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PLEASE CHECK FOR CHANGE INFORMATION AT THE REAR OF THIS MANUAL.

7B85
DELAYING TIME BASE
WITH OPTIONS

INSTRUCTION MANUAL

Tektronix, Inc.
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THE REMAINING PORTION OF THIS TABLE OF CONTENTS LIST SERVICING INSTRUCTIONS. THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRICAL SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CALLED OUT IN THE OPERATING INSTRUCTIONS UNLESS QUALIFIED TO DO SO.

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SAFETY SUMMARY

This manual contains safety information the user must follow to ensure safe operation of this instrument. WARNING information is intended to protect the operator; CAUTION information is intended to protect the instrument. The following are general safety precautions that must be observed during all phases of operation and maintenance.

WARNING

Ground the Instrument

To reduce electrical-shock hazard, the mainframe (oscilloscope) chassis must be properly grounded. Refer to the mainframe manual for grounding information.

Do Not Operate in Explosive Atmospheres

Do not operate this instrument in an area where flammable gases or fumes are present. Such operation could cause an explosion.

Avoid Live Circuits

Electrical-shock hazards are present in this instrument. The protective instrument covers must not be removed by operating personnel. Component replacement and internal adjustments must be referred to qualified service personnel.

Do Not Service or Adjust Alone

Do not service or make internal adjustments to this instrument unless another person, capable of giving first aid and resuscitation, is present.

WARNING

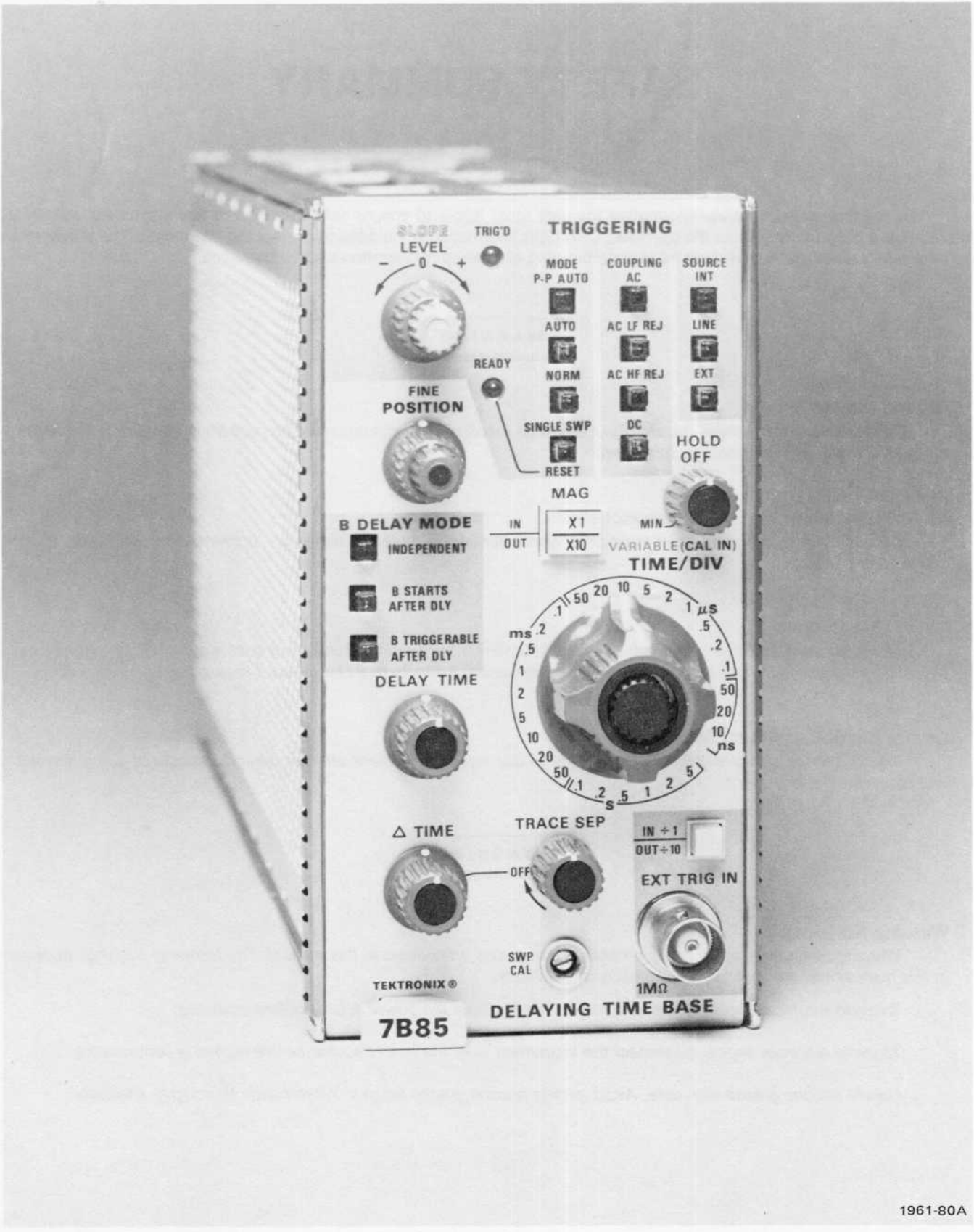
Warning Statements

Warning statements accompany potentially dangerous procedures in this manual. The following warnings appear in this manual and are listed here for additional emphasis.

To avoid electrical shock, disconnect the instrument from the power source before soldering.

To avoid electrical shock, disconnect the instrument from the power source before replacing components.

Handle silicone grease with care. Avoid getting silicone grease in eyes. Wash hands thoroughly after use.



7B85 Delaying Time Base

OPERATING INSTRUCTIONS

The 7B85 Delaying Time Base unit operates with a TEKTRONIX 7700-, 7800-, or 7900-Series oscilloscope mainframe and a 7A-Series amplifier unit to form a complete oscilloscope system. This section describes the operation of the front-panel controls and connectors, provides general operating information, a functional check procedure, and basic applications for this instrument.

FEATURES

The 7B85 Delaying Time Base unit provides calibrated sweep rates from 5 s to 10 ns and triggering to 400 MHz for 7700-, 7800-, and 7900-Series oscilloscopes. The X10 Magnifier increases each sweep rate by a factor of 10 and the VARIABLE control allows continuously variable sweep rates between calibrated steps. Variable hold off and alphanumeric readout are provided. Also, when operating in the AUTO TRIGGERING MODE, a bright baseline trace is displayed in the absence of a trigger signal.

INSTALLATION

The time-base unit is designed to operate in the horizontal plug-in compartment of the mainframe. This instrument can also be installed in a vertical plug-in compartment to provide a vertical sweep on the crt. However, when used in this manner, there are no internal triggering or retrace blanking provisions, and the unit may not meet the specifications given in Section 2.

To install the unit in a plug-in compartment, push it in until it fits firmly into the compartment. The front panel of the unit should be flush with the front panel of the mainframe. Even though the gain of the mainframe is standardized, the sweep calibration of the unit should be checked when installed. The procedure for checking the unit is given under Sweep Functions in the Functional Check procedure in this section.

To remove the unit, pull the release latch (see Fig. 1-1) and pull it out of the plug-in compartment.

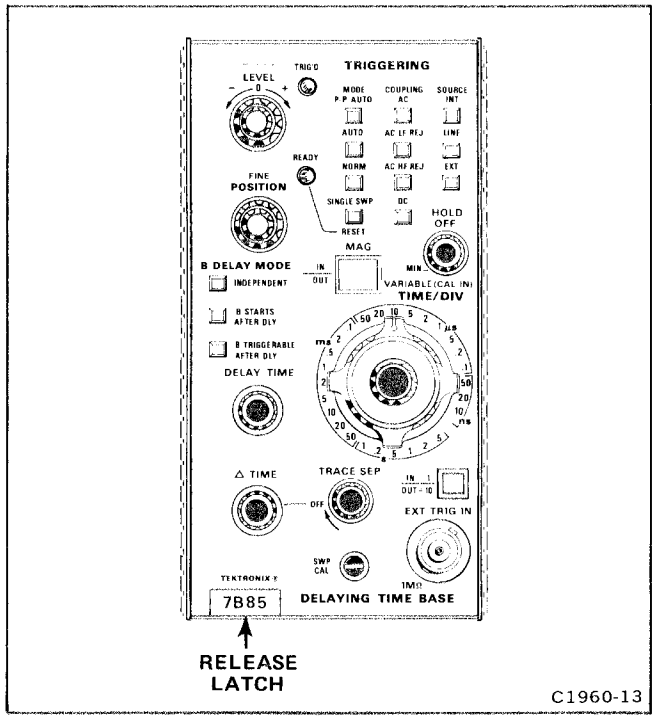


Fig. 1-1. Location of release latch.

CONTROLS, CONNECTORS, AND INDICATORS

All controls, connectors, and indicators required for the operation of the time-base unit are located on the front panel. Figure 1-2 provides a brief description of all front-panel controls, connectors, and indicators. More detailed information is given in the General Operating Instructions.

FUNCTIONAL CHECK

The following procedures are provided for checking basic instrument functions. Refer to the description of the controls, connectors, and indicators while performing this procedure. If performing the functional check procedure reveals a malfunction or possible improper adjustment, first check the operation of the associated plug-in units, then refer to the instruction manual for maintenance and adjustment procedures.

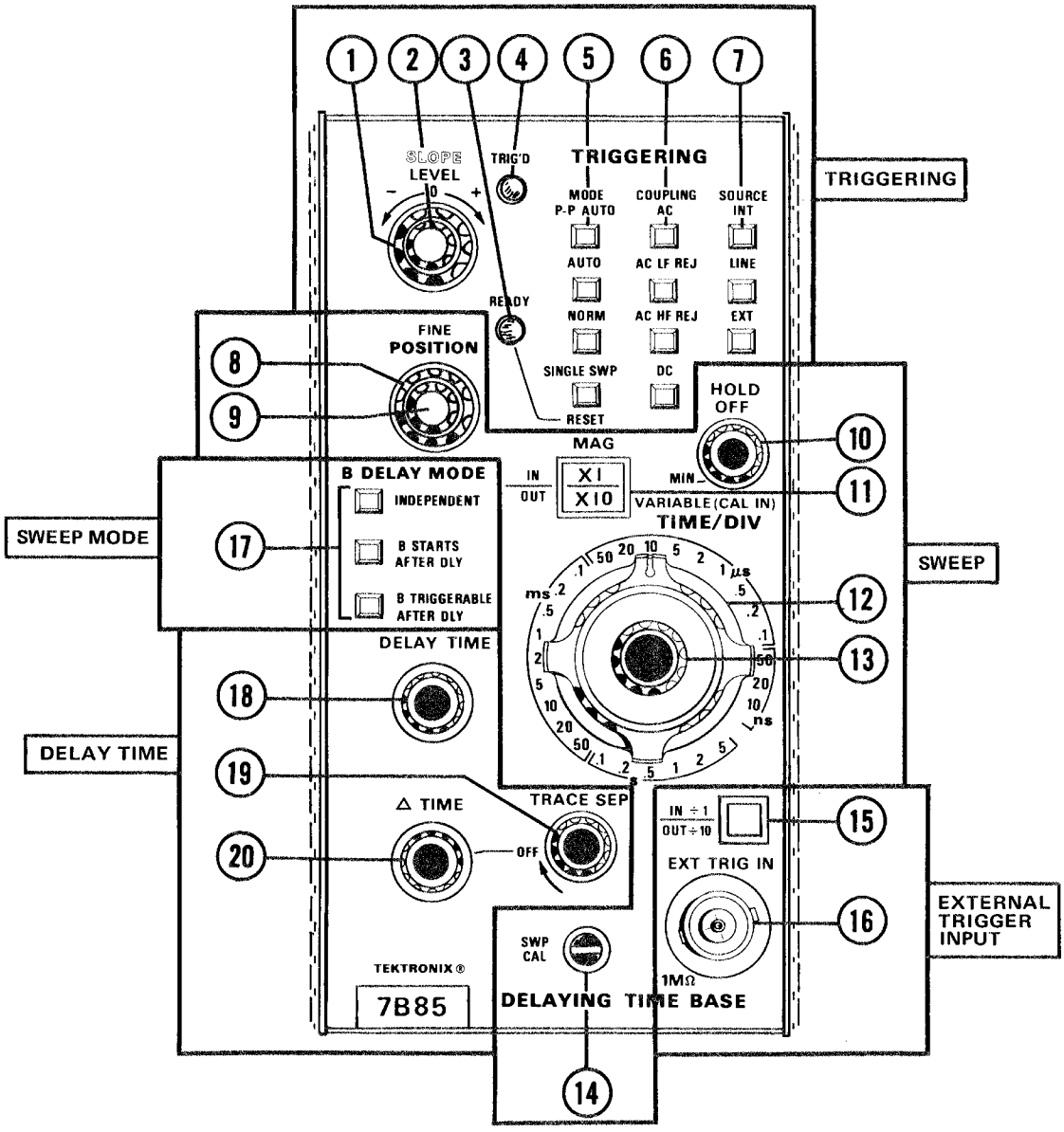


Fig. 1-2. Front-panel controls, connectors, and indicators.

TRIGGERING

(1) LEVEL Control—Selects a point on the trigger signal where triggering occurs.

(2) SLOPE Switch— Permits sweep to be triggered on negative- or positive-going portions of the trigger signal.

(3) READY Indicator—Illuminates when sweep circuit is armed (SINGLE SWEEP Mode).

(4) TRIG'D Indicator—Illuminates when the display is triggered.

(5) MODE Pushbuttons—Selects the operating mode of the triggering circuits.

(6) COUPLING Pushbuttons—Selects the method of coupling the trigger signal to triggering circuit.

(7) SOURCE Pushbuttons—Selects source of the trigger signal.

SWEEP

(8) POSITION Control—Provides horizontal positioning.

(9) FINE Control—Provides precise horizontal positioning.

(10) HOLD OFF Control—Permits hold off period to be varied to improve triggering stability of repetitive complex waveforms.

(11) MAG Pushbutton—Selects X10 magnified or unmagnified sweep.

(12) TIME/DIV Switch—Selects the sweep rate of the sweep generator.

(13) VARIABLE Control and CAL Switch—Selects calibrated or uncalibrated sweep rates. Uncalibrated sweep rates can be continuously reduced to at least the sweep rate of the next slower position.

(14) SWP CAL Adjustment—Compensates for basic timing changes due to the differences in sensitivity of mainframes in which the 7B85 may be used.

EXTERNAL TRIGGER INPUT

(15) EXT TRIG ATTENUATOR—Selects attenuation factor for external trigger signals.

(16) EXT TRIG IN Connector—Connector (BNC type) provides input for external trigger signals.

SWEEP MODE

(17) B DELAY MODE Pushbuttons—Selects independent or delaying sweep operation. In the B STARTS AFTER DLY and B TRIGGERABLE AFTER DLY delaying sweep modes, the DELAY TIME and Δ TIME functions are activated. There will be a 2 division vertical shift of the trace when switching from INDEPENDENT to B STARTS AFTER DELAY.

DELAY TIME

(18) DELAY TIME Control—Provides variable delay time before the start of the delayed sweep produced by companion time-base unit.

(19) TRACE SEP Control and Switch—Enables Δ TIME functions and provides vertical separation of the delayed sweep traces (Δ TIME operation).

(20) Δ TIME Control—Provides differential time measurements between 2 selected intensified zones on the delaying sweep trace. Two delayed sweep traces corresponding to the intensified zones are displayed by the companion time-base unit. Differential time is displayed on the crt readout.

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Fig. 1-2. Front-panel controls, connectors, and indicators (cont.).

Setup Procedure

1. Install the 7B85 in the A horizontal compartment of the mainframe.

2. Install an amplifier plug-in unit in a vertical compartment.

3. Set the 7B85 controls as follows:

SLOPE	(+)
MODE	P-P AUTO
COUPLING	AC
SOURCE	INT
B DELAY MODE	INDEPENDENT
TRACE SEP	OFF (fully clockwise)
POSITION	Midrange
TIME/DIV	1 ms
VARIABLE (CAL IN)	Calibrated (Pushed in)
HOLD OFF	MIN (fully counter-clockwise)
MAG	X1 (pushed in)

4. Turn on the oscilloscope and allow at least 20 minutes warmup.

5. Set the mainframe vertical and horizontal modes to display the plug-in units used and adjust the intensity and focus for a well-defined display. See the oscilloscope mainframe and amplifier unit instruction manuals for detailed operating instructions.

Sweep Functions

Normal Sweep. Perform the following procedure to obtain a normal sweep and to demonstrate the function of the related controls.

1. Perform the preceding Setup Procedure.

2. Connect a 0.4 V, 1 kHz signal from the mainframe calibrator to the amplifier unit input.

3. Set the amplifier unit deflection factor for 4 divisions of display.

4. Adjust the LEVEL control for a stable display.

5. Turn the POSITION control and note that the trace moves horizontally.

6. Turn the FINE control and note that the display can be precisely positioned horizontally.

7. Check the display for one complete cycle per division. If necessary, adjust the front-panel SWP CAL screwdriver adjustment for one complete cycle per division over the center 8 graticule divisions. Be sure that the timing of the mainframe calibrator signal is accurate to within 0.25% (+20 to +30°C).

8. Press to release the VARIABLE (CAL IN) control. Turn the VARIABLE (CAL IN) control fully counterclockwise and note that the displayed sweep rate changes to at least the next slower TIME/DIV switch setting (i.e., 2 ms/div). Press the VARIABLE (CAL IN) knob in to the calibrated position.

Magnified Sweep. Perform the following procedure to obtain a X10 magnified display and to demonstrate the function of the related controls.

1. Obtain a one cycle per division display as described in the preceding Normal Sweep procedure.

2. Press to release the MAG button (X10). Note that the unmagnified display within the center division of the graticule is magnified to about 10 divisions.

3. Press the MAG button (X1).

Delaying and Delayed Sweep. Perform the following procedure to obtian delaying- and delayed-sweep displays and to demonstrate the function of the related controls. To obtain a delayed-sweep display, a companion time-base unit must be installed in the B horizontal compartment of the mainframe.

1. Obtain a display as described in the preceding Normal Sweep procedure.

2. Press the B STARTS AFTER DLY button.

3. Set the mainframe horizontal mode for chopped operation.

4. Set the companion time-base unit sweep rate for 0.1 ms/div, and triggering for p-p auto mode, ac coupling, internal source, and + slope.

5. Adjust the mainframe B sweep intensity and check for an intensified zone about 1 division wide on the delaying (A) sweep display. Also note that the delayed (B) sweep provides an expanded display of the intensified portion of the delaying (A) sweep.

6. Position the start of the delaying (A) sweep to the left edge of the graticule.

7. Adjust the DELAY TIME control for a crt readout (bottom division of crt graticule) of 5.000 ms. Check that the left edge of the intensified zone is at the graticule center line.

8. Set the 7B85 TIME/DIV switch to .5 ms and the delayed (B) sweep unit sweep rate to 20 μs/div.

9. turn the DELAY TIME control fully counterclockwise to position the intensifed zone near the front corner of the first square-wave cycle. Press the B TRIGGERABLE AFTER DLY button and check that the intensifed zone moves to the front corner of the next displayed square wave.

Δ (Differential) TIME. Perform the following procedure to obtain a Δ (differential) time display and to demonstrate the function of the related controls.

1. Obtain a delaying (A) and delayed (B) sweep display as described in steps 1 through 4 of the preceding Delaying and Delayed Sweep procedure.

2. Turn the TRACE SEP control counterclockwise out of the OFF (detent) position.

3. Set the DELAY TIME and Δ TIME controls to the fully counterclockwise position. Check for two delayed (B) sweeps and note that the crt readout (bottom right of crt) is 0.000 ms.

4. Slowly turn the Δ TIME control clockwise and note that a second intensified zone moves across the delaying (A) sweep display, and the crt readout indicates the differential time between the left edge of the stationary intensified zone and the left edge of the second intensified zone. Also note that the lower delayed (B) sweep is an expanded display of the second intensified zone.

Triggering Functions

Perform the following procedure to obtain a triggered sweep and to demonstrate the functions of the related controls.

1. Obtain a display as described in the preceding Normal Sweep procedure.

2. Press the AUTO MODE button and turn the LEVEL control fully counterclockwise to obtain a free-running sweep.

3. Slowly turn the HOLD OFF control clockwise and note that a stable display can be obtained at several positions of the HOLD OFF control. Return the HOLD OFF control to the fully counterclockwise (MIN) position.

NOTE

The HOLD OFF control varies the sweep holdoff time, which effectively changes the repetition rate of the horizontal sweep signal. However, its primary function is to obtain a stable display of complex waveforms that are otherwise difficult to trigger.

4. Press the AC, AC HF REJ, and DC COUPLING buttons for both the + and − positions of the SLOPE switch and check for a stable display (LEVEL control may be adjusted, if necessary, to obtain a stable display).

5. Apply the 0.4 V, 1 kHz signal from the mainframe calibrator to the ampifier unit and to the EXT TRIG IN connector.

6. Press the EXT SOURCE button and set the amplifier unit deflection factor for a 4-division display.

7. Press the AC, AC HF REJ, and DC COUPLING buttons for both the + and − positions of the SLOPE switch and check for a stable display (LEVEL control may be adjusted, if necessary, for a stable display).

8. Press the AC COUPLING, INT SOURCE, and NORM MODE buttons. Adjust the LEVEL control for a stable display.

9. Press the AUTO MODE button and adjust the LEVEL control for a free-running display.

10. Press the NORM MODE button and check for no display.

11. Adjust the LEVEL control for a stable display and press the SINGLE SWP MODE button.

12. Note that one trace occurs when the RESET MODE button is pressed.

13. Disconnect the mainframe calibrator signal from the amplifier unit input and press the RESET MODE button. Check for no display and note that the READY indicator is lit.

14. Note that one trace occurs and that the READY indicator extinguishes when the mainframe calibrator signal is connected to the amplifier unit input.

GENERAL OPERATING INFORMATION

Triggering Switch Logic

The MODE, COUPLING, and SOURCE push buttons of the TRIGGERING switches are arranged in a sequence that places the most-often used position at the top of each series of push buttons. With this arrangement, a stable display can usually be obtained by pressing the top push buttons: P-P AUTO, AC, INT. When an adequate trigger signal is applied and the LEVEL control is correctly set, the unit is triggered as indicated by the illuminated TRIG'D light. If the TRIG'D light is not on, the LEVEL control is either at a setting outside the range of the trigger signal applied to this unit from the vertical unit, the trigger signal amplitude is inadequate, or its frequency is below the lower frequency limit of the AC COUPLING switch position. If the desired display is not obtained with these buttons pushed in, other selections must be made. Refer to the following discussions or the instruction manuals for the associated oscilloscope mainframe and vertical unit(s) for more information.

Triggering Modes

The MODE push-button switches select the mode in which the sweep is triggered.

P-P AUTO

The P-P AUTO MODE provides a triggered display at any setting of the LEVEL control whenever an adequate trigger signal is applied. The range of the LEVEL control in the P-P AUTO MODE is between approximately 10% and 90% of the peak-to-peak amplitude of the trigger signal. The LEVEL control can be set so that the displayed waveform starts at any point within this range on either slope. The trigger circuits automatically compensate for a change in trigger signal amplitude. Therefore, if the LEVEL control is set to start the waveform display at a certain percentage point on the leading edge of a low-amplitude signal, it triggers at the same percentage point on the leading edge of a high-amplitude signal if the LEVEL control is not changed. When the trigger repetition rate is outside the parameter given in the Specification section, or when the trigger signal is inadequate, the sweep free runs at the rate indicated by the TIME/DIV switch to produce a bright baseline, reference trace (TRIG'D light off). When an adequate trigger signal is again applied, the free-running condition ends and a triggered display is presented.

The P-P AUTO MODE is particularly useful when observing a series of waveforms, since it is not necessary to reset the LEVEL control for each observation. The P-P AUTO MODE is used for most applications because of the ease of obtaining a triggered display. The AUTO, NORM, and SINGLE SWP MODE settings may be used for special applications.

AUTO

The AUTO MODE provides a triggered display with the correct setting of the LEVEL control whenever an adequate trigger signal is applied (see Trigger Level discussions). The TRIG'D light indicates when the display is triggered.

When the trigger repetition rate is outside the frequency range selected by the COUPLING switch or the trigger signal is inadequate, the sweep free runs at the rate indicated by the TIME/DIV switch (TRIG'D indicator off). An adequate trigger signal ends the free-running condition and a triggered display is presented. The sweep also free runs at the rate indicated by the TIME/DIV switch when the LEVEL control is at a setting outside the amplitude range of the trigger signal. This type of free-running display is useful when it is desired to measure only the peak-to-peak amplitude of a signal without observing the waveshape (such as bandwidth measurements).

NORMal

The NORM MODE provides a triggered display with the correct setting of the LEVEL control whenever an adequate trigger signal is applied. The TRIG'D light indicates when the display is triggered.

The normal trigger mode must be used to produce triggered displays with trigger repetition rates below approximately 30 Hz. When the TRIG'D light is off, no trace is displayed.

SINGLE SWeeP

When the signal to be displayed is not repetitive or varies in amplitude, waveshape, or repetition rate, a conventional repetitive type display may produce an unstable presentation. Under these circumstances, a stable display can often be obtained by using the single-sweep feature of this unit.

The single-sweep mode is also useful to photograph non-repetitive or unstable displays.

To obtian a single-sweep display of a repetitive signal, first obtain the best possible display in the NORM MODE. Then, without changing the other TRIGGERING controls, press the SINGLE SWP RESET button. A single trace is presented each time this button is pressed. Further sweeps cannot be presented until the SINGLE SWP RESET button is pressed again. If the displayed signal is a complex waveform composed of varying amplitude pulses, successive single-sweep displays may not start at the same point on the waveform. To avoid confusion due to the crt persistence, allow the display to disappear before pressing the SINGLE SWP RESET button again. At fast sweep rates, it may be difficult to view the single-sweep display. The apparent trace intensity can be increased by reducing the ambient light level or by using a viewing hood as recommended in the mainframe instruction manual.

When using the single-sweep mode to photograph waveforms, the graticule may have to be photographed separately, in the normal manner, to prevent over-exposing the film. Be sure the camera system is well protected against stray light, or operate the system in a darkened room. For repetitive waveforms, press the SINGLE SWP RESET button only once for each waveform unless the signal is completely symmetrical. Otherwise, multiple waveforms may appear on the film. For random signals, the lens can be left open until the signal triggers the unit. Further information on photographic techniques is given in the appropriate camera instruction manual.

Trigger Coupling

The TRIGGER COUPLING push buttons select the method in which the trigger signal is connected to the trigger circuits. Each position permits selection or rejection of some frequency components of the signal that triggers the sweep.

AC. AC COUPLING blocks the dc component of the trigger signal. Signals with low-frequency components below approximately 30 Hz are attenuated. In general, AC COUPLING can be used for most applications. However, if the signal contains unwanted frequency components or if the sweep is to be triggered at a low repetition rate or dc level, one of the other COUPLING switch positions will provide a better display.

AC LF REJ. AC LF REJ COUPLING rejects dc, and attenuates low-frequency trigger signals below approximately 30 kHz. Therefore, the sweep is triggered only by the higher-frequency components of the trigger signal. This position is particularly useful for providing stable triggering if the trigger signal contains line-frequency components. Also, the AC LF REJ position provides the best alternate-mode vertical displays at fast sweep rates when comparing two or more unrelated signals.

AC HF REJ. AC HF REJ COUPLING passes all low-frequency signals between approximately 30 Hz and 50 kHz. Dc is rejected, and signals outside the above range are attenuated. When triggering from complex waveforms, this position is useful to provide a stable display of the low-frequency components.

DC. DC COUPLING can be used to provide stable triggering from low-frequency signals that would be attenuated in other COUPLING switch positions. DC COUPLING can be used to trigger the sweep when the trigger signal reaches a dc level set by the LEVEL control. When using internal triggering, the setting of the vertical unit position control affects the triggering point.

Trigger Source

The TRIGGERING SOURCE push buttons select the source of the trigger signal connected to the trigger circuits.

INTernal. The INT position connects the trigger signal from the vertical plug-in unit. Further selection of the internal trigger signal may be provided by the vertical plug-in unit or by the mainframe; see the instruction manuals for these instruments for more information. For most applications, the internal source can be used. However, some applications require special triggering that cannot be obtained in the INT position. In such cases, the LINE or EXT positions of the SOURCE switches must be used.

LINE. The LINE position connects a sample of the power-line voltage from the mainframe to the trigger circuit. Line triggering is useful when the input signal is time-related (multiple or submultiple) to the line frequency. It is also useful for providing a stable display of a line-frequency component in a complex waveform.

EXTernal. The EXT position connects the signal from the EXT TRIG IN connector to the trigger circuit. The external signal must be time-related to the displayed waveform for a stable display. An external trigger signal can be used to provide a triggered display when the internal signal is either too low in amplitude for correct triggering or contains signal components on which triggering is not desired. It is also useful when signal tracing in amplifiers, phase-shift networks, wave-shaping circuits, etc. The signal from a single point in the circuit can be connected to the EXT TRIG IN connector through a probe or cable. The sweep is then triggered by the same signal at all times and allows amplitude, time relationship, or waveshape changes of signals at var-

ious points in the circuit to be examined without resetting the TRIGGERING controls.

The ÷10 push buttons attenuates the external trigger signal by a factor of 10. Attenuation of high amplitude external trigger signals is desirable to increase the effective range of the LEVEL control.

Trigger Slope

The TRIGGERING SLOPE switch (concentric with the TRIGGERING LEVEL control) determines whether the trigger circuit responds on the positive- or negative-going portion of the trigger signal. When the SLOPE switch is in the (+) (positive-going) position, the display starts on the positive-going portion of the waveform (see Fig. 1-3). When several cycles of a signal appear in the display, the setting of the SLOPE switch is often unimportant. However, if only a certain portion of a cycle is to be displayed, correct setting of the SLOPE switch is important to provide a display that starts on the desired slope of the input switch.

Trigger Level

The TRIGGERING LEVEL control determines the voltage level on the trigger signal at which the sweep is triggered. When the LEVEL control is set in the + region, the trigger circuit responds at a more positive point on the trigger signal. When the LEVEL control is set in the − region, the trigger circuit responds at a more negative point on the trigger signal. Figure 1-3 illustrates this effect with different settings of the SLOPE switch.

To set the LEVEL control, first select the TRIGGERING MODE, COUPLING, SOURCE, and SLOPE. Then set the LEVEL control fully counterclockwise and rotate it clockwise until the display starts at the desired point. Less selection of the triggering level is available as the trigger signal frequency exceeds 150 MHz.

Horizontal Sweep Rates

The TIME/DIV switch provides calibrated sweep rates from 5 s/div to 10 ns/div in a 1-2-5 sequence. The VARIABLE TIME/DIV control must be in the calibrated position and the MAG switch set to X1 to obtain the sweep rate indicated by the TIME/DIV switch. However, the mainframe crt readout will display the appropriate sweep rate.

The VARIABLE TIME/DIV control includes a two-position switch to determine if the sweep rate is calibrated, or uncalibrated. When the VARIABLE control is pressed in, it is inoperative and the sweep rate is calibrated. When pressed and released outward, the VARIABLE control is activated for uncalibrated sweep rates, to at least the sweep rate of the next slower position.

A calibrated sweep rate can be obtained in any position of the VARIABLE control by pressing in the VARIABLE control. This feature is particularly useful when a specific uncalibrated sweep rate has been obtained and it is desired to switch between calibrated and uncalibrated displays.

Time Measurements

When making time measurements from the graticule, the area between the second and tenth vertical lines of the graticule provides the most linear time measurements (see Fig. 1-4). Position the start of the timing area to the second vertical ine and adjust the TIME/DIV switch so the end of the timing area falls between the second and tenth vertical lines.

Sweep Magnification

The sweep magnifier can be used to expand the display by a factor of 10. The center division of the unmagnified display is the portion visible on the crt in the magnified form (see Fig. 1-5). The equivalent length of the magnified sweep is more than 100 div; any 10-div portion can be viewed by adjusting the POSITION and FINE POSITION controls to bring the desired portion into the viewing area.

When the MAG switch is set to X10 (OUT), the equivalent magnified sweep rate can be determined by dividing the TIME/DIV setting by 10; the equivalent magnified sweep rate is displayed on the crt readout.

Variable Hold Off

The HOLD OFF control improves triggering stability on repetitive complex waveforms by effectively changing the repetition rate of the horizontal sweep signal. The HOLD OFF control should normally be set to its minimum setting. When a stable display cannot be obtained with the TRIGGERING LEVEL control, the HOLD OFF control can be varied for an improved display. If a stable display cannot be obtained at any setting of the LEVEL and HOLD OFF controls, check the TRIGGERING COUPLING and SOURCE switch settings.

Delay-Time Operation

A 7B85 installed in the mainframe A horizontal compartment can delay a companion time-base unit installed in the B horizontal compartment. When operating the 7B85 in a delaying mode (B DELAY MODE switch set to B STARTS AFTER DLY or B TRIGGERABLE AFTER DLY), an intensified zone is provided on the delaying sweep display during the time that the companion time-base unit runs (see Fig. 1-6). A delayed-sweep trace is provided by the companion time-base unit, corresponding to the intensifed zone on the delaying trace, at the sweep rate set by the TIME/DIV

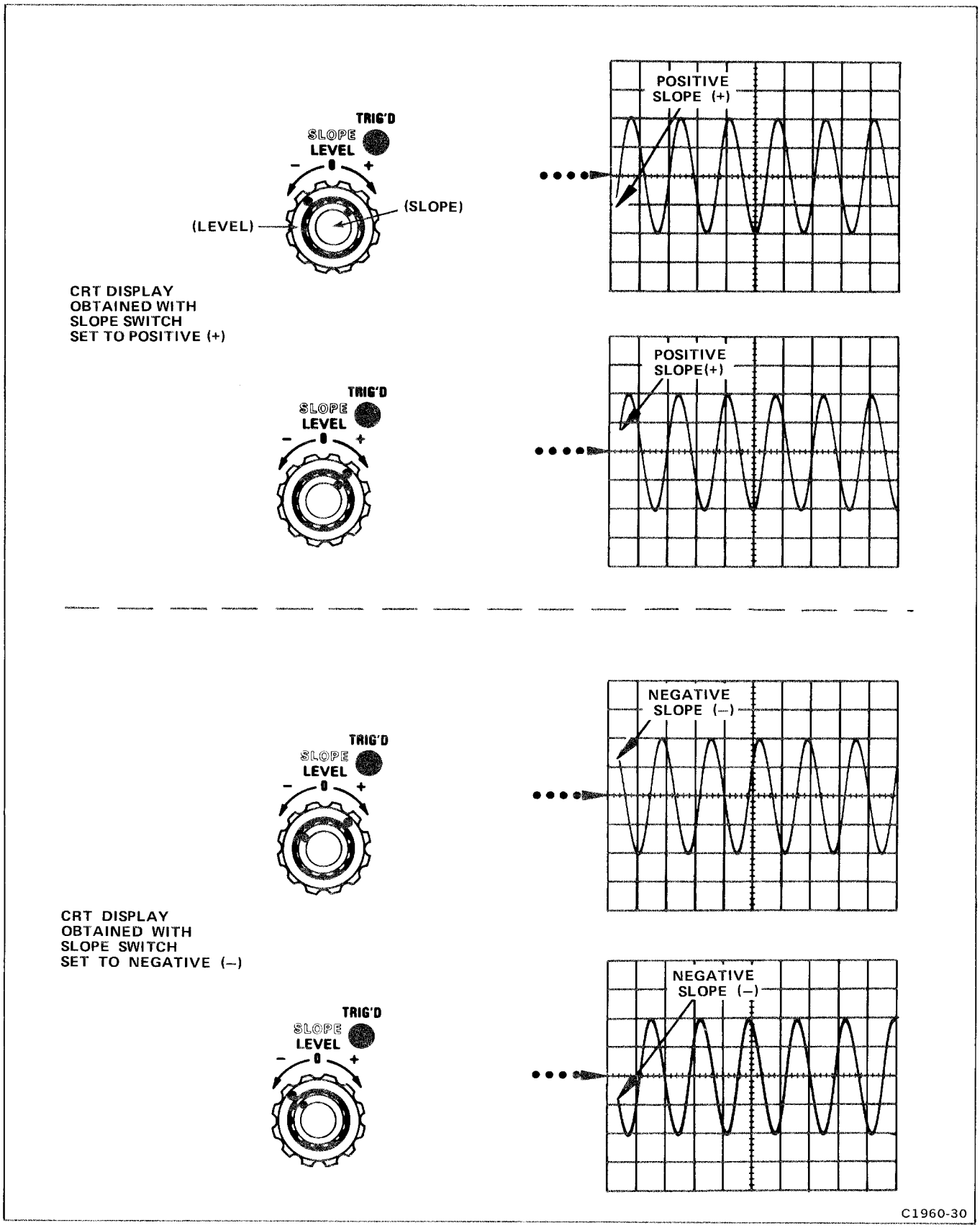


Fig. 1-3. Effects of LEVEL control and SLOPE switch on crt display.

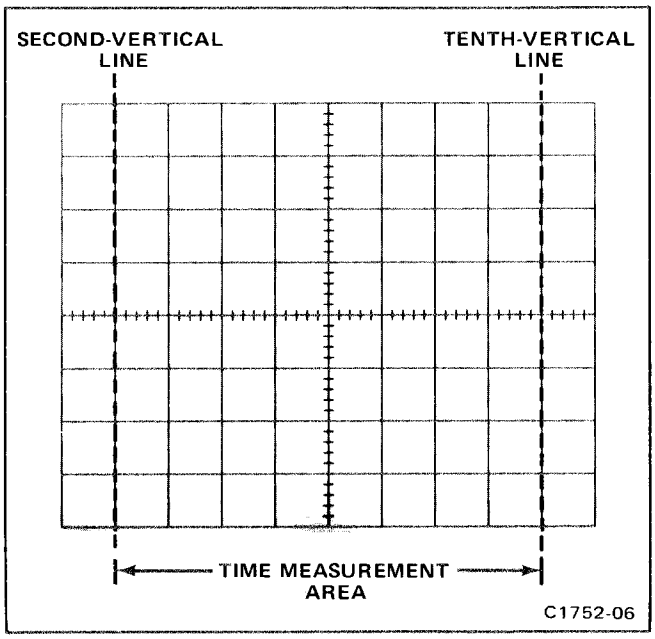


Fig. 1-4. Area of graticule used for most accurate time measurements.

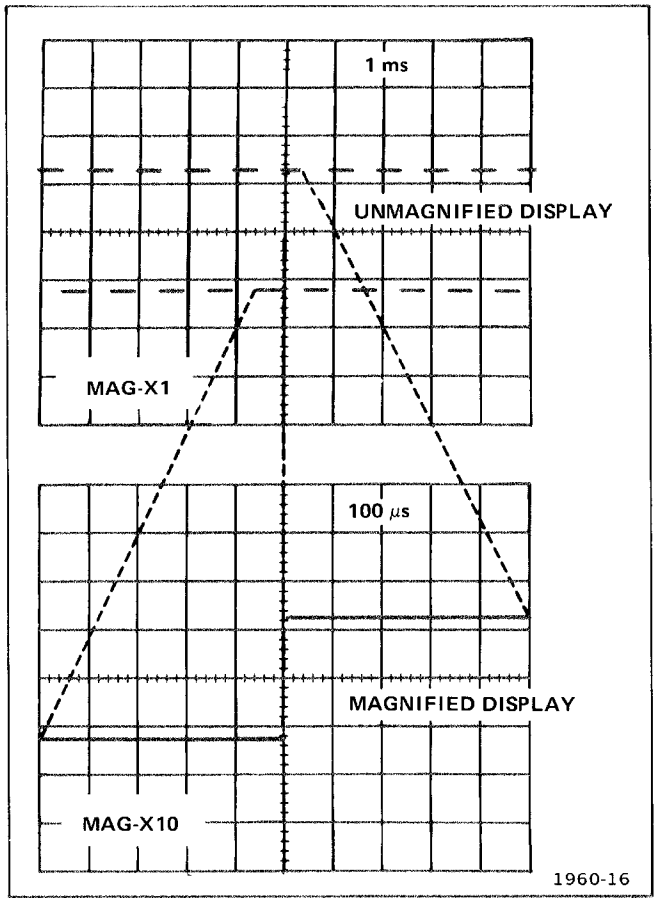


Fig. 1-5. Effect of sweep magnifier on crt display.

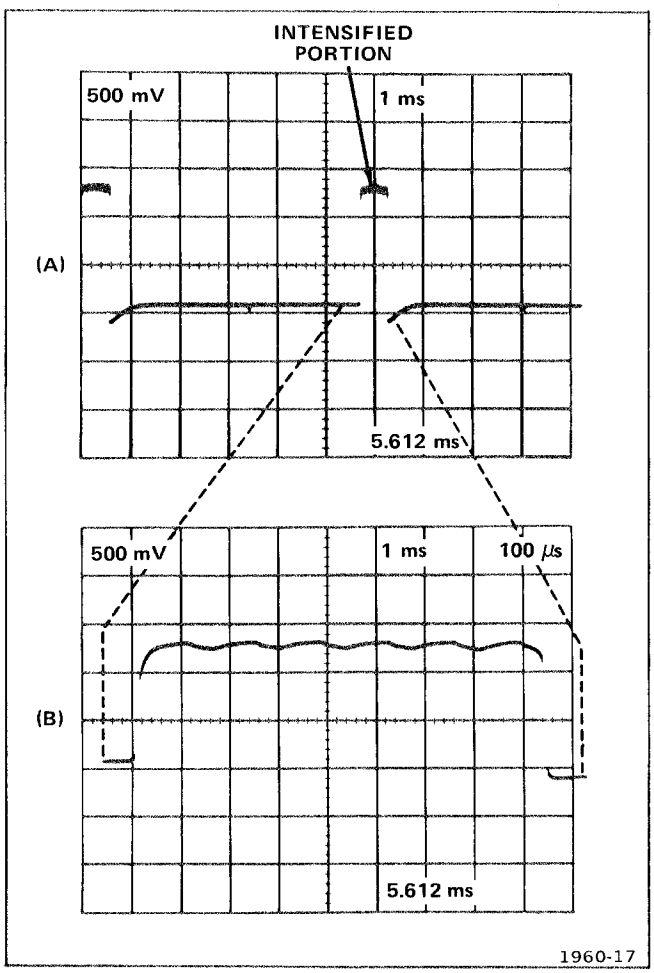


Fig. 1-6. (A) Delaying-sweep display produced by 7B85 in the A horizontal compartment. (B) Delayed-sweep display produced by companion time-base unit in the B horizontal compartment.

switch of the companion time-base unit (see Fig. 1-6). The delay time between the triggering event that starts the delaying-sweep trace and the start of the intensified zone (and corresponding delayed sweep), is determined by the 7B85 TIME/DIV switch and DELAY TIME control. The amount of calibrated delay time is displayed on the crt readout.

To view the delaying-sweep trace (intensifed display), set the mainframe horizontal mode switch to A; to view the corresponding delayed-sweep trace, set the mainframe horizontal mode switch to B. To view the delaying trace (intensifed) and the corresponding delayed-sweep trace on the same display, set the mainframe horizontal mode switch to alternate or chop.

Triggering for the delaying-sweep trace is controlled by the 7B85 TRIGGERING controls. Triggering for the intensified zone on the delaying-sweep trace and the correspond-

ing delayed-sweep trace is controlled by the triggering controls of the companion time-base unit when the 7B85 is in the B TRIGGERABLE AFTER DLY mode.

Delay-time measurements must be made with the B DELAY MODE switch set to B STARTS AFTER DLY. When the B DELAY MODE switch is set to B TRIGGERABLE AFTER DLY, the delayed sweep starts with the first trigger pulse after the delay time shown on the crt readout. Therefore, precision time measurements cannot be made in this mode because the time delay is only partially dependent on the DELAY TIME control. The crt readout displays the greater-than symbol (>) preceding the delay time when operating in the B TRIGGERABLE AFTER DLY mode to indicate that the delay time is uncalibrated. However, the B TRIGGERABLE AFTER DLY mode is useful for triggering on wavefoms with excessive jitter.

Δ TIME Operation

The Δ TIME delaying mode provides the best means of making differential time measurements. The 7B85 can delay a companion time-base unit at two separate delay times. At the end of the first delay time (determined by the 7B85 DELAY TIME control and TIME/DIV switch) an intensifed zone is provided on the delaying-sweep trace. Further, a separate delayed-sweep trace corresponding to the first intensifed zone is provided. At the end of the second delay time (determined by the 7B85 TIME/DIV switch, the DELAY TIME, and Δ TIME controls) a second intensifed zone and corresponding second delayed-sweep trace are displayed (see Fig. 1-7). The 7B85 must be installed in the A horizontal compartment. The companion time-base unit must be installed in the B horizontal compartment. The TRACE SEP control must be rotated counterclockwise out of the switch detent position for Δ TIME operation. The sweep rate for the delaying-sweep trace is determined by the 7B85 TIME/DIV switch, and the sweep rate of the intensified zones and corresponding delayed-sweep display is determined by the sweep rate setting of the companion time-base unit.

The differential time between the start of the first intensified zone and the start of the second intensified zone is displayed on the crt readout (see Fig. 1-7). A Δ symbol preceding the delay-time readout indicates a differential measurement. The > (greater-than) symbol following the Δ symbol indicates that the TIME/DIV VARIABLE control is activated or that the B DELAY MODE switch is set to B TRIGGERABLE AFTER DLY and, therefore, the differential time is uncalibrated.

The TRACE SEP control vertically positions the second delayed-sweep trace with respect to the first delayed-sweep trace. Vertical positioning of the delayed-sweep traces with respect to the delaying-sweep trace is provided by the vertical separation control on the oscilloscope mainframe.

Δ TIME Operation in a Dual-Beam Oscilloscope Mainframe. The 7B85 Δ TIME function is compatible with 7000-series dual-beam mainframes and operation is basically the same as given for Δ Time Operation. The 7B85 must be installed in the A horizontal compartment and the companion time-base unit must be installed in the B horizontal compartment, as with conventional four plug-in compartment mainframes. Set the horizontal mode switch so that the 7B85 provides horizontal deflection for one beam and the companion time-base unit provides horizontal deflection for the other beam. Apply the input signal to the desired vertical plug-in unit and select that unit for vertical deflection of both beams.

Operation of the Δ TIME mode in dual-beam mainframes with a dedicated vertical system differs slightly from conventional dual-beam mainframes with vertical-mode switches. The plug-in unit in the left vertical compartment provides vertical deflection of beam 1, and the plug-in unit in the right vertical compartment provides vertical deflection for beam 2. Therefore, the input signal must be applied to the units in both the left and right vertical compartments for Δ TIME operation.

Mainframe Operating Modes

The 7B85 can also be operated either as an independent time base in any TEKTRONIX 7700-, 7800-, and 7900-Series mainframes, or as a delayed-sweep unit (B DELAY MODE switch set to INDEPENDENT) in those mainframes that have two horizontal compartments. A companion delaying time-base unit (e.g., another 7B85) is required for delayed-sweep operation. Refer to Applications in this section for additional information.

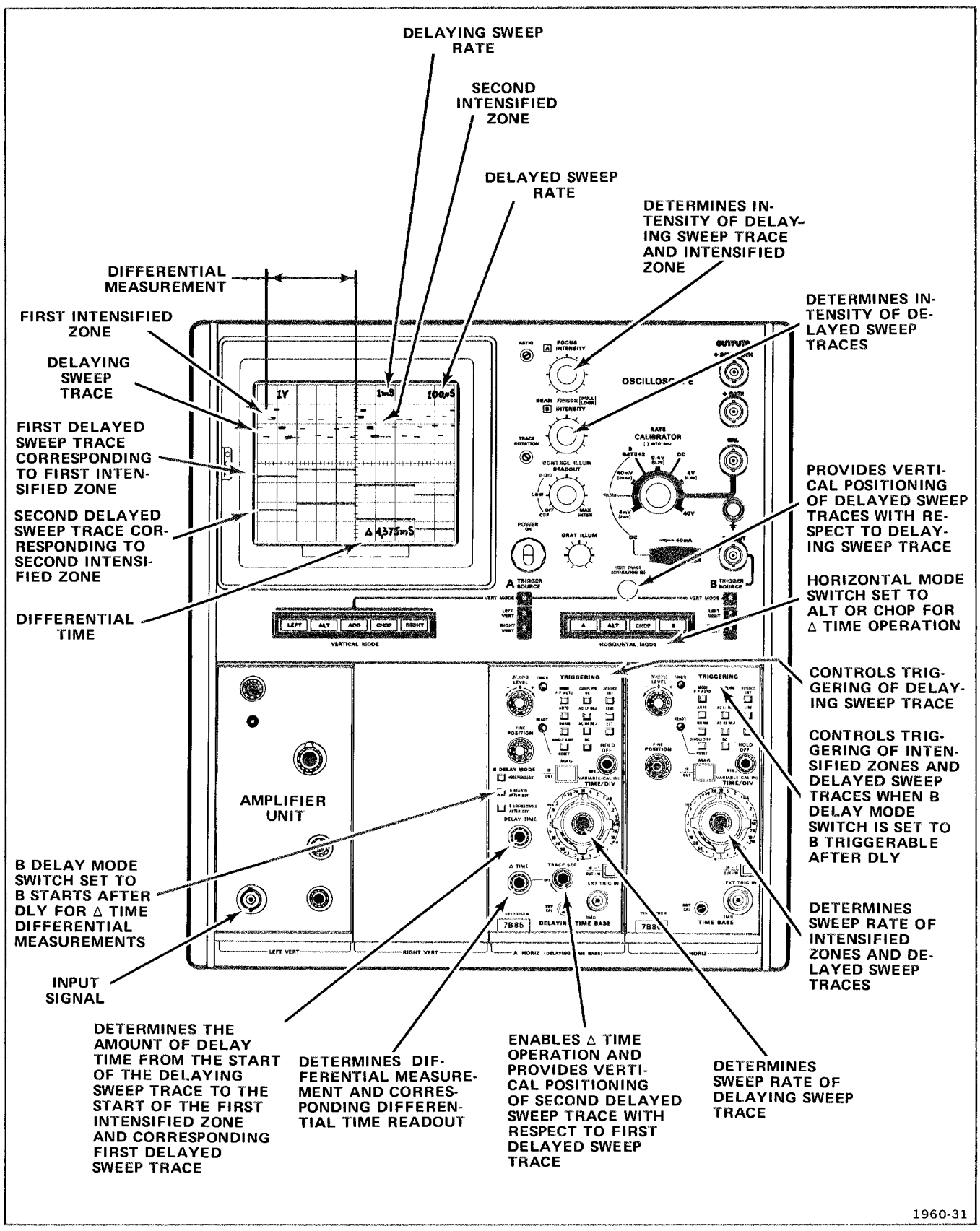


Fig. 1-7. Typical Δ (differential) time operation.

APPLICATIONS

The 7B85 is designed primarily for use with a companion time-base unit in a readout-equipped mainframe to make delayed-sweep time-interval measurements. The 7B85 can also be used as an independent non-delaying time base. The following procedures provide instructions for making several delayed-sweep time-interval measurements using the delay-time and Δ (differential) time modes. These procedures provide enough detail to enable the operator to adapt them to other related time-interval measurements. Contact your Tektronix Field Office or representative for assistance in making measurements not described in this manual.

DELAYED-SWEEP MEASUREMENTS

Complex signals often consist of a number of individual events of differing amplitudes. Since the trigger circuits are sensitive only to changes in signal amplitude, a stable display can normally be obtained only when the sweep is triggered by the event(s) having the greatest amplitude. However, this may not produce the desired display of a lower-amplitude portion following the triggering event. The delayed-sweep feature provides a means of delaying the start of the delayed sweep by a selected amount following the event that triggers the sweep generator. Then, the part of the waveform containing the information of interest can be displayed at the delayed-sweep rate with a higher apparent magnification than is provided by the MAG switch.

The delayed-sweep feature can also be used to provide rapid and accurate time-interval measurements from a triggering event (i.e., the start of the delaying sweep) to a selected point or between two selected points on a displayed waveform. See General Operating Information in this section for a further discussion of delay-time operation.

In the delay-time mode, the delayed (B) sweep runs for a selected interval after the delaying (A) sweep as indicated by an intensified zone superimposed on the delaying (A) sweep trace. The length of the intensified zone indicates the time that the delayed sweep runs and is determined by the delayed (B) sweep plug-in unit sweep rate (TIME/DIV setting). The time from the start of the delaying (A) sweep to the start of the intensified zone (i.e., the start of the delayed sweep) can be read directly on the crt readout.

In the Δ (differential) time mode, the delayed (B) sweep runs for a second selected interval indicated by a second intensified zone superimposed on the delaying (A) sweep trace. The two intensified zones can be positioned with the DELAY TIME and Δ TIME controls. The crt readout then indicates the differential (Δ) time from the start of the first to the start of the second intensified zones.

By selecting the mainframe alternate or chopped horizontal operation, the delaying (A) sweep and either the first delayed (B) sweep interval (delay-time mode) or both delayed (B) sweep intervals (Δ time mode) can be displayed simultaneously. Since the delayed (B) sweep(s) can be displayed at a higher magnification than is available with the MAG switch, more precise selection of time intervals is possible.

The following procedures provide instructions for making several types of time-interval measurements in the delay-time and Δ (differential) time modes.

Time-Interval Measurements (Delay-Time Mode)

Perform the following procedure to measure the time from a triggering event (start of sweep) to any point on a displayed waveform.

1. Install the 7B85 in the mainframe A horizontal compartment and a companion time-base unit in the B horizontal compartment.

2. Set the 7B85 controls as follows:

B DELAY MODE	B STARTS AFTER DLY (button in)
MAG	X1 (button in)
HOLD OFF	MIN (fully counter-clockwise)
TRACE SEP	OFF (fully clockwise)
VARIABLE TIME/DIV	Calibrated (knob in)

3. Connect the signal to be measured to the vertical unit input.

4. Set the mainframe for the A horizontal mode to display the 7B85, and the vertical mode to display the vertical unit.

5. Set the TRIGGERING controls for a stable display (see General Operating Information in this section to select proper triggering).

6. Set the vertical deflection factor and 7B85 sweep rate for the desired display. See the example in Fig. 1-8.

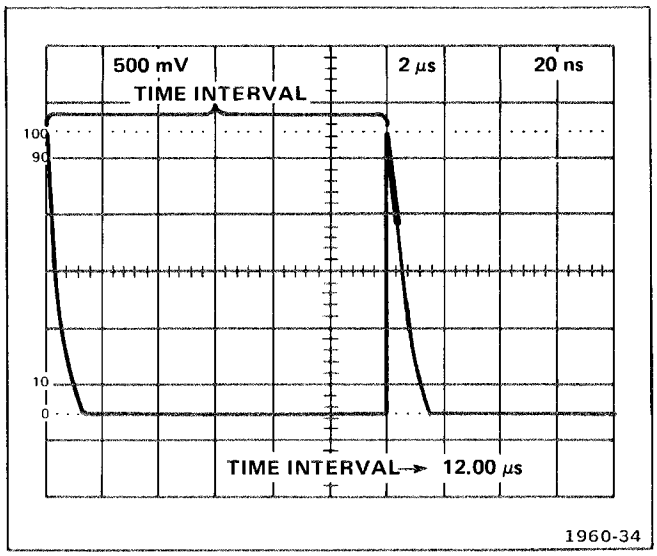


Fig. 1-8. Measuring time intervals from a triggering event (start of sweep) to any point on a waveform.

7. Set the delayed (B) unit sweep rate for about a 0.5 div intensifed zone.

8. Rotate the DELAY TIME control to position the leading edge of the intensified zone at the point on the displayed waveform where the desired time interval ends.

9. Read the time interval from the start of the sweep to the leading edge of the intensified zone directly on the crt readout (see Fig. 1-8).

Differential Time-Interval Measurements (Δ Time Mode)

Perform the following procedure to measure the time interval between any two selected points on a waveform. This procedure can be used to measure the rise time, fall time, period, frequency, or pulse width of a displayed waveform.

1. Install the 7B85 in the mainframe A horizontal compartment and a companion time-base unit in the B horizontal compartment.

2. Set the 7B85 controls as follows:

B DELAY MODE	B STARTS AFTER DLY (button in)
MAG	X1 (button in)
HOLD OFF	MIN (fully counter-clockwise)
TRACE SEP	OFF (fully clockwise)
VARIABLE TIME/DIV	Calibrated (knob in)

3. Connect the signal to be measured to the vertical unit input.

4. Set the mainframe for the A horizontal mode to displlay the 7B85 and the vertical mode to display the vertical unit.

5. Set the TRIGGERING controls for a stable display (see General Operating Information in this section to select proper triggering).

6. Set the appropriate triggering, position, deflection-factor, and sweep-rate controls to obtain the desired display. See the example in Fig. 1-9.

7. Adjust the DELAY TIME control to position the leading edge of the first intensified zone to the beginning of the time interval to be measured (se Fig. 1-9, point A).

8. Turn the TRACE SEP control counterclockwise just out of the OFF (detent) position to obtain a second intensified zone (Δ time mode) on the display.

9. Adjust the Δ TIME control to position the leading edge of the second intensified zone to the end of the time interval to be measured (see Fig. 1-9, point B).

10. Read the time interval between the intensified zones diretly from the crt readout.

NOTE

For more accurate time-interval measurements with a dual-trace magnified display, refer to the Delayed-Sweep Magnification procedure.

Delayed-Sweep Magnification

By selecting the mainframe alternate or chopped horizontal mode, a dual-trace display of both the delaying (A) sweep and the delayed (B) sweep can be obtained. In the delay-time mode (i.e., TRACE SEP control in the OFF position), the delayed (B) sweep appears as a magnified display of the single intensified portion on the delaying (A) sweep trace. In the Δ (differential) time mode (i.e., TRACE SEP control rotated counterclockwise out of the OFF position), the delayed (B) sweep appears as a dual magnified display of both intensifed portions of the delaying (A) sweep trace. The dual-delayed (B) sweep displays can be superimposed or separated by rotating the TRACE SEP control.

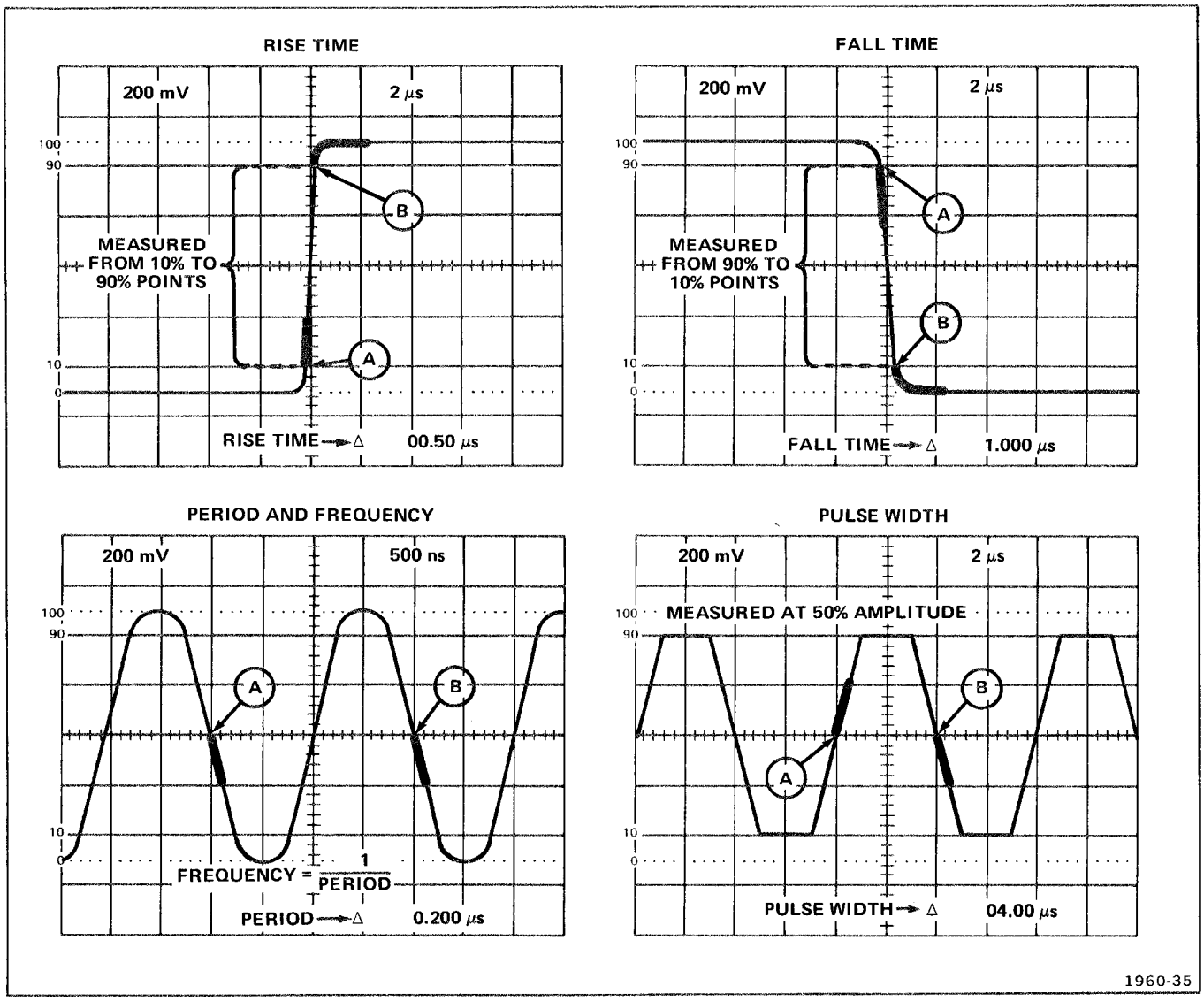


Fig. 1-9. Measuring rise time, fall time, period, frequency, or pulse width in the Δ (differential) time mode.

The following procedures use alternate or chopped horizontal (dual-trace) operation to: (1) magnify a selected segment of the delaying (A) sweep and determine apparent magnification in the delay-time mode; (2) make more accurate time-interval measurements in the delay-time and Δ (differential) time modes; and (3) examine an event that occurs within a selected time interval after a known delay time in the delay-time mode.

1. Install the 7B85 in the mainframe A horizontal compartment and a companion time-base unit in the B horizontal compartment.

2. Set the 7B85 controls as follows:

B DELAY MODE	B STARTS AFTER DLY (button in)
MAG	X1 (button in)
HOLD OFF	MIN (fully counter-clockwise)
VARIABLE TIME/DIV	Calibrated (knob in)
TRACE SEP	OFF (fully clockwise)

3. Connect the signal to be measured to the vertical unit input.

4. Set the mainframe horizontal mode for alternate or chopped operation (see oscilloscope mainframe instruction manual for discussion of alternate or chopped operation).

5. Use the following procedure to magnify a selected segment of the delaying (A) sweep waveform and determine apparent magnification in the delay-timemode.

a. Perform the procedures in step 1 through 4.

b. Set the appropriate triggering, position, deflection-factor, and sweep-rate controls for the desired dual-trace display. See the example in Fig. 1-10.

NOTE

If there is excessive jitter in the delayed (B) sweep display, refer to the Triggered Delayed Sweep Magnification discussion.

c. Turn the DELAY TIME control to position the intensified zone to the portion of the delaying (A) sweep waveform to be magnified.

d. Set the delayed (B) sweep unit sweep rate to select the desired duration of the magnified display as indicated by the length of the intensified zone.

e. Observe the magnified display on the delayed (B) sweep. See Fig. 1-10.

NOTE

For a better look at the delayed (B) sweep waveform, set the mainframe to the B horizontal mode and the amplifier-unit deflection factor to increase the display amplitude. Do not change the 7B85 TIME/DIV setting.

f. Determine apparent magnification by dividing the 7B85 TIME/DIV setting by the delayed (B) sweep unit sweep-rate setting.

Example: The apparent magnification of the delayed (B) sweep shown in Fig. 1-10 with a 7B85 TIME/DIV setting of .1 ms and a delayed (B) sweep unit sweep-rate setting of 1 μs is:

$$\text{Apparent Magnification} = \frac{\text{7B85 TIME/DIV setting}}{\text{Delayed (B) Sweep Time/Div setting}}$$

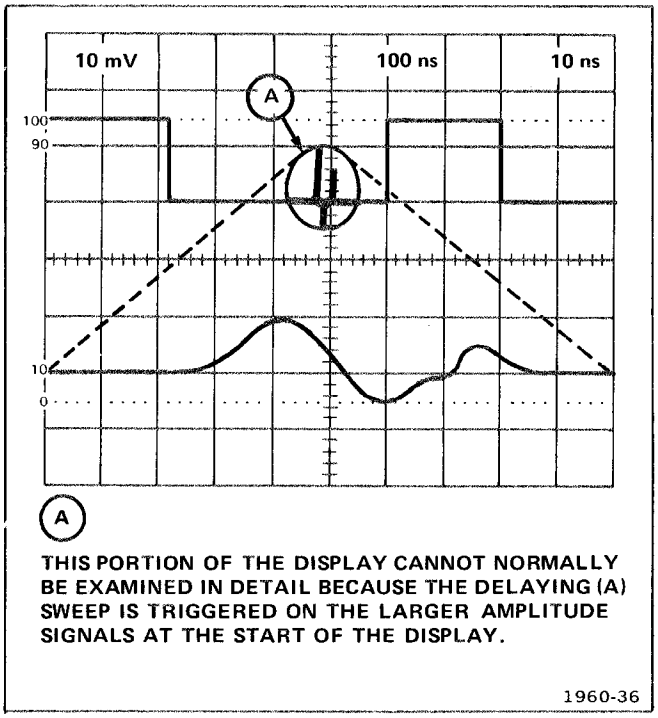


Fig. 1-10. Magnifying a selected segment of the delaying (A) sweep in the delay-time mode with mainframe alternate or chopped horizontal operation.

Substituting values:

$$\text{Apparent Magnification} = \frac{1 \times 10^{-4}}{1 \times 10^{-6}} = 100$$

The apparent magnification of the delayed (B) sweep display is 100 times the delaying (A) sweep display.

6. Use the following procedure to make more accurate time interval measurements in the delay-time or Δ (differential) time mode.

a. Perform the procedures in steps 1 through 4.

NOTE

The remaining steps of this procedure apply for both delay-time and Δ (differential) time measurements. For Δ (differential) time operation, the 7B85 TRACE SEP control must be turned counterclockwise out of the OFF (detent) position. The Δ TIME control then positions the second intensified zone and the DELAY TIME control positions the first intensified zone. Parentheses are used to indicate the instructions that apply only to Δ (differential) time operation.

b. Set the appropriate triggering, position, deflection factor, and sweep-rate controls for the desired dual-trace display. See the examples in Fig. 1-11.

NOTE

If there is excessive jitter in the delayed (B) sweep display, refer to the Triggered Delayed-Sweep Magnification discussion.

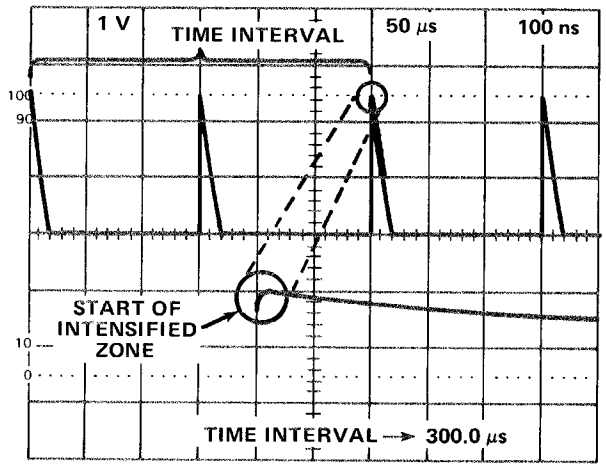
c. Turn the DELAY TIME (and Δ TIME) control(s) to position the intensified zone(s) for the precise time interval to be measured using the magnified delayed (B) sweep waveform(s). See the examples in Fig. 1-11.

