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5113 DUAL BEAM STORAGE OSCILLOSCOPE

INSTRUCTION MANUAL

NOTE

A nomenclature change has been introduced for the 500 Series products. The 5013N/D13 is now called the 5113 Dual Beam Storage Oscilloscope.

This composite manual incorporates the 5103N and D13 manuals, formerly bound under separate cover.

TEKTRONIX®

5113 DUAL BEAM STORAGE OSCILLOSCOPE

INSTRUCTION MANUAL

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WARRANTY

All TEKTRONIX instruments are warranted against defective materials and workmanship for one year. Any questions with respect to the warranty should be taken up with your TEKTRONIX Field Engineer or representative.

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Specifications and price change privileges reserved.

BEFORE READING

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

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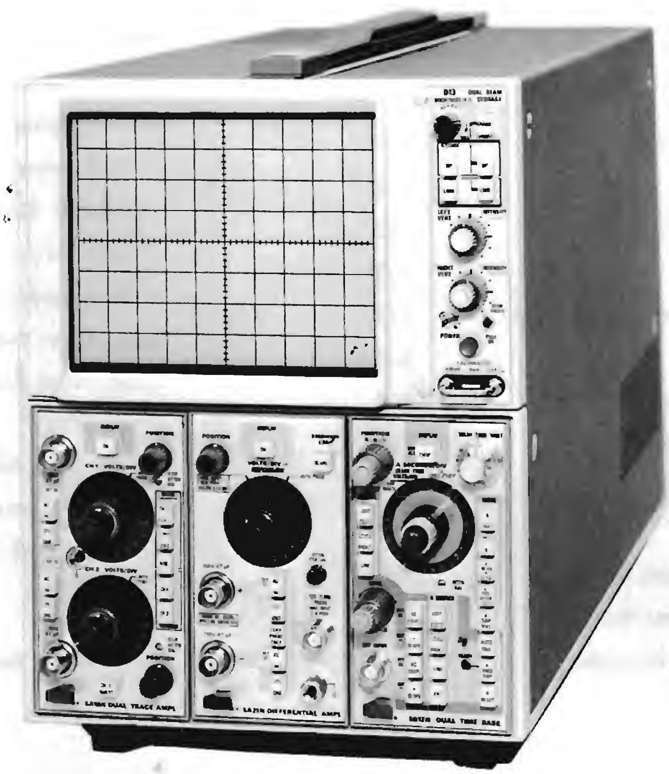


Fig. 1-1. 5103N Oscilloscope with a Dual-Beam Display Unit.

SECTION 1
OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

D12 and D13 General Description

The D12 Dual Beam Display Unit or the D13 Dual Beam Storage Display Unit provides a dual-beam cathode-ray tube (CRT) display for Tektronix 5100-series oscilloscopes. Either module is operated with a power supply/amplifier module, and comprises one-half of the oscilloscope mainframe. It has an electrostatic-deflection CRT with an 8 X 10 division (one-half inch per division) internal black graticule. A bright display is provided by a 3.5-kilovolt accelerating potential. Active geometry correction ensures display accuracy throughout the graticule area. Provision is made for application of Z-axis signals, and a front-panel loop provides a calibration signal.

The D13 has a direct-view, bistable storage tube with two 4 X 10 division screens, which can be independently controlled for split-screen applications. A variable Brightness control permits extended storage time and can be used to integrate fast, repetitive displays.

The electrical characteristics on page 1-5 apply over a room temperature range of 0°C to +50°C (+32°F to +90°F). Refer to the 5100-series Oscilloscope System manual for environmental characteristics.

NOTE

Reference to storage controls or storage operation in this manual applies to the D13 only.

Preliminary Information

The Operating Instruction section of the 5100-series Oscilloscope System instruction manual should be referred to for initial preparation. It contains information for installation of modules and plug-ins, correct operating voltage and temperature, and general oscilloscope usage.

CONTROLS AND CONNECTORS

This is a brief description of the function or operation of the front- and rear-panel controls and connectors. More detailed information is given under General Information.

UPPER and LOWER STORE	Button pushed in selects storage operation of associated storage screen. Button out selects normal operation without storage. Each button has push-push action and operates independently of the other.
UPPER and LOWER ERASE	Self-cancelling switch selects screen to be erased. Both buttons pushed in selects both screens.
ERASE	Momentary contact pushbutton initiates erasure of the storage display selected to be erased.
BRIGHTNESS (Y-T)	Provides continuously variable flood-gun current duty cycle from about 10% to 100%, permitting the intensity of a storage display to be varied. Permits extended retention of displayed information; also serves as an integrator for storing fast, repetitive signals.
LEFT VERT INTENSITY	Controls brightness of display associated with the left vertical plug-in unit.
LEFT VERT FOCUS	Provides adjustment to obtain a well-defined display.
RIGHT VERT INTENSITY	Controls brightness of display associated with the right vertical plug-in unit.
RIGHT VERT FOCUS	Provides adjustment to obtain a well-defined display.
POWER	Used to turn instrument power on or off.
BEAM FINDER	Brings both beams on-screen; limits displays to area inside graticule and intensifies both beams.
CALIBRATOR Loop	Provides positive-going accurate 400-millivolt and 4-milliampere square wave at a frequency of twice the line frequency for calibration and probe compensation.
LEFT VERTICAL EXT INTENSITY INPUT (Rear Panel)	Permits application of Z-axis signals to the CRT (DC coupled). Positive-going signal increases intensity of CRT beam associated with the left vertical plug-in unit.
RIGHT VERTICAL EXT INTENSITY INPUT (Rear Panel)	Permits application of Z-axis signals to the CRT (DC coupled). Positive-going signal increases intensity of CRT beam associated with the right vertical plug-in unit.
TRACE ROTATION (Rear Panel)	Permits alignment of the trace with respect to the graticule lines.

BASIC OPERATION

General

The following steps show the use of the controls and connectors of the display unit. It is recommended that this procedure be followed completely for familiarization with this instrument.

Preparation

1. Make sure the oscilloscope system is complete. The display unit must be properly connected to the power supply/ amplifier module and the dual-beam auxiliary board must be installed on the plug-in interface board. A 5A-series amplifier plug-in should be in each vertical (left and center) compartments, and a 5B-series time-base plug-in should be in the horizontal (right) compartment.

Turn On Procedure

Follow this procedure when first receiving the instrument and when it has been turned OFF for two weeks or more.

Turn BRIGHTNESS control fully CW.

Place the push-push STORE switches (UPPER & LOWER) in the depressed position. Turn the power ON and note that after a short delay the screen will become fully illuminated. Leave the instrument in this mode for 5 minutes before erasing or going to non-store mode.

This procedure reduces the ion content in the CRT and maximizes life.

2. Set the POWER switch off (push in) and connect the display unit to a power source that meets the voltage and frequency requirements of this instrument. See Operating Voltage (Preliminary Procedure) in the Operating Instructions section of the 5100-series Oscilloscope System manual.

3. Turn both INTENSITY controls counterclockwise and pull the POWER switch out to turn the instrument on. Set the front-panel controls as follows:

Display Unit (D12 or D13)

FOCUS (both)	Centered
UPPER and LOWER STORE	Non-store (buttons out)
BRIGHTNESS (Y-T)	Clockwise

Amplifier Plug-ins (both)

Display	On
Position	Centered
Volts/Div	.2
Variable Volts/Div	Cal (fully clockwise)
Input Coupling	DC

Time-Base Plug-in

Display	Alternate (button out)
Position	Centered
Seconds/Div	5 ms
Variable Seconds/Div	Cal (fully clockwise)
Sweep Magnifier	Off
Trigggering Level	Counterclockwise
Triggering Source	Dis Play (Left and Right button in)
Triggering/Sweep Mode	Auto Trig, DC Coupling, +Slope, Normal Sweep

4. Advance the INTENSITY controls until the traces are at the desired viewing level. The traces should appear near the graticule center.

5. Apply a signal from the CALIBRATOR loop to the input connectors of both amplifier plug-ins through a 1X probe or test lead and a dual input cable.

6. Turn the Triggering Level control clockwise until a stable display is obtained. Adjust the vertical and horizontal Position controls so the left vertical display is in the top half of the graticule area and the right vertical display is in the bottom half, and the displays start at the left edge of the graticule.

7. Adjust the FOCUS controls for sharp, well defined displays over the entire trace length.

8. Disconnect the input signal and position either trace vertically so it coincides with the center horizontal line of the graticule.

9. If the trace is not parallel with the center horizontal line, see Trace Adjustment in this section.

Calibration Check

10. Set the Volts/Div switches of both vertical plug-ins to .1, and move both traces two divisions below graticule center. Reconnect the calibration signal to the input connectors of both vertical amplifier plug-ins.

11. The display should be four divisions in amplitude with six complete cycles (five complete cycles for 50-hertz line frequency) shown horizontally. An incorrect display indicates that the oscilloscope mainframe or plug-ins need to be recalibrated.

12. Rotate the RIGHT VERT INTENSITY control counterclockwise and set the time-base Triggering Source to Left.

NOTE

The remainder of the procedure is performed using the Left Vertical controls only, since just one display is needed to demonstrate the remaining control functions.

Beam Finder

13. Move the display off-screen with the left vertical amplifier Position control.

14. Push the BEAM FINDER button and observe that the display compresses into the screen area. Reposition the display to screen center and release the BEAM FINDER button.

External Intensity Input

15. Move the calibrator signal from the amplifier plug-in input connectors and apply it to the LEFT VERTICAL EXT INTENSITY INPUT connector on the rear panel.

16. Set the Triggering Source to Line and slowly rotate the LEFT VERT INTENSITY control counterclockwise until the trace appears to be a series of dimmed and brightened segments. The brightened segments correspond with the tops of the calibrator square waves.

Storage Operation

17. Move the calibrator signal from the EXT INTENSITY INPUT connector to the left vertical amplifier plug-in unit input connector.

18. Set the Triggering Source to Left, turn the LEFT VERT INTENSITY control counterclockwise and press both the UPPER and LOWER STORE buttons. A background light level will be present on the storage screen.

19. Simultaneously press both the UPPER and LOWER ERASE screen-selector buttons and push the ERASE button to erase both screens and prepare the targets for storage.

20. Advance the INTENSITY control slowly in the clockwise direction to produce a waveform of normal intensity, then turn the control to the counterclockwise (minimum intensity) position. A stored waveform should remain on the storage screen.

21. Set the time-base plug-in to the Single Sweep Mode (Single Sweep button in).

22. Turn the BRIGHTNESS (Y-T) control counterclockwise and note that the stored display dims. Then turn the control clockwise to normal brightness.

23. To demonstrate independent screen operation, push the UPPER ERASE screen-selector button to release the LOWER ERASE button. Press the ERASE button and note that only the upper screen erases. Push the LOWER ERASE button (UPPER ERASE releases) and press the ERASE button. Set either screen to non-store (STORE button out) and note that the other screen is fully operable in the storage mode, permitting simultaneous store and non-store operation.

This completes the basic operating procedure of the display unit. Instrument operations not explained here, or operations which need further explanation are discussed under General Operating Information.

GENERAL INFORMATION

Graticule

The graticule of the display unit is internally marked on the faceplate of the CRT to provide accurate, no-parallax measurements. The graticule is marked with eight vertical and ten horizontal divisions. Each division is one-half inch square. In addition, each major division is divided into five minor divisions. The vertical gain and horizontal timing are calibrated to the graticule so accurate measurements can be made from the graticule.

Intensity Controls

Two INTENSITY controls are provided, one for each CRT beam. Each CRT beam is associated with one of the vertical deflection systems; thus, the LEFT VERT INTENSITY controls the intensity of the display associated with the left vertical plug-in unit and the RIGHT VERT INTENSITY controls the intensity of the display associated with the right vertical plug-in unit. These controls are adjusted so the displays are easily visible, but not overly bright. Readjustment will probably be required for different displays or sweep rates. Particular care should be exercised when only a spot is displayed. A high-intensity stationary spot may burn the CRT phosphor and cause permanent damage to the CRT if allowed to remain too long.

Display Focus

A FOCUS control is associated with each CRT beam. If a well-defined display cannot be obtained with the FOCUS control, even at low intensity settings, adjustment of the internal astigmatism control may be required.

To check for proper setting of the Astig control, slowly turn the FOCUS control through the optimum setting with a signal displayed on the CRT screen. If the Astig control is correctly set, the vertical and horizontal portions of the trace will come into sharpest focus at the same position of the FOCUS control.

Trace Alignment Adjustment

If a free-running trace is not parallel with the horizontal graticule lines, set the TRACE POSITION adjustment (rear panel) as follows: Position the trace to the center horizontal line and adjust the TRACE ROTATION control so the trace is parallel with the horizontal graticule lines.

Beam Finder

The BEAM FINDER switch provides a means of locating a display which overscans the viewing area either vertically or horizontally. When the BEAM FINDER switch is pressed, the display is compressed within the graticule area. To locate and reposition an overscanned display, use the following procedure.

1. Press the BEAM FINDER switch, and while holding it in, increase the vertical and horizontal deflection factors until the display is reduced to about two divisions vertically and four divisions horizontally (the horizontal deflection needs to be reduced only when in the X-Y mode of operation).

2. Adjust the vertical and horizontal position controls to center the display about the vertical and horizontal centerlines.

3. Release the BEAM FINDER switch; the display should remain within the viewing area.

Care of Storage Screens

To prolong the useful life of the storage screens, the following precautions should be observed when operating the D13.

1. Use minimum beam intensity required to produce a clear, well defined display. Care must be taken in the degree of writing-beam intensity that is used, particularly when using slow sweep rates and X-Y displays. Too-high beam intensity may permanently damage the CRT screen.

2. Avoid repeated use of the same area of the screen. If a particular display is being stored repeatedly, change the vertical position occasionally to use other portions of the display area.

3. Do not leave a stored display on the screen when it is no longer needed.

4. Turn the Store BRIGHTNESS (Y-T) control fully counterclockwise (with sweep held off) when storing a display for an extended period of time.

5. Operate in the non-store mode unless storage is required.

Storage Operation

General. Separate STORE switches are provided for both the upper and lower CRT storage screens, permitting independent screen operation. When both screens are operated in the non-stored mode (both the UPPER and LOWER STORE switches out), the instrument operates as a conventional oscilloscope. When either or both screens are operated in the storage mode (applicable STORE switch in), a display can be retained for further analysis.

A stored display is erased by first selecting the applicable screen for erasure and then pushing the ERASE button. The erasure of one screen has no effect on the other. The UPPER and LOWER ERASE switches are self-cancelling; when either button is pressed, the other button is released. Also, both switches can be pressed in or released at the same time. Thus either screen or both can be selected for erasure, or erasure of both screens can be prevented. The ERASE momentary-contact switch initiates the waveform required for erasure.

Holding and Viewing Modes. The BRIGHTNESS control permits extended retention of displayed information with negligible reduction in CRT life. The control provides continuously variable flood-gun current duty cycle from about 10% to 100%. To hold a stored display, set the time-base plug-in unit to Single Sweep and turn the control fully counterclockwise. In this position, the storage-target flood guns are on only 10% of the time, producing the effect of decreased intensity. A stored display will be very faint and may not be discernible from the background areas. Both screens are affected. To return the instrument to a viewing mode, turn the BRIGHTNESS control clockwise until the desired viewing level is achieved. In the full clockwise position, the flood guns are on 100% of the time and stored display will be its brightest. The BRIGHTNESS control is inoperable for X-Y displays and when the sweep is running. If the control is counterclockwise and the sweep is running, a blinking effect will be noticeable at the slower sweep rates because the CRT will revert to the hold mode between sweeps. To eliminate this effect, turn the control clockwise.

Integrating Fast Displays. If fast, repetitive displays cannot be stored even at maximum intensity settings, the BRIGHTNESS control can be used to increase the apparent writing speed of the CRT. To use this function, first obtain a triggered, well focused display of the signal in the non-store mode. Adjust the writing-beam INTENSITY control so the trace is just starting to defocus. Then press in both STORE buttons and erase the screen. Turn the BRIGHTNESS control counterclockwise and press the STORE button to obtain the non-store mode. Wait about two seconds, press in both STORE buttons and rotate the BRIGHTNESS control clockwise to view the integrated display. If all portions of the display are not properly stored, rotate the BRIGHTNESS control counterclockwise and return to the non-store mode to integrate the display for a few seconds more. If too much integration time is used, the stored image begins to broaden, or background fade-up may occur, obscuring the desired display. Some practice may be necessary to determine the proper intensity level and integration time required for obtaining best results.

Improving Writing Speed. After continued use (2 hours or more) in the non-store mode, or store mode with no display, fade the screen positive by obtaining a repetitive sweep in the store mode. Slowly position the trace from CRT top to bottom. Leave the CRT target fully stored for five minutes.

Intensity Modulation

Intensity (Z-axis) modulation can be used to relate a third item of electrical phenomena to the vertical (Y-axis) and the horizontal (X-axis) coordinates without affecting the waveshape of the displayed signal. The Z-axis modulating signal applied to the EXT INTENSITY INPUT changes the intensity of the displayed waveform to provide this type of display. The voltage amplitude required for visible trace modulation depends on the setting of the INTENSITY control. About +5 volts will turn on the display to a normal brightness level from an off level, and about —5 volts will turn the display off from a normal brightness level. "Gray scale" intensity modulation can be obtained by applying signals between these levels. Maximum safe input voltage is + or— 50 volts. Usable frequency range of the Z-axis circuit is DC to one megahertz.

Time markers applied to the EXT INTENSITY INPUT provide a direct time reference on the display. With uncalibrated horizontal sweep or X-Y operation, the time markers provide a means of reading time directly from the display. However, if the markers are not time-related to the displayed waveform, a single-sweep display should be used (for internal sweep only) to provide a stable display.

Intensity modulation can be used in the store mode as well as in the non-store mode; however, there is only one intensity level in a stored display. The stored waveform may be modified by either dimming portions of the waveform so they do not store, or brightening portions from a dim background so only the brightened portions store.

Calibrator

The internal calibrator of the display unit provides a convenient signal source for checking the basic vertical gain and sweep timing. The calibrated signal is also very useful for adjusting probe compensation as described in the probe instruction manual. The output square-wave voltage is 400 millivolts, within 1%, and the square-wave current is 4 milliamperes, within 1%. The frequency of the square-wave signal is twice the power-line frequency. The signal is obtained by clipping the probe to the loop.

Display Photography

A permanent record of the CRT display can be obtained with an oscilloscope camera system. The CRT bezel provides integral mounting for a Tektronix oscilloscope camera. A camera with a light source is required to illuminate the graticule in the non-store mode. The instruction manuals for the Tektronix oscilloscope cameras include complete instructions for obtaining waveform photographs. The following specific information is given for photographing stored displays.

When this instrument is operated in the storage mode, a photograph may easily be composed by erasing unwanted displays as many times as necessary before the desired display is obtained. This ability to compose a photograph in advance prevents wasted film due to incorrect displays.

Due to the background glow of the stored display produced by the flood guns, special care must be taken in determining the exposure time and f-stop settings. Of course, exact settings will depend upon the specific types of film. After the correct settings are obtained for a specific oscilloscope-camera-film combination, record these figures for future reference. Since the background glow does not change substantially between displays, these settings should produce satisfactory results for most displays. Background glow may be altered by adjustment of the BRIGHTNESS control.

Oscilloscope Applications

The 5100-series Oscilloscope, including its associated display module and plug-ins, provides a very flexible measurement system. Specific application for the individual plug-ins are described in the manuals for those units. Refer to the Operating Instructions section of the 5100-series Oscilloscope manual for basic oscilloscope applications, including peak-to-peak AC voltage measurements, instantaneous DC voltage measurements, comparison measurements, time duration measurements, determining frequency, risetime measurements, and X-Y measurements.

Electrical Characteristics

Cathode-Ray Tube. Size is 6½ inches with an 8 X 10 division (½ inch/div.) display area. P31 phosphor is standard for the D12; similar to P1 for the D13. Accelerating voltage is 3.5 kV; orthogonality, 90° (within 1°); geometry, 0.1 division or less.

Storage Display (D13 Only). Writing speed is at least 20 divisions per millisecond; storage time, one hour (longer at low brightness); erase time, about 250 milliseconds.

External Intensity Input. +5 volts will turn on display to a normal brightness level from an off level; —5 volts will turn display off from a normal brightness level. Usable frequency range is DC to one megahertz; input R and C, about 100 kΩ paralleled by about 40 pF; maximum safe input, +50 volts (DC+ peak AC).

Calibrator. Voltage amplitude is 400 mV, within 1%; current, 4 mA, within 1%. Frequency of square-wave signal is twice the line frequency.

Power Input. With the standard transformer, the 5103N Oscilloscope will operate from nominal 110V and 120V (within 10%) line voltage sources having frequencies of 60 hertz or 400 hertz. With the optional export transformer, the 5103N Oscilloscope will operate from nominal 100V, 110V, 120V, 200V, 220V and 240V (all within 10%) line voltage sources having frequencies of 50 to 60 hertz or 400 hertz.

NOTES

NOTES

SECTION 2
THEORY OF OPERATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual contains an electrical description of the circuits in the D12 and D13 Display Units. An overall block diagram of these units and complete schematics are given on pullout pages at the rear of this manual.

BLOCK DIAGRAM DESCRIPTION

The Vertical and Horizontal Deflection Amplifiers provide final amplification of the signals from the plug-in units. They produce push-pull outputs suitable to drive the CRT vertical and horizontal deflection plates. Separate vertical amplifiers are provided for independent dual-beam display of signals from the left and right vertical plug-in units. Beam-finding circuitry limits the display within the screen area when the front-panel BEAM FINDER button is pressed.

The CRT Circuit produces the high voltage (about —3400 volts) and contains the controls necessary for operation of the cathode-ray tube. The CRT Circuit also contains the Z-Axis Amplifier, which provides drive signals to control the intensity levels of the displays produced by both CRT beams.

The Storage Circuit provides the voltage levels necessary to operate the storage elements associated with the CRT in the D13. The circuit includes the erase-pulse generator for erasing stored information and a multivibrator which permits the flood-gun duty cycle to be varied.

CIRCUIT DESCRIPTION

Deflection Amplifiers

Vertical Deflection Amplifiers. The left and right Vertical Deflection Amplifiers provide the final amplification of signals applied to the left and right vertical plug-in units. These are differential amplifiers which produce push-pull outputs suitable to drive the CRT left and right vertical deflection plates for independent dual-beam displays. The left amplifier consists of Q164, Q166, Q174 and Q176, and the right amplifier consists of Q104, Q106, Q114 and Q116.

The input signal arrives via P612 from the plug-in interface circuit (power supply/amplifier module). The output signal is developed across the collector-load resistors of the output transistors, and is about 50 times the magnitude of the input signal. Variable resistors R116 and R176 (Right and Left Vert Gain) provide emitter degeneration to set the gain of their respective amplifiers to provide a calibrated vertical display.

Horizontal Deflection Amplifier. The Horizontal Deflection Amplifier consists of Q124, Q126, Q134 and Q136, and is basically the same as the Vertical Deflection Amplifiers just described. It provides final amplification of signals from the horizontal plug-in unit, which arrive via P611. Gain of the stage is set by R136, Horiz Gain, to provide a calibrated horizontal display.

Beam Finder. If a high-amplitude signal or a misadjusted control has deflected the trace or display off-screen, it can be located by pressing the front-panel BEAM FINDER pushbutton. This opens S223 (CRT Circuit diagram), allowing current to flow through R179 into the emitter circuits of the deflection amplifiers. R179 limits the current available to the transistors, and hence, to the collector-load resistors. Thus the dynamic range of the deflection plates is limited to an on-screen level, and the display is compressed within the viewing area. The intensification function of the Beam Finder is discussed in the Z-Axis Amplifier description.

X-Y Phasing. Variable capacitors C115 and C175 are connected across the output collectors of their respective Vertical Deflection Amplifiers. These capacitors are adjusted to eliminate the inherent phase difference between the vertical and horizontal deflection systems when operating in the X-Y mode.

Dynamic Geometry. Because each CRT gun is physically located off-center in the vertical plane, the beams emitted by these guns pass through an uneven magnetic field as they sweep across the screen. To compensate for the effects that the unbalanced field would have on display geometry, a dynamic geometry circuit made up of full-wave rectifier CR141-CR142 and operational amplifier Q148 applies a voltage to the vertical deflection plate shield. As the beam moves from the left towards CRT center, CR142 conducts, and the voltage applied to the shield increases in a sawtooth fashion. When the beam passes the center and continues toward the right edge of the screen, CR142 turns off and CR141 turns on, and the voltage applied to the shield decreases in a sawtooth fashion. The peak of this voltage waveform corresponds to the CRT center, and the ramp voltages are directly proportional to the distance of the CRT spot from the screen center. R145, Dynamic Geometry, adjusts the constant factor of the ratio.

Because the unregulated +200-volt collector supply of Q148 may have an undesirable effect on geometry due to ripple, the ripple component is injected via operational amplifier Q154 to the base of Q148 to cancel this effect.

CRT Circuit

General. The CRT Circuit produces the high-voltage potential and provides the control circuits necessary for operation of the cathode-ray tube (CRT). This circuit also includes the Z-Axis Amplifier circuit, which controls the CRT intensity level of both beams from several inputs.

Z-Axis Amplifier. The Z-Axis Amplifiers establish the biasing conditions of the CRT to control the intensity levels of both beams. They are current-driven, shunt-feedback operational amplifiers with voltage outputs; they consist of Q232-Q234 for the left electron gun, and Q432-Q434 for the right electron gun.

The output levels of the Z-Axis Amplifiers are established by the voltage drops across feedback resistors R236 and R436 in reference to virtual ground at the operational amplifier summing points (Q232 and Q432 bases). The currents through these feedback resistors are determined by input currents from any combination of several sources. Individual INTENSITY controls, R200A and R400A, permit the quiescent intensity levels of both beams to be adjusted independently. An EXT INTENS INPUT, J203 or J403, is provided for each Z-Axis Amplifier; the external signals are applied via operational amplifiers Q206 and Q406. The remaining inputs are simultaneous to both Z-Axis Amplifiers, and thus affect both CRT beams. The sweep blanking and chop blanking inputs are applied via emitter followers Q214 and Q218 to turn off the CRT beams during sweep retrace and during the chop-switching transitions. When BEAM FINDER switch S223 is pressed, Q224 saturates, resulting in a slight increase in the CRT beam intensity levels.

High-Voltage Primary. A repetitive, non-sinusoidal signal is produced by a phase-modulated switching circuit in the primary of T240 and induced into the secondaries. Current drive for the primary winding is furnished by Q252 in its conduction state. Q252 is turned on by positive-going feedback applied through C259 and L259 from the feedback winding, and then turned off by switching action from Q262. A sample of the output DC voltage is modulated by the AC from another feedback winding at the gate of Q268 to establish the conduction time of Q252, and thus maintain the proper output level. Q252 delivers energy to T240 only once each cycle.

Assuming Q262 and Q264 are off initially, R262 provides base drive for Q252, causing it to deliver current to T240 primary. As Q252 conducts, its increasing current through the primary winding induces a voltage into the secondaries. The gate of Q268 is driven negative by the voltage from the feedback winding, switching Q264 and Q262 on. With conduction of Q262, base drive for Q252 is removed.

With Q252 off, the transformer field collapses, reversing the polarity of the voltage induced into the secondaries. When the gate of Q268 is driven sufficiently positive to switch Q264 and Q262 off, Q252 is switched on again. Q252 again delivers energy to the primary winding and the action is repeated.

High-Voltage Regulation. Regulation is accomplished as follows: Feedback from the —3400-volt cathode supply is summed with the low-voltage levels through the voltage divider consisting of resistors R272A, R272B, R274, R275 and R276 to establish the DC level at the gate of Q268. The AC component, which is the switching signal, is derived from the transformer as described previously. If the output level of the cathode supply drops below the nominal —3400-volts (becomes more positive), the level at the gate of Q268 rises. A new point is selected on the varying AC component to cause Q262-Q264 to switch later and thus increase the conduction time of Q252. This allows more energy to be delivered to the primary winding of T240, resulting in an increase of voltage in the secondaries. Conversely, if the output level increases, Q252 is allowed to conduct for a shorter length of time. The DC level at the gate of Q268 is adjusted by R275, High Voltage, to set the voltage on the CRT cathode to exactly —3400 volts.

Electron Gun Cathode and Grid Supplies. Half-wave rectifier CR247 produces —3500 volts DC, which is applied to Q454 and VR458. Each of these devices drops 100 volts, establishing the —3400-volt cathode potential. Conduction of Q454 in the right cathode circuit is controlled by R455, Horiz Bal, to balance the horizontal sensitivity of the two displayed traces. The 6.3-volt cathode heater is elevated to —3.5 kV through R459.

Bias voltage for each grid is supplied by identical DC restorer networks, which consist of CR243, CR244, and R244 for the right grid and CR443, CR444 and R444 for the left grid. These DC resistors have the —3400-volt cathode potential applied to them as a reference voltage, and they are driven by a varying voltage obtained from one side of the 400 VAC winding of T240. R242, Right Inten Range, and R442, Left Inten Range, provide a fine adjustment of the quiescent grid voltage to bias both electron guns just below cutoff when the Z-Axis Amplifier output is at its minimum quiescent level (INTENSITY controls counterclockwise and no intensifying or blanking inputs). A change in the Z-Axis Amplifier output produces an almost equal change of voltage on the control grid, allowing the Z-Axis Amplifier to control the beam current in the CRT.

CRT Control Circuits. In addition to the INTENSITY controls discussed previously, front-panel focus and internal astigmatism controls have been incorporated for arriving at an optimum CRT display. FOCUS controls R200B and R400B provide the correct voltage for the first anode of each gun. Proper voltages for the second anodes are obtained by adjusting the Right and Left Astig controls, R286 and R486. In order to obtain optimum spot size and shape, both the focusing and astigmatism controls are adjusted to provide the proper electrostatic lens configuration in the CRT.

Two adjustments control the trace alignment. TRACE ROTATION control R291 permits adjustment of the DC current through beam-rotation coil L291 to align the display with the horizontal graticule lines. Beam Regis control R285 varies the voltage between two special sets of deflection plates to align the two traces horizontally, ensuring correct time relationship (registration) between the traces and the vertical graticule lines. Geom control R289 varies the positive level on the horizontal deflection plate shield to control the overall geometry of the display. The dynamic geometry correction which is applied to the vertical deflection plate shields has been discussed previously.

Storage Circuit (D13 Only)

General. The CRT used in the D13 is a direct-view, bistable storage cathode-ray tube with a split-screen viewing area that permits each half to be operated individually for stored displays. Only those elements associated with the storage capability of the CRT are shown inside the CRT symbol on the right side of the Storage Circuit schematic diagram. The writing gun, its deflection systems and associated elements have been discussed previously.

Storage Operation. Four low-energy electron guns (flood guns) provide full coverage of the large screen area. Each consists of a heated cathode and an anode. The cathode heaters, which receive an unfiltered pulsating DC from full-wave rectifier CR329, are elevated to the cathode potential through R329. Quiescently, Q308 is saturated, providing current to the flood-gun cathodes. The anode potential is established by VR396 and supplied via emitter follower Q396.

The collimation electrode is a metallic band around the inner wall of the CRT envelope. It produces an electrostatic field to distribute the flood-gun electrons uniformly over the storage target. R390, CE1, provides adjustment of the flood-electron trajectories to cover the extreme rim of the targets and optimize uniformity of the target coverage. Emitter follower Q392 maintains a stable voltage on the collimation electrode, providing a low-impedance current path to absorb current variations.

The storage screen consists of a thin tin-oxide layer called the target backplate, which is coated with an insulator material containing finely-ground phosphor particles called the target. A positive voltage potential is applied via Q372 and S372 to the backplate to establish the operating level of the tube, which is the difference in potential between the backplate and the flood-gun cathodes. The CRT screen area is divided into two halves, which are electrically insulated from each other to permit independent operation.

The target operates in a bistable mode because of the secondary-emission properties of the insulator material. The stable state is the rest potential, at which the target has gathered low-energy flood-gun electrons, causing it to charge down to the flood-gun cathode potential. The second stable state is the stored state, at which the target (or portions of it) is shifted to the backplate potential by increasing the secondary emission. While the flood guns do not have sufficient energy to shift the target to the stored state, they do supply sufficient energy to hold the target in the stored state after it has been shifted by the high-energy writing-gun beam (CRT beam). This is because the landing energy of the flood electrons has increased with the increased potential difference between the flood-gun cathode and the target. These higher energy electrons yield a light output and produce a visual display as long as the flood beam covers the target.

When the stored display is no longer needed, the information is erased by first shifting the entire target to the stored state and then removing the charge. A positive-going, short duration pulse is first applied to the backplate, increasing the flood-gun electron landing energy and writing the entire target area. Next, the backplate voltage is pulled well below the rest potential of the target, which follows due to its inherent capacitive coupling. Then, as the backplate is gradually returned to its quiescent potential, the target charges to the rest potential and is ready to write again.

For a comprehensive study of storage tube operating principles, a Tektronix Circuit Concepts book entitled "Storage Cathode-Ray Tubes and Circuits" is available through your local Tektronix, Inc. Field Office or representative. Tektronix Part No. 062-0861-00.

Backplate Supply. A regulated +370-volt DC power supply is incorporated in the Storage Circuit to provide the storage level for the CRT and to ensure a potential sufficient for the erasure process. A winding of high-voltage transformer T240 supplies 400 volts RMS, which is rectified by CR386. Q386 and Q388 are connected as a feedback pair to provide the regulated +370-volt DC output. VR388 establishes the reference voltage, and R387, +370 V Adj, sets the current through Q386 to set the output level. VR387 is a protection device for the transistors, and is normally operated in a region of its characteristics curve below its Zener knee.

Backplate Control. Separate STORE switches, S375A and S375B, are provided for the target backplates to permit each storage screen to be operated individually. In the store mode, the store-level potential for the backplate is supplied by either Q372 or the erase-generator output operational amplifier, depending upon the setting of the ERASE SELECT switches, S372A and S372B.

A high degree of control of the target backplates is maintained by a feedback amplifier system consisting of Q356, Q358, Q362, and Q364. The operational amplifier summing point is at the base of Q356, and the feedback resistor is R355. Variable resistor R350, Store Level, provides an adjustment of the current to the null point, and hence sets the backplate voltage through R355 to an optimum storage level. R370, Store Bal, permits matching the backplate voltages for uniform screen luminance, whether they are selected for erasure or not.

When either or both screens are operated in the store mode, the divider network in the high-voltage regulator circuit is modified to shift the high voltage slightly, correcting for the deflection sensitivity changes that occur. The backplate voltage is applied through either R381 or R382 to the base of Q384, removing the ground potential from the Q384 collector. R385, Sens Correct, permits an adjustable sensitivity correction voltage to be applied to the high-voltage regulator.

Erase Generator. The previously discussed operational amplifier is driven by a monostable multivibrator when it is desired to erase a stored display. The multivibrator consists of Q334, which is normally on, and Q336, which is normally off. When ERASE button S330 is pressed, R330 is grounded, producing a negative-going step through C331 to cut Q334 off. Q336 turns on, and the negative-going step produced at its collector causes a corresponding positive-going step at the output of the operational amplifier. This positive-going step is applied to the target backplate, increasing the storage level and "writing" the entire target.

After an RC-controlled time of 10 milliseconds, the multivibrator reverts to its quiescent state, producing a positive-going step at the collector of Q336 as the transistor turns off. This positive-going step is coupled through C342, and the backplate is pulled negative through the action of the operational amplifier. The target is pulled well below its rest potential. As C342 charges, the voltage at the cathode of CR343 decays from about +20 volts toward the —30-volt supply at an RC-controlled rate until it is clamped at ground by conduction of CR343. This action allows the target backplate to be raised slowly to its operating level, while the target remains at the flood-gun cathode potential. The total time from initiation of erasure to the ready-to-write condition is about 250 milliseconds.

