock position. Turn the AUTO ERASE control out of the detent position and notice that the erase cycles occur automatically and with increasing frequency as the control is turned clockwise.

66. Return the ERASE control to the detent (OFF) position and set the time-base unit for single sweep and external triggering. Turn the SAVE INTENSITY control fully counterclockwise.

67. Press the ERASE button; notice that no sweep occurs.

68. Press the SAVE button; notice that no sweep occurs (this is the "Auto Save" mode). Since no trigger was available, the sweep did not run; therefore, the system waits in a ready-to-store mode.

69. Set the time-base unit to internal trigger and notice that the screen goes dark. This indicates that a sweep has occurred and that the system has entered the SAVE mode.

70. Turn the SAVE INTENSITY control clockwise and notice that the stored display becomes visible.

71. Press the STORE OFF button and set the time-base unit for auto triggering.

This completes the Operator's Checkout Procedure for the 7934.

DETAILED OPERATING INFORMATION

Graticule

The graticule is marked on the inside of the crt faceplate, providing accurate, parallax-free measurements. The graticule is divided into eight vertical and ten horizontal divisions. Each full scan division is 0.9-centimeter square divided into five minor divisions along each axis. A reduced scan graticule is etched in the center of the full scan graticule. Each reduced scan division is exactly one-half of a full scan division (0.45 centimeter). The vertical gain and horizontal timing of the plug-in units are calibrated to the graticule so that accurate measurements can be made from the crt in either full or reduced scan mode. The illumination of the graticule lines can be varied with the GRAT ILLUM control.

Figure 2-3 shows the graticule and defines the various measurement lines. The terminology defined here will be used in all discussions involving measurements from the graticule. The 0%, 10, 90, and 100 markings on the left side of the graticule are provided to facilitate rise-time measurements.

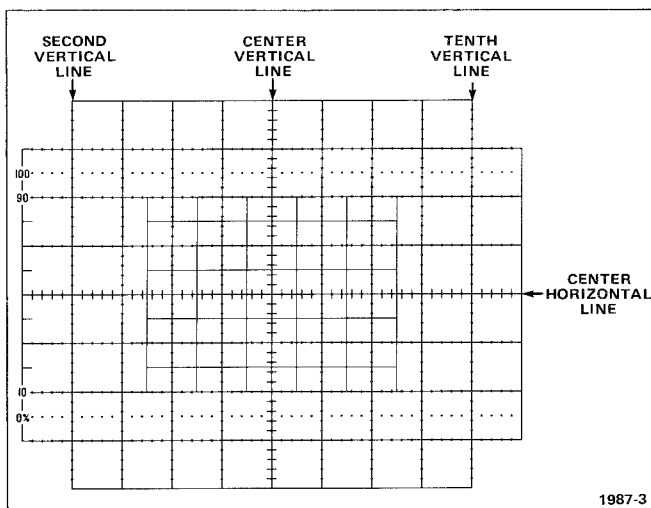


Figure 2-3. Definition of graticule measurement lines.

Light Filter

The tinted crt face-plate filter minimizes light reflections from the face of the crt to improve contrast when viewing the display under high-ambient-light conditions. This filter may be removed for waveform photographs or for viewing high-writing-rate displays. To remove the filter, pull outward on the bottom of the plastic crt mask and remove it from the crt bezel. Remove the tinted filter; leave the clear plastic face-plate protector installed and replace the mask. The face-plate protector should be left in place at all times to protect the crt face plate from scratches, and to protect the operator from crt implosion.

WARNING

Do not remove the clear plastic implosion shield covering the crt face plate; the crt implosion shield provides protection to the operator from crt implosion.

An optional mesh filter is available from Tektronix (included with Option 03). This filter provides shielding against radiated electromagnetic interference from the face of the crt. It also serves as a light filter to make the trace more visible under high-ambient-light conditions. The mesh filter fits in place of the plastic tinted filter. Order the mesh filter by Tektronix Part 378-0603-00.

Control Illumination

The rear-panel CONTROL ILLUMINATION switch sets the illumination level of the A and B INTENSITY indicators, the A and B TRIGGER SOURCE switches, and the lighted pushbutton switches on the plug-in units. The positions available are OFF, MEDIUM, and HIGH. The CONTROL ILLUMINATION switch does not affect the function-indicator lights on plug-in units (such as triggered or single-sweep ready lights).

Intensity Controls

The A INTENSITY control determines the brightness of the display produced by the plug-in unit installed in the A HORIZ compartment; the B INTENSITY control determines the brightness of the display produced by the plug-in unit installed in the B HORIZ compartment. The READOUT intensity control affects the brightness of only the readout portion of the crt display.

CAUTION

Crt damage can occur under high-intensity conditions. Avoid any condition where an extremely bright, sharply-focused dot exists on the crt. Also, remember that the light filter reduces the apparent light output from the crt.

The beam current is limited during X-Y mode operation or when either, or both, time-base units being displayed are set for a slow sweep rate. This reduces the danger of damaging the crt with a stationary or slowly moving spot.

Display Focus

This instrument contains an automatic-focusing circuit which maintains optimum focus for all intensity levels after a correct setting of the FOCUS control is established. The easiest way to obtain the correct setting of the FOCUS control is to set the READOUT intensity control so that the readout portion of the display is clearly visible. Then adjust the FOCUS control for best definition of the readout display.

Astigmatism and Focus Adjustments

If a well-defined display cannot be obtained with the FOCUS control, set the ASTIG adjustment as follows:

NOTE

To check for proper setting of the ASTIG adjustment, slowly turn the FOCUS control through the optimum setting. If the ASTIG adjustment is correctly set, the vertical and horizontal portions of the display will come into focus at the same position of the FOCUS control. This setting of the ASTIG adjustment should be correct for any display.

1. Install an amplifier unit in the LEFT VERT compartment and a time-base unit in the A HORIZ compartment.

2. Set the VERTICAL MODE switch to LEFT and the HORIZONTAL MODE switch to A.

3. Connect the output of a sine-wave generator to the input of the amplifier unit. Set the sine-wave generator repetition rate to 1 kilohertz and the vertical amplifier deflection factor for a two-division display.

4. Set the time-base unit sweep rate for 0.2 millisecond/division and the triggering for a stable display. Set the A INTENSITY control so the display is at a usable intensity level (about midrange).

5. Turn the FOCUS control fully counterclockwise and set the ASTIG adjustment to midrange.

6. Set the FOCUS control so the thickness of the sine-wave trace is as thin as possible.

7. Adjust the ASTIG adjustment so the width of the sine-wave trace is as thin as possible.

8. Repeat steps 6 and 7 for the best overall focus

Beamfinder

The BEAMFINDER helps locate a display that overscans the crt viewing area vertically and/or horizontally. When the BEAMFINDER button is pressed, the display is compressed and defocused within the graticule area. To locate and reposition an overscanned display, use the following procedure:

1. Press the BEAMFINDER button. While the display is compressed, change the vertical and horizontal deflection factors until the vertical deflection is about two divisions high and the horizontal deflection is about four divisions wide (the horizontal deflection needs to be reduced only when operating in an X-Y mode).