NOTE

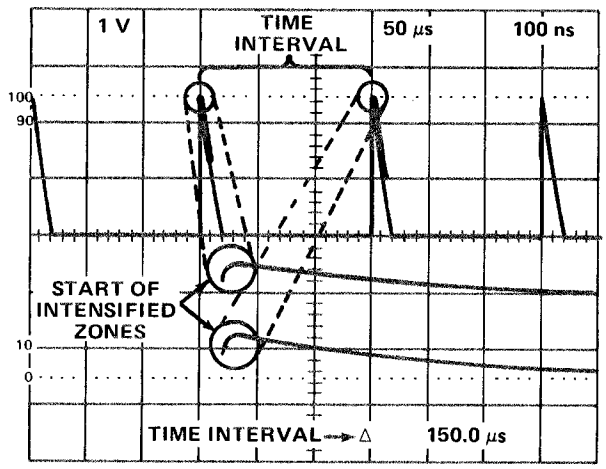
For a better look at the delayed (B) sweep waveform, set the mainframe to the B horizontal mode and the amplifier-unit deflection-factor to increase the display amplitude. Do not change the 7B85 TIME/DIV setting.

d. Read the desired time interval directly on the crt readout.

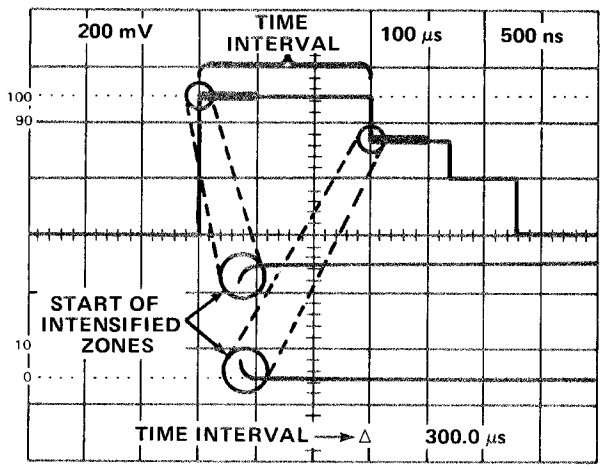
7. Use the following procedure to examine an event that occurs within a selected time interval after a known delay time in the delay-time mode.



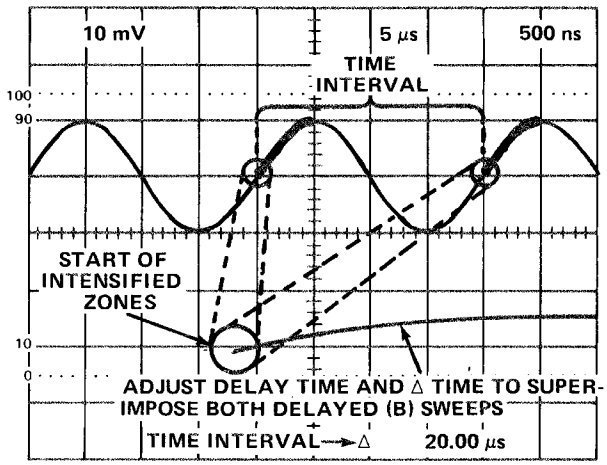
TIME-INTERVAL MEASUREMENT FROM A TRIGGERING EVENT (START OF SWEEP) IN THE DELAY TIME MODE.



TIME-INTERVAL MEASUREMENT BETWEEN TWO PULSES IN THE Δ (DIFFERENTIAL) TIME MODE.



TIME INTERVAL MEASUREMENT BETWEEN TWO POINTS ON A COMPLEX WAVEFORM IN THE Δ (DIFFERENTIAL) TIME MODE.



TIME INTERVAL MEASUREMENT BETWEEN TWO IDENTICAL POINTS ON A SINE WAVE IN THE Δ (DIFFERENTIAL) TIME MODE.

1960-37

Fig. 1-11. Time-interval measurments in the delay-time and Δ (differential) time mode with mainframe alternate or chopped operation.

a. Perform the procedures in steps 1 through 4.

b. Set the appropriate triggering, position, deflection-factor, and sweep-rate controls for the desired dual-trace display. See the example in Fig. 1-12.

NOTE

If there is excessive jitter in the delayed (B) sweep display, refer to the Triggered Delayed-Sweep Magnification discussion.

c. Adjust the DELAY TIME control for the known delay time as indicated on the crt readout.

d. Set the delayed (B) sweep rate (i.e., the intensified zone length) for the desired time interval after the delay time selected in part c. Multiply the delayed (B) sweep rate by 10 to determine the actual displayed delayed (B) sweep time interval. See the example in Fig. 1-12.

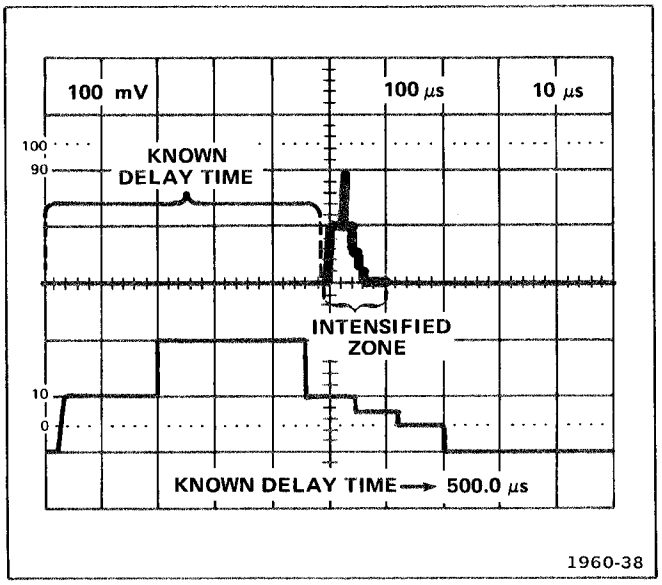


Fig. 1-12. Examining an event that occurs within a selected time interval after a known delay time in the delay-time mode.

e. Observe the magnified event to be examined on the delayed (B) sweep.

NOTE

For a better look at the delayed (B) sweep waveform, set the mainframe to the B horizontal mode and the amplifier-unit deflection-factor to increase the display amplitude. Do not change the 7B85 TIME/DIV setting.

Triggered Delayed-Sweep Magnification

The displayed waveform may have excessive jitter at the faster delayed (B) sweep-rate settings. The B TRIGGERABLE AFTER DLY position (button in) of the B DELAY MODE switch provides a more stable display, since the delayed (B) sweep display is then triggered at the same point each time. The crt readout is uncalibrated in this mode as indicated by the > symbol.

Inability to obtain the intensified zone(s) on the delaying (A) sweep display indicates that the delayed (B) sweep triggering controls are incorrectly set, or that the input signal does not meet triggering requirements. If the condition cannot be corrected with the triggering controls, or by increasing the display amplitude, externally trigger the delayed (B) sweep.

INDEPENDENT TIME-INTERVAL MEASUREMENTS

The 7B85 is designed primarily for use with a companion time-base unit in 7700-, 7800-, or 7900-Series oscilloscope mainframes with two horizontal compartments and crt readout. However, the 7B85 can also be used as an independent non-delaying time base (e.g., in a compatible mainframe with one horizontal compartment). To operate the 7B85 as an independent time base for time-interval measurements, press the INDEPENDENT button and obtain the desired display as described in steps 2 through 6 of the Time-Interval Measurements (Delay-Time Mode) procedure. Measure time intervals by multiplying the horizontal distance, in divisions, between the desired measurement points times the TIME/DIV switch setting.

SPECIFICATION

This instrument will meet the electrical characteristics listed in Table 2-1, following complete adjustment. The following electrical characteristics apply over an ambient temperature range of 0° to +50°C, except as otherwise indicated. Warmup time for given accuracy is 20 minutes.

Table 2-1
ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement				Supplemental Information
SWEEP GENERATOR					
Sweep Rates					
Calibrated Range	5 s/div to 10 ns/div in 27 steps. X10 Magnifier extends fastest calibrated sweep rate to 1 ns/div.				
Variable Range	Continuously variable uncalibrated sweep rate to at least 2.5 times the calibrated sweep rate setting.				Extends the slowest uncalibrated sweep rate to at least 12.5 s/div.
Sweep Accuracy[a] (With 7700, 7800, or 7900-Series Mainframes)	With SWP CAL adjusted at 1 ms/div within the temperature range of +20° to +30°C to a timing reference of 0.25% or better.				
Over Center 8 Div	**+15° to +35°C**		**0° to +50°C**		
	Unmag	**Mag**	**Unmag**	**Mag**	
5 s/Div to 1 s/Div	4.0%	5.0%	5.0%	6.0%	
0.5 s/Div to 0.1 μs/Div	1.5%	2.5%	2.5%	3.5%	
50 ns/Div to 10 ns/Div	2.5%	4.0%	3.5%	5.0%	
Excluded Portions of Sweep					
Start of Sweep	First 10 ns in 7800, 7900-Series mainframes. First 20 ns in 7700-Series mainframes. First 50 ns in all other 7000-Series mainframes.				
End of Sweep	Beyond 10th div unmagnified. Beyond 100th div magnified.				
Sweep Length (Unmagnified)	At least 10.2 div at all sweep rates.				
MAG Registration	0.5 div or less from graticule center when changing form MAG X10 to MAG X1.				

Table 2-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
	SWEEP GENERATOR (cont)	
Position Range		
POSITION Controls Fully Clockwise	Start of sweep must be to the right of graticule center at 1 ms/div.	
POSITION Controls Fully Counter-clockwise	End of sweep must be to the left of graticule center at 1 ms/div.	
Trigger Holdoff Time		
Minimum Holdoff Setting		
5 s/Div to 1 μs/Div	2 times TIME/DIV setting or less.	
0.5 μs/Div to 10 ns/Div	2.0 μs or less.	
Variable Holdoff Range	Extends holdoff time through at least two sweep lengths for sweep rates of 20 ms/div or faster.	
	VARIABLE TIME DELAY	
Δ TIME		
Range	0.0 to at least 9.0 TIME/DIV setting.	
Accuracy (+15° to +35°C)		
0.5 s/Div to 50 ms/Div	Within (0.5% measurement +0.1% full scale +1 least significant digit).[b]	
20 ms/Div to 100 ns/Div	Within (0.5% measurement +0.03% full scale +1 least significant digit).[b]	
TRACE SEPARATION Range	Functional only in the Δ TIME mode when alternating or chopping between time-base units. The second delayed sweep display can be vertically positioned at least 3 div below the first delayed sweep display with mainframe Vertial Separation control centered.	
DELAY TIME		
Range	0.2 or less to at least 9.0 times TIME/DIV setting.	
Jitter	(0.002% of full scale +0.1 ns) or less. (0.002% equals 1/50,000.)	
Differential Measurement Accuracy (Measurement is made by subtracting 2 delay times from the crt readout) (+15° to +35°C)		
05 s/Div to 100 ns/Div	Derate Δ TIME specification by one additional least significant digit.	

Table 2-1 (cont)

Characteristic	Performance Requirement			Supplemental Information
VARIABLE TIME DELAY (cont)				
Start of Delayed Sweep Display (With respect to start of delaying sweep display)				
0.5 s/Div to 10 μs/Div	Within (0.5% of measurement + 0.5% full scale).[b]			
TRIGGERING				
Triggering Sensitivity from Repetitive Signal (Auto, Norm and Single Sweep Modes)	**Triggering Frequency Range[c]**	**Minimum Triggering Signal Required**		
Coupling		**Internal**	**External**	
AC	30 Hz to 50 MHz	0.3 div	50 mV	
	50 MHz to 400 MHz	1.5 div	250 mV	
AC LF REJ[d]	30 kHz to 50 MHz	0.3 div	50 mV	
	50 MHz to 400 MHz	1.5 div	250 mV	
AC HF REJ	30 Hz to 50 kHz	0.3 div	50 mV	
DC[e]	Dc to 50 MHz	0.3 div	50 mV	
	50 MHz to 400 MHz	1.5 div	250 mV	
Internal Trigger Jitter	0.1 ns or less at 400 MHz.			
External Trigger Input				
Maximum Input Voltage	250 V (dc plus peak ac).			
Input R and C	1 MΩ within 5%, 20 pF within 10%.			
Level Range (Excluding P-P AUTO)	(Checked on 1 kHz sine wave.)			
EXT ÷1	At least + and −1.5 volts.			
EXT ÷10	At least + and −15 volts.			
P-P AUTO Operation Sensitivity (Ac or Dc Coupling)	**Triggering Frequency Range**	**Minimum Triggering Signal Required**		
		Internal	**External**	
	200 Hz to 50 MHz	0.5 div	125 mV	
	50 MHz to 400 MHz	1.5 div	375 mV	
Low Frequency Response	At least 50 Hz	2.0 div	500 mV	

[a]The fastest calibrated sweep rate is limited by some mainframes (oscilloscopes).

[b]Full scale equals 10 times the TIME/DIV switch setting.

[c]The triggering frequency ranges given here are limited to the −3 dB frequency of the oscilloscope vertical system (mainframe and amplifier unit) when operating from an internal source.

[d]Will not trigger on sine wves at or below 60 Hz when amplitudes are less than 8 div internal or 3 V external.

[e]The Triggering Frequency Range for DC COUPLING applies to frequencies above 30 Hz when operating in the AUTO TRIGGERING MODE.

Table 2-2
ENVIRONMENTAL CHARACTERISTICS

Refer to the Specification section of the associated mainframe manual.

Table 2-3
PHYSICAL CHARACTERISTICS

Characteristic	Description
Net Weight	Approximately 2.6 pounds (1.2 kilogram).
Dimensions	See Fig. 2-1, dimensional drawing.

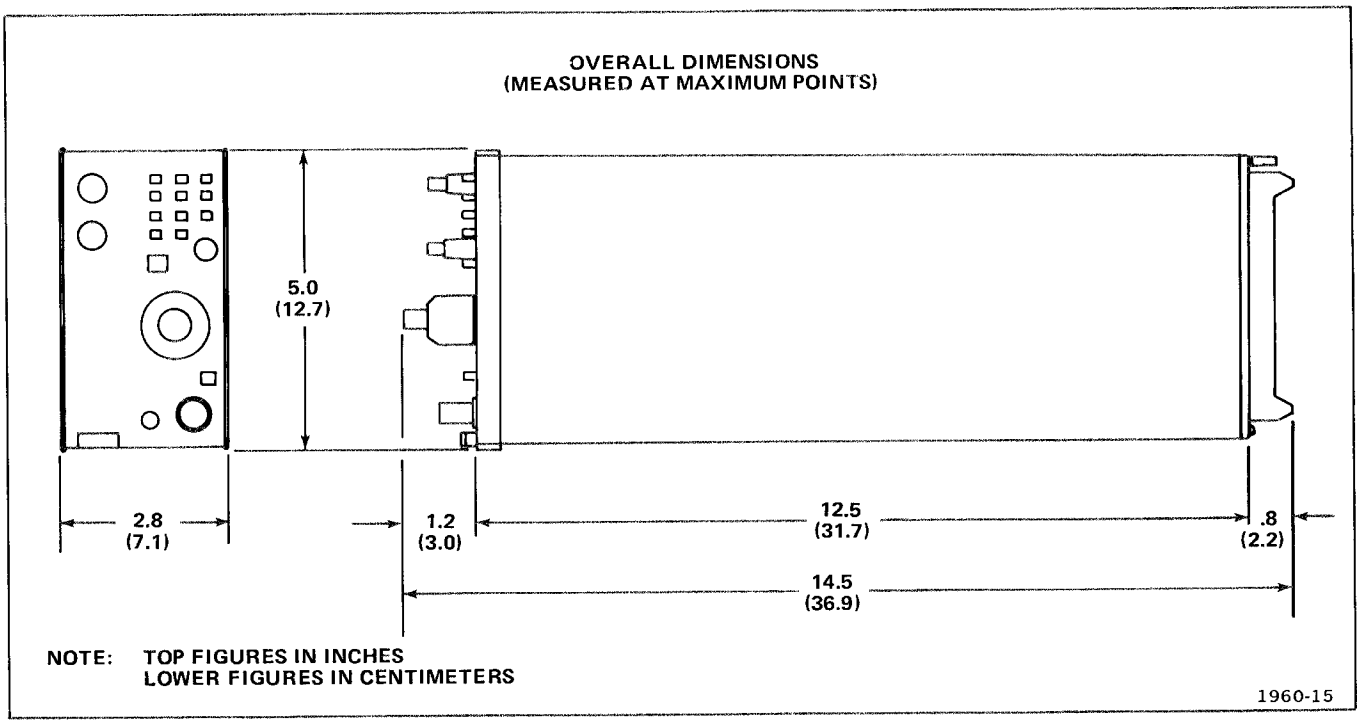


Fig. 2-1. 7B85 dimensional drawing.

STANDARD ACCESSORIES

1 ea . . . . . Operators Manual

1 ea . . . . . Instruction Manual

WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO. REFER TO OPERATORS SAFETY SUMMARY AND SERVICE SAFETY SUMMARY PRIOR TO PERFORMING ANY SERVICE.

THEORY OF OPERATION

This section of the manual describes the circuitry used in the 7B85 Delaying Time-Base unit. The description begins with a discussion of the instrument, using the block diagram shown in Fig. 3-1. Next, each circuit is described in detail with a block diagram provided to show the major interconnections between circuits, and the relationship of the front-panel controls to each circuit. Detailed schematic diagrams of each circuit are located in the diagrams foldout section at the back of this manual. Refer to these diagrams throughout the following discussions for specific electrical values and relationships.

BLOCK DIAGRAM DESCRIPTION

The following discussion is provided to aid in understanding the overall concept of the 7B85 before the individual circuits are discussed in detail. A basic block diagram is shown in Fig. 3-1. The numbered diamond in each block refers to the corresponding circuit diagram at the rear of this manual.

TRIGGER GENERATOR

The Trigger Generator ensures a stable crt display by starting each sweep at the same point on the waveform. Circuitry is included for selection of trigger mode, coupling, and source. The output of the Trigger Generator is a fast-rise gate that enables the Sweep Generator.

SWEEP GENERATOR

The sweep sawtooth signal is initiated when the Trigger Generator output is applied to the Sweep Generator. The rate of change (slope) of the sawtooth signal is determined by the TIME/DIV switch setting. The sawtooth signal provides horizontal deflection for the mainframe (oscilloscope) and is used by the Pickoff Amplifiers and the Delay Gate Generator in the 7B85. The Sweep Generator also generates a Sweep Gate pulse that unblanks the crt in the mainframe.

PICKOFF AMPLIFIERS AND DELAY GATE GENERATOR

The Pickoff Amplifiers and Delay Gate Generator circuits produce a delay gate when the sawtooth signal from the sweep generator reaches the level set by the DELAY TIME and Δ TIME controls. The DELAY TIME control determines the pickoff point for the first intensified zone and the Δ TIME control determines the pickoff point for the second intensified zone. The Delay Gate signal enables the companion delayed time-base unit.

LOGIC

The Logic circuit determines the sweep mode (B DELAY MODE) of the 7B85. The 7B85 can operate either independently or delay a companion delayed sweep time-base unit. The Logic circuit also determines the trigger mode and generates control signals for use by the mainframe (e.g., hold off, auxiliary, Y-axis, etc.).

DIGITAL VOLTMETER

The Digital Voltmeter circuit converts the selected dc pickoff levels (from the Pickoff Amplifier) to a calibrated delay-time readout on the crt. When operating in the DELAY TIME mode, the time before the start of the first intensified zone is displayed on the crt readout; when operating in the Δ TIME mode, the differential time between the start of the first intensified zone and the second intensified zone is displayed.

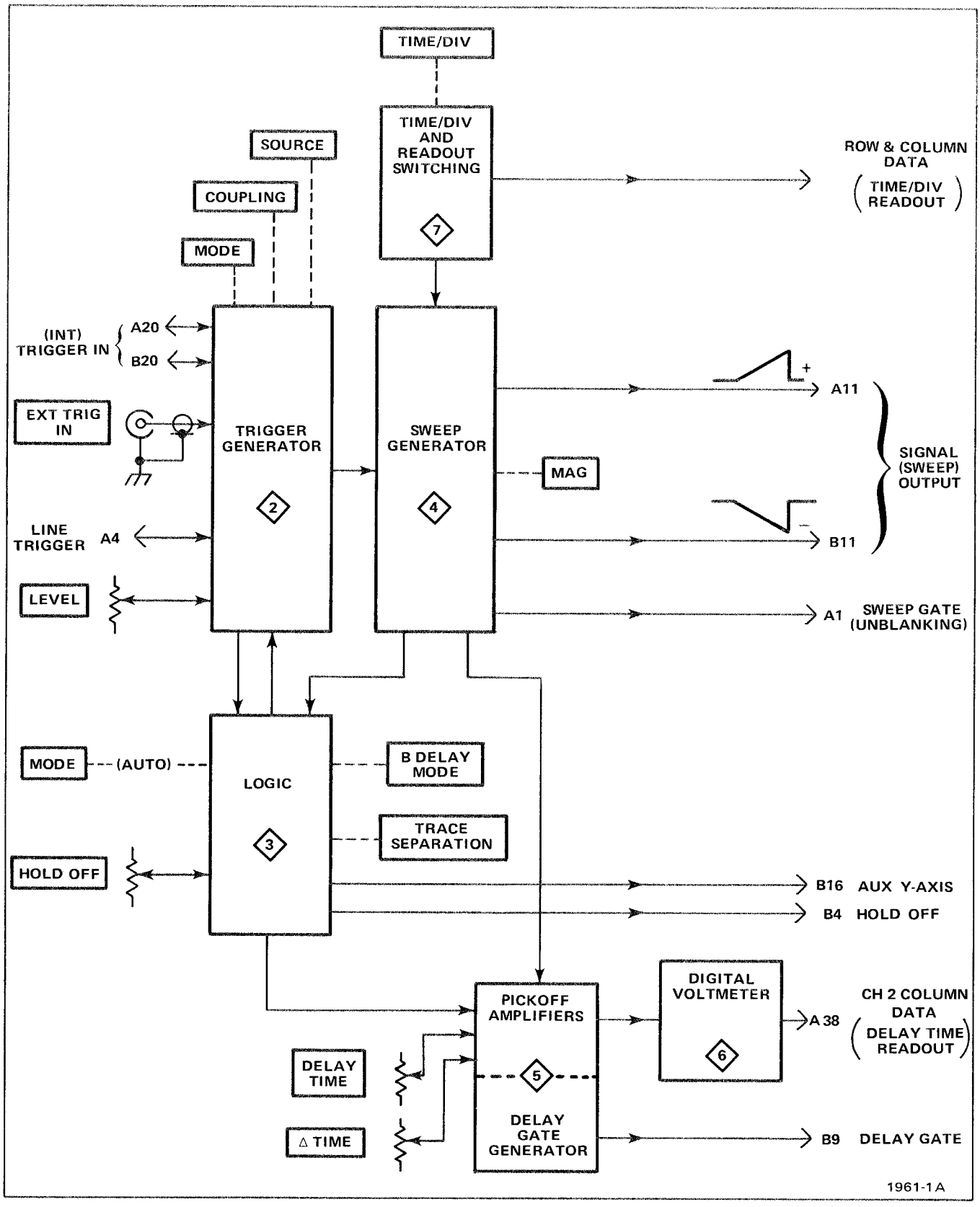


Fig. 3-1. Basic block diagram of the 7B85 Delaying Time-Base unit.

DETAILED CIRCUIT DESCRIPTION

The operation of circuits unique to this instrument is described in detail in this discussion. Circuits commonly used in the electronics industry are not described in detail.

The following circuit analysis, with supporting illustrations, gives the names of individual stages, and shows how they are connected to form major circuits. These illustrations show the inputs and outputs for each circuit and the relationship of the front-panel controls to the individual stages. The detailed circuit diagrams from which the illustrations are derived are shown in the diagrams foldout section.

LOGIC FUNDAMENTALS

Digital logic techniques are used to perform many functions within this instrument. The function and operation of the logic circuits are described using logic symbology and terminology. This portion of the manual is provided to be an aid in the understanding of these symbols and logic concepts, not a comprehensive discussion of the subject.

Symbols

The symbols used to describe digital circuits in this instrument are based on ANSI standard Y32.14-1973. Table 3-1 provides a basic reference for the logic devices used within this instrument. Any deviations from the standard symbology, or devices not defined by the standard, are described in the circuit description for the applicable device.

NOTE

Logic symbols used on the diagrams depict the logic function as used in this instrument, and may differ from the manufacturer's data.

Logic Polarity

All logic functions are described using the positive logic convention. Positive logic is a system of notation where the more positive of two levels (HI) is called the true or 1-state; the more negative level (LO) is called the false or 0-state. The HI-LO method of notation is used in this description. The specific voltages that consitute a HI or LO state may vary between individual devices. Wherever possible, the input and output lines are named to indicate the function performed when at the HI (true) state.

Input/Output Tables

Input/Output (truth) tables are used to show the input combinations important to a particular function, along with the resultant output conditions. This table may be given either for an individual device or for a complete logic stage. For examples of input/output tables for individual devices, see Table 3-1.

NON-DIGITAL DEVICES

Not all of the integrated circuits in this instrument are digital logic devices. The function of non-digital devices is described individually, using operating waveforms or other techniques to illustrate the function.

Table 3-1
BASIC LOGIC REFERENCE

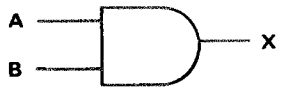
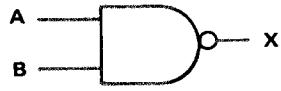
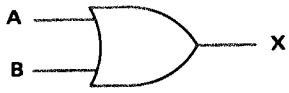
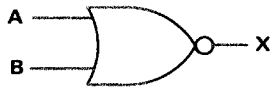
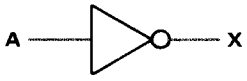
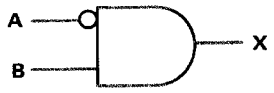
Device	Symbol	Description	Input/Output Table
AND gate		A device with two or more inputs and one output. The output of the AND gate is HI if and only if all of the inputs are at the HI state.	Input / Output A B X LO LO LO LO HI LO HI LO LO HI HI HI
NAND gate		A device with two or more inputs and one output. The output of the NAND gate is LO if and only if all of the inputs are at the HI state.	Input / Output A B X LO LO HI LO HI HI HI LO HI HI HI LO
OR gate OR gate		A device with two or more inputs and one output. The output of the OR gate is HI if one or more of the inputs are at the HI state.	Input / Output A B X LO LO LO LO HI HI HI LO HI HI HI HI
NOR gate		A device with two or more inputs and one output. The output of the NOR gate is LO if one or more of the inputs are at the HI state.	Input / Output A B X LO LO HI LO HI LO HI LO LO HI HI LO
Inverter		A device with one input and one output. The output state is always opposite to the input state.	Input / Output A X LO HI HI LO
LO-state indicator		A small circle at the input or output of a symbol indicates that the LO state is the significant state. Absence of the circle indicates that the HI state is the significant state. Two examples follow:	
		AND gate with LO-state indicator at the A input. The output of this gate is HI if, and only if, the A input is LO and the B input is HI.	Input / Output A B X LO LO LO LO HI HI HI LO LO HI HI LO

Table 3-1 (cont)

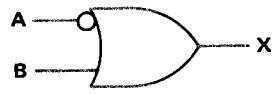
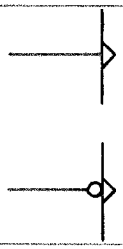
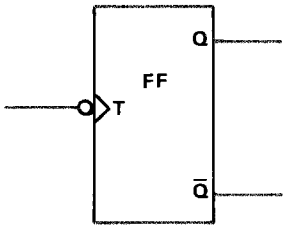
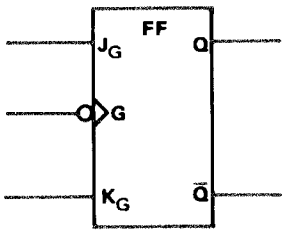
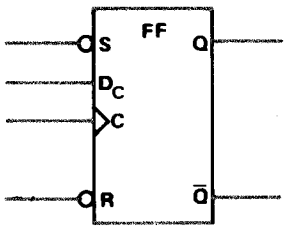
Device	Symbol	Description	Input/Output Table
		OR gate with LO-state indicator at the A input: The output of this gate is HI if either the A input is LO or the B input is HI.	Input / Output A B X LO LO HI LO HI HI HI LO LO HI HI HI
Dynamic Indicator		Indicates that this input (usually the trigger input of a flip-flop) responds to the indicated transition of the applied signal.	
Triggered (toggle) Flip-Flop		A bistable device with one input and two outputs (either or both outputs may be used). When triggered, the outputs change from one stable state to the other stable state with each trigger. The outputs are complementary (i.e., when one output is HI the other is LO). The dynamic indicator on the trigger (T) input may be of either polarity depending on the device.	Input / Output Condition before trigger pulse: Q $\bar{Q}$ Condition after trigger pulse: Q $\bar{Q}$ LO HI HI LO HI LO LO HI
Triggered Set-Clear (J-K) Flip-Flop		A bistable device with three or more inputs and two outputs (either or both outputs may be used). When gated, the outputs change state in response to the states at the inputs prior to the trigger. The outputs are complementary (i.e., when one output is HI the other is LO). The dynamic indicator on the gate (G) input may be of either polarity depending on the device.	Input / Output J K Q $\bar{Q}$ LO LO No change LO HI LO HI HI LO HI LO HI HI Changes state **Output conditions shown after gate pulse.**
D (data) Type Flip-Flop with Direct Inputs (Direct Inputs may be applied to all applied to all triggered flip-flops)		A bistable device with two inputs and two outputs (either or both outputs may be used). When clocked, the state of the Q output changes to the state at the data (D) input. The outputs are complementary (e.g., when one output is HI the other is LO). The dynamic indicator on the clock input may be of either polarity, depending upon the device.	Set (S) and reset (R) inputs override data (D) and clock (C) inputs. Input / Output S R Q $\bar{Q}$ HI LO LO HI LO LO Undefined HI HI No Effect LO HI HI LO

Table 3-1 (cont)

Device	Symbol	Description	Input/Output Table
		For devices with set (S) or reset (R) inputs, the indicated state at either of these inputs overrides all other inputs to the states shown in the Input/Output Table.	Set (S) and Reset (R) inputs both high. Input / Output Condition before clock pulse: D Condition after clock pulse: Q, $\overline{Q}$ HI → HI, LO LO → LO, HI

FRONT-PANEL DISTRIBUTION ◇1

The Front-Panel Distribution diagram shows the interconnections between front-panel functions (controls, connectors, and indicators) and circuit boards within this instrument.

TRIGGER GENERATOR ◇2

The Trigger Generator provides a stable display by starting the Sweep Generator (diagram 4) at a selected point on the input waveform. The triggering point can be varied by the LEVEL control and may be on either the positive or negative slope of the waveform. The triggering signal source may be from either the signal being displayed (INT), a signal from an external source (EXT), or a sample of the power-line voltage (LINE). A block diagram of the Trigger Generator is shown in Fig. 3-2.

External Source

The external trigger signal is connected to the Trigger Generator through EXT TRIG IN connector J12. Push-button switch S10 provides 10 times attenuation of the external trigger input signal.

When SOURCE switch S50 is set to EXT, external signals below approximately 16 kHz are coupled through R15 and R20 to External Trigger Amplifier Q22. Ac coupling is provided by C15. Triggering signals above 16 kHz are coupled through C20 to the gate of Q22A.

Field-effect transistors Q22A and Q22B form a unity-gain source follower, which couples the external trigger signal to the Trigger Source Selector and Amplifier stage (U65, pin 4). Diodes CR23 and CR24 provide input protection by clamping the input within a diode drop of ground (approximately 0.7 volt).

Internal and Line Source

The internal trigger signal from the vertical channel of the mainframe is connected to the Internal Trigger Amplifier stage (U35) differentially via interface connector pins A20 and B20.

Internal trigger signals with frequencies above 16 kHz are coupled through C37 directly into the Trigger Source Selector and Amplifier stage (U65, pin 8). Internal trigger signals with frequencies below 16 kHz are coupled differentially through R31 and R33 to U35, pins 2 and 3. The single-ended output at U35, pin 6 is coupled, along with the offset from LEVEL control R60, to U65, pin 10. Ac coupling is provided by C43.

A sample of the line voltage is connected to the trigger circuits via interface connector pin A4. The line signal is connected to the Trigger Source Selector and Amplifier stage at U65, pin 2.

Trigger Source Selector and Amplifier

The Trigger Source Selector and Amplifier stage (partial U65) determines whether the triggering signal source is from the signal being displayed (INT), a signal from an external source (EXT), or a sample of the power line voltage (LINE).

The trigger source is selected by SOURCE switch S50 by connecting the most positive voltage to the source input of U65 (refer to Fig. 3-3). The voltage offset from LEVEL control R60 is coupled to U65, pin 10. The differential trigger output signal from U65, pins 16 and 17 is coupled to the Slope Selelctor and Trigger Generator stage (U85).

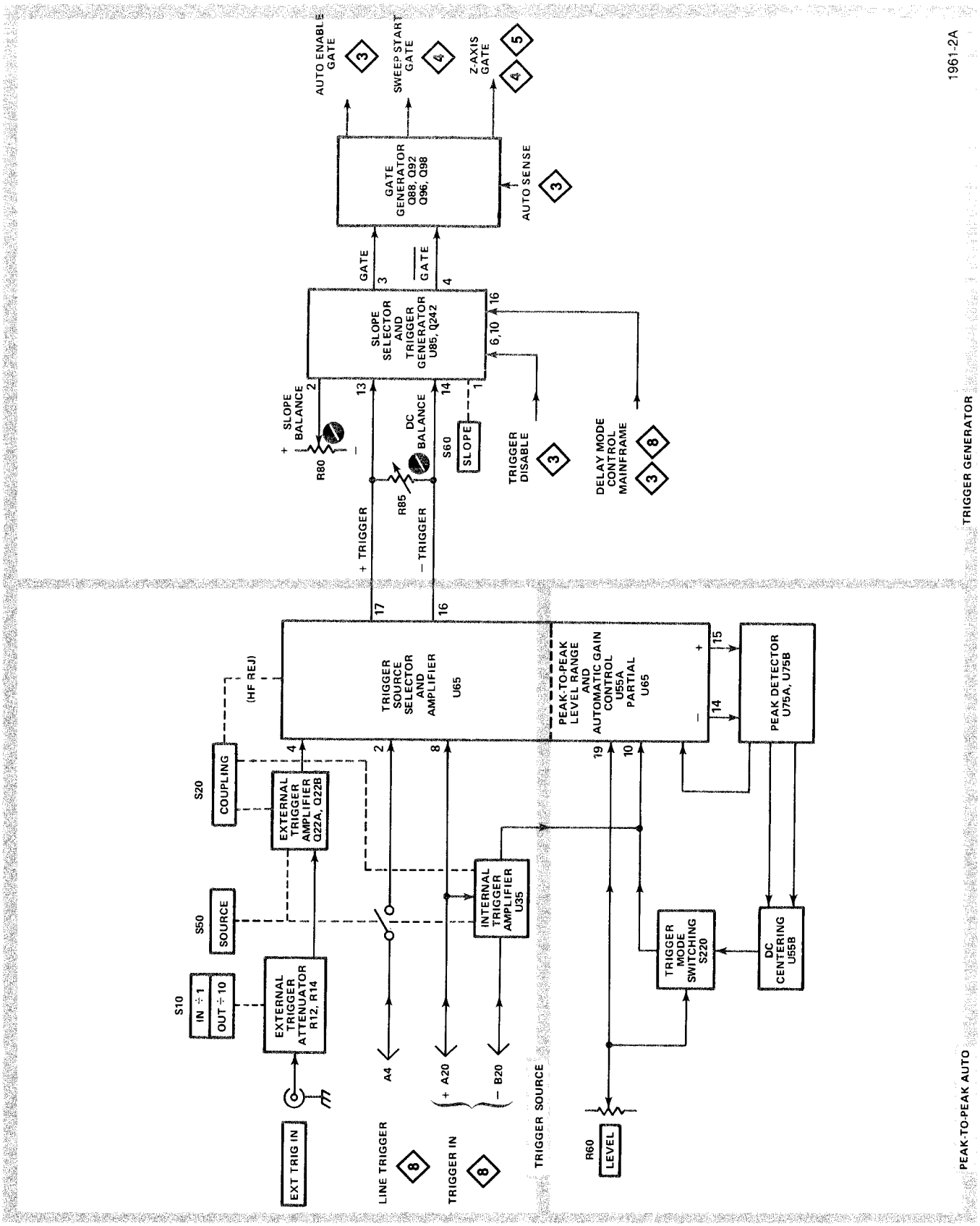


Fig. 3-2. Detailed block diagram of Trigger Generator.

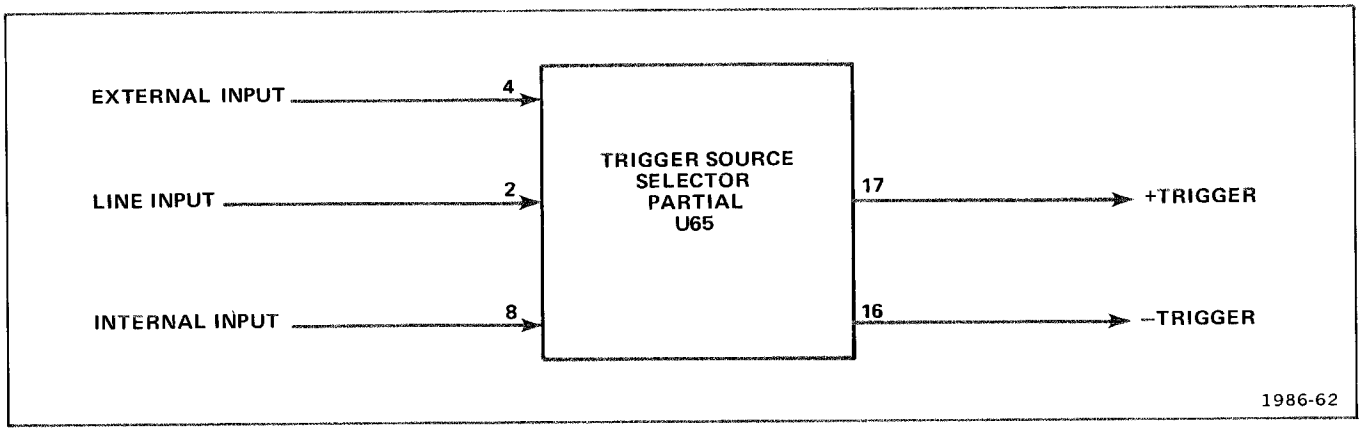


Fig. 3-3. Functional diagram of Trigger Source Selector.

High-frequency reject coupling is provided in the Trigger Source Selector stage. When the AC HF REJ pushbutton is pressed, C68 and components internal to U65, pin 9 form a high-frequency rejection filter. Only low-frequency ac triggering signals are accepted.

Peak-to-Peak Auto

The Peak-to-Peak Auto function can be divided into three distinct blocks. First, the Peak Detector determines signal size and dc positioning. Second, a DC Centering loop centers the peak-detected output regardless of the dc input and offset voltages. Third, the Peak-to-Peak Level Range output voltage is automatically adjusted until the trigger output reaches the clamp level set by the Automatic Gain Control to achieve full level range (refer to the Specification section in this manual for level range parameters).

Peak Detector. The peak detector outputs from U65, pins 14 and 15, rectified within U65, are externally filtered by C73 and C74. Secondary stages of peak detection for the positive and negative detector signals are provided by U75A-CR71-C72 and U75B-CR75-C76. Outputs from the Peak Detector stage are coupled to the Peak-to-Peak Level Range and DC Centering stages.

DC Centering. Operational amplifier U55B adjusts the input level at U65, pin 10 to null the dc input voltage and accumulated dc offsets. This allows the trigger outputs at U65, pins 16 and 17 to balance when LEVEL control R60 is set to zero. DC Balance adjustment R85 provides centering for offset voltages due to circuitry external to U65, pins 16 and 17 (e.g., U85).

Peak-to-Peak Level Range. The Peak-to-Peak Level Range stage amplifies the peak Detector signals to provide constant amplitude trigger signals and to determine the range of the front-panel LEVEL control. Peak Detector signal amplitude is dependent on triggering (input) signal amplitude.

Peak Detector signals from R58-R59 are coupled to U55A, pin 3 of the Peak-to-Peak Level Range stage. The gain of the feedback amplifier (consisting of U55A and pins 1 and 20 of U65) increases as the Peak Detector signal amplitude is reduced, thereby producing a constant trigger signal level at U65, pins 16 and 17.

The range of the front-panel LEVEL control is zero at minimum triggering signal amplitude. The LEVEL range increase as triggering signal amplitude increases, until it reaches maximum level range at the Automatic Gain Control threshold. Refer to the Specification section in this manual for triggering sensitivity and triggering LEVEL range parameters.

Automatic Gain Control. The Automatic Gain Control stage limits the trigger signal amplitude to approximately 450 mV peak to peak (at U65, pins 16 and 17) regardless of the trigger input signal amplitude. The level of the peak detected signal from R58-R59 is sensed by a feedback amplifier stage (U55A and pins 1 and 20 of U54). When the peak detected signal is above the Automatic Gain Control threshold (resulting from approximately 50 mV external trigger signal), the Automatic Gain Control stage limits the output trigger signal amplitude at U65, pins 16 and 17. Current into U65, pin 3 (established by R51) determines the current reference that sets the Automatic Gain Control threshold.

Slope Selector and Trigger Generator

Integrated circuit U85 converts the differential trigger signal from the Trigger Source Selector and Amplifier block to a differential gate waveform for use by the Gate Generator stage.

SLOPE switch S60 is connected to U85, pin 1 to determine whether the display is triggered on the positive-going or negative-going slope. When the SLOPE switch is set to +, a positive-going signal on pin 13 produces a positive-going gate on pin 3 and a negative-going gate on pin 4. When the SLOPE switch is set to −, a negative-going signal on pin 13 produces a positive-going gate on pin 3 and a negative-going gate on pin 4. Slope Balance adjustment R80 provides optimum input balance for both + and − SLOPE operation.

The delay mode control signal into U85, pin 16 is functional only when the unit is operating as a delayed sweep unit in the B Horizontal compartment of a mainframe with two horizontal compartments. When the unit is operating in the independent or triggerable after delay time modes (as determined by the delaying sweep time-base unit in the A horizontal compartment), there is no affect on the Trigger Generator circuits. However, when the unit is operating in the B starts after delay time mode, a HI level at U85 pin 16 supplies a trigger gate pulse to U85, pins 3 and 4 in the absence of a trigger disable pulse at the emitter of Q242.

At the end of each sweep, the Logic circuits (diagram 3) supply a trigger disable pulse through Q242 to U85, pins 6 and 10. A HI level disables the Trigger Generator to allow enough time for the sweep generator to stabilize before another trigger pulse starts the next sweep.

Gate Generator

The Gate Generator stage provides an auto enable gate to the Logic circuits (diagram 3), and a sweep start gate and Z-axis gate (unblanking) to the Sweep Generator circuit (diagram 4). Refer to Fig. 3-4 for a timing diagram of the Gate Generator functions.

When an adequate trigger signal is applied to U85, pins 13 and 14, a HI level is produced at U85, pin 3 and a LO level is produces at U85, pin 4.

The HI level from U85, pin3 is coupled through emitter follower Q88 and J200-2 into the Logic circuit (diagram 3) to indicate that a triggering signal has been received. The Log-

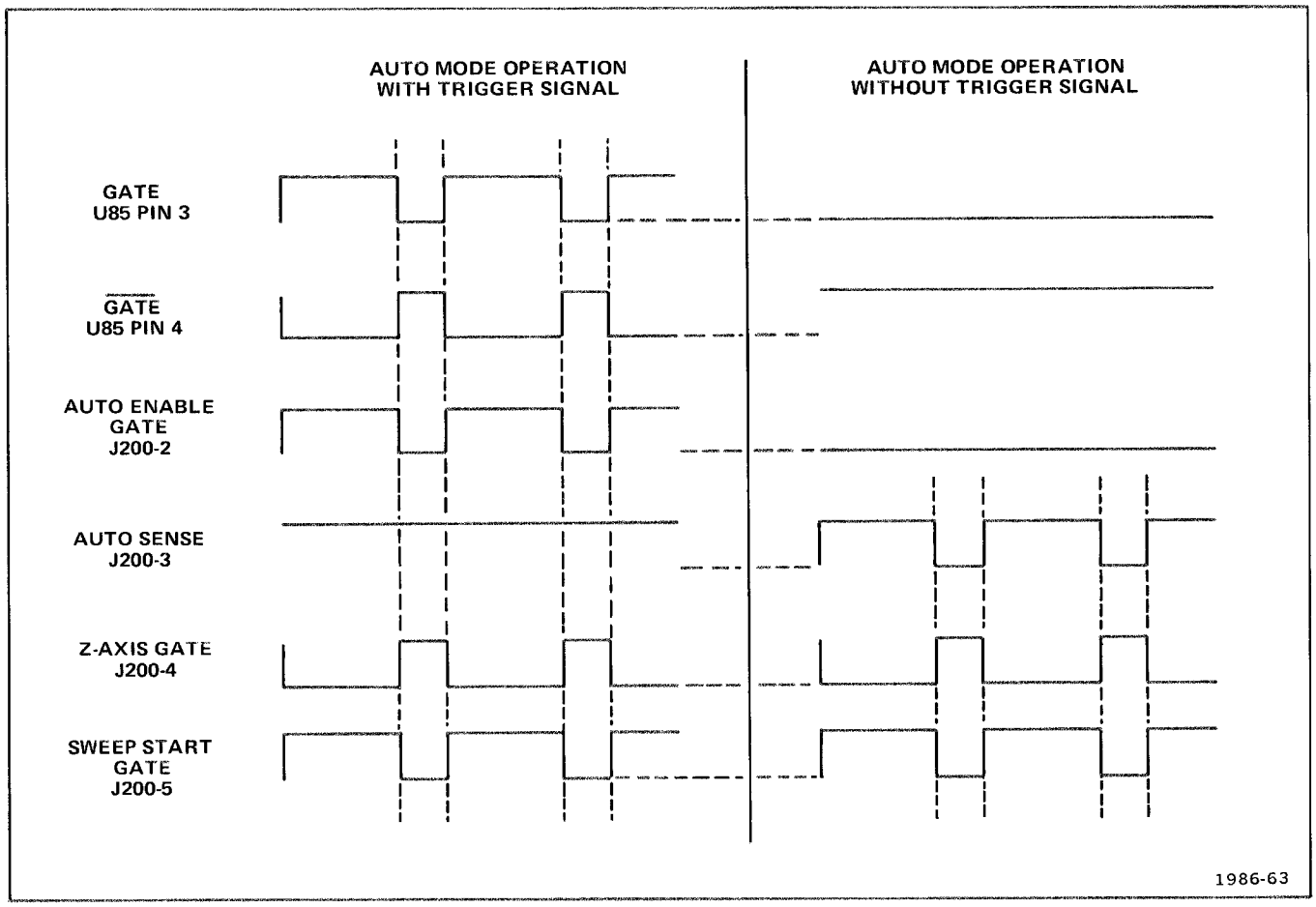


Fig. 3-4. Timing diagram for Gate Generator stage (Q92, Q96, Q98).

ic circuit (diagram 3) sets the auto sense at J200-3 HI, turning off Q98. Simultaneously, the LO level at U85, pin 4 gates comparator Q96-Q92. The collector of Q92 rises HI to provide a sweep start gate at J200-5 and the collector of Q96 falls LO to provide a Z-axis gate (unblanking) at J200-4.

In the absense of a trigger output at U85, pins 13 and 14, pin 3 is set LO and pin4 is set HI. The LO level from U85, pin 3 is coupled through J200-2 to the Logic circuit (diagram 3) to indicate the lack of a triggering signal. The Logic circuit provides a LO-level auto sense pulse through J200-3 to the base of Q98. This LO level gates the comparator (Q98 and Q96). The collector of Q98 rises high to provide a sweep start gate, and the collector of Q96 falls LO to provide a Z-axis gate (unblanking) at J200-4.

LOGIC 3

The Logic circuit controls the sweep modes and associated functions of the time-base unit (e.g., sweep display, hold off, auto sweep, single sweep, etc.). The Logic circuit also generates control signals for the mainframe. A block diagram for the Logic circuit is shown in Fig. 3-5.

Sweep Modes

Integrated circuit U220 controls the NORM, AUTO, and SINGLE SWEEP MODES and also generates control signals used in the 7B85. P-P AUTO operation is described in the Trigger Generator circuit description (diagram 2).

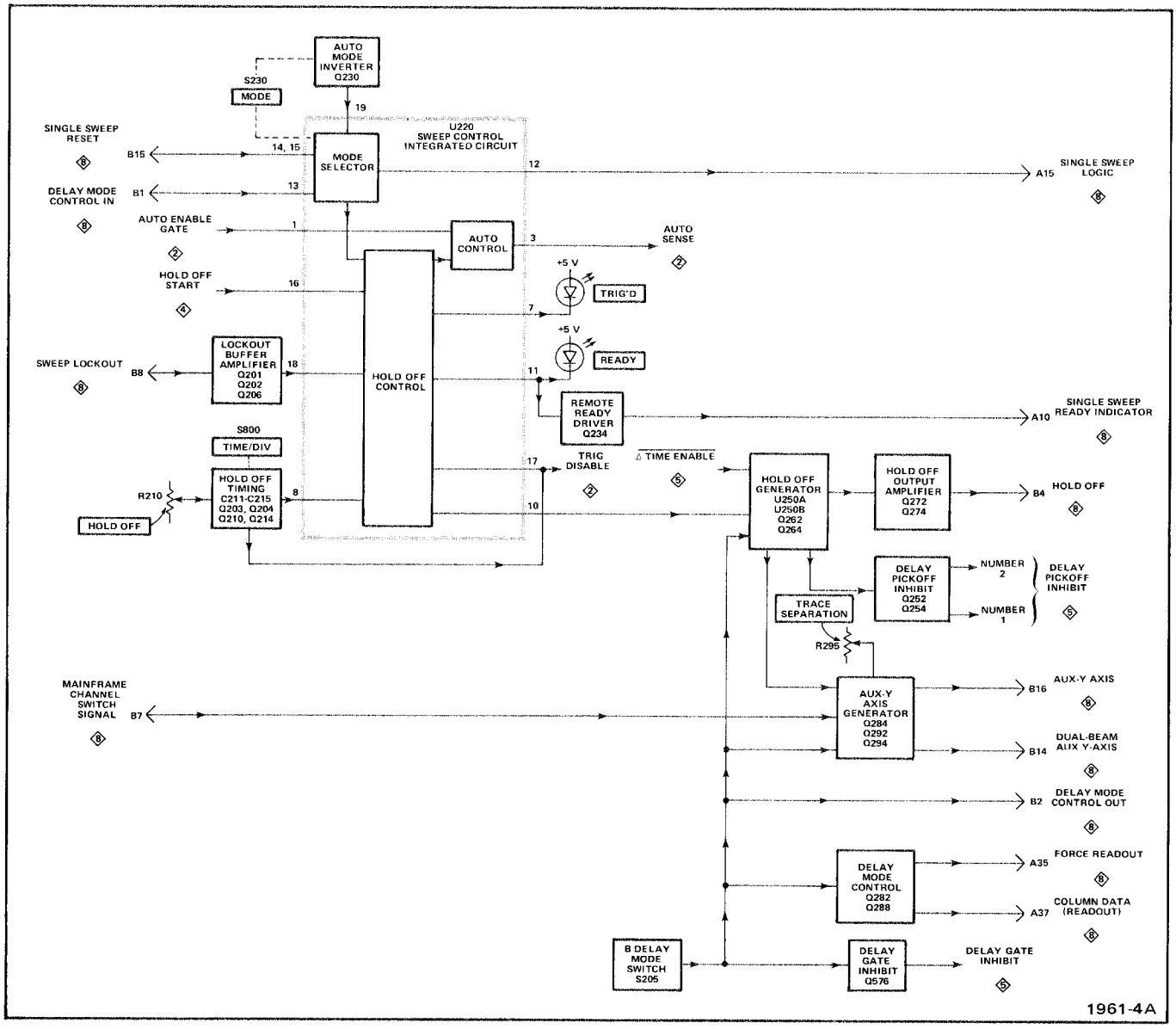


Fig. 3-5. Detailed block diagram of Logic circuit.

NORMal MODE. The NORM MODE is provided when U220, pin 12 is LO. In the NORM MODE, only an appropriate trigger signal can initiate a sweep gate to the Sweep Generator (diagram 4). Sweep Control integrated circuit U220 controls sweep lockout and hold off functions.

AUTO MODE. The Auto Control stage produces a free-running reference trace (bright base line) in the absence of a trigger signal.

A HI level from MODE switch S230 is inverted by Q230 to set U220, pin 19 LO, which selects AUTO MODE operation. In the presence of a trigger pulse from the Trigger Generator (diagram 2), a HI level at U220, pin 1 discharges the auto stage, which inhibits the auto sense signal from U220, pin 3. In the absence of a trigger pulse, the LO level at U220, pin 1 enables the Auto Control stage. After a time delay determined by R228, C228, and circuitry internal to U220, pin 6, an auto sense signal is initiated from U220, pin 3 to the Trigger Generator (diagram 2).

SINGLE SWeeP MODE. Single sweep operation provides display of only one sweep. After one sweep has run, all other sweeps are inhibited until the SINGLE SWP PRESET push button is pressed. The READY light indicates when the sweep is ready to accept a trigger.

After completion of one sweep, the hold off start pulse at U220, pin 16 causes the sweep disable out at pin 17 to rise HI. A HI level at U220, pin 12 initiates single-sweep operation and holds the sweep disable out at U220, pin 17 HI after completion of the sweep. Momentary contact of the RESET push button places a LO at U220, pins 14 and 15, which removes the sweep disable out from pin 17 and allows the Sweep Generator (diagram 4) to accept a trigger. Interface connector B15 provides a remote single-sweep reset input from compatible mainframes.

Hold Off Timing

The hold off stages prevent the Sweep Generator (diagram 4) from being retriggered until the sweep timing capacitors are discharged.

At the end of each sawtooth waveform from the Sweep Generator (diagram 4), a sweep stop comparator pulse (HI) is coupled to U220, pin 16. This pulse enables the hold off timing circuits at U220, pin 8, which sets the sweep disable out at U220, pin 17 HI and the $\overline{\text{hold off}}$ signal at pin 10 LO for the duration of the hold off cycle. Hold off timing (U220, pin 8) is provided by capacitors C212 through C215, and resistors R212 through R214. Transistors Q203 and Q204 prevent the sweep disable out pulse at U220, pin 17 from falling LO until the timing capacitors have discharged. Transistors Q212 and Q214 and front-panel HOLD OFF control R210 provide variable current to the timing components to change the hold off time period.

Lockout Buffer Amplifier

A lockout pulse (HI) may be initiated at interface connector pin B8 by mainframe switching functions. A HI level, coupled from interface connector B8 through the Lockout Buffer Amplifier (Q201, Q202, and Q206) to the lockout input at U220, pin 18, initiates a sweep disable pulse at U220, pin 17, thereby disabling the sweep. The lockout pulse (HI) is also applied through Q358 (diagram 4) to the hold off start input at U220, pin 16 to enable the hold off cycle.

Hold Off Generator

The Hold Off Generator provides an appropriate hold off pulse to the Hold Off Output Amplifier, depending upon the sweep mode.

In the Δ Time (delta time) mode, a HI level from Q546 (diagram 5) reverse biases CR248; this sets U250, pins 3 and 10 HI and removes the set input from pin 10. Since the J and K inputs of U250A (pins 2 and 3) are both HI, the outputs at pins 5 and 6 switch with every negative-going $\overline{\text{hold off}}$ pulse. The divide-by-2 output from U250B is coupled to Hold Off Output Amplifier Q272 and Q274. A HI level saturates Q272 and blocks the $\overline{\text{hold off}}$ signal from buffer Q262-Q264; a LO level allows the $\overline{\text{hold off}}$ signal to pass to the Hold Off Output Amplifier. Therefore, a hold off pulse is generated on every other $\overline{\text{hold off}}$ pulse from U220, pin 10.

When operating in the Independent or Delay Time modes, the LO level from Q546 (diagram 5) forward biases CR248, which switches the set input (pin 10) of U250B LO. As a result, pin 7 switches LO and releases the hold off thorough buffer Q262-Q264 to the Hold Off Output Amplifier. Then, a hold off pulse is generated with every $\overline{\text{hold off}}$ pulse.

Hold Off Output Amplifier

The Hold Off Output Amplifier inverts and amplifies the $\overline{\text{hold off}}$ signal from the Hold Off Generator for use by the mainframe.

Transistor Q272 inverts the $\overline{\text{hold off}}$ signal from Q264 to provide a HI level when hold off is present. The inverted signal is coupled through emitter follower Q274 to interface connector B4.

Delay Pickoff Inhibit

The Delay Pickoff Inhibit stage provides an inhibit level to disable the delay pickoff comparator (diagram 5) of the delayed sweep not being displayed (two delayed sweep traces are produced by a delayed companion time base when operating in the Δ Time mode). When the 7B85 is set to INDEPENDENT, both delay pickoff comparators are inhibited. When the 7B85 is set for Delay Time operation (TRACE SEP control set to OFF detent), the Second Delay Pickoff Comparator (diagram 5) is inhibited. During Δ Time operation, the First and Second Delay Pickoff Comparators (diagram 5) are alternately inhibited.

A HI level from the Hold Off Generator turns on Q252 and turns off Q254, which results in a LO level at P33, pin 3 and a HI level at P33, pin 2. A LO level turns off Q252 and turns on Q254, which results in a HI level at P33, pin 3 and a LO level at P33, pin 2. A LO pickoff-inhibit level (P33, pins 2 and 3) disables the appropriate delay time comparator (diagram 5). Refer to the timing diagram in Fig. 3-6.

Delay Mode Control

The Delay Mode Control stage determines whether delayed companion time-base unit operates in the B Starts After Delay or Triggerable After Delay modes. The delay mode information is coupled from S205 to the delayed companion time-base unit through interface connector B2.

In either delay mode, Q282 is turned on to provide a force readout level to the mainframe through interface connector A35. Force readout enables display in the A Horizontal compartment of a mainframe with two horizontal compartments even though the A Horizontal compartment has not been selected for display. This provides delay-time readout in the delaying sweep applications where only the B Horizontal unit is displayed.

When Q282 is on, Q288 is turned off to provide a HI level thorugh CR288 to interface connector A37. The HI level disables the channel 1 readout in the A Horizontal compartment (top of graticule) when only the B Horizontal compartment has been selected for display.

Auxiliary Y-Axis Generator

The Auxiliary Y-Axis Generator provides vertical trace separation to the mainframe when operating in the Δ Time mode (3 trace display). Information from interface connector B7 indicates which trace (delaying or delayed sweep trace) is displayed by the mainframe. Information from U250, pin 6 of the Hold Off Generator stage indicates which delayed sweep trace is displayed. The Auxiliary Y-Axis Generator processes the sweep mode information and supplies the appropriate positioning current to interface connector B16. Also, Auxiliary Y-Axis information for dual-beam mainframes is supplied at interface connector B14.

During the delaying sweep trace (intensified trace), Q292 turns off, Q294 turns on, and CR293 is reverse biased. As a result, a fixed positioning current is provided to interface connector B16 by R292 and the +15 V supply.

During the delayed sweep traces, Q292 is saturated and Q294 is turned off. Diode CR292 is reverse biased to block positioning current from R292 and the +15 V supply.

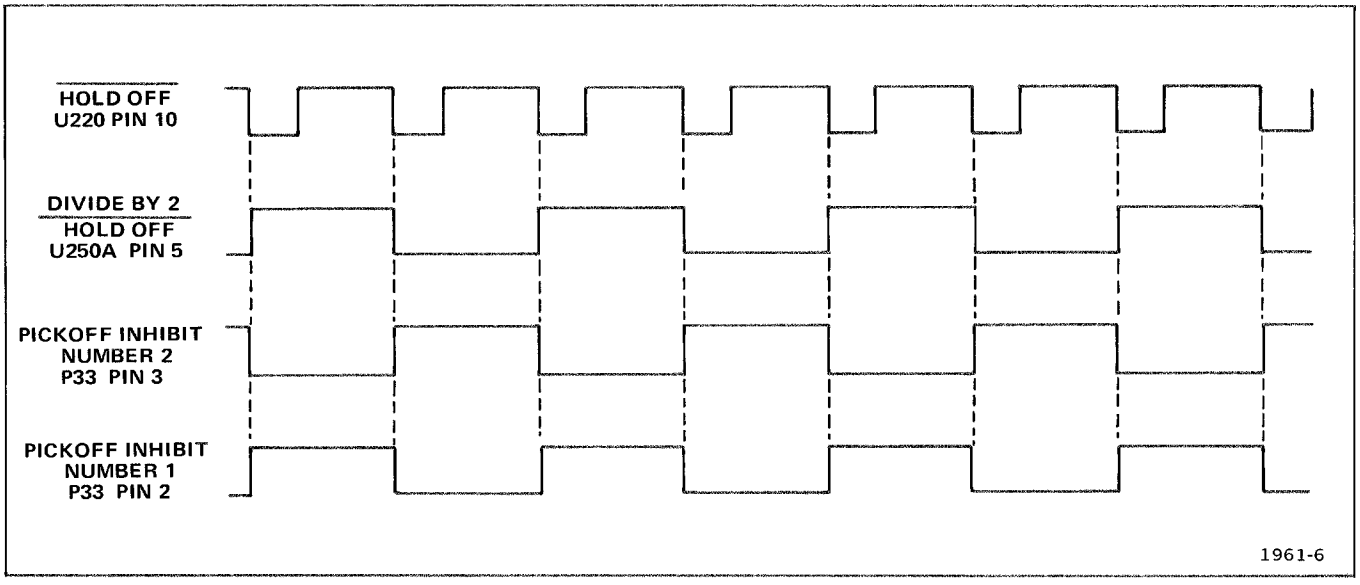


Fig. 3-6. Timing diagram for Delay Pckoff Inhibit stage.

Therefore, positioning is determined by U250A, pin 6 of the Hold Off Generator stage. The first delayed sweep trace is the reference trace and does not require vertical positioning. Therefore, the HI level from U250A, pin 6 reverse biases CR293 and block positioning current. However, during the second delayed sweep trace, the LO level from U250A reverse biases CR295 and opens the variable positioning current path from TRACE SEP control R295, through R294 and CR293 to interface connector B16.

SWEEP GENERATOR ◇4

The Sweep Generator produces a linear ramp waveform for the mainframe when gated by the Trigger Generator. The sweep trace is displayed either independently or as the intensified sweep (when used with a companion delayed timebase unit) of an alternate display. The sweep ramp is also used as a time reference for the delay pickoff comparators (diagram 5). A sweep gate (unblanking) is also generated in this circuit block.

The linear sweep ramp waveform is produced by charging a capacitor from a constant current source. The slope of the ramp determines the sweep rate of the displayed trace. A block diagram of the Sweep Generator is shown in Fig. 3-7.

Timing Current Source

The Timing Current Source stages generate a constant current for the Ramp Generator stages (see Fig. 3-7).

A Reference Voltage Source is established by the +50 volt supply and R710, R711, R717, and R705 (front-panel SWP CAL adjustment).

The reference voltage is applied to the Source Current Generator stage. Operational amplifier U722 provides unity voltage gain and low output impedance. The output of U722 is connected through the base-emitter junction of Q732 to the Timing Resistors (R741 through R749). Timing current is the result of the voltage drop across the Timing Resistors and flows through the collector of Q732 to the Ramp Generator stages.

Ramp Generator

The Ramp Generator stages produce a linear positive-going ramp for the Output Preamplifier and Sweep Gate Generator stages, and for delay pickoff in the Logic circuit (diagram 5). Refer to Fig. 3-7.

Upon the arrival of a HI-level sweep start gate at the Current Switch stage, Q322 turns on and Q324 turns off. The source current from Q732 charges the Timing Capacitors (C3332, C334, C336) in a positive ramp. Field effect transistors Q334A, Q334B, and transistsor Q338 form a unity-gain Ramp Voltage Follower for the sweep ramp. The output of Q338 is connected to the Horizontal Preamplifier, Sweep Stop Comparator, and Baseline Stabilizer stages.

When the sweep start is LO, Q322 turns off and Q324 turns on causing the Timing Capacitors (C332, C334, and C336) to discharge. The Baseline Stabilizer stage (Q304, Q314) maintains a constant level from which the ramp begins. The output of Q338 is compared (by way of Q304A) with the reference level at the base of Q304B. If the output of Q338 is less than the reference, Q314 will charge the timing capacitors through CR323 until the output and reference voltages are equal. If the output of Q338 is greater than the reference, Q314 conducts more and CR323 conducts more and CR323 conducts less, causing the Timing Capacitors to discharge through Q324 and R322. When the output and reference voltages are equal, the current through CR323 and Q732 equal the current through Q324.

Output Preamplifier

The Output Preamplifier stages connect the differential sweep signal to the mainframe and provide an offset voltage for trace positioning. Provisions are made in these stages for sweep magnification, and a negative-going sawtooth signal is supplied to the mainframe for sawtooth output and special plug-in unit functions. Refer to Fig. 3-7.

Q424 and Q434 form a single-ended to push-pull converter with Q428 and Q438 as current follower stages for the push-pull signal. Output drivers Q448 and Q458 provide final smplification and connect the sweep signal to the mainframe.

The MAG switch, S435, increases the Horizontal Preamplifier gain ten times by connecting R431 and R430 in parallel with R442.

The Position Voltage Source stage combines the dc voltages of the FINE and POSITION controls for a position voltage level at the output of operational amplifier U416. This voltage level on the base of Q434 provides a ramp waveform offset voltage to horizontally position the displayed trace.

The Auxiliary Sweep Preamplifier stage provides a negative-going sweep ramp to the mainframe (via interface con-

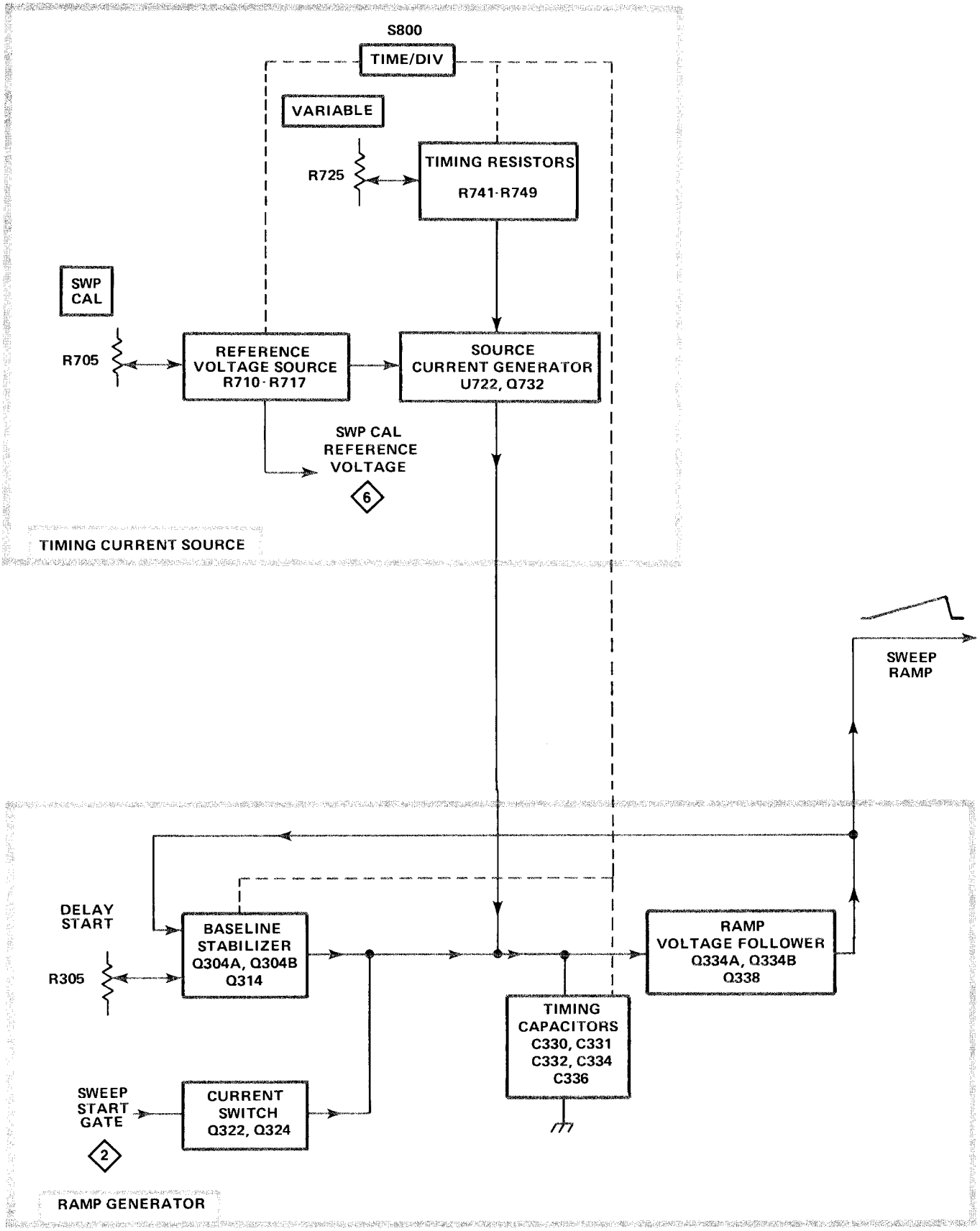


Fig. 3-7. Detailed block diagram of Sweep Generator.