Flood-Gun Cathode Control. As previously mentioned, Q308 provides the current for the flood-gun cathodes. It operates at saturation, establishing a cathode potential of nearly —30 volts. Q308 is controlled by two circuits: a transistor switch activated by the sweep gate and a multivibrator. While the sweep is running, Q304 overrides the multivibrator output and holds Q308 in its conduction state. Emitter follower Q302 receives the sweep blanking input from R203 in the Z-Axis Amplifier circuit; however, the level of interest is the zero volts applied to the base of Q302 while the sweep is running. This level permits the base of Q304 to move slightly negative, biasing the transistor into saturation and grounding the collector of Q320. Through R307-R308 divider action, Q308 is held on.

Between sweeps or when the sweep is held off, the +5-volt sweep-blanking level is applied to Q302, raising its emitter positive. This level switches Q304 off, releasing its hold on Q308. In this condition, Q308 is controlled by collector-coupled multivibrator Q310-Q320. When Q320 conducts, Q308 conducts. Symmetry of the multivibrator is controlled by R313 and R325. R325, BRIGHTNESS, is adjustable to allow Q320 to conduct anywhere from 10% to 100% of the time. Thus the duty cycle of the flood-gun cathodes can be varied from 10% to 100%, which has the effect of varying the stored brightness.

SECTION 3 CALIBRATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual contains a procedure to return the circuits of the D12 and D13 display units to within their designed operating capabilities. Calibration is generally required after a repair has been made, or after long time intervals in which normal aging of components may affect instrument accuracy. For initial inspection to verify instrument operation, the Basic Operation procedure in Section 1 should be used (the instrument is checked with its covers on, using a minimum of peripheral equipment).

Instrument Maintenance

Before complete calibration, throughly clean and inspect this instrument as outlined in the Maintenance section of the Oscilloscope System manual. Also, the system manual contains information for general maintenance of this instrument, including preventive maintenance, component identification and replacement, etc.

Services Available

Tektronix, Inc. provides complete instrument repair and calibration at local Field Service Centers and at the Factory Service Center. Contact your local Tektronix Field Office or representative for further information.

TEST EQUIPMENT REQUIRED

General

The following test equipment and accessories, or the equivalent, is required for complete calibration of the D12 or D13. Specifications given for the test equipment are the minimum necessary for accurate calibration. Therefore, some of the specifications listed here may be less rigorous than the actual performance capabilities of the test equipment. All test equipment is assumed to be correctly calibrated and operating within the listed specification.

Calibration Equipment Alternatives

If other test equipment is substituted, control settings or calibration setup may need altering to meet the requirements of the equipment used. Detailed operating instructions for the test equipment are not given in this procedure. Refer to the instruction manual for the test equipment if more information is needed.

Special Calibration Fixtures

Special Tektronix calibration fixtures are used in this procedure only when they facilitate instrument calibration. These special calibration fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

Test Instruments

1. Vertical plug-in units. Three Tektronix 5A-series amplifiers of the same type are needed for checking X-Y phase relationship; however, only two need be used if the procedure is altered slightly.

2. Time-base plug-in unit. Tektronix 5B10N or 5B12N recommended.

3. DC voltmeter. Minimum sensitivity rating, 3600 volts full scale with an accuracy of at least 3%.

4. Low-frequency sine-wave generator. Frequency, 2 hertz to at least 2 megahertz; output amplitude, from about 0.1 volt to 20 volts peak to peak. For example, General Radio 1310-B Oscillator (use a General Radio 274-QBJ Adapter to provide BNC output).

5. Standard amplitude calibrator. Frequency, about one kilohertz; square-wave output amplitude, 0.2 volt. DC voltage outputs, + and —5 for checking Z-Axis inputs. Tektronix Calibration Fixture 067-0502-01 fills all of these requirements.

Accessories

1. Coaxial cable. 50 ohms impedance, 42-inch length, BNC connectors. Tektronix Part No. 012-0057-01.

2. Dual-input cable. Provides matched signal paths to the X and Y channels; BNC connectors. Tektronix Part No. 067-0525-00.

3. Test lead to connect signal from CALIBRATION loop to the vertical input.

SHORT-FORM PROCEDURE AND INDEX

D12/D13 Serial No. ____________________

Calibration Date ____________________

Calibrated By ____________________

1. Check/Adjust Power Supplies Page 3-3

Low-Voltage Supplies: Check that each supply is within the tolerance listed in Table 3-1.

High-Voltage Supply: Meter reading between HV test point and ground is —3400 V, ±170 V. Adjust R275.

2. Check/Adjust CRT Operation Page 3-3

Intensity Range (both beams): Adjust R442 (Left Inten Range) and R242 (Right Inten Range) to establish CRT bias.

Astigmatism (both beams): Adjust R486 (Left Astig) and R286 (Right Astig) for sharp displays.

Trace Alignment: Adjust TRACE ROTATION to align the trace parallel to the center graticule line.

Geometry: Adjust R289 (Geom) and R145 (Dynamic Geometry) for minimum curvature of traces at screen edges. Beam Alignment and Horizontal Sensitivity: Adjust R285 (Beam Registration) to align the beams at screen center. Adjust R455 (Horiz Bal) to calibrate horizontal sensitivity at screen edges.

3. Check/Adjust Storage Operation Page 3-4

+370-Volt Supply: Meter reading between TP2 and ground is +370 V, ±7 V. Adjust R387 (+370 V Adj).

Operating Level: Adjust R350 (Store Level) for best stored display with Erase Selector pushed in.

Store Balance: Adjust R370 (Store Bal) for stored display with Erase Selector button out. Operating level and store balance levels must match.

Collimation: Adjust R390 (CE1) for full screen coverage and best uniform brightness over the storage target area.

Non-Store: Adjust R395 (Non-Store) so screen erases promptly and completely when changing from store to non-store mode.

Writing Speed: Check that writing speed is ≥20 divisions millisecond.

4. Check/Adjust CRT Deflection System Page 3-5

Horizontal Centering and Sweep Magnifier Registration: Adjust R675 (Horiz Cent) to establish the horizontal electrical zero at the screen center.

Vertical and Horizontal Amplifier Gain: Adjust R116 (Right Vert Gain), R176 (Left Vert Gain), and R136 (Horiz Gain) to provide calibrated deflection factor. Adjust R385 (Sensitivity Correction) in the Store mode.

X-Y Phasing: Check that phase difference between identical amplifier units is 1° or less. Adjust C115 (Right Phase) and C175 (Left Phase).

5. Check Z-Axis Amplifier Page 3-6

External Intensity Input: +5 V turns the CRT beam on from an off level; —5 V turns the beam off from an on level.

Beam Finder: Traces can be located.

6. Check Calibrator Loop Page 3-6

Amplitude and Frequency: Output amplitude is 400mV; frequency is twice the power-line frequency.

CALIBRATION PROCEDURE

Preparation

NOTE

This instrument should be adjusted at an ambient temperature between +20°C and +30°C (between +68°F and +86°F) for best overall accuracy.

1. The D12 or D13 Display Unit is operated with a 5100-series Power Supply/Amplifier unit, forming an oscilloscope mainframe. Remove the side and bottom cabinet panels.

2. Insert an amplifier plug-in unit in each vertical plug-in compartment (left and center). Insert a time-base plug-in unit in the horizontal (right) compartment.

3. Connect the oscilloscope to the power source for which it is wired.

4. Set the controls as given under Initial Control Settings.

5. Allow a 20 minute warm up time before performing the calibration procedure.

Initial Control Settings

NOTE

Do not preset internal controls unless they are known to be significantly out of adjustment, or unless repairs have been made in the circuit. In these instances, the particular controls can be set to midrange.

D12/D13

LEFT VERT	
INTENSITY	Counterclockwise
FOCUS	Midrange
RIGHT VERT	
INTENSITY	Counterclockwise
FOCUS	Midrange
POWER	ON
STORE (UPPER and LOWER)	Non-Store (button out)
BRIGHTNESS (Y-T)	Clockwise

Amplifier Units (both)

Display	On
Position	Midrange
Volts/Div	50 mV
Variable	Calibrated (fully clockwise)
Input Coupling	DC, GND

Time Base Unit

Display	Alt (button out)
Position	Sweep starts at the left edge of the graticule.
Seconds/Div	0.5 ms
Variable	Calibrated (fully clockwise)
Swp Mag	Off (button out)
Triggering Mode	Auto Trig, AC Coupling, + Slope
Triggering Level	Midrange

1. Check/Adjust Power Supplies

LOW-VOLTAGE SUPPLIES

a. Connect the DC voltmeter between each low-voltage test point and ground.

b. CHECK—Each supply is within the tolerance listed in table 3-1.

NOTE

The tolerance in Table 3-1 includes the possible 3% measurement error of the VOM. If a supply is outside the listed tolerance, refer to the Calibration section of the 5100-series Oscilloscope System manual for complete calibration instructions.

TABLE 3-1

Supply	Tolerance
—30 V	—29.025 V to —30.975 V
+5 V	+4.75 V to +5.25 V
+30 V	+28.95 V to +31.07 V
+205 V	+175 V to +247.5 V

HIGH-VOLTAGE SUPPLY

CAUTION

Turn off instrument power when connecting and disconnecting the DC voltmeter.

c. Connect the DC voltmeter (20 kΩ/volt VOM set to measure at least —3600 volts) between ground and the —3400-volt test point.

d. CHECK—Meter reading must be —3400 volts, ±170 volts. ADJUST—R275, High Voltage, for —3400 volts.

e. Disconnect the DC voltmeter.

2. Check/Adjust CRT Operation

If you are beginning calibration with this step, set the front-panel controls as listed under Initial Control Settings.

INTENSITY RANGE (BOTH BEAMS)

a. Advance the LEFT VERT and RIGHT VERT INTENSITY controls clockwise and check that traces can be obtained, then turn the controls fully counterclockwise.

b. ADJUST—Temporarily set R442 (Left Inten Range) and R242 (Right Inten Range) so two faint traces are visible. Slowly turn each INTENSITY control clockwise until its trace starts to brighten, then set the INTENSITY control 30° clockwise (1 division marked on the panel adjacent to the knob) of this point. Adjust R442 and R242 clockwise until the beams just disappear. The INTENSITY controls can now be adjusted for traces of normal brightness.

ASTIGMATISM (BOTH BEAMS)

c. Connect the low-frequency sine-wave generator output to the left and right vertical plug-in unit input connectors through a coaxial cable and a dual-input cable. Set the sine-wave generator for a 2-kilohertz, minimum amplitude output.

d. Set the input coupling switches of both vertical units to DC and adjust the sine-wave generator so both displays are about 6 divisions in amplitude. Adjust the time-base triggering controls for a stable display.

e. ADJUST—R486, Left Astig, and the front-panel LEFT VERT FOCUS control for best focus of overall left display; R286, Right Astig, and the front-panel RIGHT VERT FOCUS control for best focus of overall right display.

f. Disconnect the sine-wave signal from the vertical input connectors.

TRACE ALIGNMENT

g. Move both traces to the center of the graticule.

h. CHECK—Trace should be parallel to the center graticule line.

ADJUST—TRACE ROTATION control (rear-panel control) to align the trace horizontal.

GEOMETRY

i. Position the left trace to the top of the graticule and the right trace to the bottom.

j. CHECK—Bowing of the traces must not exceed 0.1 division.

ADJUST—R289, Geometry, for minimum curvature of the two traces.

k. Interchange the time-base plug-in unit with either of the amplifier plug-in units to obtain a vertical sweep. Position the vertical trace to the right edge of the graticule. Readjust R289 if the bowing exceeds 0.1 division.

l. Replace the time-base plug-in unit in the horizontal compartment and the amplifier unit in the vertical compartment. Move the left trace to the bottom of the graticule and right trace to the top.

m. CHECK—Bowing of the traces must not exceed 0.1 division.

ADJUST—R145, Dynamic Geometry, for minimum curvature of the two traces.

n. Repeat steps i through m to obtain optimum geometry of the display.

BEAM ALIGNMENT AND HORIZONTAL SENSITIVITY

o. Connect the standard amplitude calibrator output to the left and right amplifier plug-in unit input connectors through a coaxial cable and a dual-input cable. Set the standard amplitude calibrator for a 0.2-volt square-wave output.

p. Set the Second/Div switch to 1 ms, then position the displays so the bottom of the left display and the top of the right display are near the graticule center.

q. ADJUST—Adjust R285, Beam Registration, so the vertical transitions of both displays at the graticule vertical centerline coincide exactly (adjust horizontal positioning as required). Then adjust R455, Horiz Bal, so the vertical transitions at the left and right edges of the graticule coincide exactly.

r. Set the Input Coupling switches of both displays to GND, set the Seconds/Div switch to 0.5 ms, and disconnect the standard amplitude calibrator.

3. Check/Adjust Storage Operation (D13 Only)

If you are beginning calibration with this step, set the front-panel controls as listed under Initial Control Settings, except as follows:

STORE (both UPPER and LOWER)	In
Erase Select (both UPPER and LOWER)	In

+370-VOLT SUPPLY

a. Connect the DC voltmeter (20 kΩ/volt VOM set to measure at least +400 volts) between ground and the +370-volt test point (TP2).

b. CHECK—Meter reading must be +370 volts, ±7 volts. ADJUST—R387, +370 V Adj, for +370 volts.

OPERATING LEVEL

c. Connect the DC voltmeter between the flood-gun cathodes (pin 3 of P389) and the Store Level test point (TP1). Record the voltmeter reading so that if necessary you can return the operating level to the original setting.

NOTE

If CRT performance has been satisfactory, no adjustment of the Store Level control is necessary. Proceed to the Store Balance adjustment.

For replacement CRT's an information card is provided to show the optimum levels established by the factory for the individual CRT. All voltage levels associated with storage operation are made with respect to the flood-gun cathodes.

d. Locate the Writing Threshold (minimum store level) as follows:

1. Turn the INTENSITY control (either one) clockwise until the trace starts to defocus rapidly. Press the ERASE button to prepare the target area for storage.

2. Write about 3 lines per division across both targets by slewing the free-running trace vertically.

3. Carefully check the written lines for breaks or gaps of 0.025 inch or more. If no breaks or gaps are evident after 10 seconds, adjust R350, Store Level, to reduce the operating level by 5 volts.

4. Erase twice, wait 10 seconds, then write again and check for breaks or gaps.

5. Repeat this procedure of decreasing the operating voltage level in 5-volt steps until breaks of 0.025 inch occur. This is the Writing Threshold. Note the voltage and rotate the Store Level control clockwise until the original level noted in step c is reached.

NOTE

Do not change the INTENSITY or FOCUS control settings.

e. Locate the Upper Writing Limit (maximum store level) as follows:

1. Again write about 3 lines per division. Carefully check the stored lines and background for trace spreading or background fade-up. If no trace spreading or background fade-up is evident after 10 seconds, adjust R350, Store Level, to increase the operating level by 5 volts.

2. Erase twice, wait 10 seconds, then write again and check for spreading or fade-up.

3. Repeat this procedure until trace spreading of about 0.025 inch, or background fade-up occurs. This is the Upper Writing Limit. Note this voltage.

f. Adjust R350 for an operating point midway between the Upper Writing Limit and the Writing Threshold.

g. INTERACTION—Collimation and gain are affected if the change in operating level is significant.

STORE BALANCE

h. Move the position lead of the DC voltmeter from TP1 to the store balance test point (TP4).

i. ADJUST—R370, Store Bal, to set the store level to the same voltage as that recorded at TP1.

COLLIMATION

j. Move the positive lead of the DC voltmeter from TP4 to the CE1 test point (TP3).

k. Write the entire screen by slowly positioning the trace vertically. If the screen fails to write, adjust the INTENSITY control slightly clockwise and repeat the process until the screen is fully written. Then turn the INTENSITY control fully counterclockwise.

l. Record the voltage reading before an adjustment is made so that if necessary you can return the collimation voltage to its original setting.

m. With the screen fully written, turn R390, CE1, fully counterclockwise, noting that the screen edges are brightened and pulled. Turn R390 slowly clockwise to the point where the bright area just covers the graticule area.

n. Erase the screen and disconnect the DC voltmeter.

o. INTERACTION—Storage capabilities and display geometry should be rechecked if a significant change was made in the collimation voltage.

p. Fully write both halves of the screen by positioning the trace.

q. ADJUST—Adjust R395, Non-Store, so background glow quickly (less than 1 second) disappears when the upper or lower screen is placed in the non-store mode (STORE button out).

WRITING SPEED

r. Slowly advance the INTENSITY to the point where the trace begins to defocus rapidly.

s. Connect the sine-wave generator output to the left vertical unit input through a coaxial cable. Set the Input Coupling to DC and adjust the sine-wave generator for exactly 3.2 divisions of display amplitude at a frequency of about 1.5 kilohertz.

t. Set the time-base Sweep Mode to Single Sweep and erase the stored display. Alternately store and erase single sweeps while increasing the sine-wave generator frequency in small increments. Allow about five seconds after each erasure before writing another display. Adjust the frequency to the highest rate that will permit the vertical transition of the sine-wave display to store anywhere on the center 6 X 8 division area of the screens, with no more than a 50% loss in luminance, or with the breaks in the trace not exceeding 0.025 inch. This is the maximum writing speed of the CRT.

Maximum writing speed is calculated as follows:

$$\text{Writing Speed (in divisions/second} = \frac{2\pi F\ V_{p\text{-}p}}{2}$$

Substituting the display amplitude of 3.2 divisions for $V_{p\text{-}p}$, the expression is reduced to

$$\text{Writing Speed} \approx 10 \times F.$$

Thus, for example, if the sine-wave generator frequency is two kilohertz or greater, the maximum writing speed of the CRT is 20 divisions/millisecond (20,000 divisions/second) or greater.

u. CHECK—Writing speed is $\geq$20 divisions/millisecond.

NOTE

It may be necessary to repeat this step with a slightly higher trace intensity or store level.

v. Set the Sweep Mode to normal sweep, STORE switches to non-store, and remove the sine-wave generator.

4. Check/Adjust CRT Deflection System

If you are beginning calibration with this step, set the front-panel controls as listed under Initial Control Settings, except as follows:

INTENSITY (both)	Adjust for normal viewing brightness.
Input Coupling (both) Vertical plug-ins)	DC

HORIZONTAL CENTERING/SWEEP MAGNIFIER REGISTRATION

a. Set the standard amplitude calibrator for a 0.2-volt square wave and connect its output to the input connectors of both vertical plug-in units through a coaxial cable and dual-input cable. Position the rising edge of one of the square waves to the graticule center vertical line and push in the Swp Mag button on the time-base unit.

b. CHECK—The corresponding rising edge on the magnified sweep must be within two divisions of the graticule center.

ADJUST—While switching between magnified and unmagnified displays, alternately adjust R675, Horiz Cent (see Fig. 5-1 in the 5103N Oscilloscope System manual for location), and the horizontal Position control until the rising edge of both the unmagnified and magnified displays is at the graticule center.

VERTICAL AND HORIZONTAL AMPLIFIER GAIN

NOTE

Use two amplifier plug-ins known to be accurately calibrated, or verify their correct calibration by applying a known signal and measuring the differential output at contacts A7 and B7 of the plug-in connector. The deflection factor at the output is 50 millivolts/division.

c. CHECK—Vertical deflection of each display is 4 divisions, $\pm$0.04 division.

ADJUST—R176, Left Vert Gain, and R116, Right Vert Gain, so the vertical deflection of each display is exactly 4 divisions.

d. Temporarily disconnect the calibrator signal and remove the time-base unit from the oscilloscope mainframe. Install a third amplifier unit into the horizontal compartment, then reconnect the 0.2-volt calibrator signal through a dual-input cable to the input connectors of the left vertical and horizontal amplifier units.

e. Set the input coupling of the amplifier unit in the horizontal compartment to DC and its Volts/Div switch to 50 mV. The display should be two dots joined by a diagonal line. The dots represent opposite corners of a square having sides 4 divisions in length. Adjust the Position controls to center the display.

f. CHECK—Overall horizontal width of display is 4 divisions, $\pm$0.04 division.

ADJUST—R136, Horiz Gain, so the horizontal deflection is exactly 4 divisions.

g. Push in both STORE buttons and erase the screens (D13 only; for the D12 proceed to step j).

h. CHECK—Vertical and horizontal deflection does not change when switching between store and non-store modes.

ADJUST—R385, Sensitivity Correction, so the deflection sensitivity is the same for the store mode as it is for the non-store mode.

i. Set both STORE switches to non-store (buttons out).

X-Y PHASING

j. Set the low-frequency sine-wave generator for a 100-kilohertz, minimum amplitude output. Move the coaxial cable from the standard amplitude calibrator output to the sine-wave generator output to apply the sine-wave signal to the amplifier plug-in units.

k. Adjust the vertical and horizontal Position controls to center the diagonal display, then increase the sine-wave generator amplitude until the display is 6 divisions vertically and horizontally.

l. CHECK—The opening of the loop measured on the graticule center line is 0.07 division or less. This indicates a phase difference of 1° or less between the vertical and horizontal deflection systems.

ADJUST—C175, Left Phase, for minimum loop opening (a straight line) in the diagonal display.

m. Move the calibrator signal (dual-input cable) from the left amplifier unit input to the right amplifier unit input.

n. CHECK—Phase difference between right vertical and horizontal deflection systems is 1° or less.

ADJUST—C115, Right Phase, for minimum loop opening in the diagonal display.

o. Remove the low-frequency sine-wave generator. Remove the amplifier unit from the horizontal compartment and re-install the time-base unit.

BANDWIDTH

The requirement of the deflection amplifiers with respect to bandwidth is that the response is sufficient to pass a signal from any 5A-series plug-in unit. To verify system bandwidth, refer to the calibration sections of the individual plug-in unit manuals.

5. Check Z Axis Amplifier

Set the front-panel controls as listed under Initial control Settings, except as follows:

INTENSITY (both)	Adjust for normal brightness.

EXTERNAL INTENSITY INPUTS

a. Turn the INTENSITY controls until the traces cannot be seen, but do not turn the controls fully counterclockwise.

b. Connect the standard amplitude calibrator output to the LEFT VERTICAL and RIGHT VERTICAL EXT INTENSITY INPUT connectors through a coaxial cable and a dual-input cable. Set the calibrator for a +5-volt DC output.

c. CHECK—Traces of normal brightness are displayed.

d. Disconnect the calibrator signal and adjust the INTENSITY controls for traces of normal brightness. Set the standard amplitude calibrator for —5-volt DC output and reconnect the calibrator signal to the EXT INTENSITY INPUTS.

e. CHECK—Traces are not visible.

f. Remove the standard amplitude calibrator.

BEAM FINDER

g. Press the BEAM FINDER button and observe that the traces brighten slightly and compress into the graticule area.

h. CHECK—While holding the BEAM FINDER button in, neither trace can be positioned off screen.

i. Reposition the traces as desired and release the BEAM FINDER.

6. Check Calibrator Loop

Set the front-panel controls as listed under Initial Control Settings, except as follows:

LEFT VERT INTENSITY	Adjust for normal brightness.
Left Vertical Plug-In	
Volts/Div	.1
Input Coupling	DC
Right Vertical Plug-In Display	Off

a. Connect the front-panel CALIBRATOR loop to the left vertical plug-in unit input connector using a test lead. Adjust the time-base unit to trigger on the calibrator signal and set the Seconds/Div switch to display a few cycles of the waveform.

b. CHECK—Display amplitude is 4 divisions, ±0.04 division (400 millivolts). Frequency of the calibrator signal is twice the power-line frequency, which can be determined by measuring the length of time for two cycles of display and taking the reciprocal.

c. Disconnect all test equipment.

This completes the calibration procedure.

SECTION 4

PARTS LISTS AND DIAGRAMS

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)

Symbols used on the diagrams are based on USA Standard Y32.2-1967.

Logic symbology is based on MIL-STD-806B in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The following special symbols are used on the diagrams:

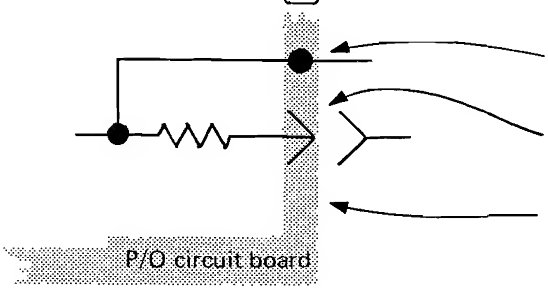
External Screwdriver adjustment.

External control or connector.

Clockwise control rotation in direction of arrow.

Refer to diagram number indicated in diamond.

Refer to waveform number indicated in hexagon.



Connection soldered to circuit board.

Connection made to circuit board with interconnecting pin.

Blue tint encloses components located on circuit board.

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.)
AT	Attenuator, fixed or variable
B	Motor
BT	Battery
C	Capacitor, fixed or variable
CR	Diode, signal or rectifier
DL	Delay line
DS	Indicating device (lamp)
F	Fuse
FL	Filter
H	Heat dissipating device (heat sink, heat radiator, etc.)
HR	Heater
J	Connector, stationary portion
K	Relay
L	Inductor, fixed or variable
LR	Inductor/resistor combination
M	Meter
Q	Transistor or silicon-controlled rectifier
P	Connector, movable portion
R	Resistor, fixed or variable
RT	Thermistor
S	Switch
T	Transformer
TP	Test point
U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
V	Electron tube
VR	Voltage regulator (zener diode, etc.)
Y	Crystal

PARTS LIST ABBREVIATIONS

BHB	binding head brass	int	internal
BHS	binding head steel	lg	length or long
cap.	capacitor	met.	metal
cer	ceramic	mtg hdw	mounting hardware
comp	composition	OD	outside diameter
conn	connector	OHB	oval head brass
CRT	cathode-ray tube	OHS	oval head steel
csk	countersunk	P/O	part of
DE	double end	PHB	pan head brass
dia	diameter	PHS	pan head steel
div	division	plstc	plastic
elect.	electrolytic	PMC	paper, metal cased
EMC	electrolytic, metal cased	poly	polystyrene
EMT	electrolytic, metal tubular	prec	precision
ext	external	PT	paper, tubular
F & I	focus and intensity	PTM	paper or plastic, tubular, molded
FHB	flat head brass	RHB	round head brass
FHS	flat head steel	RHS	round head steel
Fil HB	fillister head brass	SE	single end
Fil HS	fillister head steel	SN or S/N	serial number
h	height or high	S or SW	switch
hex.	hexagonal	TC	temperature compensated
HHB	hex head brass	THB	truss head brass
HHS	hex head steel	thk	thick
HSB	hex socket brass	THS	truss head steel
HSS	hex socket steel	tub.	tubular
ID	inside diameter	var	variable
inc	incandescent	w	wide or width
		WW	wire-wound

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
00213	NYTRONICS, COMPONENTS GROUP, INC., SUBSIDIARY OF NYTRONICS, INC.	ORANGE STREET	DARLINGTON, SC 29532
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
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
07910	TELEDYNE SEMICONDUCTOR	12515 CHADRON AVE.	HAWTHORNE, CA 90250
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
10582	CTS OF ASHEVILLE, INC.	MILLS GAP ROAD	SKYLAND, NC 28776
12697	CLAROSTAT MFG. CO., INC.	LOWER WASHINGTON STREET	DOVER, NH 03820
13511	AMPHENOL CARDRE DIV., BUNKER RAMO CORP.		LOS GATOS, CA 95030
23880	STANFORD APPLIED ENGINEERING, INC.	340 MARTIN AVE.	SANTA CLARA, CA 95050
28480	HEWLETT-PACKARD CO., CORPORATE HQ.	1501 PAGE MILL RD.	PALO ALTO, CA 94304
31514	STANFORD APPLIED ENGINEERING, INC. ADVANCED PACKAGING DIV.	3080 AIRWAY DRIVE	COSTA MESA, CA 92626
52769	SPRAGUE GOODMAN ELEC., INC.	134 FULTON AVENUE	GARDEN CITY PARK, NY 11040
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
71450	CTS CORP.	905 N. WEST BLVD	ELKHART, IN 46514
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
76055	MALLORY CONTROLS, CO., DIV. OF MALLORY P. R., AND CO., INC.	STATE RD. 28 W., P O BOX 327	FRANKFORT, IN 46041
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
81073	GRAYHILL, INC.	561 HILLGROVE AVE., PO BOX 373	LA GRANGE, IL 60525
81439	THERM-O-DISC, INC.	1320 S MAIN, P O BOX 1538	MANSFIELD, OH 44907
81483	INTERNATIONAL RECTIFIER CORP.	9220 SUNSET BLVD.	LOS ANGELES, CA 90069
90201	MALLORY CAPACITOR CO., DIV. OF P. R. MALLORY AND CO., INC.	3029 E. WASHINGTON STREET P. O. BOX 372	INDIANAPOLIS, IN 46206
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601
91929	HONEYWELL, INC., MICRO SWITCH DIV.	CHICAGO & SPRING STS.	FREEPORT, IL 61032
95238	CONTINENTAL CONNECTOR CORP.	34-63 56TH ST.	WOODSIDE, NY 11377

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	670-1508-00	B010100	B049999	CKT BOARD ASSY:DEFLECTION AMPL	80009	670-1508-00
	----- -----			* D12 ONLY		
A1	670-1508-01	B050000	B081767	CKT BOARD ASSY:DEFLECTION AMPL	80009	670-1508-01
	----- -----			* D12 ONLY		
A1	670-1508-03	B081768		CKT BOARD ASSY:DEFLECTION AMPL	80009	670-1508-03
	----- -----			* D12 ONLY		
A1	670-1508-00	B010100	B049999	CKT BOARD ASSY:DEFLECTION AMPL	80009	670-1508-00
	----- -----			* D13 ONLY		
A1	670-1508-01	B050000	B103057	CKT BOARD ASSY:DEFLECTION AMPL	80009	670-1508-01
	----- -----			* D13 ONLY		
A1	670-1508-03	B103058		CKT BOARD ASSY:DEFLECTION AMPL	80009	670-1508-03
	----- -----			* D13 ONLY		
C106	283-0598-00	B010100	B081767	CAP.,FXD,MICA D:253PF,5%,300V	00853	D153E2530J0
	----- -----			* D12 ONLY		
C106	283-0698-00	B081768		CAP.,FXD,MICA D:390PF,1%,500V	09023	CD15ED391F03
	----- -----			* D12 ONLY		
C106	283-0598-00	B010100	B103057	CAP.,FXD,MICA D:253PF,5%,300V	00853	D153E2530J0
	----- -----			* D13 ONLY		
C106	283-0698-00	B103058		CAP.,FXD,MICA D:390PF,1%,500V	09023	CD15ED391F03
	----- -----			* D13 ONLY		
C115	281-0027-00	B010100	B049999X	CAP.,VAR,PLSTC:0.7-3PF,350V	72982	535-017
C116	283-0598-00	B010100	B049999	CAP.,FXD,MICA D:253PF,5%,300V	00853	D153E2530J0
C116	281-0118-00	B050000		CAP.,VAR,MICA D:8-90PF,750V	52769	GMC20400
C126	283-0604-00	B010100	B081767	CAP.,FXD,MICA D:304PF,2%,300V	00853	D153F3040G0
	----- -----			* D12 ONLY		
C126	283-0628-00	B081768		CAP.,FXD,MICA D:410PF,1%,500V	00853	D155F411F0
	----- -----			* D12 ONLY		
C126	283-0604-00	B010100	B103057	CAP.,FXD,MICA D:304PF,2%,300V	00853	D153F3040G0
	----- -----			* D13 ONLY		
C126	283-0628-00	B103058		CAP.,FXD,MICA D:410PF,1%,500V	00853	D155F411F0
	----- -----			* D13 ONLY		
C136	283-0598-00	B010100	B049999	CAP.,FXD,MICA D:253PF,5%,300V	00853	D153E2530J0
C136	283-0672-00	B050000		CAP.,FXD,MICA D:200PF,1%,500V	00853	D155F201F0
C166	283-0598-00	B010100	B081767	CAP.,FXD,MICA D:253PF,5%,300V	00853	D153E2530J0
	----- -----			* D12 ONLY		
C166	283-0698-00	B081768		CAP.,FXD,MICA D:390PF,1%,500V	09023	CD15ED391F03
	----- -----			* D12 ONLY		
C166	283-0598-00	B010100	B103057	CAP.,FXD,MICA D:253PF,5%,300V	00853	D153E2530J0
	----- -----			* D13 ONLY		
C166	283-0698-00	B103058		CAP.,FXD,MICA D:390PF,1%,500V	09023	CD15ED391F03
	----- -----			* D13 ONLY		
C175	281-0027-00	B010100	B049999X	CAP.,VAR,PLSTC:0.7-3PF,350V	72982	535-017
C176	283-0598-00	B010100	B049999	CAP.,FXD,MICA D:253PF,5%,300V	00853	D153E2530J0
C176	281-0118-00	B050000		CAP.,VAR,MICA D:8-90PF,750V	52769	GMC20400
CR141	152-0008-00			SEMICOND DEVICE:GERMANIUM,75V,60MA	80009	152-0008-00
CR142	152-0008-00			SEMICOND DEVICE:GERMANIUM,75V,60MA	80009	152-0008-00
CR146	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR147	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR149	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
Q104	151-0279-00	B010100	B079999	TRANSISTOR:SILICON,NPN	80009	151-0279-00
	----- -----			* D12 ONLY		
Q104	151-0150-00	B080000		TRANSISTOR:SILICON,NPN	80009	151-0150-00
	----- -----			* D12 ONLY		
Q104	151-0279-00	B010100	B099999	TRANSISTOR:SILICON,NPN	80009	151-0279-00
	----- -----			* D13 ONLY		

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q104	151-0150-00	B100000		TRANSISTOR:SILICON,NPN	80009	151-0150-00
	----- -----			* D13 ONLY		
Q106	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q114	151-0279-00	B010100	B079999	TRANSISTOR:SILICON,NPN	80009	151-0279-00
	----- -----			* D12 ONLY		
Q114	151-0150-00	B080000		TRANSISTOR:SILICON,NPN	80009	151-0150-00
	----- -----			* D12 ONLY		
Q114	151-0279-00	B010100	B099999	TRANSISTOR:SILICON,NPN	80009	151-0279-00
	----- -----			* D13 ONLY		
Q114	151-0150-00	B100000		TRANSISTOR:SILICON,NPN	80009	151-0150-00
	----- -----			* D13 ONLY		
Q116	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q124	151-0279-00	B010100	B079999	TRANSISTOR:SILICON,NPN	80009	151-0279-00
	----- -----			* D12 ONLY		
Q124	151-0150-00	B080000		TRANSISTOR:SILICON,NPN	80009	151-0150-00
	----- -----			* D12 ONLY		
Q124	151-0279-00	B010100	B099999	TRANSISTOR:SILICON,NPN	80009	151-0279-00
	----- -----			* D13 ONLY		
Q124	151-0150-00	B100000		TRANSISTOR:SILICON,NPN	80009	151-0150-00
	----- -----			* D13 ONLY		
Q126	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q134	151-0279-00	B010100	B079999	TRANSISTOR:SILICON,NPN	80009	151-0279-00
	----- -----			* D12 ONLY		
Q134	151-0150-00	B080000		TRANSISTOR:SILICON,NPN	80009	151-0150-00
	----- -----			* D12 ONLY		
Q134	151-0279-00	B010100	B099999	TRANSISTOR:SILICON,NPN	80009	151-0279-00
	----- -----			* D13 ONLY		
Q134	151-0150-00	B100000		TRANSISTOR:SILICON,NPN	80009	151-0150-00
	----- -----			* D13 ONLY		
Q136	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q148	151-0150-00			TRANSISTOR:SILICON,NPN	80009	151-0150-00
Q154	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q164	151-0279-00	B010100	B079999	TRANSISTOR:SILICON,NPN	80009	151-0279-00
	----- -----			* D12 ONLY		
Q164	151-0150-00	B080000		TRANSISTOR:SILICON,NPN	80009	151-0150-00
	----- -----			* D12 ONLY		
Q164	151-0279-00	B010100	B099999	TRANSISTOR:SILICON,NPN	80009	151-0279-00
	----- -----			* D13 ONLY		
Q164	151-0150-00	B010100		TRANSISTOR:SILICON,NPN	80009	151-0150-00
	----- -----			* D13 ONLY		
Q166	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q174	151-0279-00	B010100	B079999	TRANSISTOR:SILICON,NPN	80009	151-0279-00
	----- -----			* D12 ONLY		
Q174	151-0150-00	B080000		TRANSISTOR:SILICON,NPN	80009	151-0150-00
	----- -----			* D12 ONLY		
Q174	151-0279-00	B010100	B099999	TRANSISTOR:SILICON,NPN	80009	151-0279-00
	----- -----			* D13 ONLY		
Q174	151-0150-00	B010100		TRANSISTOR:SILICON,NPN	80009	151-0150-00
	----- -----			* D13 ONLY		
Q176	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
R101	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R102	316-0470-00			RES.,FXD,CMPSN:47 OHM,10%,0.25W	01121	CB4701
R103	316-0390-00			RES.,FXD,CMPSN:39 OHM,10%,0.25W	01121	CB3901
R104	308-0668-00			RES.,FXD,WW:6.2K OHM,3%,7W	00213	1600S62000H
R106	321-0128-00			RES.,FXD,FILM:210 OHM,1%,0.125W	91637	MFF1816G210R0F