2. Adjust the vertical and horizontal position controls to center the display on the graticule.

3. Release the BEAMFINDER button; the display should remain within the graticule area.

Trace Alignment

The TRACE ROTATION adjustment allows the trace to be aligned with the horizontal graticule lines. To set trace alignment, set the amplifier unit input coupling to ground. Then, position the trace to the center horizontal line and adjust the TRACE ROTATION adjustment so that the trace is parallel with the center horizontal graticule line.

Readout Display

The Readout System provides an alpha-numeric display of information on the crt along with the analog waveform display. The information displayed by the Readout System is obtained from the plug-in units installed in the plug-in compartments.

The readout information from each channel of each plug-in unit is called a word. Up to eight words of readout information can be displayed on the crt (two channels from each of the four plug-in compartments). The location of each readout word is fixed and is directly related to the plug-in unit and channel from which it originated. Figure 2-4 shows the area of the graticule where the readout from each plug-in unit and/or channel is displayed. Notice that the readout from channel 1 of each plug-in unit is displayed in the top division of the graticule and the readout from channel 2 is displayed directly below in the bottom division of the graticule.

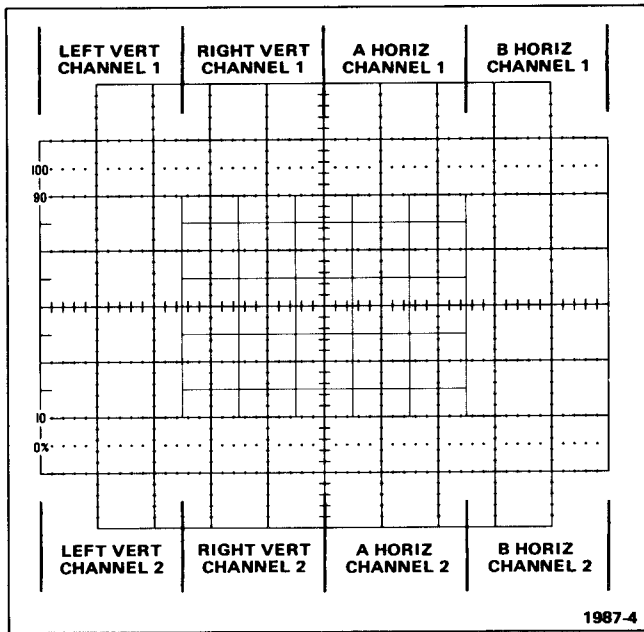


Figure 2-4. Location of readout on the crt identifying the originating plug-in and channel.

The reduced scan mode changes the location of the readout display. Figure 2-5 shows the correct readout location for the reduced scan mode. Notice that the readout display is positioned outside the half-size inner graticule and that the location of the readout words is directly related to the plug-in unit and channel from which they originated.

Usually, the readout information for plug-in units and/or channels, which are selected by the mode switches, appear in the readout display. (Some special purpose plug-in units may over-ride the mode switches to display readout even though the compartment is not selected for display.)

Readout Identify

An identify feature is provided by the Readout System to correlate the readout word with the originating plug-in unit and channel (amplifier units only). When the "identify" button of an amplifier unit is pressed, the word IDENTIFY appears in the readout location allocated to that plug-in and channel. Other readout words in the display remain unchanged. When the "identify" button is released, the readout display from this plug-in channel is again displayed. Circuitry may also be provided in the amplifier unit to produce a noticeable change in the analog waveform display to identify the associated trace when the identify button is pressed (see the plug-in unit instruction manual for details).

Readout Intensity

The READOUT control determines the intensity of only the readout portion of the display, independently of the

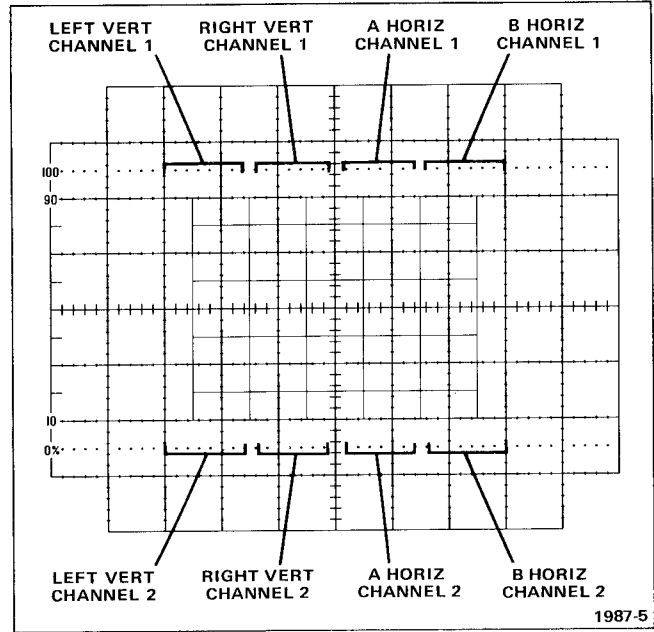


Figure 2-5. Location of readout on the crt when reduced scan is selected.

traces. The Readout System is inoperative when the READOUT control is in the fully counterclockwise OFF position. This may be desirable when the top and bottom divisions of the graticule are to be used for waveform display, or when the trace interruptions necessary to display characters interfere with the waveform display.

Readout Modes

The READOUT intensity control determines the operating mode of the Readout System. With the READOUT intensity control set in the variable area, the Readout System operates continuously, interrupting the crt display at random (for about 20 microseconds) in order to write each character on the crt. In the PULSED position, the Readout System operates in a triggered mode; one complete frame (up to eight words) of readout is displayed after the displayed time-base unit completes each sweep of the crt. Brightness of the readout display when operating in the PULSED mode is set by the READOUT PRESET adjustment.

Readout Operation With Storage

Each of the storage modes modify the operation of the Readout System to some extent.

Normal Readout Mode. With the READOUT control set in the variable area, the Readout System operates as follows:

BISTABLE and VAR PERSIST. In the BISTABLE and VAR PERSIST storage modes, the readout display is turned off during the storage erase cycle; otherwise, the Readout System operates as previously described under Readout Modes.

FAST BISTABLE and FAST VAR PERSIST. In the FAST BISTABLE and FAST VAR PERSIST storage modes, the Readout System turns off at the beginning of an erase cycle or when the single-sweep time-base mode is reset and remains off until the end of the storage transfer cycle. In addition, the Readout System is held off whenever the MULTI TRACE DELAY control is in operation (out of its detent position) and the displayed time-base unit is in a repetitive sweep mode.

Pulsed Readout Mode. With the READOUT control set to PULSED, the Readout System operates as follows:

BISTABLE. In the BISTABLE storage mode, the readout display runs continuously; however, the Readout System turns off when the storage erase cycle begins and remains off until the end of the first displayed sweep.

VAR PERSIST. In the VAR PERSIST storage mode one complete frame of readout is displayed after the displayed time-base unit completes each sweep; however, there is no readout display during a storage erase cycle.