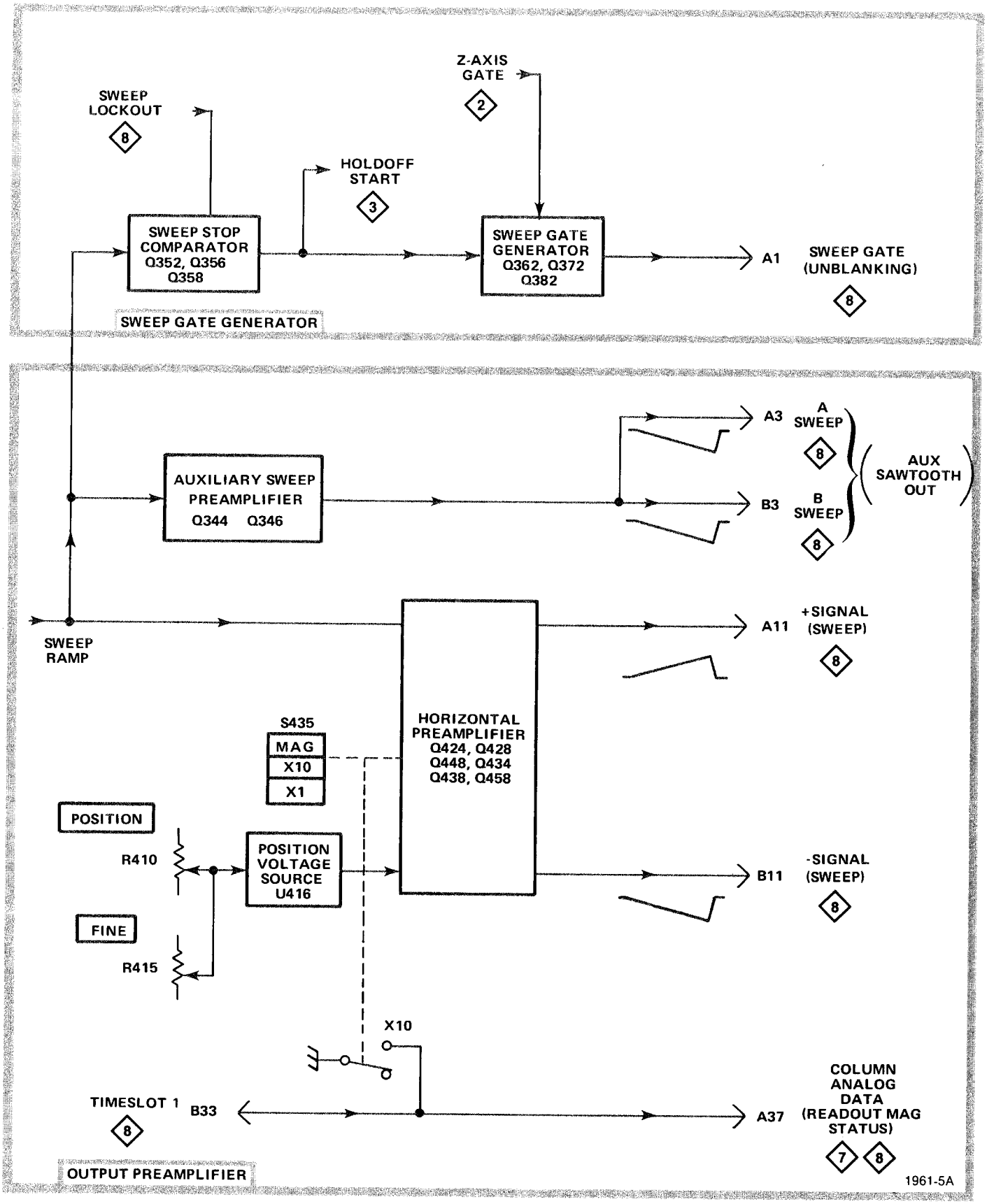


Fig. 3-7. Detailed block diagram of Sweep Generator (cont.).

nector pins A3 and B3) for sawtooth output and special plug-in unit functions. Transistors Q344 and Q346 form a unity-gain inverting amplifier for the sawtooth signal from the Ramp Voltage Follower stage. Diode CR344 provides emitter-base compensation.

Sweep Gate Generator

The Sweep Gate Generator produces an unblanking gate for the Z-axis system of the mainframe. When the sweep is displayed, the crt is unblanked (gate level LO). The sweep is blanked (gate level HI) between sweeps. Refer to Fig. 3-7.

The sweep ramp is applied to the Sweep Stop Comparator stage. A comparison voltage is set at the base of Q356. When the ramp voltage exceeds the comparison voltage, Q352 turns off and Q356 couples a HI level through common-base transistor Q358. The Sweep Stop Comparator output is coupled to the Sweep Gate Generator stage and to the Logic circuit (diagram 3) to initiate hold-off.

The Z-axis gate from the Trigger Generator circuit (diagram 2) is LO at the start of the sweep. This LO level turns off Q372. The resultant HI-level sweep gate pulse at the collector of Q372 is coupled through emitter follower Q382 to the mainframe for sweep unblanking. At the end of the sweep, the HI level from the Sweep Stop Comparator stage turns Q362 off and Q372 on. The resultant LO is coupled through emitter follower Q382 to the mainframe for sweep blanking.

PICKOFF AMPLIFIERS AND DELAY GATE GENERATOR ◇5◇

The Pickoff Amplifiers and Delay Gate Generator circuits determines the first and second delay times and generate the delay gate that allows the delayed sweep of the companion time-base unit to run. Calibrated dc voltages are supplied to the Digital Voltmeter circuit (diagram 6) to provide delay time and Δ time crt readout. A block diagram of the Pick-off Amplifiers and Delay Gate Generator circuits is shown in Fig. 3-8.

Delay Time Comparison (SN B088750 & Up)

DELAY TIME control R520 determines the delay time before the start of the first delayed sweep trace and the associated intensified zone. The delay-time voltage, selected by R520, is coupled through unity gain buffer amplifier U530B to the delay comparison voltage switch stage (Q592) and to the delay time pickoff comparator (Q512B and Q522B).

When the sweep ramp voltage at the base of Q522B exceeds the delay-time voltage at the base of Q512B, the comparator switches (Q522B turns off and Q512B turns on). The resultant LO level at the base of Q562 initiates the delay gate, which allows the delayed sweep of the companion time-base unit to run (refer to Delay Gate Generator discussion).

The current source for the delay time pickoff comparator (Q512B and Q522B) is provided by Q518. A LO level from the Logic circuits (diagram 3) at P3-3 turns off Q518 and disables the comparator. The delay time pickoff comparator (Q512B and Q522B) is then inhibited during the time that the second delayed sweep trace (Δ Time mode) is displayed.

Delay Time Comparison (SN B088749 & Below)

DELAY TIME control R520 determines the delay time before the start of the first delayed sweep trace and the associated intensified zone. The delay-time voltage, selected by R520, is coupled through unity gain buffer amplifier U530B to the Delay Comparison Voltage Switch stage (Q592) and to the First Delay Pickoff Comparator (Q512).

When the sweep ramp voltage at the base of Q512A exceeds the delay time voltage at the base of Q512B, the comparator switches (Q512A turns off and Q5121B turns on). The resultant LO level at the base of Q562 initiates the delay gate, which allows the delayed sweep of the companion time-base unit to run (refer to Delay Gate Generator discussion).

The current source for the First Delay Pickoff Comparator (Q512) is provided by Q518. A LO level from the Logic circuits (diagram 3) at P3-3 turns of Q518 and disables comparator Q512. The First Delay Pickoff Comparator (Q512) is then inhibited during the time that the second delayed sweep trace (Δ Time mode) is displayed.

Δ Time Comparison (SN B088750 & Up)

Δ Time control R530 determines the amount of delay time from the start of the first intensified zone and corresponding delayed sweep display, to start the second intensified zone and corresponding delayed sweep display (Δ Time operation only). The Δ TIME control also supplies a dc level, which corresponds to the differential time from the start of the first intensified zone to the start of the second intensified zone, through Q592 to the Digital Voltmeter circuit (diagram 6). Refer to the Delay Time and Δ Time Reference Voltage Sources discussion.

The voltage levels from the DELAY TIME control R520 and Δ TIME control R530 are added in the delay summing amplifier U556. The summed voltage levels are coupled to the Δ time pickoff comparator stage, Q522, to determine the delay time before the start of the second delayed sweep trace.

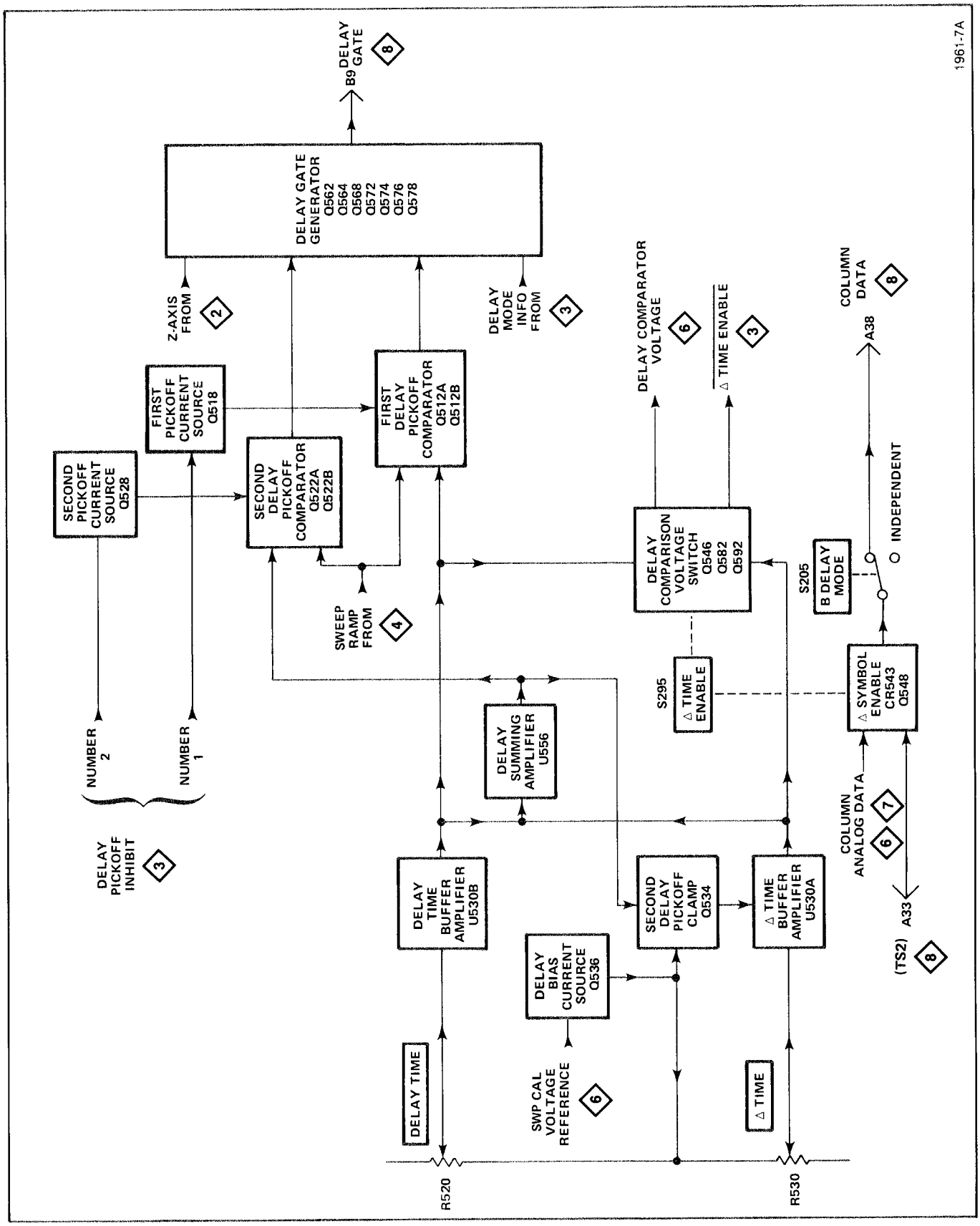


Fig. 3-8. Detailed block diagram of Pickoff Amplifiers and Delay Gate Generator.

When the sweep ramp at the base of Q522A exceeds the Δ time voltage at the base of Q512A, the comparator switches (Q522A turns off and Q512A turns on). The collectors of Q522A falls LO and initiates the delay gate, which allows the second delayed sweep of the companion time-base unit to run (refer to Delay Gate Generator discussion).

The current source for the Δ time pickoff comparator (Q512A and Q522A) is provided by Q528. A LO level from the Logic circuits at P3-2 turns off Q528 and disables this comparator. The Δ time pickoff comparator (Q512A and Q522A) is inhibited during the time that the first delayed sweep trace is displayed (Δ Time mode).

Δ Time Comparison (SN B088749 & Below)

Δ TIME control R530 determines the amount of delay time from the start of the first intensified zone and corresponding delayed sweep display, to the start of the second intensified zone and corresponding delayed sweep display (Δ Time operation only). The Δ TIME control also supplies a dc level, which corresponds to the differential time from the start of the first intensified zone to the start of the second intensified zone, through Q592 to the Digital Voltmeter circuit (diagram 6). Refer to the Delay Comparison Voltage Switch discussion.

The voltage levels from DELAY TIME control R520 and Δ TIME control R530 are added in the Delay Summing Amplifier U556. The summed voltage levels are coupled to the Second Delay Pickoff Comparator Stage Q522 to determine the delay time before the start of the second delayed sweep trace.

When the sweep ramp at the base of Q522A exceeds the Δ time voltage at the base of Q522B, the comparator switches (Q522A turns off and Q522B turns on). The collector of Q522A falls LO and initiates the delay gate, which allows the second delayed sweep of the companion time-base unit to run (refer to Delay Gate Generator discussion).

The current source for the Second Delay Pickoff Comparator (Q522) is provided by Q528. A LO level from the Logic circuits at P3-2 turns off Q528 and disables comparator Q522. The Second Delay Pickoff Comparator (Q522) is inhibited during the time that the first delayed sweep trace is displayed (Δ Time mode).

Delay Bias and Second Delay Pickoff Clamp

Bias for delay-time controls R520 and R530 is provided by Q536 and associated circuitry. Base current into Q536, and consequently delay-time bias at the junction of R537 and R533, changes with respect to the front-panel SWP CAL adjustment. The SWP CAL reference voltage is also coupled to the Reference Current Souce stage (Digital Voltmeter circuit, diagram 6) in an amount proportional to the change in delay bias and the resultant delay comparison voltage. As a result, a change in the SWP CAL adjustment does not affect the delay time readout.

Transistor Q534 senses the output of Delay Summing Amplifier U556 and limits the comparison voltage at Q512A, SN B088750 & up (Q522A, SN B088749 & below) to a level equivalent to approximately 10 div of delay time. Transistor Q534 turns on and reduces the Δ time voltage output from U530A and thereby limits the second delay pickoff to approximately 10 div. The voltage at which Q534 turns on can be varied by Second Pickoff Bias adjustment R535.

Delay Comparison Voltage Switch

Delay Time or Δ Time voltage is coupled through the Delay Comparison Voltage Switch to the Digital Voltmeter circuit (diagram 6), where voltage is converted for delay time readout.

When operating in the DELAY TIME mode, S295 couples a HI level to the base of Q546 and to the gate of Q592. Transistor Q546 turns on; the resultant LO at its collector turns of Q582. Field-effect transistor Q592 then turns on and couples the delay time comparison voltage to the Digital Voltmeter circuit (diagram 6).

In Δ time operation, S295 is open, and a LO level is coupled to the base of Q546 and to the gate of Q592. Field-effect transistor Q592 and transistor Q546 turn off. The resultant HI at the collector of Q546 turns on Q582 and couples the Δ Time comparison voltage to the Digital Voltmeter circuit (diagram 6).

Delay Gate Generator

The Delay Gate Generator produces a square-wave delay gate signal on command of the First and Second Delay Pickoff Comparators. The delay gate signal controls the delayed sweep of the delayed companion time-base unit.

At the time of delay pickoff of either the First (Q512) or Second (Q522) Delay Pickoff Comparator, transistor A turns off and transistor B turns on. The base of emitter follower Q562 then falls LO, as does the input to Schmitt trigger Q564, Q568 (base of Q564). Transistor Q564 turns off and Q568 turns on, thereby increasing the current through R572, Q574, and R574. The collector of Q574 falls and the LO level is coupled through emitter follower Q578 to interface connector B9. The LO level enables the sweep of the delayed companion time-base unit.

Transistor Q572 disables the Delay Gate Generator until the Z-axis circuits are ready for the sweep to run. A HI level at the base of Q572 turns on the transistor and diverts current from Q574, which inhibits the companion time-base unit sweep (delay gate HI).

When B DELAY MODE switch S280 is set to INDEPENDENT, a LO level at the base of Q578 holds the delay gate LO and allows the companion time base to run independently.

Δ Symbol Enable

The Δ Symbol Enable stage senses Δ time operation and sets the readout row and column output current necessary to enable the Δ symbol.

During Delay Time operation, the HI level from S295 turns Q548 on; its emitter rises and reverse biases CR543. Column current is thus blocked from interface connector A38, thereby disabling the Δ symbol.

During Δ time operation, S295 is open and the LO level through R547 holds Q548 off. A −15 V pulse, during time-slot 2, at interface connector A33 provides approximately 0.9 mA column current through R543 and approximately 0.1 mA row current through R542. This enables the Δ symbol via interface connectors A38 and B38. At time slots other than time-slot 2, the −15 V pulse is not present at interface connector A33.

DIGITAL VOLTMETER 6

The Digital Voltmeter circuit converts the Delay Comparison Voltage, determined by the DELAY TIME and Δ TIME front-panel controls, to an accurate time measurement that is displayed on the crt by the mainframe readout system. The schematic for the Digital Voltmeter circuit is given in the diagrams section of this manual. A detailed block diagram of the Digital Voltmeter circuit is shown in Fig. 3-9.

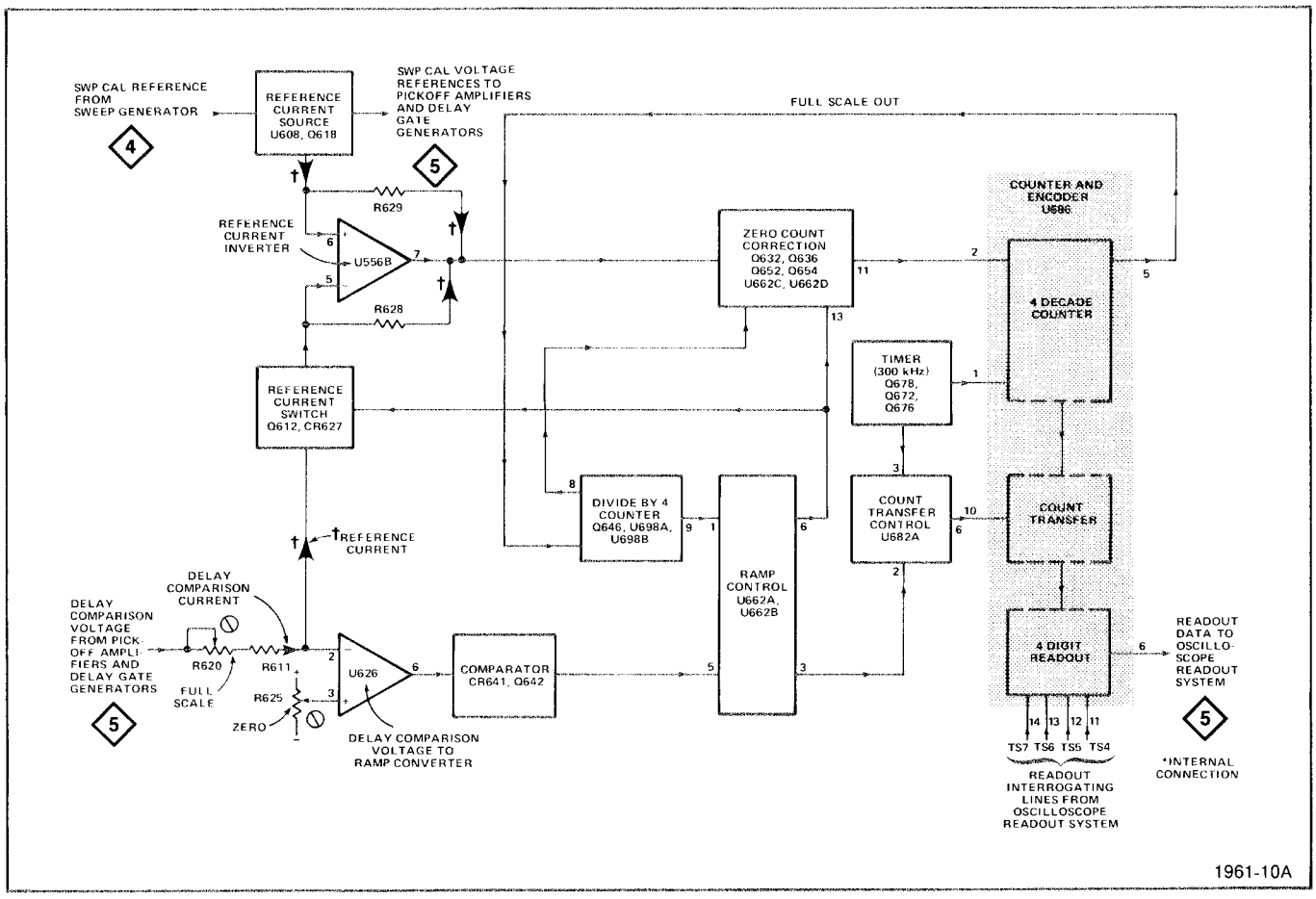


Fig. 3-9. Digital Voltmeter detailed block diagram (SN B088749 & below).

Delay Comparison Voltage to Ramp Converter (SN B088750 & Up)

The Delay Comparison Voltage to Ramp Converter stage develops a positive- and negative-going ramp (see Fig. 3-10, anode of CR641 waveform). Integrated circuit U626 is connected as a Miller integrator. The current that flows through R621 and R622 (delay comparison current, determined by the DELAY TIME and Δ TIMIE front-panel controls) causes the voltage at pin 6 of U626 to go negative. The rate at which this can occur is limited by the charging of C627. The result is a negative-going ramp with a slope proportional to the delay comparison voltage. Consequently, the more positive the delay comparison voltage, the more negative the ramp will run.

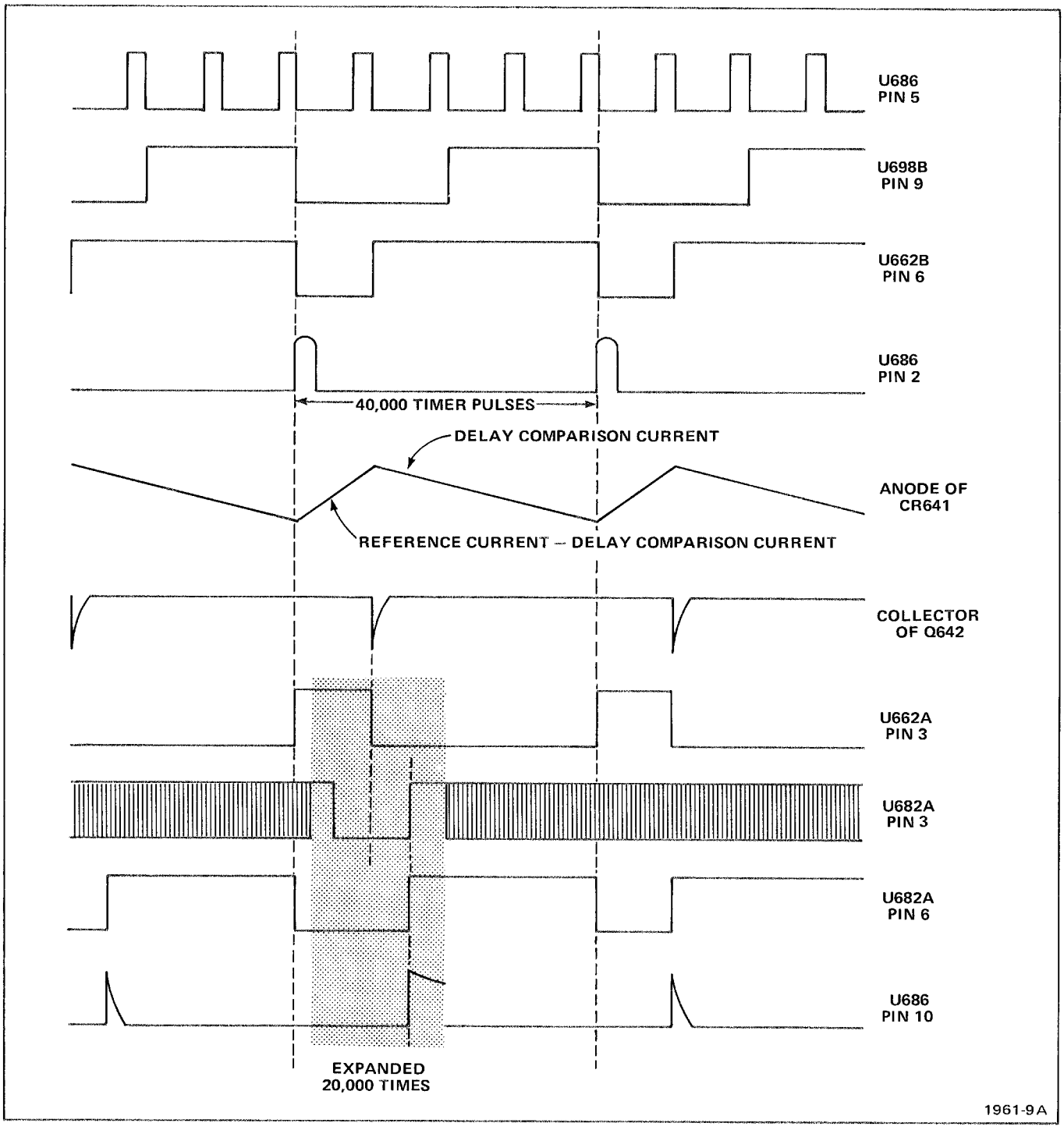


Fig. 3-10. Digital Voltmeter timing diagram.

After a period of time (determined by U686), diode CR632 turns on and adds reference current to the delay comparison current. This reference current polarity is opposite to the delay comparison current and is always at least 10 times greater. Therefore, the output of U626 becomes a positive-going ramp. When the positive-going ramp reaches approximately 7 V, the Comparator stage switches and the Ramp control turns off CR632. The output of U626 becomes a negative-going ramp, completing the cycle.

The DVM Zero adjustment, R625, provides a dc offset current to set the quiescent operating level of the Delay Comparison Voltage to Ramp Converter. DVM Gain adjustment R620 allows for calibration of the delay comparison current.

Delay Comparison Voltage to Ramp Converter (SN B088749 & Below)

The Delay Comparison Voltage to Ramp Conerter stage develops a positive- and negative-going ramp (see Fig. 3-10, anode of CR631 waveform). Integrated circuit U626 is connected as a Miller integrator. The current that flows through R620 and R621 (delay comparison current, determined by the DELAY TIME and Δ TIME front-panel controls) causes the voltage at pin 6 of U626 to go negative. The rate at which this can occur is limited by the charging of C627. The result is a negative-going ramp with a slope proportional to the delay comparison voltage. Consequently, the more positive the delay comparison voltage, the more negative the ramp will run.

After a period of time (determined by the Ramp Control stage), the Reference Current Switch turns on and adds reference current to the delay comparison current. The reference current polarity is opposite to the delay comparison current and is always at least four times greater. Therefore, the output of U626 becomes a positive-going ramp. When the positive-going ramp reaches approximately 1.2 volts, the Comparator stage switches and the Ramp Control turns off the Reference Current Switch. Now that the reference current no longer overrides the delay comparison current, the ramp output of U626 goes negative, completing the cycle.

DVM Zero adjustment R625 provides a dc offset current to set the quiescent operating level of the Delay Comparison Voltage to Ramp Converter. DVM Gain adjustment R620 allows for calibration of the delay comparison current.

Comparator (SN B088750 & Up)

The Comparator circuitry drives the comparator input of U686. When the output of U626 rises to approximately 7 V, CR643 becomes forward biased, which turns on Q644. Components U654B, U654D, and R654 provide rapid latchup of the positive-going signal from Q644. Integrated circuit U654C inverts this signal, which causes pin 8 of U686 to go low. A low is then generated at pin 16; the ramp control output of U686. This ramp control signal is used for reference current switching.

Comparator (SN B088749 & Below)

The Comparator stage provides one of two inputs to the Ramp Control stage (see Fig. 3-10, collector of Q642 waveform). The Comparator switches when the positive-going ramp from U626 reaches approximately 1.2 volts. The collector of Q642 goes LO, which sets pin 6 of U662B HI and turns Q612 of the Reference Current Switch on. When Q612 turns on, CR627 turns on and causes the ramp at pin 6 of U626 to run positive.

Ramp Control

The Ramp Control stage operates as an RS flip-flop. This stage controls the Zero Count Correction, Count Transfer Control, and Delay Comparison Voltage to Ramp Converter stages by way of the Reference Current Switch.

When the output of the Comparator goes negative (see Fig. 3-10, collector of Q641 waveform), pin 6 of U662B goes HI. This turns off the Reference Current Switch stage and actuates the Zero Count Correction stage. When the Reference Current Switch turns off, the Delay Comparison Voltage to Ramp Converter output begins to run negative, and continues to do so until the output of the Ramp Control goes LO. At this time, the ramp output of the Delay Comparison Voltage to Ramp Converter will go positive until the output of the Ramp Control again goes HI. The period of a positive-going and a negative-going waveform at pin 6 of U626 is determined by the output of the Divide by 4 Counter stage. The output of the Divide by 4 Counter is applied to the Ramp Control stage and switches the output at pin 6 of U662B to the LO state.

Divide by 4 Counter

Integrated circuit U698 is connected as a Divide by 4 Counter. Transistor Q646 operates as a buffer for the Divide by 4 Counter. Dc blocking capacitor C645 couples the full scale out pulses from pin 5 of U686 to Q646. Each full scale out pulse represents 10,000 Timer stage output pulses. Therefore, the output of the Divide by 4 Counter changes states once for every 20,000 Timer pulses.

Timer

The Timer stage produces a 300 kHz signal. Transistors Q672 and Q676 are connected as a multivibrator. Buffer Q678 provides drive to the Count Transfer Control stage.

The collector of Q672 delivers Timer pulses to the 4 Decade Counter stage (pin 1 of U686).

Reference Current Source (SN B088750 & Up)

The Reference Current Source determines the amount of current to be used for comparison with the delay comparison current. The front-panel SWP CAL control determines the absolute value of reference current. The swp cal reference input, on pin 1 of J100, changes the reference current value to compensate for different front-panel SWP CAL settings.

Reference Current Source (SN B088749 & Below)

The Reference Current Source determines the amount of current to be used for comparison with the delay comparison current. The front-panel TIME/DIV switch and SWP CAL control determine the absolute value of reference current. The setting of R605, in series with R606, determines the reference current when the TIME/DIV switch is set to a sweep rate where the numeral 1 is the scaling factor (such as 0.1, 1, or 10). Parallel combinations of R605, R606, R618, and R607 determine the reference current value for numerals 2 and 5. The swp cal reference input, on pin 1of J100, changes the reference current value to compensate for different front-panel SWP CAL settings.

Reference Current Inverter (SN B088750 & Up)

The Reference Current Inverter acts as a current "mirror" to produce an equivalent current in opposite polarity. Thus, current flowing through R631 is reversed in direction as it flows through R632. Reversing current flow direction allows U626 to sum the reference current with the delay comparison current.

Reference current switching is controlled by the ramp control output of U686. A high on pin 16 of U686 causes a low at U654's output, which reverse biases CR634. This forward biases CR632 allowing reference current to flow into the summing node at pin 2 of U626. A low at pin 16 of U686 causes CR634 to forward bias turning off CR632, which routes the reference current away from the summing node at U626.

Reference Current Inverter (SN B088749 & Below)

The Reference Current Inverter changes the direction of current flow through R628, 180° from the direction of the current through R629. Reversing current flow direction allows the Delay Comparison Voltage to Ramp Converter stage to sum the reference current with the delay comparison current.

Reference Current Switch

The Reference Current Switch is controlled by the Ramp Control stage. A HI on pin 6 of U662B causes Q612 to conduct, routing the reference current to ground. A LO on pin 6 of U662B causes Q612 to turn off, routing the reference current through CR627 to the negative input of U626.

Counter and Encoder (SN B088750 & Up)

The Counter and Encoder integrated circuit consists basically of a 4 Decade Counter with multiplexer and associated circuitry.

An integration cycle of 100,000 counts begins with the ramp control (pin 16) going high and the start of a short internal delay. During the delay, the counters are cleared and set to their initial state. After the delay, the counters are enabled and count until a transition occurs on the comparison input (pin 8) signaling that the counters contain the desired digital output that is a direct function of the unknown input current. At this point clock pulses to the counters are disabled, the ramp control is set low, and the contents of the counter are latched. The counter then resumes operation.

Each decade counter counts synchronously with data read out by sequentially strobing the four column-select lines, pins 3, 4, 5, and 6. The output appears at pin 18 as a current that varies from 0 mA to 1 mA in 100 μA steps.

Integrated circuit U686 uses S800 cam switch control voltages at pins 10 and 11 for accurate 1, 2, and 5 sweep speed scaling. The presence of voltages at pins 10 and/or 11 allows the IC to determine if it should be dividing by 2 or 5. An absence of voltage at both pins is interpreted as divide by one.

Counter and Encoder (SN B088749 & Below)

The Counter and Encoder integrated circuit consists of 3 logic stages. The 4 Decade Counter, Count Transfer and 4 Digit Readout stages are discussed in the following paragraphs.

4 Decade Counter. The 4 Decade Counter counts the pulses from the Timer stage on a continuing basis, starting at 0000 and running through 9,999. Each time the count reaches 9,999, a full scale out pulse occurs at pin 5 of U686. After 4 of these pulses occur, the Divide by 4 Counter sets pin 6 of U662B LO (Ramp Control stage). Then, the Delay Comparison Voltage to Ramp Converter output goes positive until the positive-going ramp reaches 1.2 V. At this time, the count reached in the 4 Decade Counter is transferred to the 4 Digit Readout stage (within U686).

Count Transfer. The Count Transfer stage transfers the count reached in the 4 Decade Counter (during the time the Delay Comparison Voltage to Ramp Converter output runs positive) to the 4 Digit Readout stage. The Count Transfer Control stage actuates the Count Transfer stage (through pin 10 of U686) when the Comparator switches and a Timer pulse occurs.

4 Digit Readout. After the count from the 4 Decade Counter is transferred to the 4 Digit Readout stage, the 4 Digit Readout stage formats the information. With the data properly formatted, the mainframe readout system can retrieve the information and display the measurement, made by the Digital Voltmeter circuit, on the crt.

Count Transfer Control

The Count Transfer Control stage provides a count transfer pulse to pin 10 of U686. When pin 2 of U682A is LO, the positive transition of the clock pulse at pin 3, produces a HI output at pin 6 of U682A. The transition to the HI state actuates the Count Transfer stage, within U686, to transfer the count from the 4 Decade Counter stage to the 4 Digit Readout stage.

Zero Count Correction

The Zero Count Correction stage delays the start of the 4 Decade Counter stage, within U686, by a fixed amount of time. This allows small offsets in the Digital Voltmeter circuit to be compensated during adjustment.

When pin 6 of U662B goes LO, C662 couples the negative transition to pin 13 of U662D to set pin 11 of U662D HI. This HI is then coupled to pin 2 of U686 by C683 to inhibit the 4 Decade Counter stage, until pin 2 goes LO again.

At the same time that pin 6 of U662B went LO, pin 8 of U698B went HI to turn Q636 off and allow C652 to discharge through Q632. Capacitor C652 discharges until the comparator, consisting of Q652 and U662D, goes LO on pin 11 of U662D and pulls pin 2 of U686 LO, which allows the 4 Decade Counter stage to continue counting.

TIME/DIVISION AND READOUT SWITCHING ◇7

The Readout Switching circuits provide sweep rate and delay time information to the mainframe readout system. Readout circuitry is shown on the Time/Division and Readout Switching diagram (7) at the rear of this manual.

Basic Readout System

The readout system in 7000-series mainframes provides alphanumeric display of information encoded by the plug-in units. This display is presented on the crt, and is written by the crt beam on a time-shared basis with the analog waveform display.

The readout system produces a pulse train consisting of ten negative-going pulses called time slots. Each pulse represents a possible character in a readout word, and is assigned a time-slot number corresponding to its position in the word. Each time-slot pulse is directed to one of ten output lines, labeled TS 1 through TS 10 (time slots one through ten), which are connected to the vertical and horizontal plug-in compartments. Two output lines, row and column, are connected from each channel (two channels per plug-in compartment) back to the readout system.

Data is encoded on these output lines either by connecting resistors between them and the time-slot input lines or by generating equivalent currents. The resultant output is a sequence of analog current levels on the row and column output lines. The row and column curent levels are decoded by the readout system to address a character matrix during each time slot, thus selecting a character to be displayed or a special instruction to be followed.

Time/Division Readout

Time/Division readout is displayed on channel 1 (top of the graticule) corresponding to the plug-in compartment in which the time-base unit is installed. The sweep rate is selected by TIME/DIV switch S800, which also selects the resistors that determine the various readout characters shown in Table 3-2.

Delay Time Readout

Both delay-time readout (delay time before the start of the first intensified zone) and Δ time readout (differential delay time between the start of the first intensified zone and the start of the second intensified zone) are displayed on channel 2 (bottom of the graticule) corresponding to the plug-in compartment in which the 7B85 is operating. Delay time is selected by DELAY TIME control R520 and differential delay time is selected by Δ TIME control R530, as explained in the Pickoff Amplifiers and delay Gate Generator description (diagram 5).

The resistors that control the various delay time readout functions are shown in the channel 2 portions of Table 3-2. Numerical scaling for delay time readout (0, 1, 2, 3, etc.) is explained in the Digital Voltmeter description (diagram 6). Origin of the Δ readout symbol is explained in the Logic discussion (diagram 3).

INTERFACE CONNECTORS AND POWER SUPPLY ◇8◇

The Interface Connectors provide interconnection for control signals and power supply voltages between the mainframe and the time-base unit.

The Power Supply derives supply voltages from the mainframe supplies for power requirements unique to this instrument. Additional voltage regulation is also provided.

Table 3-2
READOUT CHARACTER SELECTION

Characters	Time Slot	Description	Encoded By	
			Channel 1 (Time/Division)	Channel 2 (Delay Time)
Decimal	TS-1	Determines decimal magnitude (number of zeros displayed or prefix change information).	R751,R752 R756	R753,R754 R755,R757
Uncalibrated (>)	TS-3	Indicates calibrated or uncalibrated sweep rates and delay times.	R761,R764	S280 R762,R763
1,2,5	TS-4	Scaling (TIME/DIV).	R771 R772,R773	
0 through 9	TS-4, TS-5, TS-6, TS-7	Scaling (Delay Time).		U686 ◇6◇
m,μ,n	TS-8	Defines the prefix that modifies the units of measurement.	R781,R782 R783,R784	R785,R786 R787
s(seconds)	TS-9	Defines the unit of measurement.	R793,R794	R791,R792
Δ	TS-2	Indicates differential delay-time measurement.		R542, R543 ◇5◇

MAINTENANCE

This section of the manual contains information for performing preventive maintenance, troubleshooting, and corrective maintenance for this instrument.

PREVENTIVE MAINTENANCE

Preventive maintenance consists of cleaning, visual inspection, lubrication, etc. Preventive maintenance performed on a regular basis may prevent instrument breakdown and will improve the realiability of the instrument. The severity of the environment to which this instrument is subjucted determines the frequency of mainternace. A convenient time to perform preventive manitenance is preceding adjustment of the instrument.

CLEANING

This instrument should be cleaned as often as operating conditions require. Accumulation of dirt on components acts as an insulating blanket and prevents efficient heat dissipation, which can cause overheating and component breakdown.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. In particular, avoid chemicals that contain benzene, toluene, xylene, acetone, or similar solvents.

Exterior

Loose dust accumulated on the front panel can be removed with a soft cloth or small brush. Dirt that remains can be removed with a soft cloth dampened with a mild detergent and water solution. Abrasive cleaners should not be used.

Interior

Dust in the interior of the instrument should be removed occasionally due to its electrical conductivity under high-humidity conditions. The best way to clean the interior is to blow off the accumulated dust with dry, low-pressure air. Remove any remaining dirt with a soft brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces.

Switch Contacts

Switch contacts and pads are designed to operate dry for the life of the switch. However, as the switches are not sealed, dust attracted to the contact area may cause switch contacts to become electrically noisy. Cleaning may be accomplished by flushing the contact area with isopropl alcohol or kelite (one part kelite to 20 parts water). Do not use chemical cleaning agents that leave a film or that might damage plastic parts. Do not use cotton swabs or similar applicators to apply cleaning agents, as they tend to snag and leave strands of cotton on switch contacts. Should it become necessary to remove a switch for replacement or cleaning, refer to Component Removal and Replacement in theis section.

VISUAL INSPECTION

This instrument should be inspected occcasionally for such defects as broken connections, improperly seated semiconductors, damaged circuit boards, and heat-damaged parts.

The corrective procedure for most visible defects is obvious; however, particular care must be taken if heat-damaged components are found. Overheating usually indicates other trouble in the instrument; therefore, it is important that the cause of overheating be corrected to prevent recurrence of the damage.

LUBRICATION

Generally, there are no components in this instrument that require a regular lubrication program during the life of the instrument.

Cam Switch Lubrication

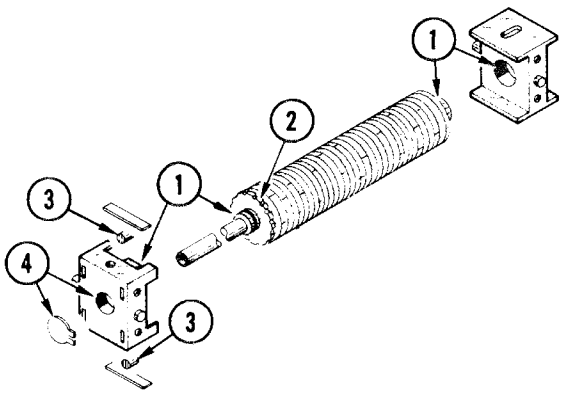
In most cases, factory lubrication should be adequate for the life of the instrument. However, if the switch has been disassembled for replacement of switch sub-parts, a lubrication kit containing the necessary lubricating materials and instructions is available through any Tektronix Field Office. Order Tektronix Part No. 003-0342-02. General Electric Versi-lube® silicone grease should be applied sparingly so that the lubricant does not get on the contacts. Refer to Fig. 4-1 for lubrication instructions.

SEMICONDUCTOR CHECKS

Periodic checks of the semiconductory in this instrument are not recommended. The best check of semiconductor performance is actual operation in the instrument. More details on checking semiconductor operation are given under Troubleshooting.

ADJUSTMENT AFTER REPAIR

After any electrical component has been replaced, the adjustment of that particular circuit should be checked, as well as the adjustment of other closely related circuits. The Performance Check and Adjustment procedure in this manual provides a quick and convenient means of checking instrument operation. In some cases, minor troubles may be revealed or corrected by adjustment.



(1) Apply lubricant to the drum journals and mating surface in the mounting bearings.

(2) Apply lubricant to the wear surface of the index wheel.

(3) Apply lubricant to the index roller and roller guide in the front bearing. A thin film should be applied to the inner face of the detent springs if more than one spring is replaced.

(4) Ensure that some lubricant is present at the interface between the bearing and retainer clip.

C1967-2

Fig. 4-1. Lubrication procedure for a typical cam switch.

TROUBLESHOOTING

The following information is provided to help troubleshoot this instrument. Information contained in other sections of this manual should be used along with the following information to aid in locating the defective component. An understanding of the circuit operation is very helpful in locating troubles, particularly where integrated circuits are used.

TROUBLESHOOTING AIDS

Diagrams

Circuit diagrams are given on foldout pages in Section 8. The component number and electrical value of each component in this instrument are shown on the diagrams. Components that are mounted on circuit boards are out-lined one the diagrams with a heavy black line.

Voltages and Waveforms

Typical operating voltages are shown on the diagrams. Voltage Conditions given on the diagram page indicate the test equipment used and the front-panel control status necessary to obtain the given voltages.

Typical operating waveforms are shown next to the diagram where they were measured. Each waveform is numbered to locate on the diagram the point where the waveform was taken. Waveform Conditions given on the diagram page list the test equipment used and the front-panel control status necessary to obtain the given waveform.

Circuit-Board Illustrations

Circuit-board illustrations are shown on the foldout page preceding the associated diagram. Each board-mounted electrical component is identified by its circuit number, as are interconnecting wires and connectors.

Figure 8-2, in the front of the diagrams section, shows the location and assembly mumber of each circuit board in this instrument.

Switch Cam Identification

Switch cam numbers shown on diagrams indicate the position of each cam in the complete switch assembly. The switch cams are numbered from front to rear.

Diode Color Code

The cathode end of each glass-encased diode is indicated by a stripe, a series of stripes, or a dot. The cathode and anode ends of metal-encased diodes are indentified by the diode symbol marked on the case. For most silicon or germanium diodes with a series of stripes, the color code identifies the four significant digits of the JEDEC or vendor number using the resistor color-code system (e.g., a diode color-coded yellow-brown-green-red indicates a 1N-4152 diode).

Wiring Color Code

Insulated wire and cable used in this instrument is color-coded to facilitate circuit tracing.

Semiconductor Basing

Figure 4-2 illustrates the basing configurations for all semiconductors used in this instrument. Some plastic-case transistors have lead configurations that do not agree with those shown here. If a replacement transistor is made by a different manufacturer than the original, check the manufactur's basing diagram. All transistor sockets in this instrument are wired for the standard basing used for metal-case transistors.

Inter-Board Pin Connector Identification

The inter-board pin connector sockets are installed on circuit boards, in groups of five sockets (as in Fig. 4-3). Socket number 1 is indexed on the circuit board with either a triangular mark or the number 1. Each group of sockets is identified by its J (jack) number etched on the circuit board. The J numbers correlate to the J (jack) and P (plug) circuit numbers on the schematic diagrams.

Multi-Pin Connector Identification

Multi-pin connectors mate with groups of pins soldered to circuit boards. Pin number 1 is indexed with a triangular mark on the circuit board and molded on the holder of the multi-pin connector, as shown in Fig. 4-4. Each group of pins is identified by its corresponding J number etched on the circuit board. The J numbers on the circuit boards correlate to the J and P component numbers on the schematic diagrams.

Interface Connector Pin Locations

The Interface circuit board couples the plug-in unit to the associated mainframe (oscilloscope). Figure 4-5 identifies the pins on the interface connector as shown on Power

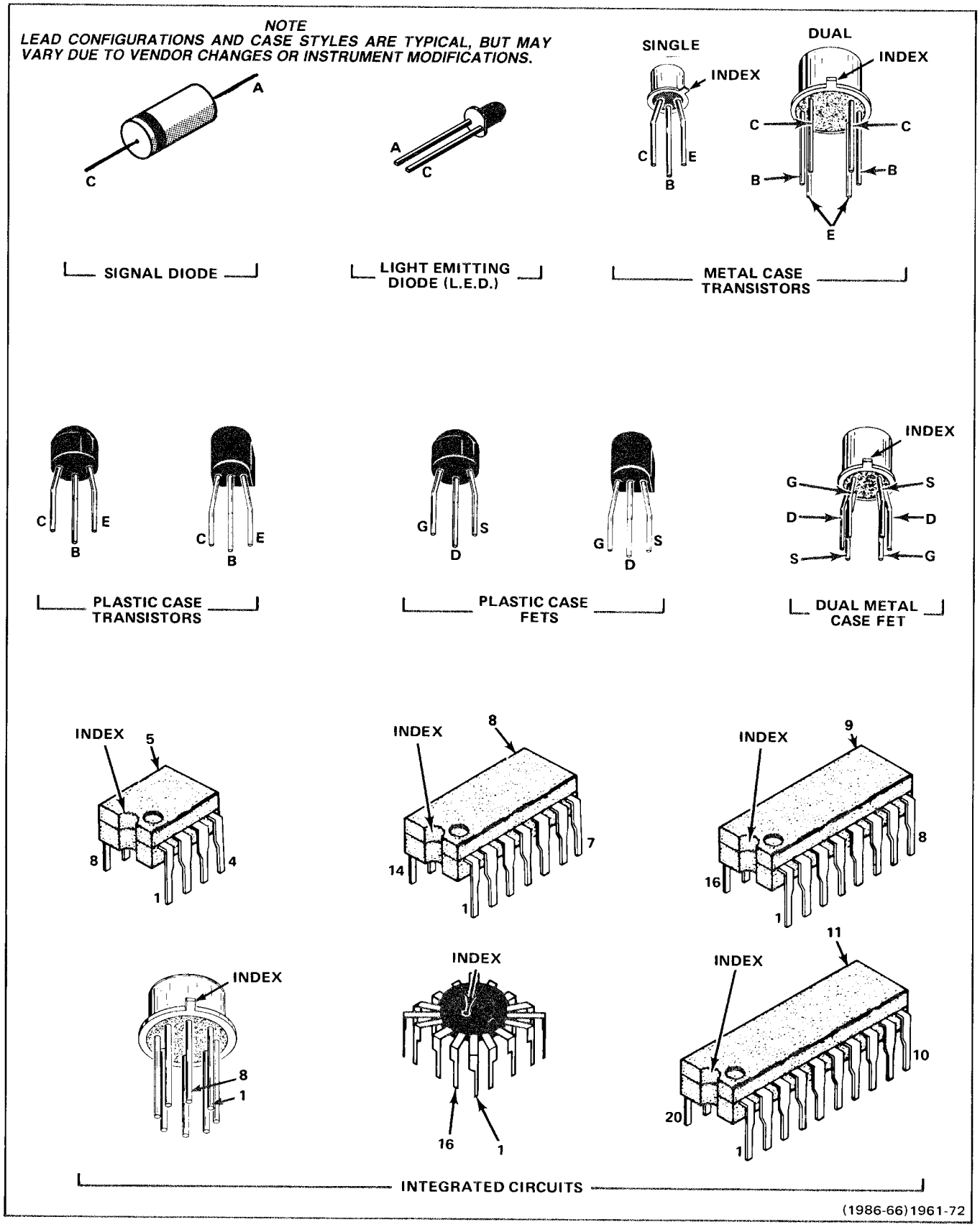


Fig. 4-2. Semiconductor lead configuration.

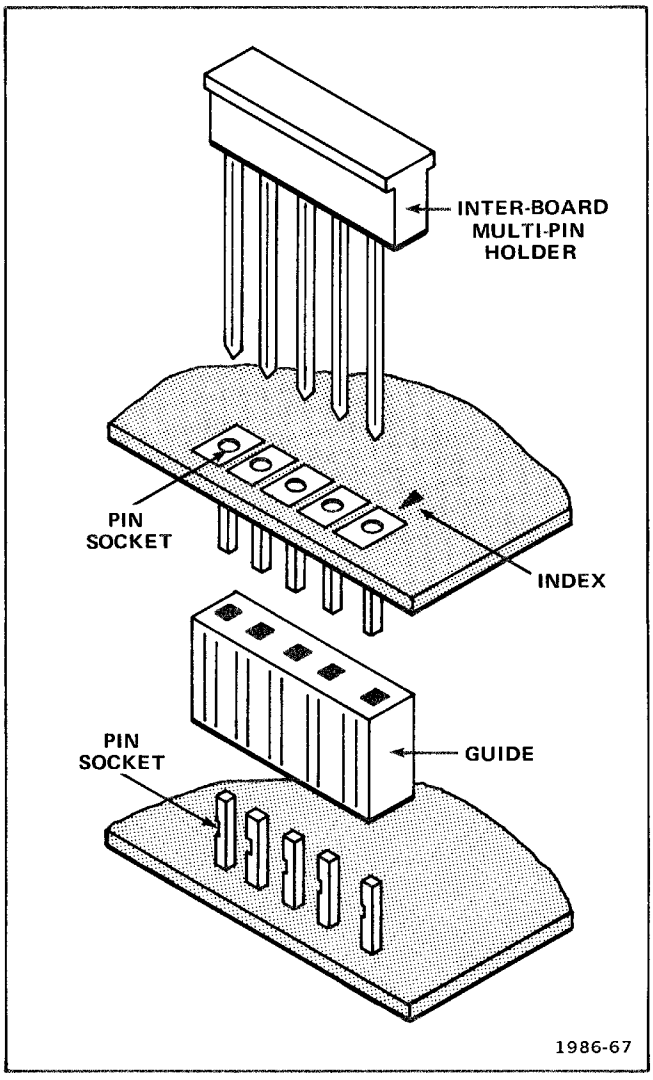


Fig. 4-3. Inter-board multi-pin connector assembly.

Supply, and Interface Connectors diagram 8 in the Diagrams section.

Performance Check and Adjustment

The Performance Check and Adjustment procedure, given in Section 5 of this manual, provides a quick and convenient means of checking instrument operation. In some cases, minor troubles may be revealed or corrected by adjustment.

TROUBLESHOOTING EQUIPMENT

The following equipment, in addition to that listed in the Performance Check and Adjustment section, is useful for troubleshooting.

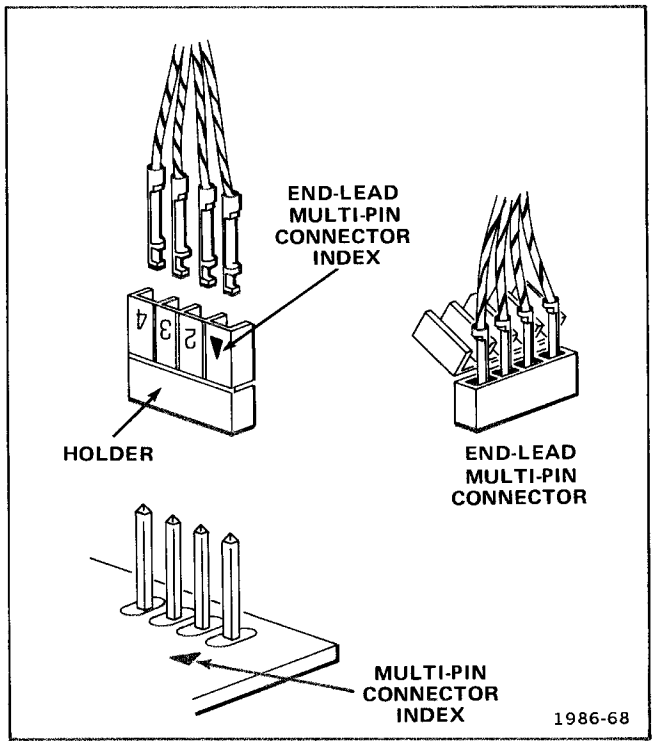


Fig. 4-4. End-lead multi-pin connector assembly.

Transistor Tester

Description: Dynamic-type tester.

Purpose: Test semiconductors.

Recommended Tektronix types: 576 Curve Tracer, 577/177 Curve Tracer system, 7CTIN Curve Tracer unit and a 7000-Series oscilloscope system, or a 5CTIN Curve Tracer unit and a 5000-Series oscilloscope.

Multimeter

Description: Voltmeter, 10 MΩ input impedance and a range from 0 to at least 50 Vdc; accuracy, within 0.1% Ohmmeter, 0 to 20 MΩ. Test probes should be insulated to prevent accidental shorting.

Purpose: Check voltage and resistance.

Test Oscilloscope

Description: Frequency response, dc to 100 MHz minimum; deflection factor, 5 mV to 5 V/div. A 10×,10 MΩ voltage probe should be used to reduce circuit loading.

Purpose: Check operating waveforms.

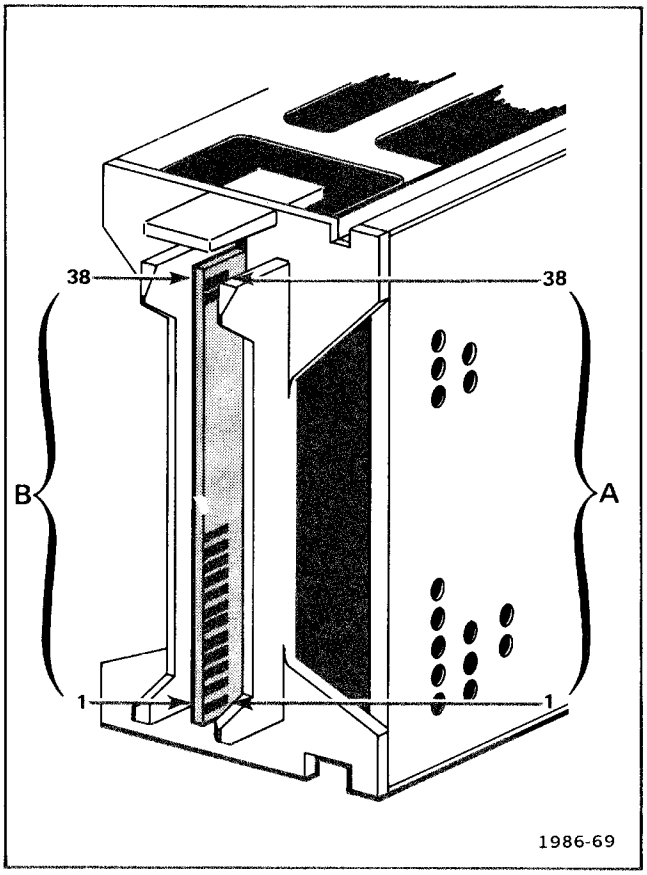


Fig. 4-5. Location of pin numbers on Interface connector.

TROUBLESHOOTING TECHNIQUES

The following troubleshooting procedure is arranged to check the simple trouble possibilities before proceeding with extensive troubleshooting. The first few checks ensure proper connection, operation, and adjustment. If the trouble is not located by these checks, the remaing steps aid in locating the defective component. When the defective component is located, it should be replaced using the replacement procedure given under Corrective Maintenance.

Troubleshooting Procedure

1. Check Control Settings

Incorrect control settings can indicate a trouble that does not exist. If there is any question about the correct function or operation of any control, see the Operating Instruction Section 2.

2. Check Associated Equipment

Before troubleshooting, check that the equipment used with this instrument is operating correctly. Check that the signal is properly connected and that the interconnecting cables are not defective. Also, check the power source. If the trouble persists, the time-base unit is probably at fault.

3. Visual Check

Visually check the portion of the instrument in which the trouble is located. Many troubles can be located by visible indications such as unsoldered connections, broken wires, damaged circuit boards, damaged components, etc.

4. Check Instrument Adjustment

Check the adjustment of this instrument, or the affected circuit if the trouble appears in one circuit. The apparent trouble may be the result of misadjustment. Complete adjustment instructions are given in the Performance Check and Adjustment, Section 5.

5. Isolate Trouble To a Circuit

To isolate trouble to a circuit, note the trouble symptom. The symptom often identifies the circuit in which the trouble is located. When trouble symptoms appear in more than one circuit, check the affected circuits by taking voltage and waveform readings. Incorrect operation of all circuits often indicates trouble in the power supply. Check first for correct voltages of the individual supplies. However, a defective component elsewhere in the instrument can appear as a power-supply trouble and may also affect the operation of other circuits.

Figure 4-6 provides a guide for locating a defective circuit. Start at the top of the chart and perform the checks given on the left side of the page until a step is found that does not produce the indicated results. Further checks, or the circuit in which the trouble is probably located, are listed to the right of the step. The shaded blocks on the Troubleshooting Chart indicate circuit(s) listed in shaded blocks are discussed in detail in the Theory of Operation section of this manual. This chart does not include checks for all possible defects; use steps 6 and 7 in such cases.

After the defective circuit has been located, proceed with steps 6 and 7 to locate the defective component(s).

6. Check Voltages and Waveforms

Often the defective component can be located by checking for the correct voltages and waveforms in the circuit. Refer to the diagram section at the rear of this manual for typical voltages and waveforms.

NOTE

Voltages and waveforms given on the diagrams are not absolute and may vary slightly between instruments. To obtain operating conditions similar to those used to take these readings, see the voltage and waveforms page adjacent to each schematic diagram. Note the recommended test equipment, front-panel control settings, voltage and waveform conditions, and test equipment cable connection instructions.

7. Check Individual Components

The following procedures describe methods for checking individual components. Two-lead components that are soldered in place are best checked by first disconnecting one end. This isolates the measurement from the effects of surrounding circuitry.

CAUTION

To avoid component damage, disconnect the power source before removing or replacing semiconductors.

Transistor. The best check of transistor operation is actual performance under operating conditions. A transistor can be most effectively checked by substituting a new component or one that has been checked previously. However, be sure that circuit conditions are such that a replacement transistor might also be damaged. If substitute transistors are not available, use a dynamic tester. Static-type testers are not recommended, since they do not check operation under simulated operating conditions.

Integrated Circuits. IC's can be checked with a voltmeter, test oscilloscope, or by direct substitution. A good understanding of circuit operation is desirable when troubleshooting circuits using IC's. Use care when checking voltages and waveforms around the IC's so that adjacent leads are not shorted together. A convenient means of clipping a test probe to the 14- and 16-pin IC's is with an IC clip. This device also serves as an extraction tool. The lead configuration for the semiconductors used in this instrument are shown on a pullout page in the front of the diagrams section.

CAUTION

Do not use an ohmmeter scale that has a high internal current. High currents may damage the diode.

Diodes. A diode can be checked for an open or shorted condition by measuring the resistance between terminals with an ohmmeter scale having a low internal source current, such as the R×1K scale. The resistance should be very high in one direction and very low when the meter leads are reversed.

The cathode end of each glass-encased diode is indicated by a stripe, a series of stripes, or a dot. The cathode and anode ends of metal-encased diodes are identified by the diode symbol marked on the case. For most silicon or germanium diodes with a series of stripes, the color code identifies the four significant digits of the JEDC or vendor number using the resistor color-code system (e.g., a diode color coded yellow-brown-green-red indicates a 1N-4152 diode).

Resistors. Check resistors with an ohmmeter. See the Replaceable Electrical Parts list for the tolerance of the resistors used in this instrument. Resistors normally do not need to be replaced unless the measured value varies widely from that specified.

Inductors. Check for open inductors by checking continuity with an ohmmeter. Shorted or partially shorted inductors can usually be found by checking the waveform response when high-frequency signals are passed through the circuit. Partial shorting often reduces high-frequency response.

Capacitors. A leaky or shorted capacitor can usually be detected by checking resistance with an ohmmeter on the highest scale. Do not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open capacitor can best be detected with a capacitance meter or by checking that the capacitor passes ac signals.

8. Repair and Adjustment.

If any defective parts are located, follow the replacement procedures given in Corrective Maintenance. Be sure to check the performance of any circuit that has been repaired or had any electrical components replaced.

TROUBLESHOOTING CHART INSTRUCTIONS:

1. Proceed down the left side of chart until the instrument does not perform as indicated. Then proceed to the right as the symptom(s) indicates.

2. Follow the path(s) of symptoms until a shaded block is reached. The shaded block indicates the circuit(s) that may cause instrument malfunction. Refer to the Theory of Operation section for a detailed discussion of the circuit(s).

NOTE

The upper case titles in shaded blocks are the same titles as used in the Theory of Operation section and on tabs in the diagrams section.

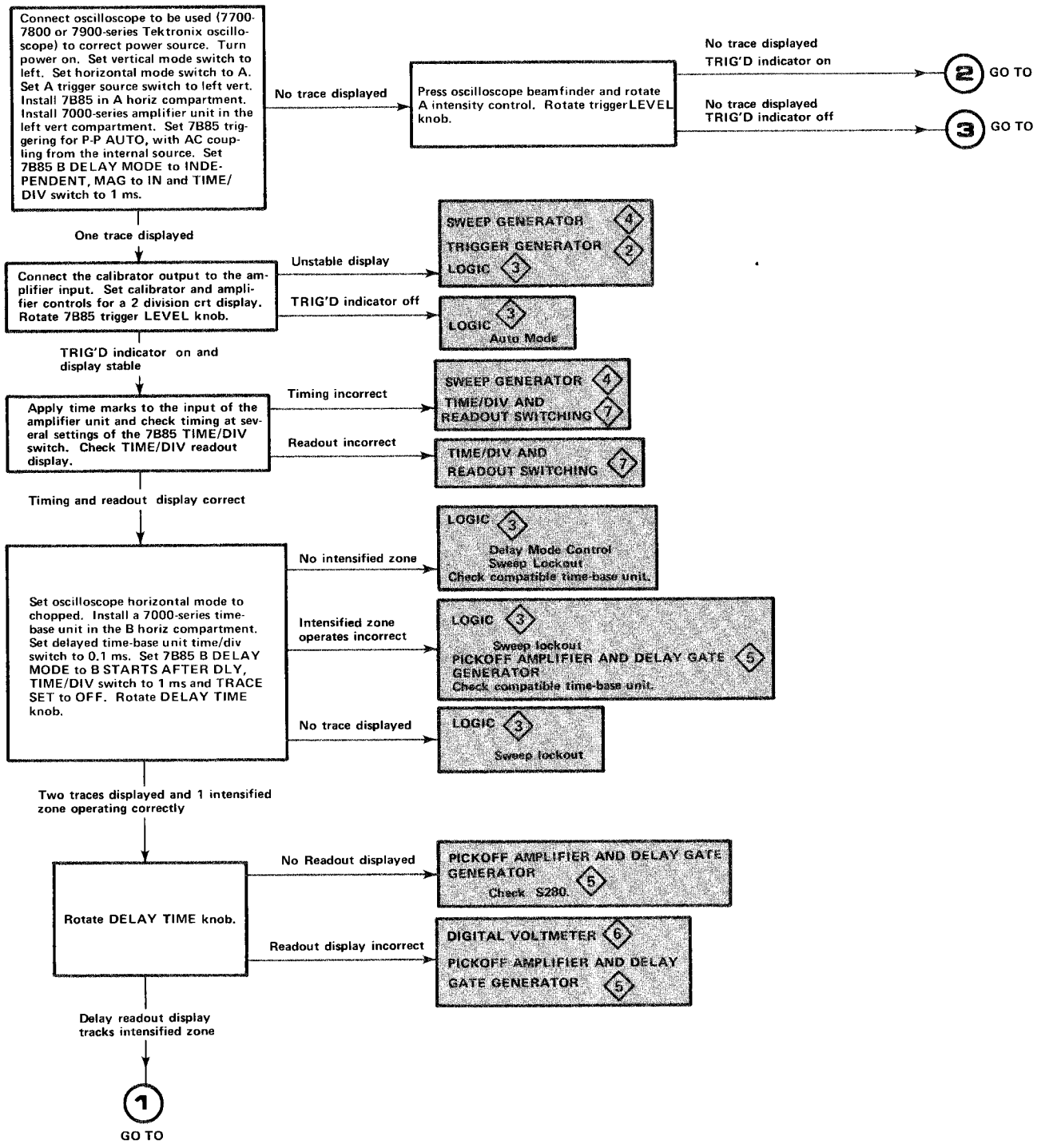


Fig. 4-6. 7B85 troubleshooting chart.