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R108	308-0539-00			RES.,FXD,WW:2.25K OHM,0.5%,3W	91637	RS2BK22500D
R112	316-0470-00			RES.,FXD,CMPSN:47 OHM,10%,0.25W	01121	CB4701
R113	316-0390-00			RES.,FXD,CMPSN:39 OHM,10%,0.25W	01121	CB3901
R114	308-0668-00			RES.,FXD,WW:6.2K OHM,3%,7W	00213	1600S62000H
R116	311-1132-00			RES.,VAR,NONWIR:TRMR,100 OHM,0.50W	73138	91D-R100
R117	316-0470-00	B010100	B049999X	RES.,FXD,CMPSN:47 OHM,10%,0.25W	01121	CB4701
R118	308-0539-00			RES.,FXD,WW:2.25K OHM,0.5%,3W	91637	RS2BK22500D
R122	316-0470-00			RES.,FXD,CMPSN:47 OHM,10%,0.25W	01121	CB4701
R123	316-0390-00			RES.,FXD,CMPSN:39 OHM,10%,0.25W	01121	CB3901
R124	308-0668-00			RES.,FXD,WW:6.2K OHM,3%,7W	00213	1600S62000H
R126	321-0128-00			RES.,FXD,FILM:210 OHM,1%,0.125W	91637	MFF1816G210R0F
R128	308-0539-00			RES.,FXD,WW:2.25K OHM,0.5%,3W	91637	RS2BK22500D
R132	316-0470-00			RES.,FXD,CMPSN:47 OHM,10%,0.25W	01121	CB4701
R133	316-0390-00			RES.,FXD,CMPSN:39 OHM,10%,0.25W	01121	CB3901
R134	308-0668-00			RES.,FXD,WW:6.2K OHM,3%,7W	00213	1600S62000H
R136	311-1132-00			RES.,VAR,NONWIR:TRMR,100 OHM,0.50W	73138	91D-R100
R137	316-0470-00	B010100	B049999X	RES.,FXD,CMPSN:47 OHM,10%,0.25W	01121	CB4701
R138	308-0539-00			RES.,FXD,WW:2.25K OHM,0.5%,3W	91637	RS2BK22500D
R141	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R142	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R144	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R145	311-1153-00			RES.,VAR,NONWIR:TRMR,5K OHM,0.50W	73138	91-69-0
R147	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R148	301-0243-00	B010100	B059999	RES.,FXD,CMPSN:24K OHM,5%,0.50W	01121	EB2435
R148	304-0473-00	B060000		RES.,FXD,CMPSN:47K OHM,10%,1W	01121	GB4731
R151	315-0754-00			RES.,FXD,CMPSN:750K OHM,5%,0.25W	01121	CB7545
R152	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R153	315-0563-00			RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
R154	301-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.50W	01121	EB3925
R157	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R162	316-0470-00			RES.,FXD,CMPSN:47 OHM,10%,0.25W	01121	CB4701
R163	316-0390-00			RES.,FXD,CMPSN:39 OHM,10%,0.25W	01121	CB3901
R164	308-0668-00			RES.,FXD,WW:6.2K OHM,3%,7W	00213	1600S62000H
R166	321-0128-00			RES.,FXD,FILM:210 OHM,1%,0.125W	91637	MFF1816G210R0F
R168	308-0539-00			RES.,FXD,WW:2.25K OHM,0.5%,3W	91637	RS2BK22500D
R172	316-0470-00			RES.,FXD,CMPSN:47 OHM,10%,0.25W	01121	CB4701
R173	316-0390-00			RES.,FXD,CMPSN:39 OHM,10%,0.25W	01121	CB3901
R174	308-0668-00			RES.,FXD,WW:6.2K OHM,3%,7W	00213	1600S62000H
R176	311-1132-00			RES.,VAR,NONWIR:TRMR,100 OHM,0.50W	73138	91D-R100
R177	316-0470-00	B010100	B049999X	RES.,FXD,CMPSN:47 OHM,10%,0.25W	01121	CB4701
R178	308-0539-00			RES.,FXD,WW:2.25K OHM,0.5%,3W	91637	RS2BK22500D
R179	301-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.50W	01121	EB5615
A2	670-1453-00			CKT BOARD ASSY:DUAL BEAM AUXILIARY	80009	670-1453-00
C715	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
CR702	152-0185-00			SEMICOND DEVICE:SILICON,40PIV,150MA	07910	1N4152
CR712	152-0185-00			SEMICOND DEVICE:SILICON,40PIV,150MA	07910	1N4152
Q701	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q702	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q711	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q712	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R701	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R702	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R703	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R705	316-0103-00			RES.,FXD,CMPSN:10K OHM,10%,0.25W	01121	CB1031
R708	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R709	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R710	321-0159-00			RES.,FXD,FILM:442 OHM,1%,0.125W	91637	MFF1816G442R0F
R711	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R712	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R713	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R715	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
A3	670-1503-00			CKT BOARD ASSY:HIGH VOLTAGE	80009	670-1503-00
C241	283-0261-00			CAP.,FXD,CER DI:0.01UF,20%,4000V	56289	575C1A1
C243	283-0021-00			CAP.,FXD,CER DI:0.001UF,20%,5000V	72982	848-556-Y5S-102M
C247	283-0261-00			CAP.,FXD,CER DI:0.01UF,20%,4000V	56289	575C1A1
C248	283-0261-00			CAP.,FXD,CER DI:0.01UF,20%,4000V	56289	575C1A1
C251	290-0194-00			CAP.,FXD,ELCTLT:10UF,+50-10%,100V	56289	30D106F100DC4
C252	283-0617-00			CAP.,FXD,MICA D:4700PF,10%,300V	00853	D193F472K0
C253	283-0068-00			CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C254	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N031Z5U0105Z
C258	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N031Z5U0105Z
C259	283-0208-00			CAP.,FXD,CER DI;0.22UF,10%,200V	72982	8151N230 C 224K
C264	283-0004-00	XB040000		CAP.,FXD,CER DI:0.02UF,(NOM VALUE),SEL	72982	855-558-Z5V0203Z
C269	283-0198-00	B010100	B069999	CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8121N083Z5U0224M
	----- -----			* D12 ONLY		
C269	283-0208-00	B070000		CAP.,FXD,CER DI:0.22UF,10%,200V	72982	8151N230 C 224K
	----- -----			* D12 ONLY		
C269	283-0198-00	B010100	B079999	CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8121N083Z5U0224M
	----- -----			* D13 ONLY		
C269	283-0208-00	B080000		CAP.,FXD,CER DI:0.22UF,10%,200V	72982	8151N230 C 224K
	----- -----			* D13 ONLY		
C272	283-0021-00			CAP.,FXD,CER DI:0.001UF,20%,5000V	72982	848-556-Y5S-102M
C276	283-0119-00	B010100	B039999X	CAP.,FXD,CER DI:2200PF,5%,200V	72982	855-535B222J
C279	283-0078-00	B010100	B039999X	CAP.,FXD,CER DI:0.001UF,20%,500V	56289	20C114A8
C441	283-0261-00			CAP.,FXD,CER DI:0.01UF,20%,4000V	56289	575C1A1
C443	283-0021-00			CAP.,FXD,CER DI:0.001UF,20%,5000V	72982	848-556-Y5S-102M
C452	283-0211-00			CAP.,FXD,CER DI:0.1UF,10%,200V	72982	8141N210X7R0104K
C458	283-0211-00			CAP.,FXD,CER DI:0.1UF,10%,200V	72982	8141N210X7R0104K
CR204	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR208	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR221	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR224	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR234	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR238	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR241	152-0242-00			SEMICOND DEVICE:SILICON,225V,200MA	80009	152-0242-00
CR242	152-0242-00			SEMICOND DEVICE:SILICON,225V,200MA	80009	152-0242-00
CR243	152-0242-00			SEMICOND DEVICE:SILICON,225V,200MA	80009	152-0242-00
CR244	152-0242-00			SEMICOND DEVICE:SILICON,225V,200MA	80009	152-0242-00
CR247	152-0409-00			SEMICOND DEVICE:SILICON,12,000V,5MA	80009	152-0409-00
CR253	152-0414-00			SEMICOND DEVICE:SILICON,200V,0.75A	80009	152-0414-00

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CR255	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR256	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR262	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR264	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR404	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR408	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR421	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR424	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR434	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR438	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR441	152-0242-00			SEMICOND DEVICE:SILICON,225V,200MA	80009	152-0242-00
CR442	152-0242-00			SEMICOND DEVICE:SILICON,225V,200MA	80009	152-0242-00
CR443	152-0242-00			SEMICOND DEVICE:SILICON,225V,200MA	80009	152-0242-00
CR444	152-0242-00			SEMICOND DEVICE:SILICON,225V,200MA	80009	152-0242-00
DS240	150-0030-00	XB080000		LAMP,GLOW:NEON,T-2,60 TO 90 VOLTS	08806	A2B-T
	----- -----			* D12 ONLY		
DS240	150-0030-00	XB100000		LAMP,GLOW:NEON,T-2,60 TO 90 VOLTS	08806	A2B-T
	----- -----			* D13 ONLY		
DS242	150-0030-00	XB080000		LAMP,GLOW:NEON,T-2,60 TO 90 VOLTS	08806	A2B-T
	----- -----			* D12 ONLY		
DS242	150-0030-00	XB100000		LAMP,GLOW:NEON,T-2,60 TO 90 VOLTS	08806	A2B-T
	----- -----			* D13 ONLY		
DS440	150-0030-00	XB080000		LAMP,GLOW:NEON,T-2,60 TO 90 VOLTS	08806	A2B-T
	----- -----			* D12 ONLY		
DS440	150-0030-00	XB100000		LAMP,GLOW:NEON,T-2,60 TO 90 VOLTS	08806	A2B-T
	----- -----			* D13 ONLY		
DS442	150-0030-00	XB080000		LAMP,GLOW:NEON,T-2,60 TO 90 VOLTS	08806	A2B-T
	----- -----			* D12 ONLY		
DS442	150-0030-00	XB100000		LAMP,GLOW:NEON,T-2,60 TO 90 VOLTS	08806	A2B-T
	----- -----			* D13 ONLY		
F201	159-0003-00			FUSE,CARTRIDGE:3AG,1.6A,250V,SLOW-BLOW	71400	MDX16-10
	----- -----			* DOMESTIC (120V NOMINAL LINE)		
F201	159-0019-00			FUSE,CARTRIDGE:3AG,1A,250V,SLOW BLOW	71400	MDL1
	----- -----			* EXPORT (240V NOMINAL LINE)		
J203	131-0955-00			CONNECTOR,RCPT,:BNC,FEMALE,W/HARDWARE	13511	31-279
J403	131-0955-00			CONNECTOR,RCPT,:BNC,FEMALE,W/HARDWARE	13511	31-279
L259	108-0564-00			COIL,RF:FIXED,74UH	80009	108-0564-00
L291	108-0644-00			COIL,TUBE DEFLE:TRACE ROTATOR	80009	108-0644-00
Q206	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q214	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q218	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q224	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q232	151-0228-00	B010100	B081728	TRANSISTOR:SILICON,PNP,SEL FROM 2N4888	80009	151-0228-00
	----- -----			* D12 ONLY		
Q232	151-0350-00	B081729		TRANSISTOR:SILICON,PNP	80009	151-0350-00
	----- -----			* D12 ONLY		
Q232	151-0228-00	B010100	B103031	TRANSISTOR:SILICON,PNP,SEL FROM 2N4888	80009	151-0228-00
	----- -----			* D13 ONLY		
Q232	151-0350-00	B103032		TRANSISTOR:SILICON,PNP	80009	151-0350-00
	----- -----			* D13 ONLY		
Q234	151-0150-00			TRANSISTOR:SILICON,NPN	80009	151-0150-00
Q252	151-0256-00			TRANSISTOR:SILICON,NPN	80009	151-0256-00
Q262	151-0207-00			TRANSISTOR:SILICON,NPN	80009	151-0207-00
Q264	151-0342-00			TRANSISTOR:SILICON,PNP	80009	151-0342-00

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Q268	151-1005-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	80009	151-1005-00
Q406	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q432	151-0228-00	B010100	B081728	TRANSISTOR:SILICON,PNP,SEL FROM 2N4888	80009	151-0228-00
	----- -----			* D12 ONLY		
Q432	151-0350-00	B081729		TRANSISTOR:SILICON,PNP	80009	151-0350-00
	----- -----			* D12 ONLY		
Q432	151-0228-00	B010100	B103031	TRANSISTOR:SILICON,PNP,SEL FROM 2N4888	80009	151-0228-00
	----- -----			* D13 ONLY		
Q432	151-0350-00	B103032		TRANSISTOR:SILICON,PNP	80009	151-0350-00
	----- -----			* D13 ONLY		
Q434	151-0150-00			TRANSISTOR:SILICON,NPN	80009	151-0150-00
Q454	151-0280-00			TRANSISTOR:SILICON,PNP	80009	151-0280-00
R200A/R200B	311-1176-00	B010100	B069999	RES.,VAR,NONWIR:100K X 5 MEG OHM,1W	12697	381-CM39672
R200A/R200B	311-1452-00	B070000		RES.,VAR,NONWIR:100K X 6 MEG OHM,0.5W	12697	381-CM39970
R202	315-0563-00			RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
R203	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R204	315-0623-00			RES.,FXD,CMPSN:62K OHM,5%,0.25W	01121	CB6235
R206	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R207	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R208	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R209	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R211	316-0104-00			RES.,FXD,CMPSN:100K OHM,10%,0.25W	01121	CB1041
R212	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R214	316-0104-00			RES.,FXD,CMPSN:100K OHM,10%,0.25W	01121	CB1041
R216	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	91637	MFF1816G90900F
R217	316-0104-00			RES.,FXD,CMPSN:100K OHM,10%,0.25W	01121	CB1041
R218	316-0104-00			RES.,FXD,CMPSN:100K OHM,10%,0.25W	01121	CB1041
R219	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R221	316-0823-00			RES.,FXD,CMPSN:82K OHM,10%,0.25W	01121	CB8231
R222	315-0563-00			RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
R223	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R224	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R231	315-0564-00			RES.,FXD,CMPSN:560K OHM,5%,0.25W	01121	CB5645
R232	316-0102-00			RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R233	316-0682-00			RES.,FXD,CMPSN:6.8K OHM,10%,0.25W	01121	CB6821
R234	305-0473-00			RES.,FXD,CMPSN:47K OHM,5%,2W	01121	HB4735
R236	321-0399-00			RES.,FXD,FILM:140K OHM,1%,0.125W	91637	MFF1816G14002F
R238	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R240	302-0273-00			RES.,FXD,CMPSN:27K OHM,10%,0.50W	01121	EB2731
R241	316-0185-00	B010100	B029999	RES.,FXD,CMPSN:1.8M OHM,10%,0.25W	01121	CB1851
R241	316-0105-00	B030000		RES.,FXD,CMPSN:1M OHM,10%,0.25W	01121	CB1051
R242	311-1136-00			RES.,VAR,NONWIR:100K OHM,30%,0.25W	71450	201-YA5536
R243	315-0471-00	XB080000		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
	----- -----			* D12 ONLY		
R243	315-0471-00	XB100000		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
	----- -----			* D13 ONLY		
R244	316-0106-00			RES.,FXD,CMPSN:10M OHM,10%,0.25W	01121	CB1061
R245	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R248	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R251	307-0058-00			RES.,FXD,CMPSN:5.6 OHM,5%,0.5W	01121	EB56G5
R252	308-0075-00			RES.,FXD,WW:100 OHM,5%,3W	91637	CW2B-100R0J
R254	308-0365-00			RES.,FXD,WW:1.5 OHM,5%,3W	56289	242EX1R500JQ151
R256	316-0102-00			RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R262	301-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.50W	01121	EB4725

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R263	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R264	315-0753-00	XB040000	B069999	RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
	----- -----			* D12 ONLY		
R264	315-0753-00	B070000		RES.,FXD,CMPSN:75K OHM,(NOM VALUE),SEL	01121	CB7535
	----- -----			* D12 ONLY		
R264	315-0753-00	XB040000	B079999	RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
	----- -----			* D13 ONLY		
R264	315-0753-00	B080000		RES.,FXD,CMPSN:75K OHM,(NOM VALUE),SEL	01121	CB7535
	----- -----			* D13 ONLY		
R266	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R267	315-0334-00			RES.,FXD,CMPSN:330K OHM,5%,0.25W	01121	CB3345
R268	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R269	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R270	302-0564-00	XB060000	B069999X	RES.,FXD,CMPSN:560K OHM,10%,0.50W	01121	EB5641
	----- -----			* D12 ONLY		
R270	302-0564-00	XB050000	B069999X	RES.,FXD,CMPSN:560K OHM,10%,0.50W	01121	EB5641
	----- -----			* D13 ONLY		
R271	315-0182-00	XB080000		RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
	----- -----			* D12 ONLY		
R271	315-0182-00	XB100000		RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
	----- -----			* D13 ONLY		
R272A R272B R272C R272D	307-0304-00			RES.,FXD,FILM:	80009	307-0304-00
R273	316-0105-00			RES.,FXD,CMPSN:1M OHM,10%,0.25W	01121	CB1051
R274	316-0395-00			RES.,FXD,CMPSN:3.9M OHM,10%,0.25W	01121	CB3951
R275	311-1136-00			RES.,VAR,NONWIR:100K OHM,30%,0.25W	71450	201-YA5536
R276	316-0105-00			RES.,FXD,CMPSN:1M OHM,10%,0.25W	01121	CB1051
R279	316-0104-00	B010100	B039999X	RES.,FXD,CMPSN:100K OHM,10%,0.25W	01121	CB1041
R282	301-0133-00			RES.,FXD,CMPSN:13K OHM,5%,0.50W	01121	EB1335
R285	311-1206-00			RES.,VAR,NONWIR:250K OHM,30%,0.25W	71450	201-YA5546
R286	311-1296-00			RES.,VAR,NONWW:500K OHM,0.25W	71450	201-YA5548
R289	311-1135-00			RES.,VAR,NONWIR:TRMR,1M OHM,0.25W	71450	YA5535
R291	311-1189-00			RES.,VAR,WW:PNL,5K OHM,2W	10582	AW3349
R400A R400B	311-1176-00	B010100	B0699999	RES.,VAR,NONWIR:100K X 5 MEG OHM,1W	12697	381-CM39692
R400A R400B	311-1452-00	B070000		RES.,VAR,NONWIR:100K X 6 MEG OHM,0.5W	12697	381-CM39970
R402	315-0563-00			RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
R403	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R404	315-0623-00			RES.,FXD,CMPSN:62K OHM,5%,0.25W	01121	CB6235
R406	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R407	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R408	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R409	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R416	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	91637	MFF1816G90900F
R419	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R421	316-0823-00			RES.,FXD,CMPSN:82K OHM,10%,0.25W	01121	CB8231
R422	315-0563-00			RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
R424	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R431	315-0564-00			RES.,FXD,CMPSN:560K OHM,5%,0.25W	01121	CB5645
R432	316-0102-00			RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R433	316-0682-00			RES.,FXD,CMPSN:6.8K OHM,10%,0.25W	01121	CB6821
R434	305-0473-00			RES.,FXD,CMPSN:47K OHM,5%,2W	01121	HB4735
R436	321-0399-00			RES.,FXD,FILM:140K OHM,1%,0.125W	91637	MFF1816G14002F
R438	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R441	316-0185-00	B010100	B029999	RES.,FXD,CMPSN:1.8M OHM,10%,0.25W	01121	CB1851
R441	316-0105-00	B030000		RES.,FXD,CMPSN:1M OHM,10%,0.25W	01121	CB1051
R442	311-1136-00			RES.,VAR,NONWIR:100K OHM,30%,0.25W	71450	201-YA5536

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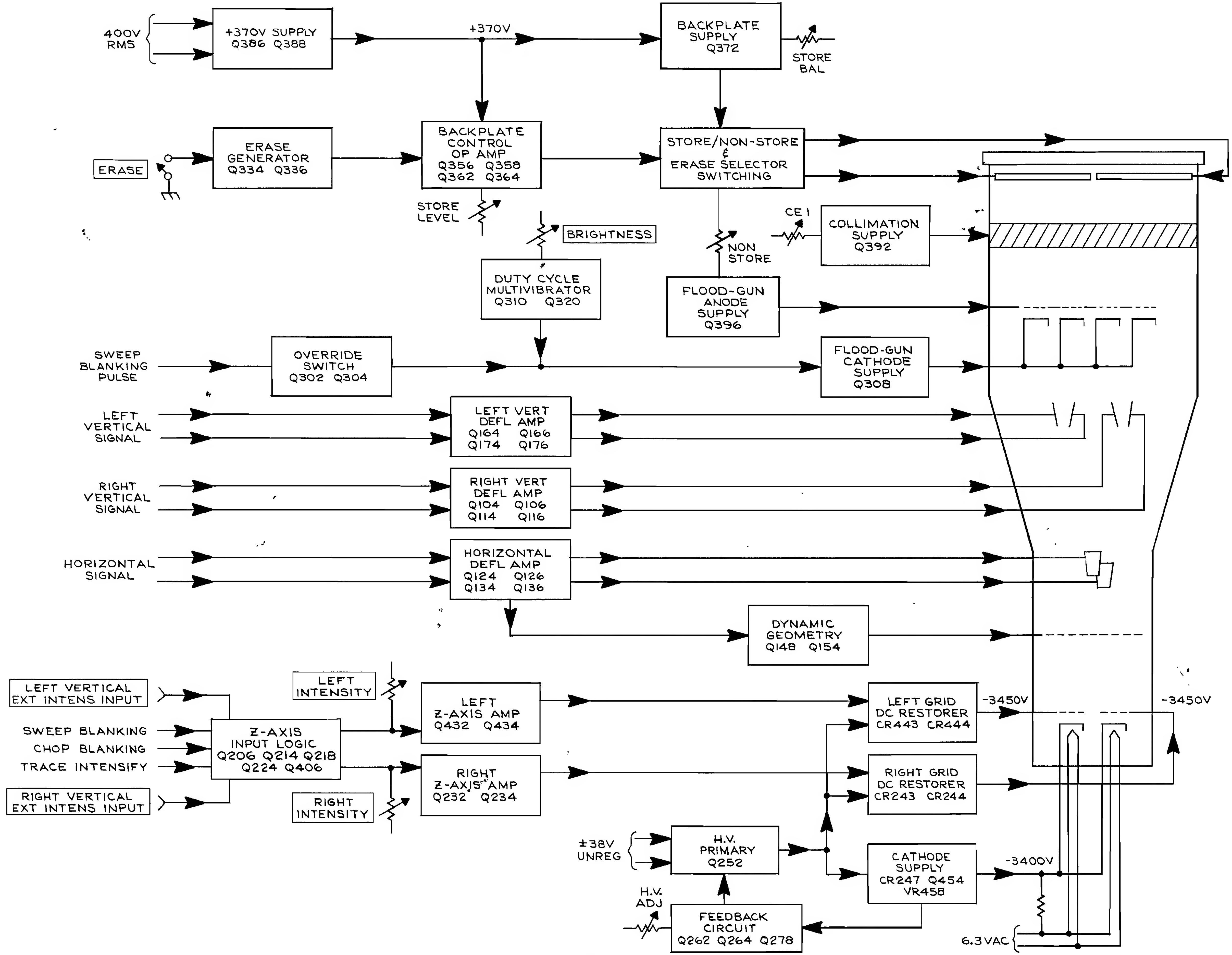
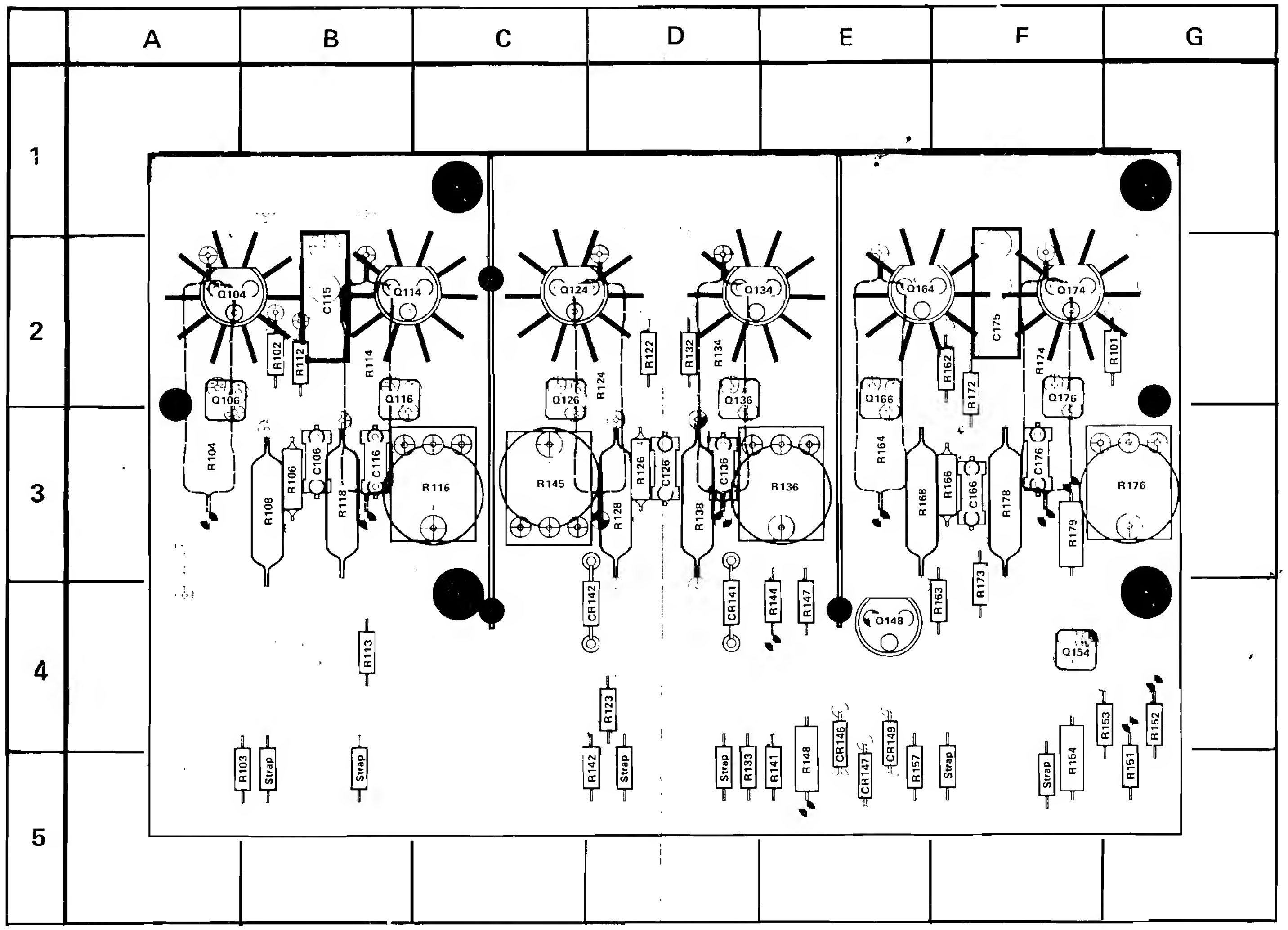
R443	315-0471-00	XB080000		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
	----- -----			* D12 ONLY		
R443	315-0471-00	XB100000		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
	----- -----			* D13 ONLY		
R444	316-0106-00			RES.,FXD,CMPSN:10M OHM,10%,0.25W	01121	CB1061
R445	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R454	316-0472-00			RES.,FXD,CMPSN:4.7K OHM,10%,0.25W	01121	CB4721
R455	311-1205-00			RES.,VAR,NONWIR:TRMR,2M OHM,0.25W	71450	YA5545
R459	316-0104-00			RES.,FXD,CMPSN:100K OHM,10%,0.25W	01121	CB1041
R486	311-1296-00			RES.,VAR,NONWW:2 MEG OHM,0.25W	71450	201-YA5548
R498	303-0471-00			RES.,FXD,CMPSN:470 OHM,5%,1W	01121	GB4715
R499	303-0561-00			RES.,FXD,CMPSN:560 OHM,5%,1W	01121	GB5615
S200	260-0227-00			SWITCH,THRMSTC:NC,OPEN 73.9,CL 51.7,10A	81439	SE11S6316
S201	260-1222-00			SWITCH,PUSH-PUL:10A,250VAC	91929	2DM301
S223	260-1238-00			SWITCH,PUSH:0.5A AT 115VAC	81073	39YY2084
T240	120-0706-00			XFMR,PWR,STU:	80009	120-0706-00
V291	154-0635-00	B010100	B069999	ELECTRON TUBE:CRT	80009	154-0635-00
	----- -----			* D12 ONLY		
V291	154-0635-05	B070000		ELECTRON TUBE:CRT	80009	154-0635-05
	----- -----			* D12 ONLY		
V291	154-0636-00	B010100	B079999	ELECTRON TUBE:CRT	80009	154-0636-00
	----- -----			* D13 ONLY		
V291	154-0636-10	B080000		ELECTRON TUBE:CRT	80009	154-0636-10
	----- -----			* D13 ONLY		
VR240	152-0283-00			SEMICOND DEVICE:ZENER,0.4W,43V,5%	04713	1N976B
VR242	152-0283-00			SEMICOND DEVICE:ZENER,0.4W,43V,5%	04713	1N976B
VR258	152-0438-00			SEMICOND DEVICE:ZENER,3W,9.1V,5%	80009	152-0438-00
VR281	152-0513-00			SEMICOND DEVICE:ZENER,1W,91V,5%	80009	152-0513-00
VR282	152-0513-00			SEMICOND DEVICE:ZENER,1W,91V,5%	80009	152-0513-00
VR456	152-0427-00			SEMICOND DEVICE:ZENER,0.4W,100V,5%	04713	1N985B
VR458	152-0427-00			SEMICOND DEVICE:ZENER,0.4W,100V,5%	04713	1N985B
A4	670-1434-00			CKT BOARD ASSY:STORAGE	80009	670-1434-00
	----- -----			(A4, D13 ONLY)		
C303	283-0067-00			CAP.,FXD,CER DI:0.001UF,10%,200V	72982	835-515B102K
C307	283-0067-00			CAP.,FXD,CER DI:0.001UF,10%,200V	72982	835-515B102K
C311	281-0500-00			CAP.,FXD,CER DI:2.2PF,+/-0.5PF,500V	72982	301-000C0J0229D
C321	281-0500-00			CAP.,FXD,CER DI:2.2PF,+/-0.5PF,500V	72982	301-000C0J0229D
C325	283-0026-00			CAP.,FXD,CER DI:0.2UF,+80-20%,25V	56289	274C3
C330	290-0267-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	162D105X0035CD2
C331	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C337	290-0188-00			CAP.,FXD,ELCTLT:0.1UF,10%,35V	56289	162D104X9035BC2
C342	290-0135-00			CAP.,FXD,ELCTLT:15UF,20%,20V	56289	150D156X0020B2
C385	290-0134-00			CAP.,FXD,ELCTLT:22UF,20%,15V	56289	150D226X0015B2
C386	285-0562-00			CAP.,FXD,PLSTC:0.47UF,20%,400V	56289	410P47404
C387	283-0067-00			CAP.,FXD,CER DI:0.001UF,10%,200V	72982	835-515B102K
C389	283-0013-00			CAP.,FXD,CER DI:0.01UF,+100-0%,1000V	56289	33C29A7
C391	283-0008-00			CAP.,FXD,CER DI:0.1UF,20%,500V	56289	275C8
C394	283-0057-00			CAP.,FXD,CER DI:0.1UF,+80-20%,200V	56289	274C10
C398	290-0267-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	162D105X0035CD2

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C399	290-0247-00			CAP.,FXD,ELCTLT:5.6UF,10%,6V	56289	162D565X9006CD2
CR329	152-0488-00			SEMICOND DEVICE:SILICON,200V,1500MA	80009	152-0488-00
CR332	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR343	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR351	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR358	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR386	152-0331-00			SEMICOND DEVICE:SILICON,800V,25MA	80009	152-0331-00
CR392	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
Q302	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q304	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q308	151-0279-00			TRANSISTOR:SILICON,NPN	80009	151-0279-00
Q310	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q320	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q334	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q336	151-0207-00			TRANSISTOR:SILICON,NPN	80009	151-0207-00
Q356	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q358	151-0169-00			TRANSISTOR:SILICON,NPN	80009	151-0169-00
Q362	151-0279-00			TRANSISTOR:SILICON,NPN	80009	151-0279-00
Q364	151-0279-00			TRANSISTOR:SILICON,NPN	80009	151-0279-00
Q372	151-0279-00			TRANSISTOR:SILICON,NPN	80009	151-0279-00
Q384	151-0216-00			TRANSISTOR:SILICON,PNP	80009	151-0216-00
Q386	151-0342-00			TRANSISTOR:SILICON,PNP	80009	151-0342-00
Q388	151-0331-00			TRANSISTOR:SILICON,NPN	80009	151-0331-00
Q392	151-0169-00			TRANSISTOR:SILICON,NPN	80009	151-0169-00
Q396	151-0279-00			TRANSISTOR:SILICON,NPN	80009	151-0279-00
R302	316-0102-00			RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R303	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R304	316-0474-00			RES.,FXD,CMPSN:470K OHM,10%,0.25W	01121	CB4741
R307	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R308	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R310	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R311	315-0125-00			RES.,FXD,CMPSN:1.2M OHM,5%,0.25W	01121	CB1255
R312	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R313	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R321	315-0125-00			RES.,FXD,CMPSN:1.2M OHM,5%,0.25W	01121	CB1255
R322	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R324	315-0243-00			RES.,FXD,CMPSN:24K OHM,5%,0.25W	01121	CB2435
R325	311-1155-00			RES.,VAR,NONWIR:20K OHM,0.5W	01121	W-7796
R329	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R330	316-0105-00			RES.,FXD,CMPSN:1M OHM,10%,0.25W	01121	CB1051
R331	315-0202-00	XB090000		RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R332	315-0201-00	B010100	B089999	RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R332	315-0202-00	B090000		RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R334	316-0472-00	B010100	B089999	RES.,FXD,CMPSN:4.7K OHM,10%,0.25W	01121	CB4721
R334	315-0622-00	B090000		RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R336	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R337	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R339	315-0623-00			RES.,FXD,CMPSN:62K OHM,5%,0.25W	01121	CB6235
R341	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R342	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R343	316-0473-00			RES.,FXD,CMPSN:47K OHM,10%,0.25W	01121	CB4731
R346	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R347	321-0359-00			RES.,FXD,FILM:53.6K OHM,1%,0.125W	91637	MFF1816G53601F
R350	311-1153-00			RES.,VAR,NONWIR:TRMR,5K OHM,0.50W	73138	91-69-0
R351	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R352	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R354	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R355	323-0452-00			RES.,FXD,FILM:499K OHM,1%,0.50W	75042	CECTO-4993F
R364	303-0473-00			RES.,FXD,CMPSN:47K OHM,5%,1W	01121	GB4735
R365	303-0473-00			RES.,FXD,CMPSN:47K OHM,5%,1W	01121	GB4735
R370	311-1166-00			RES.,VAR,NONWIR:250K OHM,0.5W	73138	91-71-0
R371	316-0393-00			RES.,FXD,CMPSN:39K OHM,10%,0.25W	01121	CB3931
R381	316-0334-00			RES.,FXD,CMPSN:330K OHM,10%,0.25W	01121	CB3341
R382	316-0334-00			RES.,FXD,CMPSN:330K OHM,10%,0.25W	01121	CB3341
R384	316-0123-00			RES.,FXD,CMPSN:12K OHM,10%,0.25W	01121	CB1231
R385	311-1153-00			RES.,VAR,NONWIR:TRMR,5K OHM,0.50W	73138	91-69-0
R386	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R387	311-1154-00			RES.,VAR,NONWIR:TRMR,1K OHM,0.50W	73138	91D-R1K
R388	321-0261-00			RES.,FXD,FILM:5.11K OHM,1%,0.125W	91637	MFF1816G51100F
R389	323-0436-00			RES.,FXD,FILM:340K OHM,1%,0.50W	91637	MFF1226G34002F
R390	311-1166-00			RES.,VAR,NONWIR:250K OHM,0.5W	73138	91-71-0
R392	301-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.50W	01121	EB7535
R395	311-1152-00			RES.,VAR,NONWIR:100K OHM,0.5W	73138	91D-R100K
R396	315-0623-00			RES.,FXD,CMPSN:62K OHM,5%,0.25W	01121	CB6235
R397	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
S330	260-1223-00			SWITCH,PUSH:4PDT,MOMENTARY	80009	260-1223-00
S372A S372B	260-1232-00	B010100	B069999	SWITCH,PUSH:4PDT,2 BUTTON	80009	260-1232-00
S372A S372B	260-1232-01	B070000		SWITCH,PUSH:4PDT,2 BUTTON	80009	260-1232-01
S375A S375B	260-1207-00			SWITCH,PUSH:2 MODULE	80009	260-1207-00
VR370	152-0287-00			SEMICOND DEVICE:ZENER,0.4W,110V,5%	04713	1N986B
VR387	152-0283-00			SEMICOND DEVICE:ZENER,0.4W,43V,5%	04713	1N976B
VR388	152-0166-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	81483	69-9035
VR396	152-0288-00			SEMICOND DEVICE:ZENER,0.4W,140V,5%	80009	152-0288-00