FAST BISTABLE. In the FAST BISTABLE storage mode the readout display runs continuously (as in the normal mode); however, the Readout System turns off at the beginning of each erase cycle or when the single sweep time-base mode is reset and remains off until the end of the storage transfer cycle. In addition, the Readout System is held off whenever the MULTI TRACE DELAY control is in operation (out of its detent position) and the displayed time-base unit is in a repetitive sweep mode.

FAST VAR PERSIST. In the FAST VAR PERSIST storage mode, one complete frame of readout is displayed after the completion of the storage transfer cycle. However, there is no readout during the storage erase cycle and there is no readout when the MULTI TRACE DELAY control is out of the detent position and the displayed time-base unit is in a repetitive sweep mode.

Readout With Save Storage Mode. When the SAVE storage mode is used, operation of the Readout System changes from that previously described. (Refer to the SAVE mode discussion, in this manual, for information on SAVE storage mode operation.)

Save With Normal Readout. With the READOUT control set in the variable area and any of the storage modes selected, the Readout System turns off approximately one second after the storage system enters the SAVE mode.

Save With Pulsed Readout. With the READOUT control set to PULSED and the storage mode switch set to BISTABLE or FAST BISTABLE, the readout is displayed for approximately one second after the storage system enters the SAVE mode; then it turns off. With the READOUT control set to PULSED and the storage mode switch set to VAR PERSIST, one complete frame of readout is displayed at the end of the displayed sweep. With the READOUT control set to PULSED and the storage mode switch set to FAST VAR PERSIST, one frame of readout is displayed at the end of the storage transfer cycle, or whenever the storage system is set to the SAVE mode and the MULTI TRACE DELAY control is out of its detent position.

Reduced Scan Mode

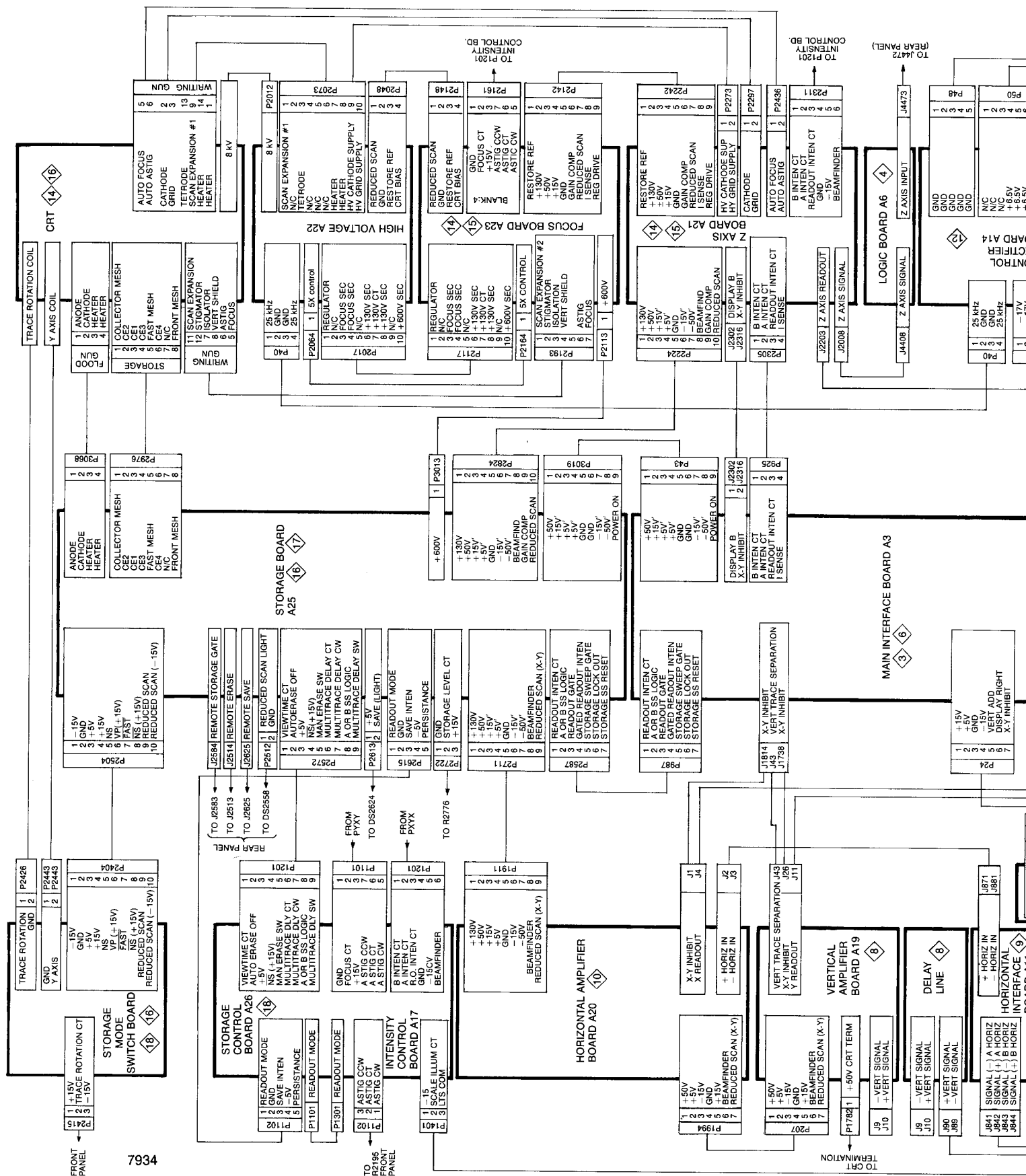
The reduced scan mode increases the stored writing speed. The calibrated graticule division is reduced to 0.45 centimeters in the reduced scan mode. Calibrated measurements are confined to the inner half-size 8 x 10 graticule area. The operation of the instrument controls do not change from their operation in the full scan mode.