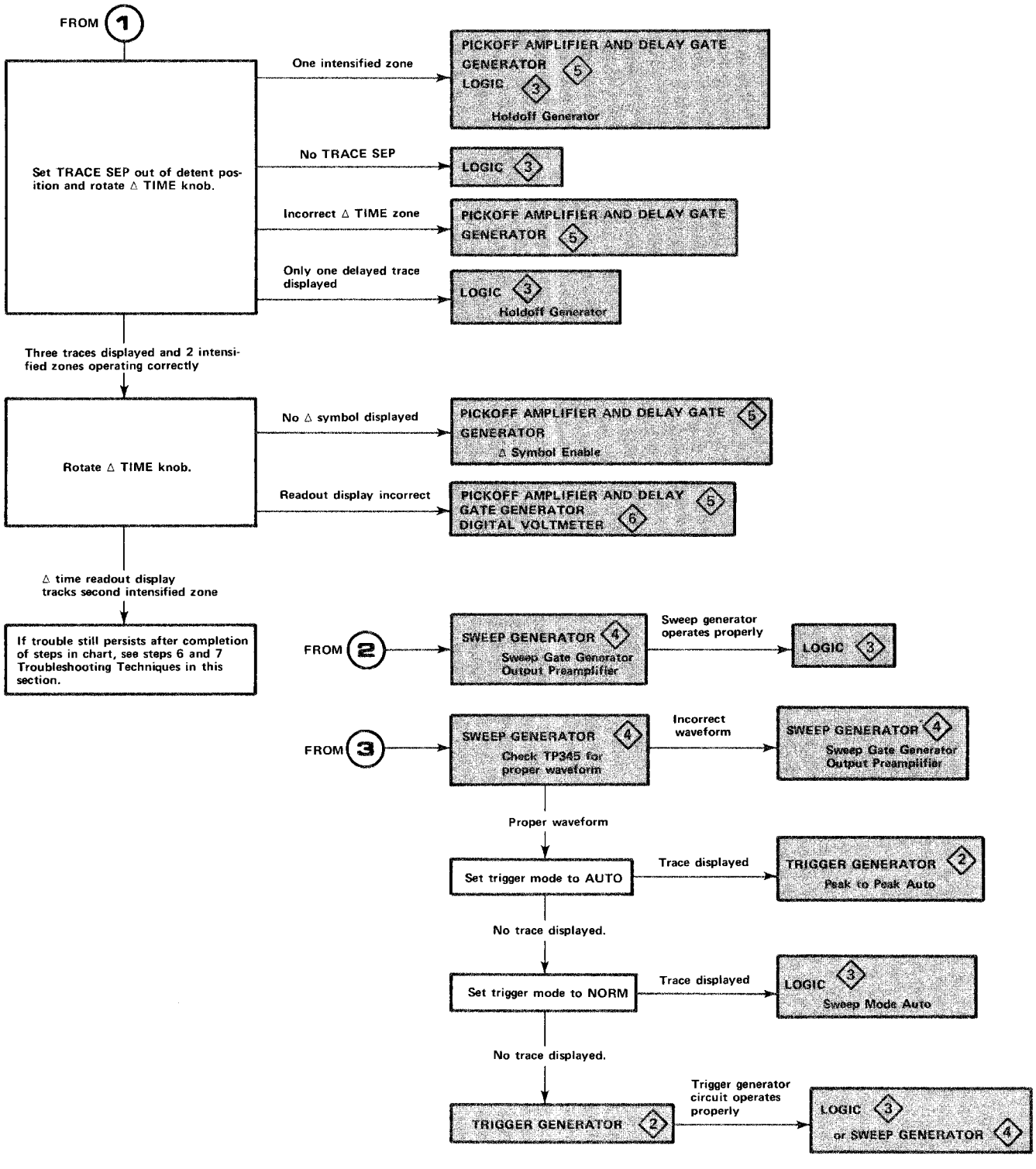


Fig. 4-6. 7B85 troubleshooting chart (cont.).

CORRECTIVE MAINTENANCE

Corrective maintenance consists of component replacement and instrument repair. Special techniques required to replace components in this instrument are given here.

OBTAINING REPLACEMENT PARTS

All electrical and mechanical part replacements can be obtained through your Tektronix Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating and description.

NOTE

When selecting replacement parts, remember that the physical size and shape of a component may affect the performance of the instrument, particularly at high frequencies. All parts should be direct replacements unless a different component will not adversely affect instrument performance.

Some parts are manufactured or selected by Tektronix, Inc, to satisfy particular requirements, or are manufactured to specifications for Tektronix, Inc. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. To determine the manufacturer of parts, refer to parts list, Cross Index Mfr. Code Number to Manufacturer.

When ordering replacement parts from Tektronix, Inc, include the following information:

1. Instrument type.

2. Instrument serial number.

3. A description of the part (if electrical, include circuit number).

4. Tektronix part number.

SOLDERING TECHNIQUES

WARNING

To avoid electrical shock, disconnect the instrument from the power source before soldering.

The reliability and accuracy of this instrument can be maintained only if proper soldering techniques are used when repairing or replacing parts. General soldering techniques, which apply to maintenance of any precision electronic equipment, should be used when working on this instrument. Use only 60/40 rosin-core, electronic-grade solder. The choice of soldering iron is determined by the repair to be made. When soldering on circuit boards, use a 15 to 40 W pencil-type soldering iron with a 1/8-inch wide, wedge-shaped tip. Keep the tip properly tinned for best heat transfer to the solder joint. A higher wattage soldering iron may separate the wiring from the base material. Avoid excessive heat; apply only enough heat to remove the component or to make a good solder joint. Also, apply only enough solder to make a firm solder joint; do not apply too much solder.

CAUTION

All circuit boards, except the readout circuit board, in this instrument are multilayer type boards with a conductive path(s) laminated between the top and bottom board layers. All soldering on these boards should be done with extreme care to prevent breaking the connections to the center conductor(s); only experienced maintenance personnel should attempt repair of these boards.

For metal terminals (e.g., switch terminals, potentiometers, etc.), a higher wattage-rating soldering iron may be required. Match the soldering iron to the work being done. For example, if the component is connected to the chassis or other large heat-radiating surface, it will require a 75 W or larger soldering iron.

The following techniques should be used to replace a component on a circuit board.

1. Grip the component lead with long-nose pliers. Touch the soldering iron to the lead at the solder connection. Do not lay the iron directly on the board, as it may damage the board.

2. When the solder begins to melt, gently pull the lead out. If unable to pull out the lead without using force, try removing the other end of the component as it may be more easily removed.

NOTE

The reason some component leads are troublesome to remove is due to a bend placed on each lead during the manufacturing process. The bent leads hold components in place during a process that solders many components at one time.

If a component lead is extremely difficult to remove, it may be helpful to straighten the leads on the back side of the board with a small screwdriver or pliers while heating the soldered connection.

Use only enough heat to remove the component lead without removing the solder from the board. If it is desired to remove solder from a circuit-board hole for easier installation of a new component, a solder-removing wick should be used.

3. Bend the leads of the new component to fit the holes in the board. If the component is replaced while the board is mounted in the instrument, cut the leads so they will just protrude through the board. Insert the leads into the holes so the component is firmly seated against the board (or as positioned originally). If it does not seat properly, heat the solder and gently press the component into place.

4. Touch the iron to the connection and apply a small amount of solder to make a firm solder joint. To protect heat-sensitive components, hold the lead between the component body and the solder joint with a pair of long-nose pliers or other heat sink.

5. Clip any excess lead protruding through the board (if not clipped in step 3).

6. Clean the area around the solder connection with a flux-removing solvent. Be careful not to remove information printed on the board.

COMPONENT REMOVAL AND REPLACEMENT

WARNING

To avoid electrical shock, disconnect the instrument from the power source before replacing components.

The exploded-view drawing associated with the Replaceable Mechanical Parts list may be helpful in the removal or disassembly of individual components or subassemblies. Component locations and circuit board locations are shown in the Diagrams section.

Circuit Boards

If a circuit board is damaged beyond repair, replace the entire board assembly. Part numbers for completely wired boards are given in the Replaceable Electrical Parts list.

A4-Digital Voltmeter Circuit Board.

To remove the circuit board; perform the following steps.

1. Remove two inter-board multi-pin connectors (see Fig. 4-3 for identification).

2. Note the color of the other multi-pin connectors and J number to which each is attached (see Fig. 4-4 for identification).

3. Disconnect all cables that terminate on the Digital Voltmeter board.

4. Remove three securing screws from circuit board; do not remove the three screws securing the metal shield to the bottom of the board.

5. Lift the rear of the circuit board away from the frame and slide it toward the rear until the board clears the B DELAY MODE switch.

To replace the circuit board, reverse the order of removal.

A3-Readout Circuit Board.

To remove the circuit board, follow the procedure given in Figure 4-7.

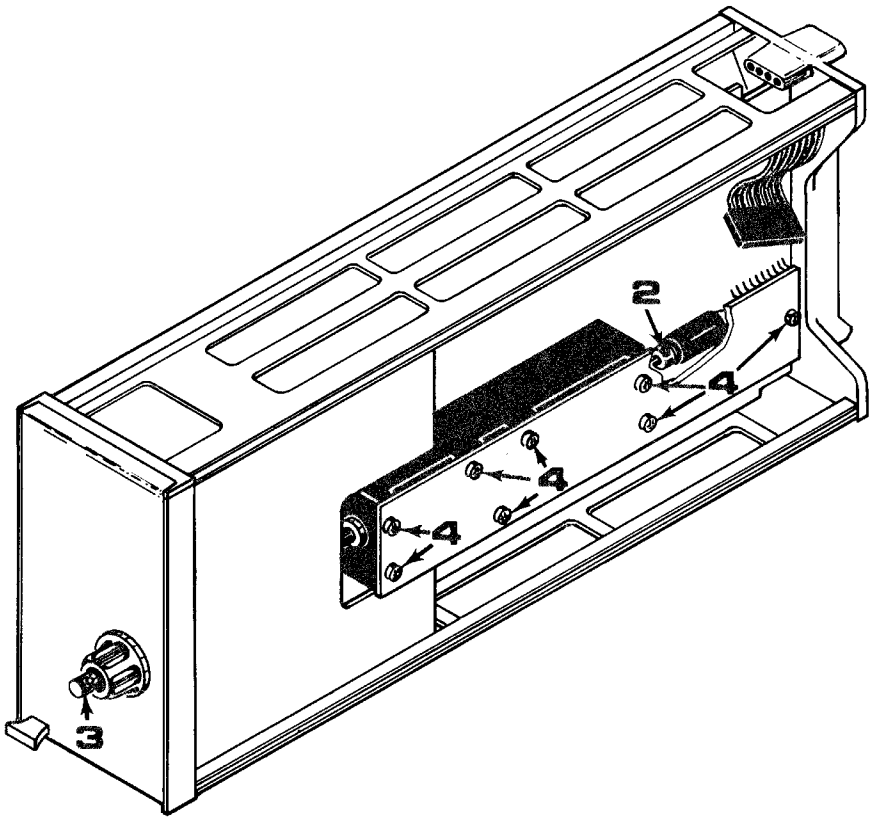
A2-Trigger Circuit Board.

Remove the circuit board; perform the following steps.

1. Remove three inner-board multi-pin connectors (see Fig. 4-3 for identification).

2. Remove the two screws from the circuit board.

3. Lift the rear of the circuit board away from the frame and slide the board to the rear until push-button switches are clear of the front panel.



REMOVE READOUT BOARD AS FOLLOWS:

1. Note index of multi-pin connector attached to board and disconnect cable.
2. Loosen set screw on variable switch assembly.
3. Remove VARIABLE (CAL IN) TIME/DIV knob and attached shaft out the front of the instrument.
4. Remove the 8 securing screws from board.
5. Lift board away from cam switch assembly.

TO REPLACE READOUT BOARD, REVERSE THE ORDER OF REMOVAL.

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Fig. 4-7. Readout board removal procedure.

4. Note the wire color on the single-conductor shielded cables (see Fig. 4-8 for identification) and the connector to which each is attached.

5. Disconnect the cables from the back of the circuit board.

To replace the circuit board, reverse the order of removal.

A1-Interface Circuit Board.

To remove the circuit board; perform the following steps.

1. Remove the trigger and digital Voltmeter circuit boards using procedure given previously.

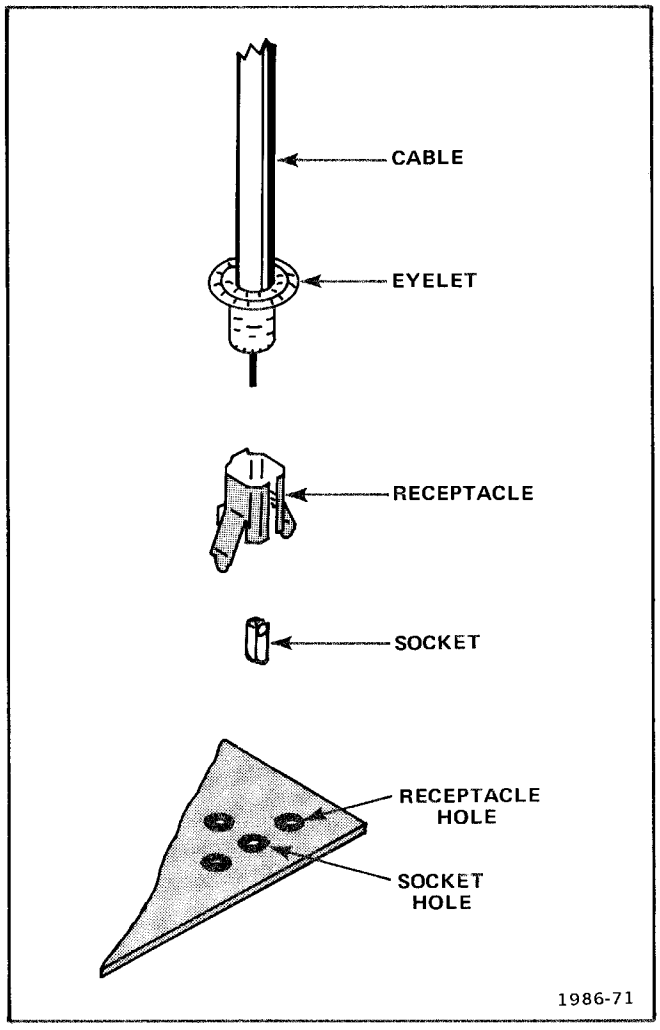


Fig. 4-8. Coaxial end-lead connector assembly.

2. Set the TIME/DIV knob to the 2 ms position and the VARIABLE TIME/DIV knob to expose the set screw.

3. With hex-key wrench, loosen the set screws in both knobs. Remove the knobs from the shafts.

4. Note the color of the multi-pin connectors (see Fig. 4-4 for identification) and P numbers to which each connected. Disconnect all multi-pin connectors from the board.

5. Remove the four screws that secure the gray plastic rear panel to the instrument frame.

6. Remove the six screws that secure the perimeter of the board to the instrument frame.

7. Remove the Interface circuit board through the rear of the instrument.

To install the Interface circuit board; perform the following steps.

1. Guide the TIME/DIV switch shaft through the hole in the front panel.

2. Install the six screws that secure the perimeter of the board to the instrument frame.

3. Install the gray plastic rear panel with the four securing screws.

4. Replace the TIME/DIV knob on the shaft. Align the knob index with the 2 ms position; then, tighten the two set screws on the knob.

5. Replace the VARIABLE knob and tighten the set screw.

6. Replace all cables as noted during the removal procedure.

7. Replace the Trigger and Digital Voltmeter circuit boards.

Switches

Two types of switches are used in this instrument. Contact alignment and spacing are critical to the operation of the push button and cam switches. Therefore, defective switches should either be replaced as a unit or repaired only by personnel experienced with these types of switches. Your local Tektronix Field Office or representative can provide additonal repair information. The following special maintenance information is provided for switch replacement.

Cam Switches. Cam switches consist of a rotating cam that mates with contacts on the adjacent circuit board. These contacts are activated by lobes on the cam as the switch is rotated. A cam switch can be disassembled for inspection, cleaning, repair, or replacement; however, it is recommended that the switch be removed and replaced as a unit. Refer to Fig. 4-9 for special instruction on cam switch removal.

CAUTION

Repair of a cam switch should be undertaken only by experienced maintenance personnel. Switch alignment and contact spacing must be carefully maintained for proper operation. A cam switch repair kit is available (Tektronix part No. 040-0541-00) that contains special alignment tools for use in repairing or replacing the switch contacts. For information or assistance on maintenance of cam switches, contact your local Tektronix Field Office or representive.

Push-Button Switches. Removal and replacement instructions for push button switches are shown in Fig. 4-10.

Semiconductors

CAUTION

To avoid component damage, power must be turned off before removing or replacing semiconductors.

Semiconductors should not be replaced unless actually defective. If semiconductors are removed during routine maintenance, return them to their original sockets. Unnecessary replacement of semiconductors may affect the adjustment of this instrument. When semiconductors are replaced, check the operation of the part of the instrument that may be affected.

WARNING

Handle silicone grease with care. Avoid getting silicone grease in eyes. Wash hands thoroughly after use.

Replacement devices should be of the original type or a direct replacement. Figure 4-2 shows the lead configurations of the semiconductor devices used in this instrument. Some plastic-case transistors have lead configurations that do not agree with those shown here. When replacing, check the manufacture's basing diagram for correct basing. All transistor sockets in this instrument are wired for the standard basing used for metal-case transistor. Semiconductors that have heat radiators use silicone grease to increase heat transfer. Replace the silicone grease when replacing these semiconductors.

An extraction tool should be used to remove the 14- and 16-pin integrated circuits to prevent damage to the pins. This tool is available from Tektronix, Inc. Order Tektronix Part No. 003-0619-00. If an extraction tool is not available when removing one of these integrated circuits, pull slowly and evenly on both ends of the device. Try to avoid having one end of the integrated circuit disengage from the socket before the other, as the pins may be damaged.

Interconnecting Pins

Three methods of interconnection are used to connect the circuit boards with other boards and components. When the interconnection is made with a coaxial cable, a special end-lead connector plugs into a socket on the board (Fig. 4-8). When the interconnection is made with a wire lead, an end-lead connector is used that mates with the interconnecting pin soldered into the board (Fig. 4-4). When the interconnection is made between adjacent boards, an interboard multi-pin connector is used (Fig. 4-3). The following information provides the removal and replacement procedure for the various types of interconnection methods.

Coaxial End-Lead Connectors. Replacement of the coaxial-type end-lead connectors requires special tools and techniques; only experienced maintenance personnel should attempt to remove and replace these connectors. It is recommended that the cable be replaced as a unit. For cable part numbers, see the Replaceable Mechanical Parts list. An alternative solution is to refer the replacement of the defective connector to your local Tektronix Field Office or representive.

End-Lead Pin Connectors. The pin connectors used to connect the wires to the interconnecting pins are clamped to the ends of the associated leads. To remove and replace

damaged end-lead pin connectors, remove the old pin connector from the end of the lead and clamp the replacement connector to the lead.

Some of the pin connectors are grouped together and mounted in a plastic holder; the overall result is that these connectors are removed and installed as a multi-pin connector (see Fig. 4-4). To provide correct orientation of this multi-pin connector when it is replaced, an arrow is marked on the circuit board and a matching arrow is molded into the plastic holder of the multi-pin connector. Be sure these arrows are aligned as the multi-pin connector is replaced. If the individual end-lead pin connectors are removed from the plastic holder, note the color of the individual wires for replacement.

Inter-Board Multi-Pin Connector. The inter-board multi-pin connector pin-holder is not repairable and should be replaced as a unit (see Fig. 4-3). Refer to the Replaceable Mechanical Parts list for part number. Inter-board multi-pin connector pin-sockets are soldered to circuit boards (see Fig. 4-3). To replace a socket, first remove the guide. Then, remove the old socket using soldering techniques previously described. Solder the new socket in place, making sure it will align properly with the inter-board connector pins.

Circuit-Board Pins

CAUTION

All circuit boards in this instrument, except the Readout circuit board, are multi-layer type boards with a conductive path(s) laminated between the top and bottom board layers. All soldering on these boards should be done with extreme care to prevent breaking the connection to the center conductor(s); only experienced maintenance personnel should attempt repair of these boards.

A circuit-board pin replacement kit including the necessary tools, instructions, and replacement pins is available from Tektronix, Inc. Order Tektronix Part No. 040-0542-00. Replacement of circuit-board pins on multi-layer boards is not recommended; refer such repairs to your local Tektronix Field Office or representative.

To replace a damaged pin mounted on a single-layer circuit board, first disconnect any pin connectors. Then (using Soldering Techniques given earlier in this section), unsolder the damaged pin and pull it from the board with a pair of pliers, leaving the ferrule (see Fig. 4-11) in the hole, if possible. If the ferrule remains in the circuit board, remove the spare ferrule from the replacement pin and press the new pin into the hole in the circuit board. If the ferrule is removed with the damaged pin, clean out the hole using a solder-removing wick and a scribe. Then, press the replacement pin with attached spare ferrule into the hole. Position the replacement pin in the same manner as the damaged pin. Solder the pin to the circuit board on each side of the board. If the old pin was bent at an angle to mate with a connector, carefully bend the new pin to the same angle. Replace the pin connector.

Front-Panel Lights

This instrument uses LED's (light-emitting diodes) and incandescent lamps for front-panel lights.

LED's are used to illuminate the TRIG'D and SINGLE SWP READY lights. To replace LED's, remove the cap from the sleeve as in Fig. 4-12. Note the lead wire color coding and the LED lead configuration. Unsolder the wire leads and remove the LED from the cap. Solder the replacement LED and lead wires to the socket cap as noted previously. Install the cap in the sleeve.

Incandescent lamps are used to illuminate the transparent pushbutton switches. To replace incandescent lamps, unsolder the lead wires from the rear of the cap (see Fig. 4-12) and pull the cap and bulb out of the sleeve. Solder the replacement lamp and lead wires to the cap. Install the assembly in the sub-panel sleeve.

ADJUSTMENT AFTER REPAIR

After any electrical component has been replaced, the adjustment of that particular circuit should be checked, as well as other closely related circuits. See Section 5 for a complete adjustment procedure.

INSTRUMENT REPACKAGING

If the Tektronix instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag showing: owner (with address) and the name of an individual at your firm that can be contacted, complete instrument serial number, and a description of the service required.

Save and re-use the package in which your instrument was shipped. If the original packaging is unfit for use or not available, repackage the instrument as follows.

1. Obtain a carton of corrugated cardboard having inside dimensions of no less than six inches more than the instrument dimensions; this will allow for cushioning. Refer to Table 4-1 for carton test strength requirements.

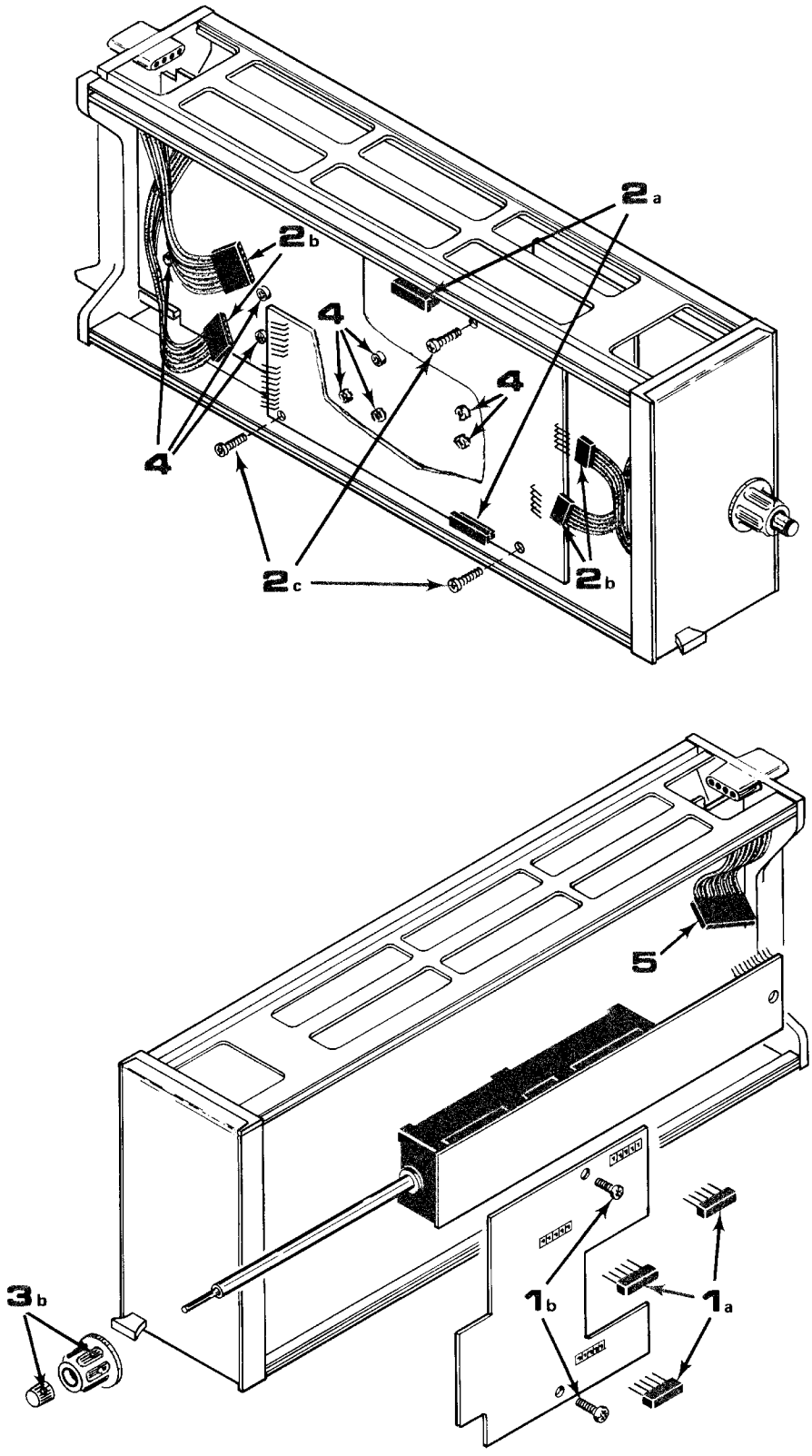


Fig. 4-9. Cam switch removal procedure.

REMOVE CAM-TYPE SWITCH ASSEMBLY AS FOLLOWS:

1. Remove Trigger circuit board as follows:
   a. Remove the 3 inter-board multi-pin connectors.
   b. Remove 2 screws from circuit board.
   c. Lift rear of board away from frame and slide toward rear of instrument.
   d. Note wire color of single-conductor shielded cables and connector to which each attach. Then, disconnect cables.

2. Remove Digital Voltmeter circuit board as follows:
   a. Remove the 2 inter-board multi-pin connectors.
   b. Note color of multi-pin connectors and J numbers to which each attach. Then, disconnect 4 multi-pin connectors.
   c. Remove the 3 securing screws from circuit board.
   d. Lift rear of board and slide toward rear of instrument until board clears the B DELAY MODE switch.

3. Remove the TIME/DIV and VARIABLE (CAL IN) knobs as follows:
   a. Set the TIME/DIV switch to the 2 ms position and the VARIABLE (CAL IN) knob out to expose set screw.
   b. With a hex key wrench loosen the set screws in both knobs. Remove knobs from shaft.

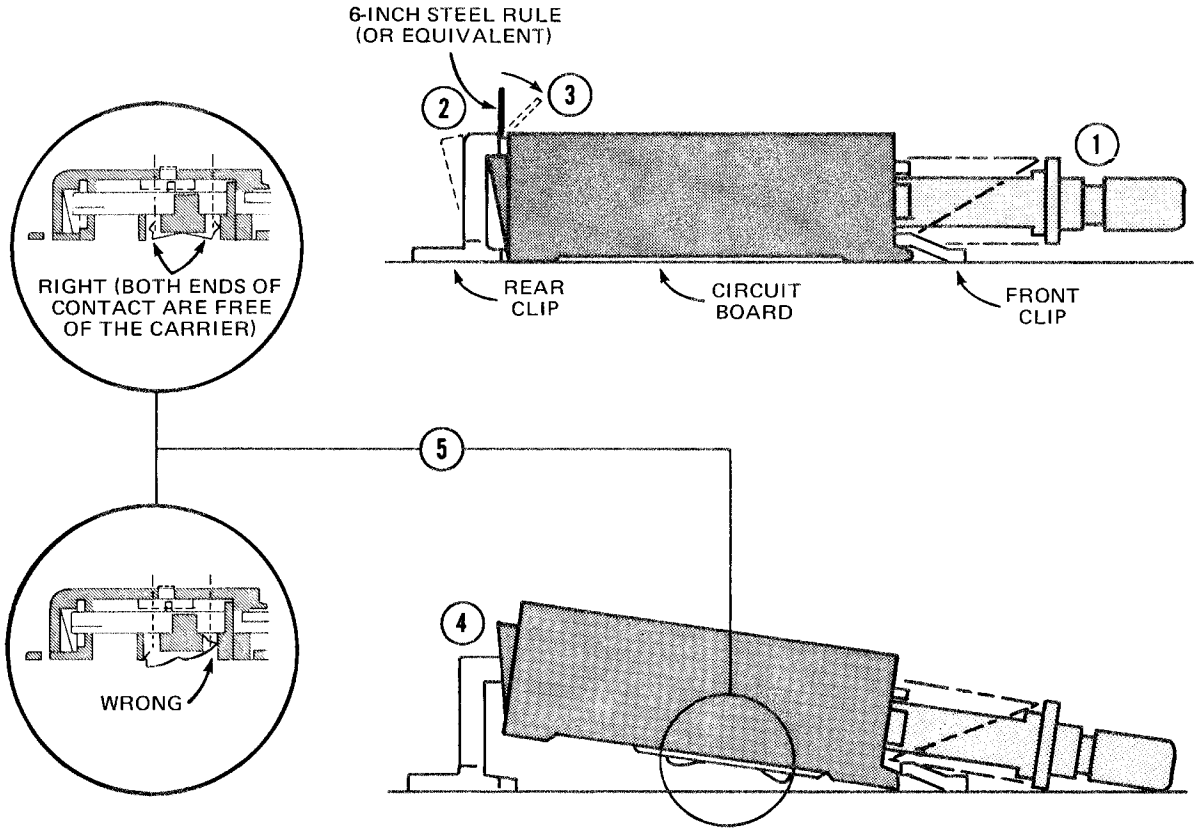
4. Remove 8 screws securing cam-type switch to the Interface circuit board.

5. Disconnect multi-pin connector from Readout circuit board.

To replace the cam-type switch, reverse the order of removal.

1961-20

Fig. 4-9. Cam switch removal procedure (cont.).



(1) Make sure that all switch shafts are in the OUT position to clear the rear clip.

(2) Place the long edge of a six-inch rule or similar thin straight edge between the top edge of the rear clip and the switch body.

(3) Carefully pry the rear clip back just far enough to push the steel rule down between the clip and switch body.

CAUTION

When the switch is removed, the contacts may drop free and be damaged or lost. Body salts or acids can contaminate the switch contacts. Wear cotton gloves to prevent touching the contacts in the switch or on the board with bare hands.

(4) Pull the rear of the switch up, remove the steel rule, and pull the switch out of the front clip.

(5) To replace the switch, first check that the slide contacts are properly installed in the carrier. Then, place the front of the switch into the front clip and push the rear of the switch down until the rear clip catches and holds the switch in place.

1967-3

Fig. 4-10. Removal procedure for typical push-button switch.

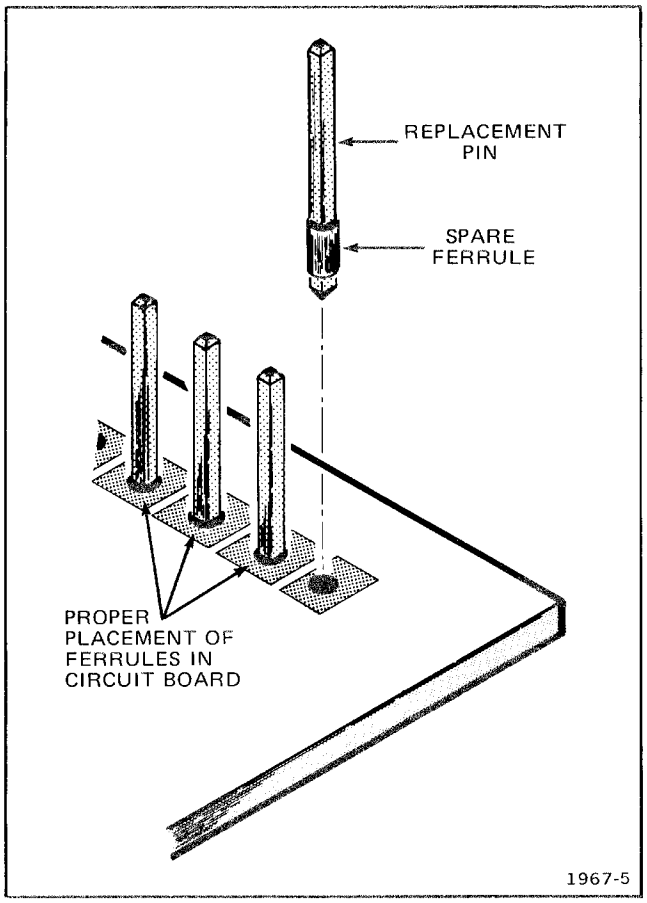


Fig. 4-11. Exploded view of circuit-board pin and ferrule.

2. Surround the instrument with polyethylene sheeting to protect the finish of the instrument.

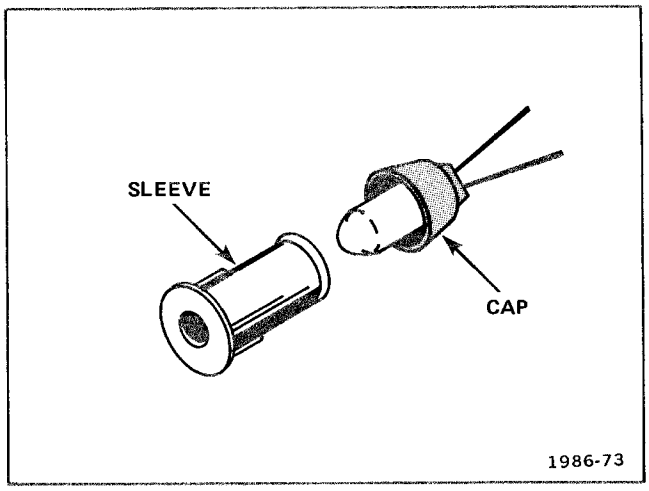


Fig. 4-12. Front-panel light socket assembly.

3. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between the carton and the instrument, allowing three inches on all sides.

4. Seal the carton with shipping tape or an industrial stapler.

Table 4-1
SHIPPING CARTON TEST STRENGTH

Gross Weight (lb)	Carton Test Strength (lb)
0-10	200
10-30	275
30-120	375
120-140	500
140-160	600

PERFORMANCE CHECK AND ADJUSTMENT

This section contains information necessary to perform a complete instrument performance check and adjustment. The information in this section describes procedures to verify that the instrument is performing properly and meets the specifications listed in the Performance Requirement column of Table 2-1 in Section 2, Specifications.

PRELIMINARY INFORMATION

Adjustment Interval

To maintain instrument accuracy, check the performance of the 7B85 every 1000 hours of operation, or every six months if used infrequently. Before complete adjustment, thoroughly clean and inspect this instrument as outlined in Section 4, Maintenance.

Tektronix Field Service

Tektronix Field Service Centers and the Factory Service Center provide instrument repair and adjustment services. Contact your Tektronix Field Office or representative for further information.

Using This Procedure

This Performance Check and Adjustment procedure can be used either for complete adjustment or as a check of instrument performance. Completion of each step in the procedure ensures that the instrument is correctly adjusted and operating within specified limits. Refer to the following discussion for instructions on a complete or partial check and adjustment.

Index. An index precedes the procedure to aid in locating Performance Check and Adjustment steps.

Performance Check. Instrument performance can be checked by performing the complete Performance Check and Adjustment procedure and omitting only the ADJUST parts of the steps.

Adjustment. Completion of each step in the Performance Check and Adjustment procedure ensures that the instrument is correctly adjusted and performing within specified limits. Where possible, instrument performance is checked before an adjustment is made. For best overall performance when performing the complete adjustment procedure, make each adjustment to the exact setting indicated.

Partial Procedures. The following procedure is written to completely check and adjust the instrument to the Performance Requirements listed in Section 2, Specification. If the applications for which the instrument is used do not require the full available performance, the procedures and the required equipment list can be shortened accordingly.

A partial performance check and adjustment may be desirable after replacing components, or to touch up the adjustment of a portion of the instrument. To check or adjust only part of the instrument, refer to the Equipment Required list preceding that portion of the procedure to be performed. To avoid unnecessary adjustment of other parts, adjust only if the tolernace given in each CHECK is not met.

TEST EQUIPMENT REQUIRED

The test equipment listed in Table 5-1 is required for a complete performance check and adjustment of this instrument. The specifications given in Table 5-1 for test equipment are the minimum required to meet the Performance Requirements listed in Section 2, Specification. Detailed operating instructions for test equipment are omitted in this procedure. Refer to the test equipment instruction manual if more information is needed.

Special Fixtures

Special fixtures are used only where they facilitate instrument adjustment. These fixtures are available from Tektronix, Inc. Order by part number from Tektronix Field Offices or representatives.

Test Equipment Alternatives

The test equipment listed in the Examples of Applicable Test Equipment column, Table 5-1, is required to check and adjust this instrument. The Performance Check and Adjustment procedure is based on the first item of equipment given as an example. If other equipment is substituted, control

settings or setups may need to be altered. If the exact item of equipment given as an example is not available, refer to the Minimum Specifications column to determine if other equipment may be substituted. Then check the Purpose column. If you determine that your measurement requirements will not be affected, the item and corresponding step(s) can be deleted.

Table 5-1
TEST EQUIPMENT

Description	Minimum Specifications	Purpose	Examples of Applicable Test Equipment
Oscilloscope mainframe	TEKTRONIX 7000-Series with 2 horizontal plug-in compartments; bandwidth, 400 MHz.	Provides a display for unit under test.	TEKTRONIX 7904 Oscilloscope.
Amplifier plug-in unit	TEKTRONIX 7A-Series. Bandwidth, 400 MHz; deflection factor, 10 mV to 0.5 V/div.	Provides vertical input to oscilloscope system.	TEKTRONIX 7A19 Amplifier plug-in unit.
Time-base unit	TEKTRONIX 7B-Series delayed sweep unit.	Companion delayed sweep unit for delay time checks and adjustments.	a. TEKTRONIX 7B80 Time-Base unit. b. TEKTRONIX 7B85 Time-Base unit.
High-frequency signal generator[a]	Frequency, 50 MHz to 400 MHz; output amplitude, variable from 50 mV to 0.5 V into 50 Ω.	High-frequency triggering checks.	a. TEKTRONIX SG 504 Leveled Sine Wave Generator with power module. b. Wavetek 1002 Sweep/ Signal Generator.
Time-mark generator	Marker outputs, 2 ns to 5 s; accuracy, within 0.1%.	Sweep timing checks and adjustments. Sweep delay checks and adjustments.	a. TEKTRONIX TG 501 Time-Mark generator with power module. b. TEKTRONIX 2901 Time-Mark Generator. c. TEKTRONIX 184 Time-Mark Generator.
Digital voltmeter (with test leads)[b]	Range, 5 mV to 105 mV; accuracy, within 0.1%. Digital Voltmeter must have at least 4 1/2 digit readout.	Readout bias checks and adjustments.	a. TEKTRONIX DM 501A Digital Multimeter with power module. b. TEKTRONIX 7D12 A/D Converter with M1 Multi-function Module.

Table 5-1 (Cont.)

Description	Minimum Specifications	Purpose	Examples of Applicable Test Equipment
Low-frequency sine-wave generator	Frequency, 30 Hz to 50 kHz; output amplitude, variable from 50 mV to 3 V into 50 Ω.	Low-frequency triggering checks and adjustments.	a. TEKTRONIX FG 503 Function Generator with power module. b. General Radio 1310-B Oscillator.
Plug-in extender[b]	TEKTRONIX 7000-Series extender.	Provides access to internal adjustments and test points.	TEKTRONIX 067-0589-00 Calibration Fixture.
Coaxial cables (2 required)	Impedance, 50 Ω; type RG 58/U; length, 42 and 18 inches; connectors, bnc.	Provides signal interconnections.	Tektronix Part No. 012-0057-01 (42 inches) and 012-0076-00 (18 inches).
T connector	Connectors, bnc.	External trigger checks and adjustments.	Tektronix Part No. 103-0030-00.
Impedance, 50 Ω; accuracy, within 2%; connectors, bnc.	Magnified sweep timing check.	Tektronix Part No. 011-0049-01.	Termination[a] Screwdriver[b]
3-inch shaft, 3/32-inch bit.	Adjustments.	Xcelite R3323.	

[a]**Used for performance check only; NOT used for adjustment.**

[b]**Used for adjustment only; NOT used for performance check.**

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PRELIMINARY PROCEDURE

1. Install an amplifier unit into the left vertical compartment of the mainframe.

2. Install the 067-0589-00 plug-in extender into the A horizontal compartment of the mainframe. Remove the side covers and install the 7B85 in the plug-in extender.

3. Install the delayed sweep time-base unit into the B horizontal compartment of the mainframe.

4. Set the mainframe vertical mode switch to display the left vertical unit and the horizontal mode switch to display the A horizontal unit. Set the mainframe intensity controls fully counterclockwise, and set the trigger source switches to vertical mode.

5. Turn on the mainframe and allow at least 20 minutes warmup before beginning the procedure.

NOTE

The performance of this instrument can be checked at any ambient temperature within the 0° to +50° C range unless stated otherwise. This instrument must be adjusted at an ambient temperature of +20° to +30° C for quoted accuracy.

A. TRIGGERING SYSTEM

Equipment Required

Oscilloscope mainframe	Plug-in extender
Amplifier plug-in unit	50 Ω cables (2)
Low-frequency sine-wave generator	Bnc T connector
High-frequency signal generator	

BEFORE YOU BEGIN, see TEST POINT AND ADJUSTMENT LOCATIONS **in the Diagrams section.**

Control Settings

Set the 7B85 controls as follows:

TRIGGERING

MODE	P-P AUTO
COUPLING	AC
SOURCE	INT

SWEEP MODE

B DELAY MODE	INDEPENDENT

DELAY TIME

TRACE SEP (Δ TIME enable)	OFF

SWEEP

POSITION	Midrange
TIME/DIV	20 μs/DIV
VARIABLE	IN (calibrated)
MAG	X1
HOLD OFF	MIN

A1. Adjust DC Balance and Slope Balance (R85, R80)

a. Connect the low-frequency sine-wave generator to the amplifier unit input with a 50 Ω cable.

b. Set the oscilloscope mainframe intensity and focus controls for the desired display.

c. Set the low-frequency sine-wave generator and the amplifier unit deflection factor for a 0.3-div display at 50 kHz. Center the display vertically.

d. Set the TRIGGERING LEVEL control to approximately 0 (midrange) and TRIGGERING SLOPE to (+).

e. Check for a stable display with TRIG'D light on.

f. ADJUST—R85 (DC Balance) for a stable crt display.

g. Set the SLOPE switch to (−) and check for a stable display.

h. ADJUST—R80 (Slope Balance) for a stable display.

i. Check for a stable display when the SLOPE switch is set to (+) and (−).

j. INTERACTION—Repeat the adjustment of R85 (DC Balance) and R80 (Slope Balance) until a stable display is obtained while changing TRIGGERING SLOPE.

NOTE

If any of the CHECK parts in the following steps cannot be met, repeat step A1.

A2. Check Triggering Modes

a. Remove the 7B85 and plug-in extender; then, install the 7B85 directly into the A horizontal compartment.

b. Set the low-frequency sine-wave generator and the amplifier unit deflection factor for approximately a 2-division display.

c. CHECK—for a stable display at all LEVEL control settings (P-P AUTO MODE).

d. Set TRIGGERING MODE to AUTO.

e. CHECK—Set the TRIGGERING LEVEL control for a stable display (TRIG'D light on).

f. CHECK—For a free-running display with the TRIG'D light off when the TRIGGERING LEVEL control is set fully clockwise and fully counterclockwise.

g. Set TRIGGERING MODE to NORM.

h. CHECK—Set the TRIGGERING LEVEL control for a stable display (TRIG'D light on).

i. CHECK—For no display (TRIG'D light off) when the TRIGGERING LEVEL control is set fully clockwise and fully counterclockwise.

j. Set the TRIGGERING LEVEL control for a stable display (TRIG'D light on).

k. Set TRIGGERING MODE to SINGLE SWP and the SOURCE to EXT.

l. CHECK—Press the SINGLE SWP RESET push button and check that the READY light is on.

m. CHECK—for one sweep and that the READY light is out after completion of that sweep when the INT SOURCE push button is pressed (oscilloscope intensity may need to be increased to view the single-sweep display.

n. Remove signal connection.

A3. Check External Level Range

a. Connect the low-frequency sine-wave generator to the EXT TRIG IN connector with a 42-inch 50 Ω cable and T connector. Connect the output of the T connector to the amplifier unit input with an 18-inch 50 Ω cable.

b. Set TRIGGERING MODE to AUTO, SLOPE to (+), and SOURCE to EXT. Set the TIME/DIV switch to 0.5 ms and the EXT TRIG IN attenuator to IN ÷ 1.

c. Set the amplifier unit deflection factor for 0.5 V/div. Set the low-frequency sine-wave generator for a 6-division display (3 V) at 1 kHz.

d. CHECK—That all levels of the positive slope may be selected for the sweep starting point as the TRIGGERING LEVEL control is rotated throughout its range (indicates an external level range of at least plus and minus 1.5 V). Check that the display is not triggered at either end of the LEVEL control rotation.

e. CHECK—Change TRIGGERING SLOPE to (—) and repeat part d for the negative slope of the waveform.

A4. Adjust Triggering Sensitivity (R49)

a. Set the TRIGGERING LEVEL control to 0. Set the TRIGGERING MODE to NORM, SOURCE to INT.

b. Set the amplifier unit deflection factor to 50 mV/div. Set the low-frequency sine-wave generator for a 5-division display (250 mV) at 1 kHz.

c. Set the amplifier unit deflection factor to 1 V/div (0.25 div). Set the TRIGGERING LEVEL control for a stable display.

d. ADJUST—R49, Trigger Sensitivity, for a stable crt display.

A5. Check External Triggering Sensitivity

a. Set the amplifier unit deflection factor for 10 mV/div. Set the low-frequency sine-wave generator for a 5-division display (50 mV) at 30 Hz.

b. Set TRIGGERING SLOPE to (+), MODE to NORM, TIME/DIV to 20 ms, and set the LEVEL control for a stable display.

c. CHECK—Set TRIGGERING MODE to AUTO and check for a stable display (TRIG'D light on) with the COUPLING push button set to:

1. AC
2. AC HF REJ
3. DC

(Set the TRIGGERING LEVEL control as necessary.)

d. CHECK—Change TRIGGERING SLOPE to (−) and repeat part c.

e. Set TRIGGERING MODE to P-P AUTO and COUPLING to AC.

f. Set the amplifier unit deflection factor for 0.1 V/div and the low-frequency sine-wave generator for a 5-division display (500 mV) at 50 Hz.

g. CHECK—for a stable display (TRIG'D light on) at all settings of the LEVEL control with COUPLING set to:

1. AC
2. DC

h. CHECK—Set the SLOPE to (+) and repeat part g.

i. Set the amplifier unit deflection factor for 50 mV/div and the low-frequency sine-wave generator for a 2.5-division display (125 mV) at 200 Hz. Set the TIME/DIV switch to 5 ms.

j. CHECK—Repeat part g for both the (+) and (−) SLOPE.

k. Disconnect the low-frequency sine-wave generator from the T connector and connect the high-frequency signal generator to the T connector.

l. Set TRIGGERING MODE to AUTO and the SLOPE to (+). Set the TIME/DIV switch to 20 ns.

m. Set the amplifier unit deflection factor to 10 mV/div and the high-frequency signal generator for a 5-division display (50 mV) at 50 MHz.

n. CHECK—for a stable display (TRIG'D light on) with the COUPLING switch set to:

1. AC
2. AC LF REJ
3. DC

(Set the LEVEL control as necessary.)

o. CHECK—Set the SLOPE switch to (−) and repeat part n.

p. Set the amplifier unit deflection factor to 50 mV/div and set the high-frequency signal generator for a 2.5-division display (125 mV).

q. CHECK—Set TRIGGERING MODE to P-P AUTO and check for a stable display (TRIG'D light on) at all settings of the LEVEL control with COUPLING set to:

1. AC
2. DC

r. CHECK—Set the SLOPE switch to (+) and repeat part q.

s. Set the high-frequency signal generator for a 7.5-division display (375 mV) at 400 MHz. Set the TIME/DIV switch to 10 ns and the MAG switch to X10.

t. CHECK—Set TRIGGERING MODE to P-P AUTO and check for a stable display (TRIG'D light on) when the LEVEL control setting is within the ends of the arrows on the front panel. Repeat for both the (+) and (−) SLOPE.

u. Set the high-frequency signal generator for a 5-division display (250 mV) at 400 MHz. Set TRIGGERING MODE to AUTO and the SLOPE to (+).

v. CHECK—for a stable display (TRIG'D light on) with COUPLING set to:

1. AC
2. AC LF REJ
3. DC

(Set the LEVEL control as necessary.)

w. CHECK—Set the SLOPE switch to (−) and repeat part v.

A6. Check Internal Triggering Sensitivity

a. Remove all signal connections; then, connect the low-frequency sine-wave generator to the amplifier unit input.

b. Set the TIME/DIV switch to 20 ms and the MAG switch to X1.

c. Set the low-frequency sine-wave generator and the amplifier unit deflection factor for a 0.3-division display at 30 Hz.

d. Set TRIGGERING for (+) SLOPE, NORM MODE, AC COUPLING, and INT SOURCE, and set the LEVEL control for a stable display (TRIG'D light on).

e. CHECK—Set TRIGGERING MODE to AUTO and check for a stable display (TRIG'D light on) with COUPLING set to:

1. AC
2. AC HF REJ
3. DC

(Set the TRIGGERING LEVEL control as necessary.)

f. Change the TRIGGERING SLOPE to (−) and repeat part e.

g. Set TRIGGERING MODE to P-P AUTO and COUPLING to AC.

h. Set the low-frequency sine-wave generator and the amplifier unit deflection factor for a 2-division display at 50 Hz.

i. CHECK—for a stable display (TRIG'D light on) at all settings of the LEVEL control with COUPLING set to:

1. AC
2. DC

j. Set the SLOPE switch to (+) and repeat part i.

k. Set the low-frequency sine-wave generator and the amplifier unit deflection factor for a 0.5-division display at 200 Hz. Set the TIME/DIV switch to 5 ms.

l. CHECK—Repeat part i for both the (+) and (−) SLOPE.

m. Disconnect the low-frequency sine-wave generator and connect the high-frequency signal generator to the amplifier unit input.

n. Set TRIGGERING MODE to AUTO and the SLOPE switch to (+). Set the TIME/DIV switch to 20 ns.

o. Set the high-frequency signal generator and the amplifier unit deflection factor for a 0.3-division display at 50 MHz.

p. CHECK—for a stable display (TRIG'D light on) with COUPLING set to:

1. AC
2. AC LF REJ
3. DC

(Set the LEVEL control as necessary.)

q. CHECK—Set the SLOPE switch to (−) and repeat part p.

r. Set the high-frequency signal generator and the amplifier unit deflection factor for a 0.5-division display.

s. CHECK—Set TRIGGERING MODE to P-P AUTO and check for a stable display at all settings of the LEVEL control (TRIG'D light on) with COUPLING set to:

1. AC
2. DC

t. CHECK—Set the SLOPE switch to (+) and repeat part s.

u. Set the high-frequency signal generator and the amplifier unit deflection factor for a 1.5-division display at 400 MHz. Set the TIME/DIV switch to 10 ns and the MAG switch to X10.

v. CHECK—Set TRIGGERING MODE to P-P AUTO and check for a stable display (TRIG'D light on) when the LEVEL control setting is within the ends of the arrows on the front panel. Repeat for both the (+) and (−) SLOPE.

w. Set TRIGGERING MODE to AUTO and SLOPE to (+).

x. CHECK—for a stable display (TRIG'D light on) with COUPLING set to:

1. AC
2. AC LF REJ
3. DC

(Set the LEVEL control as necessary.)

y. CHECK—Set the SLOPE to (−) and repeat part x.

A7. Check Internal Trigger Jitter

a. Set TRIGGERING COUPLING to AC and set the LEVEL control for a stable display (TRIG'D light on).

b. CHECK—for a stable display with no more than 0.1 division (0.1 ns) of jitter.

A8. Check Line Triggering

a. Remove all signal connections.

b. Set TRIGGERING SOURCE to LINE, the TIME/DIV switch to 1 ms, and the MAG switch to X1.

c. CHECK—Set TRIGGERING LEVEL to approximately midrange and check that the TRIG'D light is on.

d. CHECK—that the display is not triggered (TRIG'D light off) at either end of the LEVEL control rotation.

B. HORIZONTAL SYSTEM

Equipment Required

Oscilloscope mainframe	Plug-in extender
Amplifier plug-in unit	50 Ω cable (1)
Time-base unit	50 Ω termination
Digital voltmeter with test leads	
Time-mark generator	

Control Settings

Set the 7B85 controls as follows:

TRIGGERING

MODE	AUTO
COUPLING	AC
SOURCE	INT

SWEEP MODE

B DELAY MODE	INDEPENDENT

DELAY TIME

TRACE SEP	OFF
DELAY TIME	Fully counterclockwise
Δ TIME	Fully clockwise

SWEEP

POSITION	Midrange
TIME/DIV	1 ms
VARIABLE	IN (calibrated)
MAG	X1
HOLD OFF	MIN

B1. Set Basic Sweep Calibration

a. Set the companion time-base unit triggering for auto mode, ac coupling, and internal source. Set the companion unit for a 1 ms/div sweep rate.

b. Remove the 7B85 from the oscilloscope mainframe and install the plug-in extender in the A horizontal compartment. Then, install the 7B85 in the plug-in extender.

c. Connect the time-mark generator to the amplifier unit input with a 50 Ω cable. Set the time-mark generator for 1 ms markers, and set the mainframe horizontal mode to alternate. Set the mainframe intensity and focus for the desired display.

d. Set both time-base unit LEVEL controls for a stable display (TRIG'D lights on). Set the amplifier unit for approximately a 2-division display of each trace. Center the 7B85 trace in the upper half of the graticule and the companion unit trace in the lower half.

e. Set the 7B85 front-panel SWP CAL adjustment for exactly 1 marker/div (upper trace) over the center 8 divisions (position as necessary).

f. Set the front-panel sweep calibration adjustment of the companion time-base unit for exactly 1 marker/div (lower trace) over the center 8 divisions (position as necessary).

B2. Check Sweep Length and Positioning Range

a. Set the mainframe horizontal mode to display the A horizontal compartment. Center the display vertically.

b. Horizontally position the display to place the second time marker to the first graticule line.

c. CHECK—that the end of the sweep extends to at least 9.2 graticule divisions (indicates sweep length of at least 10.2 div).

d. Set the POSITION and FINE controls fully clockwise.

e. CHECK—the start of the sweep must be to the right of graticule center.

f. Set the POSITION and FINE controls fully counterclockwise.

g. CHECK—the end of the sweep must be to the left of graticule center.

B3. Check/Adjust Magnifier Gain and Registration (R430, R445)

a. Set the time-mark generator for 0.1 ms markers.

b. Set the MAG switch to X10 and set the POSITION controls to midrange. Set the mainframe intensity controls for the desired display.

c. Check for 1 marker/div over the center 8 divisions of the display (position as necessary).

d. ADJUST—R430 (Mag Gain) for 1 marker/div over the center 8 divisions of the display.

e. Set the time-mark generator for 5 ms markers. Align the center time marker with graticule center.

f. CHECK—Set the MAG switch to X1 and check that the center time marker is at graticule center within 0.5 div.

g. ADJUST—R445 (Mag Reg) to align the center time marker with graticule center.

h. INTERACTION—Set the MAG switch to X10 and repeat parts e, f, and g as necessary.

B4. Check Variable Time/Division and Variable Hold Off

a. Press and release the VARIABLE TIME/DIV control for uncalibrated sweep rates. Set the VARIABLE control fully clockwise and note 3 time markers in 10 graticule divisions.

b. CHECK—Set the VARIABLE control fully counterclockwise and check for 2 divisions or less between 5 ms markers.

c. Press in the VARIABLE control for calibrated sweep rates.

d. Set the LEVEL control for a free-running display (TRIG'D light off).

e. Set the HOLD OFF control fully counterclockwise.

f. CHECK—Rotate the HOLD OFF control slowly clockwise throughout its range and check that the display (3 time markers in 10 divisions) will stabilize at least three times throughout the range of the HOLD OFF control (disregard any slow drift).

g. Set the HOLD OFF control counterclockwise to MIN and set the LEVEL control for a stable display.

B5. Adjust Sweep Timing (C330, R710, R715)

a. Set the TIME/DIV switch to 50 ns and set the time-mark generator for 50 ns markers.

b. Check for 1 marker/div over the center 8 divisions of the display (position as necessary).

c. ADJUST—C330 (50 ns Timing) for 1 marker/div over the center 8 divisions of the display (position as necessary).

d. Set the TIME/DIV switch to 10 μs and set the time-mark generator for 10 μs markers.

e. Check for 1 marker/div over the center 8 divisions of the display (position as necessary).

f. ADJUST—R710 (10 μs Timing) for 1 marker/div over the center 8 divisions of the display (position as necessary).

g. Set the TIME/DIV switch to 10 ms and set the time-mark generator for 10 ms markers.

h. Check for 1 marker/div over the center 8 divisions of the display (position as necessary).

i. ADJUST—R715 (10 ms Timing) for 1 marker/div over the center 8 divisions of the display (position as necessary).

NOTE

Final adjustment of R710 and R715 is made in step B13.

B6. Check Delay Modes

a. Set the TIME/DIV switch to 1 ms and set the time-mark generator for 1 ms markers.

b. CHECK—Rotate the DELAY TIME control and note that it has no effect on the independent sweep display.

c. CHECK—Rotate the TRACE SEP control counterclockwise out of switch detent to enable the Δ TIME mode. Rotate the Δ TIME control and check for no effect on the independent sweep display.

d. Rotate the TRACE SEP control into the switch detent to disable the Δ TIME operation. Set the B DELAY MODE switch to B STARTS AFTER DLY.

e. Set the mainframe horizontal mode to alternate. Set the companion time-base sweep rate to 0.1 ms/div and set the level control for a triggered display (TRIG'D light on).

f. Set the mainframe intensity control for optimum brightness of the intensified- and delayed-sweep traces. Center the delaying-sweep trace in the upper half of the graticule and the delayed-sweep trace in the lower half of the graticule.

g. CHECK—Rotate the DELAY TIME control throughout its range and note that the delay before the start of the intensified zone is continuously variable.

h. Set the B DELAY MODE switch to B TRIGGERABLE AFTER DLY.

i. CHECK—Rotate the DELAY TIME control throughout its range and note that the intensified zone jumps from time marker to time marker. This indicates that the intensified zone does not start at the completion of delay time, but waits for the next trigger pulse.

j. CHECK—That the greater-than symbol (>) precedes the delay-time readout, thereby indicating that the delay-time readout is uncalibrated.

NOTE

The 7B85 may be operated as a delayed-sweep unit (B horizontal compartment) with a companion delaying-sweep unit (A horizontal compartment). To check 7B85 delayed-sweep operation, install the 7B85 in the B horizontal compartment and a companion delaying-sweep unit into the A horizontal compartment. Set the 7B85 B DELAY MODE to INDEPENDENT and the TIME/DIV switch to 0.1 ms. Set the delaying-sweep unit for a 1 ms/div sweep rate and apply 1 ms time markers to the amplifier unit input. Check delayed-sweep operation as outlined in step B6, parts d through i.

B7. Adjust Delay Time Readout Bias (R685) (SN B088749 & Below)

a. Rotate the DELAY TIME control fully counterclockwise and rotate the TRACE SEP control counterclockwise out of the switch detent.

b. Disconnect multi-pin connector P32 from the Digital Voltmeter circuit board (A4). Disconnect the two-pin jumper (P34) from pins 1 and 2 and place it on P32 pin 9 and P34 pin 1. Place P32 pin 1 to pin 1 only on the circuit board.

c. Set the digital voltmeter to the 2 V dc-voltage range.

d. Connect the digital voltmeter test leads across R541.

e. Rotate the Δ TIME control to display symbols and nines (.>>99.99RE9) on the delay-time readout.

f. Check the digital voltmeter readout for 0.100 V within 0.001 V.

g. ADJUST—R685 (Readout Bias) for 0.100 V within 0.001 V.

h. ADJUST—Set the Δ TIME control for the readout numerals given in Table 5-2 (various symbols will also appear in the readout display), and check for the corresponding digital voltmeter readings. If necessary, adjust R685 and recheck.

Table 5-2
DELAY TIME READOUT BIAS

Readout Numeral	Digital Voltmeter Reading
(9)s	.100 V (Within .001 V)
(8)s	.090 V (Within .001 V)
(7)s	.080 V (Within .001 V)
(6)s	.070 V (Within .001 V)
(5)s	.060 V (Within .001 V)
(4)s	.050 V (Within .001 V)
(3)s	.040 V (Within .001 V)
(2)s	.030 V (Within .001 V)
(1)s	.020 V (Within .001 V)
(0)s	.010 V (Within .001 V)

j. Disconnect the digital voltmeter test leads from R541. Disconnect the two-pin jumper (from P32 pin 9 and P34 pin 1) and place it on P34 pins 1 and 2. Disconnect multi-pin connector P32 from pin 1 and replace it on pins 1 through 9.

B8. Adjust Delay Offset and Delay Gain (R555, R510)

a. Set the B DELAY MODE switch to B STARTS AFTER DLY.

b. Set the companion delayed-sweep time-base unit for a 10 μs/div sweep rate.

c. Rotate the Δ TIME control fully counterclockwise. Rotate the DELAY TIME control to start the intensified zone approximately 1 div from the start of the delaying-sweep trace (upper trace). Rotate the DELAY TIME control to further position the time markers on the delayed-sweep traces to graticule center.

NOTE

Do not disturb the setting of the Δ TIME control (fully counterclockwise) during the remainder of step B8.

d. Check that the time markers of both the first and second delayed-sweep traces are horizontally aligned with 0.1 div. It may be necessary to rotate the TRACE SEP control to distinguish between the two delayed-sweep traces.

e. ADJUST—R555 (Delay Offset) to horizontally align the time markers of the first and second delayed-sweep traces.

f. Rotate the DELAY TIME control to start the intensified zone approximately 8 divisions from the start of the trace. Further rotate the DELAY TIME control to position the time markers of the delayed-sweep traces near graticule center.

g. Check that the time-markers of both delayed-sweep traces are horizontally aligned within 0.1 div.

h. ADJUST—R510 (Delay Gain) to horizontally align the time markers of the delayed-sweep traces.

i. INTERACTION—Repeat step B8 until there is no change in the adjustment.

B9. Adjust DVM Zero (R625) (SN B088750 & up)

a. Rotate the Δ TIME control fully counterclockwise and TRACE SEP counterclockwise out of the switch detent.

b. Set the DELAY TIME control to position the intensified zones near the second graticule line so that the time markers in the delayed-sweep display are on the center graticule line.

c. Advance the Δ TIME control until the first and second delayed time markers are 2.0 div (20 μs) apart (1 horizontal division equals 10 μs of delayed sweep).

NOTE

If it is difficult to set the Δ TIME control for exactly 2 divisions (20 μs) between delayed-sweep time markers, note the actual time separation displayed. Then, follow the procedure outlined in part d and adjust R625 so that the Δ TIME readout corresponds to the actual time separation displayed between the delayed-sweep time markers.

EXAMPLE: A 2.2 div time delay corresponds to a 0.022 ms Δ time readout. Adjust R625 for a Δ TIME readout of 0.021 ms. Then, adjust R625 until the Δ TIME readout just changes to 0.022 ms.

d. ADJUST—R625 (DVM Zero) for a Δ TIME readout of 0.019 ms. Then, adjust R625 until the Δ TIME readout just changes to 0.020 ms.

e. Rotate the Δ TIME control fully counterclockwise.

f. Check for a Δ time readout of exactly 0.000 ms and for horizontal alignment of the delayed sweep time markers within 0.1 div. Disregard an occasional Δ TIME readout of 0.001 ms.

B9. Adjust Scaling and DVM Zero (R605, R625) (SN B088749 & Below)

a. Set the DELAY TIME control fully counterclockwise and set the Δ TIME control for a Δ time readout of 8.000 ms.

b. Set the TIME/DIV switch to 2 ms and check for a Δ TIME readout of 16.02 ms.

c. Note the difference in readout from 16.02 ms.

d. ADJUST—Set the TIME/DIV switch to 1 ms and adjust R605 (Scaling) for a Δ TIME readout of 8.000 ms plus one-half the difference in the readout noted in part c.

EXAMPLE: If the reading in part c was 16.21 ms, the difference would be (16.21 − 16.02) = 0.19 ms. Adjust R605 for a Δ time readout of [8.000 ms + 0.5 (0.19 ms)] = 8.095 ms.

e. INTERACTION—Set the Δ TIME control for a Δ TIME readout of 8.000 ms. Repeat parts b, c, and d as necessary.

f. Set the TIME/DIV switch to 5 ms and check for a Δ TIME readout between 39.97 and 40.07 ms.

g. Set the TIME/DIV switch to 1 ms and rotate the Δ TIME control fully counterclockwise.

h. Set the DELAY TIME control to position the intensified zones near the second graticule line so that the time markers in the delayed-sweep display are on the center graticule line.

i. Advance the Δ TIME control until the first and second delayed time markers are 2.0 div (20 μs) apart (1 horizontal division equals 10 μs of delayed sweep).

NOTE

If it is difficult to set the Δ TIME control for exactly 2 div (20 μs) between delayed-sweep time markers, note the actual time separation displayed. Then, follow the procedure outlined in part j and adjust R625 so that the Δ TIME readout corresponds to the actual time separation displayed between the delayed-sweep time markers.

EXAMPLE: A 2.2 div time delay corresponds to a 0.022 ms Δ TIME readout. Adjust R625 for a Δ time readout of 0.021 ms. Then, adjust R625 until the Δ time readout just changes to 0.022 ms.

j. ADJUST—R625 (DVM Zero) for Δ time readout of 0.019 ms. Then, adjust R625 until the Δ TIME readout just changes to 0.020 ms.

k. Rotate the Δ TIME control fully counterclockwise.

l. Check for a Δ TIME readout of exactly 0.000 ms and for horizontal alignment of the delayed sweep time markers within 0.1 div.

B10. Adjust DVM Gain (R620)

a. Set the DELAY TIME control to start the first intensified zone on the second time marker and set the Δ TIME control to start the second intensified zone on the tenth time marker. Further rotate the Δ TIME control to horizontally align the delayed-sweep traces (it may be necessary to rotate the TRACE SEP control to view the two delayed-sweep traces).

NOTE

If the Δ TIME control cannot be set to obtain 8 divisions between intensified zones, preset R535 (Second Pickoff Bias) fully clockwise. Final adjustment of R535 is made in step B12.

b. Check for a Δ TIME readout of 8.000 ms.

c. ADJUST—R620 (DVM Gain) for a Δ TIME readout of 8.000 ms.

B11. Adjust Delay Start and Second Pickoff Bias (R305, R535)

a. Set the TRACE SEP control fully clockwise into the switch detent to disable Δ TIME operation.

b. Position both traces horizontally (7B85 trace and companion time-base trace) to start on the first graticule line.

c. Set the DELAY TIME control for 0.950 ms of delay-time readout.

d. Check for a delayed-sweep time marker (lower trace) at graticule center, within 1.0 div.

e. ADJUST—R305 (Delay Start) to position the delayed time marker, corresponding to the intensified delaying-sweep time marker, to graticule center.

f. Rotate the TRACE SEP control counterclockwise, just out of switch detent, to enable the Δ TIME mode. Set the DELAY TIME control fully counterclockwise and the Δ TIME control fully clockwise.

g. Check for a time readout of 9.200 ms, within 0.100 ms.

h. ADJUST—R535 (Second Pickoff Bias) for a Δ TIME readout of 9.200 ms.