400V RMS
+370V SUPPLY Q386 Q388
+370V
BACKPLATE SUPPLY Q372
STORE BAL
ERASE
ERASE GENERATOR Q334 Q336
BACKPLATE CONTROL OP AMP Q356 Q358 Q362 Q364
STORE LEVEL
STORE/NON-STORE & ERASE SELECTOR SWITCHING
BRIGHTNESS
NON STORE
CE1
COLLIMATION SUPPLY Q392
DUTY CYCLE MULTIVIBRATOR Q310 Q320
FLOOD-GUN ANODE SUPPLY Q396
SWEEP BLANKING PULSE
OVERRIDE SWITCH Q302 Q304
FLOOD-GUN CATHODE SUPPLY Q308
LEFT VERTICAL SIGNAL
LEFT VERT DEFL AMP Q164 Q166 Q174 Q176
RIGHT VERTICAL SIGNAL
RIGHT VERT DEFL AMP Q104 Q106 Q114 Q116
HORIZONTAL SIGNAL
HORIZONTAL DEFL AMP Q124 Q126 Q134 Q136
DYNAMIC GEOMETRY Q148 Q154
LEFT VERTICAL EXT INTENS INPUT
SWEEP BLANKING
CHOP BLANKING
TRACE INTENSIFY
RIGHT VERTICAL EXT INTENS INPUT
Z-AXIS INPUT LOGIC Q206 Q214 Q218 Q224 Q406
LEFT INTENSITY
LEFT Z-AXIS AMP Q432 Q434
RIGHT INTENSITY
RIGHT Z-AXIS AMP Q232 Q234
LEFT GRID DC RESTORER CR443 CR444
-3450V
-3450V
RIGHT GRID DC RESTORER CR243 CR244
±38V UNREG
H.V. PRIMARY Q252
CATHODE SUPPLY CR247 Q454 VR458
-3400V
H.V. ADJ
FEEDBACK CIRCUIT Q262 Q264 Q278
6.3VAC

DEFLECTION AMPLIFIER BOARD PARTS LOCATION



CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C106	B-3	CR141	D-4	Q140	A-2	R101	G-2	R142	D-5
*C115	B-2	CR142	D-4	Q106	A-2	R102	B-2	R144	E-4
C116	B-3	CR146	E-5	Q114	B-2	R103	B-5	R145	C-3
C126	D-3	CR147	E-5	Q116	B-2	R104	A-3	R147	E-4
C136	D-3	CR149	E-4	Q124	C-2	R106	B-3	R148	E-5
C166	F-3			Q126	C-2	R108	B-3	R151	G-5
*C175	F-2			Q134	D-2	R112	B-2	R152	G-4
C176	F-3			Q136	D-2	R113	B-4	R153	G-4
				Q148	E-4	R114	B-2	R154	F-5
				Q154	F-4	R116	C-3	R157	E-5
				Q164	E-2	R118	B-3	R162	F-2
				Q166	E-2	R122	D-2	R163	F-4
				Q174	F-2	R123	D-4	R164	E-3
				Q176	F-2	R124	D-2	R166	F-3
						R126	D-3	R168	E-3
						R128	D-3	R172	F-2
						R132	D-2	R173	F-4
						R133	D-5	R174	F-2
						R134	D-2	R176	G-3
						R136	E-3	R178	F-3
						R138	D-3	R179	F-3
						R141	E-5		

SEE PARTS LIST FOR SERIAL NUMBER RANGES OF PARTS STARRED.

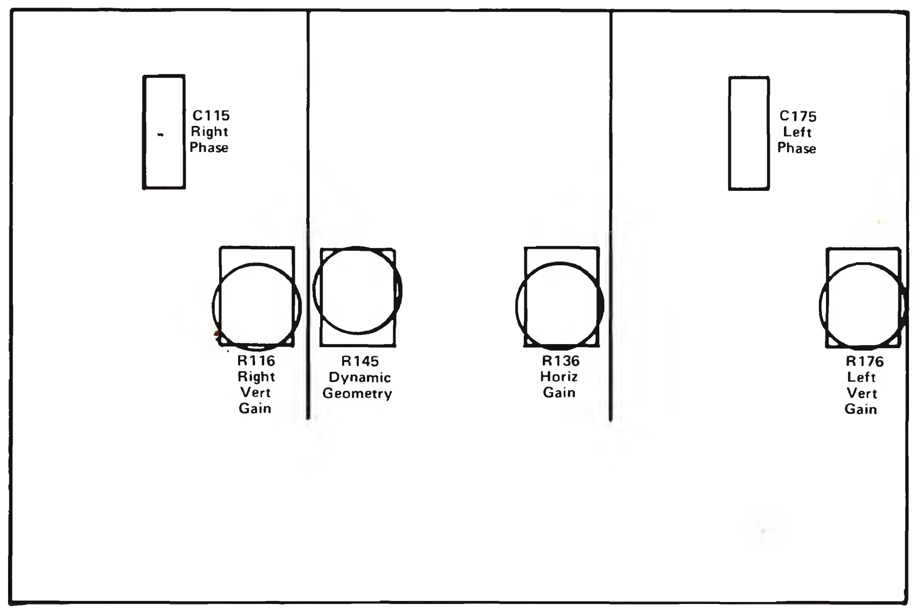


Fig. 4-2. Location of Deflection Amplifier adjustments.

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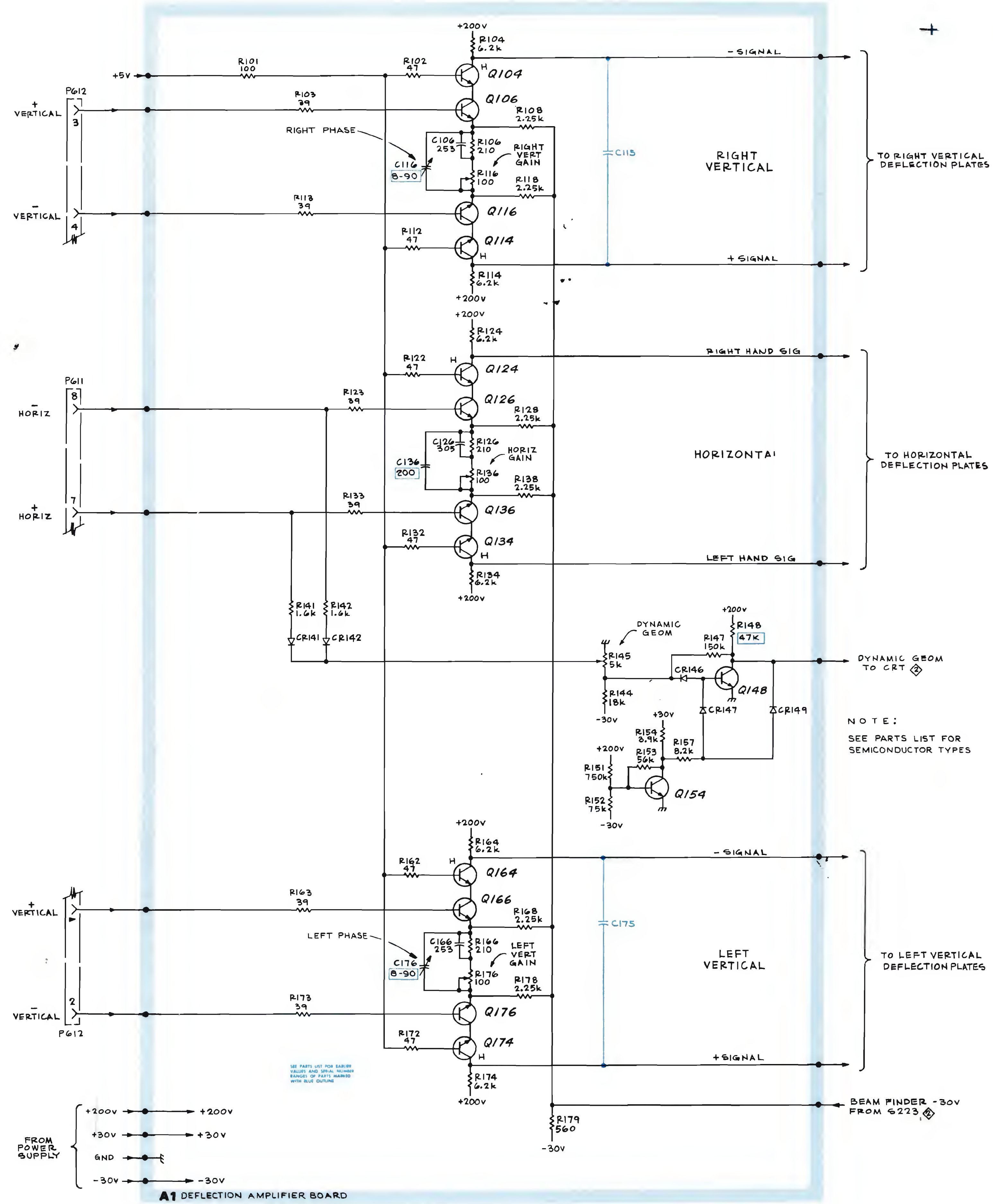
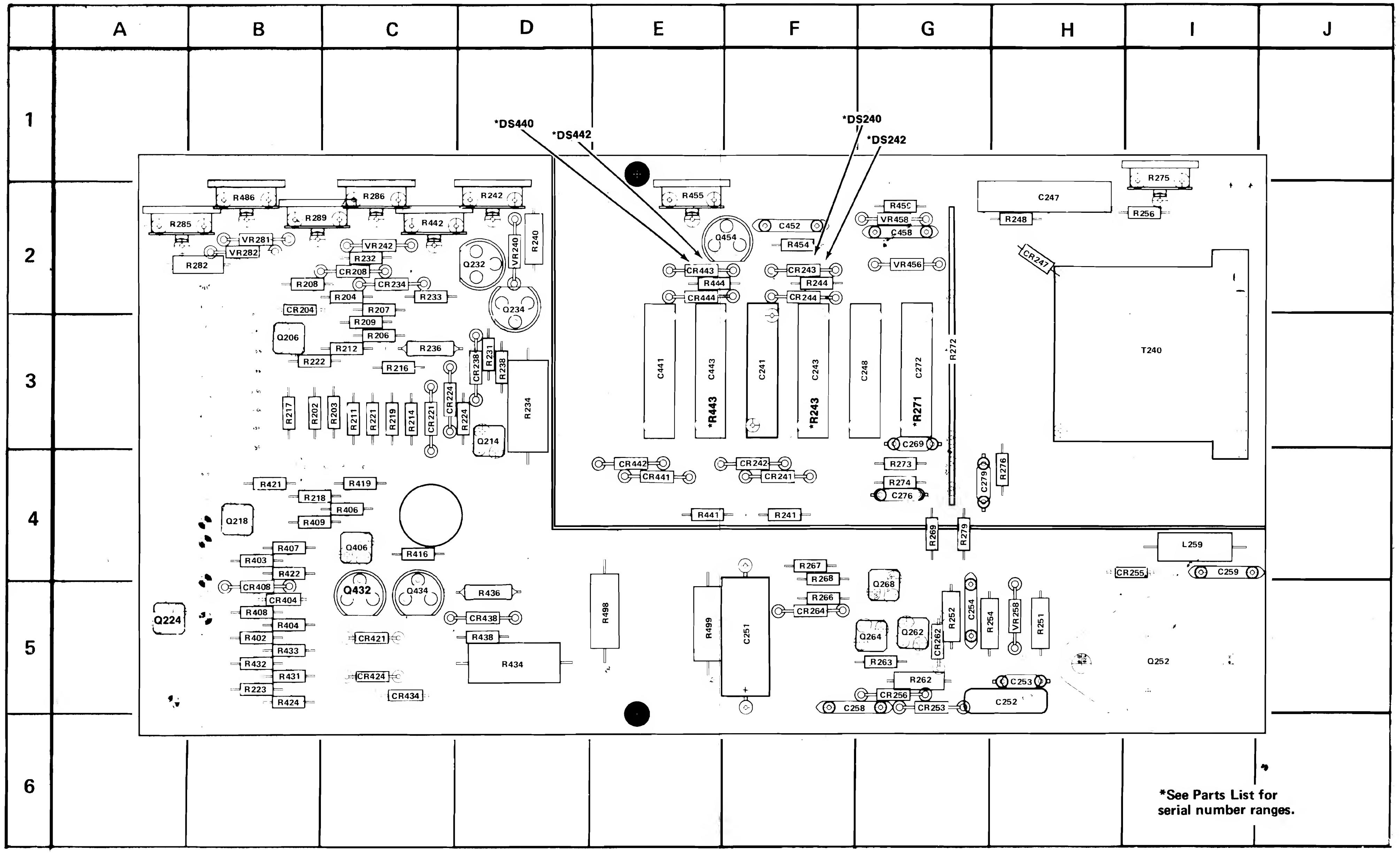
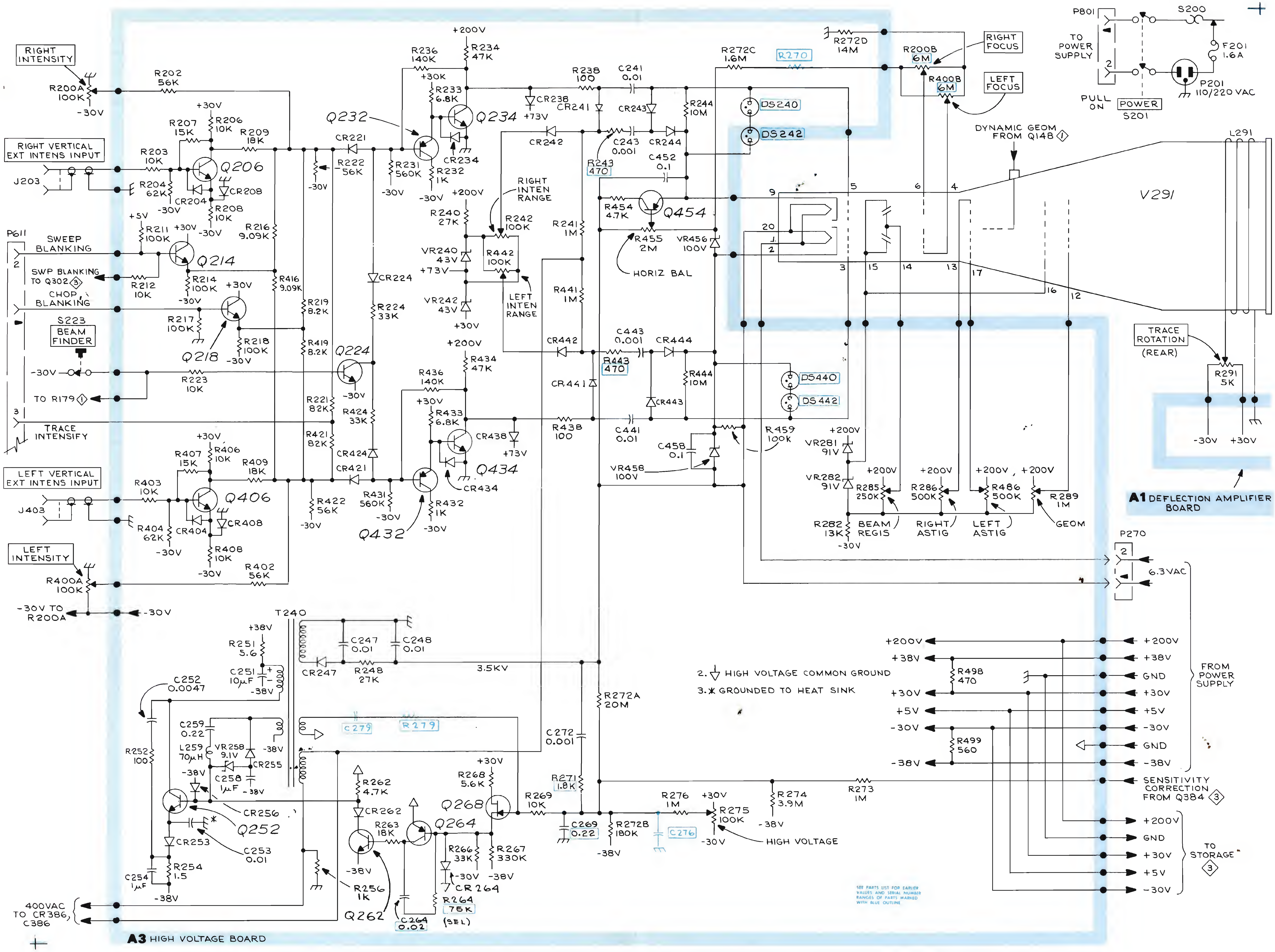


DEFLECTION AMPLIFIERS ①

HIGH VOLTAGE BOARD PARTS LOCATION



CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C241	F-3	C443	E-3	CR204	B-2	CR404	B-5	VR458	G-2	Q206	B-3	R202	B-3	R223	B-5	R254	H-5	R285	A-2	R433	B-5
C243	F-3	C452	F-2	CR208	C-2	CR408	B-5			Q214	B-3	R203	C-3	R224	D-3	R256	I-2	R286	C-2	R434	D-5
C247	H-2	C458	G-2	CR221	C-3	CR421	C-5	L259	I-4	Q218	B-4	R204	C-2	R231	D-3	R262	G-5	R289	B-2	R436	D-5
C248	G-3			CR224	C-3	CR424	C-5			Q224	A-5	R206	C-3	R232	C-2	* R264	F-5	R402	B-5	R438	D-5
C251	F-5			CR234	C-2	CR434	C-5			Q232	D-2	R207	C-2	R233	C-2	R263	G-5	R403	B-4	R441	E-4
C252	H-5	DS240	F-2	CR238	D-3	CR438	D-5			Q234	D-2	R208	B-2	R234	D-3	R266	F-5	R404	B-5	R442	C-2
C253	H-5	DS242	F-2	CR241	F-4	CR441	E-4			Q252	I-5	R209	C-3	R236	C-3	R267	F-4	R406	C-4	R443	E-3
C254	G-5	DS440	E-2	CR242	F-4	CR442	E-4			Q262	G-5	R211	C-3	R238	D-3	R268	F-4	R407	B-4	R444	E-2
C258	G-5	DS442	E-2	CR243	F-2	CR443	E-2			Q264	G-5	R212	C-3	R240	D-2	R269	G-4	R408	B-5	R445	E-2
C259	I-4			CR244	F-2	CR444	E-2			Q268	G-5	R214	C-3	R241	F-4	R271	G-3	R409	C-4	R454	F-2
* C264	F-5			CR247	H-2	VR240	D-2			Q406	C-4	R216	C-3	R242	D-2	R272	G-3	R416	C-4	R455	E-2
C269	G-4			CR253	G-5	VR242	C-2			Q432	C-5	R217	B-3	R243	F-3	R273	G-4	R419	C-4	R459	G-2
C272	G-3			CR255	I-4	VR258	H-5			Q434	C-5	R218	B-4	R244	F-2	R274	G-4	R421	B-4	R486	B-2
* C276	G-4			CR256	G-5	VR281	B-2			Q454	F-2	R219	C-3	R245	F-2	R275	I-1	R422	B-4	R498	E-5
* C279	G-4			CR262	G-5	VR282	B-2					R221	C-3	R248	H-2	R276	H-4	R424	B-5	R499	E-5
C441	E-3			CR264	G-5	VR456	G-2					R222	B-2	R251	H-5	* R279	G-4	R431	B-5		
						VR458	G-2							R252	G-5	R282	B-2	R432	B-5	T240	I-3



REV. E, AUG. 1974

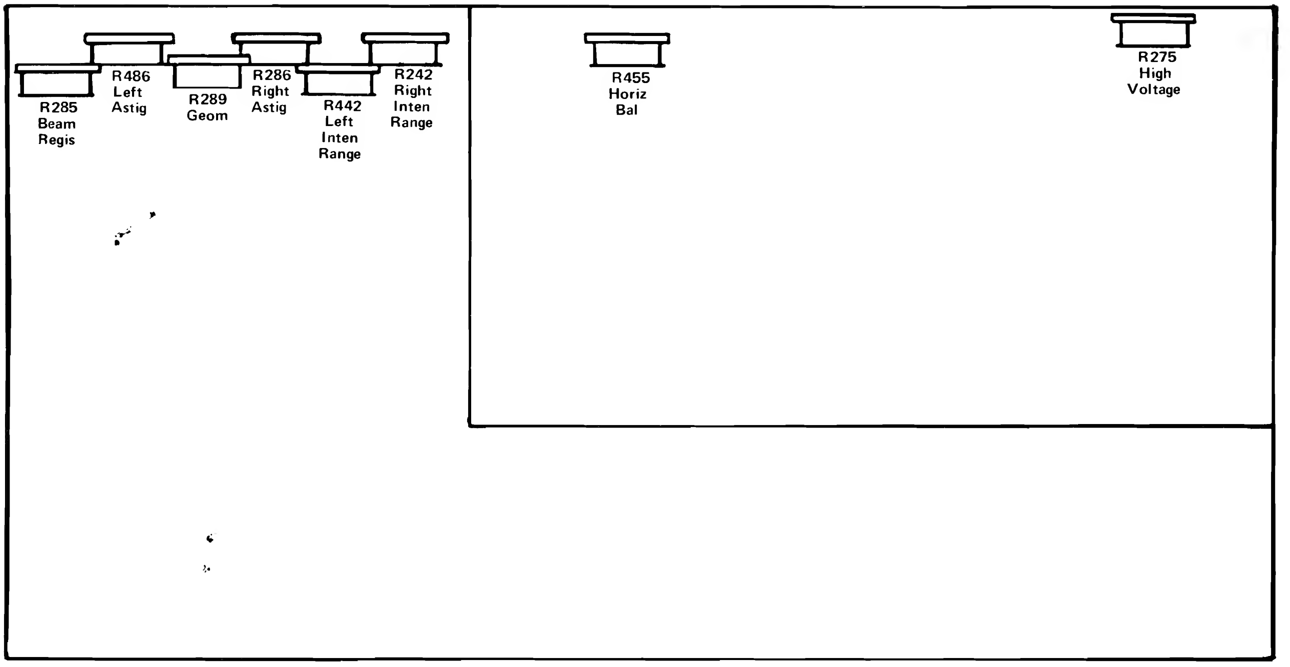


Fig. 4-4. Location of CRT Circuit adjustments.

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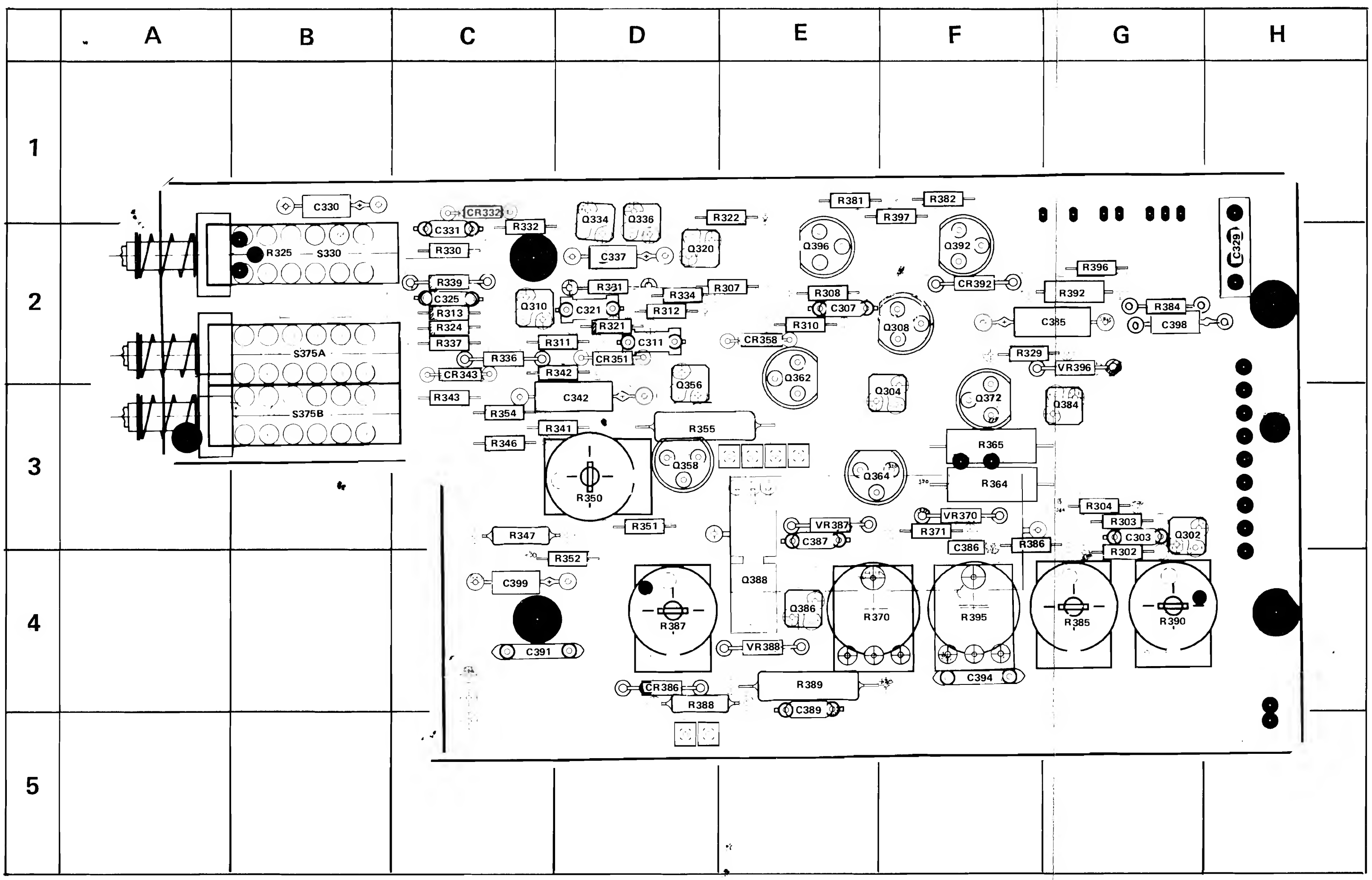
STORAGE BOARD PARTS LOCATION
SN B090000-up



CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C303	G-3	C394	F-4	Q302	G-3	Q388	E-4	R324	C-2	R350	D-3	R387	D-4
C307	E-2	C398	G-2	Q304	F-3	Q392	F-2	R325	B-2	R351	D-3	R388	D-4
C311	D-2	C399	C-4	Q308	F-2	Q396	E-2	R329	G-2	R352	D-4	R389	E-4
C321	D-2	CR329	H-2	Q310	C-2	R302	G-4	R330	C-2	R354	C-3	R390	G-4
C325	C-2	CR332	C-1	Q320	D-2	R303	G-3	R331	D-2	R355	D-3	R392	G-2
C330	B-1	CR343	C-2	Q334	D-1	R304	G-3	R332	C-1	R364	F-3	R395	F-4
C331	C-1	CR351	D-2	Q336	D-1	R307	E-2	R334	D-2	R365	F-3	R396	G-2
C337	D-2	CR358	E-2	Q356	D-2	R308	E-2	R336	C-2	R370	F-4	R397	F-1
C342	D-3	CR386	D-4	Q358	D-3	R310	E-2	R337	C-2	R371	F-3		
C385	G-2	CR392	F-2	Q362	E-2	R311	D-2	R339	C-2	R381	E-1		
C386	F-4	VR370	F-3	Q364	F-3	R312	D-2	R341	D-3	R382	F-1		
C387	E-3	VR387	E-3	Q372	F-3	R313	C-2	R342	D-2	R384	G-2		
C389	E-4	VR388	E-4	Q384	G-3	R321	D-2	R343	C-3	R385	G-4		
C391	C-4	VR396	G-2	Q386	E-4	R322	E-1	R346	C-3	R386	G-4		
								R347	C-3				

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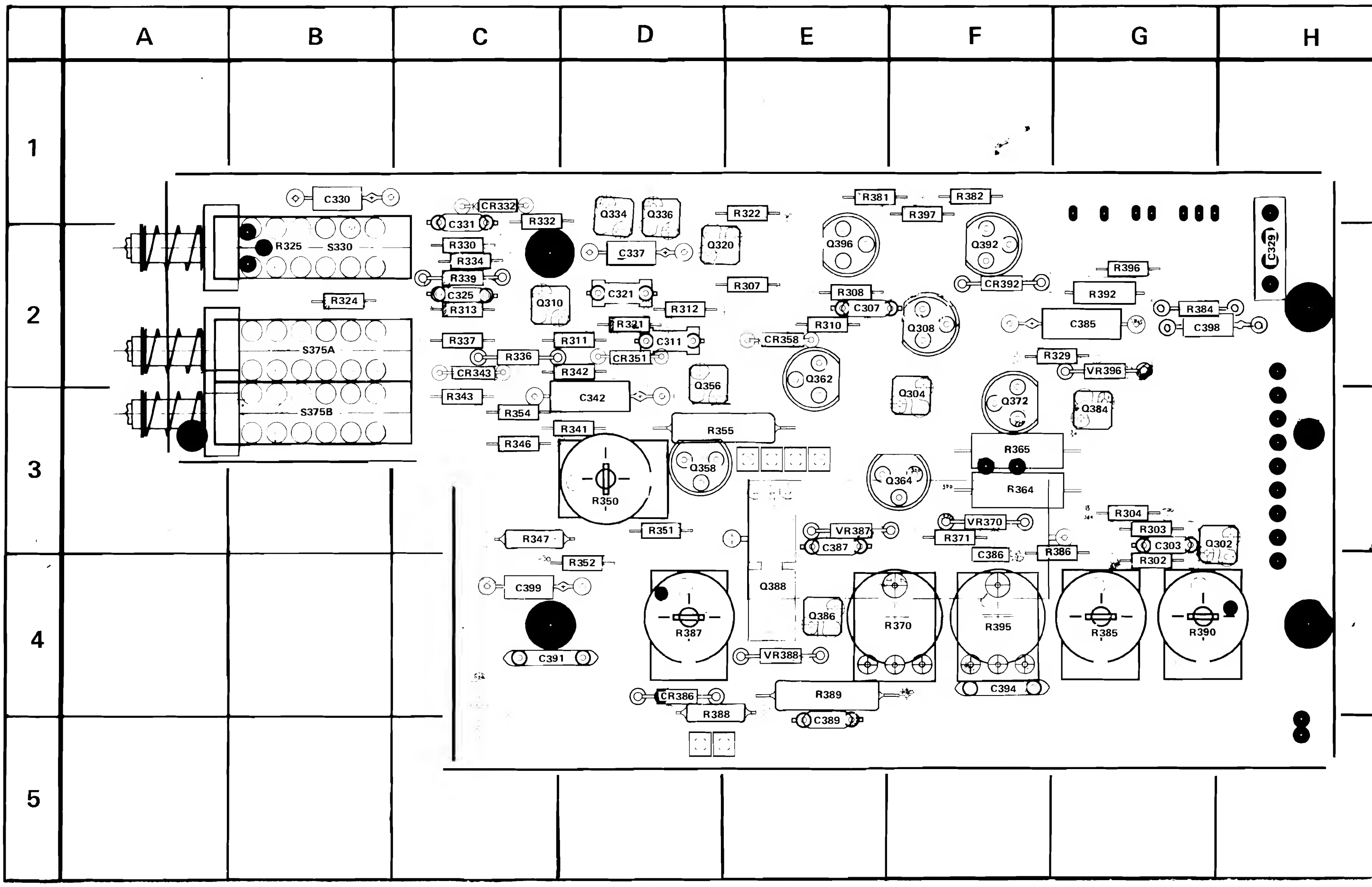
STORAGE BOARD PARTS LOCATION
Below SN B090000



CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C303	G-3	CR329	H2	Q302	G-3	R302	G-4	R343	C-3	R395	F-4
C307	E-2	CR332	C-1	Q304	F-3	R303	G-3	R346	C-3	R396	G-2
C311	D-2	CR343	C-2	Q308	F-2	R304	G-3	R347	C-3	R397	F-1
C321	D-2	CR351	D-2	Q310	C-2	R307	E-2	R350	D-3		
C325	C-2	CR358	E-2	Q320	D-2	R308	E-2	R351	D-3		
C330	B-1	CR386	D-4	Q334	D-1	R310	E-2	R352	D-4		
C331	C-1	CR392	F-2	Q336	D-1	R311	D-2	R354	C-3		
C337	D-2			Q356	D-2	R312	D-2	R355	D-3		
C342	D-3	VR370	F-3	Q358	D-3	R313	C-2	R364	F-3		
C385	G-2	VR387	E-3	Q362	E-2	R321	D-2	R365	F-3		
C386	F-4	VR388	E-4	Q364	F-3	R322	E-1	R370	F-4		
C387	E-3	VR396	G-2	Q372	F-3	R324	B-2	R371	F-3		
C389	E-4			Q384	G-3	R325	B-2	R381	E-1		
C391	C-4			Q386	E-4	R329	G-2	R382	F-1		
C394	F-4			Q388	E-4	R330	C-2	R384	G-2		
C398	G-2			Q392	F-2	R332	C-1	R385	G-4		
C399	C-4			Q396	E-2	R334	C-2	R386	G-4		
						R336	C-2	R387	D-4		
						R337	C-2	R388	D-4		
						R339	C-2	R389	E-4		
						R341	D-3	R390	G-4		
						R342	D-2	R392	G-2		

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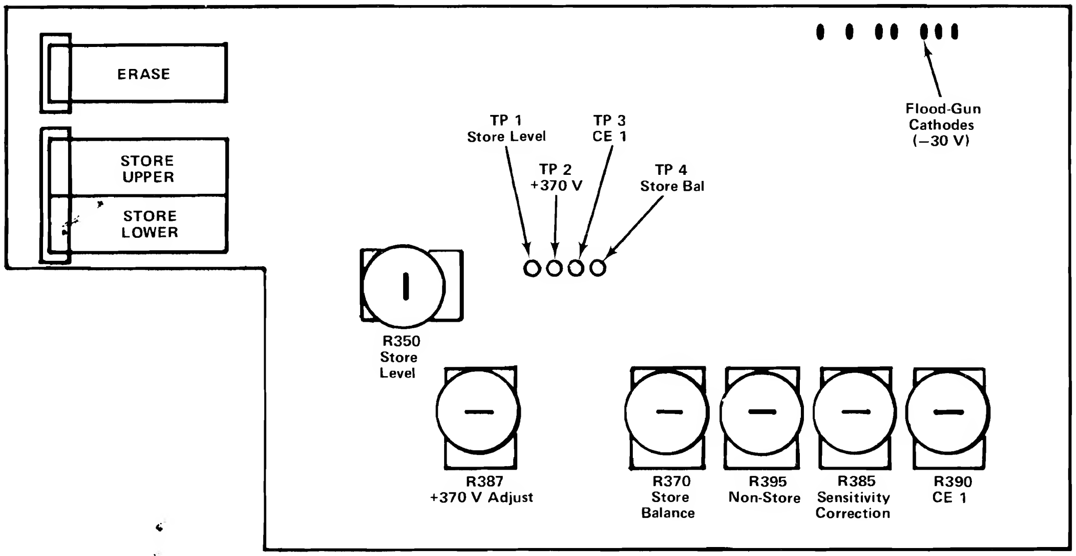

Fig. 4-6. Location of Storage Circuit adjustments and test points.