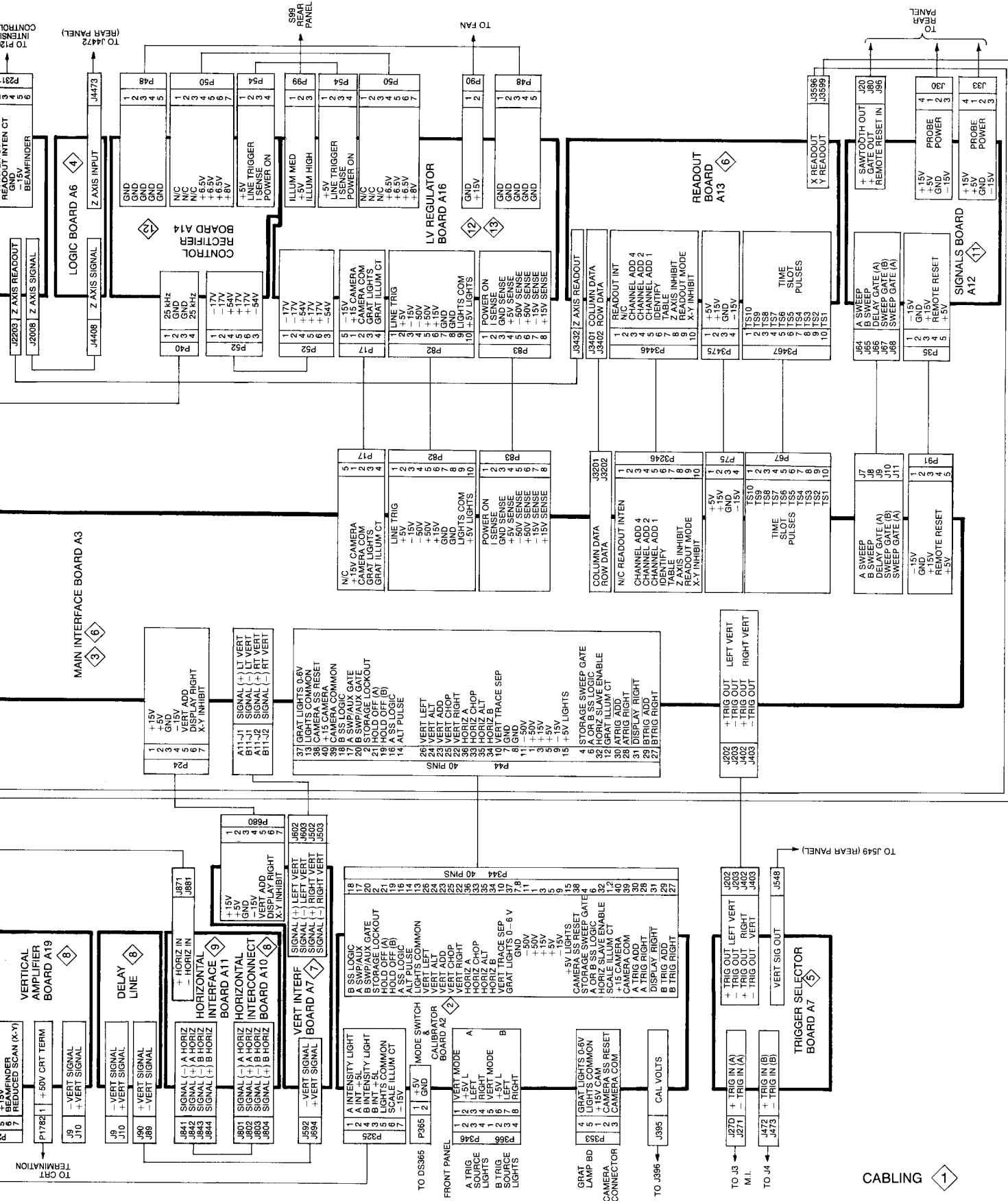
Storage Display

The 7934 Storage Oscilloscope has four selectable storage modes. Listed in order of increasing writing speed, they are: BISTABLE, VAR PERSIST, FAST BISTABLE, and FAST VAR PERSIST. In each mode the viewed image is stored on the storage target located in the front of the crt.

Bistable Storage. In the BISTABLE mode the luminance of any point on the storage target takes on one of two discrete levels, either written or unwritten. In this mode, only the A or B INTENSITY controls affect the stored writing speed; writing speed is quite low but the stored view time is indefinitely long.

Variable Persistence Storage. In the VAR PERSIST mode, points on the storage target can vary in luminance between totally dark and very bright. In this mode, writing speed is greater than in the BISTABLE mode, but the stored display is essentially unstable, or continuously fading away. The rate of fading is adjusted by the PERSISTENCE control. The VAR PERSIST storage mode is particularly useful for viewing high-speed repetitive signals with low repetition rates. The PERSISTENCE control can be adjusted in conjunction with the STORAGE LEVEL and INTENSITY controls, to produce a steady, bright trace. Writing speed is varied in this mode by the STORAGE LEVEL control as well





CABLING

FRONT
←

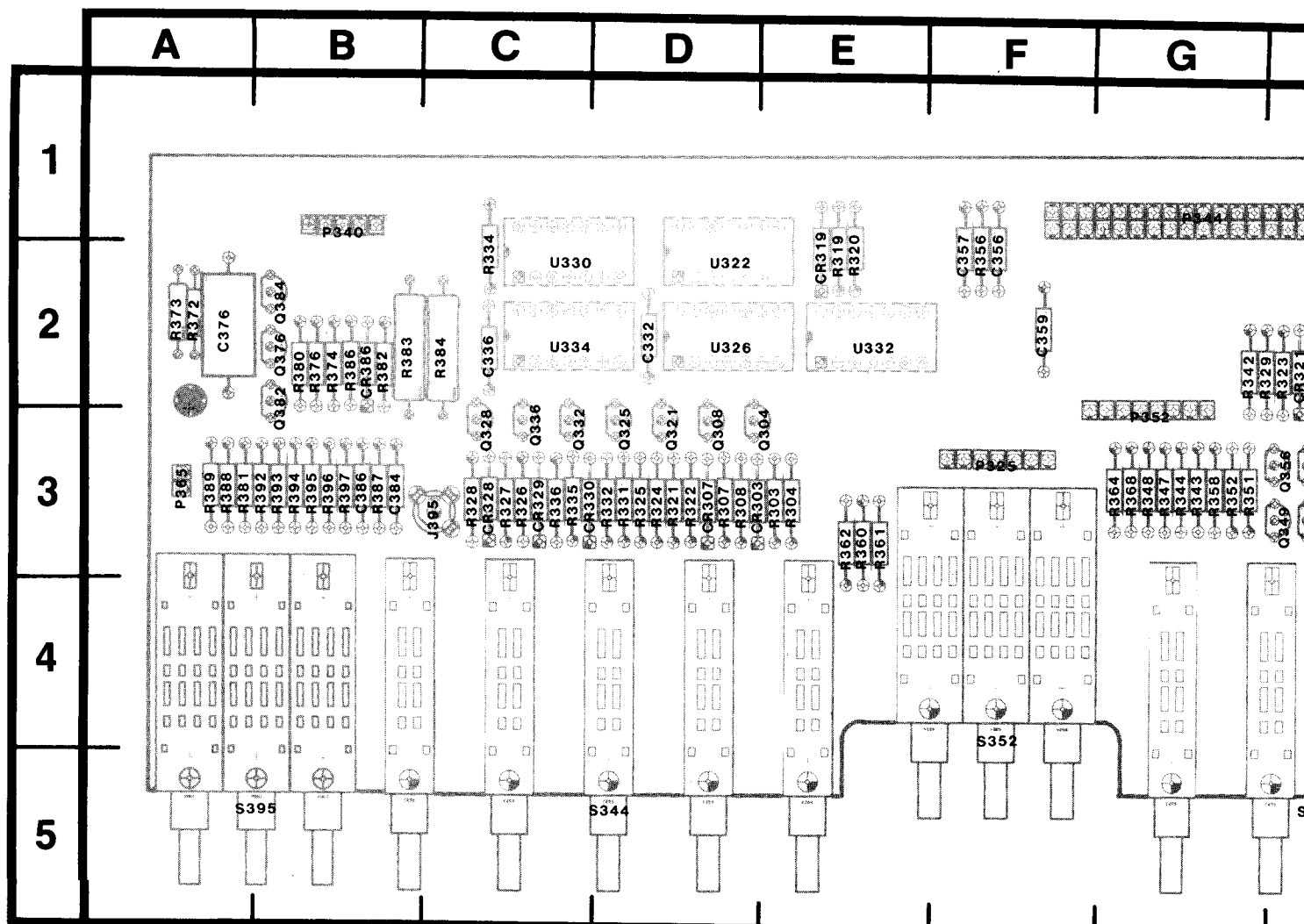
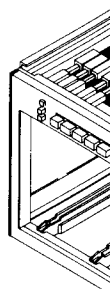
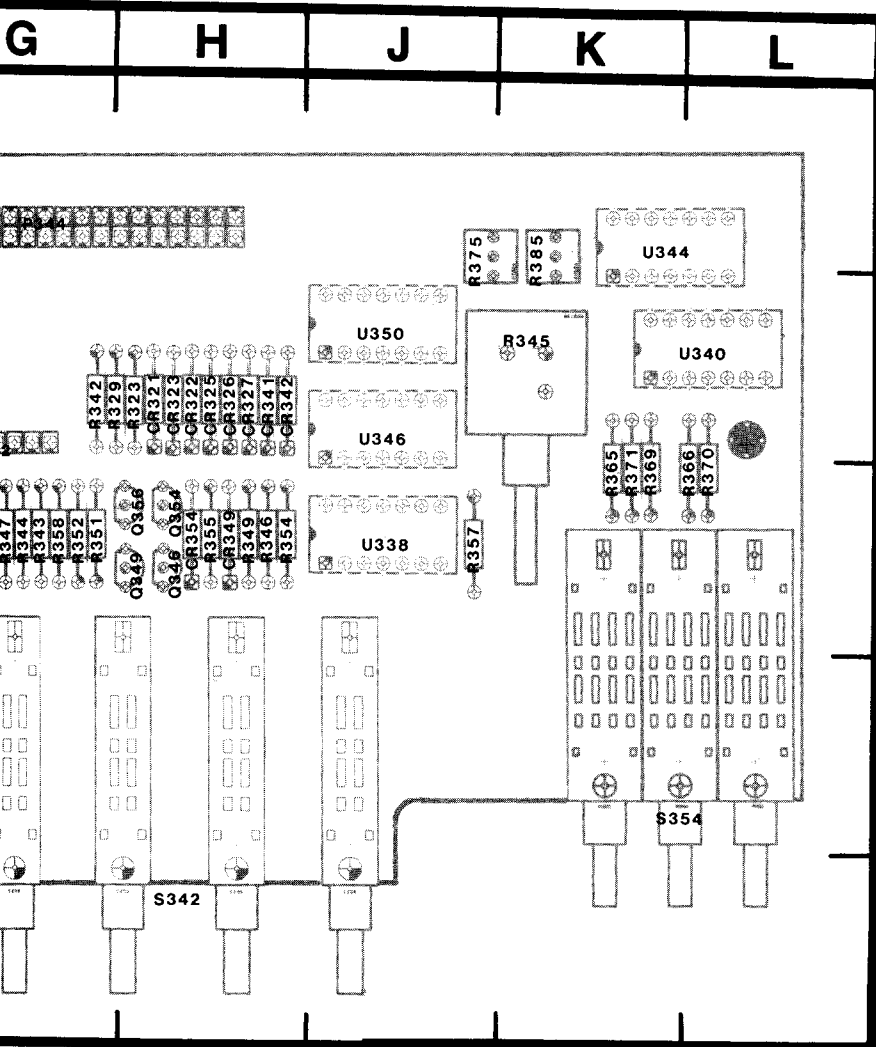