B12. Check Delay Time, Δ Time, and Trace Separation Ranges

a. CHECK—Set the TRACE SEP control clockwise into the OFF detent to disable Δ TIME operation. Check that the Δ symbol disappears from the delay-time readout.

b. CHECK—Set the DELAY TIME control fully clockwise and check for a delay-time readout of 9.000 ms or greater.

c. CHECK—Set the DELAY TIME control fully counterclockwise and check for a delay-time readout of 0.200 ms or less.

d. Set the TRACE SEP control counterclockwise, out of the switch detent, to enable Δ TIME operation.

e. CHECK—Set the Δ TIME control fully clockwise and check for a Δ TIME reading of 9.000 ms or greater.

f. CHECK—Set the Δ TIME control fully counterclockwise and check for a Δ TIME readout of 0.000 ms. Check that the Δ symbol precedes the readout display.

g. Set the TRACE SEP control fully clockwise. Set the mainframe vertical trace separation control to midrange. Position the delayed-sweep trace, with the amplifier unit position control, to the center graticule line.

h. CHECK—Set the TRACE SEP control fully counterclockwise and check that the second delayed-sweep trace is at least 3 divisions below graticule center.

B13. Adjust 10 μs and 10 ms Delay Timing (R710, R715)

a. Set the 7B85 TIME/DIV switch to 10 μs and set the companion time-base unit for a 0.2 μs/div sweep rate.

b. Set the time-mark generator for 10 μs markers.

c. Set the amplifier unit position control to center the intensified trace in the upper half of the graticule. Set the TRACE SEP control clockwise to position the delayed-sweep traces together.

d. Set the DELAY TIME control to start the first intensified zone on the second time marker and set the Δ TIME control to start the second intensified zone on the tenth time marker. Rotate the Δ TIME control for a Δ TIME readout of exactly 80.00 μs.

e. Check that the time markers of both the first and second delayed-sweep traces are horizontally aligned within 1.0 div.

f. ADJUST—R710 (10 μs Timing) to horizontally align the delayed-sweep time markers.

g. Set the 7B85 TIME/DIV switch to 10 ms and set the companion time-base unit for a 0.2 ms/div sweep rate.

h. Set the time-mark generator for 10 ms markers.

i. Set the DELAY TIME control to start the first intensified zone on the second time marker, and set the Δ TIME control to start the second intensified zone on the tenth marker. Rotate the Δ TIME control for a Δ TIME readout of exactly 80.00 ms.

j. check that the time markers of both the first and second delayed-sweep traces are horizontally aligned within 1.0 div.

k. ADJUST—R715 (10 ms Timing) to horizontally align the delayed-sweep time markers.

B14. Check Δ Time Accuracy

a. Remove the 7B85 and plug-in extender from the A horizontal compartment. Then, install the 7B85 directly into the A horizontal compartment.

b. Set the TRACE SEP control to position the second delayed-sweep trace approximately 0.2 div below the first delayed-sweep trace.

c. Set the time-mark generator for 0.2 μs markers. Set the TIME/DIV switch to 0.1 μs and the companion time-base unit for a 10 ns/div sweep rate (unmagnified).

d. Position the display for 1 marker/div over the center 8 divisions of intensified display.

e. Set the DELAY TIME control to start the first intensified zone on the time marker that is nearest the second graticule line. Set the Δ TIME control to start the second intensified zone on the time marker that is nearest the tenth graticule line.

f. Further adjust the Δ TIME control to horizontally align the time markers of the first and second delayed-sweep traces.

g. CHECK—for a Δ TIME readout between 795.6 ns and 804.4 ns.

NOTE

The limits in part g and Table 5-3 are derived from the Performance Requirement in the Specification section.

EXAMPLE: The Performance Requirement for Δ TIME accuracy at 0.1 μs/DIV is:

Within (0.5% measurement + 0.03% full scale + 1 least significant digit).

For an 8 division measurement (80 ns), the accuracy is:

±(0.5% of 800 ns + 0.03% of 1000 ns + 0.1 ns) = ±(4.0 ns + 0.3 ns + 0.1 ns) = ± 4.4 ns

Therefore, the specified limits for a measurement interval of 800 ns are:

800 ns ± 4.4 ns = 795.6 ns to 804.4 ns.

h. CHECK—Follow the procedure outlined in parts c through g and check for Δ TIME accuracy as given in Table 5-3.

Table 5-3
Δ TIME ACCURACY

7B85 TIME/DIV	Companion Time Base Sweep Rate	Time Markers	Δ Time Readout Range
.1 μs	10 ns	.1 μs	795.6 ns to 804.4 ns
.2 μs	20 ns	.2 μs	1.591 μs to 1.609 μs
.5 μs	50 ns	.5 μs	3.977 μs to 4.023 μs
1 μs	.1 μs	1 μs	7.956 μs to 8.044 μs
2 μs	.2 μs	2 μs	15.91 μs to 16.09 μs
5 μs	.5 μs	5 μs	39.77 μs to 40.23 μs
10 μs	1 μs	10 μs	79.56 μs to 80.44 μs
20 μs	2 μs	20 μs	159.1 μs to 160.9 μs
50 μs	5 μs	50 μs	397.7 μs to 402.3 μs
.1 ms	10 μs	.1 ms	795.6 μs to 804.4 μs
.2 ms	20 μs	.2 ms	1.591 ms to 1.609 ms
.5 ms	50 μs	.5 ms	3.977 ms to 4.023 ms
1 ms	.1 ms	1 ms	7.956 ms to 8.044 ms
2 ms	.2 ms	2 ms	15.91 ms to 16.09 ms
5 ms	.5 ms	5 ms	39.77 ms to 40.23 ms
10 ms	1 ms	10 ms	79.56 ms to 80.44 ms
20 ms	2 ms	20 ms	159.1 ms to 160.9 ms
50 ms	5ms	50 ms	397.4 ms to 402.6 ms
.1 s	10 ms	.1 s	794.9 ms to 805.1 ms
.2 s	20 ms	.2 s	1.589 s to 1.611 s
.5 s	50 ms	.5 s	3.974 s to 4.026 s

B15. Check Δ TIME Linearity

a. Set the TIME/DIV switch to 1 ms.

b. Set the time-mark generator for 0.5 ms markers and set the companion time-base unit for a 10 μs/div sweep rate.

c. Position the delaying- and delayed-sweep traces horizontally to start on the first graticule line.

d. Set the DELAY TIME control to place the first intensified zone on the time marker that is between the first and second graticule lines (second time marker).

e. Set the Δ TIME control to place the second intensified zone to the time marker that is 0.5 division from the first intensified time marker (third time marker).

f. Set the Δ TIME control to precisely align the delayed-sweep traces.

g. CHECK—Δ TIME readout for 0.496 ms to 0.504 ms.

h. Set the DELAY TIME control to position the first intensified zone to the next 0.5 ms time marker (third time marker). Then, rotate the Δ TIME control to precisely align the delayed-sweep traces.

i. CHECK—Δ TIME readout for 0.496 ms to 0.504 ms.

j. Set the DELAY TIME control to position the first intensified zone to the next 0.5 ms time marker (fourth time marker). Then, rotate the Δ TIME control to precisely align the delayed sweep traces.

k. CHECK—Δ TIME readout for 0.496 ms to 0.504 ms.

l. CHECK—Use the procedure outlined in parts h through k and check Δ TIME linearity at each 0.5 div point until the first intensified zone is beyond the tenth graticule line.

B16. Check Delay Time Accuracy (Start of Delayed Sweep Display with Respect to Delaying Sweep Display)

a. Set the TRACE SEP control into the OFF detent to disable the Δ TIME operation.

b. Set the time-mark generator for 1 ms markers.

c. Position the delaying- and delayed-sweep traces to start on the first graticule line.

d. Set the DELAY TIME control to place the intensified zone on the second time marker.

e. Set the DELAY TIME control to precisely position the leading edge of the delayed-time marker to the first graticule line.

f. CHECK—delay-time readout for 0.945 ms to 1.055 ms.

g. Set the DELAY TIME control to place the intensified zone on the sixth time marker.

h. Set the DELAY TIME control to precisely position the leading edge of the delayed time marker to the first graticule line.

i. CHECK—delay-time readout for 4.925 ms to 5.075 ms.

j. Set the DELAY TIME control to place the intensified zone on the tenth time marker.

k. Set the DELAY TIME control to precisely position the leading edge of the delayed time marker to the first graticule line.

l. CHECK—delay time readout for 8.905 ms to 9.095 ms.

B17. Check Delay Time Jitter

a. Set the companion time-base unit sweep rate to 2 μs/div. Set the time-mark generator for 10 μs markers.

b. Set the DELAY TIME control for a delay-time readout of approximately 1.000 ms

c. Set the DELAY TIME control further to position a delayed-sweep time marker near the display center.

d. Magnify the companion time-base unit sweep rate to 200 ns/div (MAG X10) and position the delayed-sweep time marker near the graticule center.

e. CHECK—for 1 division or less jitter.

f. Set the companion time-base unit for X1 sweep magnification (2 μs/div). Set the DELAY TIME control for a delay-time readout of approximately 9.000 ms.

g. CHECK—Repeat parts c through e.

h. Set the companion time-base unit sweep rate to 20 ns/div and magnification to X1. Set the time-mark generator for 0.1 μs markers.

i. Set the 7B85 TIME/DIV switch to 10 μs.

j. Set the DELAY TIME control for a delay-time readout of approximately 10.00 μs.

k. Set the DELAY TIME control further to position a delayed-sweep time marker near the display center.

l. Magnify the companion time-base unit sweep rate to 2 ns/div (MAG X10) and position the delayed-sweep time marker near the graticule center.

m. CHECK—for 1 division or less jitter.

n. Set the companion time-base unit sweep magnification to X1 (20 ns/div). Set the DELAY TIME control for a delay-time readout of approximately 90.00 μs.

o. CHECK—Repeat parts k through m.

B18. Check Sweep Timing

NOTE

The tolerances given in Table 5-4 are for an ambient temperature range of +15° to +35° C. If outside this range, see the Specification section for applicable tolerances.

a. Set the POSITION controls to midrange and TRIGGERING MODE to NORM. Set the mainframe horizontal mode to A.

b. CHECK—Using the TIME/DIV setting and time-mark generator settings from Table 5-4, check sweep accuracy for 1 time mark/div over the center 8 divisions within the tolerance given in Table 5-4. Set the POSITION controls and TRIGGERING LEVEL control as necessary for a stable display aligned with the vertical graticule lines.

NOTE

If the time-mark generator used does not have 1-2-5 sequence markers, apply 1 unit markers in place of 2 unit markers and check for 2 markers/div over the center 8 divisions of display, to the tolerances given in Tables 5-4 and 5-5.

Table 5-4
SWEEP TIMING

TIME/DIV	Time Markers	Tolerance (+15° to +35°C)
10 ns	10 ns	Within 0.2 div
20 ns	20 ns	Within 0.2 div
50 ns	50 ns	Within 0.2 div
.1 μs	.1 μs	Within 0.12 div
.2 μs	.2 μs	Within 0.12 div
.5 μs	.5 μs	Within 0.12 div
1 μs	1 μs	Within 0.12 div
2 μs	2 μs	Within 0.12 div
5 μs	5 μs	Within 0.12 div
10 μs	10 μs	Within 0.12 div
20 μs	20 μs	Within 0.12 div
50 μs	50 μs	Within 0.12 div
.1 ms	.1 ms	Within 0.12 div
.2 ms	.2 ms	Within 0.12 div
.5 ms	.5 ms	Within 0.12 div
1 ms	1 ms	Within 0.12 div
2 ms	2 ms	Within 0.12 div
5 ms	5 ms	Within 0.12 div
10 ms	10 ms	Within 0.12 div
20 ms	20 ms	Within 0.12 div
50 ms	50 ms	Within 0.12 div
.1 s	.1 s	Within 0.12 div
.2 s	.2 s	Within 0.12 div
.5 s	.5 s	Within 0.12 div
1 s	1 s	Within 0.32 div
2 s	2 s	Within 0.32 div
5 s	5 s	Within 0.32 div

B19. Check Magnified Sweep Timing

NOTE

The tolerances in Table 5-5 are for an ambient temperature range of +15° to +35° C. If outside this range, see the Specification section for applicable tolerances.

a. Set the POSITION controls to midrange. Set the MAG switch to X10 and the SOURCE switch to EXT.

b. Connect the time-mark generator trigger output to the EXT TRIG IN connector with a 50 Ω cable and 50 Ω termination.

c. CHECK—Using the TIME/DIV settings and time-mark generator settings in Table 5-5, check magnified sweep accuracy for 1 time mark/div, over the center 8 divisions, within the tolerance given in Table 5-5. Set the POSITION controls and TRIGGERING LEVEL control as necessary for a stable display aligned with the vertical graticule lines.

This completes the Performance Check and Adjustment procedure.

Table 5-5
MAGNIFIED SWEEP TIMING

TIME/DIV	Time Markers	Tolerance (+15° to +35°C)
10 ns	2 ns	[a] Within 0.32 div
20 ns	2 ns	Within 0.32 div
50 ns	5 ns	Within 0.32 div
.1 μs	10 ns	Within 0.2 div
.2 μs	20 ns	Within 0.2 div
.5 μs	50 ns	Within 0.2 div
1 μs	.1 μs	Within 0.2 div
2 μs	.2 μs	Within 0.2 div
5 μs	.5 μs	Within 0.2 div
10 μs	1 μs	Within 0.2 div
20 μs	2 μs	Within 0.2 div
50 μs	5 μs	Within 0.2 div
.1 ms	10 μs	Within 0.2 div
.2 ms	20 μs	Within 0.2 div
.5 ms	50 μs	Within 0.2 div
1 ms	.1 ms	Within 0.2 div
2 ms	.2 ms	Within 0.2 div
5 ms	.5 ms	Within 0.2 div
10 ms	1 ms	Within 0.2 div
20 ms	2 ms	Within 0.2 div
50 ms	5 ms	Within 0.2 div
.1 s	10 ms	Within 0.2 div
.2 s	20 ms	Within 0.2 div
.5 s	50 ms	Within 0.2 div
1 s	.1 s	Within 0.4 div
2 s	.2 s	Within 0.4 div
5 s	.5 s	Within 0.4 div

[a] **Check for 1 time-marker in 2 div over the center 8 div.**

INSTRUMENT OPTIONS

No options were available for this instrument at the time of this printing.

Information on any subsequent options may be found in the CHANGE INFORMATION section in the back of this manual.

REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

ACTR	ACTUATOR	PLSTC	PLASTIC
ASSY	ASSEMBLY	QTZ	QUARTZ
CAP	CAPACITOR	RECP	RECEPTACLE
CER	CERAMIC	RES	RESISTOR
CKT	CIRCUIT	RF	RADIO FREQUENCY
COMP	COMPOSITION	SEL	SELECTED
CONN	CONNECTOR	SEMICOND	SEMICONDUCTOR
ELCTLT	ELECTROLYTIC	SENS	SENSITIVE
ELEC	ELECTRICAL	VAR	VARIABLE
INCAND	INCANDESCENT	WW	WIREWOUND
LED	LIGHT EMITTING DIODE	XFMR	TRANSFORMER
NONWIR	NON WIREWOUND	XTAL	CRYSTAL

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P O BOX 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
02111	SPECTROL ELECTRONICS CORPORATION	17070 EAST GALE AVENUE	CITY OF INDUSTRY, CA 91745
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
03508	GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR PRODUCTS DEPARTMENT	ELECTRONICS PARK	SYRACUSE, NY 13201
04222	AVX CERAMICS, DIVISION OF AVX CORP.	P O BOX 867, 19TH AVE. SOUTH	MYRTLE BEACH, SC 29577
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
08806	GENERAL ELECTRIC CO., MINIATURE LAMP PRODUCTS DEPARTMENT	NELA PARK	CLEVELAND, OH 44112
09023	CORNELL-DUBILIER ELECTRONIC DIVISION FEDERAL PACIFIC ELECTRIC CO.	2652 DALRYMPLE ST.	SANFORD, NC 27330
11237	CTS KEENE, INC.	3230 RIVERSIDE AVE.	PASO ROBLES, CA 93446
12697	CLAROSTAT MFG. CO., INC.	LOWER WASHINGTON STREET	DOVER, NH 03820
12969	UNITRODE CORPORATION	580 PLEASANT STREET	WATERTOWN, MA 02172
14552	MICRO SEMICONDUCTOR CORP.	2830 E FAIRVIEW ST.	SANTA ANA, CA 92704
14752	ELECTRO CUBE INC.	1710 S. DEL MAR AVE.	SAN GABRIEL, CA 91776
17856	SILICONIX, INC.	2201 LAURELWOOD DRIVE	SANTA CLARA, CA 95054
18324	SIGNETICS CORP.	811 E. ARQUES	SUNNYVALE, CA 94086
24546	CORNING GLASS WORKS, ELECTRONIC COMPONENTS DIVISION	550 HIGH STREET	BRADFORD, PA 16701
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
32293	INTERSIL, INC.	10900 N. TANTAU AVE.	CUPERTINO, CA 95014
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
50434	HEWLETT-PACKARD COMPANY	640 PAGE MILL ROAD	PALO ALTO, CA 94304
51984	NEC AMERICA INC. RADIO AND TRANSMISSION DIV.	2990 TELESTAR CT. SUITE 212	FALLS CHURCH, VA 22042
53184	XCITON CORPORATION	5 HEMLOCK STREET	LATHAM, NY 12110
56289	SPRAGUE ELECTRIC CO.	87 MARSHALL ST.	NORTH ADAMS, MA 01247
59660	TUSONIX INC.	2155 N FORBES BLVD	TUCSON, AZ 85705
71590	CENTRALAB ELECTRONICS, DIV. OF GLOBE-UNION, INC.	P O BOX 858	FORT DODGE, IA 50501
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
74970	JOHNSON, E. F., CO.	299 10TH AVE. S. W.	WASECA, MN 56093
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
78488	STACKPOLE CARBON CO.		ST. MARYS, PA 15857
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
90201	MALLORY CAPACITOR CO., DIV. OF P. R. MALLORY AND CO., INC.	3029 E. WASHINGTON STREET P. O. BOX 372	INDIANAPOLIS, IN 46206
91418	RADIO MATERIALS COMPANY, DIV. OF P.R. MALLORY AND COMPANY, INC.	4242 W BRYN MAWR	CHICAGO, IL 60646
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	----- -----			CKT BOARD ASSY:INTERFACE		
A1	----- -----			(REPLACEABLE UNDER 672-0540-XX ONLY)		
A2	670-4181-00	B010100	B069999	CKT BOARD ASSY:TRIGGER	80009	670-4181-00
A2	670-4181-01	B070000		CKT BOARD ASSY:TRIGGER	80009	670-4181-01
A3	670-4183-00			CKT BOARD ASSY:READOUT	80009	670-4183-00
A4	670-4184-00	B010100	B088749	CKT BOARD ASSY:DVM	80009	670-4184-00
A4	670-4184-01	B088750		CKT BOARD ASSY:DVM	80009	670-4184-01
C3	290-0748-00			CAP.,FXD,ELCTLT:10UF,+50-10%,20V	56289	500D149
C5	290-0748-00			CAP.,FXD,ELCTLT:10UF,+50-10%,20V	56289	500D149
C7	290-0748-00			CAP.,FXD,ELCTLT:10UF,+50-10%,20V	56289	500D149
C9	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C12	281-0661-00			CAP.,FXD,CER DI:0.8PF,+/-0.1PF,500V	04222	7001-1268
C14	281-0503-00			CAP.,FXD,CER DI:8PF,+/-0.5PF,500V	59660	301-000C0H0809D
C15	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C20	281-0505-00			CAP.,FXD,CER DI:12PF,+/-1.2PF,500V	59660	301-012C0G0120K
C21	283-0299-00			CAP.,FXD,CER DI:51PF,5%,500V	72982	8121N501C0G510J
C22	283-0299-00			CAP.,FXD,CER DI:51PF,5%,500V	72982	8121N501C0G510J
C23	281-0812-00	B070000		CAP.,FXD,CER DI:1000PF,10%,100V	72982	8035D9AADX7R102K
C30	281-0773-00	B010100	B069999	CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C30	281-0813-00	B070000		CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
C34	281-0525-00			CAP.,FXD,CER DI:470PF,+/-94PF,500V	04222	7001-1364
C35	281-0551-00			CAP.,FXD,CER DI:390PF,10%,500V	04222	7001-1363
C37	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C43	283-0203-00			CAP.,FXD,CER DI:0.47UF,20%,50V	72982	8131M058Z5U0474M
C46	281-0792-00			CAP.,FXD,CER DI:82PF,10%,100V	72982	8035D2AADC0G820K
C51	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C52	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C53	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C56	283-0010-00	B010100	B039999	CAP.,FXD,CER DI:0.05UF,+100-20%,50V	56289	273C20
C56	283-0341-00	B040000		CAP.,FXD,CER DI:0.047UF,10%,100V	72982	8121N153X7R0473K
C57	283-0203-00			CAP.,FXD,CER DI:0.47UF,20%,50V	72982	8131M058Z5U0474M
C66	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C67	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C68	283-0195-00			CAP.,FXD,CER DI:680PF,5%,50V	72982	8121N075C0G0681J
C69	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C71	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C72	290-0580-00			CAP.,FXD,ELCTLT:0.27UF,20%,50V	56289	196D274X0050HA1
C73	283-0114-00			CAP.,FXD,CER DI:0.0015UF,5%,200V	59660	534 Y5D0 152 J
C74	283-0114-00			CAP.,FXD,CER DI:0.0015UF,5%,200V	59660	534 Y5D0 152 J
C75	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C76	290-0580-00			CAP.,FXD,ELCTLT:0.27UF,20%,50V	56289	196D274X0050HA1
C84	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C85	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C88	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C89	281-0786-00			CAP.,FXD,CER DI:150PF,10%,100V	72982	8035D2AADX5P151K
C92	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C99	281-0786-00	B050000		CAP.,FXD,CER DI:150PF,10%,100V	72982	8035D2AADX5P151K
C204	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	0831610Y5P0102D
C211	283-0672-00			CAP.,FXD,MICA D:200PF,1%,500V	00853	D155F2010F0
C212	283-0555-00			CAP.,FXD MICA D:2000PF,1%,500V	09023	CD19FD202J03
C213	285-0683-00			CAP.,FXD,PLSTC:0.022UF,5%,100V	56289	192P22352
C214	290-0269-00			CAP.,FXD,ELCTLT:0.22UF,5%,35V	56289	162D224X5035BC2
C215	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0020HA1

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C221	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C222	283-0110-00			CAP.,FXD,CER DI:0.005UF,+80-20%,150V	56289	19C242B
C225	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C228	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C255	283-0028-00			CAP.,FXD,CER DI:0.0022UF,20%,50V	56289	55C144
C263	281-0782-00	B010100	B088749	CAP.,FXD,CER DI:33PF,10%,500V	59660	301-000N4700330K
C263	281-0629-00	B088750		CAP.,FXD,CER DI:33PF,5%,600V	04222	7027-C0G-330J
C312	283-0691-00			CAP.,FXD,MICA D:650PF,1%,300V	00853	D153F651F0
C324	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C330	281-0166-00			CAP.,VAR,AIR DI:1.9-15.7PF,250V	74970	187-0109-055
C331	283-0633-00			CAP.,FXD,MICA D:77PF,1%,100V	00853	D151E770F0
C332	295-0172-00			CAP SET,MATCHED:0.1UF,10UF,905PF,0.75%	80009	295-0172-00
C333	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C334	295-0172-00			CAP SET,MATCHED:0.1UF,10UF,905PF,0.75%	80009	295-0172-00
C335	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C336	295-0172-00			CAP SET,MATCHED:0.1UF,10UF,905PF,0.75%	80009	295-0172-00
C356	283-0616-00			CAP.,FXD,MICA D:75PF,5%,500V	00853	D155E750J0
C416	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	91418	SP103Z151-4R9
C432	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C440	281-0616-00			CAP.,FXD,CER DI:6.8PF,+/-0.5PF,200V	59660	374-018-C0H0689D
C441	281-0592-00			CAP.,FXD,CER DI:4.7PF,+/-0.5PF,500V	59660	301-000-C0H0479D
C515	283-0004-00	B010100	B039999	CAP.,FXD,CER DI:0.02UF,+80-20%,150V	91418	SP203Z151-4R9
C515	283-0111-00	B040000		CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C520	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C522	283-0119-00			CAP.,FXD,CER DI:2200PF,5%,200V	59660	855-536Y5E0222J
C523	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C526	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C530	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C532	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C556	281-0826-00	B092075		CAP.,FXD,CER DI:2200PF,5%,100V	12969	CGB222KEX
C573	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C576	283-0111-00	B050000	B088749	CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C608	281-0791-00	B010100	B088749	CAP.,FXD,CER DI:270PF,10%,100V	72982	8035D2AADX5R271K
C627	285-0809-00	B010100	B092054	CAP.,FXD,PLSTC:1UF,10%,50V	56289	LP66A1A105K
C627	285-1056-00	B092055		CAP.,FXD,PLSTC:1UF,2%,50V	14752	650B1A105G
C626	281-0762-00	B088750		CAP.,FXD,CER DI:27PF,20%,100V	72982	8035D9AADC0G270M
C645	281-0786-00	B010100	B088749	CAP.,FXD,CER DI:150PF,10%,100V	72982	8035D2AADX5P151K
C652	285-0627-00	B010100	B088749	CAP.,FXD,PLSTC:0.0033UF,5%,100V	56289	192P33252
C654	283-0032-00	B010100	B088749	CAP.,FXD,CER DI:470PF,5%,500V	72982	0831085Z5E00471J
C662	281-0786-00	B010100	B088749	CAP.,FXD,CER DI:150PF,10%,100V	72982	8035D2AADX5P151K
C676	283-0673-00	B010100	B088749	CAP.,FXD,MICA D:455PF,1%,500V	00853	D155F4550F0
C679	283-0198-00	B010100	B088749	CAP.,FXD,CER DI:0.22UF,20%,50V	56289	1C10Z5U223M050B
C683	290-0512-00	B010100	B088749	CAP.,FXD,ELCTLT:22UF,20%,15V	56289	196D226X0015KA1
C684	283-0000-00	B010100	B088749	CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	0831610Y5P0102D
C686	281-0791-00	B010100	B088749	CAP.,FXD,CER DI:270PF,10%,100V	72982	8035D2AADX5R271K
C686	283-0691-00	B088750		CAP.,FXD,MICA D:650PF,1%,300V	00853	D153F651F0
C687	281-0773-00	B088750		CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C690	290-0531-00	B010100	B059999	CAP.,FXD,ELCTLT:100UF,20%,10V	90201	TDC107M010WLC
C691	290-0748-00			CAP.,FXD,ELCTLT:10UF,+50-10%,20V	56289	500D149
C692	290-0748-00			CAP.,FXD,ELCTLT:10UF,+50-10%,20V	56289	500D149
C693	281-0775-00	B088750		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
C694	290-0748-00	B088750		CAP.,FXD,ELCTLT:10UF,+50-10%,20V	56289	500D149
C695	283-0111-00	B010100	B088794	CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C696	290-0535-00	B010100	B059999	CAP.,FXD,ELCTLT:33UF,20%,10V	56289	196D336X0010KA1

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C697	290-0748-00	B010100	B088749	CAP.,FXD,ELCTLT:10UF,+50-10%,20V	56289	500D149
C699	281-0786-00	B010100	B088749	CAP.,FXD,CER DI:150PF,10%,100V	72982	8035D2AADX5P151K
C712	290-0420-00			CAP.,FXD,ELCTLT:0.68UF,20%,75V	56289	150D684X0075A2
C722	283-0054-00			CAP.,FXD,CER DI:150PF,5%,200V	59660	855-535U2J0 151J
C730	283-0110-00			CAP.,FXD,CER DI:0.005UF,+80-20%,150V	56289	19C242B
C731	283-0204-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N061Z5U0103M
C810	283-0178-00			CAP.,FXD,CER DI:0.1UF,+80-20%,100V	72982	8131N145651 104Z
C820	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
C822	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	91418	SP203Z151-4R9
C830	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
C840	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
C844	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	91418	SP203Z151-4R9
CR23	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR24	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR53	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR55	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR71	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR75	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR201	152-0153-00			SEMICOND DEVICE:SILICON,15V,50MA	07263	FD7003
CR206	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR208	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR224	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR225	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR226	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR248	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR250	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR252	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR254	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR255	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR256	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR264	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR273	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR286	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR288	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR291	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR292	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR293	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR294	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR295	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR296	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR301	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR302	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR314	152-0141-02	B040000		SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR323	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
CR324	152-0242-00	B040000		SEMICOND DEVICE:SILICON,225V,200MA	07263	FDH5004
CR334	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR344	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR356	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR362	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR372	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
CR382	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR423	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR433	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R

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CR435	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR526	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR543	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR548	152-0141-02	B088750		SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR567	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR574	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR627	152-0246-00	B010100	B088749	SEMICOND DEVICE:SW,SI,40V,200MA	03508	DE140
CR632	152-0141-02	B088750		SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR634	152-0141-02	B088750		SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR635	152-0141-02	B088750		SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR641	152-0141-02	B010100	B088794	SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR642	152-0141-02	B010100	B088794	SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR643	152-0141-02	B088750		SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR683	152-0141-02	B010100	B088749	SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR684	152-0322-00	B010100	B088794	SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
CR717	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR718	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR723	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR724	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR725	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR751	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR752	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR753	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR754	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR763	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR772	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR773	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR782	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR783	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR785	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR786	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR844	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
DS220	150-1029-00			LT EMITTING DIO:GREEN,565NM,35MA	53184	XC209G
DS232	150-1033-00			LT EMITTING DIO:YELLOW,585NM,40MA MAX	50434	HLMP 1401
DS810	150-0048-01			LAMP,INCAND:5V,0.06A,SEL	08806	683AS15
DS820	150-0048-01			LAMP,INCAND:5V,0.06A,SEL	08806	683AS15
L274	276-0507-00			SHIELDING BEAD,:FERRITE	78488	57-3443
L382	276-0507-00			SHIELDING BEAD,:FERRITE	78488	57-3443
L691	108-0543-00			COIL,RF:FIXED,1.1UH	80009	108-0543-00
L692	108-0543-00	B010100	B088749	COIL,RF:FIXED,1.1UH	80009	108-0543-00
L694	108-0543-00	B088750		COIL,RF:FIXED,1.1UH	80009	108-0543-00
L697	108-0543-00	B010100	B088749	COIL,RF:FIXED,1.1UH	80009	108-0543-00
LR3	108-0543-00			COIL,RF:FIXED,1.1UH	80009	108-0543-00
LR5	108-0537-00			COIL,RF:200UH	80009	108-0537-00
LR7	108-0543-00			COIL,RF:FIXED,1.1UH	80009	108-0543-00
LR70	108-0328-00			COIL,RF:0.3UH	80009	108-0328-00
LR75	108-0328-00			COIL,RF:0.3UH	80009	108-0328-00
LR326	108-0271-00			COIL,RF:0.025UH	80009	108-0271-00
LR810	108-0537-00			COIL,RF:200UH	80009	108-0537-00
LR820	108-0537-00			COIL,RF:200UH	80009	108-0537-00
LR830	108-0537-00			COIL,RF:200UH	80009	108-0537-00

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LR840	108-0537-00			COIL,RF:200UH	80009	108-0537-00
Q22	151-1042-00			SEMICOND DVC SE:MATCHED PAIR FET	01295	SKA5390
Q48	151-0190-00	B070000		TRANSISTOR:SILICON,NPN	07263	S032677
Q88	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q92	151-0271-00	B010100	B088450	TRANSISTOR:SILICON,PNP	04713	SPS8236
Q92	151-0221-00	B088451		TRANSISTOR:SILICON,PNP	04713	SPS246
Q96	151-0271-00	B010100	B088450	TRANSISTOR:SILICON,PNP	04713	SPS8236
Q96	151-0221-00	B088451		TRANSISTOR:SILICON,PNP	04713	SPS246
Q98	151-0325-00	B010100	B083999	TRANSISTOR:SILICON,PNP,SEL FROM 2N4258	80009	151-0325-00
Q98	151-0342-00	B084000		TRANSISTOR:SILICON,PNP	07263	S035928
Q201	151-0325-00	B010100	B083999	TRANSISTOR:SILICON,PNP,SEL FROM 2N4258	80009	151-0325-00
Q201	151-0221-00	B084000		TRANSISTOR:SILICON,PNP	04713	SPS246
Q202	151-0325-00			TRANSISTOR:SILICON,PNP,SEL FROM 2N4258	80009	151-0325-00
Q203	151-0220-00	B010100	B029999	TRANSISTOR:SILICON,PNP	07263	S036228
Q203	151-0216-00	B030000		TRANSISTOR:SILICON,PNP	04713	SPS8803
Q204	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q206	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q210	151-0273-00			TRANSISTOR:SILICON,NPN	80009	151-0273-00
Q214	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q230	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
Q234	151-0301-00			TRANSISTOR:SILICON,PNP	27014	2N2907A
Q242	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q252	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q254	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q262	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q264	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q272	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q274	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q282	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q284	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q288	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q292	151-0190-00	B010100	B088749	TRANSISTOR:SILICON,NPN	07263	S032677
Q292	151-0192-00	B088750		TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q294	151-0221-00	B010100	B088749	TRANSISTOR:SILICON,PNP	04713	SPS246
Q294	151-0220-00	B088750		TRANSISTOR:SILICON,PNP	07263	S036228
Q304	151-0354-00			TRANSISTOR:SILICON,PNP,DUAL	32293	ITS1200A
Q314	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q322	151-0367-00			TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	01295	SKA6516
Q324	151-0367-00			TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	01295	SKA6516
Q334	151-1036-00			TRANSISTOR:SILICON,JFE,N-CHANNEL,DUAL	17856	DN1663
Q338	151-0437-00	B010100	B083449	TRANSISTOR:SILICON,NPN,SEL FROM 2N5769	80009	151-0437-00
Q338	151-0127-00	B083450		TRANSISTOR:SILICON,NPN	07263	S006075
Q344	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q346	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q352	151-0325-00	B010100	B083999	TRANSISTOR:SILICON,PNP,SEL FROM 2N4258	80009	151-0325-00
Q352	151-0221-00	B084000		TRANSISTOR:SILICON,PNP	04713	SPS246
Q356	151-0325-00	B010100	B083999	TRANSISTOR:SILICON,PNP,SEL FROM 2N4258	80009	151-0325-00
Q356	151-0221-00	B084000		TRANSISTOR:SILICON,PNP	04713	SPS246
Q358	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q362	151-0325-00	B010100	B083999	TRANSISTOR:SILICON,PNP,SEL FROM 2N4258	80009	151-0325-00
Q362	151-0221-00	B084000		TRANSISTOR:SILICON,PNP	04713	SPS246
Q372	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q382	151-0367-00			TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	01295	SKA6516

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Q424	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q428	151-0325-00			TRANSISTOR:SILICON,PNP,SEL FROM 2N4258	80009	151-0325-00
Q434	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q438	151-0325-00			TRANSISTOR:SILICON,PNP,SEL FROM 2N4258	80009	151-0325-00
Q448	151-0472-00			TRANSISTOR:SILICON,NPN	51984	NE41632B
Q458	151-0472-00			TRANSISTOR:SILICON,NPN	51984	NE41632B
Q512	151-0354-00			TRANSISTOR:SILICON,PNP,DUAL	32293	ITS1200A
Q518	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q522	151-0354-00			TRANSISTOR:SILICON,PNP,DUAL	32293	ITS1200A
Q528	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q534	151-0220-00	B010100	B088749	TRANSISTOR:SILICON,PNP	07263	S036228
Q534	151-0216-00	B088750		TRANSISTOR:SILICON,PNP	04713	SPS8803
Q536	151-0410-00	B010100	B088749	TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q536	151-0216-00	B088750		TRANSISTOR:SILICON,PNP	04713	SPS8803
Q546	151-0432-00			TRANSISTOR:SILICON,NPN	27014	T07391E2
Q548	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q562	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q564	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q568	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q572	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q574	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q576	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q578	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q582	151-1059-00			TRANSISTOR:SILICON,FE,N-CHANNEL	80009	151-1059-00
Q592	151-1059-00			TRANSISTOR:SILICON,FE,N-CHANNEL	80009	151-1059-00
Q612	151-0192-00	B010100	B088794	TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q618	151-0410-00	B010100	B088749	TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q618	151-0216-00	B088750		TRANSISTOR:SILICON,PNP	04713	SPS8803
Q632	151-0192-00	B010100	B088794	TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q636	151-0220-00	B010100	B088794	TRANSISTOR:SILICON,PNP	07263	S036228
Q642	151-0192-00	B010100	B088794	TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q644	151-0301-00	B088750		TRANSISTOR:SILICON,PNP	27014	2N2907A
Q646	151-0190-00	B010100	B088794	TRANSISTOR:SILICON,NPN	07263	S032677
Q652	151-0192-00	B010100	B088794	TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q654	151-0192-00	B010100	B088794	TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q672	151-0220-00	B010100	B088749	TRANSISTOR:SILICON,PNP	07263	S036228
Q676	151-0220-00	B010100	B088749	TRANSISTOR:SILICON,PNP	07263	S036228
Q678	151-0190-00	B010100	B088749	TRANSISTOR:SILICON,NPN	07263	S032677
Q696	151-0350-00	B010100	B088749	TRANSISTOR:SILICON,PNP	04713	SPS6700
Q732	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q844	151-0301-00			TRANSISTOR:SILICON,PNP	27014	2N2907A
R8	315-0512-00	B010100	B069999	RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R8	315-0622-00	B070000		RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R9	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R12	315-0915-00			RES.,FXD,CMPSN:9.1M OHM,5%,0.25W	01121	CB9155
R13	317-0470-00	B070000		RES.,FXD,CMPSN:47 OHM,5%,0.125W	01121	BB4705
R14	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R15	315-0824-00			RES.,FXD,CMPSN:820K OHM,5%,0.25W	01121	CB8245
R16	315-0274-00			RES.,FXD,CMPSN:270K OHM,5%,0.25W	01121	CB2745
R19	315-0274-00			RES.,FXD,CMPSN:270K OHM,5%,0.25W	01121	CB2745
R20	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R21	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R22	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725

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R23	315-0751-00	B070000		RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R28	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R29	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R30	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R31	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R32	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R33	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R34	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R35	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R36	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R37	315-0560-00			RES.,FXD,CMPSN:56 OHM,5%,0.25W	01121	CB5605
R38	317-0101-00	B085317		RES.,FXD,CMPSN:100 OHM,5%,0.125W	01121	BB1015
R41	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R42	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R43	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R44	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R45	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R47	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R48	315-0682-00	B070000		RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R49	311-1564-00	B070000		RES.,VAR,NONWIR:TRMR,500 OHM,0.5W	73138	91-86-0
R50	315-0133-00			RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335
R51	321-0274-00			RES.,FXD,FILM:6.98K OHM,1%,0.125W	91637	MFF1816G69800F
R52	321-0431-01			RES.,FXD,FILM:301K OHM,0.5%,0.125W	91637	MFF1816G30102D
R53	315-0124-00			RES.,FXD,CMPSN:120K OHM,5%,0.25W	01121	CB1245
R54	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R55	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R56	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R57	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R58	321-0443-00			RES.,FXD,FILM:402K OHM,1%,0.125W	91637	MFF1816G40202F
R59	321-0443-00			RES.,FXD,FILM:402K OHM,1%,0.125W	91637	MFF1816G40202F
R60	311-1192-00			RES.,VAR,NONWIR:10K OHM,20%,1W,W/SW	71590	BA-232-001
R61	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R62	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R63	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R64	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
R65	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R67	323-0155-00			RES.,FXD,FILM:402 OHM,1%,0.50W	75042	CECT0-4020F
R68	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R69	315-0131-00	B010100	B069999	RES.,FXD,CMPSN:130 OHM,5%,0.25W	01121	CB1315
R69	315-0820-00	B070000		RES.,FXD,CMPSN:82 OHM,5%,0.25W	01121	CB8205
R72	315-0205-00			RES.,FXD,CMPSN:2M OHM,5%,0.25W	01121	CB2055
R73	315-0514-00			RES.,FXD,CMPSN:510K OHM,5%,0.25W	01121	CB5145
R74	315-0514-00			RES.,FXD,CMPSN:510K OHM,5%,0.25W	01121	CB5145
R76	315-0205-00			RES.,FXD,CMPSN:2M OHM,5%,0.25W	01121	CB2055
R80	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
R83	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R84	315-0680-00			RES.,FXD,CMPSN:68 OHM,5%,0.25W	01121	CB6805
R85	311-1594-00			RES.,VAR,NONWIR:10 OHM,20%,0.50W	73138	91-93-0
R86	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R88	315-0100-00	B082252		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R89	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R90	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R91	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R92	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025

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R93	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R94	321-0202-00			RES.,FXD,FILM:1.24K OHM,1%,0.125W	91637	MFF1816G12400F
R95	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R96	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R97	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R98	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R99	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
R200	315-0201-00	B010100	B052214	RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R201	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R202	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R203	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R204	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R205	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R206	321-0219-00			RES.,FXD,FILM:1.87K OHM,1%,0.125W	91637	MFF1816G18700F
R207	321-0173-00			RES.,FXD,FILM:619 OHM,1%,0.125W	91637	MFF1816G619R0F
R208	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R209	321-0274-00			RES.,FXD,FILM:6.98K OHM,1%,0.125W	91637	MFF1816G69800F
R210	311-0467-00			RES.,VAR,NONWIR:100K OHM,20%,0.50W	11237	300SF-41334
R211	301-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.50W	01121	EB7525
R212	321-0373-00			RES.,FXD,FILM:75K OHM, 1%,0.125W	91637	MFF1816G75001F
R213	321-0373-00			RES.,FXD,FILM:75K OHM, 1%,0.125W	91637	MFF1816G75001F
R214	321-0327-00			RES.,FXD,FILM:24.9K OHM,1%,0.125W	91637	MFF1816G24901F
R215	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R216	321-0327-00			RES.,FXD,FILM:24.9K OHM,1%,0.125W	91637	MFF1816G24901F
R217	321-0288-00	B010100	B029999	RES.,FXD,FILM:9.76K OHM,1%,0.125W	91637	MFF1816G97600F
R217	321-0291-00	B030000		RES.,FXD,FILM:10.5K OHM,1%,0.125W	91637	MFF1816G10501F
R218	321-0274-00	B010100	B029999	RES.,FXD,FILM:6.98K OHM,1%,0.125W	91637	MFF1816G69800F
R218	321-0267-00	B030000		RES.,FXD,FILM:5.9K OHM,1%,0.125W	91637	MFF1816G59000F
R222	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R224	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R226	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R227	315-0121-00			RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
R228	315-0184-00			RES.,FXD,CMPSN:180K OHM,5%,0.25W	01121	CB1845
R231	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R232	315-0121-00			RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
R233	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
R234	315-0430-00			RES.,FXD,CMPSN:43 OHM,5%,0.25W	01121	CB4305
R240	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R241	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
R242	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R243	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R244	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R248	315-0163-00			RES.,FXD,CMPSN:16K OHM,5%,0.25W	01121	CB1635
R249	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R250	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R251	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R253	315-0912-00	B010100	B088749	RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R253	315-0113-00	B088750		RES.,FXD,CMPSN:11K OHM,5%,0.25W	01121	CB1135
R254	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R255	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R256	315-0102-00	B010100	B088749	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R257	315-0133-00	B010100	B088749	RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335
R261	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R262	315-0472-00	B010100	B049999	RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725

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R263	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R264	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R271	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R272	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R274	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R275	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R280	315-0820-00			RES.,FXD,CMPSN:82 OHM,5%,0.25W	01121	CB8205
R281	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R282	315-0624-00			RES.,FXD,CMPSN:620K OHM,5%,0.25W	01121	CB6245
R283	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R284	315-0511-00	B010100	B088749	RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R284	315-0471-00	B088750		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R285	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R286	315-0563-00			RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
R287	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R288	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R291	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R292	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R293	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R294	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R295	311-1322-00			RES.,VAR,NONWIR:5K OHM,10%,1W	12697	381-CM39701
R296	315-0512-00	B010100	B088749	RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R296	315-0432-00	B088750		RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R297	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R301	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R303	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R304	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R305	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
R307	321-0301-00			RES.,FXD,FILM:13.3K OHM,1%,0.125W	91637	MFF1816G13301F
R308	321-0275-00			RES.,FXD,FILM:7.15K OHM,1%,0.125W	91637	MFF1816G71500F
R312	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R313	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R314	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R315	315-0112-00			RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
R321	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R322	323-0175-00			RES.,FXD,FILM:649 OHM,1%,0.50W	75042	CECT0-6490F
R323	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R324	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R325	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R326	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R330	315-0330-00			RES.,FXD,CMPSN:33 OHM,5%,0.25W	01121	CB3305
R331	315-0330-00			RES.,FXD,CMPSN:33 OHM,5%,0.25W	01121	CB3305
R332	315-0560-00			RES.,FXD,CMPSN:56 OHM,5%,0.25W	01121	CB5605
R333	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R334	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R335	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R336	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R337	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R338	315-0120-00			RES.,FXD,CMPSN:12 OHM,5%,0.25W	01121	CB1205
R339	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R341	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R342	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R343	321-0263-00			RES.,FXD,FILM:5.36K OHM,1%,0.125W	91637	MFF1816G53600F
R344	315-0431-00			RES.,FXD,CMPSN:430 OHM,5%,0.25W	01121	CB4315

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R345	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R346	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R347	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R351	315-0101-00	B010100	B091399	RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R351	315-0161-00	B091400		RES.,FXD,CMPSN:160 OHM,5%,0.25W	01121	CB1615
R352	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R353	321-0222-07			RES.,FXD,FILM:2K OHM,0.1%,0.125W	91637	MFF1816C20000B
R354	321-0196-00			RES.,FXD,FILM:1.07K OHM,1%,0.125W	91637	MFF1816G10700F
R355	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R356	321-0229-00			RES.,FXD,FILM:2.37K OHM,1%,0.125W	91637	MFF1816G23700F
R358	321-0185-00			RES.,FXD,FILM:825 OHM,1%,0.125W	91637	MFF1816G825R0F
R362	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R371	315-0121-00			RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
R372	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R381	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R382	315-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
R383	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R410	311-1781-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	12697	388CM40913
R412	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
R413	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R414	321-0362-00			RES.,FXD,FILM:57.6K OHM,1%,0.125W	91637	MFF1816G57601F
R415	311-1781-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	12697	388CM40913
R416	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R422	315-0101-00	B010100	B029999	RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R422	315-0680-00	B030000		RES.,FXD,CMPSN:68 OHM,5%,0.25W	01121	CB6805
R424	323-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.50W	75042	CECT0-9091F
R426	315-0180-00			RES.,FXD,CMPSN:18 OHM,5%,0.25W	01121	CB1805
R427	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R428	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R430	311-1423-00			RES.,VAR,NONWIR:20 OHM,20%,0.50W	73138	72-1-0
R431	321-0122-00			RES.,FXD,FILM:182 OHM,1%,0.125W	91637	MFF1816G182R0F
R432	315-0180-00			RES.,FXD,CMPSN:18 OHM,5%,0.25W	01121	CB1805
R433	315-0820-00			RES.,FXD,CMPSN:82 OHM,5%,0.25W	01121	CB8205
R434	323-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.50W	75042	CECT0-9091F
R435	321-0400-00			RES.,FXD,FILM:143K OHM,1%,0.125W	91637	MFF1816G14302F
R436	315-0180-00			RES.,FXD,CMPSN:18 OHM,5%,0.25W	01121	CB1805
R437	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R438	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R439	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R440	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R441	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R442	321-0225-06			RES.,FXD,FILM:2.15K OHM,0.25%,0.125W	91637	MFF1816C21500C
R444	322-0210-00			RES.,FXD,FILM:1.5K OHM,1%,0.25W	75042	CEBT0-1501F
R445	311-1226-00			RES.,VAR,NONWIR:2.5K OHM,20%,0.50W	32997	3386F-T04-252
R446	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R447	321-0928-03			RES.,FXD,FILM:250 OHM,0.25% 0.125W	91637	MFF1816D250R0C
R448	322-0218-00			RES.,FXD,FILM:1.82K OHM,1%,0.25W	75042	CEBT0-1821F
R449	322-0224-00			RES.,FXD,FILM:2.15K OHM,1%,0.25W	75042	CEBT0-2101F
R454	322-0210-00			RES.,FXD,FILM:1.5K OHM,1%,0.25W	75042	CEBT0-1501F
R455	321-0124-00			RES.,FXD,FILM:191 OHM,1%,0.125W	91637	MFF1816G191R0F
R456	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R457	321-0928-03			RES.,FXD,FILM:250 OHM,0.25% 0.125W	91637	MFF1816D250R0C
R458	322-0218-00			RES.,FXD,FILM:1.82K OHM,1%,0.25W	75042	CEBT0-1821F
R459	322-0224-00			RES.,FXD,FILM:2.15K OHM,1%,0.25W	75042	CEBT0-2101F

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R509	321-0222-07			RES.,FXD,FILM:2K OHM,0.1%,0.125W	91637	MFF1816C20000B
R510	311-1594-00			RES.,VAR,NONWIR:10 OHM,20%,0.50W	73138	91-93-0
R513	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R514	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R515	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R518	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R520	311-0946-00	B010100	B039999	RES.,VAR,WW:50K OHM,3%,2W	02111	534-70
R520	311-1889-00	B040000		RES.,VAR,WW:PNL,50K OHM,2W	32997	3541S-458-503
R521	315-0331-00	B010100	B088794	RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R521	321-0222-07	B088750		RES.,FXD,FILM:2K OHM,0.1%,0.125W	91637	MFF1816C20000B
R522	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R523	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R524	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R526	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R527	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	91637	MFF1816G90900F
R528	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R530	311-0946-00	B010100	B039999	RES.,VAR,WW:50K OHM,3%,2W	02111	534-70
R530	311-1889-00	B040000		RES.,VAR,WW:PNL,50K OHM,2W	32997	3541S-458-503
R531	321-0222-07			RES.,FXD,FILM:2K OHM,0.1%,0.125W	91637	MFF1816C20000B
R532	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R533	321-0161-00			RES.,FXD,FILM:464 OHM,1%,0.125W	91637	MFF1816G464R0F
R534	321-0257-09	B010100	B088749	RES.,FXD,FILM:4.64K OHM,1%,0.125W	91637	MFF1816C46400F
R534	321-0257-00	B088750		RES.,FXD,FILM:4.64K OHM,1%,0.125W	91637	MFF1816G46400F
R535	311-1560-00			RES.,VAR,NONWIR:5K OHM,20%,0.50W	73138	91-82-0
R536	321-0342-00	B010100	B088749	RES.,FXD,FILM:35.7K OHM,1%,0.125W	91637	MFF1816G35701F
R536	321-0340-00	B088750		RES.,FXD,FILM:34K OHM,1%,0.125W	91637	MFF1816G34001F
R537	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R541	321-0097-00	B010100	B088749	RES.,FXD,FILM:100 OHM,1%,0.125W	91637	MFF1816G100R0F
R541	315-0101-00	B088750		RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R542	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R543	321-0308-00			RES.,FXD,FILM:15.8K OHM,1%,0.125W	91637	MFF1816G15801F
R544	315-0204-00			RES.,FXD,CMPSN:200K OHM,5%,0.25W	01121	CB2045
R545	315-0433-00	B010100	B088749	RES.,FXD,CMPSN:43K OHM,5%,0.25W	01121	CB4335
R546	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
R547	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R548	315-0204-00			RES.,FXD,CMPSN:200K OHM,5%,0.25W	01121	CB2045
R549	315-0104-00	B010100	B088749	RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R552	321-0222-07			RES.,FXD,FILM:2K OHM,0.1%,0.125W	91637	MFF1816C20000B
R554	315-0205-00			RES.,FXD,CMPSN:2M OHM,5%,0.25W	01121	CB2055
R555	311-1230-00			RES.,VAR,NONWIR:20K OHM,20%,0.50W	32997	3386F-T04-203
R560	321-0196-00			RES.,FXD,FILM:1.07K OHM,1%,0.125W	91637	MFF1816G10700F
R561	321-0302-00			RES.,FXD,FILM:13.7K OHM,1%,0.125W	91637	MFF1816G13701F
R562	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R563	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R564	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R567	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R570	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R571	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R572	315-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
R573	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R574	315-0362-00			RES.,FXD,CMPSN:3.6K OHM,5%,0.25W	01121	CB3625
R575	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R576	315-0112-00			RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
R577	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215

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R578	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R582	315-0275-00			RES.,FXD,CMPSN:2.7M OHM,5%,0.25W	01121	CB2755
R592	315-0275-00			RES.,FXD,CMPSN:2.7M OHM,5%,0.25W	01121	CB2755
R605	311-1466-00	B010100	B088749	RES.,VAR,NONWIR:2K OHM,20%,0.5OW	73138	72-39-0
R606	321-0963-00	B010100	B088749	RES.,FXD,FILM:98.73K OHM,0.1%,0.125W	91637	MFF1816C98731B
R607	321-0986-00	B010100	B088749	RES.,FXD,FILM:25K OHM,0.1%,0.125W	91637	MFF1816C25001B
R613	315-0333-00	B010100	B088749	RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R614	315-0272-00	B010100	B088749	RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R615	315-0132-00	B010100	B088749	RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
R616	321-0346-00	B010100	B088749	RES.,FXD,FILM:39.2K OHM,1%,0.125W	91637	MFF1816G39201F
R616	321-0820-06	B088750		RES.,FXD,FILM:42K OHM,0.25%,0.125W	91637	MFF1816C42001C
R617	321-0243-00	B010100	B088749	RES.,FXD,FILM:3.32K OHM,1%,0.125W	91637	MFF1816G33200F
R617	321-0259-00	B088750		RES.,FXD,FILM:4.87K OHM,1%,0.125W	91637	MFF1816G48700F
R618	321-0385-07	B010100	B088749	RES.,FXD,FILM:100K OHM,0.1%,0.125W	91637	MFF1816C10002B
R620	311-1339-00	B010100	B088749	RES.,VAR,NONWIR:5K OHM,10%,0.50W	73138	89-131-1
R620	311-1336-00	B088750		RES.,VAR,NONWIR:100K OHM,0.50W	02111	43P104T672
R621	321-0820-06	B010100	B088749	RES.,FXD,FILM:42K OHM,0.25%,0.125W	91637	MFF1816C42001C
R621	321-0967-03	B088750		RES.,FXD,FILM:55K OHM,0.25%,0.125W	91637	MFF1816D55001C
R622	321-0995-00	B088750		RES.,FXD,FILM:549K OHM,1%,0.125W	24546	NA55D5493F
R623	315-0433-00	B010100	B088749	RES.,FXD,CMPSN:43K OHM,5%,0.25W	01121	CB4335
R623	315-0513-00	B088750		RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
R624	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R625	311-1230-00			RES.,VAR,NONWIR:20K OHM,20%,0.50W	32997	3386F-T04-203
R626	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R627	315-0152-00	B010100	B088749	RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R628	321-0257-09	B010100	B088749	RES.,FXD,FILM:4.64K OHM,1%,0.125W	91637	MFF1816C46400F
R629	321-0257-09	B010100	B088749	RES.,FXD,FILM:4.64K OHM,1%,0.125W	91637	MFF1816C46400F
R631	321-0289-06	B088750		RES.,FXD,FILM:10K OHM,0.25%,0.125W	91637	MFF1816C10001C
R632	315-0432-00	B010100	B088749	RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R632	321-0289-06	B088750		RES.,FXD,FILM:10K OHM,0.25%,0.125W	91637	MFF1816C10001C
R634	315-0202-00	B010100	B088749	RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R635	315-0392-00	B010100	B088749	RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R636	315-0563-00	B088750		RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
R637	315-0222-00	B088750		RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R641	315-0202-00	B010100	B088749	RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R642	315-0512-00	B010100	B088749	RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R644	315-0182-00	B088750		RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R645	315-0333-00	B010100	B088749	RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R646	315-0332-00	B010100	B088749	RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R653	315-0243-00	B010100	B088749	RES.,FXD,CMPSN:24K OHM,5%,0.25W	01121	CB2435
R653	315-0103-00	B088750		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R654	315-0183-00	B010100	B088749	RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R654	315-0392-00	B088750		RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R655	315-0391-00	B088750		RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R661	315-0203-00	B010100	B088749	RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R662	315-0273-00	B010100	B088749	RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R671	315-0202-00	B010100	B088749	RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R672	315-0133-00	B010100	B088749	RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335
R672	315-0473-00	B088750		RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R673	315-0153-00	B010100	B088749	RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R674	315-0103-00	B010100	B088749	RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R674	315-0472-00	B088750		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R675	321-0241-00	B010100	B039999	RES.,FXD,FILM:3.16K OHM,1%,0.125W	91637	MFF1816G31600F
R675	321-0225-00	B040000	B088749	RES.,FXD,FILM:2.15K OHM,1%,0.125W	91637	MFF1816G21500F

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R676	315-0133-00	B010100	B088749	RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335
R676	315-0473-00	B088750		RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R677	315-0822-00	B010100	B088749	RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R678	315-0103-00	B010100	B039999	RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R678	315-0362-00	B040000	B088749	RES.,FXD,CMPSN:3.6K OHM,5%,0.25W	01121	CB3625
R678	315-0472-00	B088750		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R679	315-0152-00	B010100	B088749	RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R681	315-0512-00	B010100	B088749	RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R681	315-0202-00	B088750		RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R682	315-0102-00	B010100	B088749	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R682	315-0332-00	B088750		RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R683	315-0103-00	B010100	B088749	RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R683	315-0331-00	B088750		RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R684	321-0302-00	B010100	B088749	RES.,FXD,FILM:13.7K OHM,1%,0.125W	91637	MFF1816G13701F
R685	311-1560-00	B010100	B088749	RES.,VAR,NONWIR:5K OHM,20%,0.50W	73138	91-82-0
R686	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R687	321-1651-04	B088750		RES.,FXD,FILM:37.5K OHM,0.1%,0.125W	91637	MFF1816D37501B
R690	315-0432-00	B010100	B059999	RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R693	321-0217-00	B010100	B088749	RES.,FXD,FILM:1.78K OHM,1%,0.125W	91637	MFF1816G17800F
R694	321-0202-00	B010100	B088749	RES.,FXD,FILM:1.24K OHM,1%,0.125W	91637	MFF1816G12400F
R695	315-0100-00	B010100	B088749	RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R696	315-0131-00	B010100	B088749	RES.,FXD,CMPSN:130 OHM,5%,0.25W	01121	CB1315
R697	315-0203-00	B010100	B088749	RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R698	315-0102-00	B010100	B088749	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R699	315-0273-00	B010100	B088749	RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R705	311-0467-00			RES.,VAR,NONWIR:100K OHM,20%,0.50W	11237	300SF-41334
R706	321-0438-00			RES.,FXD,FILM:357K OHM,1%,0.125W	91637	MFF1816G35702F
R710	311-1232-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	32997	3386F-T04-503
R711	321-0458-00			RES.,FXD,FILM:576K OHM,1%,0.125W	91637	MFF1816G57602F
R712	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R713	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R714	321-0363-00			RES.,FXD,FILM:59K OHM,1%,0.125W	91637	MFF1816G59001F
R715	311-1232-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	32997	3386F-T04-503
R717	321-0360-00			RES.,FXD,FILM:54.9K OHM,1%,0.125W	91637	MFF1816G54901F
R721	315-0121-00			RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
R722	321-0225-06			RES.,FXD,FILM:2.15K OHM,0.25%,0.125W	91637	MFF1816C21500C
R723	321-0642-00			RES.,FXD,FILM:20.3K OHM,0.25%,0.125W	91637	MFF1816C20301C
R724	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R725	311-1590-00			RES.,VAR,NONWIR:10K OHM,10%,1W	12697	CM40256
R728	301-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.50W	01121	EB3025
R729	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R731	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R732	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R741	323-0810-07			RES.,FXD,FILM:4M OHM,0.1%,0.50W	91637	HFF129C40003B
R742	323-0809-07			RES.,FXD,FILM:2.667M OHM,0.1%,0.50W	91637	HFF129C26673B
R743	323-1500-07			RES.,FXD,FILM:1.6M OHM,0.1%,0.50W	91637	HFF129C16003B
R744	323-0620-07			RES.,FXD,FILM:800K OHM,0.1%,0.50W	91637	MFF1226C80002B
R745	323-0806-07			RES.,FXD,FILM:266.7K OHM,0.1%,0.50W	91637	MFF1226C26672B
R746	323-1404-07			RES.,FXD,FILM:160K OHM,0.1%,0.50W	91637	MFF1226C16002B
R747	323-0805-07			RES.,FXD,FILM:80.0K OHM,0.1%,0.50W	91637	MFF1226C80001B
R748	323-0802-07			RES.,FXD,FILM:26.67K OHM,0.1%,0.50W	91637	MFF1226C26671B
R749	323-1308-07			RES.,FXD,FILM:16.0K OHM,0.1%,0.50W	91637	MFF1226C16001B
R751	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R752	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R753	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R754	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R755	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	91637	MFF1816G37401F
R756	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R757	321-0327-00			RES.,FXD,FILM:24.9K OHM,1%,0.125W	91637	MFF1816G24901F
R761	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R762	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R763	315-0133-00			RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335
R764	315-0133-00			RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335
R771	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R772	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R773	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R779	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R781	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R782	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R783	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R784	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R785	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R786	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R787	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R791	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	91637	MFF1816G37401F
R792	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R793	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	91637	MFF1816G37401F
R794	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R821	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R832	315-0150-00			RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
R841	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R842	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R844	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
S10	263-0010-01			SWITCH PB ASSY:1 PUSH,7.5 MM,1 CONTACT	80009	263-0010-01
S20	263-0016-00			SWITCH PB ASSY:4 LATCHING,7.5 MM,5 CONTACT	80009	263-0016-00
S50	263-0015-00			SWITCH PB ASSY:3 LATCHING,7.5 MM	80009	263-0015-00
S60	----- -----			(PART OF R60)		
S205	263-0015-01			SWITCH PB ASSY:3 LATCHING,7.5 MM,5 CONTACT	80009	263-0015-01
S230	263-0016-01			SWITCH PB ASSY:3 LCH & 1 CANC,7.5MM,5 CONT	80009	263-0016-01
S435	260-1771-00			SWITCH,PUSH:DPDT,1 BUTTON,2 POLE	80009	260-1771-00
S435	260-1771-00			SWITCH,PUSH:DPDT,1 BUTTON,2 POLE	80009	260-1771-00
S800	263-1134-00			SW CAM ACTR AS:TIME/CM	80009	263-1134-00
T35	120-0444-00			XFMR,TOROID:5 TURNS,BIFILAR	80009	120-0444-00
U35	156-0067-02			MICROCIRCUIT,LI:OPNL AMPLIFIER,SELECTED	80009	156-0067-02
U55	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
U65	155-0126-00			MICROCIRCUIT,LI:TRIGGER AMPLIFIER	80009	155-0126-00
U75	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
U85	155-0109-01			MICROCIRCUIT,LI:MONOLITHIC TRIGGER	80009	155-0109-01
U220	155-0049-01	B010100	B052214	MICROCIRCUIT,DI:MONOLITHIC,SWEEP CONTROL	80009	155-0049-01
U220	155-0049-02	B052215		MICROCIRCUIT,DI:SWEEP CONTROL,W/LOCKOUT	80009	155-0049-02
U250	156-0118-00	B010100	B091399	MICROCIRCUIT,DI:J-K MASTER-SLAVE FLIP-FLOP	80009	156-0118-00
U250	156-0118-03	B091400		MICROCIRCUIT,DI:1 DUAL J-K FF,BURN-IN	01295	SN74S112JP3
U416	156-0067-02			MICROCIRCUIT,LI:OPNL AMPLIFIER,SELECTED	80009	156-0067-02
U530	156-0158-00	B010100	B091399	MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
U530	156-0158-07	B091400		MICROCIRCUIT,LI:DUAL OPNL AMPL,SCREENED	01295	MC1458JG4

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U556	156-0158-00	B010100	B091399	MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
U556	156-0158-07	B091400		MICROCIRCUIT,LI:DUAL OPNL AMPL,SCREENED	01295	MC1458JG4
U608	156-0686-00	B010100	B088749	MICROCIRCUIT,LI:OPNL AMPL,HIGH IMPEDANCE	02735	CA3130S
U608	156-1149-00	B088750	B091399	MICROCIRCUIT,LI:OPERATIONAL AMP,JFET INPUT	27014	LF351N
U608	156-1149-01	B091400		MICROCIRCUIT,LI:OPER AMPL,JFET,BURN-IN	27014	LF351N/A+
U626	156-0067-02	B010100	B088749	MICROCIRCUIT,LI:OPNL AMPLIFIER,SELECTED	80009	156-0067-02
U626	156-0105-00	B088750	B091399	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	27014	LM301AN
U626	156-0105-02	B091400		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER,SEL	01295	LM301AJG4
U662	156-0113-00	B010100	B088749	MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	80009	156-0113-00
U662	156-0030-00	B088750	B091399	MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN7400(N OR J)
U662	156-0030-03	B091400		MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	27014	DM8000
U682	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U686	155-0090-00	B010100	B059999	MICROCIRCUIT,DI:MONOLITHIC,4 DECADE COUNTER	80009	155-0090-00
U686	155-0171-00	B060000	B088749	MICROCIRCUIT,DI:4 DECADE COUNTER	80009	155-0171-00
U686	155-0185-00	B088750		MICROCIRCUIT,LI:ML 4 DECADE DGTL VOLTMETER	80009	155-0185-00
U698	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U722	156-0686-00			MICROCIRCUIT,LI:OPNL AMPL,HIGH IMPEDANCE	02735	CA3130S
U842	156-0067-02			MICROCIRCUIT,LI:OPNL AMPLIFIER,SELECTED	80009	156-0067-02
VR314	152-0168-00			SEMICOND DEVICE:ZENER,0.4W,12V,5%	04713	SZG35009K4
VR644	152-0280-00	B088750		SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	80009	152-0280-00
VR728	152-0226-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	14552	TD3810980

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF). Values less than one are in microfarads (μF).

Resistors = Ohms (Ω).

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it goes to the low state.

Abbreviations are based on ANSI Y1.1-1972.

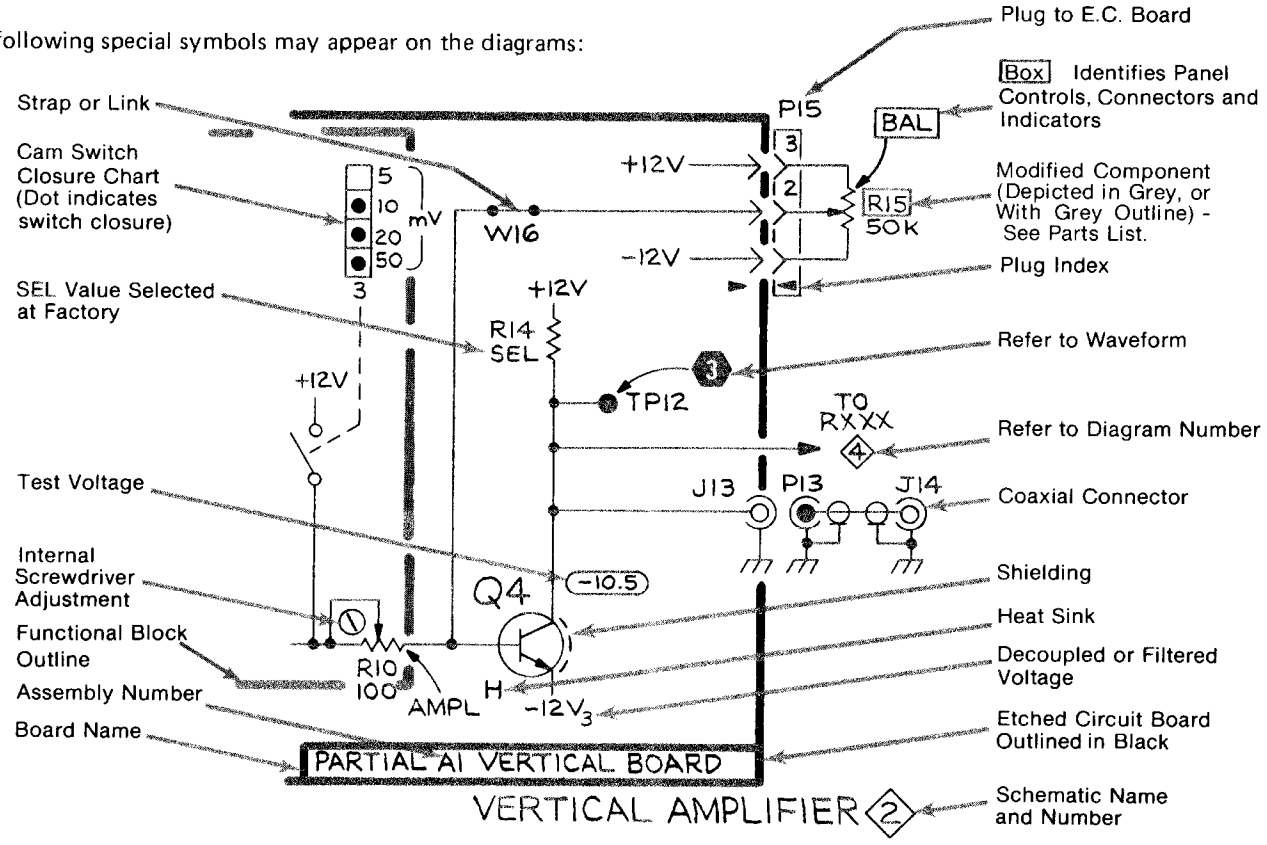
Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

Y14.15, 1966	Drafting Practices.
Y14.2, 1973	Line Conventions and Lettering.
Y10.5, 1968	Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

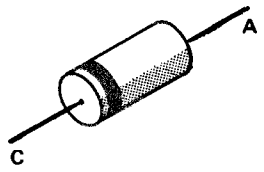
The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly, separable or repairable (circuit board, etc)	H	Heat dissipating device (heat sink, heat radiator, etc)	S	Switch or contactor
AT	Attenuator, fixed or variable	HR	Heater	T	Transformer
B	Motor	HY	Hybrid circuit	TC	Thermocouple
BT	Battery	J	Connector, stationary portion	TP	Test point
C	Capacitor, fixed or variable	K	Relay	U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
CB	Circuit breaker	L	Inductor, fixed or variable	V	Electron tube
CR	Diode, signal or rectifier	M	Meter	VR	Voltage regulator (zener diode, etc.)
DL	Delay line	P	Connector, movable portion	W	Wirestrap or cable
DS	Indicating device (lamp)	Q	Transistor or silicon-controlled rectifier	Y	Crystal
E	Spark Gap, Ferrite bead	R	Resistor, fixed or variable	Z	Phase shifter
F	Fuse	RT	Thermistor		
FL	Filter				

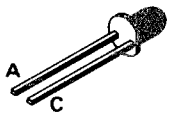
The following special symbols may appear on the diagrams:



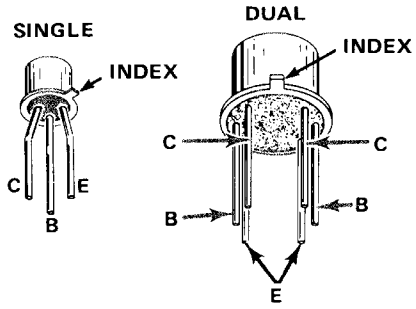
NOTE
LEAD CONFIGURATIONS AND CASE STYLES ARE TYPICAL, BUT MAY VARY DUE TO VENDOR CHANGES OR INSTRUMENT MODIFICATIONS.