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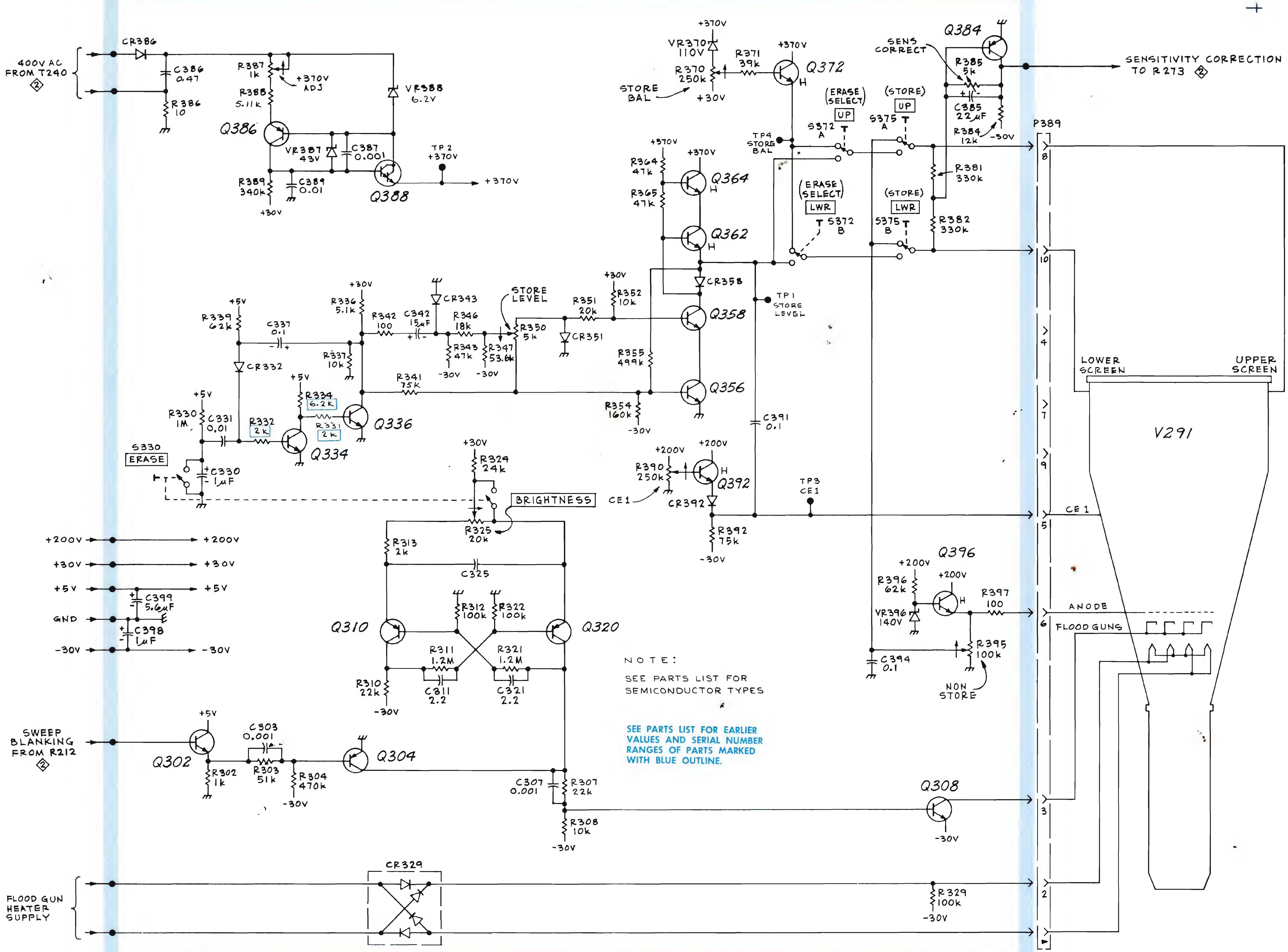

A4 STORAGE BOARD

D13 (ONLY)

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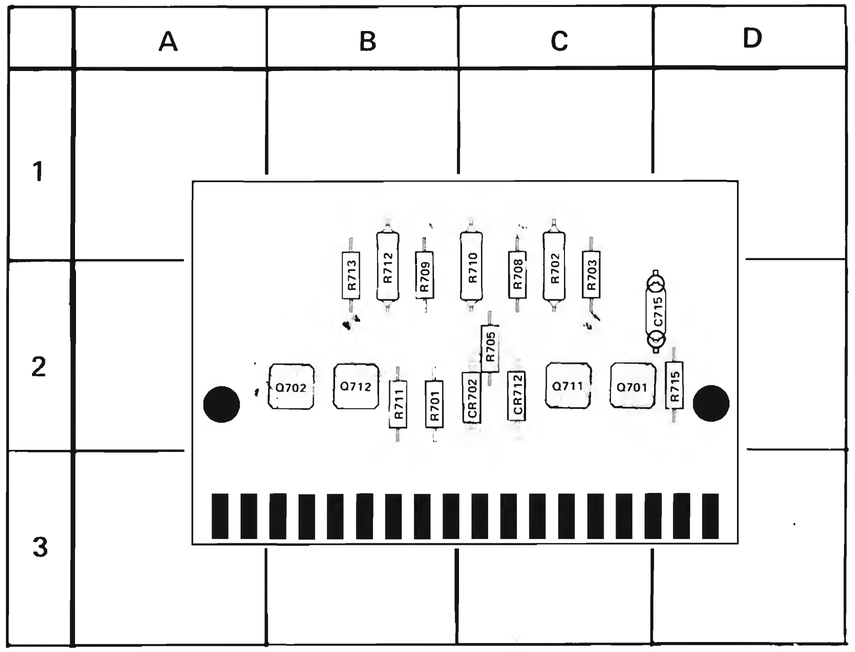
STORAGE CIRCUIT 3 GAB

AUXILIARY BOARD PARTS LOCATION



CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C715	D-2	CR702	C-2	Q701	C-2	R701	B-2
		CR712	C-2	Q702	B-2	R702	C-2
				Q711	C-2	R703	C-2
				Q712	B-2	R705	C-2
						R708	C-2
						R709	B-2
						R710	C-2
						R711	B-2
						R712	B-2
						R713	B-2
						R715	D-2

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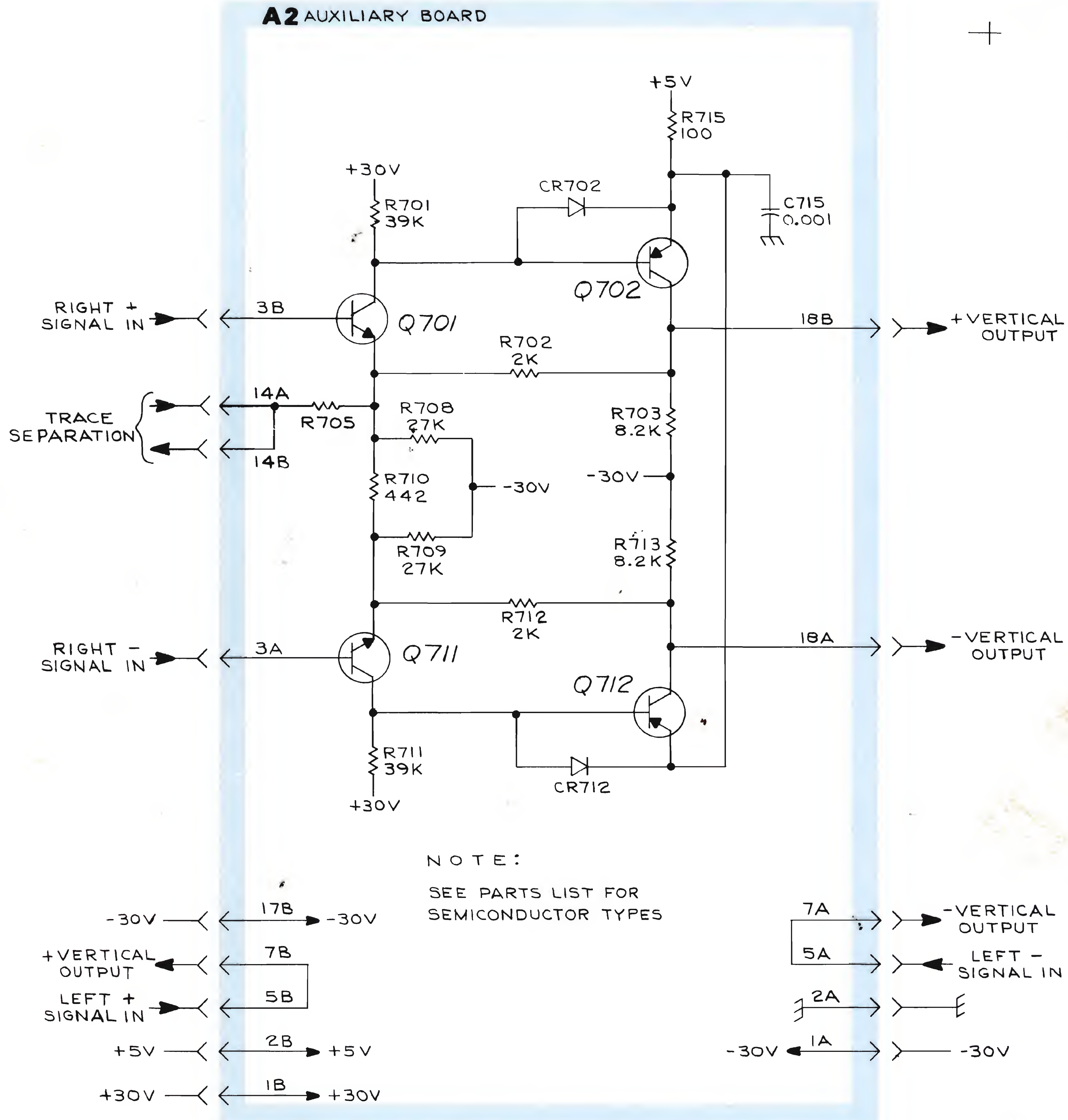


AUXILIARY BOARDS 4

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	ELCTRN	ELECTRON	IN	INCH	SE	SINGLE END
#	NUMBER SIZE	ELEC	ELECTRICAL	INCAND	INCANDESCENT	SECT	SECTION
ACTR	ACTUATOR	ELCTLT	ELECTROLYTIC	INSUL	INSULATOR	SEMICOND	SEMICONDUCTOR
ADPTR	ADAPTER	ELEM	ELEMENT	INTL	INTERNAL	SHLD	SHIELD
ALIGN	ALIGNMENT	EPL	ELECTRICAL PARTS LIST	LPHLDR	LAMPHOLDER	SHLDR	SHOULDERED
AL	ALUMINUM	EQPT	EQUIPMENT	MACH	MACHINE	SKT	SOCKET
ASSEM	ASSEMBLED	EXT	EXTERNAL	MECH	MECHANICAL	SL	SLIDE
ASSY	ASSEMBLY	FIL	FILLISTER HEAD	MTG	MOUNTING	SLFLKG	SELF-LOCKING
ATTEN	ATTENUATOR	FLEX	FLEXIBLE	NIP	NIPPLE	SLVG	SLEEVING
AWG	AMERICAN WIRE GAGE	FLH	FLAT HEAD	NON WIRE	NOT WIRE WOUND	SPR	SPRING
BD	BOARD	FLTR	FILTER	OBD	ORDER BY DESCRIPTION	SQ	SQUARE
BRKT	BRACKET	FR	FRAME or FRONT	OD	OUTSIDE DIAMETER	SST	STAINLESS STEEL
BRS	BRASS	FSTNR	FASTENER	OVH	OVAL HEAD	STL	STEEL
BRZ	BRONZE	FT	FOOT	PH BRZ	PHOSPHOR BRONZE	SW	SWITCH
BSHG	BUSHING	FXD	FIXED	PL	PLAIN or PLATE	T	TUBE
CAB	CABINET	GSKT	GASKET	PLSTC	PLASTIC	TERM	TERMINAL
CAP	CAPACITOR	HDL	HANDLE	PN	PART NUMBER	THD	THREAD
CER	CERAMIC	HEX	HEXAGON	PNH	PAN HEAD	THK	THICK
CHAS	CHASSIS	HEX HD	HEXAGONAL HEAD	PWR	POWER	TNSN	TENSION
CKT	CIRCUIT	HEX SOC	HEXAGONAL SOCKET	RCPT	RECEPTACLE	TPG	TAPPING
COMP	COMPOSITION	HLCPS	HELICAL COMPRESSION	RES	RESISTOR	TRH	TRUSS HEAD
CONN	CONNECTOR	HLEXT	HELICAL EXTENSION	RGD	RIGID	V	VOLTAGE
COV	COVER	HV	HIGH VOLTAGE	RLF	RELIEF	VAR	VARIABLE
CPLG	COUPLING	IC	INTEGRATED CIRCUIT	RTNR	RETAINER	W/	WITH
CRT	CATHODE RAY TUBE	ID	INSIDE DIAMETER	SCH	SOCKET HEAD	WSHR	WASHER
DEG	DEGREE	IDENT	IDENTIFICATION	SCOPE	OSCILLOSCOPE	XFMR	TRANSFORMER
DWR	DRAWER	IMPLR	IMPELLER	SCR	SCREW	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, OREGON 97005
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
05820	WAKEFIELD ENGINEERING, INC.	AUDUBON ROAD	WAKEFIELD, MA 01880
06229	ELECTROVERT, INC.	86 HARTFORD AVENUE	MT. VERNON, NY 10553
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
13511	AMPHENOL CARDRE DIV., BUNKER RAMO CORP.		LOS GATOS, CA 95030
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
24618	TRANSCON MFG. CO.	2655 PERTH ST.	DALLAS, TX 75220
28520	HEYMAN MFG. CO.	147 N. MICHIGAN AVE.	KENILWORTH, NJ 07033
55210	GETTIG ENG. AND MFG. COMPANY	PO BOX 85, OFF ROUTE 45	SPRING MILLS, PA 16875
70485	ATLANTIC INDIA RUBBER WORKS, INC.	571 W. POLK ST.	CHICAGO, IL 60607
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
74921	ITEN FIBRE CO., THE	4001 BENEFIT AVE., P O BOX 9	ASHTABULA, OH 44004
75915	LITTELFUSE, INC.	800 E. NORTHWEST HWY	DES PLAINES, IL 60016
76854	OAK INDUSTRIES, INC., SWITCH DIV.	S. MAIN ST.	CRYSTAL LAKE, IL 60014
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
78471	TILLEY MFG. CO.	900 INDUSTRIAL RD.	SAN CARLOS, CA 94070
79136	WALDES, KOHINOOR, INC.	47-16 AUSTEL PLACE	LONG ISLAND CITY, NY 11101
79807	WROUGHT WASHER MFG. CO.	2100 S. O BAY ST.	MILWAUKEE, WI 53207
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
81073	GRAYHILL, INC.	561 HILLGROVE AVE., PO BOX 373	LA GRANGE, IL 60525
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
86445	PENN FIBRE AND SPECIALTY CO., INC.	2032 E. WESTMORELAND ST.	PHILADELPHIA, PA 19134
86928	SEASTROM MFG. COMPANY, INC.	701 SONORA AVENUE	GLENDALE, CA 91201
91929	HONEYWELL, INC., MICRO SWITCH DIV.	CHICAGO & SPRING STS.	FREEPORT, IL 61032
98278	MALCO A MICRODOT COMPANY, INC. CONNECTOR AND CABLE DIVISION	220 PASADENA AVE.	SOUTH PASADENA, CA 91030

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	670-1453-00			1	CKT BOARD ASSY:AUXILIARY A2	80009	670-1453-00
-2	200-1218-00			1	RTNR,CRT SCALE:6.814 X 5.125,NYLON	80009	200-1218-00
-3	211-0188-00			2	SCREW,MACHINE:4-40 X 0.30 INCH,SST	83385	OBD
-4	354-0233-00	B010100	B069999X	2	RING,RETAINING:0.100 ID X 0.203 INCH OD	79136	5133-14PP
-5	337-1440-00	B010100	B092334	1	SHLD,IMPLOSION:	80009	337-1440-00
	337-1440-01	B092335		1	SHLD,IMPLOSION:GREEN	80009	337-1440-01
-6	386-1946-00			1	SUPPORT,CRT:FRONT	80009	386-1946-00
-7	348-0279-00			2	PAD,CUSHIONING:3.5 X 0.67 X 0.188	80009	348-0279-00
-8	348-0070-01			3	PAD,CUSHIONING:0.69 INCH,RUBBER	80009	348-0070-01
-9	348-0145-00			1	GROMMET,PLASTIC:U-SHP,1.0 X 0.42 INCH	80009	348-0145-00
-10	334-1379-00			1	LABEL:CRT,ADHESIVE BACK	80009	334-1379-00
-11	252-0562-00			FT	PLASTIC CHANNEL:0.100 X 0.120,POLYETHYLENE	06229	GS2
-12	337-1447-00			2	SHLD,CRT:FRONT	80009	337-1447-00
					(ATTACHING PARTS)		
-13	211-0587-00			1	SCREW,MACHINE:6-32 X 0.188 INCH,HSB	80009	211-0587-00
					- - - * - - -		
-14	337-1445-00			1	SHLD,CRT:REAR	80009	337-1445-00
-15	407-0931-00			1	BRKT,CRT SHIELD:REAR,POLYAMIDE	80009	407-0931-00
					(ATTACHING PARTS)		
-16	211-0590-00			3	SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL	83385	OBD
-17	211-0507-00			2	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-18	220-0419-00			5	NUT,PLAIN,SQ:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-19	384-1064-00			1	KNOB:10.185 L X 0.125 OD,5-40 THD	80009	384-1064-00
-20	119-0238-00	B010100	B081715	1	COIL,CAL:	80009	119-0238-00
	----- -----			-	* D12 ONLY		
	119-0373-00	B081716		1	COIL,CAL:	80009	119-0373-00
	----- -----			-	* D12 ONLY		
	119-0238-00	B010100	B102853	1	COIL,CAL:	80009	119-0238-00
	----- -----			-	* D13 ONLY		
	119-0373-00	B102854		1	COIL,CAL:	80009	119-0373-00
	----- -----			-	* D13 ONLY		
					(ATTACHING PARTS)		
	210-0442-00			2	NUT,PLAIN,HEX.:3-48 X 0.187 INCH,CD PL BRS	73743	3014-402
	210-0004-00			2	WASHER,LOCK:#4 INTL,0.015THK,STL CD PL	78189	1204-00-00-0541C
	210-0994-00			2	WASHER,FLAT:0.125 ID X 0.25" OD,STL	86928	5714-147-20N
	210-0935-00			2	WASHER,NONMETAL:FIBER,0.14 IDX 0.375"OD	74921	OBD
-21	361-0059-01			1	SPACER,CUR LOOP:1.094 X 0.344 X 0.125 INCH	80009	361-0059-01
-22	210-0593-00			2	NUT,FINISHING:0.25 HEX X 0.312" LONG,BRS	80009	210-0593-00
					- - - * - - -		
-23	358-0216-00			1	BUSHING,PLASTIC:0.257 ID X 0.412 INCH OD	80009	358-0216-00
-24	366-1327-00			2	KNOB:GRAY	80009	366-1327-00
	213-0153-00			1	. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-25	366-1326-00	B010100	B071165	2	KNOB:GY,0.127 ID X0.588 OD X 0.6H	80009	366-1326-00
	----- -----			-	* D12 ONLY		
	366-1280-00	B071166		2	KNOB:GRAY	80009	366-1278-00
	----- -----			-	* D12 ONLY		
	366-1326-00	B010100	B091838	2	KNOB:GY,0.127 ID X0.588 OD X 0.6H	80009	366-1326-00
	----- -----			-	* D13 ONLY		
	366-1280-00	B091839		2	KNOB:GRAY	80009	366-1278-00
	----- -----			-	* D13 ONLY		
	213-0153-00			1	. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-26	260-1238-00			1	SWITCH,PUSH:0.5A AT 115VAC	81073	39YY2084
-27	----- -----			2	RES,VARIABLE:		
					(ATTACHING PARTS)		
-28	210-0583-00			2	NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-29	210-0940-00			2	WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
-30	210-0046-00			2	WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
					- - - * - - -		
-31	200-0608-00			2	COVER,VAR RES.:PLASTIC	80009	200-0608-00
-32	333-1440-00	B010100	B089999	1	PANEL,FRONT:D12	80009	333-1440-00
	333-1440-01	B090000		1	PANEL,FRONT:D12	80009	333-1440-01
-33	337-1446-00			1	SHIELD,ELEC:HIGH VOLTAGE	80009	337-1446-00
					(ATTACHING PARTS)		
-34	211-0504-00			4	SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-35	348-0115-00			2	GROMMET,PLASTIC:U-SHP,0.548 X0.462 INCH	80009	348-0115-00
-36	407-0896-00			1	BRACKET,CHASSIS:ALUMINUM	80009	407-0896-00
					(ATTACHING PARTS)		
-37	211-0541-00			1	SCREW,MACHINE:6-32 X 0.25"100 DEG,FLH STL	83385	OBD
					- - - * - - -		
-38	260-1222-00			1	SWITCH,PUSH-PUL:10A,250VAC	91929	2DM301
	407-0895-00	B010100	B092223	1	BRACKET,ELEC SW:ALUMINUM	80009	407-0895-00
	407-0895-01	B092224		1	BRACKET,ELEC SW:ALUMINUM	80009	407-0895-01
-39	376-0127-00			1	COUPLER,SHAFT:PLASTIC	80009	376-0127-00
-40	----- -----			1	RES,VARIABLE:		
					(ATTACHING PARTS)		
-41	210-0590-00			1	NUT,PLAIN,HEX.:0.375 X 0.438 INCH,STL	73743	2X28269-402
-42	210-0978-00			1	WASHER,FLAT:0.375 ID X 0.50 INCH OD,STL	78471	OBD
	210-0012-00			1	WASHER,LOCK:INTL,0.375 ID X 0.50" OD STL	78189	1220-02-00-0541C
					- - - * - - -		
-43	200-1204-01			1	COVER,CRT:REAR ALUMINUM,PTD BLUE	80009	200-1204-01
					(ATTACHING PARTS)		
-44	210-0401-00			2	NUT,PLAIN,HEX.:6-32 X 0.312 INCH,CD PLATED	73743	3262-402
					- - - * - - -		
	006-0531-00	XB092571		1	STRAP,TIE DN,EL:5 INCH LONG	24618	700-3688
-45	161-0033-08			1	CABLE ASSY,PWR,:	80009	161-0033-08
-46	358-0366-00			1	BSHG,STRAIN RLF:	80009	358-0366-00
	358-0365-00			1	BSHG,STRAIN RLF:	80009	358-0365-00
-47	200-1004-00			1	CABLE,NIP.,ELEC:0.265 ID X 0.38"OD W/FLG	80009	200-1004-00
-48	352-0076-00	B010100	B092442	1	FUSEHOLDER:W/HARDWARE	75915	342012-L
	352-0362-00	B092443		1	FUSEHOLDER: W/MOUNTING HARDWARE	75915	345001
					(ATTACHING PARTS)		
-49	210-0873-00			1	WASHER,NONMETAL:0.5 ID X 0.688 INCH OD,NPRN	70485	OBD
					- - - * - - -		
-50	210-0201-00			1	TERMINAL,LUG:SE #4	86928	A373-157-2
					(ATTACHING PARTS)		
-51	210-0586-00			1	NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	211-041800-00
-52	333-1448-00	B010100	B089999	1	PANEL REAR:	80009	333-1448-00
	333-1448-01	B090000	B092736	1	PANEL,REAR:D12	80009	333-1448-01
	----- -----			-	* D12 ONLY		
	333-1448-02	B092737		1	PANEL REAR:	80009	333-1448-02
	----- -----			-	* D12 ONLY		
-53	441-1009-00			1	CHAS,DSPL UNIT:MAIN	80009	441-1009-00
-54	210-0659-01			4	. EYELET,METALLIC:0.121 OD X 0.156 INCH LONG	80009	210-0659-01
-55	344-0131-00			4	. CLIP,SPG TENS:CIRCUIT CARD MOUNTING	80009	344-0131-00
					(ATTACHING PARTS FOR CHASSIS)		
-56	211-0504-00			2	SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL	83385	OBD
-57	211-0538-00			2	SCREW,MACHINE:6-32 X 0.312"100 DEG,FLH STL	83385	OBD
-58	210-0457-00			2	NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-59	----- -----			1	SW:THERMOSTATIC		
					(ATTACHING PARTS)		
-60	210-0586-00			2	NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	211-041800-00
					- - - * - - -		
-61	343-0088-00			5	CLAMP,LOOP:0.062 INCH DIA	80009	343-0088-00
	343-0213-00			1	CLAMP,LOOP:PRESS MT,PLASTIC	80009	343-0213-00
-62	348-0067-00	B010100	B113910	1	GROMMET,PLASTIC:0.312 INCH DIA	80009	348-0067-00
	----- -----			-	* D13 ONLY		
	348-0516-00	B113911		1	GROMMET,PLASTIC:BLACK,ROUND,0.188 ID	28520	SB312-3
	----- -----			-	* D13 ONLY		
	348-0067-00	B010100	B092257	1	GROMMET,PLASTIC:0.312 INCH DIA	80009	348-0067-00
	----- -----			-	* D12 ONLY		
	348-0516-00	B092258		1	GROMMET,PLASTIC:BLACK,ROUND,0.188 ID	28520	SB312-3
	----- -----			-	* D12 ONLY		
-63	348-0150-00			2	GROMMET,PLASTIC:U SHAPED	80009	348-0150-00
-64	670-1503-00			1	CKT BOARD ASSY:HIGH VOLTAGE A3	80009	670-1503-00
-65	136-0183-00			5	. SOCKET,PLUG-IN:3 PIN,ROUND	80009	136-0183-00
-66	136-0220-00			8	. SOCKET,PLUG-IN:3 PIN,SQUARE	71785	133-23-11-034
-67	136-0254-00			2	. SOCKET,PIN TERM:0.088 OD X 0.145 INCH LONG	00779	1-331892-5

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-68	131-0589-00			2	. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-69	131-0621-00			15	. CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
-70	214-0579-00			1	. TERM.,TEST PT:BRS CD PL	80009	214-0579-00
-71	175-0855-00			FT	. WIRE,ELECTRICAL:10 WIRE RIBBON	08261	SS-1022(1061)0C
-72	175-0860-00			FT	. WIRE,ELECTRICAL:5 WIRE RIBBON	08261	SS-0522-1910610C
-73	352-0202-00			1	. HLDR,TERM CONN:6 WIRE BLACK	80009	352-0202-00
-74	352-0206-00			1	. HLDR,TERM CONN:10 WIRE BLACK	80009	352-0206-00
-75	----- -----			1	. TRANSISTOR		
					(ATTACHING PARTS)		
-76	211-0511-00			2	. SCREW,MACHINE:6-32 X 0.50 INCH,PNH STL	83385	OBD
-77	214-1536-00			1	. HEAT SINK,DIODE:TO-3,AL	80009	214-1536-00
-78	210-1133-00			2	. WASHER,NONMETAL:0.142 ID X 0.25"OD FIBER	86445	OBD
-79	214-1610-00			1	. HEAT SINK,ELEC:TRANSISTOR	80009	214-1610-00
-80	210-0055-00			2	. WASHER,LOCK:SPLIT,0.145 ID X 0.253 OD,STL	83385	OBD
-81	210-0407-00			2	. NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS	73743	3038-0228-402
					- - - * - - -		
					(ATTACHING PARTS FOR CKT BD)		
-82	211-0510-00			1	SCREW,MACHINE:6-32 X 0.375 INCH,PNH STL	83385	OBD
-83	210-0975-00			1	WSHR,SHOULDERED:0.14 ID X 0.247" OD,PLSTC	80009	210-0975-00
					- - - * - - -		
-84	131-0955-00			2	CONNECTOR,RCPT,:BNC,FEMALE,W/HARDWARE	13511	31-279
					(ATTACHING PARTS)		
-85	210-0255-00			1	TERMINAL,LUG:0.391" ID INT TOOTH	80009	210-0255-00
-86	367-0154-00			1	HANDLE,BOW:	80009	367-0154-00
-87	200-0869-00			1	COVER,CRT SKT:	80009	200-0869-00
-88	136-0469-00			1	SKT,PL-IN ELEK:ELECTRN TUBE,14 CONT W/LEADS	80009	136-0469-00
-89	136-0358-00			1	. SKT,PL-IN ELEK:ELECTRN TUBE,20 CONTACT	80009	136-0358-00
-90	441-1010-00			1	CHAS,DSPL UNIT:	80009	441-1010-00
					(ATTACHING PARTS)		
-91	211-0541-00			1	SCREW,MACHINE:6-32 X 0.25"100 DEG,FLH STL	83385	OBD
-92	211-0504-00			2	SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-93	670-1508-00			1	CKT BOARD ASSY:DEFLECTION(SEE A1 EPL)	80009	670-1508-00
-94	131-0566-00			6	. LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L	55210	L-2007-1
-95	131-0621-00			6	. CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
-96	136-0183-00	B010100	B049999X	7	. SOCKET,PLUG-IN:3 PIN,ROUND	80009	136-0183-00
-97	136-0220-00	B010100	B049999	7	. SOCKET,PLUG-IN:3 PIN,SQUARE	71785	133-23-11-034
	136-0252-04	B050000	B070000X	42	. SOCKET,PIN TERM:0.188 INCH LONG	22526	75060
	----- -----			-	. * D12 ONLY		
	136-0252-04	B050000	B090000X	42	. SOCKET,PIN TERM:0.188 INCH LONG	22526	75060
	----- -----			-	. * D13 ONLY		
-98	214-1291-00			6	. HEAT SINK,ELEC:XSTR,0.72 OD X 0.375"H	05820	207-AB
-99	337-1179-00			2	. SHIELD,ELEC:DEFLECTION AMP	80009	337-1179-00
-100	175-0829-00			FT	. WIRE,ELECTRICAL:6 WIRE RIBBON	08261	SS-0626-710610C
-101	175-0860-00			FT	. WIRE,ELECTRICAL:5 WIRE RIBBON	08261	SS-0522-1910610C
-102	175-0863-00			FT	. WIRE,ELECTRICAL:2 WIRE RIBBON	08261	SS-0222-1910610C
-103	152-0198-00			1	. SEMICOND DEVICE:SILICON,200V,3A	04713	1N4721
-104	352-0200-00			1	. HLDR,TERM CONN:4 WIRE BLACK	80009	352-0200-00
					(ATTACHING PARTS)		
-105	211-0008-00			4	SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-106	426-0767-00			1	FR ASSY,DSPL UN:	80009	426-0767-00
-107	348-0063-00	B010100	B113910	1	GROMMET,PLASTIC:0.50 INCH DIA	80009	348-0063-00
	----- -----			-	* D13 ONLY		
	348-0442-00	B113911		1	GROMMET,PLASTIC:BLACK,ROUND,0.375" ID	28520	SB-500-6
	----- -----			-	* D13 ONLY		
	348-0063-00	B010100	B092257	1	GROMMET,PLASTIC:0.50 INCH DIA	80009	348-0063-00
	----- -----			-	* D12 ONLY		
	348-0442-00	B092258		1	GROMMET,PLASTIC:BLACK,ROUND,0.375" ID	28520	SB-500-6
	----- -----			-	* D12 ONLY		
-108	175-0861-00			FT	WIRE,ELECTRICAL:4 WIRE RIBBON	08261	SS-0422-1910610C
-109	175-0862-00			FT	WIRE,ELECTRICAL:3 WIRE RIBBON	08261	SS-0322-1910610C
-110	175-0863-00			FT	WIRE,ELECTRICAL:2 WIRE RIBBON	08261	SS-0222-1910610C
-111	200-1075-00			4	COVER,ELEC CONN:PLASTIC	00779	1-480435-0
-112	131-0861-00			3	TERM,QIK DISC:16-20 AWG,0.22 W X 0.02 THK	00779	42617-2
-113	131-0865-00			7	CONTACT,ELEC:0.450 INCH L	80009	131-0865-00
-114	131-0621-00			2	CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231

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-	131-0371-00			2	CONTACT,ELEC:FOR NO.26 AWG WIRE	98278	122-0182-019
-115	131-0707-00			2	CONNECTOR,TERM.:22-26 AWG,BRS& CU BE GOLD	22526	47439
-116	352-0161-00			1	HLDR,TERM CONN:3 WIRE BLACK	80009	352-0161-00
-117	352-0198-00			1	HLDR,TERM CONN:2 WIRE BLACK	80009	352-0198-00
-118	670-1434-00			1	CKT BOARD ASSY:		
-119	131-0589-00	B010100	B089999X	4	. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
	----- -----			-	. * D13 ONLY		
	131-0608-00	B010100	B089999	7	. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
	----- -----			-	. * D13 ONLY		
	131-0608-00	B090000		11	. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-120	136-0252-04			45	. SOCKET,PIN TERM:0.188 INCH LONG	22526	75060
-121	175-0856-00			FT	. WIRE,ELECTRICAL:9 WIRE RIBBON	08261	SS-0922-1910610C
-122	175-0863-00			FT	. WIRE,ELECTRICAL:2 WIRE RIBBON	08261	SS-0222-1910610C
-123	214-1612-00	B010100	B079999	1	. HEAT SINK,XSTR:TO-5,AL	80009	214-1612-00
	214-1612-01	B080000		1	. HEAT SINK,XSTR:TO-5,AL	80009	214-1612-01
-124	214-1611-00			5	. HEAT SINK,ELEC:0.280 ID,W/ 4-40 THREADS	05820	260-4T5E-C4631
					(ATTACHING PARTS)		
-125	211-0007-00			1	. SCREW,MACHINE:4-40 X 0.188 INCH,PNH STL	83385	OBD
-126	210-0004-00			1	. WASHER,LOCK:#4 INTL,0.015THK,STL CD PL	78189	1204-00-00-0541C
					- - - * - - -		
-127	260-1207-00			1	. SWITCH,PUSH:2 MODULE	80009	260-1207-00
-128	260-1223-00			1	. SWITCH,PUSH:4PDT,MOMENTARY	80009	260-1223-00
-129	260-1232-00	B010100	B069999	1	. SWITCH,PUSH:4PDT,2 BUTTON	80009	260-1232-00
	260-1232-01	B070000		1	. SWITCH,PUSH:4PDT,2 BUTTON	80009	260-1232-01
-130	361-0411-00	B010100	B079999	10	. SPACER,PUSH SW:0.13 W X 0.375 INCH L,PLSTC	71590	J64285-00
	361-0542-00	B080000		4	. SPACER,SWITCH:PLASTIC	71590	J-64281
					(ATTACHING PARTS)		
-131	211-0008-00	B010100	B079999	4	SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
	211-0008-00	B080000		3	SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
	211-0018-00	XB080000		1	SCREW,MACHINE:4-40 X 0.875 PNH,STL	83385	OBD
	166-0169-00	B080000	B081230	1	SPACER,SLEEVE:0.562 L X 0.562 ID,STL CD PL	76854	3-5162-263
	361-0564-00	B081231		1	SPACER,SLEEVE:0.50 L X 0.133 ID BRS CD	76854	3-5165-275
					- - - * - - -		
-132	366-1023-01			1	KNOB:GRAY	80009	366-1023-01
	----- -----			-	* D13 ONLY		
	213-0153-00			1	. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
	----- -----			-	. * D13 ONLY		
-133	358-0378-00			1	BUSHING,SLEEVE:PRESS MOUNT	80009	358-0378-00
	----- -----			-	* D13 ONLY		
-134	426-0681-00			5	FR,PUSH BUTTON:GRAY PLASTIC	80009	426-0681-00
	----- -----			-	* D13 ONLY		
-135	333-1439-00			1	PANEL,FRONT:D13	80009	333-1439-00
	----- -----			-	* D13 ONLY		
-136	426-0766-00			1	FR ASSY,DSPL UN:D13	80009	426-0766-00
	----- -----			-	* D13 ONLY		
-137	344-0226-00			1	CLIP,CABLE:	80009	344-0226-00
	----- -----			-	* D13 ONLY		
-138	366-1257-46			1	PUSH BUTTON:SIL GRAY,ERASE	80009	366-1257-46
	----- -----			-	* D13 ONLY		
-139	366-1257-44			2	PUSH BUTTON:SIL GRAY,UPPER	80009	366-1257-44
-140	366-1257-45			2	PUSH BUTTON:SIL GRAY,LOWER	80009	366-1257-45
-141	333-1413-00			1	PANEL:REAR	80009	333-1413-00
	195-0092-00			1	LEAD SET,ELEC:	80009	195-0092-00

Blue reference numbers denote parts which are not common to both instruments.