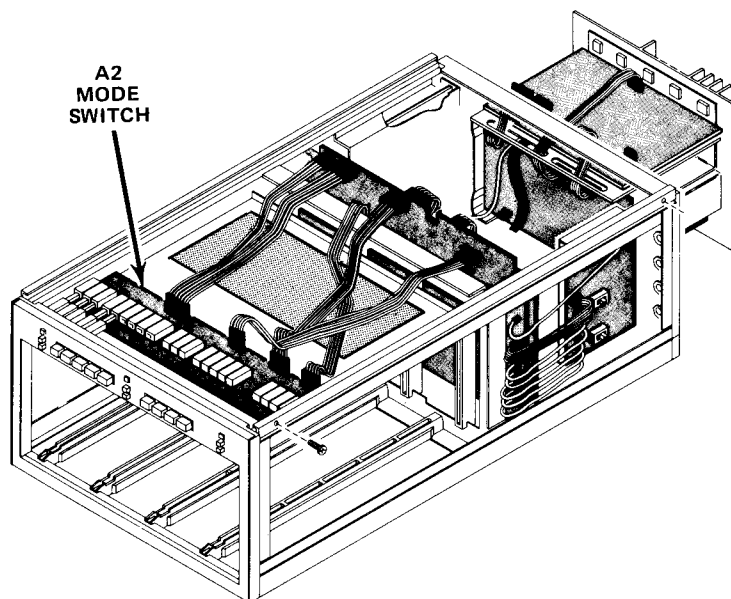
Figure 8-3. A2-Mode Switch Circuit Board Assembly.





5880-200

assembly.



CALIBRATOR AND MODE SWITCH DIAGRAM

2

ASSEMBLY A1 — Graticule Light Circuit Board (not pictured)

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
DS304	G5	Not pictured			
DS305	C5	Not pictured			
DS306	G4	Not pictured			

ASSEMBLY A2 — Mode Switch Circuit Board

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C332	C4	D2	R307	A4	D3
C336	C4	C2	R308	A4	D3
C356	H4	F1	R319	B1	E1
C357	H3	F1	R320	B1	E1
C359	H4	F2	R321	C5	D3
C376	G3	A2	R322	A4	D3
C384	G3	B3	R323	B3	H2
C386	G2	B3	R324	B4	D3
			R325	B4	D3
CR303	A4	D3	R326	B5	C3
CR307	A4	D3	R327	B4	C3
CR319	B1	E1	R328	B4	C3
CR321	A3	H2	R329	B3	G2
CR322	B3	H2	R331	B5	D3
CR323	A3	H2	R332	C4	D3
CR325	B3	H2	R334	B3	C1
CR326	B3	H2	R335	C4	C3
CR327	B3	H2	R336	C4	C3
CR328	C4	C3	R342	C3	G2
CR329	B2	C3	R343	E4	G3
CR330	B5	C3	R344	E4	G3
CR341	C3	H2	R345	D1	K2
CR342	C3	H2	R346	E3	H3
CR349	E4	H3	R347	E4	G3
CR354	F4	H3	R348	E4	G3
CR386	G2	B2	R349	E3	H3
			R351	F4	G3
J395	G1	C3	R352	F4	G3
			R354	F3	H3
P325	C1	F3	R355	F4	H3
P340	F4	B1	R356	H3	F1
P344	A1	G1	R357	F3	J3
P344	A5	G1	R358	F4	G3
P344	F1	G1	R360	D3	E3
P344	G4	G1	R361	D3	E3
P352	E4	G2	R362	D2	E3
P365	G4	A3	R364	F3	G3
Q304	A3	D2	R365	E2	K2
Q308	A4	D2	R366	F2	K2
Q321	A4	D2	R368	E1	G3
Q325	B4	D2	R369	E3	K2
Q328	B4	C2	R370	F2	L2
Q332	C4	C2	R371	F1	K2
Q336	C4	C2	R372	G3	A2
Q346	E4	H3	R373	G3	A2
Q349	E4	H3	R374	G3	B2
Q354	E4	H3	R375	G3	J1
Q356	F4	H3	R376	H3	B2
Q376	G3	B2	R380	G3	B2
Q382	G3	B2	R381	H3	A3
Q384	G3	B2	R382	G2	B2
			R383	G3	B2
R303	A4	E3	R384	G3	C2
R304	A3	E3	R385	G2	K1