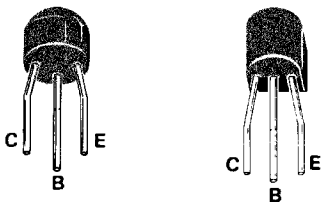
SIGNAL DIODE



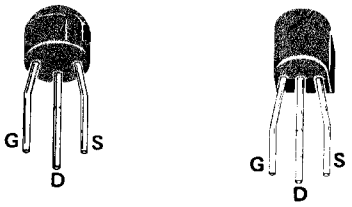
LIGHT EMITTING DIODE (L.E.D.)



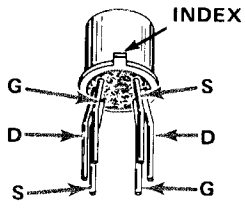
METAL CASE TRANSISTORS



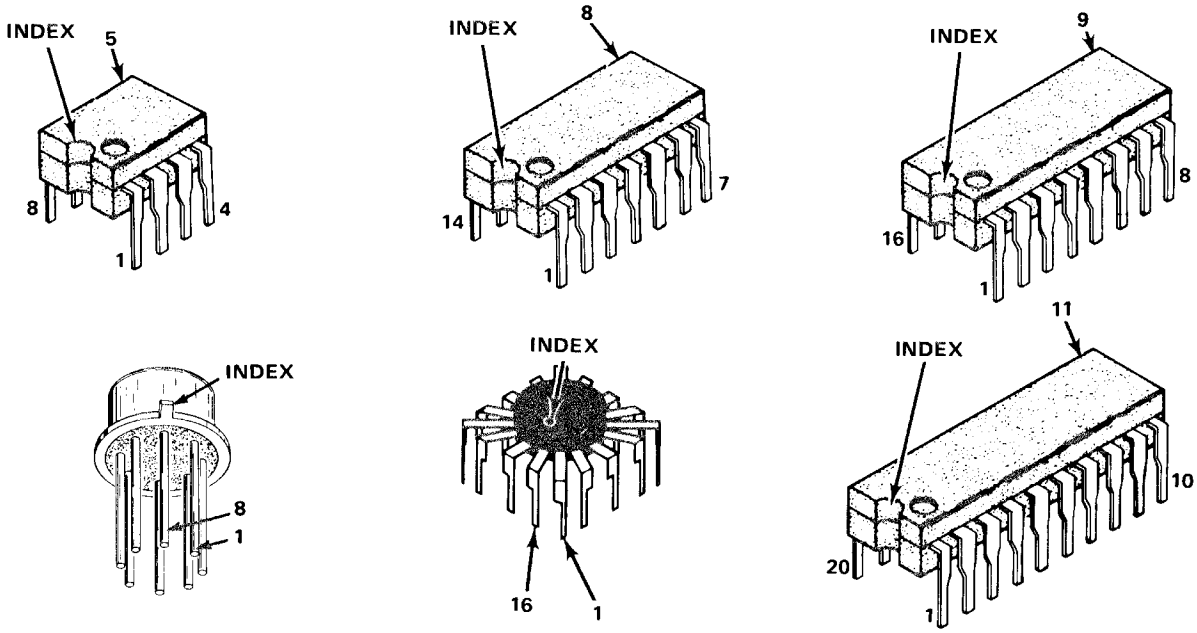
PLASTIC CASE TRANSISTORS



PLASTIC CASE FETS



DUAL METAL CASE FET



INTEGRATED CIRCUITS

(1986-66)1961-72

Fig. 8-1. Semiconductor lead configurations.

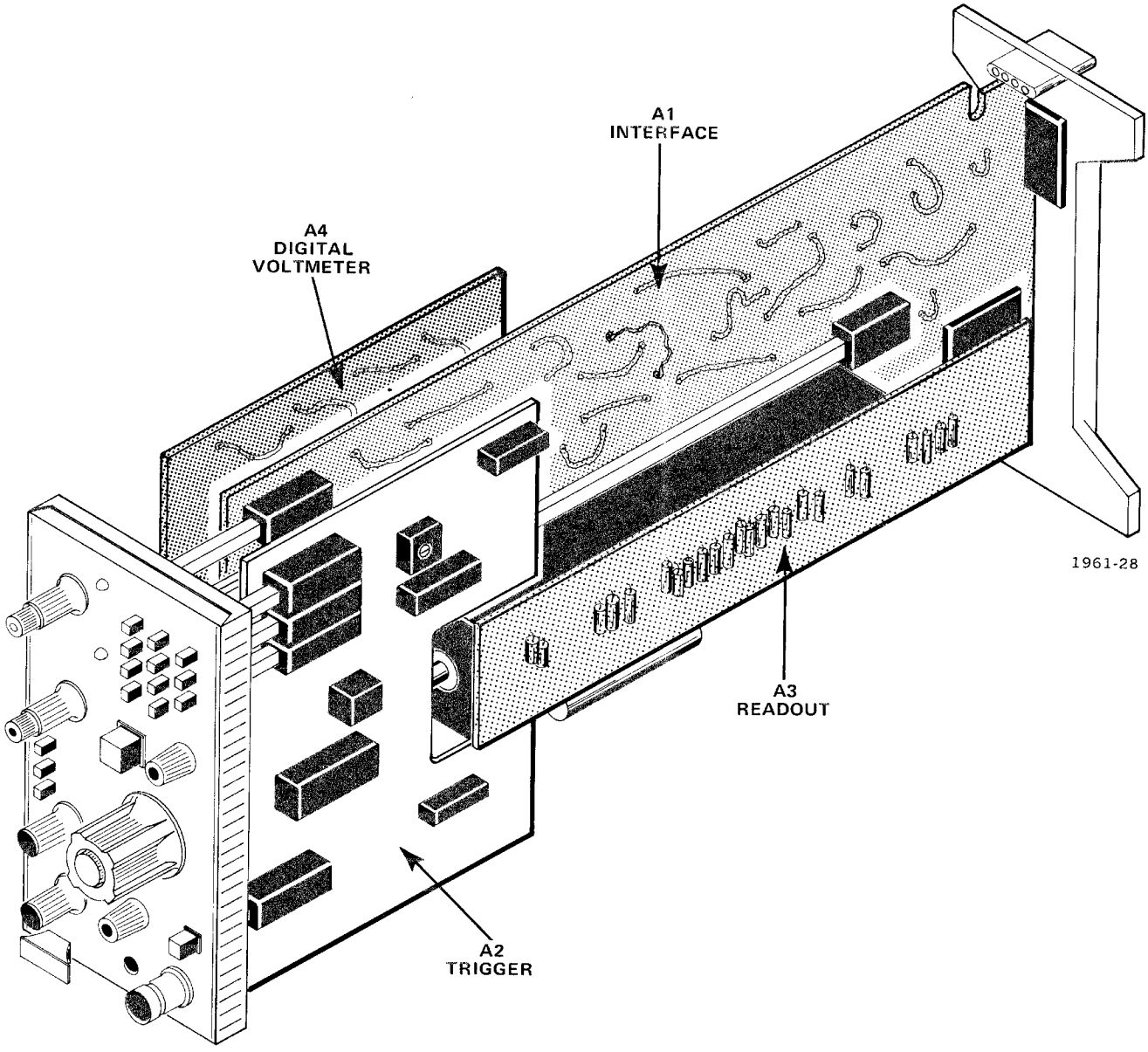


Fig. 8-2. Location of circuit boards in the 7B85.

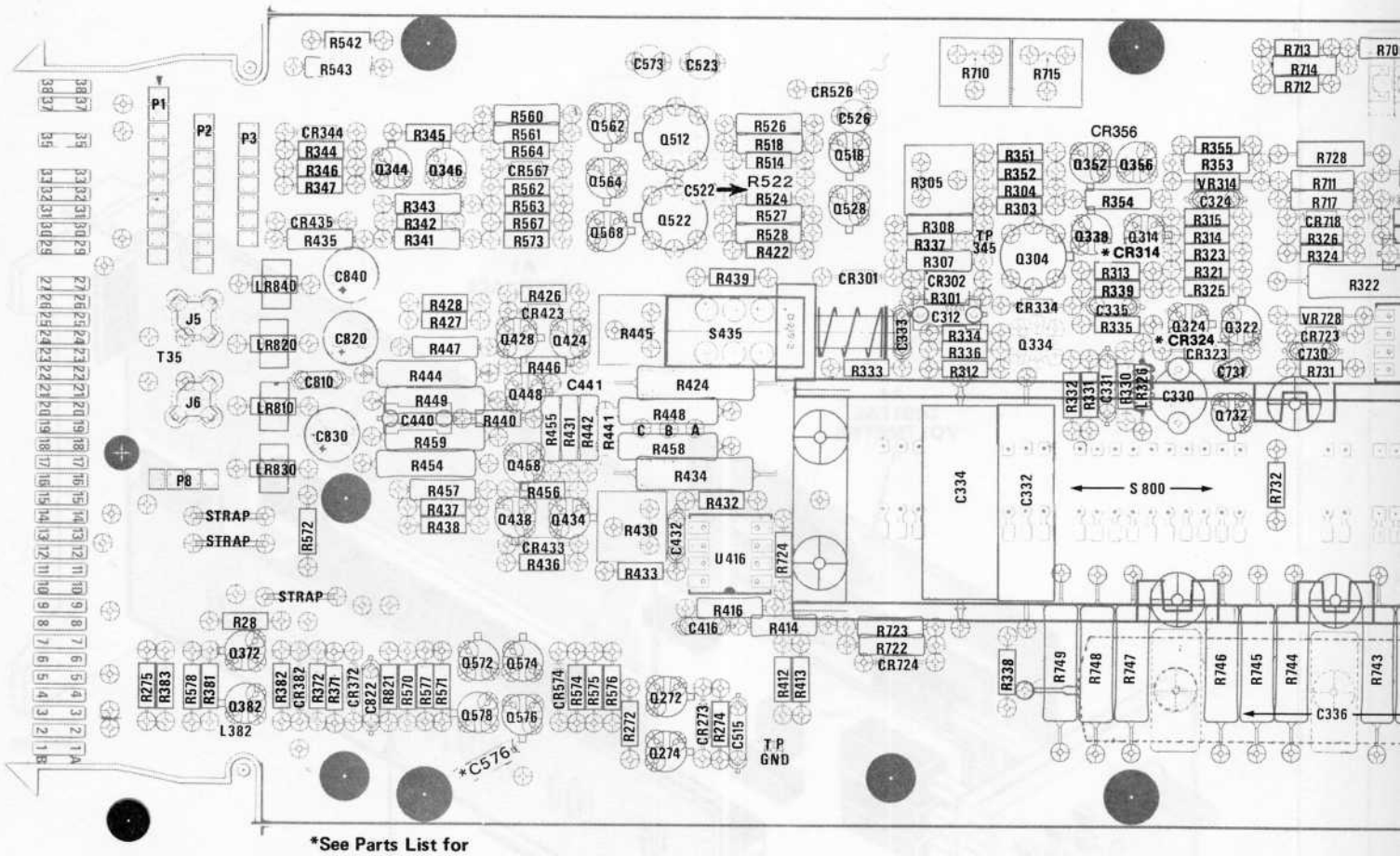


Fig. 8-3. A1—Interface circuit board assembly.

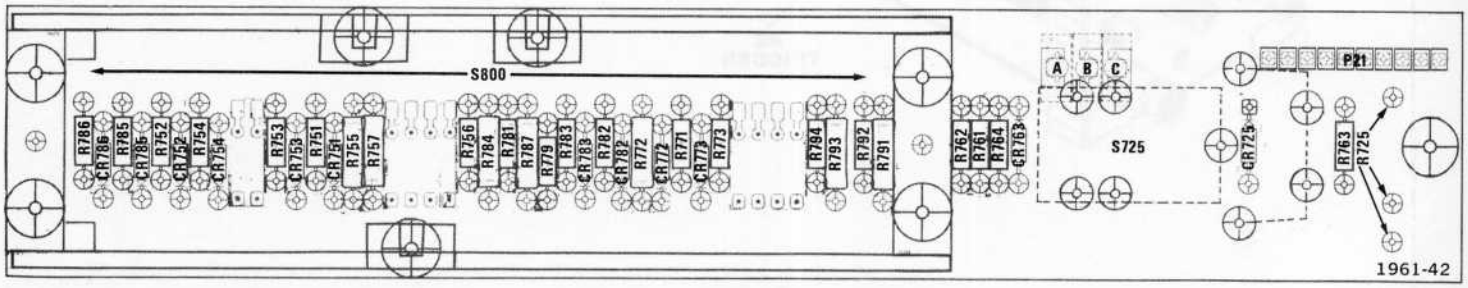


Fig. 8-5. A3—Readout circuit board assembly.

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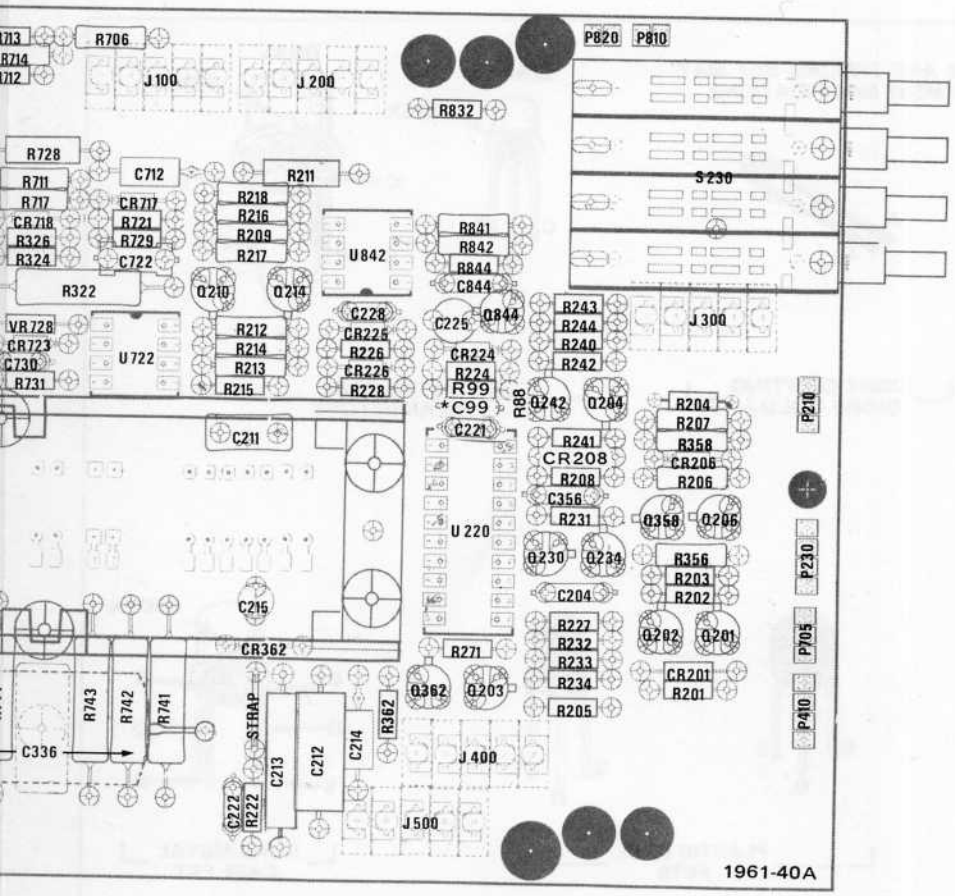
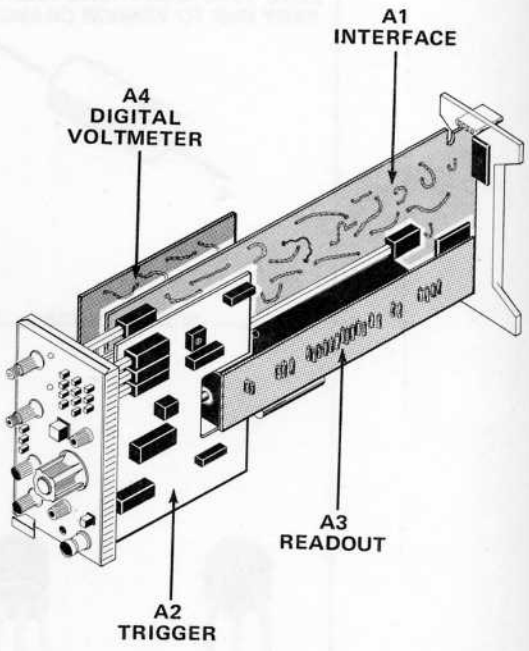
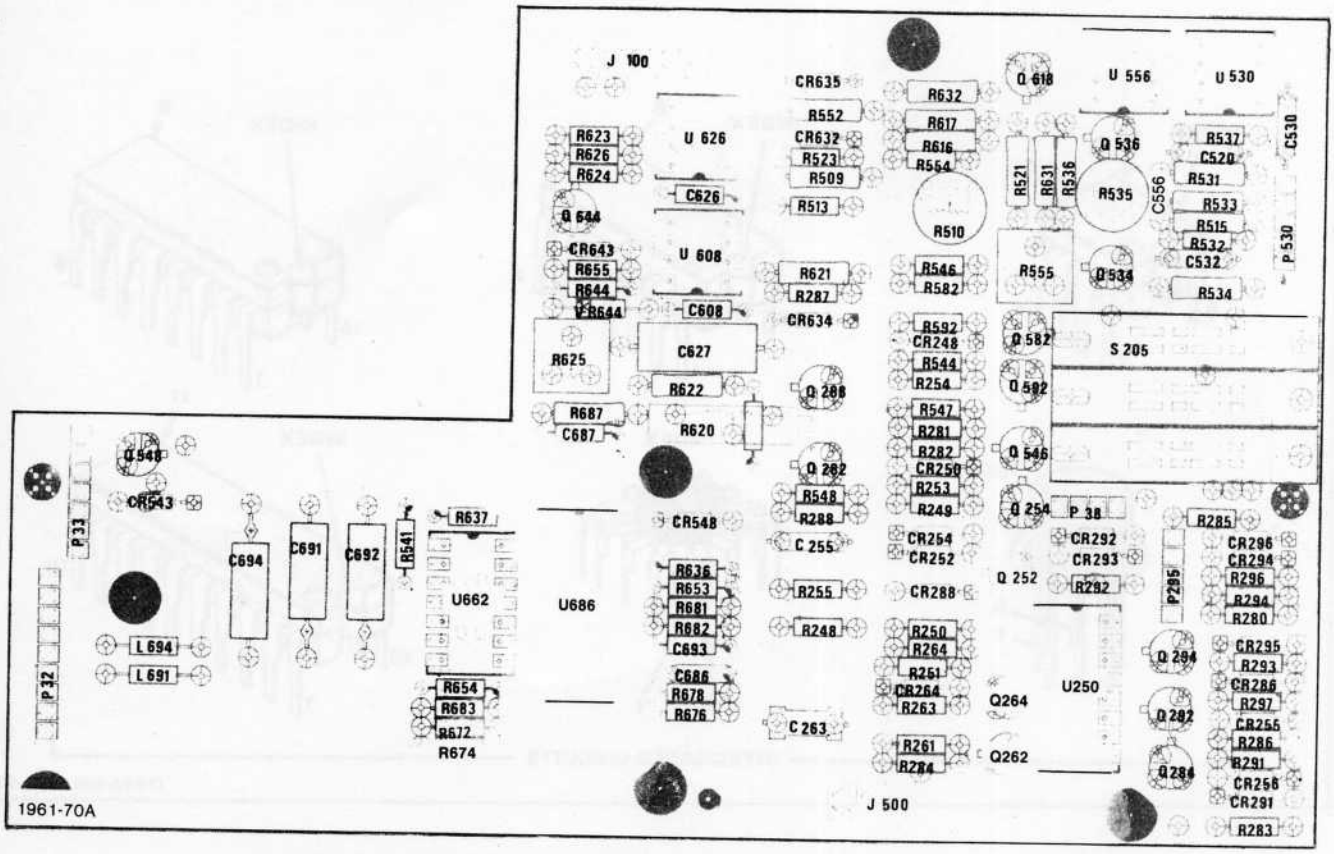




ssembly.



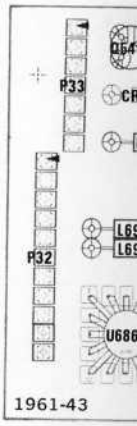
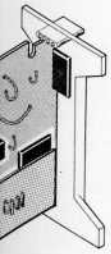


Fig. 8-6A. A4—(SN B088750 & Up) Digital Voltmeter circuit board assembly. REV JUL 1982



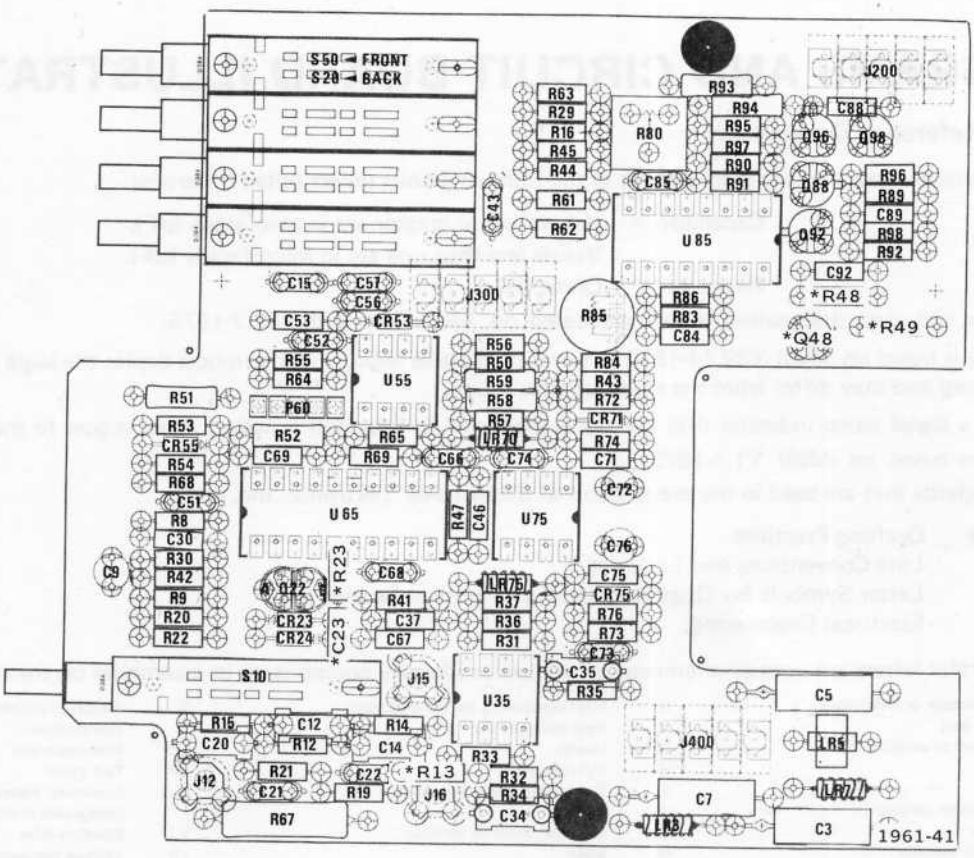


Fig. 8-4. A2—Trigger circuit board assembly.

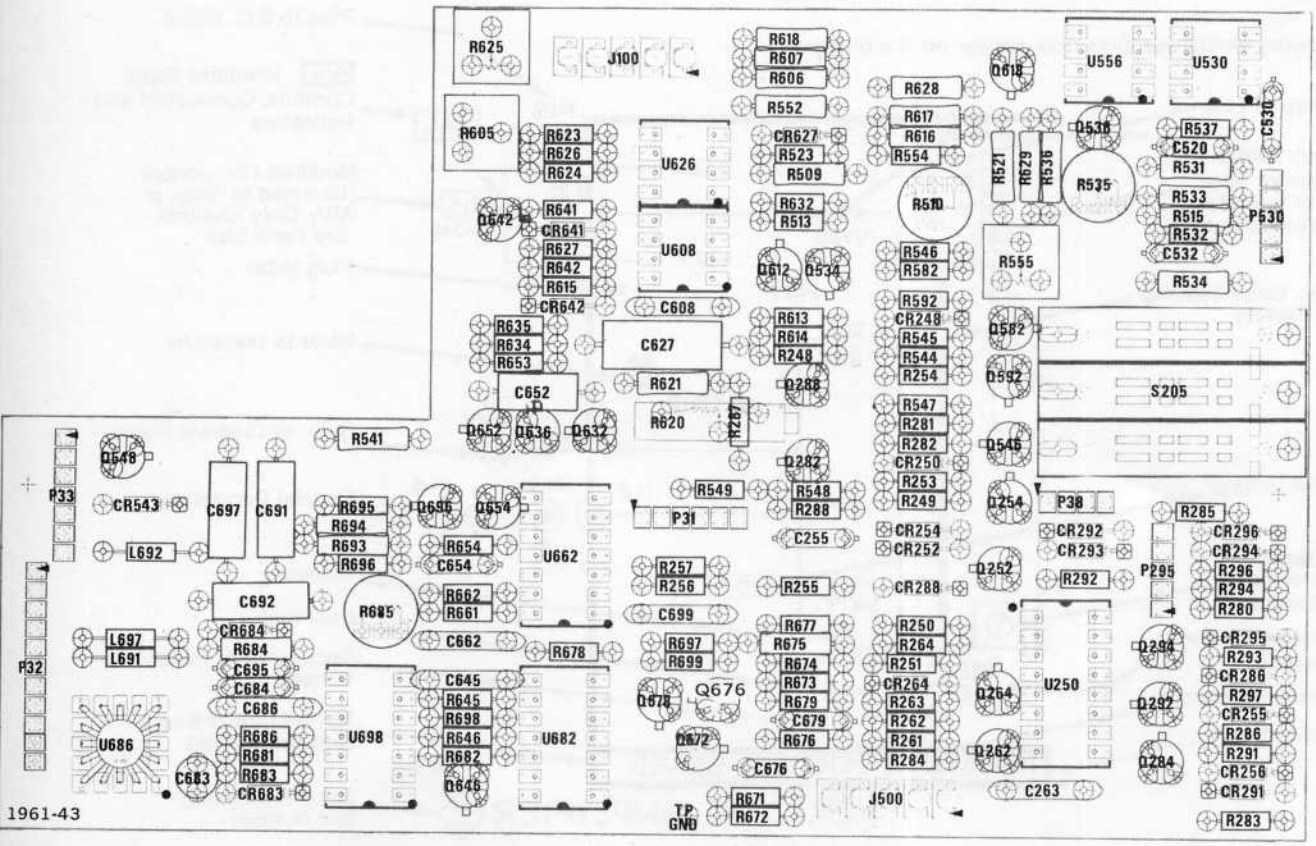
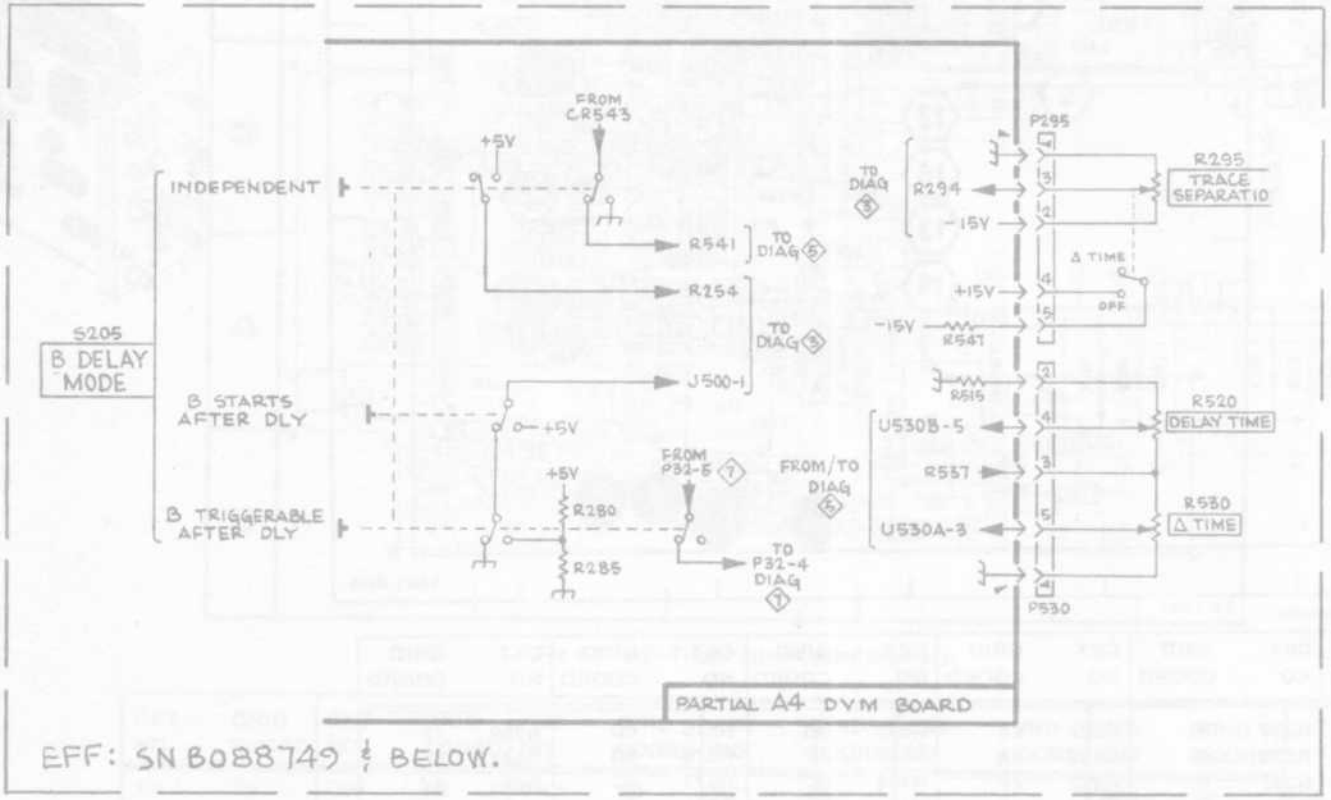
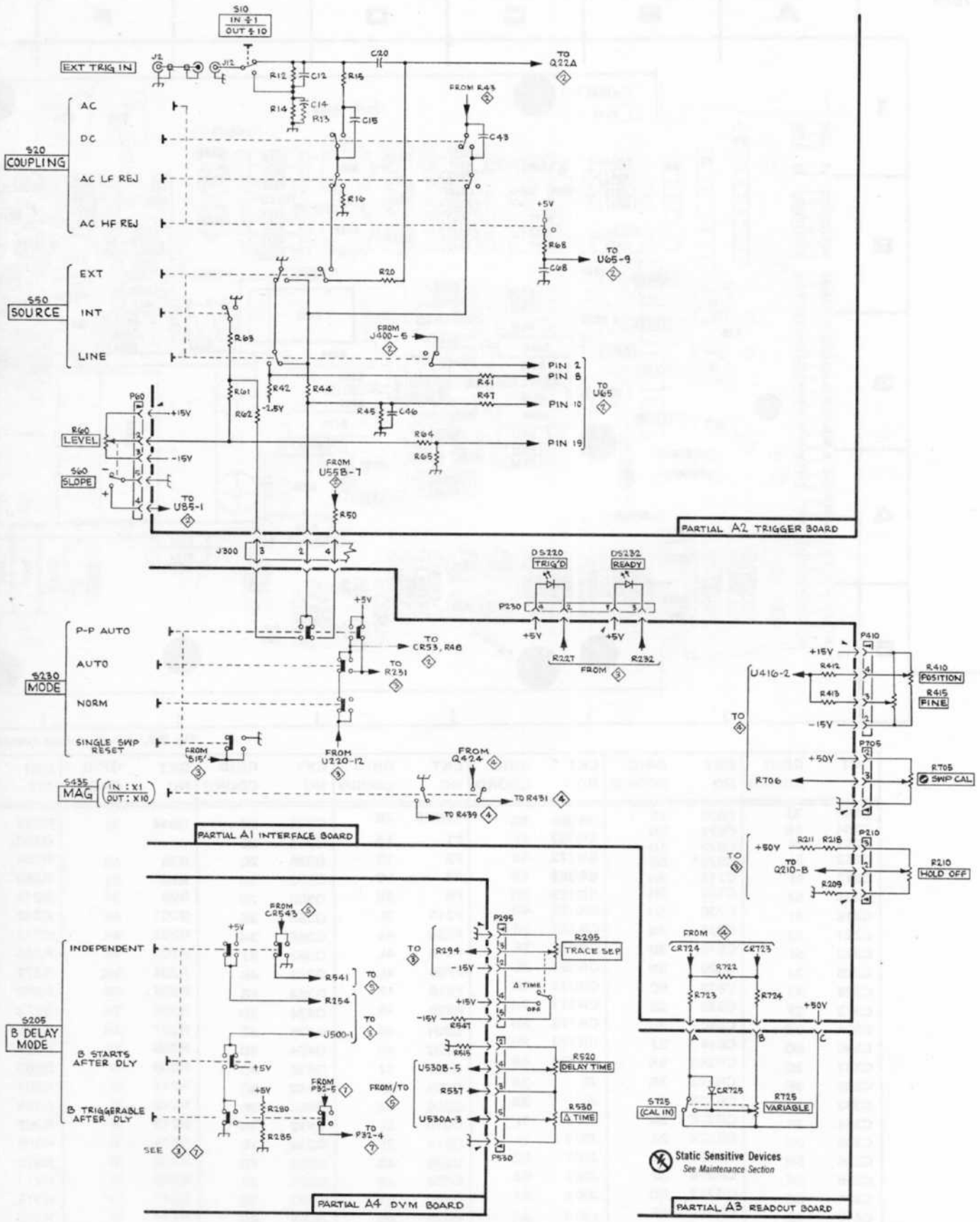


Fig. 8-6B. A4—(SN B088749 & Below) Digital Voltmeter circuit board assembly.



EFF: SN B088749 & BELOW.

7B85



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FRONT PANEL DISTRIBUTION ◇1

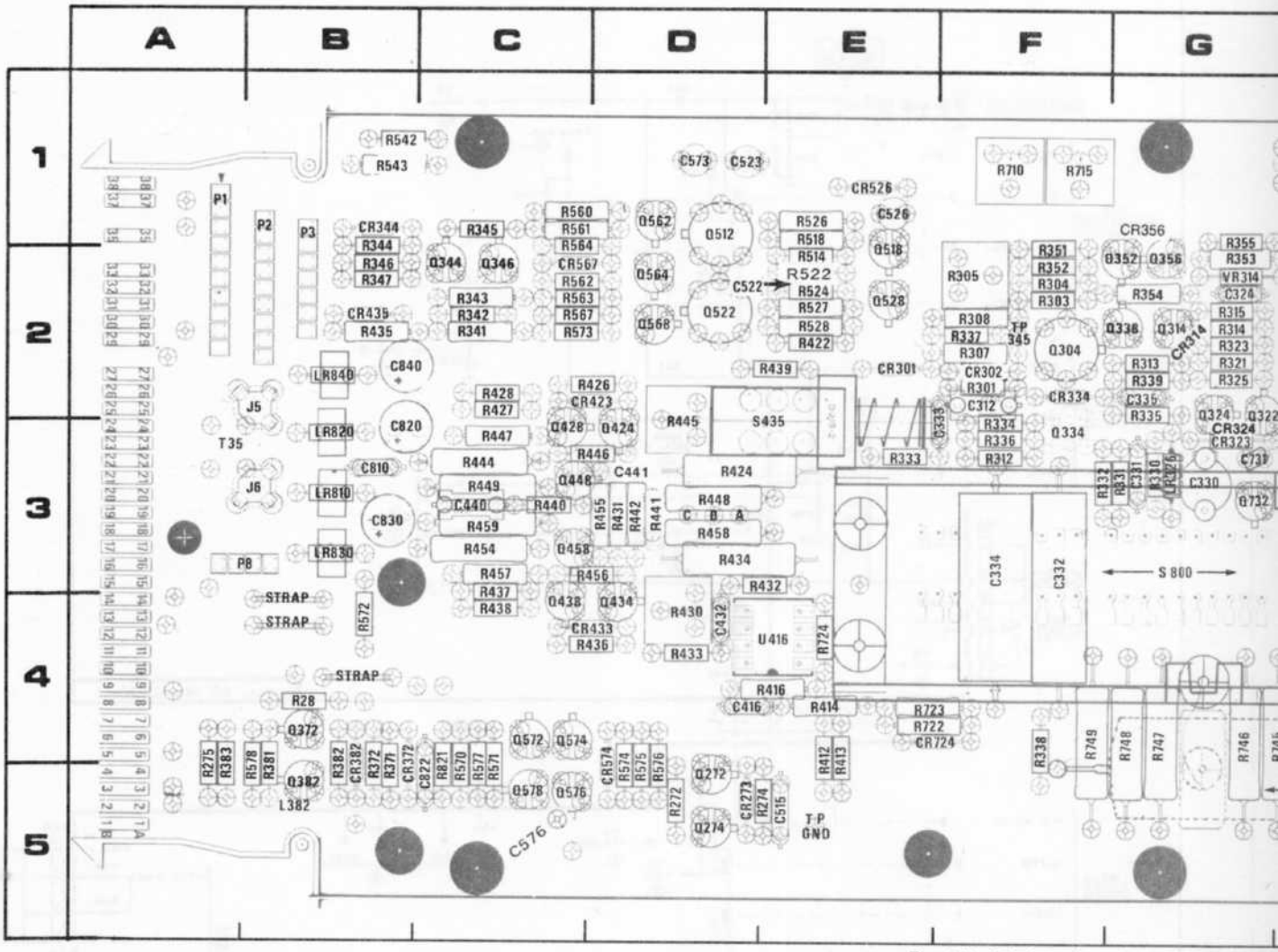
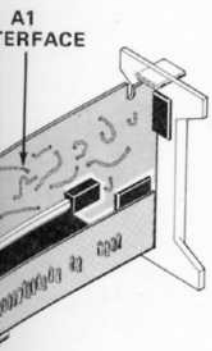


Fig. 8-7. A1—Interface circuit board assembl

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CK NO
C99*	3J	C526	1E	CR356	1G	LR840	2B	Q338	2G	Q844	2J	R232	4K	R3
C204	4K	C571	3G	CR362	4I	P1	1A	Q344	2C			R233	4K	R3
C211	3I	C573	1D	CR372	4B	P2	1B	Q346	2C	R28	4B	R234	4K	R3
C212	5I	C576*	5C	CR382	4B	P3	1B	Q352	2G	R88	3J	R240	2K	R3
C213	5I	C712	2H	CR423	2D	P8	3B	Q356	2G	R99	3J	R241	3K	R3
C214	5J	C722	2H	CR433	4D	P210	3L	Q358	3K	R201	4K	R242	3K	R3
C215	4I	C730	3H	CR435	2B	P230	4L	Q368	3K	R202	4K	R243	2K	R3
C221	3J	C731	3G	CR526	1E	P410	4L	Q362	4J	R203	4K	R244	2K	R3
C222	5I	C810	3B	CR567	2C	P705	4L	Q372	4B	R204	3K	R271	4J	R3
C225	2J	C820	3B	CR574	4D	P810	1K	Q382	5B	R205	4K	R272	5D	R3
C228	2J	C822	5C	CR717	2H	P820	1K	Q424	3D	R206	3K	R274	5E	R3
C312	2F	C830	3B	CR718	2H	Q201	4K	Q428	3C	R207	3K	R275	4A	R3
C324	2G	C840	2B	CR723	2H	Q202	4K	Q434	4D	R208	3K	R301	2F	R3
C330	3G	C844	2J	CR724	4E	Q203	4J	Q438	4C	R209	2I	R303	2F	R3
C331	3G	CR201	4K	J5	2B	Q204	3K	Q448	3C	R211	2I	R304	2F	R3
C332	3F	CR202	3K	J6	3B	Q206	3K	Q458	3C	R212	2I	R305	2F	R3
C333	3F	CR206	3K	J100	1I	Q210	2I	Q512	1D	R213	3I	R307	2F	R3
C334	3F	CR208	3K	J200	1I	Q214	2I	Q518	1E	R214	2I	R308	2F	R3
C335	2G	CR224	2J	J300	2K	Q230	4K	Q522	2D	R215	3I	R312	3F	R3
C336	5H	CR225	2J	J400	5J	Q234	4K	Q528	2E	R216	2I	R313	2G	R3
C356	3K	CR226	3J	J500	5J	Q242	3K	Q562	1D	R217	2I	R314	2G	R3
C381	3G	CR273	5D	L274	5A	Q272	5D	Q564	2D	R218	2I	R315	2G	R3
C416	4D	CR301	2E	L326	3G	Q274	5D	Q568	2D	R222	5I	R321	2G	R3
C432	4D	CR302	2F	L382	5B	Q304	2F	Q572	4C	R224	3J	R322	2H	R3
C440	3C	CR314*	2G	LR326	3G	Q314	2G	Q574	4C	R226	2J	R323	2G	R3
C441	3D	CR323	3G	LR810	3B	Q322	2G	Q576	5C	R227	4K	R324	2H	R3
C515	5E	CR324*	3G	LR820	3B	Q324	2G	Q578	5C	R228	3J	R325	2G	R3
C522	2E	CR334	2F	LR830	3B	Q334	3F	Q732	3G	R231	3K	R326	2H	R3
C523	1D	CR344	1B											



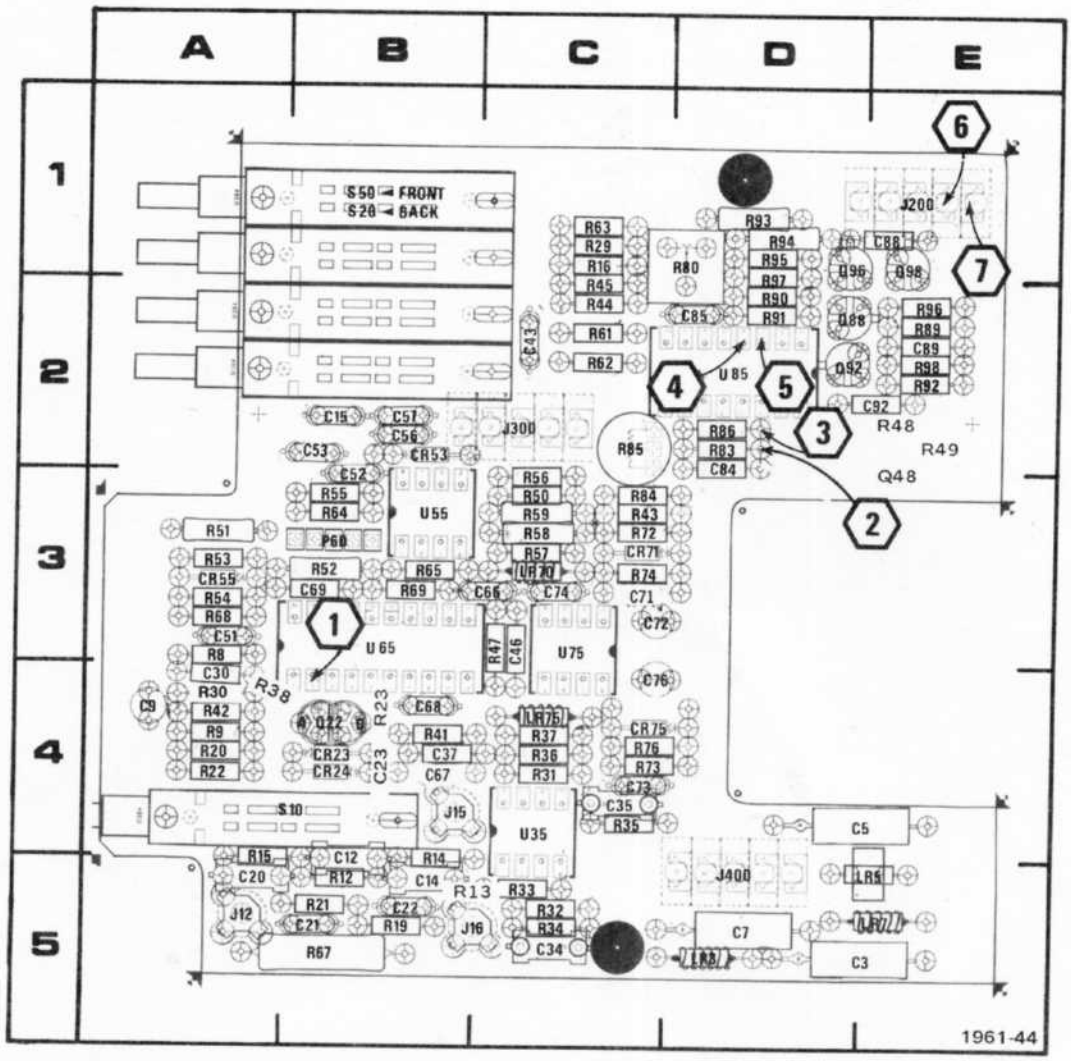


Fig. 8-8. A2—Trigger circuit board assembly.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT CKT	GRID COORD
C3	5E	C69	3B	LR3	5D	R21	5B			R85	2C
C5	4E	C71	3C	LR5	5E	R22	4A	R52	3B	R86	2D
C7	5D	C73	4C	LR7	5E	R23*	4B	R53	3A	R89	2E
C9	4A	C74	3C	LR70	3C	R29	1C	R54	3A	R90	2D
C12	5B	C76	4C	LR75	4C	R30	4A	R55	3B	R91	2D
C14	5B	C77	1E			R31	4C	R56	3C	R92	2E
C15	2B	C84	2D	P60	3B	R32	5C	R57	3C	R93	1D
C20	5A	C85	2D			R33	5C	R58	3C	R94	1D
C21	5B	C88	1E	Q22	4B	R34	5C	R59	3C	R95	1D
C22	5B	C89	2E	Q48*	2E	R35	4C	R61	2C	R96	2E
C23*	4B	C92	2E	Q88	2D	R36	4C	R62	1C	R97	1D
C30	4A			Q92	2D	R37	4C	R63	1C	R98	2E
C34	5C	CR23	4B	Q96	1D	R38*†	4B	R64	3B		
C35	4C	CR24	4B	Q98	1E	R41	4B	R65	3B	S10	4B
C37	4B	CR53	2B			R42	4A	R67	5B	S20	1B
C43	2C	CR55	3A	R8	3A	R43	3C	R68	3A	S50	1B
C46	3C	CR71	3C	R9	4A	R44	2C	R69	3B		
C51	3A	CR75	4C	R12	5B	R45	2C	R72	3C	U35	4C
C52	3B			R13*	5C	R47	3C	R73	4C	U55	3B
C53	2B	J12	5A	R14	5B	R48*	2E	R74	3C	U65	3B
C56	2B	J15	4B	R15	5A	R49*	2E	R76	4C	U75	3C
C57	2B	J16	5C	R16	1C	R50	3C	R80	1D	U85	2D
C66	3C	J200	1E	R19	5B	R51	3A	R83	2D		
C67	4B	J300	2C	R20	4A			R84	3C		
C68	4B	J400	5D								

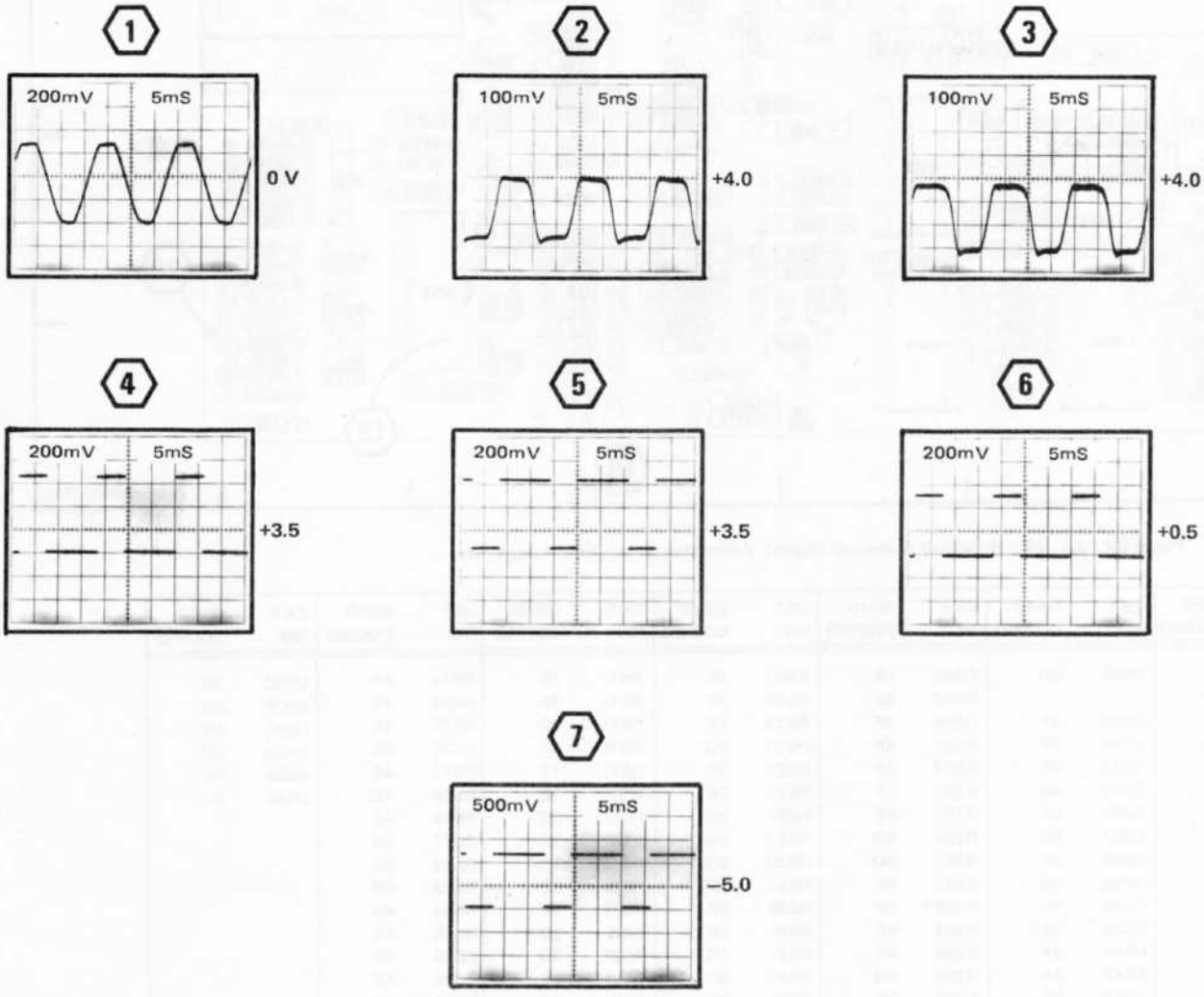
VOLTAGE AND WAVEFORM CONDITIONS

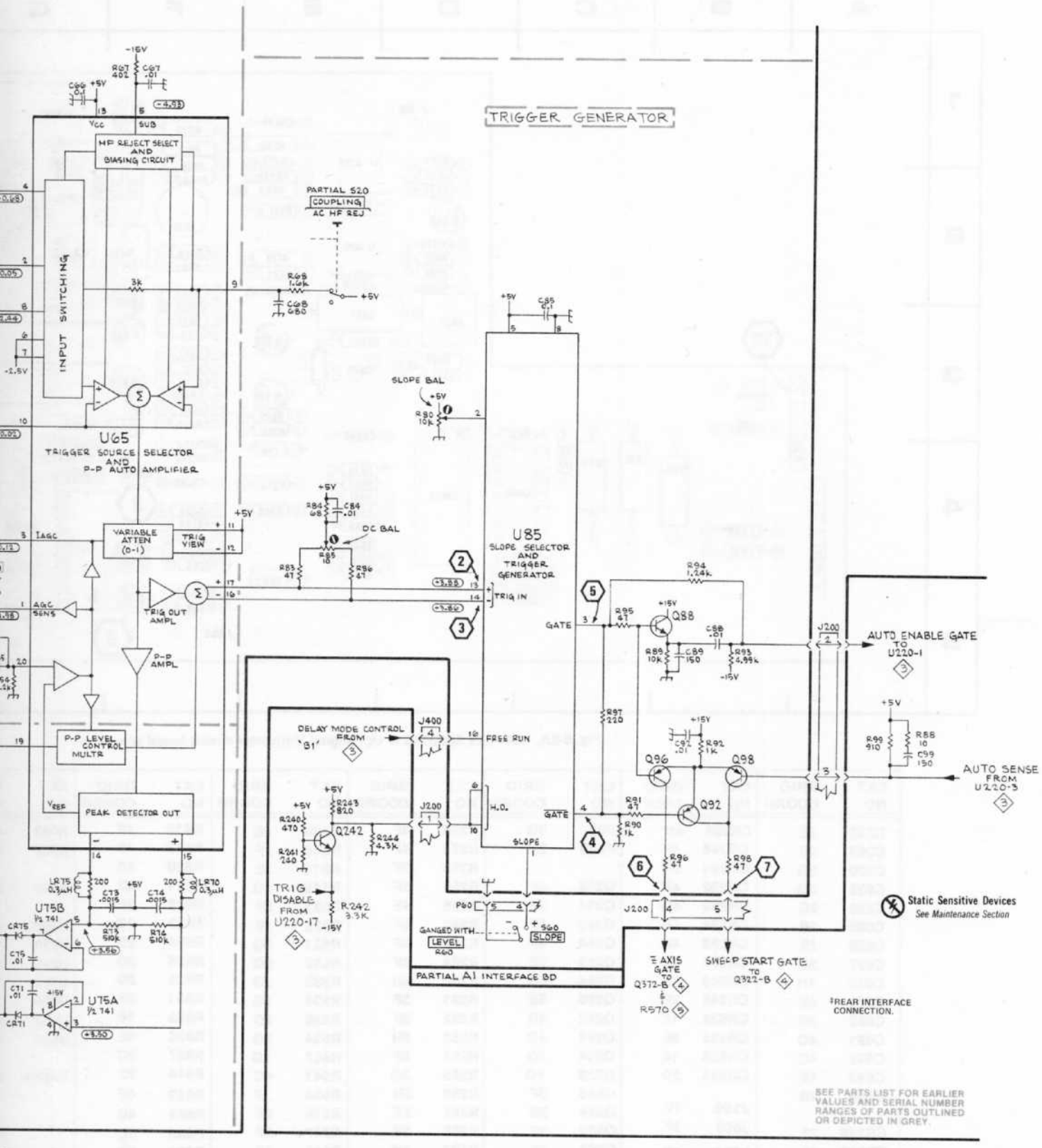
The voltages and waveforms shown were obtained with the 7B85 controls set as follows:

TIME/DIV, 1 ms; VARIABLE (CAL IN), knob in; MAG, X1 (button in); HOLD OFF, fully counterclockwise; SWP CAL, midranged; POSITION, midranged; TRIGGERING: LEVEL, midranged; MODE, P-P AUTO; COUPLING, AC; SOURCE, LINE; SLOPE, +. B DELAY MODE, B STARTS AFTER DLY; DELAY TIME, fully counterclockwise; Δ TIME, fully clockwise; TRACE SEP, fully counterclockwise.

Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimeter with a 10 MΩ input impedance (Tektronix DM 501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with readout equipped, 7000-series oscilloscope).

Waveform Conditions. The waveforms shown below were obtained using a test oscilloscope system with 10 MΩ input impedance and at least 60 MHz bandwidth (Tektronix 7603 Oscilloscope, 7B53A Time Base, and 7A13 Differential Comparator equipped with 10X probe).





TRIGGER GENERATOR 2

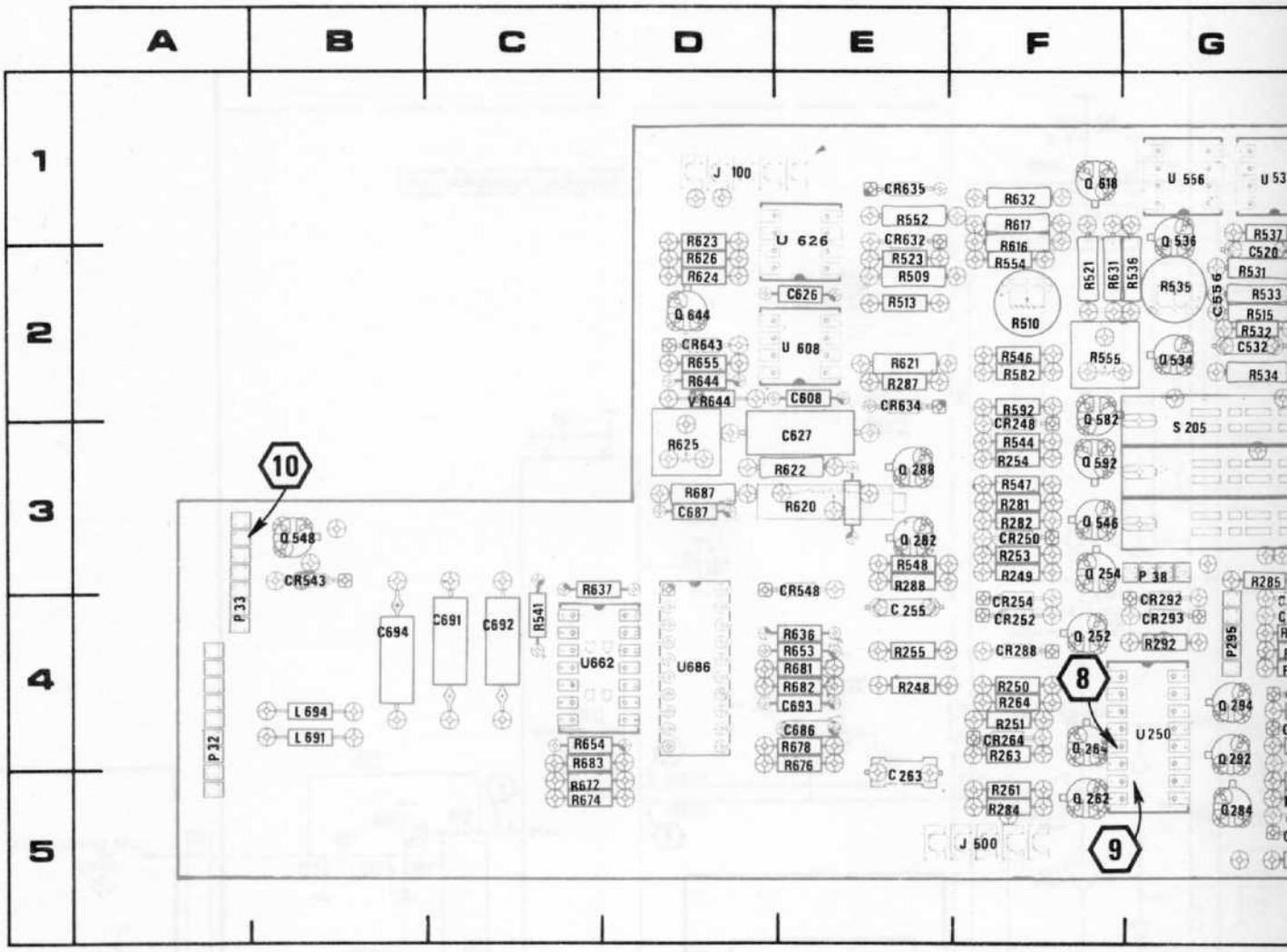
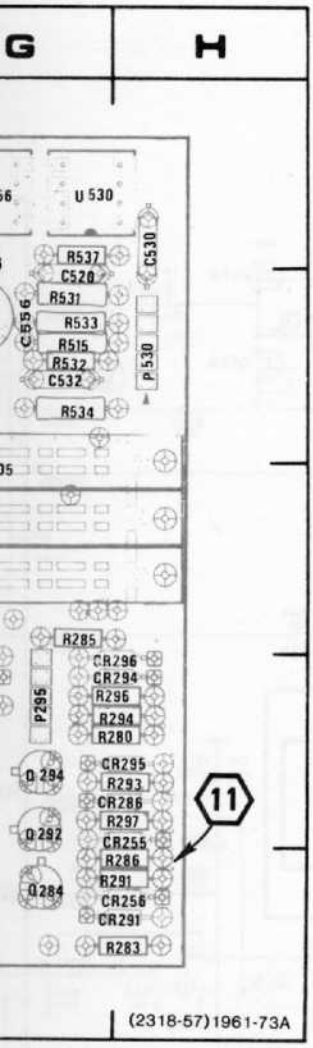


Fig. 8-9A. A4—(SN B088750 & Up) Digital Voltmeter circuit board assembly.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRI COO
C255	4E	CR286	4H	P38	3G	R250	4F	R509	2E	R616	1F	R683	4C
C263	5E	CR288	4F	P530	2H	R251	4F	R510	2F	R617	1F	R687	3D
C520	2G	CR291	5H			R253	3F	R513	2E	R620	3E		
C532	2G	CR292	4G	Q252	4F	R254	3F	R515	2G	R621	2E	S205	3G
C556	2G	CR293	4G	Q254	3F	R255	4E	R521	2F	R622	3E		
C608	2E	CR294	4H	Q262	5F	R261	5F	R523	2E	R623	1D	U250	4G
C626	2E	CR295	4H	Q264	4F	R263	4F	R531	2G	R624	2D	U530	1G
C627	3E	CR296	4H	Q282	3E	R264	4F	R532	2G	R625	3D	U556	1G
C630	1H	CR543	3B	Q284	5G	R280	4H	R533	2G	R626	2D	U608	1E
C686	4E	CR548	3E	Q288	3E	R281	3F	R534	2G	R631	2F	U626	1E
C687	3D	CR632	1E	Q292	4G	R282	3F	R535	2G	R632	1F	U662	4C
C691	4C	CR634	2E	Q294	4G	R283	5H	R536	2G	R636	4E	U686	4D
C692	4C	CR635	1E	Q534	2G	R284	5F	R537	1G	R637	3C		
C693	4E	CR643	2D	Q536	1G	R285	3G	R541	4C	R644	2D	VR644	2D
C694	4B			Q546	3F	R286	5H	R554	3F	R653	4E		
		J100	1D	Q548	3B	R287	2E	R546	2F	R654	4C		
CR248	2F	J500	5F	Q582	2F	R288	3E	R547	3F	R655	2D		
CR250	3F	L691	4B	Q592	3F	R291	5H	R548	3E	R672	5C		
CR252	4F	L694	4B	Q618	1F	R292	4G	R552	1E	R674	5C		
CR254	4F			Q644	2D	R293	4H	R554	2F	R676	4E		
CR255	4H	P295	4G			R294	4H	R555	2F	R678	4E		
CR256	5H	P32	4A	R248	4E	R296	4H	R582	2F	R681	4E		
CR264	4F	P33	4A	R249	3F	R297	4H	R592	2F	R682	4E		



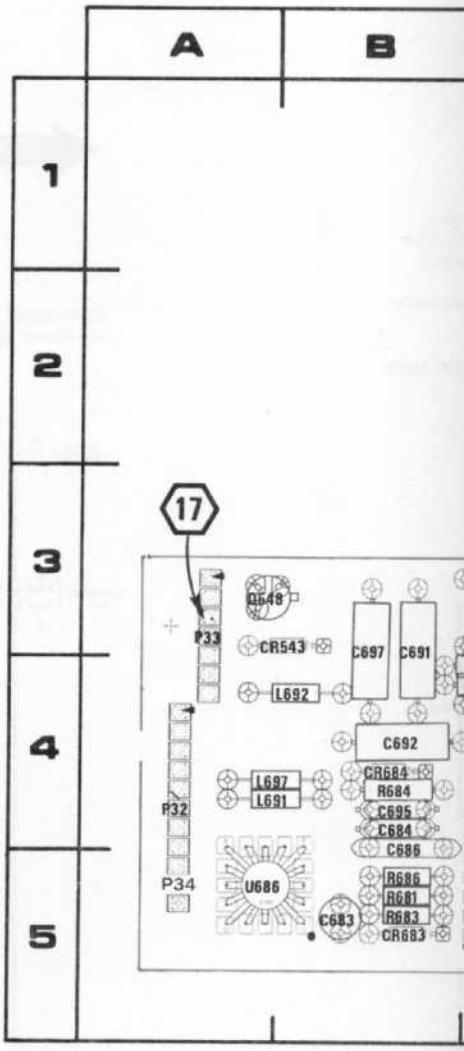
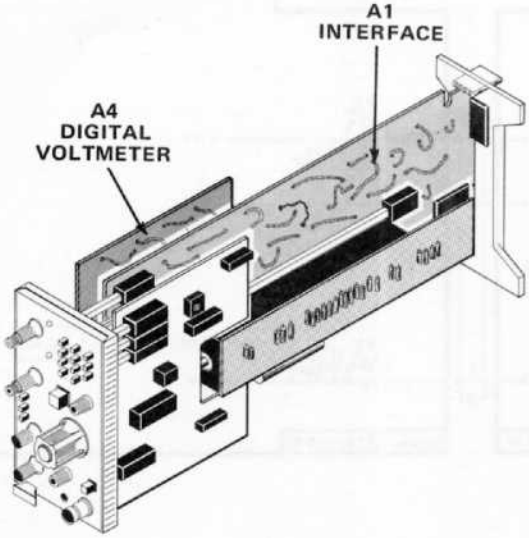


Fig.