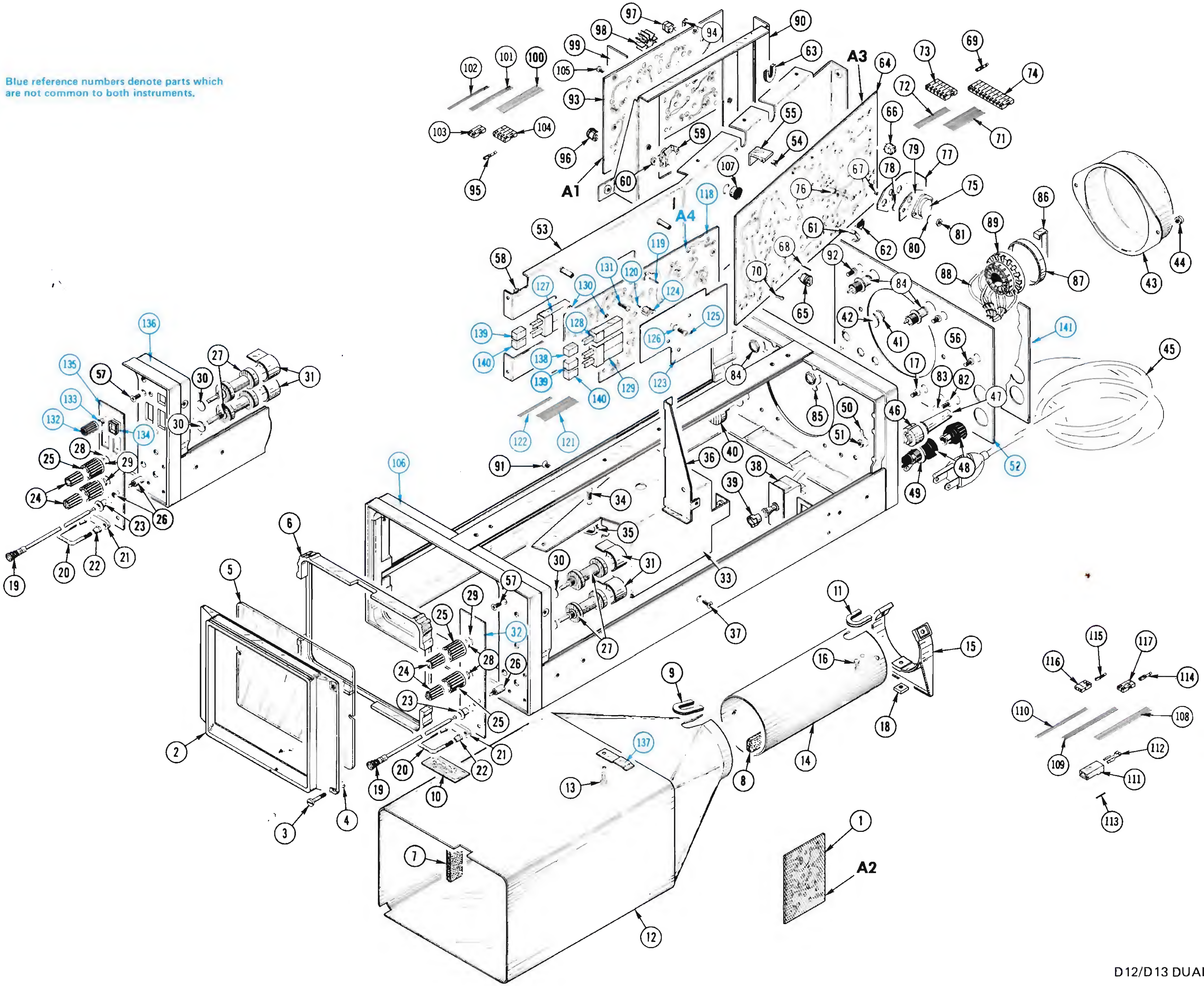


FIG. 1 EXPLODED

D12/D13 DUAL BEAM DISPLAY UNITS

Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
	070-1134-00			1	MANUAL,TECH:INSTRUCTION	80009	070-1134-00

ACCESSORIES

TABLE OF CONTENTS

Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.

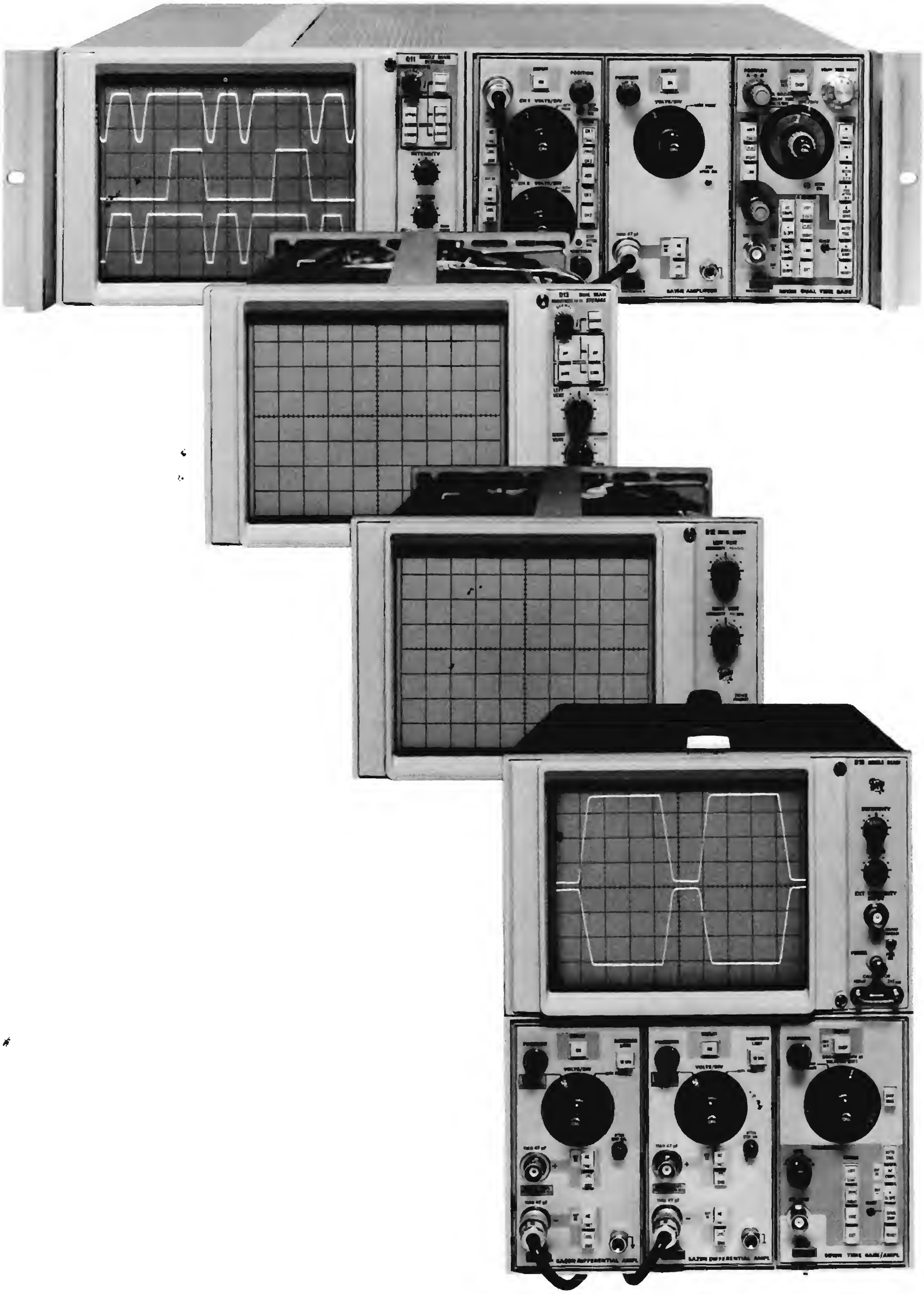


Fig. 1-1. 5100-Series Oscilloscope System.

SECTION 1 SPECIFICATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

The 5103N Power Supply/Amplifier module is an interconnection unit for the display module and plug-in units. It is operated with a display module, and comprises one-half of the 5100-series oscilloscope mainframe. It accepts up to three plug-in units and provides pre-amplification for the deflection signals. The center and left plug-in compartments are connected to the vertical deflection system, and the right plug-in compartment is connected to the horizontal deflection system. Electronic switching between the left and center plug-ins allow a multi-trace vertical display (chopped and alternate time-sharing modes). The unit also contains regulated DC-voltage supplies to provide power to the instrument system.

The following electrical characteristics apply over an ambient temperature range of 0°C to +50°C.

In this manual the word Volts/Div or division refers to major graticule division.

NOTE

Many of the measurement capabilities of the 5100-Series Oscilloscope are determined by the choice of display modules and plug-in units. The following electrical characteristics apply to the Power Supply/Amplifier unit only, unless noted otherwise. For display modules or plug-ins only, see the specification section of the manual for that unit.

Power Transformer

The transformer permits operation from 100-volt, 110-volt, 120-volt, 200-volt, 220-volt, and 240-volt sources with power line frequencies of from 50 to 60 hertz and 400 hertz.

TABLE 1-1

ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Vertical and Horizontal Amplifiers		
Input Signal Amplitude (Differential Input)		50 millivolts per displayed division, vertical and horizontal.
Horizontal Centering		0.5 division or less.
Bandwidth	DC to at least 2.5 megahertz.	
X-Y Phase Difference (Checked with two plug-ins of the same type)	1° or less to 100 kilohertz.	
Sensitivity Change	Accuracy degrades by up to 1% when operated in split-screen storage.	

TABLE 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
Channel Switching		
Chop Clock Frequency	About 200 kilohertz.	
Channel Chop Rate	About 100 kilohertz.	
Plug-In Chop Rate	About 50 kilohertz.	
Alternate Frequency	Sweep rate (once each sweep).	
Plug-In Alternate Rate		One-half sweep rate (once every two sweeps).
Channel Alternate Rate		One-fourth sweep rate (once every four sweeps).

TABLE 1-2

ENVIRONMENTAL CHARACTERISTICS

Characteristic	Performance
Temperature	
Operating Range	0°C to +50°C.
Non-operating Range	–40°C to +70°C.
Altitude	
Operating Range	To 15,000 feet.
Non-operating Range	To 50,000 feet.
Vibration Range	To 0.015 inch peak-to-peak displacement at 50 cycles per second.
Shock Range	To 30 g's, 1/2 sine, 11 milliseconds duration.

TABLE 1-3

MAINFRAME PHYSICAL DATA

(5103N with a Display Unit)

Characteristic		5100-Series Oscilloscope	R5100-Series Oscilloscope
Dimensions (maximum)			
Height	(overall)	11.6 in. (29.5 cm)	5.2 in. (13.2 cm)
	(cabinet)	10.5 in. (26.7 cm)	
Length	(overall)	19.9 in. (50.5 cm)	20.0 in. (51.0 cm)
	(cabinet)	18.3 in. (46.5 cm)	18.3 in. (46.5 cm)
Width	(overall)	8.4 in. (21.4 cm)	19.0 in. (48.3 cm)
	(cabinet)		16.8 in. (42.7 cm)
Net Weight		≈22.8 lbs. (10.3 kg)	≈23.5 lbs. (10.7 kg)
Shipping Weight		≈30.0 lbs. (13.6 kg)	≈39.0 lbs. (17.7 kg)
Export Weight		≈45.0 lbs. (20.4 kg)	≈59.0 lbs. (26.8 kg)

NOTES

SECTION 2
OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of this manual.

General

To effectively use the 5103N, the operation and capabilities of the instrument must be known. The 5103N Power Supply/Amplifier module forms the basis of an oscilloscope system, and requires a display module and plug-ins to complete the system. This section describes interconnection and general operation of the units, including preliminary information for first-time turn-on, selection and installation of plug-ins, general operating information, and some basic oscilloscope applications.

Detailed operating information for a specific display module or plug-in is given in the instruction manual for that unit.

PRELIMINARY INFORMATION

Rackmounting

The 5103N Power Supply/Amplifier module and the display module can be fastened together stacked or side by side, permitting operation as a bench oscilloscope, or it can be operated in a standard 19-inch rack. Complete instructions for rackmounting are given in Section 6, Rackmounting.

NOTE

Before attempting to operate the instrument, make sure the module wiring interconnections are correct, and if display modules have been changed, that the correct auxiliary board is installed in the socket on the plug-in interface board.

Operating Voltage

CAUTION

This instrument is designed for operation from a power source with its neutral at or near earth (ground) potential with a separate safety-earth conductor. It is not intended for operation from two phases of a multi-phase system, or across the legs of a single-phase, three-wire system.

Power Cord Conductor Identification

Conductor	Color	Alternate Color
Ungrounded (Line)	Brown	Black
Grounded (Neutral)	Blue	White
Grounding (Earthing)	Green-Yellow	Green-Yellow

Power Transformer

The 5100-Series Oscilloscope is to be operated from either a 120-volt or a 220-volt nominal line voltage source. This transformer is wired to permit one of three regulating ranges to be selected for either 120-volt or 220-volt nominal operation. The range for which the primary taps are set is marked on the rear panel of the instrument. Use the following procedure to obtain correct instrument operation from the line voltage available.

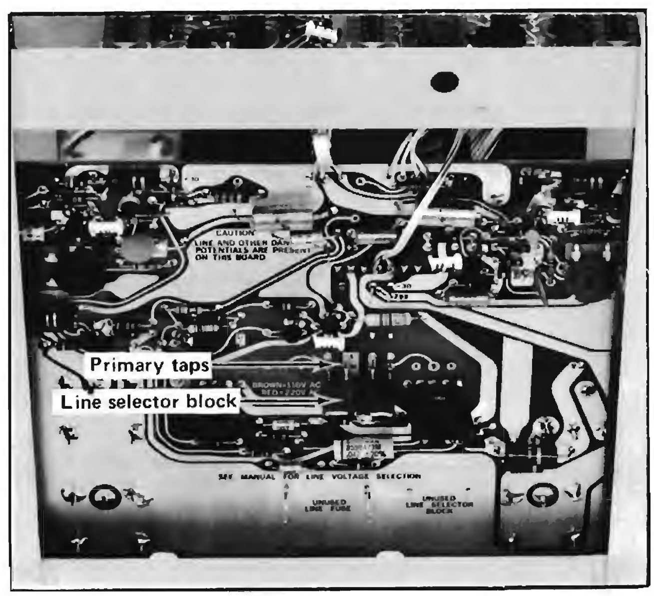


Fig. 2-1. Location of the line-selector block on the Power Supply circuit board.

1. Disconnect the instrument from the power source.

2. Remove the bottom dust cover of the instrument to gain access to the Power Supply circuit board.

3. To convert from 120 volts to 220 volts nominal line voltage, or vice versa, remove the line-selector block from the square-pin connectors (see Fig. 2-1) and replace it with the other block. Remove the line fuse from the fuse holder located on the rear panel of the display module and replace

it with one having the correct rating. The unused line-selector block and line fuse can be stored on the Power Supply circuit board. Change the line-cord power plug to match the power-source receptacle or use an adapter.

NOTE

The 120-volt block is color coded brown, and it connects the transformer primary windings in parallel. The 220-volt block is color coded red, and it connects the primary windings in series.

4. To change regulating ranges, place the line-selector block on the desired set of square pins. Select a range which is centered about the average line voltage to which the instrument is to be connected (see Table 2-1).

5. Change the nominal line voltage information on the rear panel of the instrument. Use a non-abrasive eraser to remove the previous data, and mark in new data with a pencil.

6. Replace the bottom dust cover and apply power to the instrument.

CAUTION

Damage to the instrument may result from incorrect placement of the line-selector block.

TABLE 2-1

Standard Transformer (SN BO50000 - below)

Line Selector Block Position	Regulating Ranges
L Do not use	Internally disconnected
M (110 V Nominal)	99 VAC to 121 VAC
H (120 V Nominal)	108 VAC to 132 VAC

Universal Transformer (SN BO50000-up)

Line Selector Block Position	Regulating Ranges 120-Volts Nominal	Regulating Ranges 220-Volts Nominal
L	90 VAC to 110 VAC	180 VAC to 220 VAC
M	99 VAC to 121 VAC	198 VAC to 242 VAC
H	108 VAC to 132 VAC	216 VAC to 264 VAC
Line Fuse Data	1.6 A slow-blow	1A slow-blow

Operating Temperature

The 5103N can be operated where the ambient air temperature is between 0°C and +50°C. The instrument can be stored in ambient temperature between −40°C and +70°C. After storage at a temperature beyond the operating limits, allow the chassis temperature to come within the operating limits before power is applied.

A thermal cutout in the display module provides thermal protection and disconnects the power to the instrument if the internal temperature exceeds a safe operating level. This device will automatically re-apply power when the temperature returns to a safe level.

PLUG-IN UNITS

General

The 5103N is designed to accept up to three Tektronix 5-series plug-in units. This plug-in feature allows a variety of display combinations and also allows selection of bandwidth, sensitivity, display mode, etc., to meet the measurement requirements. In addition, it allows the oscilloscope system to be expanded to meet future measurement requirements. The overall capabilities of the resultant system are in large part determined by the characteristics of the plug-ins selected.

Installation

To install a plug-in unit into one of the plug-in compartments, align the slots in the top and bottom of the plug-in with the associated guides in the plug-in compartment. Push the plug-in unit firmly into the plug-in compartment until it locks into place. To remove a plug-in, pull the release latch on the plug-in unit to disengage it and pull the unit out of the plug-in compartment. Plug-in units can be removed or installed without turning off the instrument power. It is not necessary that all of the plug-in compartments be filled to operate the instrument; the only plug-ins needed are those required for the measurement to be made.

When the display unit is calibrated in accordance with the calibration procedure given in the display unit instruction manual, the vertical and horizontal gain are standardized. This allows calibrated plug-in units to be changed from one plug-in compartment to another without recalibration. However, the basic calibration of the individual plug-in units should be checked when they are installed in this system to verify their measurement accuracy. See the operating instructions section of the plug-in unit manual for verification procedure.

Selection

The plug-in versatility of the 5100-series oscilloscope allows a variety of display modes with many different plug-ins. The following information is provided here to aid in plug-in selection.

To produce a single-trace display, install a single-channel vertical unit (or dual-channel unit set for single-channel operation) in either of the vertical (left or center) compartments and a time-base unit in the horizontal (right) compartment. For dual-trace displays, either install a dual-channel vertical unit in one of the vertical compartments or install a single-channel vertical unit in each vertical compartment. A combination of a single-channel and a dual-channel vertical unit allows a three-trace display; likewise, a combination of two dual-channel vertical units allows a four-trace display.

To obtain a vertical sweep with the input signal displayed horizontally, insert the time-base unit into one of the vertical compartments and the amplifier unit in the horizontal compartment. If a vertical sweep is used, there is no retrace blanking; however, if used in the right vertical (center) compartment, internal triggering is provided.

For X-Y displays, either a 5A-series amplifier unit or a 5B-series time-base unit having an amplifier channel can be installed in the horizontal compartment to accept the X signal. The Y signal is connected to a 5A-series amplifier unit installed in a vertical compartment.

Special purpose plug-in units may have specific restrictions regarding the compartments in which they can be installed. This information will be given in the instruction manuals for these plug-ins.

GENERAL OPERATING INFORMATION

Display Switching Logic

General. The electronic switching for time-shared displays is produced at the plug-in interface within the mainframe; however, the switching logic is selected on the plug-in units. The system allows any combination of plug-ins and Display switch settings. Refer to the individual plug-in manuals for specific capabilities and operating procedures.

Vertical Plug-in Compartments. When a vertical plug-in is in the active mode (Display button pushed in), a logic level is applied to the switching circuit in the mainframe and a display from this plug-in will occur. When two plug-ins are both active in the vertical compartments, a multi-trace display will occur (Alternate or Chopped). When no plug-in is in the active mode, the signal from the left compartment will be displayed. A time-base unit operated in one of the vertical compartments has a permanent internal connection to apply a logic level to the switching circuit; thus, a vertical trace produced by this unit will always be displayed.

Horizontal Plug-in Compartment. Alternate or Chopped display switching is selected on a time-base unit operated in the horizontal compartment. When the Display switch is out (Alt), a negative impulse is supplied at the end of the sweep to allow alternate switching between plug-ins and plug-in channels. When the Display switch is pushed in (Chop), a chopped display will appear if a multi-trace display is required by the plug-ins in the vertical compartments. An amplifier plug-in unit operated in the horizontal compartment has a permanent internal connection to provide a chopped display if it is required.

Switching Sequence. Four display time slots are provided on a time-sharing basis. When two vertical plug-ins are active, each receives two time slots and the switching sequence is left, left, right, right, etc. The two time slots allotted to each plug-in are divided between amplifier channels in a dual-trace unit; if two dual-trace plug-ins are active, then the switching sequence is left Channel 1, left Channel 2, right Channel 1, right Channel 2, etc. If only one vertical plug-in is active, it receives all four time slots. The switching sequence is the same for both the Alternate and Chopped display modes.

Vertical Display Mode

Display On. To display a signal, the Display button of the applicable vertical plug-in unit must be pushed in to activate the unit. If two plug-ins are installed in the vertical compartments and only the signal from one of the units is wanted, set the Display switch of the unwanted unit to Off (button out). If neither plug-in is activated, the signal from the left unit will be displayed. Both plug-ins can be activated for multi-trace displays.

Alternate Mode. The alternate position of the time-base unit Display switch produces a display which alternates between activated plug-ins and amplifier channels with each sweep of the CRT. The switching sequence is described under Display Switching Logic in this section. Although the Alternate mode can be used at all sweep rates, the Chop mode provides a more satisfactory display at sweep rates from about one millisecond/division to five seconds/division. At these slower sweep rates, alternate-mode switching becomes difficult to view.

Chopped Mode. The Chop position of the time-base unit Display switch produces a display which is electronically switched between channels at a 200-kilohertz rate. The switching sequence has been discussed earlier. In general, the Chop mode provides the best display at sweep rates slower than about one millisecond/division or whenever dual-trace, single-shot phenomena are to be displayed. At faster sweep rates, the chopped switching becomes apparent and may interfere with the display.

Dual-Sweep Displays. When a dual-sweep time-base unit is operated in the horizontal compartment, the alternate and chopped time-shared switching for either the A or B sweep is identical to that for a single time-base unit. However, if both the A and B sweeps are operating, the 5103N operates in the independent pairs mode. Under this condition, the left vertical unit is always displayed at the sweep rate of the A time base and the right vertical unit is displayed at the sweep rate of the B time base (non-delayed sweep only). This results in two displays that have completely independent vertical deflection and chopped or alternate sweep switching.

Dual-Beam Displays. When a dual-beam display module is operated with the 5103N, the switching sequence is altered slightly. Between-channel switching occurs; however, switching between plug-ins is not necessary and does not occur. Also, the left vertical unit is always displayed by the upper CRT beam and the right vertical unit is displayed by the lower CRT beam.

X-Y Operation

In some applications, it is desirable to display one signal versus another (X-Y) rather than against an internal sweep. The flexibility of the plug-in units available for use with the 5103N provides a means for applying a signal to the horizontal deflection system for this type of display. Some of the 5B-series time-base units can be operated as amplifiers in addition to their normal use as time-base generators, or an amplifier unit can be installed in the horizontal compartment. The latter method provides the best X-Y display, particularly if two identical amplifier units are used, since both the X and Y input systems will have the same capabilities and characteristics. In either case, the mainframe bandwidth and sensitivity are equal and inherent phase shift is adjustable to 0 degrees in the display module. For further information on obtaining X-Y displays, see the plug-in unit manuals.

Raster Display

A raster-type display can be used to effectively increase the apparent sweep length. For this type of display, the trace is deflected both vertically and horizontally by sawtooth signals, and is accomplished by installing a 5B-series time-base unit in one of the vertical compartments as well as one in the horizontal compartment. Normally, the unit in the vertical compartment should be set to a slower sweep rate than the one in the horizontal compartment; the number of horizontal traces in the raster depends upon the ratio between the two sweep rates. Information can be displayed on the raster using the Ext Intensity Input to provide intensity modulation of the display. This type of raster display could be used to provide a television-type display. Complete information on operation using the Z-axis feature is given in the operating instructions section of the display module manuals.

BASIC OSCILLOSCOPE APPLICATIONS

General

The 5100-Series Oscilloscope and its associated plug-in units provide a very flexible measurement system. The capabilities of the overall system depend mainly upon the plug-ins that are chosen for use with this instrument. The following information describes the procedures and techniques for making basic measurements. These applications are not described in detail, since each application must be adapted to the requirements of the individual measurement. Specific applications for the individual plug-in units are described in the manuals for those units. The overall system can also be used for many applications which are not described in detail either in this manual or in the manuals for the individual plug-in units. Contact your local Tektronix Field Office or representative in making specific measurements with this instrument.

The following books describe oscilloscope measurement techniques which can be adapted for use with this instrument.

Harley Carter, "An Introduction to the Cathode Ray Oscilloscope", Philips Technical Library, Cleaver-Hume Press Ltd., London, 1960.

J. Czech, "Oscilloscope Measuring Techniques", Philips Technical Library, Springer-Verlag, New York, 1965.

Robert G. Middleton, "Scope Waveform Analysis", Howard W. Sams & Co. Inc., The Bobbs-Merrill Company Inc., Indianapolis, 1963.

Robert G. Middleton and L. Donald Payne, "Using the Oscilloscope in Industrial Electronics", Howard W. Sams & Co. Inc., The Bobbs-Merrill Company Inc., Indianapolis, 1961.

John F. Rider and Seymour D. Uslan, "Encyclopedia of Cathode-Ray Oscilloscopes and Their Uses", John F. Rider Publisher Inc., New York, 1959.

John F. Rider, "Obtaining and Interpreting Test Scope Traces", John F. Rider Publisher Inc., New York, 1959.

Rufus P. Turner, "Practical Oscilloscope Handbook", Volumes 1 and 2, John F. Rider Publisher Inc., New York, 1964.

Peak-to-Peak Voltage Measurements—AC

To make peak-to-peak voltage measurements, use the following procedure:

1. Set the Input Coupling on the vertical plug-in unit to GND and connect the signal to the input connector.

2. Set the Input Coupling to AC and set the Volts/Div switch to display about 5 or 6 vertical divisions of the waveform. Check that the Variable Volts/Div control (red knob) is in the Cal position.

3. Adjust the time-base triggering controls for a stable display and set the Seconds/Div switch to display several cycles of the waveform.

4. Turn the vertical Position control so the lower portion of the waveform coincides with one of the graticule lines below the center horizontal line, and the top of the waveform is in the viewing area. Move the display with the horizontal Position control so one of the upper peaks is aligned with the center vertical reference line (see Fig. 2-2).

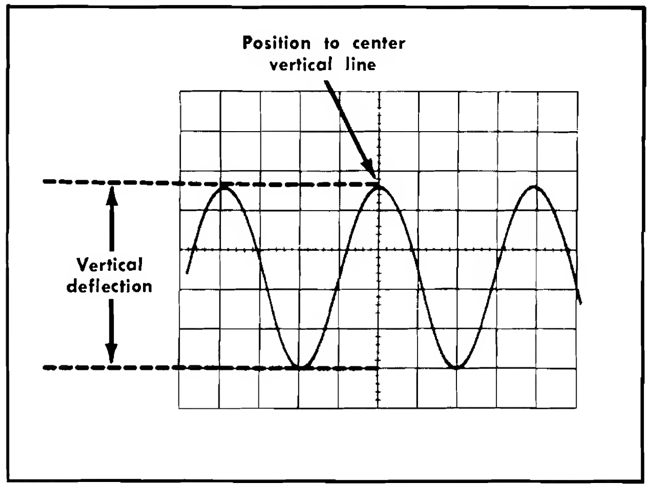


Fig. 2-2. Measuring peak-to-peak voltage of a waveform.

5. Measure the vertical deflection from peak to peak (divisions).

NOTE

This technique may also be used to make measurements between two points on the waveform, rather than peak to peak.

6. Multiply the distance (in divisions) measured in step 5 by the Volts/Div switch setting. Also include the attenuation factor of the probe, if applicable.

EXAMPLE: Assume a peak-to-peak vertical deflection of 4.6 divisions and a Volts/Div switch setting of 5 V.

$$\text{Peak-to-peak volts} = 4.6 \text{ (divisions)} \times 5 \text{ (Volts/Div setting)} = 23 \text{ volts}$$

NOTE

If an attenuator probe not having the capability to change the scale factor readout (Volts/Div) is used, multiply the right side of the above equation by the attenuation factor.

Instantaneous Voltage Measurement—DC

To measure the DC level at a given point on a waveform, use the following procedure:

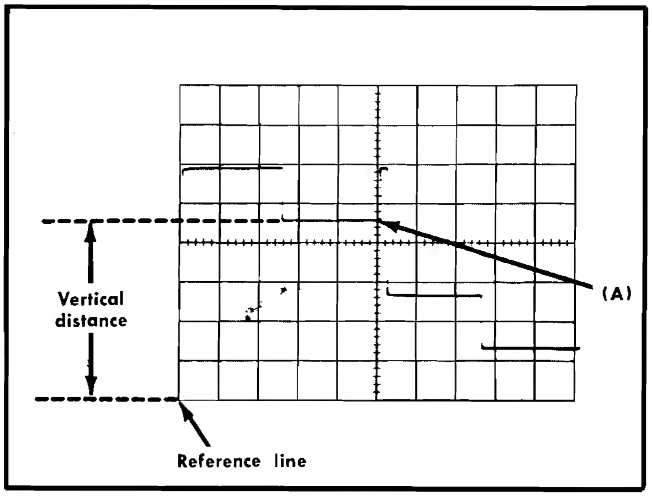


Fig. 2-3. Measuring instantaneous DC voltage with respect to a reference voltage.

1. Set the Input Coupling of the vertical plug-in unit to GND and position the trace to the bottom line of the graticule (or other selected reference line). If the voltage to be measured is negative with respect to ground, position the trace to the top line of the graticule. Do not move the vertical Position control after this reference has been established.

NOTE

To measure a voltage level with respect to a voltage other than ground, make the following changes to step 1: Set the Input Coupling switch to DC and apply the reference voltage to the input connector, then position the trace to the reference line.

2. Connect the signal to the input connector. Set the Input Coupling to DC (the ground reference can be checked at any time by setting the Input Coupling to GND).

3. Set the Volts/Div switch to display about 5 or 6 vertical divisions of the waveform. Check that the Variable Volts/Div control (red knob) is in the Cal position. Adjust the time-base triggering controls for a stable display.

4. Measure the distance in divisions between the reference line and the point on the waveform at which the DC level is to be measured. For example, in Fig. 2-3 the measurement is made between the reference line and point A.

5. Establish the polarity. The voltage is positive if the signal is applied to the + input connector and the waveform is above the reference line.

6. Multiply the distance measured in step 4 by the Volts/Div switch setting. Include the attenuation factor of the probe, if applicable (see the note following the Peak-to-Peak Voltage Measurement example).

EXAMPLE: Assume that the vertical distance measured is 4.6 divisions, the polarity is positive, and the Volts/Div switch setting is 2 V.

$$\text{Instantaneous Voltage} = \underset{\text{(divisions)}}{4.6} \times \underset{\text{(Volts/Div)}}{2} = \underset{\text{volts}}{+9.2}$$

Comparison Measurements

In some applications, it may be necessary to establish a set of deflection factors other than those indicated by the Volts/Div or Seconds/Div switches. This is useful for comparing signals to a reference voltage amplitude or period. To establish a new set of deflection factors based upon a specific reference amplitude or period, proceed as follows:

VERTICAL DEFLECTION FACTOR

1. Apply a reference signal of known amplitude to the vertical input connector. Using the Volts/Div switch and Variable Volts/Div control, adjust the display for an exact number of divisions. Do not move the Variable Volts/Div control after obtaining the desired deflection.

2. Divide the amplitude of the reference signal (volts) by the product of the deflection in divisions (established in step 1) and the Volts/Div switch setting. This is the Deflection Conversion Factor.

$$\text{Deflection Conversion Factor} = \frac{\text{reference signal amplitude (volts)}}{\text{deflection (divisions X Volts/Div setting}}$$

3. To determine the peak-to-peak amplitude of a signal compared to a reference, disconnect the reference and apply the signal to the input connector.

4. Set the Volts/Div switch to a setting that provides sufficient deflection to make the measurement. Do not readjust the Variable Volts/Div control.

5. To establish a Modified Deflection Factor at any setting of the Volts/Div switch, multiply the Volts/Div switch setting by the Deflection Conversion Factor established in step 2.

$$\text{Modified Deflection Factor} = \text{Volts/Div setting} \times \text{Deflection Conversion Factor}$$

6. Measure the vertical deflection in divisions and determine the amplitude by the following formula:

$$\text{Signal Amplitude} = \text{Modified Deflection Factor} \times \text{deflection (divisions)}$$

EXAMPLE: Assume a reference signal amplitude of 30 volts, a Volts/Div switch setting of 5 V and a deflection of four divisions. Substituting these values in the Deflection Conversion Factor formula (step 2):

$$\frac{30\ \text{V}}{(4)\ (5\ \text{V})} = 1.5$$

Then, with a Volts/Div switch setting of 2 V, the Modified Deflection Factor (step 5) is:

$$(2\ \text{V})\ (1.5) = 3\ \text{volts/division}$$

To determine the peak-to-peak amplitude of an applied signal which produces a vertical deflection of five divisions with the above conditions, use the Signal Amplitude formula (step 6):

$$(3\ \text{V})\ (5) = 15\ \text{volts}$$

SWEEP RATE

1. Apply a reference signal of known frequency to the vertical input connector. Using the Seconds/Div switch and Variable Seconds/Div control, adjust the display so that one cycle of the signal covers an exact number of horizontal divisions. Do not change the Variable Seconds/Div control after obtaining the desired deflection.