Circuit Board (not pictured)

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
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Circuit Board

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
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A4	D3		R386	G2	B2
A4	D3		R387	G3	B3
B1	E1		R388	G2	A3
B1	E1		R389	G2	A3
C5	D3		R392	G2	B3
A4	D3		R393	G2	B3
B3	H2		R394	G2	B3
B4	D3		R395	G2	B3
B4	D3		R396	G2	B3
B5	C3		R397	H2	B3
B4	C3				
B4	C3		S342	C4	H5
B3	G2		S344	D4	D5
B5	D3		S352	E4	F4
C4	D3		S354	F4	K4
B3	C1		S395	G1	A5
C4	C3				
C4	C3		U322A	A2	D1
C3	G2		U322B	A2	D1
E4	G3		U322C	B1	D1
E4	G3		U322D	B2	D1
D1	K2		U326A	B2	D2
E3	H3		U326B	A2	D2
E4	G3		U326C	A2	D2
E4	G3		U326D	B2	D2
E3	H3		U330A	C3	C1
F4	G3		U330B	C3	C1
F4	G3		U332A	C3	E2
F3	H3		U332B	C2	E2
F4	H3		U332C	C2	E2
H3	F1		U332D	B1	E2
F3	J3		U334A	C4	C2
F4	G3		U334B	C4	C2
D3	E3		U334C	C4	C2
D3	E3		U334D	C4	C2
D2	E3		U338A	E3	J3
F3	G3		U338B	E3	J3
E2	K2		U338C	F3	J3
F2	K2		U338D	F3	J3
E1	G3		U340A	E3	L2
E3	K2		U340B	E2	L2
F2	L2		U340C	F3	L2
F1	K2		U344A	E2	K1
G3	A2		U344B	E3	K1
G3	A2		U344C	F2	K1
G3	B2		U344D	F2	K1
G3	J1		U346A	F2	J2
H3	B2		U346B	E2	J2
G3	B2		U346C	E2	J2
H3	A3		U346D	F2	J2
G2	B2		U350A	F1	J2
G3	B2		U350B	E1	J2
G3	C2		U350C	F2	J2
G2	K1				

ASSEMBLY A17 — Partial Intensity Control Circuit Board (not pictured). See Figure 8-30

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
P1401	A3	B2	R1402	A3	B2			

ASSEMBLY A27 — A Trigger Light Circuit Board (not pictured)

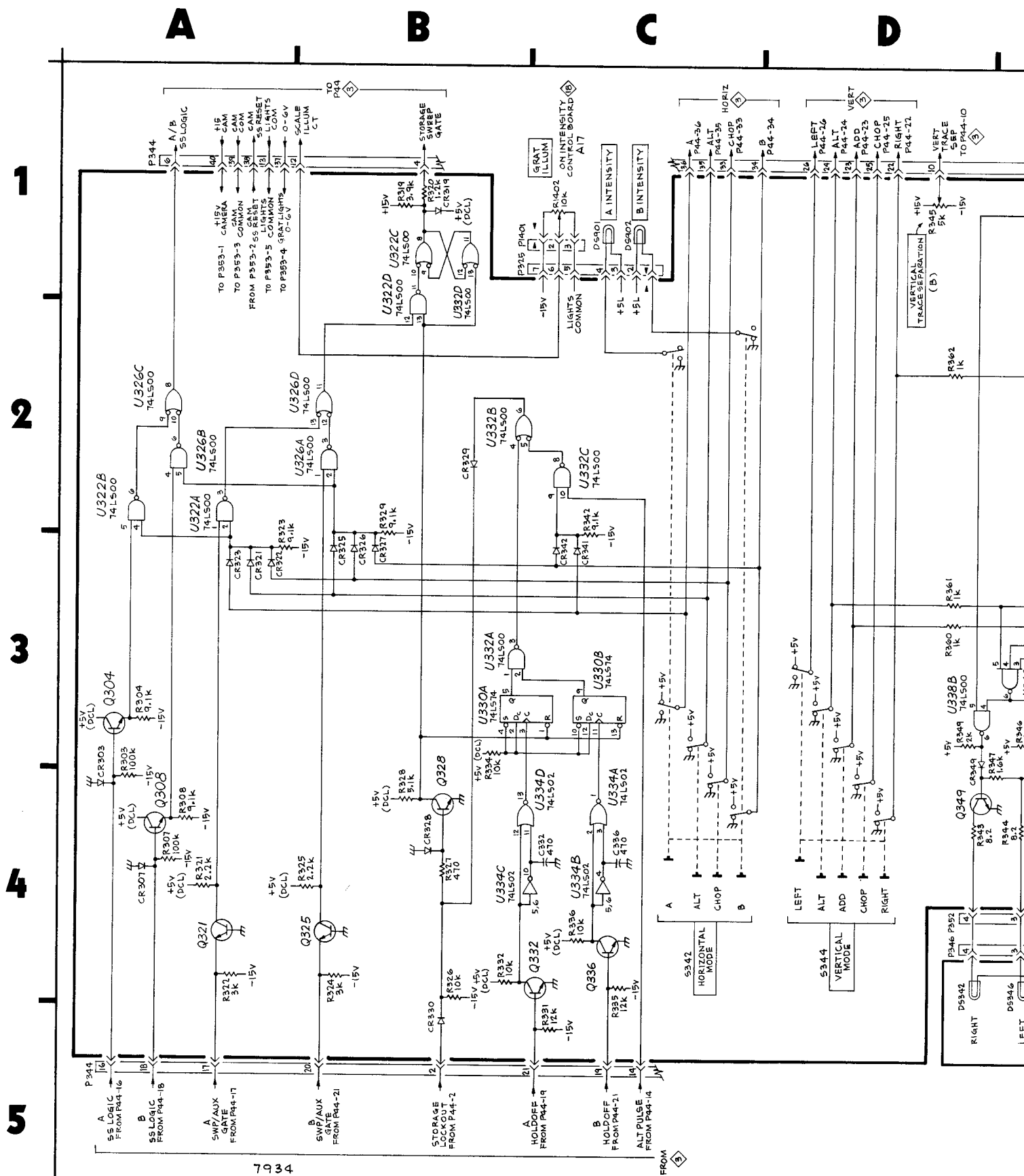
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
DS342	E4	Not pictured	P346	E4	Not pictured			
DS345	E4	Not pictured						
DS346	E4	Not pictured						