T	GRID COORD
33	4C
37	3D
05	3G
50	4G
30	1G
56	1G
08	1E
26	1E
52	4C
36	4D
644	2D



CKT NO	GRID COORD	CKT NO	GRID COORD
C255	4E	CR264	4F
C263	5F	CR286	4G
C520	2G	CR288	4F
C530	1G	CR291	5G
C532	2G	CR292	4F
C608	2D	CR293	4F
C627	3D	CR294	4G
C645	4C	CR295	4G
C652	3D	CR296	4G
C654	4C	CR543	3B
C662	4C	CR627	1E
C676	5E	CR641	2D
C679	5E	CR642	2D
C683	5B	CR683	5B
C684	4B	CR684	4B
C686	4B		
C691	3B	J100	1D
C692	4B	J500	5E
C695	4B		
C697	3B	L691	4A
C699	4D	L692	4B
		L697	4A
CR248	2F		
CR250	3F	P31	3D
CR252	4F	P32	4A
CR254	4F	P33	3A
CR255	4G	P38	3F
CR256	5G	P295	4G

Static Sensitive Devices
See Maintenance Section

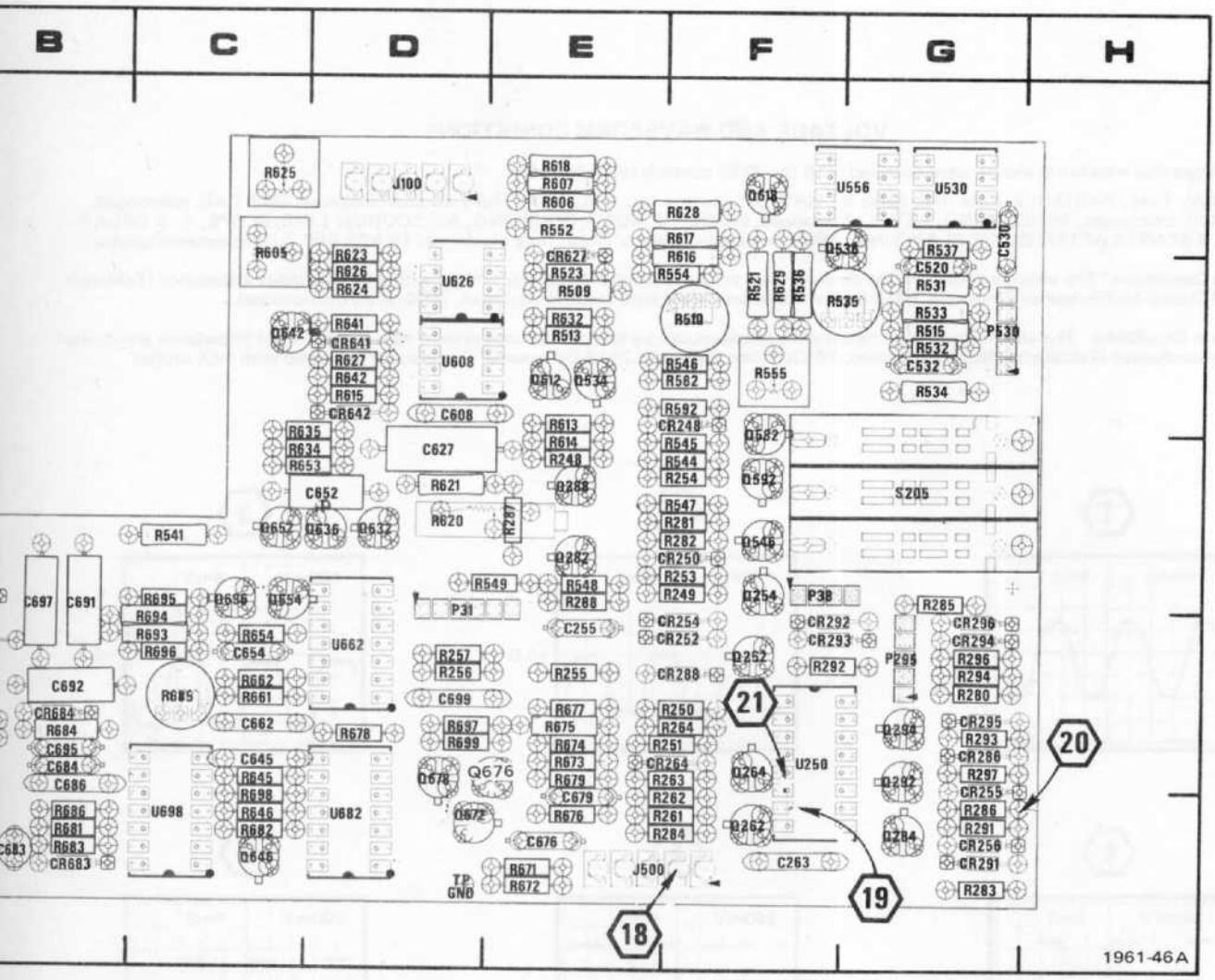


Fig. 8-9B. A4–(SN B088749 & Below) Digital Voltmeter circuit board assembly.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
264	4F	P530	2G	R248	3E	R509	2E	R613	2E	R673	4E	U608	2D
286	4G			R249	3F	R510	2F	R614	3E	R674	4E	U626	2D
288	4F	Q252	4F	R250	4F	R513	2E	R615	2D	R675	4E	U662	4D
291	5G	Q254	3F	R251	4F	R515	2G	R616	1F	R676	5E	U682	5D
292	4F	Q262	5F	R253	3F	R521	2F	R617	1F	R677	4E	U686	5A
293	4F	Q264	4G	R254	3F	R523	2E	R618	1E	R678	4D	U698	5C
294	4G	Q282	3E	R255	4E	R531	2G	R620	3D	R679	4E		
295	4G	Q284	5G	R256	4D	R532	2G	R621	3D	R681	5B		
296	4G	Q288	3E	R257	4D	R533	2G	R623	1D	R682	5C		
543	3B	Q292	4G	R261	5F	R534	2G	R624	2D	R683	5B		
627	1E	Q294	4G	R262 *	5F	R535	2F	R625	1C	R684	4B		
641	2D	Q534	2E	R263	4F	R536	2F	R626	2D	R685	4C		
642	2D	Q546	3F	R264	4F	R537	1G	R627	2D	R686	5B		
683	5B	Q548	3A	R280	4G	R541	3C	R628	1F	R693	4C		
684	4B	Q582	2F	R281	3F	R544	3F	R629	2F	R694	4C		
		Q592	3F	R282	3F	R545	3F	R632	2E	R695	3C		
0	1D	Q612	2E	R283	5G	R546	2F	R634	3C	R696	4C		
0	5E	Q618	1F	R284	5F	R547	3F	R635	2C	R697	4D		
		Q632	3D	R285	3G	R548	3E	R641	2D	R698	5C		
1	4A	Q636	3D	R286	5G	R549	3D	R642	2D	R699	4D		
2	4B	Q642	2C	R287	3E	R552	1E	R645	4C				
7	4A	Q646	5C	R288	3E	R554	2F	R646	5C	S205	3G		
		Q652	3C	R291	5G	R555	2F	R653	3C				
	3D	Q654	3C	R292	4F	R582	2F	R654	4C	TPGND	5D		
	4A	Q672	5D	R293	4G	R592	2F	R661	4C				
	3A	Q676	4E	R294	4G	R605	1C	R662	4C	U250	4F		
	3F	Q678	4D	R296	4G	R606	1E	R671	5E	U530	1G		
5	4G	Q696	3C	R297	4G	R607	1E	R672	5E	U556	1G		

VOLTAGE AND WAVEFORM CONDITIONS

The voltages and waveforms shown were obtained with the 7B85 controls set as follows:

TIME/DIV, 1 ms; VARIABLE (CAL IN), knob in; MAG, X1 (button in); HOLD OFF, fully counterclockwise; SWP CAL, midranged; POSITION, midranged; TRIGGERING: LEVEL, midranged; MODE, P-P AUTO; COUPLING, AC; SOURCE, LINE; SLOPE, +. B DELAY MODE, B STARTS AFTER DLY; DELAY TIME, fully counterclockwise; Δ TIME, fully clockwise; TRACE SEP, fully counterclockwise.

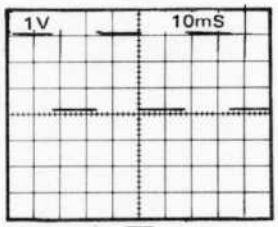
Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimeter with a 10 MΩ input impedance (Tektronix DM 501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with readout equipped, 7000-series oscilloscope).

Waveform Conditions. The waveforms shown below were obtained using a test oscilloscope system with 10 MΩ input impedance and at least 60 MHz bandwidth (Tektronix 7603 Oscilloscope, 7B53A Time Base, and 7A13 Differential Comparator equipped with 10X probe).

NOTE

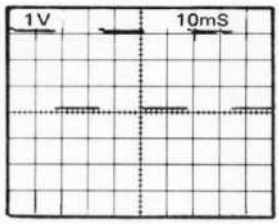
Some voltages and waveforms were measured with the Digital Voltmeter board removed.

8



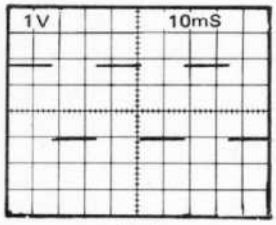
0 V

9



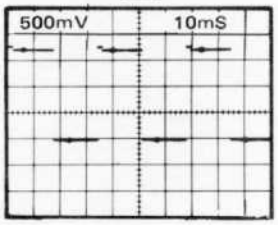
0 V

10



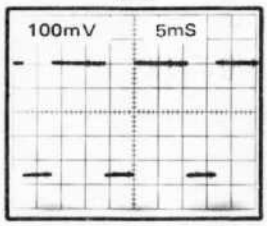
8 V

11



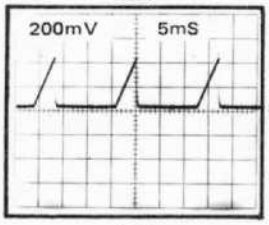
0 V

12



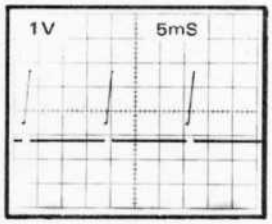
0 V

13



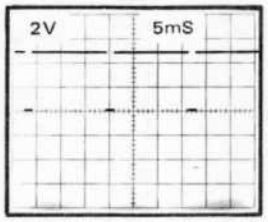
0 V

14



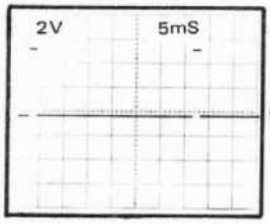
+2.0

15



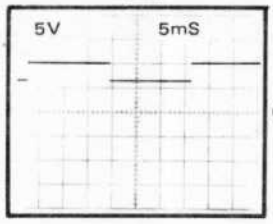
0 V

16



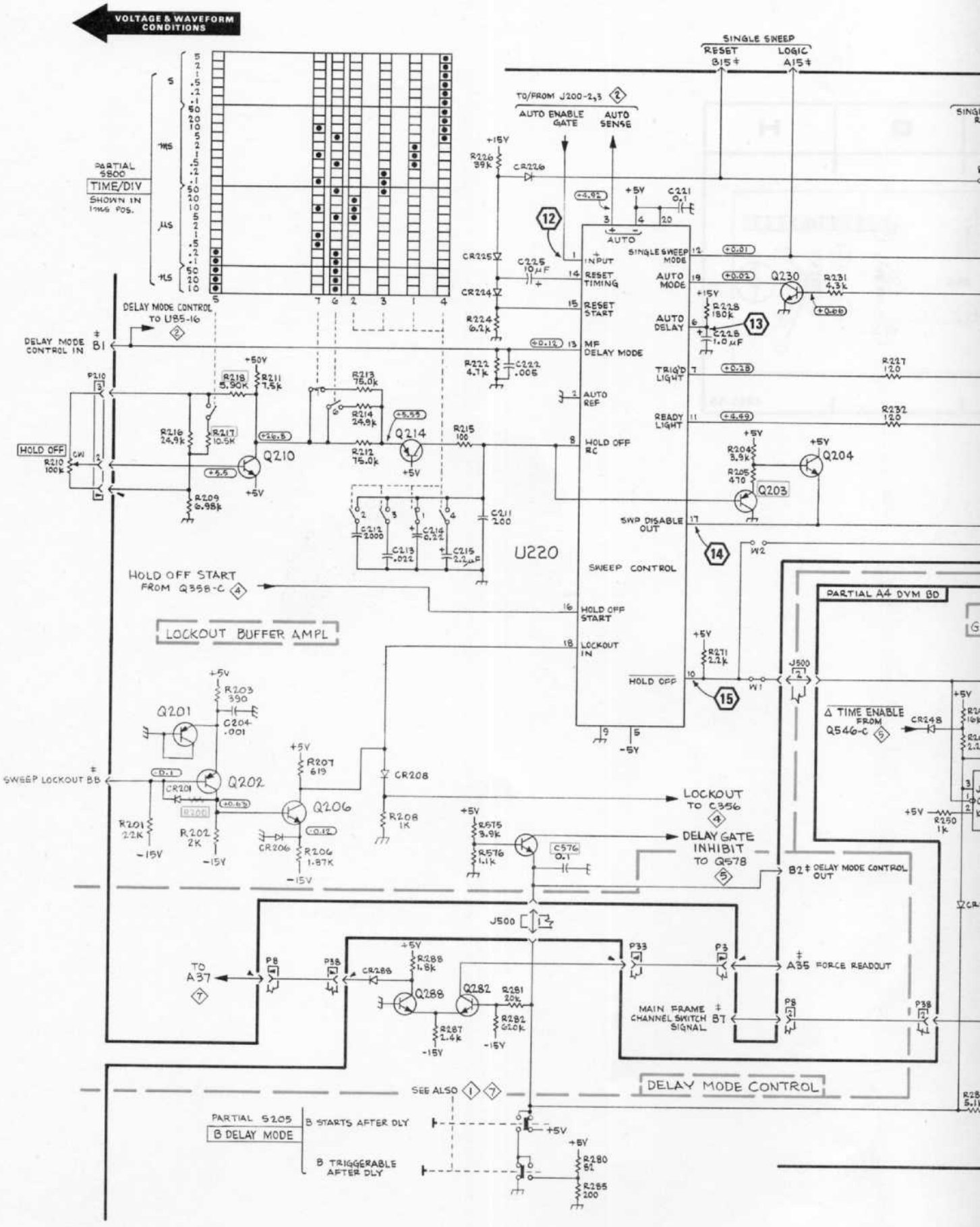
0 V

17



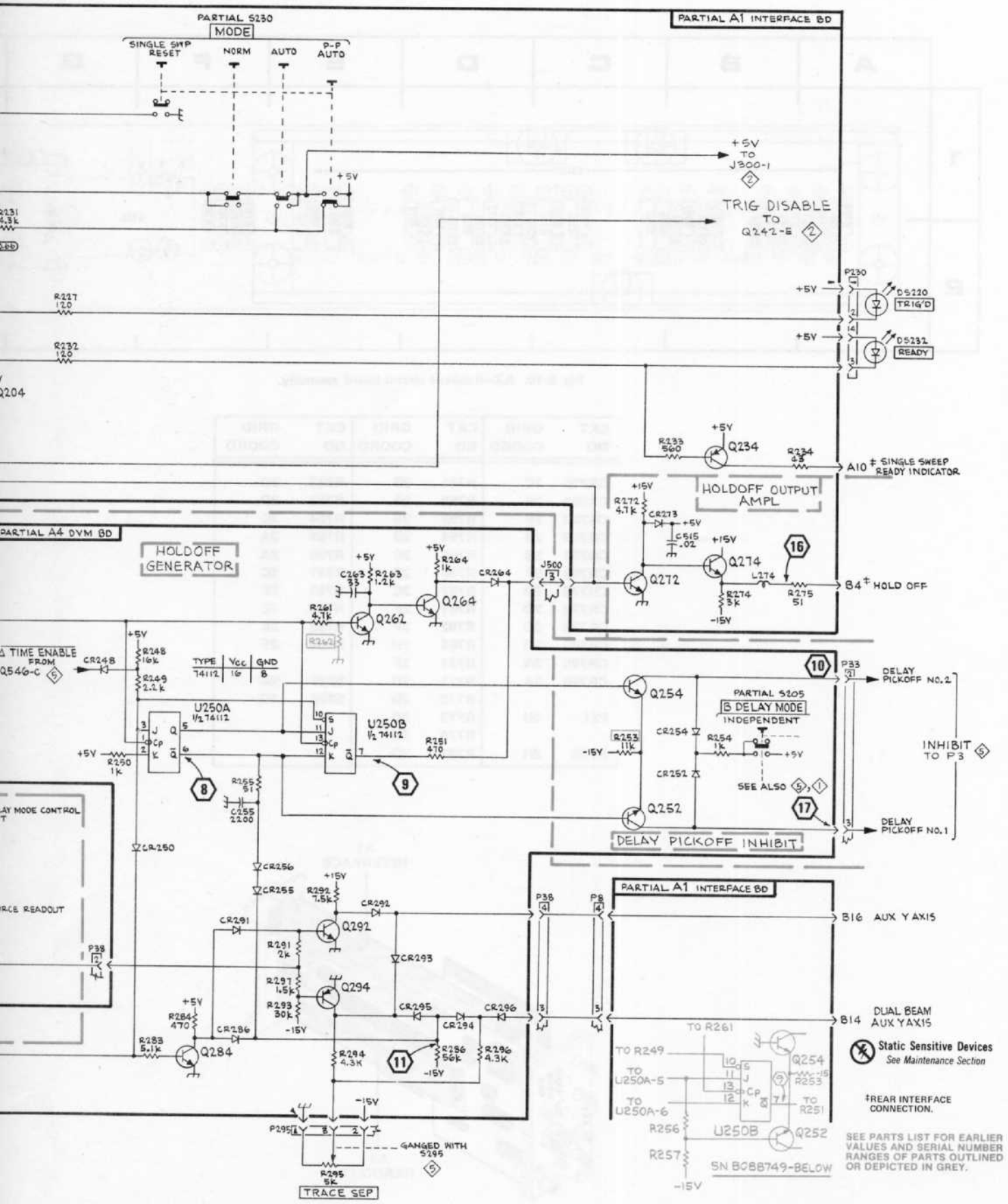
0 V

NOTE: 18 through 21 not used.



7B85

2318-66
REV JUL 1982



2318-66
REV JUL 1982

LOGIC 3

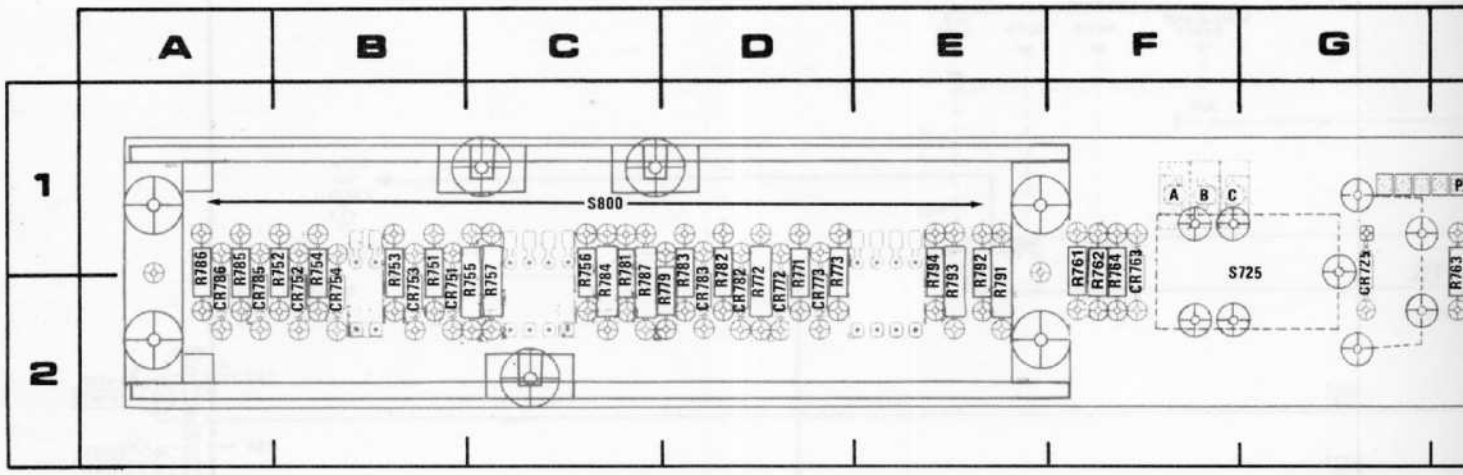
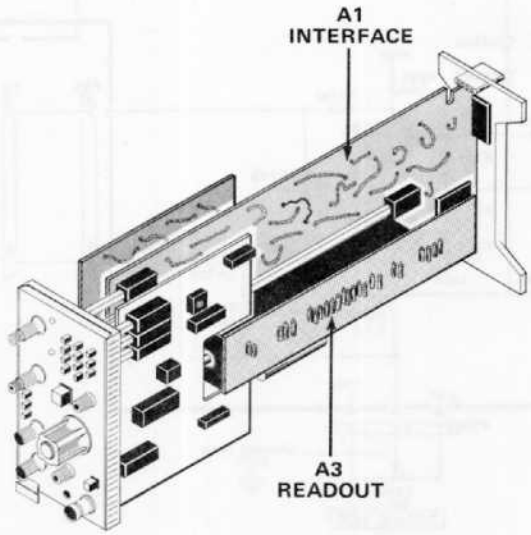
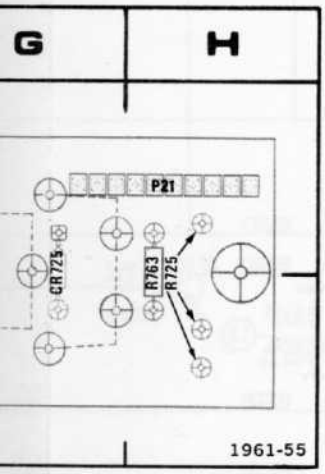


Fig. 8-10. A3—Readout circuit board assembly.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
CR725	1C	R751	2B	R782	2D
CR751	2B	R752	2B	R783	2D
CR752	2B	R753	2B	R784	2C
CR753	2B	R754	2B	R785	2A
CR754	2B	R755	2C	R786	2A
CR763	2F	R756	2C	R787	2C
CR772	2D	R757	2C	R791	2E
CR773	2D	R761	2F	R792	2E
CR782	2D	R762	2F	R793	2E
CR783	2D	R763	2H	R794	2E
CR785	2A	R764	2F		
CR786	2A	R771	2D	S725	2C
		R772	2D	S800	1C
P21	1H	R773	2D		
		R779	2D		
R725	2H	R781	2D		



Static Sensitive Devices
See Maintenance Section


G
H
P21
CR725
R763
R725
1961-55

VOLTAGE AND WAVEFORM CONDITIONS

The voltages and waveforms shown were obtained with the 7B85 controls set as follows:

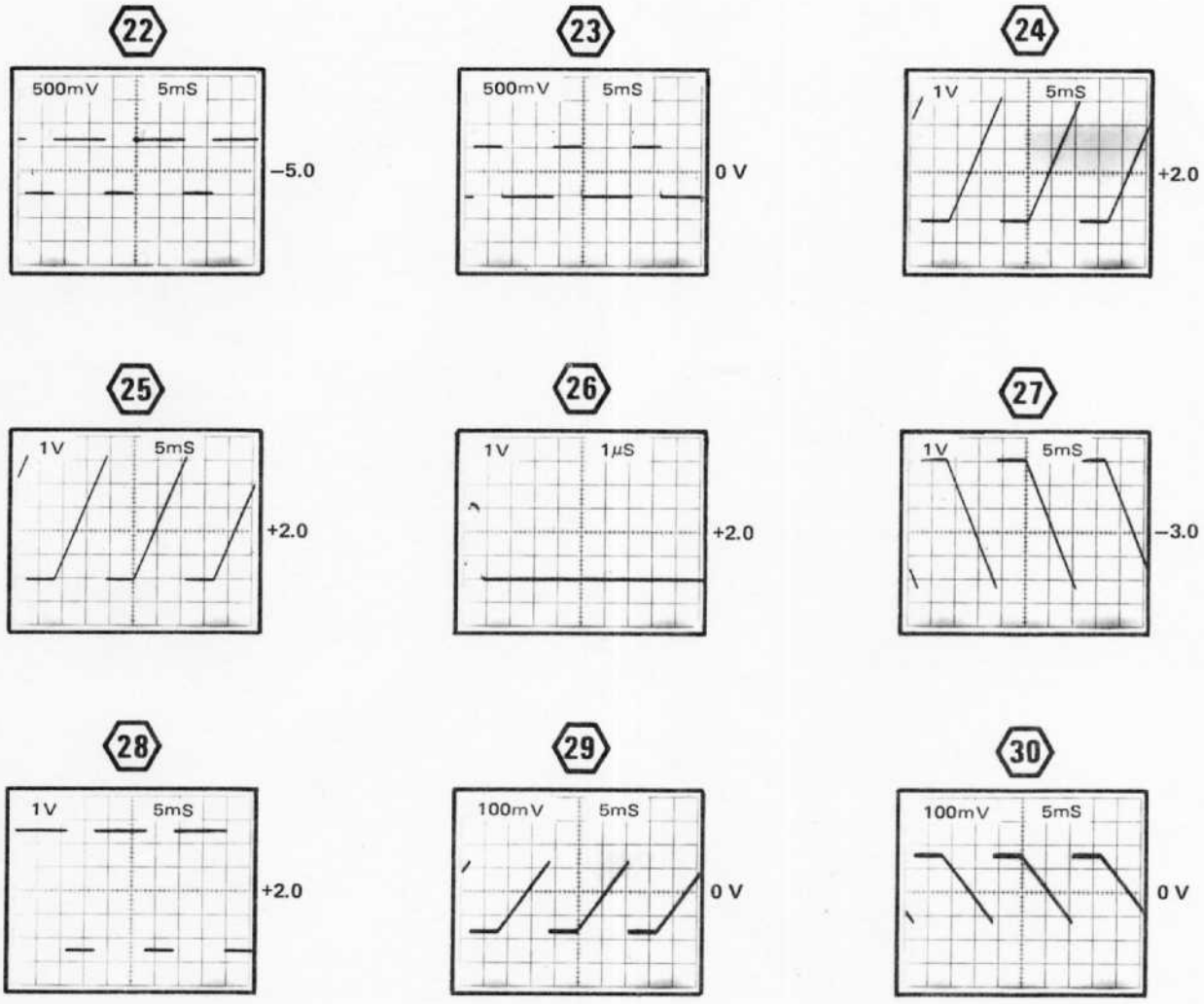
TIME/DIV, 1 ms; VARIABLE (CAL IN), knob in; MAG, X1 (button in); HOLD OFF, fully counterclockwise; SWP CAL, midranged; POSITION, midranged; TRIGGERING: LEVEL, midranged; MODE, P-P AUTO; COUPLING, AC; SOURCE, LINE; SLOPE, +. B DELAY MODE, B STARTS AFTER DLY; DELAY TIME, fully counterclockwise; Δ TIME, fully clockwise; TRACE SEP, fully counterclockwise.

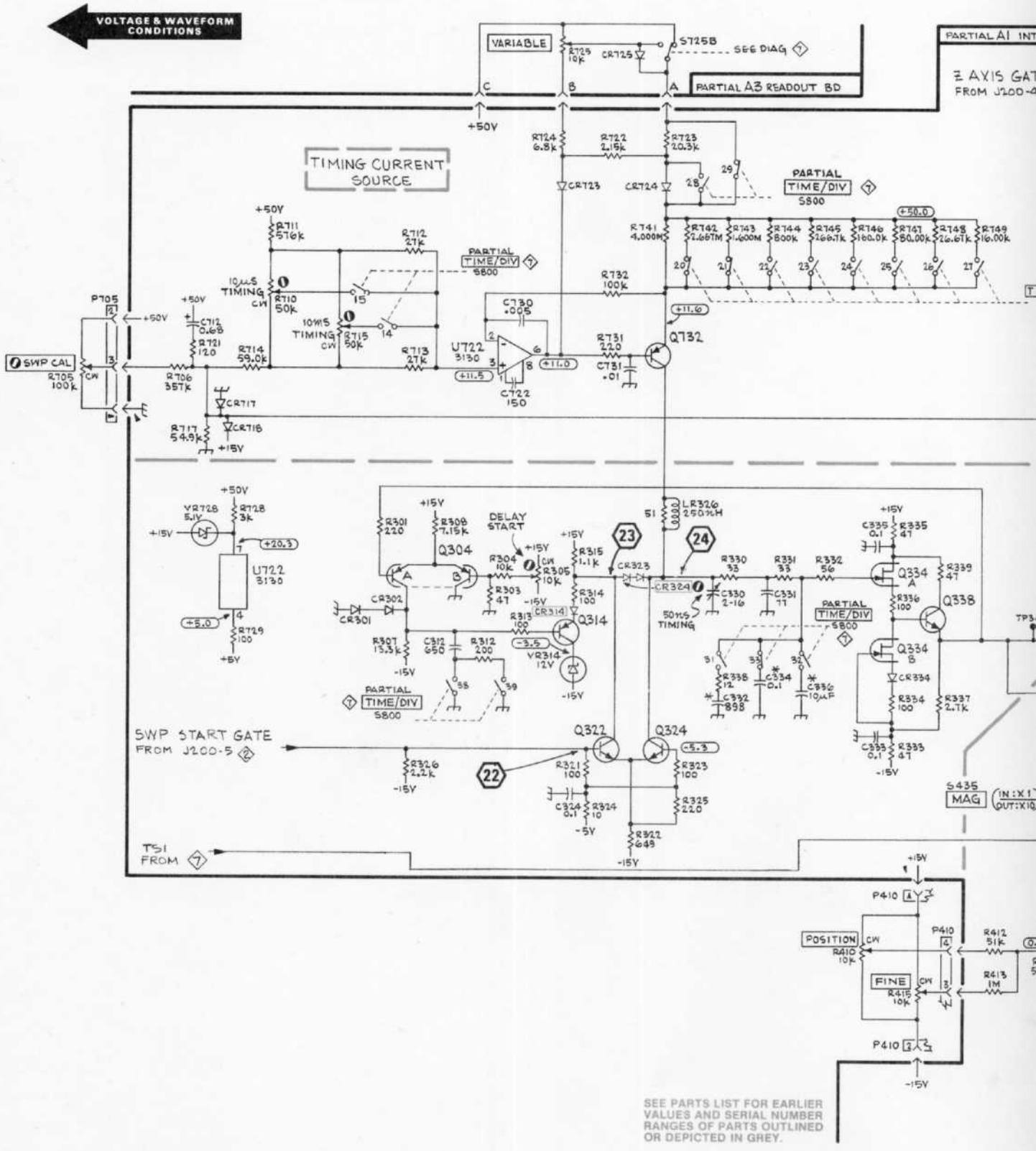
Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimeter with a 10 MΩ input impedance (Tektronix DM 501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with readout equipped, 7000-series oscilloscope).

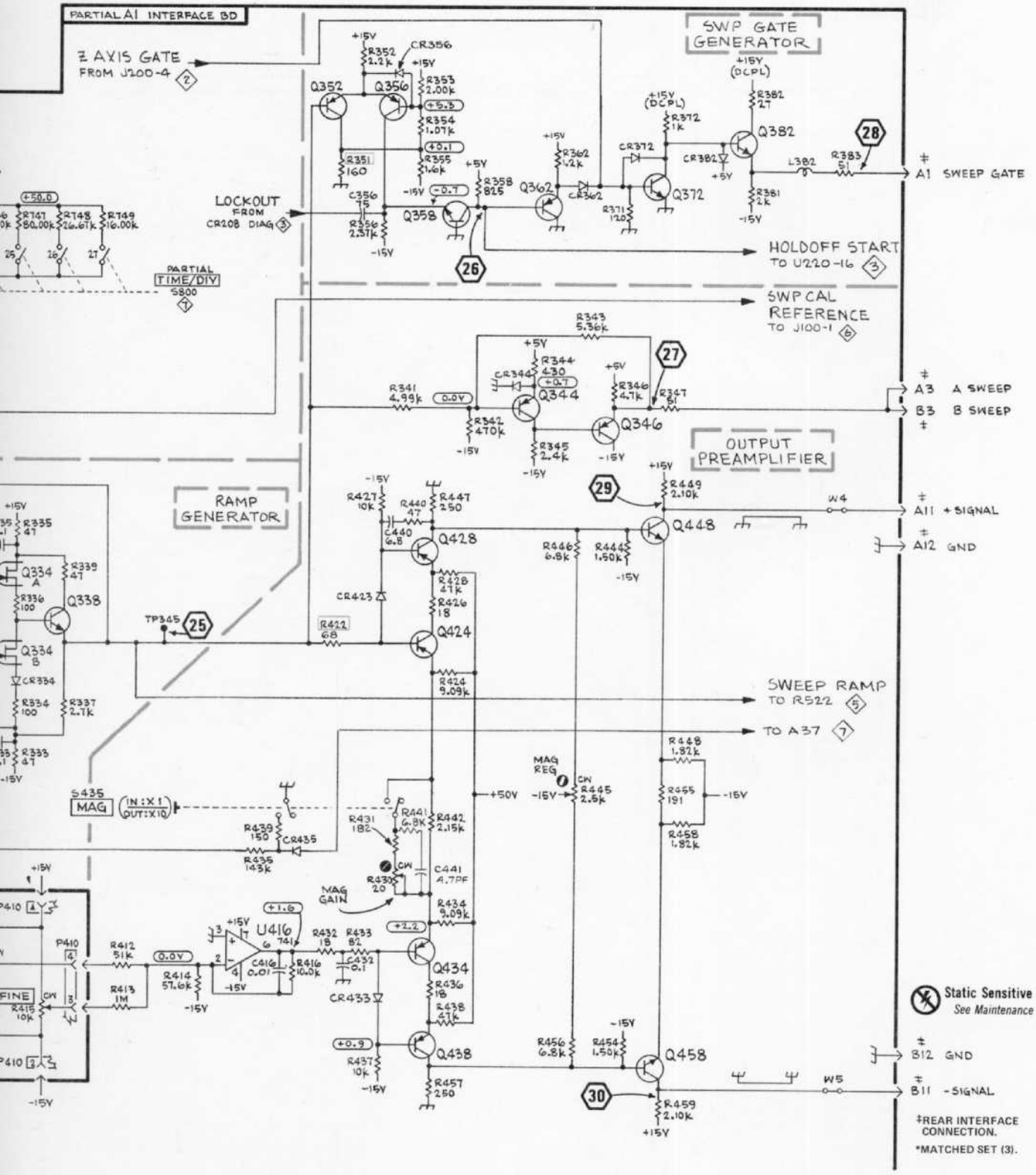
Waveform Conditions. The waveforms shown below were obtained using a test oscilloscope system with 10 MΩ input impedance and at least 60 MHz bandwidth (Tektronix 7603 Oscilloscope, 7B53A Time Base, and 7A13 Differential Comparator equipped with 10X probe).

NOTE

Some voltages and waveforms were measured with the Digital Voltmeter board removed.




VOLTAGE & WAVEFORM CONDITIONS
VARIABLE
R725 10K
CR725
S725B
SEE DIAG 7
PARTIAL A3 READOUT BD
PARTIAL A1 INT
Z AXIS GAT
FROM J100-4
+50V
R724 6.8k
R722 2.15k
R723 20.3k
TIMING CURRENT SOURCE
CR723
CR724
PARTIAL TIME/DIV S800
R741 4.000M
R742 2.66TM
R743 1.600M
R744 800k
R745 266.7k
R746 160.0k
R747 80.00k
R748 26.67k
R749 16.00k
+50.0
R732 100k
C730 .005
+11.6
Q732
U722 3130
+11.5
+11.0
C722 150
C731 .01
R731 220
R711 576k
R712 27k
10µS TIMING CW R710 50k
10MS TIMING CW R715 50k
R714 59.0k
R713 27k
P705
SWP CAL R705 100k CW
R706 357k
C712 0.68
R721 120
CR717
CR718
R717 54.9k
+15V
VR728 5.1V
R728 3k
+20.3
+5.0
R729 100
+5V
R301 220
R308 7.15k
Q304
DELAY START
R304 10k
R305 10k CW
R303 47
R314 100
R315 1.1k
CR323
CR324
LR326 250µH
R330 33
R331 33
R332 56
C330 2-16
C331 77
50MS TIMING
CR302
CR301
R307 13.3k
C312 650
R312 200
R313 100
CR314
Q314
VR314 12V
-3.5
PARTIAL TIME/DIV S800
C335 0.1
R335 47
Q334 A
R339 47
Q338
R336 100
Q334 B
CR334
R334 100
R337 2.7k
R333 47
C333 0.1
R338 12
C332 898
C334 0.1
C336 10µF
SWP START GATE FROM J200-5
R326 2.2k
Q322
Q324
-5.3
R321 100
R323 100
R325 220
C324 0.1
R324 10
R322 649
-5V
-15V
TS1 FROM 7
S435 MAG
P410
POSITION R410 10k CW
FINE R415 10k CW
R412 51k
R413 1M
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.


PARTIAL A1 INTERFACE BD
Z AXIS GATE
FROM J200-4 2
LOCKOUT
FROM
CR208 DIAG 3
PARTIAL
TIME/DIV
S800 1
SWP GATE
GENERATOR
HOLDOFF START
TO U220-16 3
SWP CAL
REFERENCE
TO J100-1 6
OUTPUT
PREAMPLIFIER
RAMP
GENERATOR
SWEEP RAMP
TO R522 5
TO A37 7
A1 SWEEP GATE
A3 A SWEEP
B3 B SWEEP
A11 +SIGNAL
A12 GND
B12 GND
B11 -SIGNAL
W4
W5
S435
MAG
(IN:X1
OUT:X10)
MAG
GAIN
MAG
REG
Q352
Q356
Q358
Q362
Q372
Q382
Q344
Q346
Q334
A
Q334
B
Q338
Q428
Q424
Q448
Q438
Q458
Q434
U416
741
CR356
CR372
CR382
CR362
CR344
CR423
CR435
CR433
CR334
TP345
25
26
27
28
29
30
+15V
-15V
+5V
+50V
0.0V
+0.1
-0.7
+1.6
+2.2
+0.9
R352 2.2k
R353 2.00k
R354 1.07k
R355 1.6k
R351 160
R356 2.57k
C356 75
R358 825
R362 1.2k
R371 120
R372 1k
R381 2k
R382 27
R383 51
L382
R341 4.99k
R342 470k
R343 5.36k
R344 430
R345 2.4k
R346 4.7k
R347 51
R335 47
R339 47
R336 100
R334 100
R337 2.7k
R333 47
R427 10k
R440 47
R447 250
C440 6.8
R428 47k
R426 18
R422 68
R424 9.09k
R449 2.10k
R446 6.8k
R444 1.50k
R439 150
R435 143k
R441 6.8k
R431 182
R430 20
C441 4.7PF
R442 2.15k
R434 9.09k
R448 1.82k
R455 191
R458 1.82k
R445 2.5k
R412 51k
R413 1M
R414 57.6k
R415 10k
FINE
C416 0.01
R416 10.0k
R432 18
R433 82
C432 0.1
R436 18
R438 47k
R437 10k
R457 250
R456 6.8k
R454 1.50k
R459 2.10k
R747 50.00k
R748 26.6.7k
R749 10.00k
P410
Static Sensitive Devices
See Maintenance Section
‡REAR INTERFACE
CONNECTION.
*MATCHED SET (3).

VOLTAGE AND WAVEFORM CONDITIONS

The voltages and waveforms shown were obtained with the 7B85 controls set as follows:

TIME/DIV, 1 ms; VARIABLE (CAL IN), knob in; MAG, X1 (button in); HOLD OFF, fully counterclockwise; SWP CAL, midranged; POSITION, midranged; TRIGGERING: LEVEL, midranged; MODE, P-P AUTO; COUPLING, AC; SOURCE, LINE; SLOPE, +. B DELAY MODE, B STARTS AFTER DLY; DELAY TIME, fully counterclockwise; Δ TIME, fully clockwise; TRACE SEP, fully counterclockwise.

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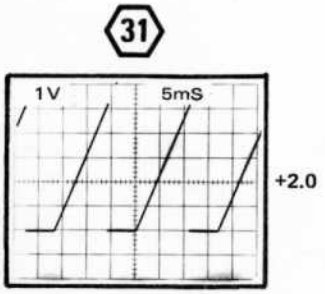
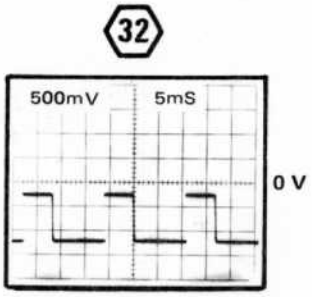
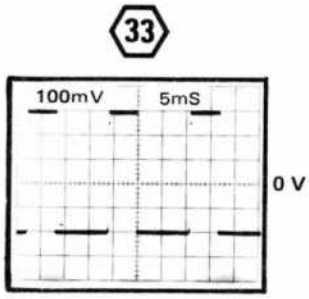
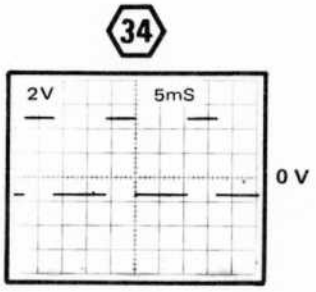
NOTE

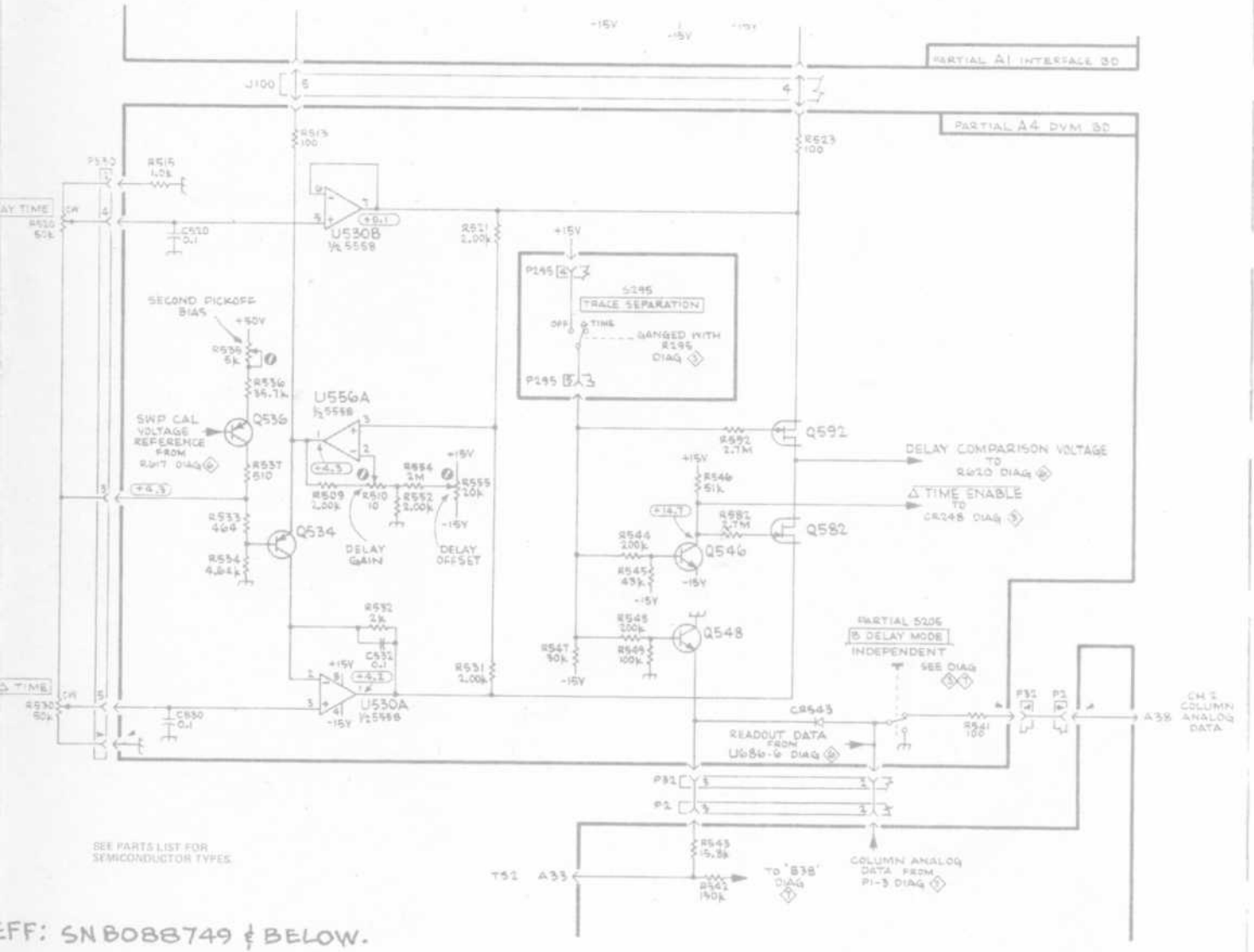
Some voltages and waveforms were measured with the Digital Voltmeter board removed.



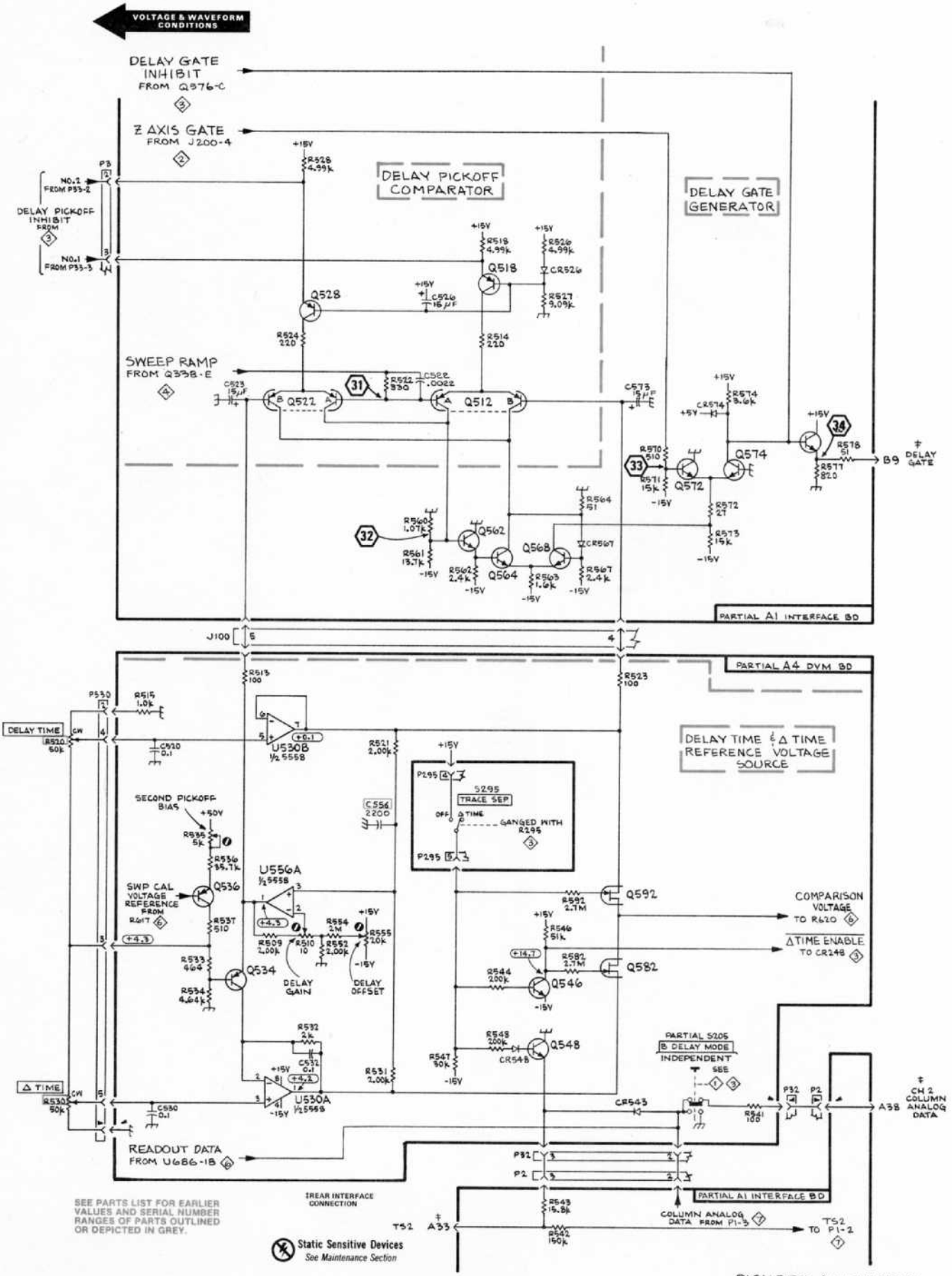








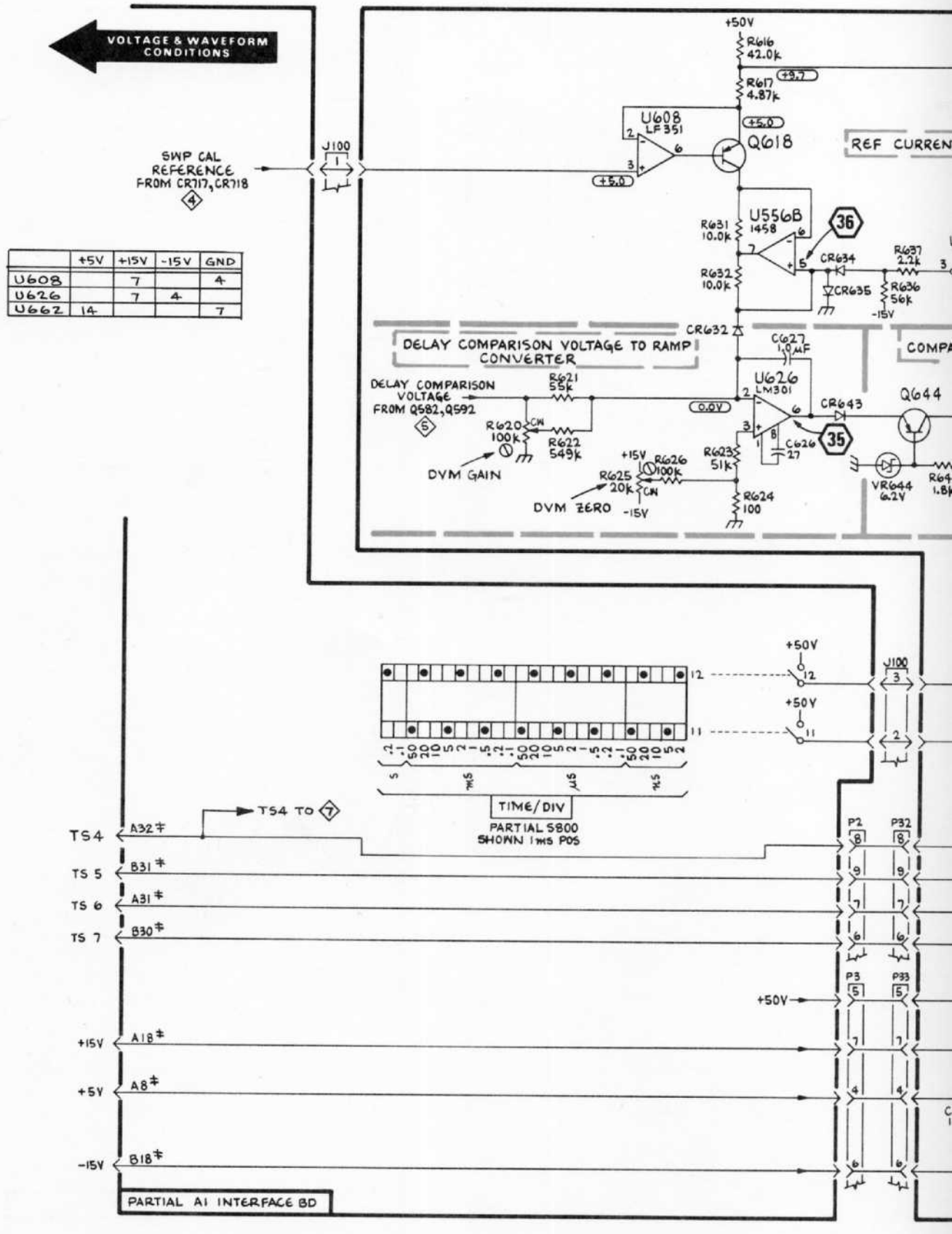
EFF: SN B088749 & BELOW.



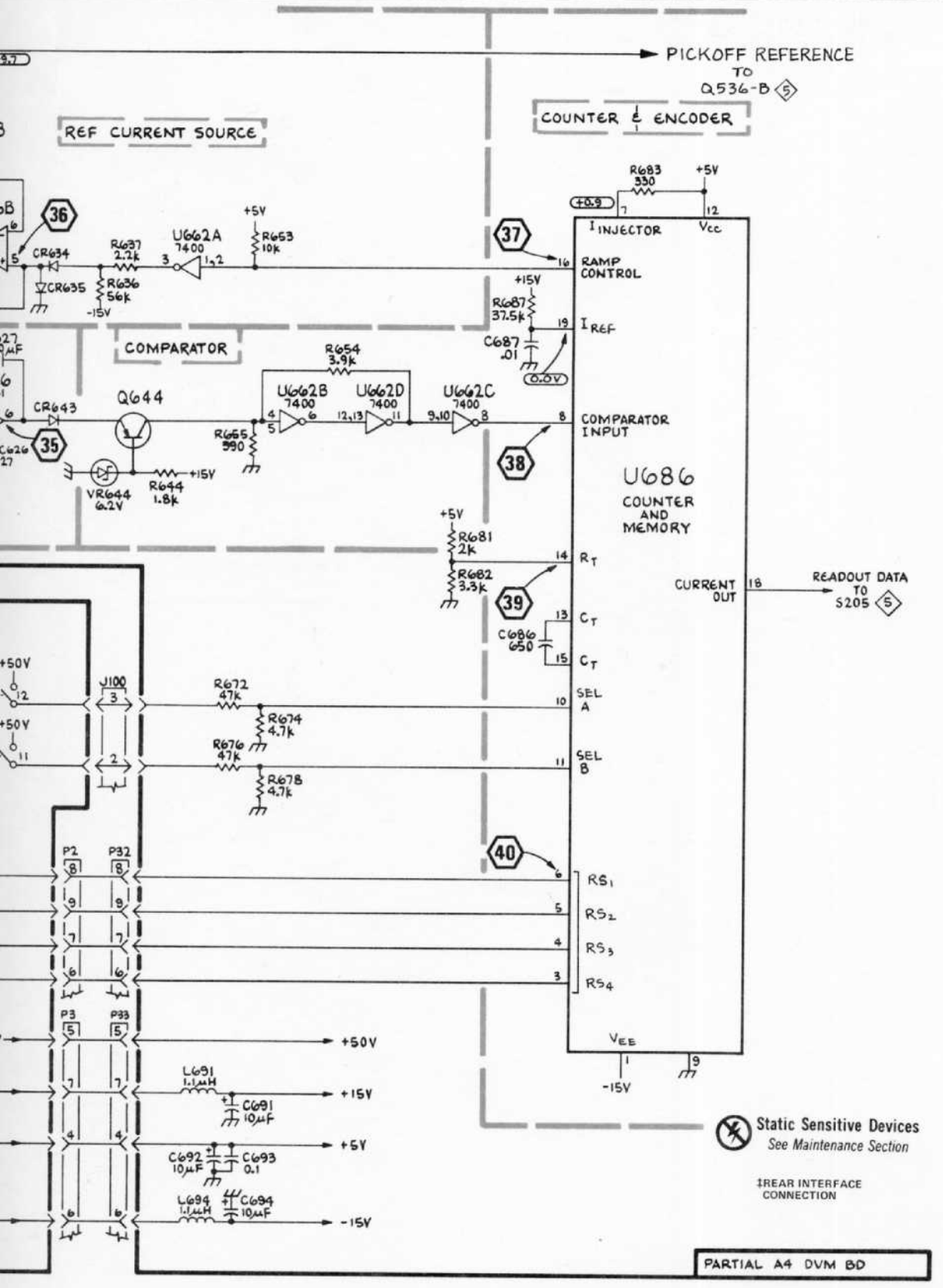
7B85

1961-64
REV DEC 1982

PICKOFF AMPLIFIERS AND DELAY GATE GENERATOR 5



	+5V	+15V	-15V	GND
U608		7		4
U626		7	4	
U662	14			7


PICKOFF REFERENCE TO Q536-B (5)
COUNTER & ENCODER
REF CURRENT SOURCE
COMPARATOR
R683 330
+5V
+0.9
I INJECTOR
Vcc
U662A 7400
R653 10k
R637 2.2k
CR634
CR635
R636 56k
-15V
RAMP CONTROL
+15V
R687 37.5k
I REF
C687 .01
0.0V
R654 3.9k
U662B 7400
U662D 7400
U662C 7400
Q644
CR643
R665 390
COMPARATOR INPUT
VR644 6.2V
R644 1.8k
U686
COUNTER AND MEMORY
R681 2k
R682 3.3k
R T
CURRENT OUT
READOUT DATA TO S205 (5)
C6866 650
C T
J100
+50V
R672 47k
R674 4.7k
R676 47k
R678 4.7k
SEL A
SEL B
P2
P32
P3
P33
RS1
RS2
RS3
RS4
VEE
L691 1.1μH
C691 10μF
C692 10μF
C693 0.1
L694 1.1μH
C694 10μF
Static Sensitive Devices
See Maintenance Section
‡REAR INTERFACE CONNECTION
PARTIAL A4 DVM BD

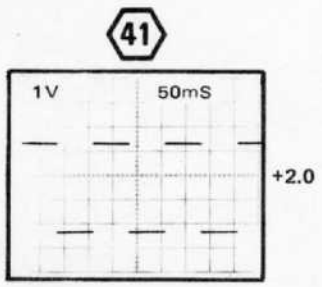
VOLTAGE AND WAVEFORM CONDITIONS

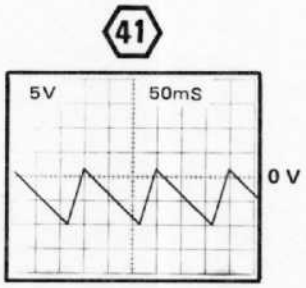
The voltages and waveforms shown were obtained with the 7B85 controls set as follows:

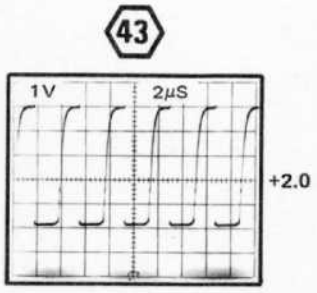
TIME/DIV, 1 ms; VARIABLE (CAL IN), knob in; MAG, X1 (button in); HOLD OFF, fully counterclockwise; SWP CAL, midranged; POSITION, midranged; TRIGGERING: LEVEL, midranged; MODE, P-P AUTO; COUPLING, AC; SOURCE, LINE; SLOPE, +. B DELAY MODE, B STARTS AFTER DLY; DELAY TIME, fully counterclockwise; Δ TIME, fully clockwise; TRACE SEP, fully counterclockwise.

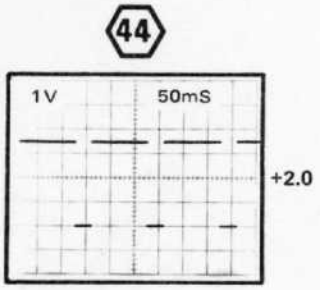
Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimeter with a 10 MΩ input impedance (Tektronix DM 501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with readout equipped, 7000-series oscilloscope).

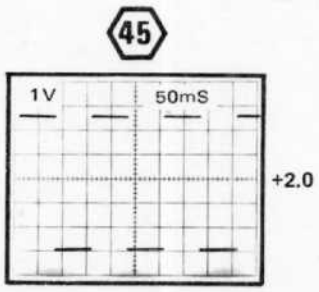
Waveform Conditions. The waveforms shown below were obtained using a test oscilloscope system with 10 MΩ input impedance and at least 60 MHz bandwidth (Tektronix 7603 Oscilloscope, 7B53A Time Base, and 7A13 Differential Comparator equipped with 10X probe).

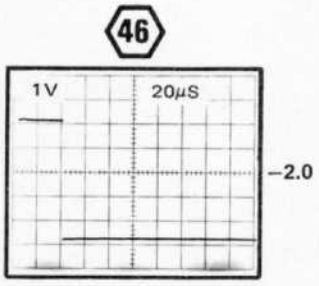


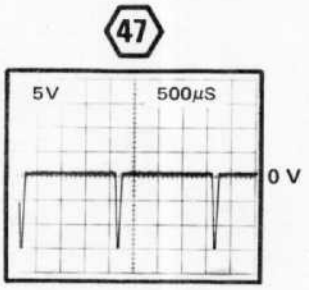


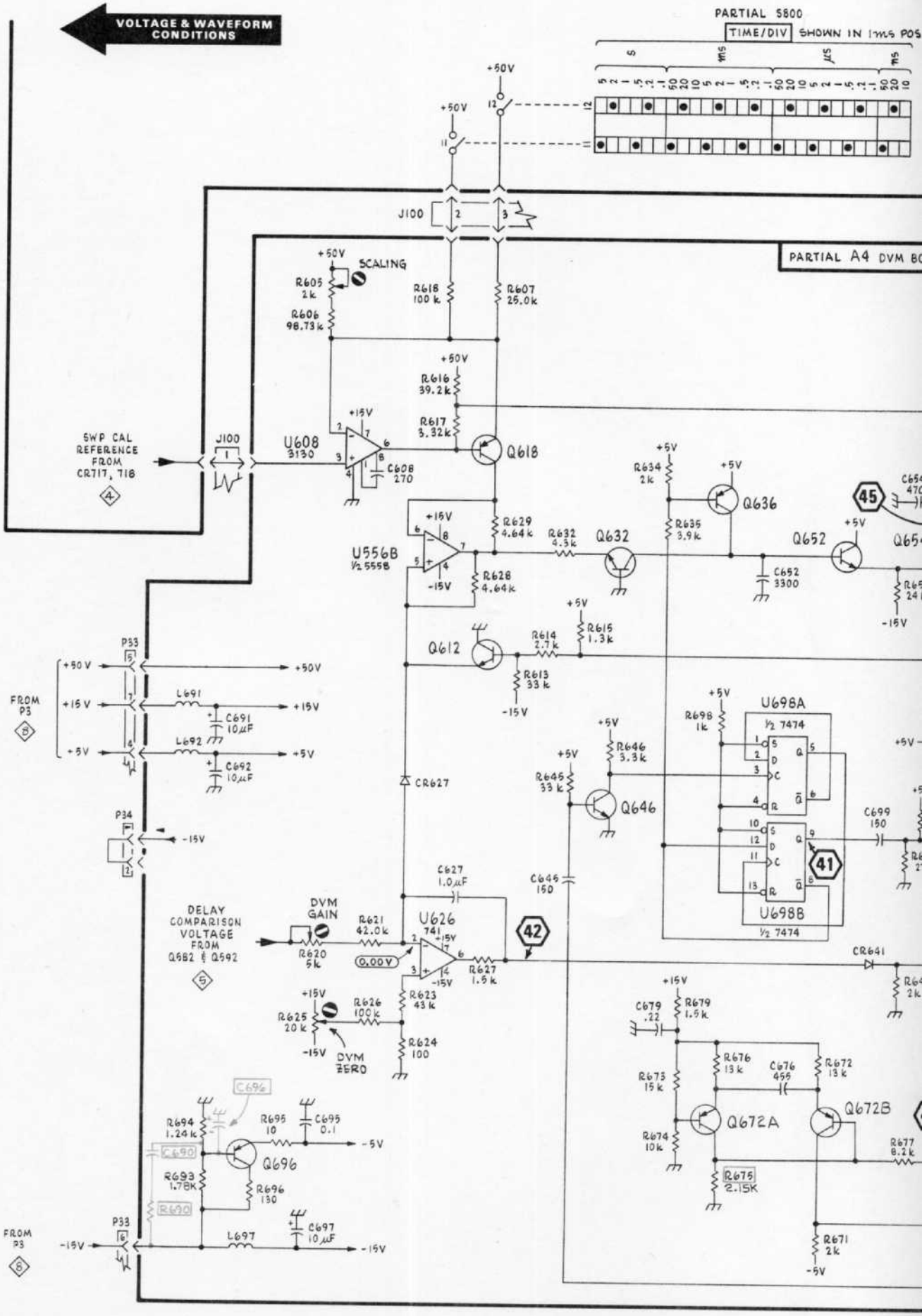












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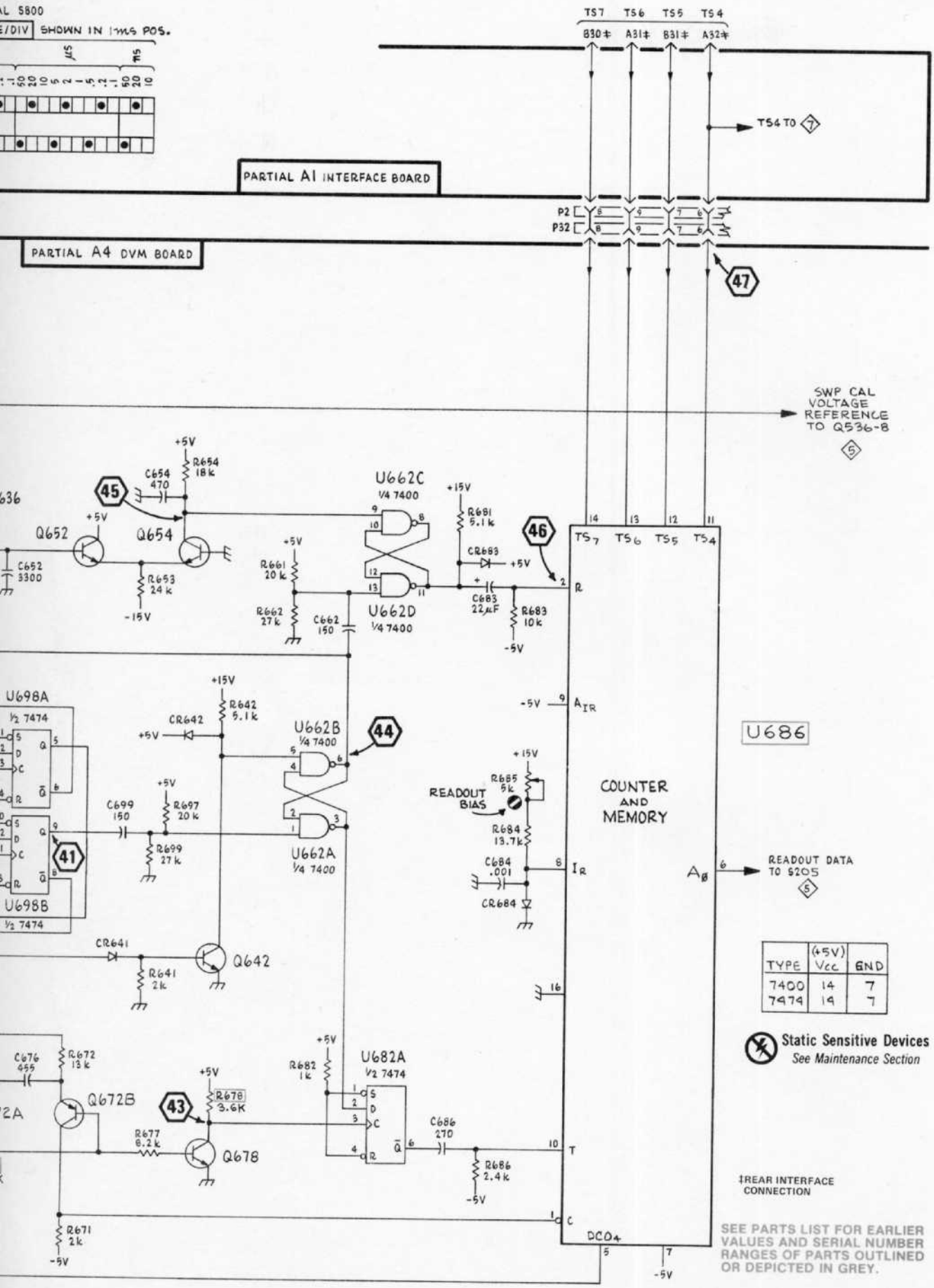
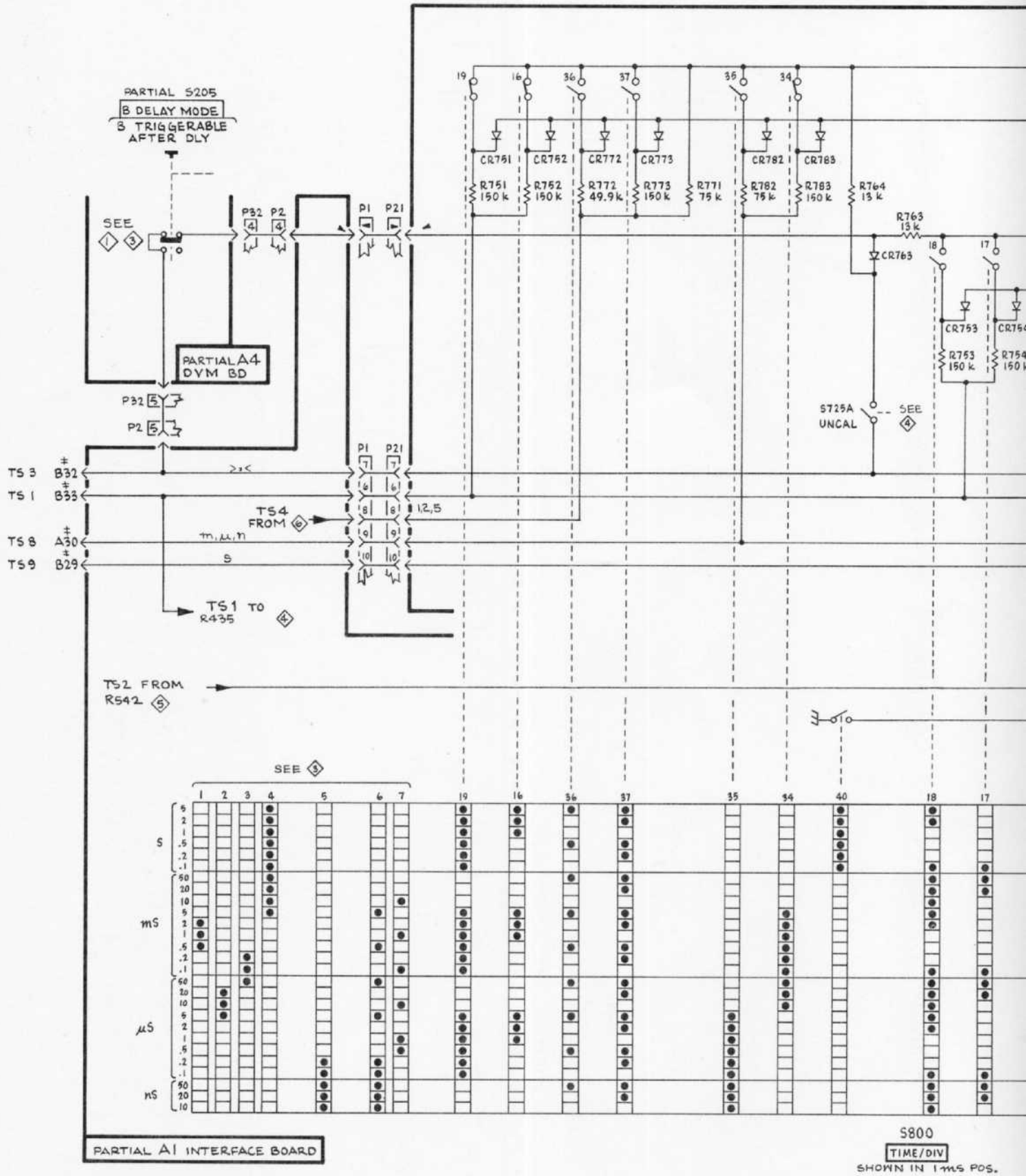
1961-65
REV JUL 1982


AL 5800
E/DIV SHOWN IN 1ms POS.
TS7 TS6 TS5 TS4
B30‡ A31‡ B31‡ A32‡
TS4 TO 7
PARTIAL A1 INTERFACE BOARD
P2
P32
PARTIAL A4 DVM BOARD
47
SWP CAL VOLTAGE REFERENCE TO Q536-8
5
+5V
R654 18k
C654 470
45
Q652
Q654
C652 3300
R653 24k
-15V
U662C 1/4 7400
+15V
R681 5.1k
46
CR683
C683 22µF
R683 10k
-5V
R661 20k
R662 27k
C662 150
U662D 1/4 7400
TS7 TS6 TS5 TS4
R
U686
U698A 1/2 7474
+15V
R642 5.1k
CR642
U662B 1/4 7400
44
-5V
A_IR
C699 150
R697 20k
R699 27k
41
U662A 1/4 7400
U698B 1/2 7474
READOUT BIAS
R685 5k
R684 13.7k
C684 .001
CR684
I_R
COUNTER AND MEMORY
A_ø
READOUT DATA TO S205
5
CR641
Q642
R641 2k
16
TYPE | (+5V) Vcc | GND
7400 | 14 | 7
7474 | 14 | 7
Static Sensitive Devices
See Maintenance Section
C676 455
R672 13k
Q672B
+5V
R678 3.6K
43
R677 8.2k
Q678
R682 1k
U682A 1/2 7474
C686 270
R686 2.4k
10
T
‡REAR INTERFACE CONNECTION
R671 2k
-5V
C
DCO+
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.