2. Divide the period of the reference signal (seconds) by the product of the horizontal deflection in divisions (established in step 1) and the setting of the Seconds/Div switch. This is the Deflection Conversion Factor.

$$\text{Deflection Conversion Factor} = \frac{\text{reference signal period (seconds)}}{\text{horizontal deflection (divisions)} \times \text{Seconds/Div switch setting}}$$

3. To determine the period of an unknown signal, disconnect the reference and apply the unknown signal.

4. Set the Seconds/Div switch to a setting that provides sufficient horizontal deflection to make an accurate measurement. Do not readjust the Variable Seconds/Div control.

5. To establish a Modified Deflection Factor at any setting of the Seconds/Div switch, multiply the Seconds/Div switch setting by the Deflection Conversion Factor established in step 2.

$$\text{Modified Deflection Factor} = \text{Seconds/Div switch setting} \times \text{Deflection Conversion Factor}$$

6. Measure the horizontal deflection in divisions and determine the period by the following formula:

$$\text{Period} = \text{Modified Deflection Factor} \times \text{horizontal deflection (divisions)}$$

EXAMPLE: Assume a reference signal frequency of 455 hertz (period 2.2 milliseconds), a Seconds/Div switch setting of .2 ms, and a horizontal deflection of eight divisions. Substituting these values in the Deflection Conversion Factor formula (step 2):

$$\frac{2.2\ \text{ms}}{(8)\ (0.2\ \text{ms})} = 1.375$$

Then, with a Seconds/Div switch setting of 50 μs, the Modified Deflection Factor (step 5) is:

$$(50\ \mu\text{s})\ (1.375) = 68.75\ \text{microseconds/division}$$

To determine the time period of an applied signal which completes one cycle in seven horizontal divisions, use the Period formula (step 6):

$$(68.75\ \mu\text{s})\ (7) = 481\ \text{microseconds}$$

This product can be converted to frequency by taking the reciprocal of the period (see application on Determining Frequency).

Time Period Measurement

To measure the time (period) between two points on a waveform, use the following procedure:

1. Connect the signal to the vertical input connector, select either AC or DC input coupling, and set the Volts/Div switch to display about four divisions of the waveform.

2. Set the time-base triggering controls to obtain a stable display. Set the Seconds/Div switch to the fastest sweep rate that will permit displaying one cycle of the waveform in less than eight divisions (some non-linearity may occur in the first and last graticule divisions of display). Refer to Fig. 2-4.

3. Adjust the vertical Position control to move the points between which the time measurement is made to the

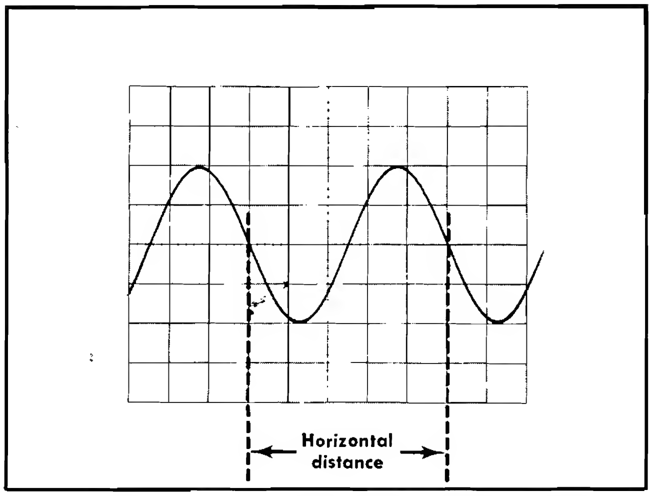


Fig. 2-4. Measuring time duration (period) between points on a waveform.

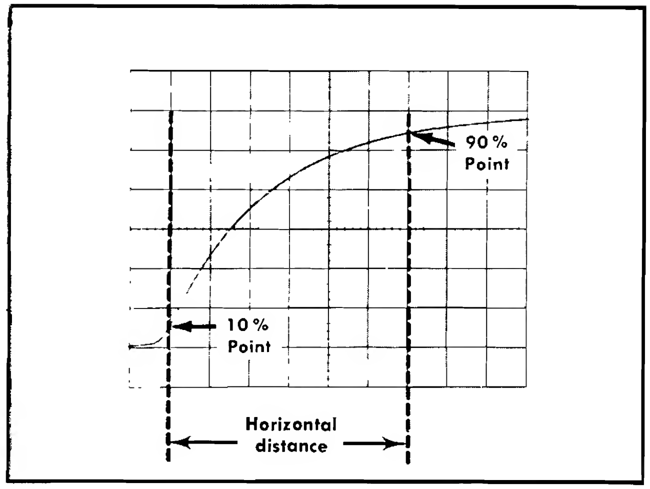


Fig. 2-5. Measuring risetime.

center horizontal line. Adjust the horizontal Position control to center the time-measurement points within the center eight divisions of the graticule.

4. Measure the horizontal distance between the time measurement points. Be sure the Variable Seconds/Div control is in the Cal position.

5. Multiply the distance measured in step 4 by the setting of the Seconds/Div switch.

EXAMPLE: Assume that the horizontal distance between the time-measurement points is five divisions and the Seconds/Div switch is set to .1 ms.

Using the formula:

$$\text{Period} = \frac{\text{horizontal distance}}{\text{(divisions)}} \times \frac{\text{Seconds/Div}}{\text{switch setting}}$$

$$= (5)\ (0.1\ \text{ms}) = 0.5\ \text{ms}$$

The period is 0.5 millisecond.

Determining Frequency

The time measurement technique can also be used to determine the frequency of a signal. The frequency of a periodically recurrent signal is the reciprocal of the time duration (period) of one cycle. Use the following procedure:

1. Measure the period of one cycle of the waveform as described in the previous application.

2. Take the reciprocal of the period to determine the frequency.

EXAMPLE: The frequency of the signal shown in Fig. 2-4, which has a period of 0.5 millisecond, is:

$$\text{Frequency} = \frac{1}{\text{period}} = \frac{1}{0.5\ \text{ms}} = 2\ \text{kilohertz}$$

Risetime Measurements

Risetime measurements employ basically the same techniques as the time-period measurements. The main difference is the points between which the measurement is made. The following procedure gives the basic method of measuring risetime between the 10% and 90% points of the waveform.

1. Connect the signal to the input connector.

2. Set the Volts/Div switch and Variable Volts/Div control to produce a display an exact number of divisions in amplitude.

3. Center the display about the center horizontal line with the vertical Position control.

4. Set the time-base triggering controls to obtain a stable display. Set the Seconds/Div switch to the fastest sweep rate that will display less than eight divisions between the 10% and 90% points on the waveform (see Fig. 2-5).

5. Determine the 10% and 90% points on the rising portion of the waveform. The figures given in Table 2-2 are for 10% up from the start of the rising portion and 10% down from the top of the rising portion (90% point).

TABLE 2-2

Divisions of display	10% and 90% points	Divisions vertically between 10% and 90% points
4	0.4 and 3.6 divisions	3.2
5	0.5 and 4.5 divisions	4.0
6	0.6 and 5.4 divisions	4.8
7	0.7 and 6.3 divisions	5.6
8	0.8 and 7.2 divisions	6.4

6. Adjust the horizontal Position control to move the 10% point of the waveform to the second vertical line of the graticule. For example, with a six-division display, the 10% point would be 0.6 division up from the start of the rising portion.

7. Measure the horizontal distance between the 10% and 90% points. Be sure the Variable Seconds/Div control is in the Cal position.

8. Multiply the distance measured in step 7 by the setting of the Seconds/Div switch.

EXAMPLE: Assume that the horizontal distance between the 10% and 90% points is six divisions and the Seconds/Div switch is set to 1 μs.

Using the period formula to find risetime:

$$\text{Risetime period} = \text{horizontal distance (divisions)} \times \text{Seconds/Div setting}$$

$$= (6)\ (1\ \mu s) = 6 \text{ microseconds}$$

The risetime is 6 microseconds

Time Difference Measurements

When used in conjunction with a calibrated time-base plug-in unit, the multi-trace feature of the 5100-series oscilloscope permits measurement of time difference between two or more separate events. To measure time difference, use the following procedure:

1. Set the Input Coupling switches of the amplifier channels to either AC or DC.

2. Set the Display Mode switch on the time-base unit to either Chop or Alt. In general, Chop is more suitable for low-frequency signals and the Alt position is more suitable for high-frequency signals. More information on determining the mode is given under Vertical Display Mode in this section.

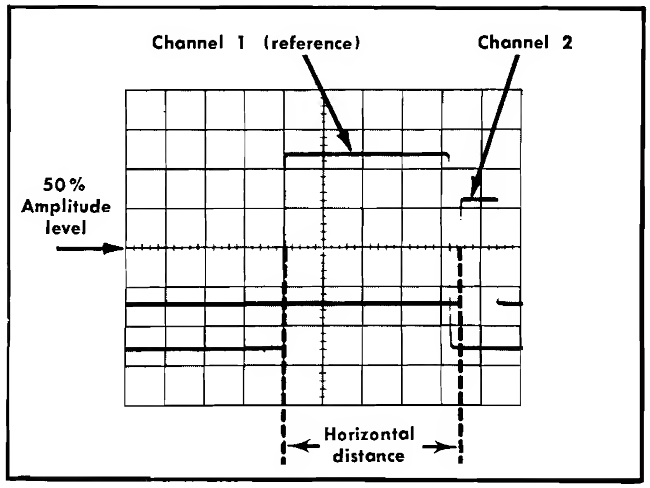


Fig. 2-6. Measuring time difference between two pulses.

3. Set the Triggering Mode switches to trigger the display on Channel 1 (or Left Plug-in).

4. Connect the reference signal to the Channel 1 input connector and the comparison signal to the Channel 2 input connector. The reference signal should precede the comparison signal in time. Use coaxial cables or probes which have similar time-delay characteristics to connect the signal to the input connectors.

5. If the signals are of opposite polarity, push the Invert button to invert the Channel 2 display. (Signals may be of opposite polarity due to 180° phase difference; if so, take this into account in the final calculation.)

6. Set the Volts/Div switches to produce about four divisions of displayed waveform.

7. Set the time-base triggering controls for a stable display. Set the Seconds/Div switch for a sweep rate which shows three or more divisions between the measurement points, if possible.

8. Adjust the vertical Position controls to bring the measurement points to the center horizontal reference line.

9. Adjust the horizontal Position control so the Channel 1 waveform (reference) crosses the center horizontal line at a vertical graticule line.

10. Measure the horizontal distance between the two measurement points (see Fig. 2-6).

11. Multiply the measured distance by the setting of the Seconds/Div switch.

EXAMPLE: Assume that the Seconds/Div switch is set to 50 μs and the horizontal distance between measurement points is four divisions.

Using the formula:

$$\text{Time Delay} = \begin{matrix}\text{Seconds/Div}\\ \text{setting}\end{matrix} \times \begin{matrix}\text{horizontal distance}\\ \text{(divisions)}\end{matrix}$$

$$= (50\ \mu s)\ (4) = 200\ \mu s.$$

The time delay is 200 microseconds.

Multi-Trace Phase Difference Measurement

Phase comparison between two or more signals of the same frequency can be made using a dual-trace plug-in or two single-trace plug-ins. This method of phase difference measurement can be used up to the frequency limit of the vertical system. To make the comparison, use the following procedure:

1. Set the Input Coupling switches of the amplifier channels to either AC or DC.

2. Set the Display Mode switch on the time-base unit to either Chop or Alt. In general, Chop is more suitable for low-frequency signals and the Alt position is more suitable for high-frequency signals. More information on determining the mode is given under Vertical Display Mode in this section.

3. Set the Triggering Mode switches to trigger the display on Channel 1 (or Left plug-in).

4. Connect the reference signal to the Channel 1 input connector and the comparison signal to the Channel 2 input connector. The reference signal should precede the comparison signal in time. Use coaxial cables or probes which have similar time-delay characteristics to connect the signals to the input connectors.

5. If the signals are of opposite polarity, push the Invert button to invert the Channel 2 display. (Signals may be of opposite polarity due to 180° phase difference; if so, take this into account in the final calculation.)

6. Set the Volts/Div switches and the Variable Volts/Div controls so the displays are equal and about five divisions in amplitude.

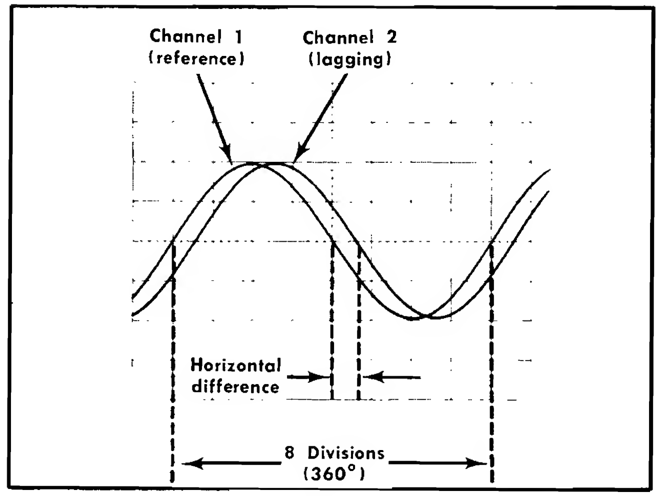


Fig. 2-7. Measuring phase difference.

7. Set the time-base triggering controls to obtain a stable display. Set the Seconds/Div switch to a sweep rate which displays about one cycle of the waveform.

8. Move the waveforms to the center of the graticule with the vertical Position controls.

9. Turn the Variable Seconds/Div control until one cycle of the reference signal (Channel 1) occupies exactly eight divisions between the second and tenth vertical lines of the graticule (see Fig. 2-7). Each division of the graticule represents 45° of the cycle (360° ÷ 8 divisions = 45°/division). The sweep rate can be stated in terms of degrees as 45°/division.

10. Measure the horizontal difference between corresponding points on the waveforms.

11. Multiply the measured distance (in divisions) by 45°/division (sweep rate) to obtain the exact amount of phase difference.

EXAMPLE: Assume a horizontal difference of 0.6 division with a sweep rate of 45°/division as shown in Fig. 2-7.

Using the formula:

$$\text{Phase Difference} = \begin{matrix}\text{horizontal}\\ \text{difference}\\ \text{(divisions)}\end{matrix} \times \begin{matrix}\text{sweep rate}\\ \text{(degrees/}\\ \text{division)}\end{matrix}$$

$$= (0.6)\ (45^\circ) = 27^\circ$$

The phase difference is 27°.

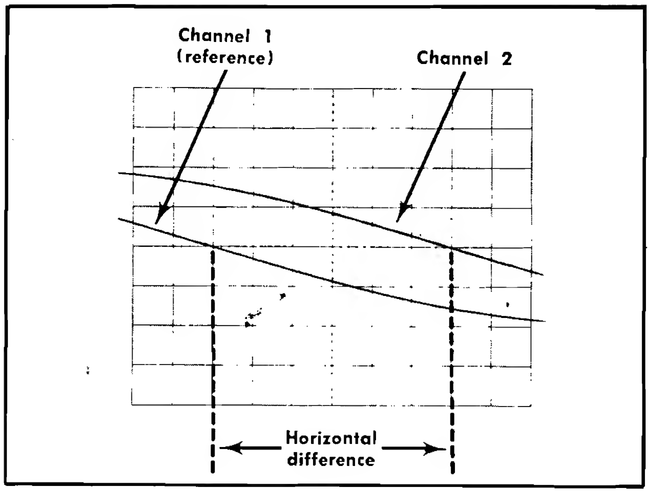


Fig. 2-8. High-resolution phase-difference measurement with increased sweep rate.

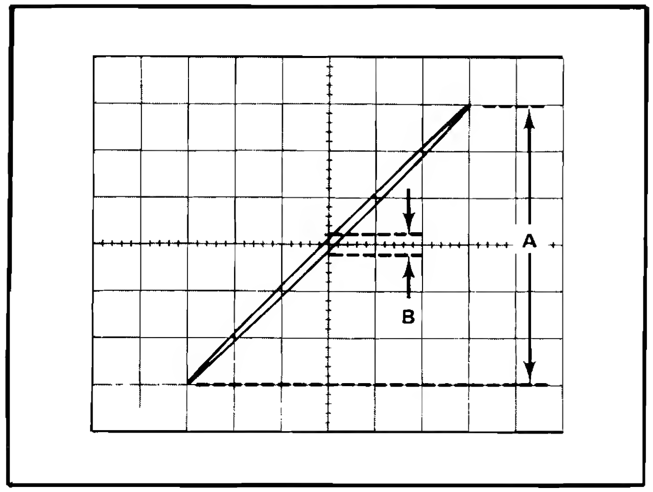


Fig. 2-9. Phase difference measurement from an X-Y display.

High Resolution Phase Measurements

More accurate dual-trace phase measurements can be made by increasing the sweep rate (without changing the Variable Seconds/Div control setting). One of the easiest ways to increase the sweep rate is with the SWP MAG (10X) button on the time-base unit. The magnified sweep rate is automatically indicated by the knob-skirt scale-factor readout.

EXAMPLE: If the sweep rate were increased 10 times with the magnifier, the magnified sweep rate would be 45°/division ÷ 10 = 4.5°/division. Fig. 2-8 shows the same signals as used in Fig. 2-7, but with the SWP MAG button pushed in. With a horizontal difference of six divisions, the phase difference is:

$$\text{Phase Difference} = \begin{matrix}\text{horizontal}\\ \text{difference}\\ \text{(divisions)}\end{matrix} \times \begin{matrix}\text{magnified}\\ \text{sweep rate}\\ \text{(degrees/division)}\end{matrix}$$

$$= (6)\ (4.5^\circ) = 27^\circ$$

The phase difference is 27°.

X-Y Phase Measurements

The X-Y phase measurement method can also be used to measure the phase difference between two signals of the same frequency. The phase angle is determined from the Lissajous pattern as outlined in the following steps:

1. Insert an amplifier plug-in unit into one of the vertical plug-in compartments and an amplifier of the same type into the horizontal plug-in compartment.

2. Connect a signal to the input connector of each plug-in and select the desired input coupling.

3. Position the display to the center of the screen and adjust the Volts/Div switches to produce a display six divisions vertically (Y) and six divisions horizontally (X).

4. Center the display in relation to the center vertical graticule line. Measure the distances A and B as shown in Fig. 2-9. Distance B is the vertical measurement between the two points where the trace crosses the center vertical line. Distance A is the maximum vertical amplitude of the display.

5. Divide B by A to obtain the sine of the phase angle (Φ) between the two signals. The angle can then be obtained from a trigonometric table. If the display appears as a diagonal straight line, the two signals are either in phase (tilted upper right to lower left), or 180° out of phase (tilted upper left to lower right). If the display is a circle, the signals are 90° out of phase. Fig. 2-10 shows the Lissajous displays produced between 0° and 360°. Notice that above 180° phase shift, the resultant display is the same as at some lower angle.

EXAMPLE: Assume a display as shown in Fig. 2-9 where A is 6 divisions and B is 0.4 division.

Using the formula:

$$\text{Sine}\ \Phi = \frac{B}{A} = \frac{0.4}{6} = 0.0667$$

From the trigonometric tables (or slide rule):

$$\Phi = \arcsin 0.0660 = 3.82^\circ$$

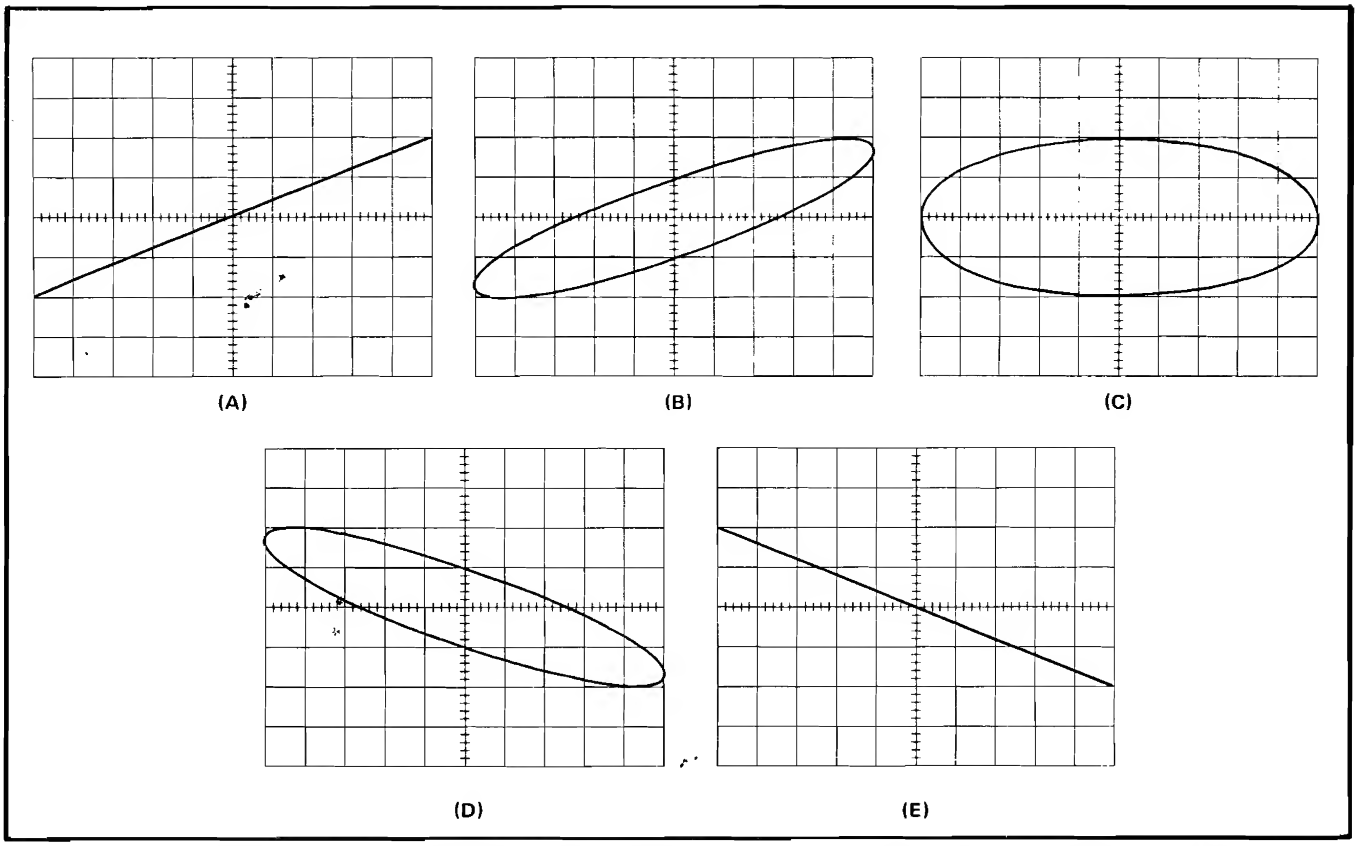


Fig. 2-10. Phase of a Lissajous display. (A) 0° or 360°, (B) 30° or 330°, (C) 90° or 270°, (D) 150° or 210°, and (E) 180°.

SECTION 3
CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of this manual.

Introduction

This section of the manual contains an electrical description of the circuits in the 5103N Power Supply/Amplifier unit, and discusses their relationship to the other instruments comprising the Oscilloscope System. An overall block diagram of the unit and complete schematics are given on pullout pages at the back of this manual.

BLOCK DIAGRAM DESCRIPTION

Vertical signals to be displayed on the cathode-ray tube are applied to the Interface circuit from both vertical plug-in compartments. With single-beam display units, the Interface circuit determines whether the signal from the left and/or right vertical unit is displayed; with dual-beam units, the Interface circuit establishes the proper routing to associate the left vertical plug-in signal with the upper CRT beam and right vertical plug-in signal with the lower CRT beam. The Vertical Amplifier circuit provides intermediate amplification between the vertical plug-in units and the deflection amplifiers in the display unit.

Time-base and external signals for horizontal display on the CRT are connected to the Interface circuit from the horizontal plug-in compartment. The Horizontal Amplifier circuit provides intermediate amplification between the horizontal plug-in unit and the deflection amplifier in the display unit.

Additionally, the Interface circuit provides an interconnection of logic levels, time-base triggering signals, display-related signals, and power-supply voltages between the plug-in units and the display unit.

The Low-Voltage Regulator circuits provide the voltage necessary for operation of the oscilloscope system. These voltages are connected to all circuits within the instrument. Also included in this circuit is the Calibrator, which produces a square-wave output with accurate amplitude at a repetition rate of twice the power-line frequency. This output signal is useful for calibration and probe compensation, and is available at the front panel of the display unit.

INTERFACE

General

The Interface circuit provides an interconnection of signals, logic levels, and power-supply voltages between plug-in units and the oscilloscope mainframe. It incorporates circuits that determine the vertical display mode and amplify the vertical and horizontal display signals. Functions of interconnections not discussed are labelled on the Interface diagram.

Clock Generator

The Clock Generator stage produces a 200-kilohertz timing signal (clock) for chopping between vertical plug-ins and amplifier channels within the plug-ins. This circuit consists of Q620, Q626, and their associated passive components, which are connected as a multivibrator. When the multivibrator receives a chop actuate level (+5 volts), it free runs at a 200-kilohertz rate. (The chop actuate level is routed through the vertical plug-ins to the time-base unit, and is present at contact A20 of J603 when a multi-trace display is required and the time-base Display switch is set to Chop.) The chop actuate level also disables Q630, locking out alternate-drive pulses. The Clock Generator has two outputs; one is sent to the Countdown circuit as a timing signal, and the other is sent to the CRT circuit in the display unit to blank the chop-switching transients.

Countdown Circuit

The Countdown produces the display switching signal for both the Alternate and Chopped switching modes. This circuit is composed of U640 and its discrete passive components, which are connected as a pair of RS flip-flops. Each flip-flop is a divide-by-two counter, and the first one drives the second. The Countdown Circuit is activated by a negative-going transition, which can come from either the Clock Generator or from the time-base plug-in unit via grounded-base amplifier Q630. The Clock Generator input results in chopped-mode vertical switching. The input from the time-base unit coincides with the end of each sweep, and results in alternate-mode vertical switching. The output from the divide-by-two portion of the Countdown Circuit (U640A-U640B) is sent via contacts B21 of J601 and J602 to the channel-switching circuits incorporated within dual-trace vertical plug-in units. The outputs from the divide-by-four portion of the Countdown Circuit (U640C-U640D) are used for plug-in switching; one output is sent to contact A15 of J604 to produce plug-in switching on the single-beam-display auxiliary board, and the other output is sent via contact B21 of J603 to produce dual-sweep switching in dual time-base units. The vertical mode switching sequence and some of the display combination possibilities are fully discussed under General Operating Information in the Operating Instructions section of this manual.

Auxiliary Boards

Because switching between plug-ins is required for simultaneous viewing of displays on single-beam cathode-ray tubes and not required for use with dual-beam cathode-ray tubes, an auxiliary board is supplied with each display unit to provide the correct signal-routing function. An auxiliary board plugs into J604 on the Interface circuit board, and becomes part of the Interface circuit. The single-beam auxiliary board accepts the push-pull signal outputs from both vertical plug-ins. Emitter followers Q701, Q703, Q711, and Q713 provide a high-impedance input to two pairs of grounded-gate FET amplifiers, Q702-Q704 and Q712-Q714. The switching circuit consists of Q721 and Q722, connected as a comparator. Plug-in "on" logic levels are applied to the switching circuit in addition to the switching signal from the Countdown Circuit. The switching circuit permits only one pair of amplifiers to be on at a time, thus permitting only one of the two vertical plug-in signals to pass to the Vertical Amplifier. In the chopped switching mode, the switching between pairs of amplifiers occurs at a 50-kilohertz rate (switching occurs on both the negative- and positive-going transition), and in the alternate mode, switching occurs at the end of every second sweep. If no "on" logic level is applied to the switching circuit from either vertical plug-in, Q702 and Q704 will remain on, passing any signal from the left vertical plug-in.

The dual-beam auxiliary board has no switching circuit. It routes the signal from the left vertical plug-in to the Vertical Amplifier circuit on the Interface circuit board, and amplifies the signal from the right vertical plug-in. The amplifier circuit on the dual-beam auxiliary board is identical to the Vertical Amplifier which is discussed next, and consists of Q701, Q702, Q711, and Q712. The output of this amplifier is sent directly to the lower-beam deflection amplifier in the display unit.

Vertical Amplifier

The Vertical Amplifier circuit provides approximately 10X amplification of the vertical signal before passing it to the vertical deflection amplifier in the display unit. The Vertical Amplifier consists of Q650, Q658, Q660, Q668, and their associated passive components, connected in a differential configuration. The output signal is in phase with the output of the vertical plug-in.

Horizontal Amplifier

The Horizontal Amplifier consists of Q670, Q678, Q680, Q688, and their associated passive components. The circuit is nearly identical to the Vertical Amplifier just described. It receives a push-pull input directly from the horizontal plug-in compartment via contacts A7, A13, B7, and B13 of J603. The two halves of this amplifier are balanced in the quiescent condition by adjustment of R675, Horiz Cent. The output of the Horizontal Amplifier is sent to the horizontal deflection amplifier in the display unit.

POWER SUPPLY

General

The Power Supply circuit provides the low-voltage operating power for the oscilloscope system from three regulated supplies and three unregulated supplies. Electronic regulation is used to provide stable, low-ripple output voltages. The circuit also includes the calibrator circuit to produce an accurate square-wave output.

Power Input

Power is applied to the primary of transformer T801 through the display unit (fuse F201, thermal cutout S200, and Power switch S201), and the line-selector block, P810. The line-selector block allows changing the primary-winding taps of T801 to fit different line requirements.

Low-Voltage Rectifiers and Unregulated Outputs

The full-wave bridge rectifiers and associated filter components in the secondaries of T801 provide filtered DC voltages for operation of the oscilloscope system or for regulation by the Low-Voltage Regulators. The unregulated outputs are +200 volts, +38 volts, and −38 volts. The +205-volt and +38-volt outputs to the display unit are fuse-protected by F810 and F835 respectively.

Low-Voltage Regulators

−30-Volt Supply. The −30-Volt Supply, besides providing power to circuitry throughout the instrument, provides a reference-voltage source to establish operating levels for the feedback regulators in the +30-Volt and +5-Volt supplies. The regulator for the −30-Volt Supply is a feedback amplifier system which operates between ground and the unregulated −38 volts. Current to the load is delivered by the series-pass transistor, Q860, and the supply voltage is established by the drop across R877, R878, and R879. The feedback path is through R875, Q875, and Q865 to the base of Q860. Any variation in output voltage due to ripple, change of current through the load, etc., is immediately transmitted to the base of Q860 and nullified by a change in Q860 conduction, thus maintaining a steady output. The output of the supply is set to exactly −30 volts by adjustment of R878, −30 V Adj. This control sets the conduction of Q870, which controls the bias levels of Q865 and Q860. CR865 and Q865 provide short-circuit protection by limiting the current through Q860.

+30-Volt Supply. The regulator for the +30-Volt Supply consists of series-pass transistor Q840 and error amplifier Q850. This is a feedback amplifier system similar to that just described for the −30-Volt Supply. R858, +30 V Adj, provides an adjustment to set the output of the supply at exactly +30 volts. Q845 protects the supply in the event the output is shorted by limiting the current demanded from the series-pass transistor under excessive load. During normal operation, Q845 is biased off.

+5-Volt Supply. The regulator for the +5-Volt Supply consists of series-pass transistor Q815 and error amplifier Q820. Operation of this feedback amplifier system is similar to that described for the −30-Volt Supply. The short-protection transistor, Q825, functions as described for Q845 in the +30-Volt Supply.

Line Trigger

A line-frequency signal is obtained from the secondary of T801 and attenuated by R830, R832, and R834 to provide a line-trigger source for the time-base plug-in unit.

CRT Heater Windings

Two separate secondary windings are provided for the CRT writing-gun heaters and the flood-gun heaters. The writing-gun heaters are elevated to −3500 volts in the CRT circuit (display unit) to maintain a potential near that of the CRT cathode.

Calibrator

The Calibrator circuit composed of Q885, Q890, and their associated passive components produces a square-wave output with accurate amplitude and at a rate of twice the power-line frequency. This output is available at the probe test loop on the display unit front panel as a 4-milliampere (peak to peak) square-wave current, or as a 400-millivolt (ground to peak) square-wave voltage.

The resistive-capacitive network at the base of Q885 receives a pulsating DC voltage from full-wave rectifier CR835-CR836 and produces a nearly symmetrical switching signal for Q885 and Q890. As Q890 is alternately switched on and off at twice the line frequency, current through R890 is alternately switched through the transistor or through CR890, the probe test loop, and R891, producing the required test signal.

NOTES

SECTION 4
SYSTEM MAINTENANCE

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual applies to all instruments in the 5100-series oscilloscope system, including display units and plug-in units. It contains information for preventive maintenance, troubleshooting, obtaining replacement parts, and replacing components and sub-assemblies.

5100 Panel Removal

WARNING

Dangerous potentials exist at several points throughout the oscilloscope. When the instrument must be operated with the cabinet panels removed, do not touch exposed connections or components. Some transistors have voltage present on their cases. Disconnect power before cleaning the instrument or replacing parts.

The cabinet panels of the 5100-series oscilloscope are held in place by slotted fasteners. To remove the panels, turn each fastener counterclockwise a quarter turn with a large screwdriver, coin, or similar device. Then the panels can be lifted away. The instrument should be operated with the panels in place to protect the interior from dust, and to eliminate shock hazard.

PREVENTIVE MAINTENANCE

General

Preventive maintenance, consisting of cleaning, visual inspection, etc., performed on a regular basis, will improve the reliability of the oscilloscope. Periodic checks of the semiconductor devices used in the system are not recommended as a preventive maintenance measure. See semiconductor-checking information given under troubleshooting. A convenient time to perform preventive maintenance is preceding instrument calibration.

Cleaning

CAUTION

Avoid the use of chemical cleaning agents which might damage plastic parts. Avoid chemicals containing benzene, toluene, xylene, acetone, or similar solvents.

Exterior. Loose dust may be removed with a soft cloth or a dry brush. Water and mild detergent may be used; however, abrasive cleaners should not be used.

Interior. Cleaning the interior of the unit should precede calibration, since the cleaning process could alter the settings of the calibration adjustments. Use low-velocity compressed air to blow off the accumulated dust. Hardened dirt can be removed with a soft, dry brush, cotton-tipped swab, or cloth dampened with a water and mild detergent solution.

Calibration

To ensure accurate measurements, the performance of individual units comprising the 5100-Series Oscilloscope should be checked periodically. Complete calibration instructions are given in the manuals for each unit.

The calibration procedure can be helpful in isolating major troubles in a unit. Moreover, minor troubles not apparent during regular operation may be revealed and corrected during calibration.

TROUBLESHOOTING

General

The following is provided to augment information contained elsewhere in this and in other manuals when troubleshooting the 5100-Series Oscilloscope or its plug-in units. The schematic diagrams, circuit description and calibration sections should be used to full advantage. The circuit description sections give detailed information about circuit behavior and output requirements.