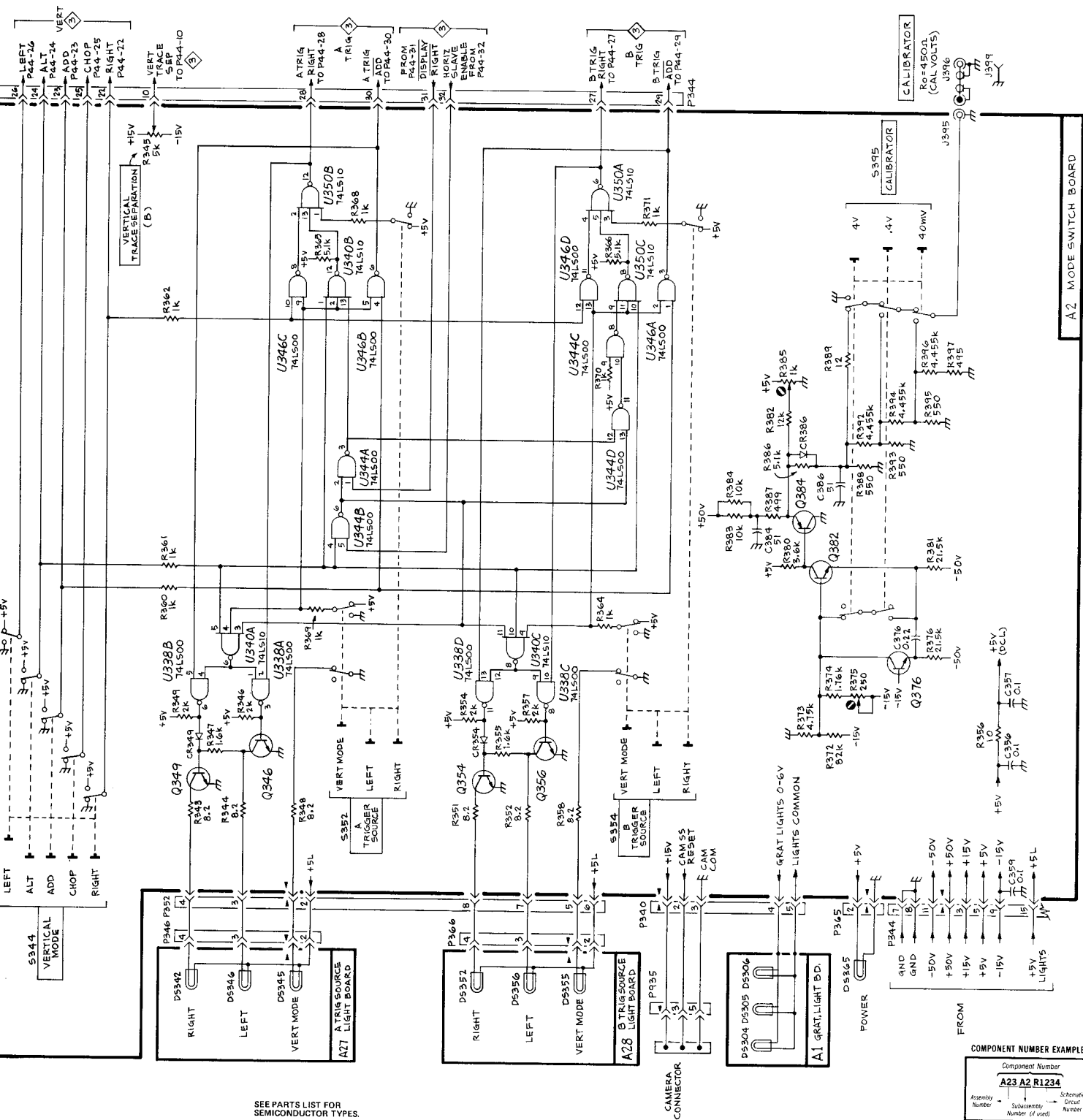
ASSEMBLY A28 — B Trigger Light Circuit Board (not pictured)

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
DS352	F4	Not pictured	P366	F4	Not pictured			
DS355	F4	Not pictured						
DS356	F4	Not pictured						

CHASSIS MOUNTED PARTS (not pictured)

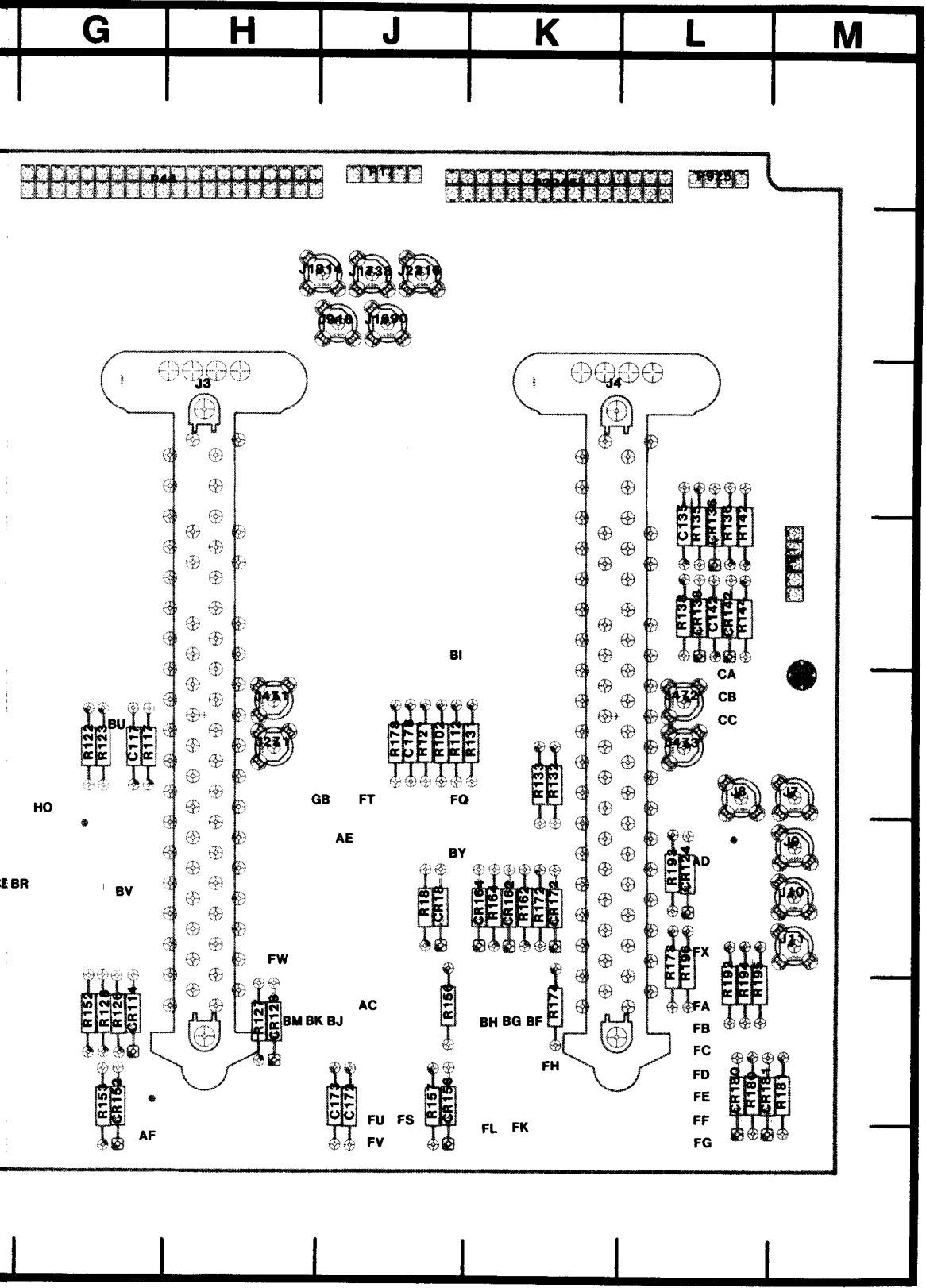
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
DS365	G4	Chassis	J396	H1	Chassis	P935	F5	Chassis
DS901	C1	Chassis	J399	H1	Chassis			
DS902	C1	Chassis						