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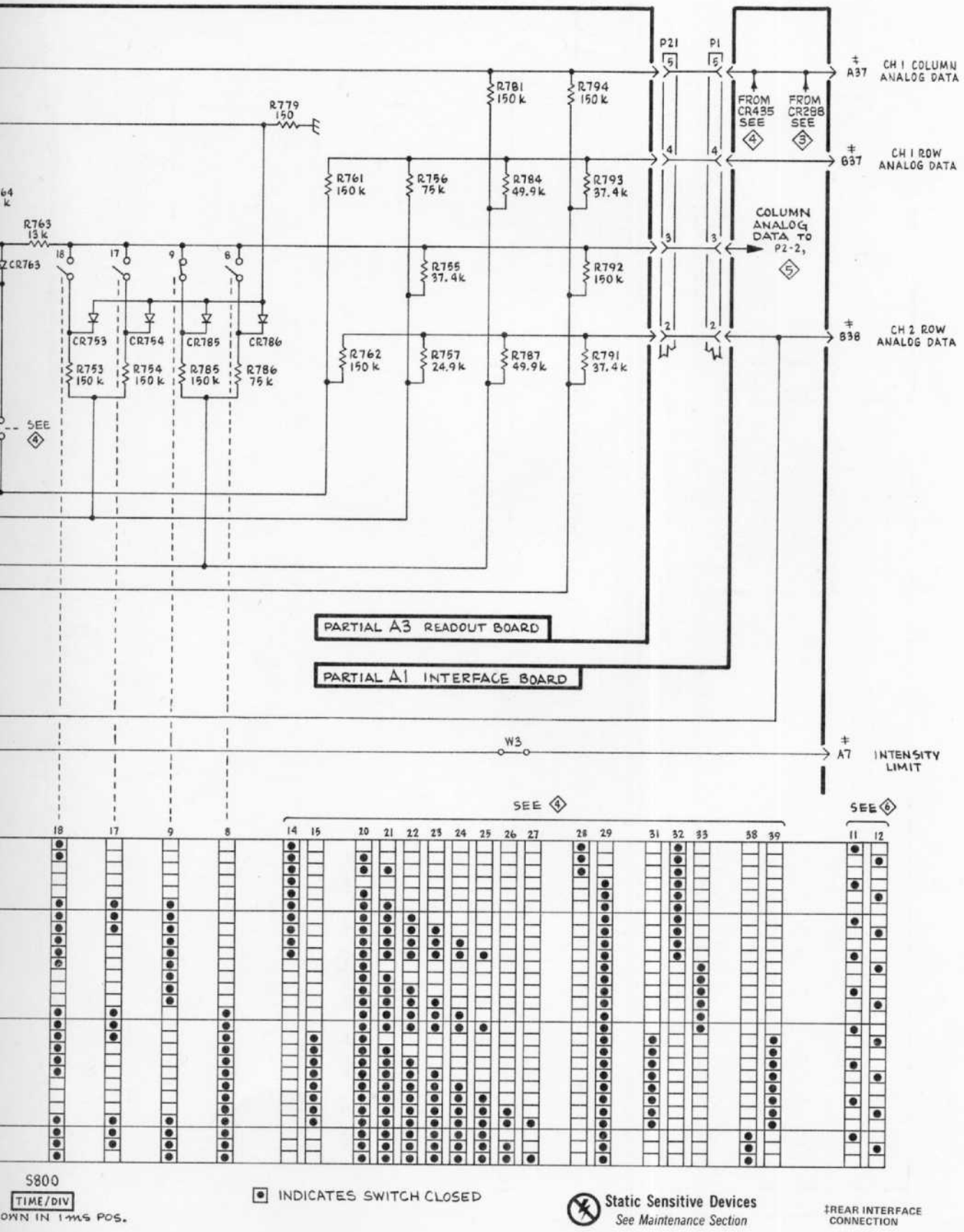
1961-66
REV JUL 1982



S800
TIME/DIV
OWN IN 1 MS POS.

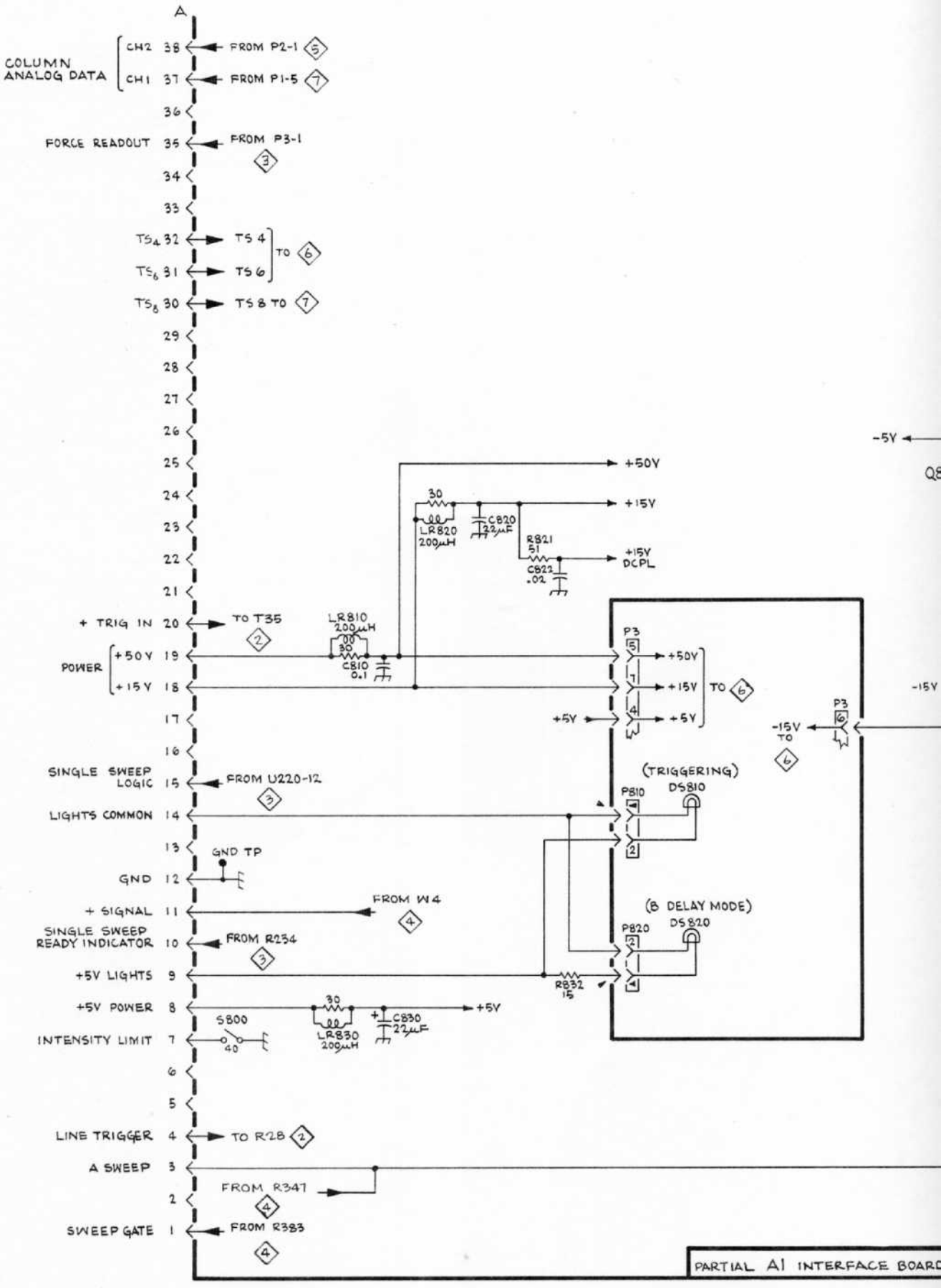
● INDICATES SWITCH CLOSED

Static Sensitive Devices
See Maintenance Section

‡REAR INTERFACE CONNECTION

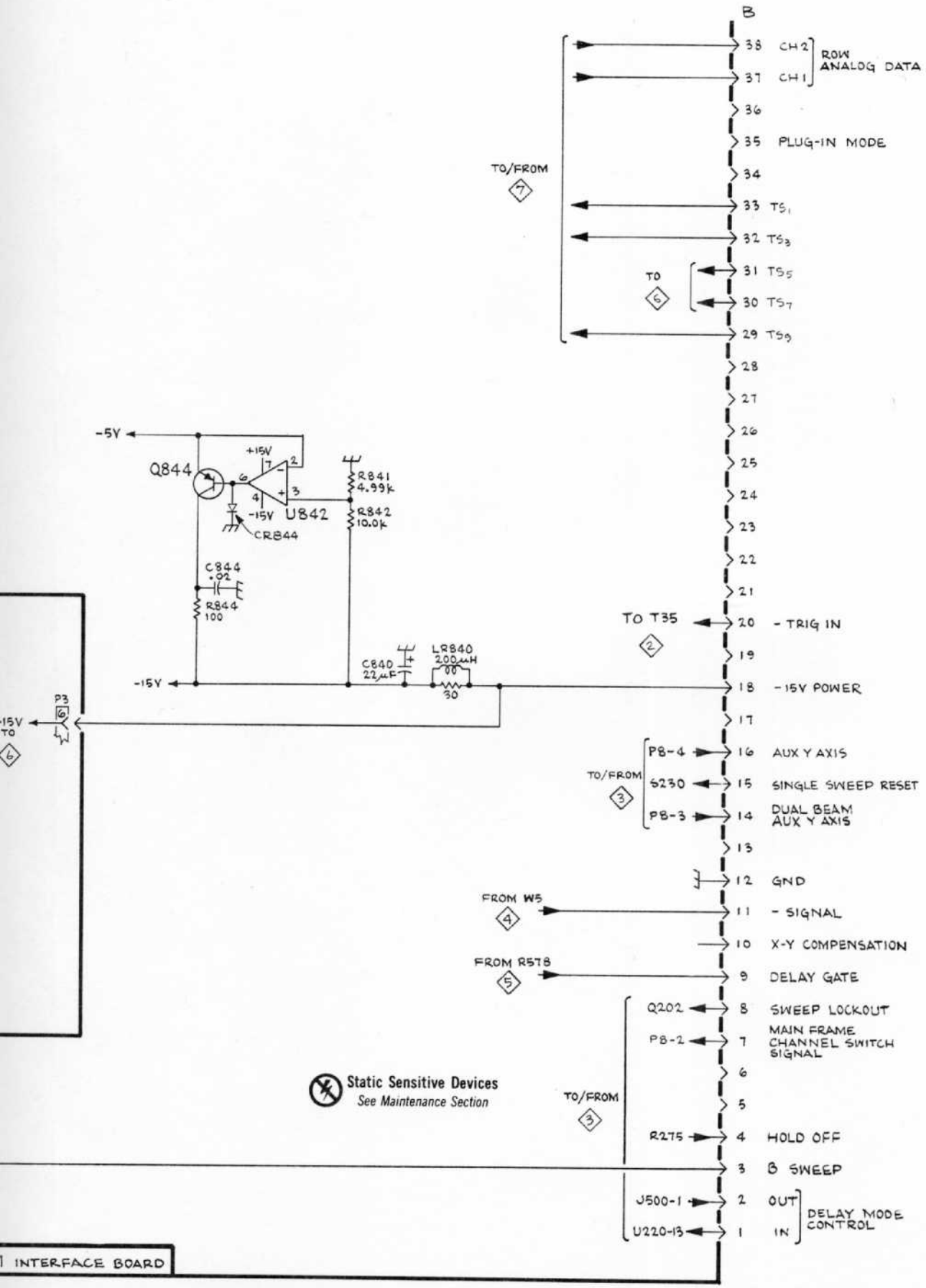
1961-66
REV JUL 1982

TIME/DIVISION AND READOUT SWITCHING 7



7B85

1961-67
REV JULY 198



1961-67
REV JULY 1981

POWER SUPPLY AND INTERFACE CONNECTORS

8

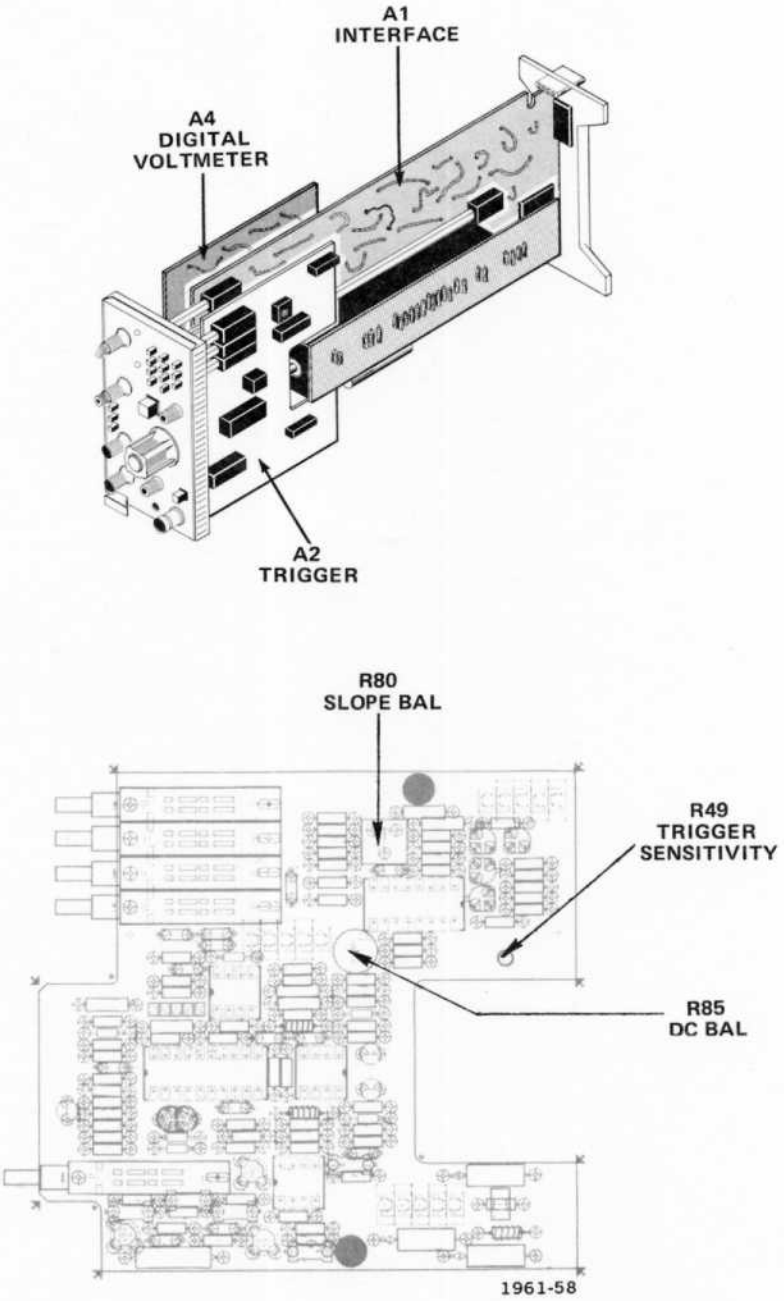


Fig. 8-12. Location of Triggering adjustments.

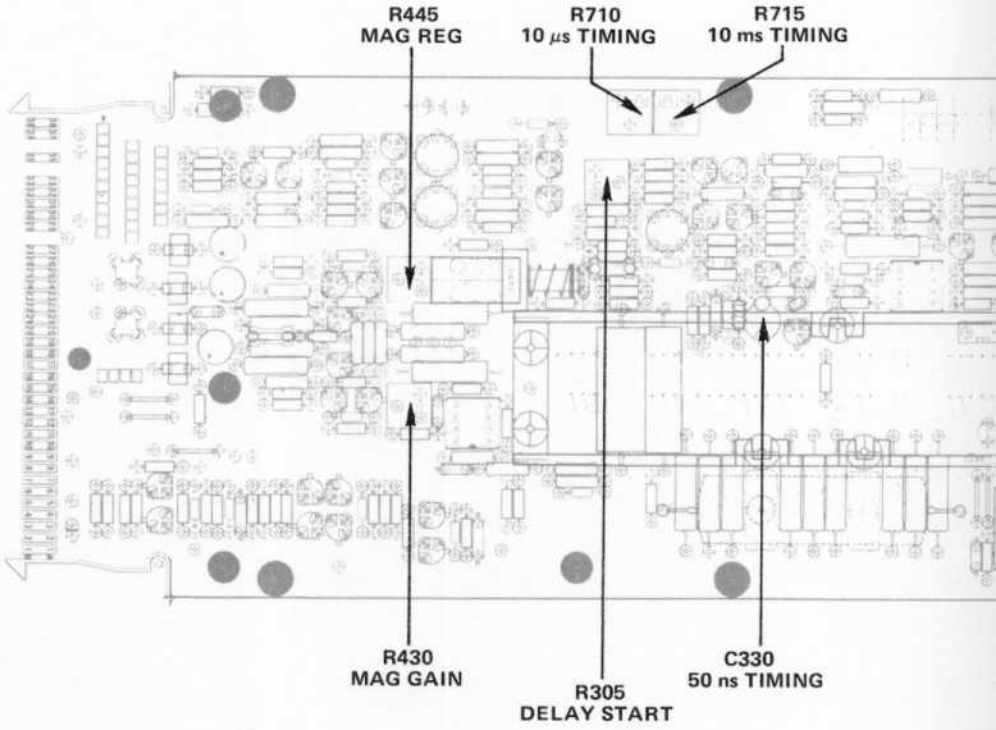


Fig. 8-11. Location of Sweep Timing adjustments.

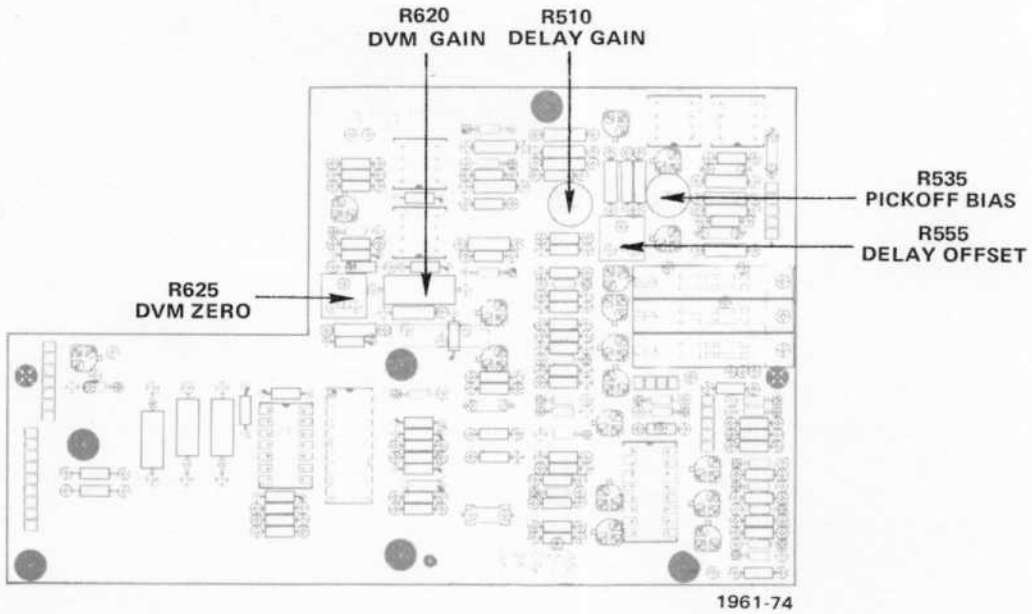
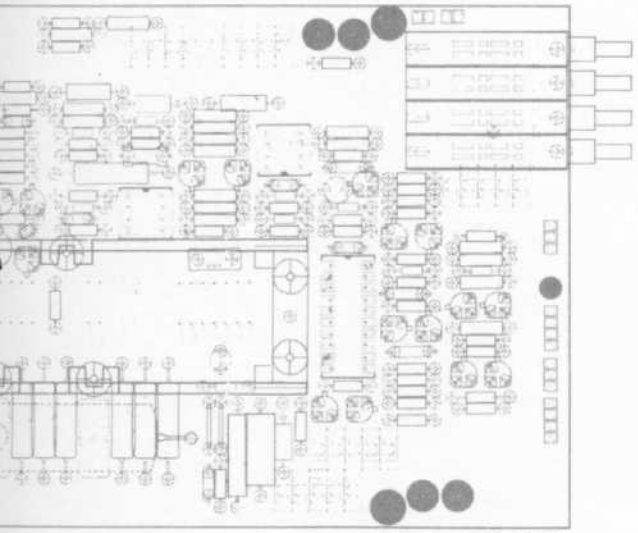


Fig. 8-13A. (SN B088750 & Up) Location of Digital Voltmeter adjustments.

715
TIMING



1961-57

0
MING

ning adjustments.

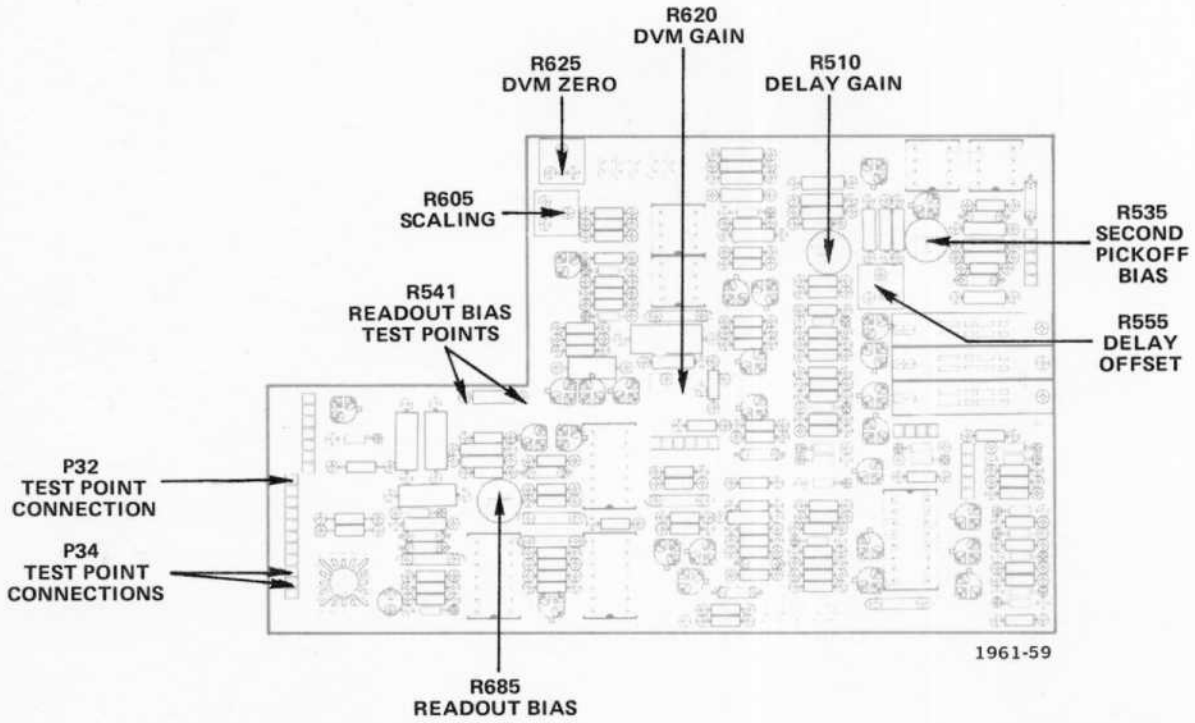


Fig. 8-13B. (SN B088749 & Below) Location of Digital Voltmeter adjustments.

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

1 2 3 4 5 . Name & Description

Assembly and/or Component
Attaching parts for Assembly and/or Component
\- - - * - - -
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
\- - - * - - -
Parts of Detail Part
Attaching parts for Parts of Detail Part
\- - - * - - -

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol - - - * - - - indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

"	INCH
#	NUMBER SIZE
ACTR	ACTUATOR
ADPTR	ADAPTER
ALIGN	ALIGNMENT
AL	ALUMINUM
ASSEM	ASSEMBLED
ASSY	ASSEMBLY
ATTEN	ATTENUATOR
AWG	AMERICAN WIRE GAGE
BD	BOARD
BRKT	BRACKET
BRS	BRASS
BRZ	BRONZE
BSHG	BUSHING
CAB	CABINET
CAP	CAPACITOR
CER	CERAMIC
CHAS	CHASSIS
CKT	CIRCUIT
COMP	COMPOSITION
CONN	CONNECTOR
COV	COVER
CPLG	COUPLING
CRT	CATHODE RAY TUBE
DEG	DEGREE
DWR	DRAWER
ELCTRN	ELECTRON
ELEC	ELECTRICAL
ELCTLT	ELECTROLYTIC
ELEM	ELEMENT
EPL	ELECTRICAL PARTS LIST
EQPT	EQUIPMENT
EXT	EXTERNAL
FIL	FILLISTER HEAD
FLEX	FLEXIBLE
FLH	FLAT HEAD
FLTR	FILTER
FR	FRAME or FRONT
FSTNR	FASTENER
FT	FOOT
FXD	FIXED
GSKT	GASKET
HDL	HANDLE
HEX	HEXAGON
HEX HD	HEXAGONAL HEAD
HEX SOC	HEXAGONAL SOCKET
HLCPS	HELICAL COMPRESSION
HLEXT	HELICAL EXTENSION
HV	HIGH VOLTAGE
IC	INTEGRATED CIRCUIT
ID	INSIDE DIAMETER
IDENT	IDENTIFICATION
IMPLR	IMPELLER
IN	INCH
INCAND	INCANDESCENT
INSUL	INSULATOR
INTL	INTERNAL
LPHLDR	LAMPHOLDER
MACH	MACHINE
MECH	MECHANICAL
MTG	MOUNTING
NIP	NIPPLE
NON WIRE	NOT WIRE WOUND
OBD	ORDER BY DESCRIPTION
OD	OUTSIDE DIAMETER
OVH	OVAL HEAD
PH BRZ	PHOSPHOR BRONZE
PL	PLAIN or PLATE
PLSTC	PLASTIC
PN	PART NUMBER
PNH	PAN HEAD
PWR	POWER
RCPT	RECEPTACLE
RES	RESISTOR
RGD	RIGID
RLF	RELIEF
RTNR	RETAINER
SCH	SOCKET HEAD
SCOPE	OSCILLOSCOPE
SCR	SCREW
SE	SINGLE END
SECT	SECTION
SEMICOND	SEMICONDUCTOR
SHLD	SHIELD
SHLDR	SHOULDERED
SKT	SOCKET
SL	SLIDE
SLFLKG	SELF-LOCKING
SLVG	SLEEVING
SPR	SPRING
SQ	SQUARE
SST	STAINLESS STEEL
STL	STEEL
SW	SWITCH
T	TUBE
TERM	TERMINAL
THD	THREAD
THK	THICK
TNSN	TENSION
TPG	TAPPING
TRH	TRUSS HEAD
V	VOLTAGE
VAR	VARIABLE
W/	WITH
WSHR	WASHER
XFMR	TRANSFORMER
XSTR	TRANSISTOR

@

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
000CY	NORTHWEST FASTENER SALES, INC.	7923 SW CIRRUS DRIVE	BEAVERTON, OR 97005
000EX	O'HARA METAL PRODUCT COMPANY	542 BRANNAN STREET	SAN FRANCISCO, CA 94107
000FW	WESTERN SINTERING CO INC.	2620 STEVENS DRIVE	RICHLAND, WA 99352
00779	AMP, INC.	P.O. BOX 3608	HARRISBURG, PA 17105
07707	USM CORP., USM FASTENER DIV.	510 RIVER RD.	SHELTON, CT 06484
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
09922	BURNDY CORPORATION	RICHARDS AVENUE	NORWALK, CT 06852
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
22599	ESNA, DIV. OF AMERACE CORPORATION	16150 STAGG STREET	VAN NUYS, CA 91409
24931	SPECIALITY CONNECTOR CO., INC.	2620 ENDRESS PLACE	GREENWOOD, IN 46142
56878	STANDARD PRESSED STEEL COMPANY	BENSON EAST	JENKINTOWN, PA 19046
57668	R-OHM CORP.	16931 MILLIKEN AVE.	IRVINE, CA 92713
71159	BRISTOL SOCKET SCREW, DIV. OF AMERICAN CHAIN AND CABLE CO., INC.	P O BOX 2244, 40 BRISTOL ST.	WATERBURY, CT 06720
71590	CENTRALAB ELECTRONICS, DIV. OF GLOBE-UNION, INC.	P O BOX 858	FORT DODGE, IA 50501
71785	TRW, CINCH CONNECTORS	1501 MORSE AVENUE	ELK GROVE VILLAGE, IL 60007
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
73803	TEXAS INSTRUMENTS, INC., METALLURGICAL MATERIALS DIV.	34 FOREST STREET	ATTLEBORO, MA 02703
74445	HOLO-KROME CO.	31 BROOK ST. WEST	HARTFORD, CT 06110
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
79136	WALDES, KOHINOOR, INC.	47-16 AUSTEL PLACE	LONG ISLAND CITY, NY 11101
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
87308	N. L. INDUSTRIES, INC., SOUTHERN SCREW DIV.	P. O. BOX 1360	STATESVILLE, NC 28677
92101	SCHULZE MFG, 50 INGOLD RD BURLINGAME, CA 94010		
93907	TEXTRON INC. CAMCAR DIV	600 18TH AVE	ROCKFORD, IL 61101

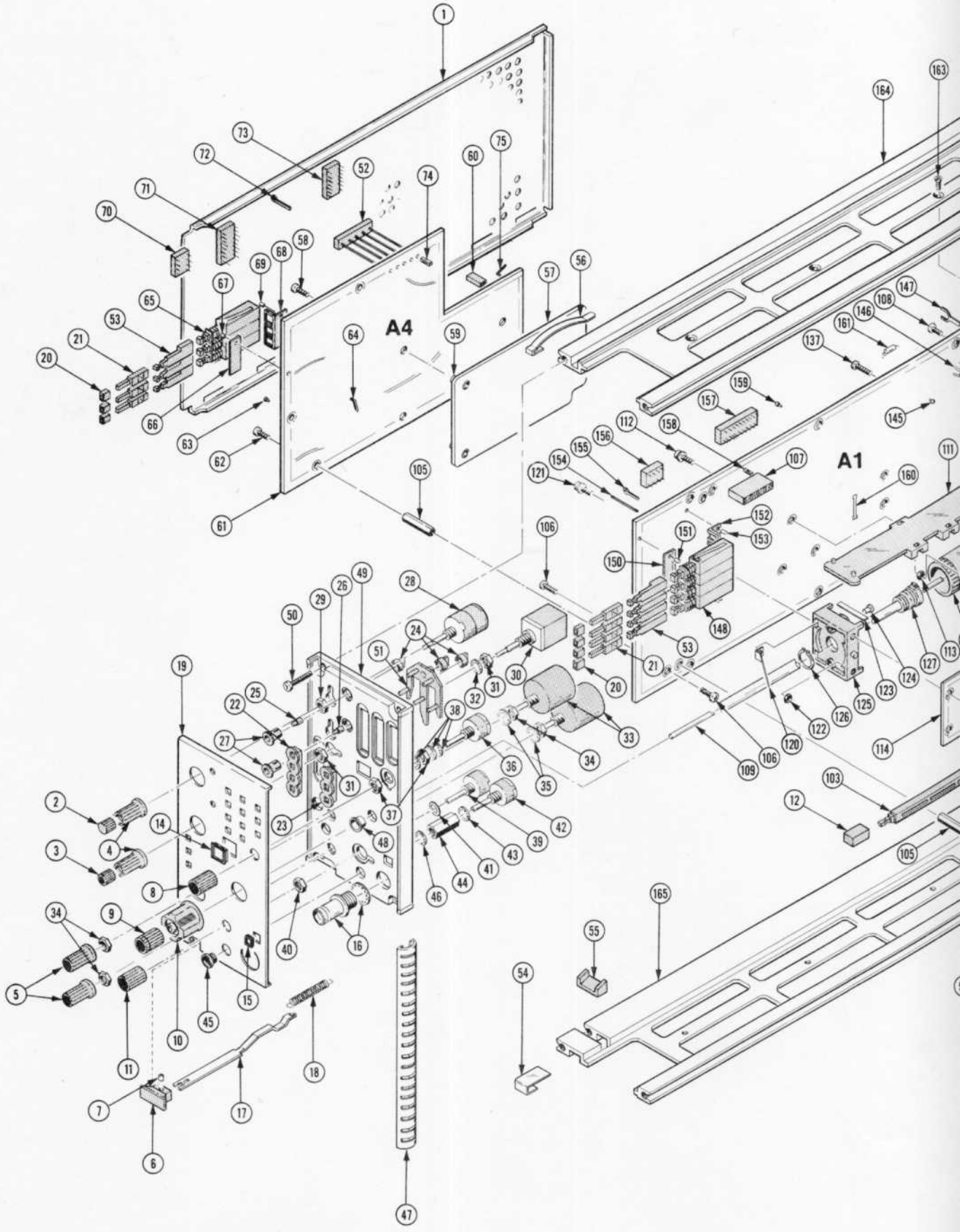
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-1	337-1064-04			2		SHIELD,ELEC:SIDE PLUG-IN UNITS	80009	337-1064-00
-2	366-1391-02			1		KNOB:GY,0.081 ID 0.28 OD,0.32 L	80009	366-1391-02
	213-0725-00			1		.SETSCREW:3-48 X 0.095 INCH,HEX SOC S	74445	OBD
-3	366-1319-02			1		KNOB:GY,0.79 ID,0.28 OD,0.32 H	80009	366-1319-02
	213-0725-00			1		.SETSCREW:3-48 X 0.095 INCH,HEX SOC S	74445	OBD
-4	366-1077-00			2		KNOB:GRAY	80009	366-1077-00
	213-0153-00			2		.SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-5	366-1189-00			2		KNOB:GRAY	80009	366-1189-00
	213-0153-00			2		.SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-6	366-1058-67			1		KNOB:LATCH--7B85	80009	366-1058-67
						**********(ATTACHING PARTS)**********		
-7	214-1095-00			1		PIN,SPG,SPLIT:0.094 OD X 0.187 INCH LONG	22599	52-022-094-0187
						**********(END ATTACHING PARTS)*********		
-8	366-1023-01			1		KNOB:GY,0.127 ID X 0.392 OD X 0.	80009	366-1023-01
	213-0153-00			1		.SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-9	366-1166-00			1		KNOB:RED,0.127 ID X 0.392 OD	80009	366-1166-00
	213-0153-00			1		.SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-10	366-1103-00			1		KNOB:GRAY	80009	366-1103-00
	213-0153-00			2		.SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-11	366-1023-01			1		KNOB:GY,0.127 ID X 0.392 OD X 0.	80009	366-1023-01
-12	366-1257-93			1		PUSH BUTTON:+10 MAG	80009	366-1257-93
-13	366-1559-00			1		PUSH BUTTON:SIL GY,0.18 SQ X 0.43	80009	366-1559-00
-14	426-0681-00			1		FR,PUSH BUTTON:GRAY PLASTIC	80009	426-0681-00
-15	426-1072-00			1		FRAME,PUSH BTN:PLASTIC	80009	426-1072-00
-16	131-1315-01			1		CONN,RCPT,ELEC:BNC,FEMALE	24931	28JR 306-1
-17	105-0076-02	B010100	B092229	1		REL BAR,LATCH:PLUG-IN UNIT	80009	105-0076-02
	105-0076-04	B092230		1		RELEASE BAR,LCH:PLUG-IN UNIT	80009	105-0076-04
-18	214-1280-00			1		SPRING,HLCPS:0.14 OD X 1.126"L,0.16"DIA	80009	214-1280-00
-19	333-1836-00	B010100	B085809	1		PANEL,FRONT:	80009	333-1836-00
	333-1836-01	B085810		1		PANEL,FRONT:	80009	333-1836-01
-20	378-0074-00			14		REFLECTOR,LIGHT:PUSH BUTTON	80009	378-0074-00
-21	366-1650-00			14		PUSH BUTTON:CLEAR,0.184 X 0.214 X 8.0 L	80009	360-1650-00
-22	351-0469-00			2		GUIDE,SWITCH:4 BUTTON	80009	351-0469-00
-23	351-0469-01			2		GUIDE,SWITCH:3 BUTTON	80009	351-0469-01
-24	200-0935-00			4		BASE,LAMPHOLDER:0.29 OD X 0.19 CASE	80009	200-0935-00
-25	----- -----			1		LAMP,LED:2.0 VOLTS,GREEN(SEE CR220 REPL)		
-26	----- -----			1		LAMP,LED:2.2 VOLTS,YELLOW(SEE CR232 REPL)		
-27	352-0157-00			2		LAMPHOLDER:WHITE PLASTIC	80009	352-0157-00
-28	----- -----			1		RESISTOR,VAR:(SEE R60 REPL)		
						**********(ATTACHING PARTS)**********		
-29	210-0583-00			1		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
						**********(END ATTACHING PARTS)*********		
-30	----- -----			1		RESISTOR,VAR:(SEE R410/R415 REPL)		
						**********(ATTACHING PARTS)**********		
-31	210-0583-00			2		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-32	210-0046-00			1		WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
						**********(END ATTACHING PARTS)*********		
-33	----- -----			2		RESISTOR,VAR:(SEE R520 AND R530 REPL)		
						**********(ATTACHING PARTS)**********		
-34	210-0583-00			4		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-35	210-0046-00			2		WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
						**********(END ATTACHING PARTS)*********		
-36	----- -----			1		RESISTOR,VAR:(SEE R210 REPL)		
						**********(ATTACHING PARTS)**********		
-37	210-0583-00			2		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-38	210-0046-00			3		WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
						**********(END ATTACHING PARTS)*********		
-39	----- -----			1		RESISTOR,VAR:(SEE R295 REPL)		
						**********(ATTACHING PARTS)**********		
-40	210-0583-00			1		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-41	210-0046-00			1		WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
						**********(END ATTACHING PARTS)*********		
-42	----- -----			1		RESISTOR,VAR:(SEE R705 REPL)		
-43	210-0046-00			1		WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-44	129-0290-00			1		POST,ELEC-MECH:0.635 INCH LONG,HEX	80009	129-0290-00
						**********(ATTACHING PARTS)**********		
-45	358-0342-00			1		BSHG,MACH.THD:0.25 X 32 X 0.352 INCH LONG	80009	358-0342-00
-46	210-0046-00			1		WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
						**********(END ATTACHING PARTS)*********		
-47	348-0235-00			2		SHLD GSKT,ELEC:4.734 INCH LONG	92101	OBD
-48	348-0067-00			1		GROMMET,PLASTIC:0.312 INCH DIA	80009	348-0067-00
-49	386-3256-00			1		SUBPANEL,FRONT:	80009	386-3256-00
						**********(ATTACHING PARTS)**********		
-50	213-0192-00	B010100	B090000	4		SCR,TPG,THD FOR:6-32 X 0.50 INCH,PNH STL	87308	OBD
	213-0793-00	B090001		4		SCREW,TPG,TF:6-32 X 0.4375,TAPTITE,FIL	93907	OBD
						**********(END ATTACHING PARTS)*********		
-51	386-3440-00			1		LT CNDCT,PB ILL:3 BUTTON,7.5 MM SPACING	80009	386-3440-00
-52	131-1820-00			5		CONNECTOR,PLUG,:CKT CD,5 MALE	22526	65306-002
-53	384-1382-00			7		EXTENSION SHAFT:1.09 INCH LONG	80009	384-1382-00
-54	214-1054-00			1		SPRING,FLAT:0.825 X 0.322,SST	80009	214-1054-00
-55	105-0075-00			1		BOLT,LATCH:7A & 7B SER PL-IN	80009	105-0075-00
-56	214-1061-00			1		SPRING,GROUND:FLAT	80009	214-1061-00
-57	337-2253-00	B010100	B088749	1		SHIELD,ELEC:DVM CARD	80009	337-2253-00
						**********(ATTACHING PARTS)**********		
-58	211-0008-00	B010100	B088749	4		SCREW,MACHINE:4-40 X 0.250,PNH,STL,CD PL	83385	OBD
						**********(END ATTACHING PARTS)*********		
	----- -----			-		SHIELD INCLUDES:		
-59	129-0124-00			3		.SPACER,POST:0.187 OD X 0.148 INCH LONG	80009	129-0124-00
-60	131-0993-03	B010100	B088749	1		LINK,TERM.CONNE:2 WIRE ORANGE	00779	850100-3
-61	----- -----			-		CKT BOARD ASSY:DVM(SEE A4 REPL)		
						**********(ATTACHING PARTS)**********		
-62	211-0008-00			3		SCREW,MACHINE:4-40 X 0.250,PNH,STL,CD PL	83385	OBD
						**********(END ATTACHING PARTS)*********		
	----- -----			-		CKT BOARD ASSY INCLUDES:		
-63	136-0252-07	B010100	B088749	105		.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
	136-0252-07	B088750		41		.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-64	131-0608-00	B010100	B088749	10		.TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-65	263-0015-01			1		.SWITCH PB ASSY:3 LATCHING,7.5 MM,5 CONTAC	80009	263-0015-01
-66	343-0495-03	B010100	B088749	5		.CLIP,SWITCH:FRONT,7.5 MM,3 UNIT	80009	343-0495-03
	343-0495-03	B088750		1		.CLIP,SWITCH:FRONT,7.5 MM,3 UNIT	80009	343-0495-03
						. **********(ATTACHING PARTS)**********		
-67	210-3033-00			3		.EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
						. *********(END ATTACHING PARTS)*********		
-68	343-0499-03	B010100	B090499	1		.CLIP,SWITCH:7.5 MM,4 UNIT	80009	343-0499-03
	343-0499-12	B090500		1		.CLIP,SWITCH:REAR,7.5MM X 3 UNIT	80009	343-0499-12
						. **********(ATTACHING PARTS)**********		
-69	210-3033-00			3		.EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
						. *********(END ATTACHING PARTS)*********		
-70	136-0514-00	B010100	B088749	3		.SKT,PL-IN ELEC:MICROCIRCUIT,8 DIP	73803	CS9002-8
	136-0514-00	B088750		4		.SKT,PL-IN ELEC:MICROCIRCUIT,8 DIP	73803	CS9002-8
-71	136-0260-02			1		.SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP,LOW CL	71785	133-51-92-008
-72	214-0579-00			1		.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-73	136-0269-02	B010100	B088749	3		.SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP,LOW CL	73803	CS9002-14
	136-0269-02	B088750		1		.SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP,LOW CL	73803	CS9002-14
-74	136-0263-04			10		.SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	22526	75377-001
-75	131-0589-00	B010100	B088749	22		.TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
	131-0589-00	B088750		30		.TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
	136-0634-00	B088750	B092491	1		.SOCKET,PLUG-IN:20 LEAD DIP,CKT BD MTG	73803	CS9002-20
	136-0752-00	B092492		1		.SKT,PL-IN ELEK:MICROCIRCUIT,20 DIP	09922	DILB20P-108
	131-0566-00	B088750		1		.BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
-76	----- -----			1		CKT BOARD ASSY:TRIGGER(SEE A2 REPL)		
						**********(ATTACHING PARTS)**********		
-77	211-0008-00			2		SCREW,MACHINE:4-40 X 0.250,PNH,STL,CD PL	83385	OBD
						**********(END ATTACHING PARTS)*********		
	----- -----			-		CKT BOARD ASSY INCLUDES:		
-78	263-0016-00			1		.SWITCH PB ASSY:4 LATCHING,7.5 MM,5 CONTAC	80009	263-0016-00
-79	263-0015-00			2		.SWITCH PB ASSY:3 LATCHING,7.5 MM	80009	263-0015-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-80	343-0495-04			1	.CLIP,SWITCH:FRONT,7.5 MM,4 UNIT	80009	343-0495-04
					. **********(ATTACHING PARTS)**********		
-81	210-3050-00			3	.EYELET,METALLIC:0.218 L X 0.059 OD,BRS	07707	SE-27
	210-3033-00			1	.EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
					. **********(END ATTACHING PARTS)**********		
-82	343-0499-04	B010100	B090499	1	.CLIP,SWITCH:REAR,7.5MM X 4 UNIT	80009	343-0499-04
	343-0499-13	B090500		1	.CLIP,SWITCH:7.5MM X 4 UNIT	80009	343-0499-13
					. **********(ATTACHING PARTS)**********		
-83	210-3050-00			3	.EYELET,METALLIC:0.218 L X 0.059 OD,BRS	07707	SE-27
	210-3033-00			1	.EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
					. **********(END ATTACHING PARTS)**********		
-84	343-0495-03			1	.CLIP,SWITCH:FRONT,7.5 MM,3 UNIT	80009	343-0495-03
-85	343-0499-03			1	.CLIP,SWITCH:7.5 MM,4 UNIT	80009	343-0499-03
-86	263-0010-01			1	.SWITCH PB ASSY:1 PUSH,7.5 MM,1 CONTACT	80009	263-0010-01
-87	343-0495-01			1	.CLIP,SWITCH:FRONT,7.5 MM,1 UNIT	80009	343-0495-01
					. **********(ATTACHING PARTS)**********		
-88	210-3033-00			1	.EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
					. **********(END ATTACHING PARTS)**********		
-89	343-0499-01			1	.CLIP,SWITCH:REAR,7.5 MM,1 UNIT	80009	343-0499-01
					. **********(ATTACHING PARTS)**********		
-90	210-3033-00			1	.EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
					. **********(END ATTACHING PARTS)**********		
-91	131-0608-00			5	.TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-92	131-1003-00			3	.CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-93	136-0252-04	B010100	B069999	21	.SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
	136-0252-04	B070000		24	.SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-94	214-0579-00			2	.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-95	136-0634-00	B010100	B092491	1	.SOCKET,PLUG-IN:20 LEAD DIP,CKT BD MTG	73803	CS9002-20
	136-0752-00	B092492		1	.SKT,PL-IN ELEK:MICROCIRCUIT,20 DIP	09922	DILB20P-108
-96	136-0514-00	B010100	B092491	3	.SKT,PL-IN ELEC:MICROCIRCUIT,8 DIP	73803	CS9002-8
	136-0727-00	B092492		3	.SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
-97	136-0260-02	B010100	B092491	1	.SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP,LOW CL	71785	133-51-92-008
	136-0729-00	B092492		1	SKT,PL-IN ELEK:MICROCKT,16 CONTACT	09922	DILB16P-108T
-98	214-0973-00			1	.HEAT SINK,ELEC:0.28 X 0.18 OVAL X 0.187"H	80009	214-0973-00
-99	136-0263-04			15	.SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	22526	75377-001
	136-0263-07			10	.SOCKET,PIN TERM:U/W 0.025 SQ PIN	22526	OBD
-100	386-1402-02	B010100	B079999	1	PANEL,REAR:	80009	386-1402-02
	386-1402-00	B080000		1	PANEL,REAR:	80009	386-1402-00
					**********(ATTACHING PARTS)**********		
-101	213-0192-00	B010100	B090000	4	SCR,TPG,THD FOR:6-32 X 0.50 INCH,PNH STL	87308	OBD
	213-0793-01	B090001		4	SCREW,TPG,TF:6-32 X 0.4375 TAPTITE,FIL	93907	OBD
-102	361-0326-00			1	SPACER,SLEEVE:0.18 ID X 0.25 OD X 0.10"L	80009	361-0326-00
					**********(END ATTACHING PARTS)**********		
-103	384-1100-00			1	EXTENSION SHAFT:0.13 SQ X 6.215" LONG,PLST	80009	384-1100-00
-104	384-1292-00			1	EXTENSION SHAFT:2.417 INCH LONG,PLASTIC	80009	384-1292-00
-105	129-0198-00			5	POST,ELEC-MECH:0.188 HEX X 0.74 INCH L,BRS	80009	129-0198-00
					**********(ATTACHING PARTS)**********		
-106	211-0008-00			5	SCREW,MACHINE:4-40 X 0.250,PNH,STL,CD PL	83385	OBD
					**********(END ATTACHING PARTS)**********		
-107	204-0683-00			5	BODY,CONN,RCPT:5 FEMALE POSN CONTACT	22526	65058-061
	672-0540-00			1	CKT BOARD ASSY:TIME/CM	80009	672-0540-00
					**********(ATTACHING PARTS)**********		
-108	211-0008-00			6	SCREW,MACHINE:4-40 X 0.250,PNH,STL,CD PL	83385	OBD
					**********(END ATTACHING PARTS)**********		
	----- -----			-	CKT BOARD ASSY INCLUDES:		
-109	384-1417-00			1	.EXTENSION SHAFT:10.275 INCH LONG,PLASTIC	80009	384-1417-00
					. **********(ATTACHING PARTS)**********		
-110	213-0299-00			1	.SETSCREW:4-40 X 0.125 INCH,HEX SOC S	56878	OBD
					. **********(END ATTACHING PARTS)**********		
-111	200-1362-00			2	.COVER,CAM SW:BLACK PLASTIC	80009	200-1362-00
					. **********(ATTACHING PARTS)**********		
-112	211-0244-00	B010100	B090929	3	.SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	OBD
	211-0292-00	B090930		3	.SCR,ASSEM WSHR:4-40 X 0.29,BRS NI PL	78189	OBD
-113	210-0406-00			3	.NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
					. **********(END ATTACHING PARTS)**********		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-114	----- -----			1	.CKT BOARD ASSY:READOUT(SEE A3 REPL)		
					. **********(ATTACHING PARTS)**********		
-115	211-0244-00	B010100	B090929	4	.SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	OBD
	211-0292-00	B090930		4	.SCR,ASSEM WSHR:4-40 X 0.29,BRS NI PL	78189	OBD
-116	211-0008-00			1	.SCREW,MACHINE:4-40 X 0.250,PNH,STL,CD PL	83385	OBD
					. **********(END ATTACHING PARTS)**********		
	----- -----			-	.CKT BOARD ASSEMBLY INCLUDES:		
-117	131-0604-00			13	..CONTACT,ELEC:CKT BD SW,SPR,CU BE	80009	131-0604-00
-118	136-0263-04			3	..SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PI	22526	75377-001
-119	131-0589-00			10	..TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
-120	131-0963-00			1	.CONTACT,ELEC:GROUNDING	000EX	OBD
	263-1134-00			1	.SW CAM ACTR AS:TIME/CM	80009	263-1134-00
					. **********(ATTACHING PARTS)**********		
-121	211-0244-00	B010100	B090929	4	.SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	OBD
	211-0292-00	B090930		4	.SCR,ASSEM WSHR:4-40 X 0.29,BRS NI PL	78189	OBD
					. **********(END ATTACHING PARTS)**********		
	----- -----			-	.ACTR ASSY INCLUDES:		
-122	210-0406-00			3	..NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-123	214-1139-03			2	..SPRING,FLAT:RED COLORED	80009	214-1139-03
-124	214-1752-00			2	..ROLLER,DETENT:	80009	214-1752-00
-125	401-0180-00			1	..BEARING,CAM SW:FRONT & REAR	80009	401-0180-00
	214-1139-00	B091100		1	..SPRING,FLAT:0.885 X 0.156 CU BE GLD CLR	80009	214-1139-00
	214-1139-02	B091100		1	..SPRING,FLAT:GREEN COLORED	80009	214-1139-02
					. . **********(ATTACHING PARTS)**********		
-126	354-0390-00			1	..RING,RETAINING:0.338 ID X 0.025" THK,STL	79136	5100-37MD
					. . ********(END ATTACHING PARTS)**********		
-127	384-0878-08			1	..SHAFT,CAM SW:4.964 L X 0.248 OD OUTER	80009	384-0878-08
-128	105-0696-00			1	..ACTUATOR,CAM SW:TIME/CM,FRONT	80009	105-0696-00
-129	210-0406-00			2	..NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-130	401-0178-01			1	..BEARING,CAM SW:CENTER/REAR	80009	401-0178-01
-131	260-1771-00			1	.SWITCH,PUSH:DPDT,1 BUTTON,2 POLE	80009	260-1771-00
-132	361-0411-00			2	.SPACER,PUSH SW:0.13 W X 0.375 INCH L,PLST	71590	J64285-00
-133	352-0274-00			1	.HOLDER,TERMINAL:FOR 8 SQUARE PINS	80009	352-0274-00
-134	131-0593-00			3	.CONTACT,ELEC:1.15 INCH LONG	22526	47354
-135	351-0180-00			1	.SLIDE,GUIDE:SWITCH ACTUATOR	80009	351-0180-00
-136	129-0570-00			1	.POST,ELEC-MECH:0.188 HEX X 0.976"LONG,BRS	80009	129-0570-00
					. **********(ATTACHING PARTS)**********		
-137	211-0008-00			1	.SCREW,MACHINE:4-40 X 0.250,PNH,STL,CD PL	83385	OBD
					. **********(END ATTACHING PARTS)**********		
-138	214-1136-00			1	.ACTUATOR,SL SW:DUAL DPST	80009	214-1136-00
-139	214-1190-00			1	.CPLG,SHAFT,RGD:0.125 OD TO 0.125 OD,AL	80009	214-1190-00
-140	----- -----			1	.RESISTOR,VAR:(SEE R725 REPL)		
					. **********(ATTACHING PARTS)**********		
-141	213-0239-00			1	.SETSCREW:3-48 X 0.062 INCH,HEX SOC S	71159	OBD
-142	210-0583-00			1	.NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-143	210-0046-00			1	.WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
					. **********(END ATTACHING PARTS)**********		
-144	407-0803-00			1	.BRACKET,ELEC SW:BRASS	80009	407-0803-00
-145	136-0252-07			5	.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-146	131-1003-00			2	.CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-147	352-0196-00			2	.HLDR,ELEK CMPNT:PNL MT 0.531 ID MOLD PLST	80009	352-0196-00
-148	263-0016-01			1	.SWITCH PB ASSY:3 LCH & 1 CANC,7.5MM,5 CON	80009	263-0016-01
-149	----- -----			1	.CKT BOARD ASSY:INTERFACE(SEE A1 REPL)		
-150	343-0495-04			1	..CLIP,SWITCH:FRONT,7.5 MM,4 UNIT	80009	343-0495-04
					. . **********(ATTACHING PARTS)**********		
-151	210-3033-00			4	..EYELET,METALLIC:0.59 OD X 0.156 INCH LON	07707	SE-25
					. . ********(END ATTACHING PARTS)**********		
-152	343-0499-04	B010100	B090499	1	..CLIP,SWITCH:REAR,7.5MM X 4 UNIT	80009	343-0499-04
	343-0499-13	B090500		1	..CLIP,SWITCH:7.5MM X 4 UNIT	80009	343-0499-13
					**********(ATTACHING PARTS)**********		
-153	210-3033-00			4	..EYELET,METALLIC:0.59 OD X 0.156 INCH LON	07707	SE-25
					**********(END ATTACHING PARTS)**********		
-154	131-0608-00			48	..TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-155	214-0579-00			3	..TERM,TEST POINT:BRS CD PL	80009	214-0579-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-156	136-0514-00	B010100	B092491	3	..SKT,PL-IN ELEC:MICROCIRCUIT,8 DIP	73803	CS9002-8
	136-0727-00	B092492		3	.SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
-157	136-0634-00	B010100	B092491	1	..SOCKET,PLUG-IN:20 LEAD DIP,CKT BD MTG	73803	CS9002-20
	136-0752-00	B092492		1	..SKT,PL-IN ELEK:MICROCIRCUIT,20 DIP	09922	DILB20P-108
-158	136-0263-04			25	..SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PI	22526	75377-001
-159	136-0252-04			144	..SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-160	131-0604-00			29	..CONTACT,ELEC:CKT BD SW,SPR,CU BE	80009	131-0604-00
-161	131-0566-00			5	..BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
	210-0261-00	B050000		1	..TERMINAL,LUG:0.14 ID,PLAIN,BRASS	80009	210-0261-00
-162	220-0547-01			6	NUT,BLOCK:0.38 X 0.26 X 0.282 (2)4-40	000FW	OBD
					**********(ATTACHING PARTS)**********		
-163	211-0105-00			1	SCREW,MACHINE:4-40 X 0.188,100 DEG,FLH ST	83385	OBD
					**********(END ATTACHING PARTS)*********		
-164	426-0505-11			1	FR SECT,PLUG-IN:TOP	80009	426-0505-11
-165	426-0499-11			1	FR SECT,PLUG IN:BOTTOM	80009	426-0499-11
-166	131-0707-00			31	CONNECTOR,TERM:22-26 AWG,BRS & CU BE GOLD	22526	47439
-167	352-0169-00			2	HLDR,TERM CONN:2 WIRE BLACK	80009	352-0169-00
-168	352-0161-07			1	CONN BODY,PL,EL:3 WIRE VIOLET	80009	352-0161-07
-169	352-0162-00			1	HLDR,TERM CONN:4 WIRE BLACK	80009	352-0162-00
	352-0162-04			1	CONN BODY,PL,EL:4 WIRE YELLOW	80009	352-0162-04
-170	352-0163-05			1	CONN BODY,PL,EL:5 WIRE GREEN	80009	352-0163-05
	352-0163-06			1	CONN BODY,PL,EL:5 WIRE BLUE	80009	352-0163-06
-171	175-0825-00			FT	WIRE,ELECTRICAL:2 WIRE RIBBON	80009	175-0825-00
-172	175-0828-00			FT	WIRE,ELECTRICAL:5 WIRE RIBBON	08261	SS-0526-710610C
	175-0826-00			FT	WIRE,ELECTRICAL:3 WIRE RIBBON	80009	175-0826-00
	198-2309-00			1	WIRE SET,ELEC:	80009	198-2309-00
	131-0707-00			63	.CONNECTOR,TERM:22-26 AWG,BRS & CU BE GOLD	22526	47439
	352-0161-05			1	.CONN BODY,PL,EL:3 WIRE GREEN	80009	352-0161-05
	352-0162-05			2	.CONN BODY,PL,EL:4 WIRE GREEN	80009	352-0162-05
-173	352-0165-06			2	.CONN BODY,PL,EL:7 WIRE BLUE	80009	352-0165-06
-174	352-0167-07			2	.CONN BODY,PL,EL:9 WIRE VIOLET	80009	352-0167-07
-175	352-0168-00			2	.CONN BODY,PL,EL:10 WIRE BLACK	80009	352-0168-00
-176	175-0827-00			FT	.CABLE,SP,ELEC:4,26 AWG,STRD.PVC JKT,RBN	08261	SS04267(1061)0C
-177	175-0830-00			FT	.WIRE,ELECTRICAL:7 WIRE RIBBON	08261	SS-0726-710610C
-178	175-0832-00			FT	.WIRE,ELECTRICAL:9 WIRE RIBBON	08261	SS-0926(1061)0C
	175-0833-00			FT	.WIRE,ELECTRICAL:10 WIRE RIBBON	08261	SS-1026-7



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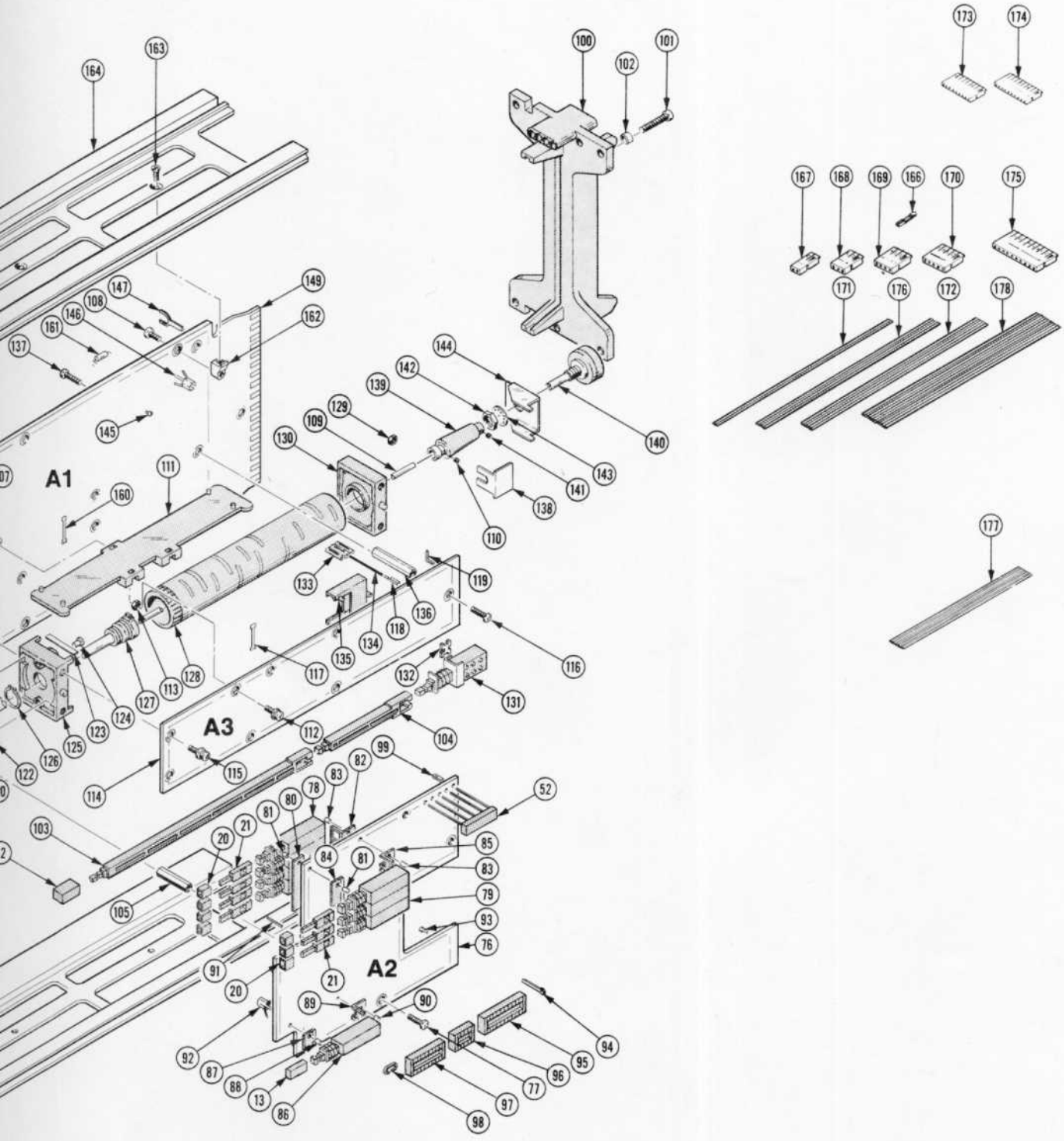
A1
A2
A3

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
	070-1960-00			1		MANUAL,TECH:OPERATORS	80009	070-1960-00
	070-1961-01			1		MANUAL,TECH:INSTRUCTION	80009	070-1961-01

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

GUERNSEY TYPE 7B85 - TENTATIVE S/N 100233

ELECTRICAL PARTS LIST CHANGE

CHANGE TO:-

R354	321-0195-00	Resistor, 1.05K Ohm Nominal Value, Selected

3337/1277

GUERNSEY TYPE 7B85 - TENTATIVE S/N 100353

ELECTRICAL PARTS LIST CHANGE

CHANGE TO:-

Q230	151-0302-02	Transistor, Silicon

3499/978

GUERNSEY TYPE 7B85 - TENTATIVE S/N 100413

ELECTRICAL PARTS LIST CHANGE

CHANGE TO:-

C31	283-0010-00	Cap., Fxd., Cer., Di:. .05uF 50V

3539/1178

GUERNSEY TYPE 7B85 - TENTATIVE S/N 101279

ELECTRICAL PARTS LIST CHANGE

CHANGE TO:-

U654	156-0030-00	Microcircuit
VR644	152-0227-00	Semincond Device

3772/380

GUERNSEY TYPE 7B85 - TENTATIVE S/N 102758

ELECTRICAL PARTS LIST CHANGE

CHANGE TO:-

U530	156-0158-03	Integrated Circuit
U556	156-0158-03	Integrated Circuit

4151/783