MAIN INTERFACE DIAG

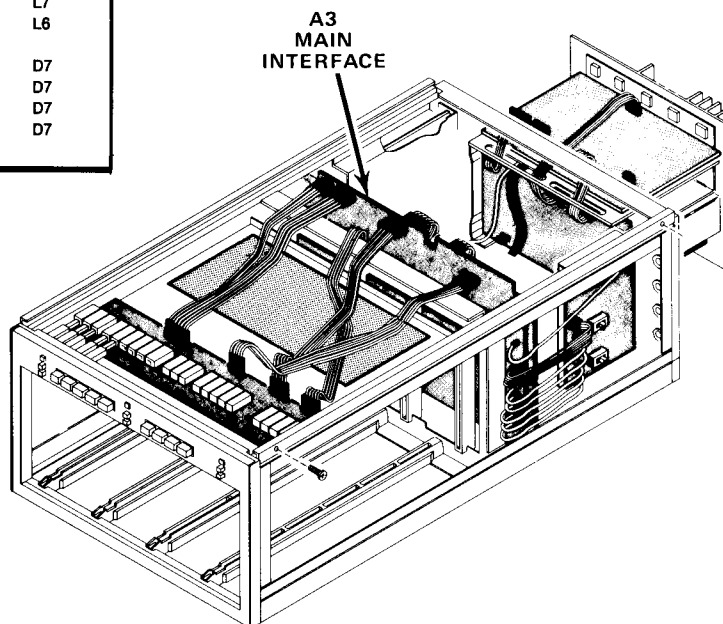


ASSEMBLY A3 — Partial Main

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C29	B4	D6
C117	D3	G5
C135	G3	L4
C142	G3	L4
C145	G2	C3
C146	G2	D3
C147	G2	D3
C148	H2	C3
C149	H2	D5
C172	G5	J7
C173	G5	J7
C178	G3	J5
CR18	F3	J6
CR21	B1	C2
CR22	B1	C2
CR23	B1	B2
CR24	B1	B2
CR25	B1	C2
CR26	B1	C2
CR27	B1	B2
CR28	B1	B2
CR31	C1	C2
CR32	C1	C2
CR33	C1	B2
CR34	C1	B2
CR35	C1	C2
CR36	C1	C2
CR37	C1	B2
CR38	C1	B2
CR41	E1	C2
CR42	E1	C2
CR43	E1	B2
CR44	E1	B2
CR45	E1	C2
CR46	E1	C2
CR47	E1	B2
CR48	E1	B2
CR51	F1	C2
CR52	F1	C2
CR53	F1	B2
CR54	F1	B2
CR55	F1	C2
CR56	F1	C2
CR57	F1	B2
CR58	F1	B2
CR114	D3	G7
CR124	F3	L6
CR128	E4	H7
CR136	G3	L4
CR138	G3	L4
CR142	H3	L4
CR152	G5	G7
CR156	G4	J7
CR162	F4	K6

A3 — Partial Main Interface Circuit Board

SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
B4	D6	CR164	G4	K6	R52	F1	C2
D3	G5	CR172	G3	K6	R54	F1	C2
G3	L4	CR180	G3	L7	R56	F1	C2
G3	L4	CR181	G4	M7	R58	F1	C2
G2	C3	CR184	G4	C6	R60	B4	F3
G2	D3				R61	B4	F3
G2	D3	J1	B1	B3	R67	B4	C7
H2	C3	J2	C1	E3	R68	B4	C7
H2	D5	J3	E1	H3	R87	C4	F7
G5	J7	J4	F1	K3	R88	D4	F7
G5	J7	J7	H5	M5	R102	B2	J5
G3	J5	J8	H5	L5	R112	C2	J5
		J9	H5	M6	R117	D3	G5
F3	J6	J10	H5	M6	R121	E2	J5
B1	C2	J11	H4	M6	R122	D3	G5
B1	C2	J270	E2	H5	R123	D3	G5
B1	B2	J271	E2	H5	R126	E4	G7
B1	B2	J472	F2	L5	R127	E4	H7
B1	C2	J473	F2	L5	R128	E4	G7
B1	C2	J1738	H2	J2	R131	G2	K5
B1	B2	J1814	A2	J2	R132	G3	K5
B1	B2	J2316	A2	J2	R133	G3	K5
C1	C2				R135	G3	L4
C1	C2	P17	H2	J1	R136	G3	L4
C1	B2	P24	A3	D2	R138	G3	L4
C1	B2	P43	A2	F2	R142	H3	L4
C1	C2	P44	A1	G1	R144	H3	L4
C1	C2	P44	A4	G1	R152	E5	G7
C1	B2	P44	B5	G1	R153	E5	G7
C1	B2	P44	H3	G1	R156	F4	J7
E1	C2	P44	H4	G1	R157	F4	J7
E1	C2	P82	H1	E2	R162	F4	K6
E1	B2	P83	H2	F2	R164	G4	K6
E1	B2	P91	H3	M4	R172	G3	K6
E1	C2	P925	H5	L1	R173	G4	L6
E1	C2	P987	A5	D1	R174	G4	K7
E1	B2	P3246	A4	K1	R178	G3	J5
E1	B2				R180	G3	L7
F1	C2	Q60	B4	F2	R181	G4	M7
F1	C2	Q182	G3	C7	R182	G3	C6
F1	B2	R18	E3	J6	R183	G4	C6
F1	B2	R22	B1	D2	R184	G4	C6
F1	C2	R24	B1	D2	R186	G3	E6
F1	C2	R26	B1	D2	R187	H3	E6
F1	B2	R28	B1	D2	R192	G5	L7
F1	B2	R29	B4	D6	R193	G5	L6
D3	G7	R32	C1	D2	R194	G5	L7
F3	L6	R34	C1	D2	R195	G4	L7
E4	H7	R36	C1	D2	R196	G5	L6
G3	L4	R38	C1	D2			
G3	L4	R42	E1	D2	U92A	H3	D7
H3	L4	R44	E1	D2	U92B	D4	D7
G5	G7	R46	E1	D2	U92C	D4	D7
G4	J7	R48	E1	D2	U92D	D4	D7
F4	K6						





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