Troubleshooting Aids

Diagrams. Circuit diagrams are given on foldout pages in the diagram section of each individual manual. The circuit number and electrical value of each component in this instrument system are shown on the diagrams (see first page of each diagram section for definition of the reference designators used to identify components in each unit). Each main circuit is assigned a series of component numbers. Important voltages and waveforms are also shown on the diagrams. The portions of the circuits mounted on circuit boards are enclosed with blue lines.

Cam Switch Contact Identification. Cam switches shown on the diagrams are coded to indicate the position of the contact in the complete switch assembly counting from the front, or knob end of the switch, toward the rear. The contact closure chart given on the diagrams indicates when each contact is closed.

Circuit Boards. Pictures of the circuit boards are shown in the diagram sections. These pictures are located near their respective associated schematic diagrams to aid in cross reference between the diagrams and the circuit board pictures. Where applicable, circuit boards are identified by assembly numbers, which are used on the diagrams and in the parts lists to aid in locating the boards. Each electrical component on the boards is identified by its circuit number. The circuit boards are also outlined on the diagrams with a blue line to show which portions of the circuit are located on a circuit board.

Component and Wiring Color Code. Colored stripes or dots on resistors and capacitors signify electrical values, tolerances, etc., according to the EIA standard color code. Components not color coded usually have the value printed on the body.

WARNING

This color code applies to leads within the 5100-Series Oscilloscope system only. Color code of the AC power cord is:

Black — Line
White — Neutral
Green with a yellow stripe — Safety Earth (ground)

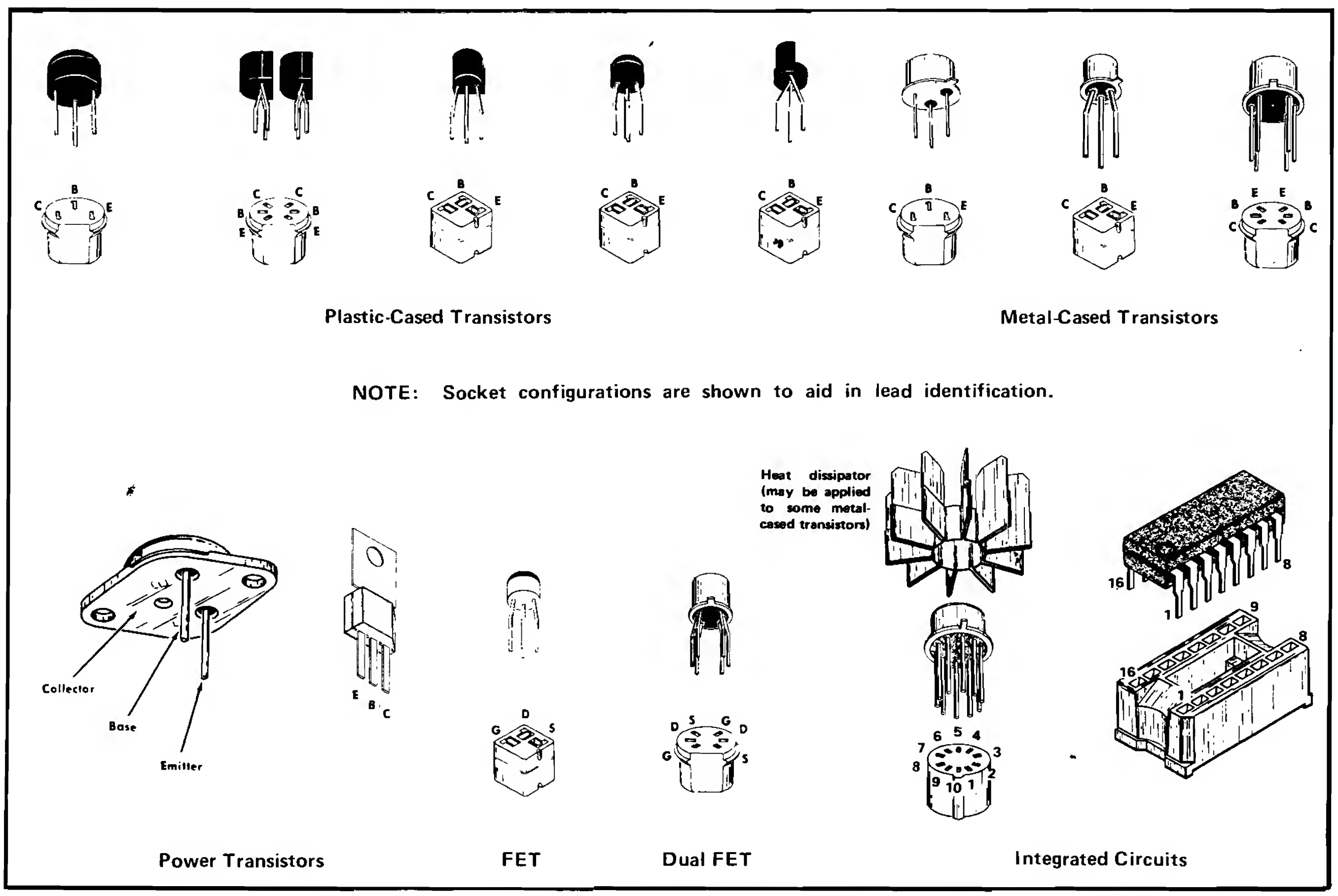


Fig. 4-1. Electrode configuration data for semiconductor devices.

Semiconductor Lead Configuration. Fig. 4-1 shows the lead configuration of the semiconductor devices used in this instrument.

Multi-Connector Holders. The multi-connector holder is keyed with two triangles, one on the holder and one on the circuit board. When a connection is made perpendicular to a circuit board surface, the orientation of the triangle and the slot numbers on the connector holder is determined by the direction of the nomenclature marking (see Fig. 4-2).

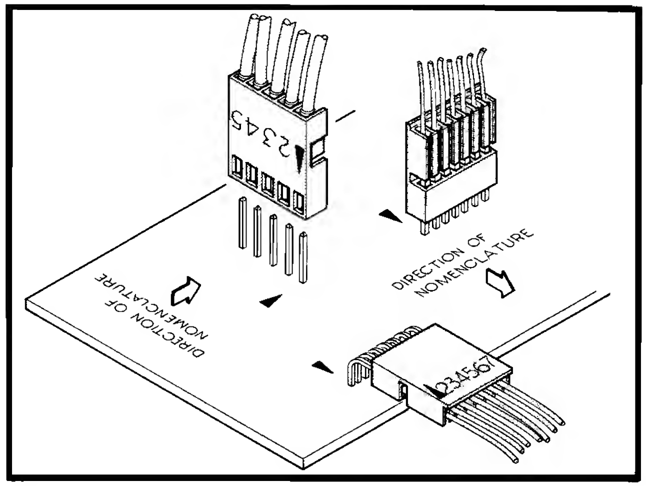


Fig. 4-2. Multi-connector holder orientation.

Troubleshooting Equipment

The following equipment is useful for troubleshooting the 5100-Series Oscilloscope and its plug-in units:

1. Semiconductor Tester

   Description: Dynamic-type tester.

   Purpose: To test the semiconductors used in this instrument system.

   Recommended type: Tektronix Type 576 Transistor Curve Tracer or equivalent.

2. Multimeter

   Description: VTVM, 10-megohm input impedance and 0 to 300 volts range, AC and DC; ohmmeter, 0 to 50 megohms. Accuracy, within 3%. Test probes must be insulated to prevent accidental shorting.

   Purpose: To check voltages and for general troubleshooting in this instrument system.

   NOTE

   A 20,000 ohms/volt VOM can be used to check the voltages in this instrument if allowances are made for the circuit loading of the VOM at high-impedance points.

3. Test Oscilloscope

   Description: Frequency response, DC to 2 megahertz minimum; deflection factor, 1 millivolt/division to 5 volts/division. A 10X, 10-megohm voltage probe should be used to reduce circuit loading for voltage measurements.

   Purpose: To check operating waveforms in this instrument.

Troubleshooting Techniques

This troubleshooting procedure is arranged in an order which checks the simple trouble possibilities before proceeding with extensive troubleshooting. When a defective component is located, it should be replaced following the replacement procedure given under Component Replacement.

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 instructions section of the manual for the instrument involved.

2. Check System and Associated Equipment. Before proceeding with troubleshooting of the 5100 system, check that the instruments in the system are operating correctly. Check for proper interconnection between the display unit and the power supply/amplifier unit. Check that the signal is properly connected and that the interconnecting cables or signal source are not defective. Also, check the power source. The associated plug-in units can be checked for proper operation by substituting other units which are known to be operating properly (preferably of the same types), or by interchanging plug-in units within the 5103N. If the trouble persists after substitution, the oscilloscope mainframe is probably at fault.

3. Visual Check. Visually check the portion of the instrument in which the trouble is suspected. Many troubles can be located by visual indications such as unsoldered connections, broken wires, damaged circuit board, damaged components, etc.

4. Check Instrument Calibration. Check the calibration of the 5100-Series Oscilloscope and its associated plug-ins, or check the affected circuit if the trouble appears in one circuit. The apparent trouble may only be a result of misadjustment or may be corrected by calibration. Complete calibration instructions are given in the calibration section of the manual for each instrument in the system.

5. Isolate the Trouble to a Circuit. To isolate trouble to a particular circuit, note the trouble symptom. The symptom often identifies the circuit in which the trouble is located. For example, poor focus indicates that the CRT circuit (includes high-voltage supplies) is probably at fault. When trouble symptoms appear in more than one circuit, check affected circuits by taking voltage and waveform readings.

Incorrect operation of all circuits often indicates trouble in the power supply. Check first for correct voltage 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. Table 4-1 lists the tolerances of the power supplies in this instrument. These voltages are measured between the power-supply test points and ground on the Power Supply circuit board (see Fig. 5-1 in the calibration section of this manual for test point locations). If a power-supply voltage is within the listed tolerance, the supply can be assumed to be working correctly. If outside the tolerance, the supply may be misadjusted or operating incorrectly. Use the procedure given in the calibration section to adjust the power supplies.

TABLE 4-1

Power Supply Tolerances

Power Supply	Tolerance	Typical Ripple
+205 V	+180 V to +240 V	3 V or less
+30 V	+29.85 V to +30.15 V	3 mV or less
+5 V	+4.9 V to +5.1 V	2 mV or less
−30 V	−29.925 V to −30.075 V	2 mV or less

6. Check Voltages and Waveforms. Often the defective component can be located by checking for the correct voltage or waveform in the circuit. Typical voltages and waveforms are given on the diagrams.

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 first diagram page.

7. Check Individual Components. The following methods are provided for checking the individual components in the 5100-series instrument system. Components which are soldered in place are best checked by disconnecting one end, isolating the measurement from the effects of surrounding circuitry.

A. TRANSISTORS and INTEGRATED CIRCUITS

CAUTION

Power switch must be turned off before removing or replacing semiconductors.

A good check of transistor operation is actual performance under operating conditions. A transistor can most effectively be checked by substituting a new component for it (or one which has been checked previously). However, be sure that circuit conditions are not 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. A suction-type desoldering tool must be used to remove soldered-in transistors; see component replacement procedure for details.

Integrated circuits can be checked with a voltmeter, test oscilloscope, or by direct substitution. A good understanding of the circuit description is essential to troubleshooting circuits using IC's. Operating waveforms, logic levels, and other operating information for the IC's are given in the circuit description section of the appropriate manual. 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 in-line IC's is with an integrated-circuit test clip. This device also doubles as an extraction tool.

B. DIODES

A diode can be checked for an open or for a short circuit by measuring the resistance between terminals with an ohmmeter set to the R X 1k scale. The diode resistance should be very high in one direction and very low when the meter leads are reversed. Do not check tunnel diodes or back diodes with an ohmmeter.

CAUTION

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

C. RESISTORS

Check the resistors with an ohmmeter. Resistor tolerance is given in the Electrical Parts List. Resistors normally do not need to be replaced unless the measured value varies widely from the specified value.

D. CAPACITORS

A leaky or shorted capacitor can be detected by checking resistance with an ohmmeter on the highest scale. Use an ohmmeter which will 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 whether the capacitor passes AC signals.

8. Repair and Readjust the Circuit. Special techniques required to replace the components in this unit are given under Component Replacement. Be sure to check the performance of any circuit that has been repaired or that has had any electrical components replaced. Calibration of the affected circuit may be necessary.

REPLACEMENT PARTS

Standard Parts

All electrical and mechanical part replacements for the 5100-series oscilloscope system can be obtained through your local 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 lists for value, tolerance, rating, and description.

NOTE

When selecting replacement parts, it is important to remember that the physical size and shape of the component may affect its performance in the instrument. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect the instrument performance.

Special Parts

Some parts are manufactured or selected by Tektronix to satisfy particular requirements, or are manufactured for Tektronix to our specifications. These special parts are indicated in the parts list by an asterisk preceding the part number. Most of the mechanical parts used in this system have been manufactured by Tektronix. Order all special parts directly from your local Tektronix Field Office or representative.

Ordering Parts

When ordering replacement parts from Tektronix, Inc., refer to the Parts Ordering Information and Special Notes and Symbols on the page immediately preceding each electrical parts list section. Include the following information:

1. Instrument Type (5103N, D10, 5A15N, etc.)

2. Instrument Serial Number

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

4. Tektronix Part Number

COMPONENT REPLACEMENT

General

The exploded-view drawings associated with the mechanical parts lists (pullout pages) may be helpful when disassembling or re-assembling individual components or sub-assemblies.

Circuit Board Replacement

If a circuit board is damaged beyond repair, the entire assembly including all soldered-on components can be replaced. Part numbers are given in the mechanical parts lists for the completely wired (670 prefix) board.

To remove or replace a board, proceed as follows:

1. Disconnect all leads connected to the board (both soldered lead connections and solderless pin connections).

2. Remove all screws holding the board to the chassis or other mounting surface. Some boards may be held fast by plastic mounting clips around the board edges (for example, the H.V. board in the display modules). For these, push the mounting clips away from the circuit board edges to free the board. Also, remove any knobs, etc., that would prevent the board from being lifted out of the instrument.

3. Lift the circuit board out of the unit. Do not force or bend the board.

4. To replace the board, reverse the order of removal. Use care when replacing pin connectors; if forced into place incorrectly positioned, the pin connectors may be damaged.

Transistor and Integrated Circuit Replacement

Transistors and IC's should not be replaced unless they are actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement or switching of semiconductor devices may affect the calibration of the instrument. When a transistor is replaced, check the operation of the part of the instrument that may be affected.

CAUTION

POWER switch must be turned off before removing or replacing semiconductors.

Replacement semiconductors should be of the original type or a direct replacement. Fig. 4-1 shows the lead configuration of the semiconductors used in this instrument system. When removing soldered-in transistors, use a suction-type de-soldering tool to remove the solder from the holes in the circuit board.

An extracting 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 extracting tool is not available, use care to avoid damaging the pins. Pull slowly and evenly on both ends of the IC. Try to avoid having one end of the IC disengage from the socket before the other end.

To replace one of the power transistors mounted on the chassis adjacent to the Power Supply circuit board, first unsolder the leads. Then, loosen the nuts on the plastic bar that clamps the transistor to the chassis. Remove the defective transistor. When replacing the transistor, use silicone grease on the metal tab to increase heat transfer from the transistor to the chassis.

Interconnecting Pin Replacement

NOTE

A pin replacement kit including necessary tools, instructions, and replacement pins is available from Tektronix, Inc. Order Tektronix Part No. 040-0542-00.

To replace a pin which is mounted on a circuit board, first disconnect any pin connectors. Then, unsolder the damaged pin and pull it out of the board with a pair of pliers. Be careful not to damage the wiring on the board with too much heat. Ream out the hole in the circuit board with a 0.031-inch drill. Remove the ferrule from the new interconnecting pin and press the new pin into the hole in the circuit board. Position the pin in the same manner as the old pin. If the old pin was bent at an angle to mate with a connector, bend the new pin to match the associated pins.

Switch Replacement

The following special maintenance information is provided for the cam-type switches and pushbutton switches used in this instrument system.

CAUTION

Repair of cam-type switches should be undertaken only by experienced maintenance personnel. Switch alignment and spring tension of the contacts must be carefully maintained for proper operation of the switch. For assistance in maintenance of the cam-type switches, contact your local Tektronix Field Office or representative.

A. CAM-TYPE SWITCHES

NOTE

A cam-type switch repair kit including necessary tools, instructions, and replacement contacts is available from Tektronix, Inc. Order Tektronix Part No. 040-0541-00.

The cam-type switches consist of rotating cam drums which are turned by front-panel knobs, and sets of spring-leaf contacts mounted on adjacent circuit boards. The contacts are actuated by lobes on the cams. In the 5100-Series Oscilloscope system, the Volts/Div and Seconds/Div switches are of the cam type. These switches can be disassembled for inspection, cleaning, repair, or replacement as follows:

1. Remove the screws which hold the metal cover on the switch, and lift the cover off the switch. The switch is now open for inspection or cleaning.

2. To completely remove a switch from the circuit board, first remove any knobs or shaft extensions. Loosen the coupling at the potentiometer at the rear of the switch, and pull the long shaft (with red knob attached) out of the switch assembly.

3. Remove the screws (from the opposite side of the circuit board) which hold the cam drum to the board.

4. To remove the cam drum from the front support block, remove the retaining ring from the shaft on the front of the switch and slide the cam drum out of the support block. Be careful not to lose the small detent roller.

5. To replace defective switch contacts, follow the instructions given in the switch repair kit.

6. To re-install the switch assembly, reverse the above procedure.

B. PUSHBUTTON SWITCHES

The pushbutton switches are not repairable and should be replaced as a unit if defective. Use a suction-type desoldering tool to remove solder from the holes in the circuit board when unsoldering the switches.

Cathode-Ray Tube Replacement

The following procedure outlines the removal and replacement of the cathode-ray tube. Refer to Fig. 4-3.

WARNING

Use care when handling a CRT. Protective clothing and safety glasses should be worn. Avoid striking it on any object which might cause it to crack or implode. When storing a CRT, place it in a protective carton or set it face down in a protected location on a smooth surface with a soft mat under the faceplate to protect it from scratches.

A. REMOVAL:

1. Remove the bezel assembly, which is held in place with two screws. (The bezel assembly includes a snap-in implosion shield.)

2. For storage CRT's (D11, D13), disconnect the storage-element cable connector from the Storage circuit board. For dual-beam CRT's (D12, D13), disconnect deflection leads from neck pins.

NOTE

The red and black wires entering the CRT shield are connected to the trace-rotation coil inside the shield.

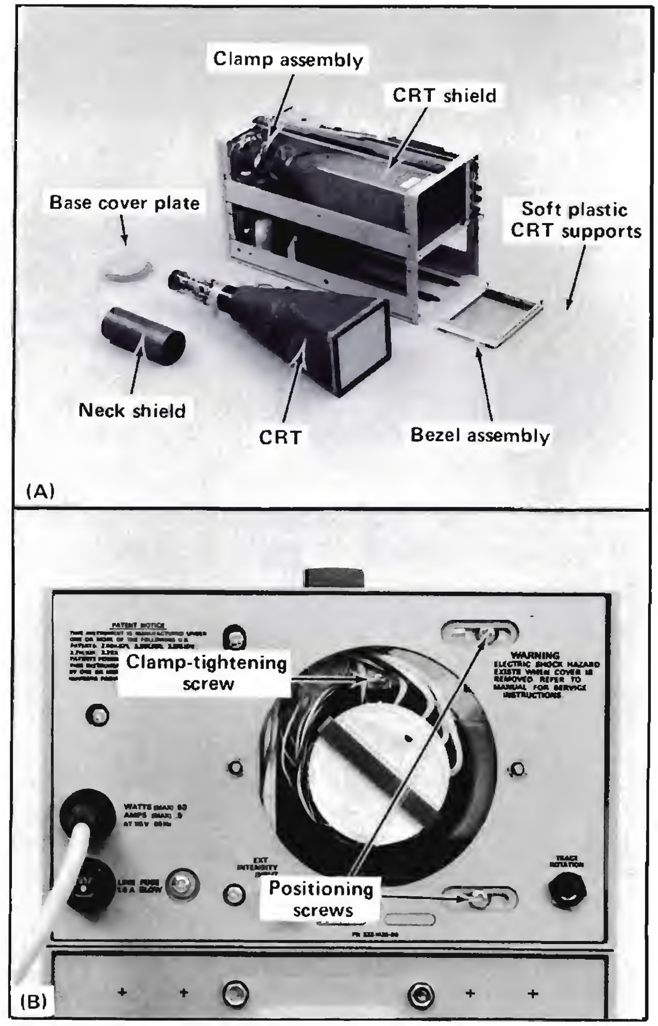


Fig. 4-3. Replacing the cathode-ray tube.

They will not hamper CRT removal and need not be unsoldered.

3. Remove the CRT base cover on the rear panel of the instrument.

4. Remove the CRT base socket.

5. Loosen the CRT clamp. The CRT and neck portion of the shield will be removed as a unit, and to facilitate removal, it may be best to remove all hardware from the CRT clamp (bracket and positioning screws, and clamp-tightening hardware).

6. With one hand on the CRT faceplate, push on the CRT base (and neck shield). Slide the CRT and neck shield forward, and at the same time feed the storage-element

cable through the slot in the main portion of the CRT shield. Pull the CRT out of the instrument from the front, then remove the neck shield.

B. REPLACEMENT:

1. Slide the neck shield onto the CRT neck.

2. Make sure the soft plastic CRT faceplate supports are in place, then insert the CRT into the main shield while feeding the storage-element cable through the slot in the shield. Before the CRT is completely inserted, slide the CRT clamp over the neck shield.

3. With the CRT fully inserted and loose in the shield, mount the bezel assembly into place and tighten the bezel screws.

4. Mount the CRT clamp and positioning hardware, temporarily leaving it loose.

5. Position the rear of the CRT (socket end) so there is no tilt of the faceplate in relation to the bezel assembly. Tighten the positioning screws, then tighten the clamp hardware.

6. Place the CRT base socket onto the CRT base pins. Replace the cover. If applicable, connect the storage-element cable to the pin connectors on the Storage circuit board, and connect the deflection leads to the CRT neck pins.

7. Replacing the CRT will require partial instrument recalibration. Refer to the calibration section of the display unit manual.

Neon Bulb Replacement

To replace the knob-skirt deflection-factor readout bulbs, proceed as follows:

1. Remove the light shield.

2. Unsolder the defective bulb, and install its replacement.

3. Replace the light shield.

Power Transformer Replacement

Replace the power transformer only with a direct replacement Tektronix transformer. After the transformer has been replaced, check the power supply output voltages as outlined in the calibration section of this manual. Also, check the CRT operation as outlined in the calibration section of the display unit manual.

Fuse Replacement

Table 4-3 gives the rating, location, and function of the fuses used in this instrument system.

TABLE 4-1

Circuit Number	Rating	Function	Location
F20, F206	1/16 A Fast	Input Protection	5A20N/5A21N circuit board
F201	1.6 A Fast	Line-Voltage Input	Display unit rear panel
F810	0.25 A Fast	+205 V Unreg supply	5103N Power Supply board
F835	0.5 A Fast	+38 V Unreg supply	5103N Power Supply board

RECALIBRATION AFTER REPAIR

After any electrical component has been replaced, the calibration of that particular circuit should be checked, as well as the calibration of other closely related circuits. The Performance Check instructions in each manual provide a quick and convenient means of checking the instrument operation.

REPACKAGING FOR SHIPMENT

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:

> Surround the instrument with polyethylene sheeting to protect the finish of the instrument. Obtain a carton of corrugated cardboard of the correct carton strength and having inside dimensions of no less than six inches more than the instrument dimensions. Cushion the instrument by tightly packing three inches of dunnage or urethane foam between carton and instrument, on all sides. Seal carton with shipping tape or industrial stapler.

The carton test strength for your instrument is 275 pounds.

SECTION 5
CALIBRATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

Before complete calibration, thoroughly clean and inspect this instrument as outlined in the Maintenance section of this manual.

NOTE

This procedure facilitates checking and adjusting the Low-Voltage Power Supply ONLY. For complete oscilloscope mainframe calibration (plug-in interface, deflection amplifiers, CRT circuits, etc.), refer to the calibration procedure given in the manual for the display unit.

Services Available

Tektronix, Inc. provides complete instrument repair and calibration at local Field Service Centers and at the Factory Service Center. Contact your local Tektronix Field Office or representative for further information.

Equipment Required

For power-supply calibration, proper loading must be established to ensure correct operation and regulation of the low-voltage supplies. For best results, the 5103N should be operated with a display unit and plug-in units because this provides actual operating-condition loads for the supplies.

For measurement of the supply voltages, a precision DC voltmeter is required. The voltmeter must have an accuracy of within ±0.1%, and a measurement range from about −35 volts to +250 volts. For example, a Fairchild Model 7050 Digital Multimeter, a Tektronix 7D13 Digital Multimeter (operated with a Tektronix 7000-Series Readout Oscilloscope), or any DC voltmeter meeting the listed requirements may be used.

Preliminary Procedure

NOTE

The performance of this instrument can be checked at any temperature within the 0°C to +50°C range. Make any adjustments at a temperature of +25°C, ±5°C.

a. Remove the bottom dust cover of the 5103N to gain access to the power supply circuit board. If necessary, set the line-selector block in accordance with the line voltage source to be used (see Section 2, Operating Voltage, in this manual for complete instructions).

b. Connect the 5103N to the line voltage source. Turn the Intensity control on the display unit counterclockwise and pull the Power switch out to turn the instrument on.

c. Allow a 20 minute warm up time before performing the calibration procedure.

Location of the power-supply test points and calibration adjustments is shown in Fig. 5-1. Table 5-1 shows the tolerances of the low-voltage supplies.

TABLE 5-1

Supply	Tolerance
−30 V	−29.925 V to −30.075 V
+5 V	+4.9 V to +5.1 V
+30 V	+29.85 V to +30.15 V
+205 V	+180 V to +240 V

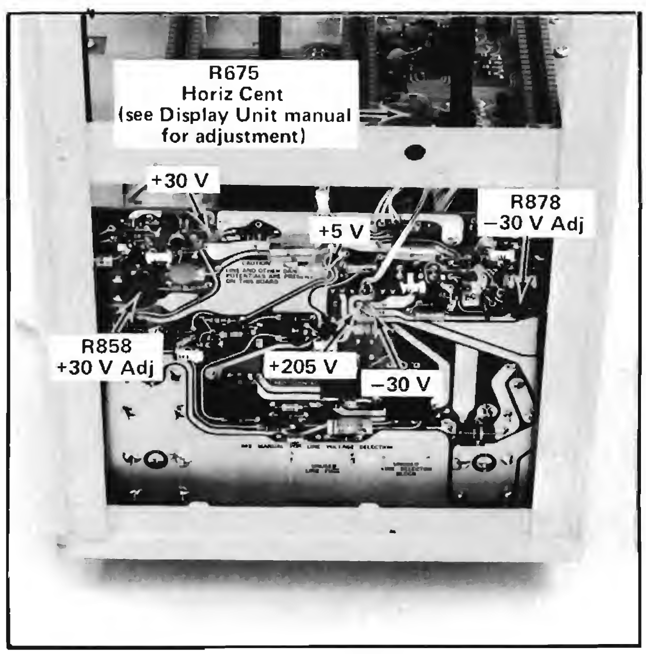


Fig. 5-1. Locations of power-supply test points and adjustment controls.

1. Power Supply Checks

a. Connect the precision DC voltmeter between each low-voltage test point and ground.

b. CHECK—Each supply is within the tolerance listed in Table 5-1.

2. Power Supply Voltage Adjustments

a. Connect the precision DC voltmeter between each test point (−30 V and +30 V) and ground.

b. ADJUST—R878, −30 V ADJ, and R858, +30 V ADJ, respectively, for voltmeter readings of exactly 30 volts.

This completes the Power Supply calibration for the 5103N.

SECTION 6 RACKMOUNTING

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

The R5100-Series Oscilloscope is designed for operation in a standard 19-inch wide rack which has Universal, EIA, RETMA, or Western Electric hole spacing. When properly mounted, this instrument will meet all electrical and environmental specifications given in Section 1.

Instrument Conversion

The 5100-Series Oscilloscope can quickly be converted from a bench model to a rackmount model, or vice versa. Field conversion kits, including the necessary tools, parts, and instructions are available from Tektronix, Inc. Order: 040-0583-00, Bench-to-rack conversion; 040-0584-00, Rack-to-bench conversion.

Mounting Method

This instrument will fit most 19-inch wide racks whose front and rear holes conform to Universal hole spacing. The slide-out tracks easily mount to the cabinet rack front and rear vertical mounting rails if the inside distance between the front and rear rails is within 10-9/16 inches to 24-3/8 inches. If the inside distance exceeds 24-3/8 inches, some means of support is required for the rear ends of the slide-out tracks (for example, make extensions for the rear mounting brackets).

Rack Dimensions

Height. At least 5-1/4 inches of vertical space is required to mount this instrument in a rack. If other instruments are operated in the rack, an additional 1/4 inch is required both above and below the R5100 to allow space for proper circulation of cooling air.

Width. A standard 19-inch wide rack may be used. The dimension of opening between the front rails must be at least 17-5/8 inches for a cabinet in which the front lip of the stationary section is mounted behind an untapped front rail as shown in Fig. 6-1A. If the front rails are tapped, and the stationary section is mounted in front of the front rail as shown in Fig. 6-2B, the dimension between the front rails should be at least 17-3/4 inches. These dimensions allow room on each side of the instrument for the slide-out tracks to operate so the instrument can move freely in and out of the rack.

Depth. For proper circulation of cooling air, allow at least two inches clearance behind the rear of the instrument and any enclosure on the rack. If it is sometimes necessary or desirable to operate the R5100 in the fully extended position, use cables that are long enough to reach from the signal source to the instrument.

Installing the Slide-Out Tracks

General Information. The slide-out tracks for the instrument consist of two assemblies, one for the left side of the instrument and one for the right side. Each assembly consists of three sections. A stationary section attaches to the front and rear rails of the rack, the chassis section attaches to the instrument (and is installed at the factory), and the intermediate section fits between the other two sections to allow the instrument to fully extend out of the rack.

The small hardware components included with the slide-out track assemblies are used to mount the tracks to the vertical rack rails having this compatibility:

1. Front and rear rail holes must be large enough to allow inserting a 10-32 screw through the rail mounting hole if the rails are untapped (see Fig. 6-1A).

2. Or, front and rear rail holes must be tapped to accept a 10-32 screw if Fig. 6-1B mounting method is used. Note in Fig. 6-1B right illustration that a #10 washer (not supplied) may be added to provide increased bearing surface for the slide-out track stationary section front flange.

3. Front and rear rail holes must be located on Universal spacing; that is, the sequence for the hole spacing is 1/2 inch, 5/8 inch, 5/8 inch, 1/2 inch, etc.

Because of the above compatibility, there will be some small parts left over. The stationary and intermediate sections for both sides of the rack are shipped as a matched set and should not be separated. The matched sets of both sides including hardware are marked 351-0195-00 on the package. To identify the assemblies, note that the automatic latch and intermediate section stop is located near the top of the matched set.

Mounting Procedure. Use the following procedure to mount both sides. See Fig. 6-1 for installation details.

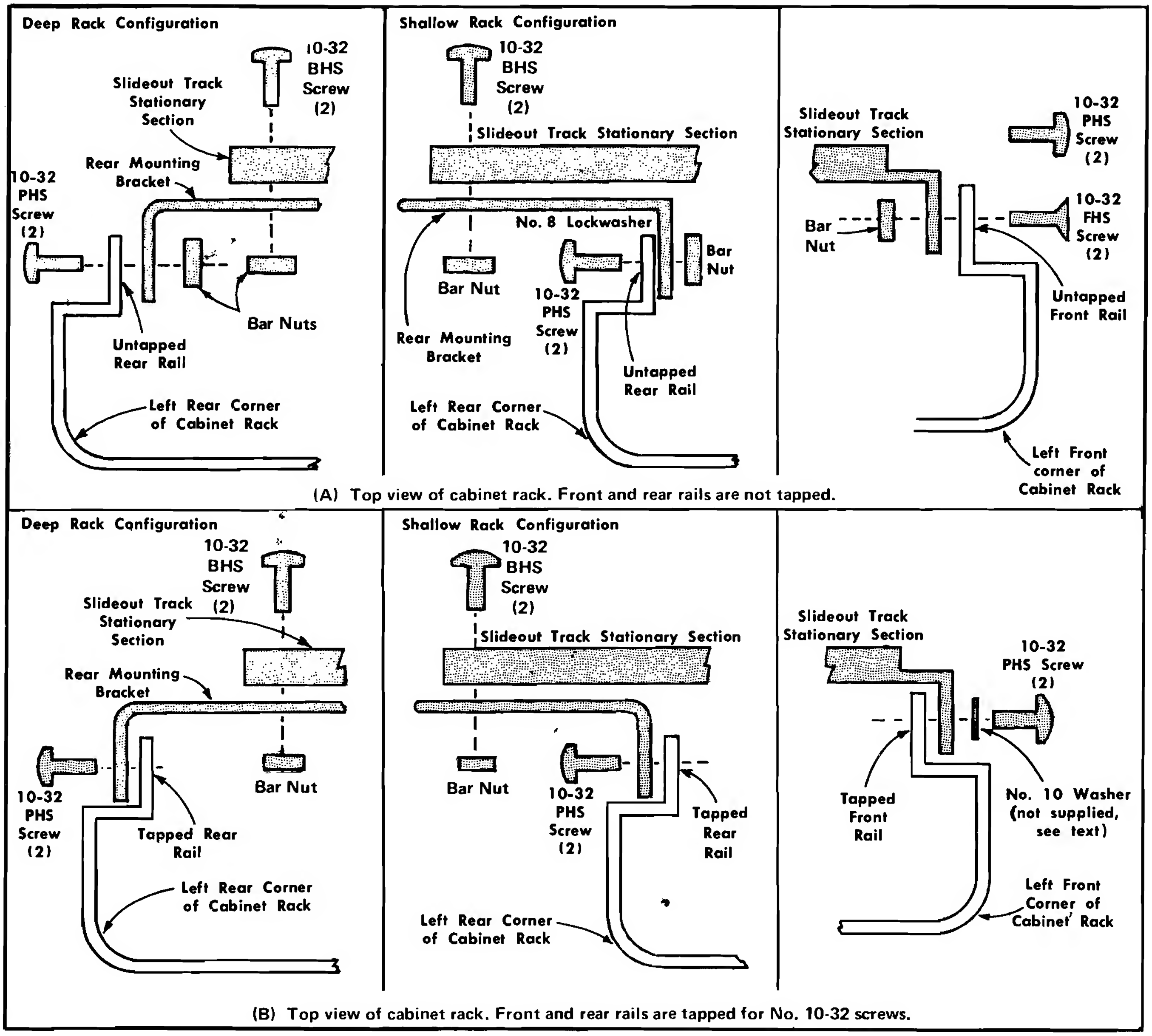


Fig. 6-1. Mounting the left stationary section (with its matched intermediate section, not shown in illustrations A and B) to the rack rails.

1. To mount the instrument directly above or below another instrument in a cabinet rack, select the appropriate holes in the front rack rails for the stationary sections, using Fig. 6-2 as a guide.

2. Mount the stationary slide-out track sections to the front rack rails using either of these methods:

(a) If the front flanges of the stationary sections are to be mounted behind the front rails (rails are countersunk or not tapped), mount the stationary sections as shown in Fig. 6-1A right illustration.

(b) If the front flanges of the stationary sections are to be mounted in front of the front rails (rails are tapped for 10-32 screws), mount the stationary sections as shown in Fig. 6-1B right illustration. To provide increased bearing surface for the screw head to securely fasten the front flange to the rail, a flat washer (not supplied) may be added under the screw head. However, consider that when this mounting method is used, the front panel will not fit flush against the front rail because of the stationary section and washer thickness. If a flush fit is preferred, method 2 (a) should be used.

3. Mount the stationary slide-out sections to the rear rack rails using either of these methods:

(a) If the rear rack rail holes are not tapped to accept 10-32 machine screws, mount the left stationary section

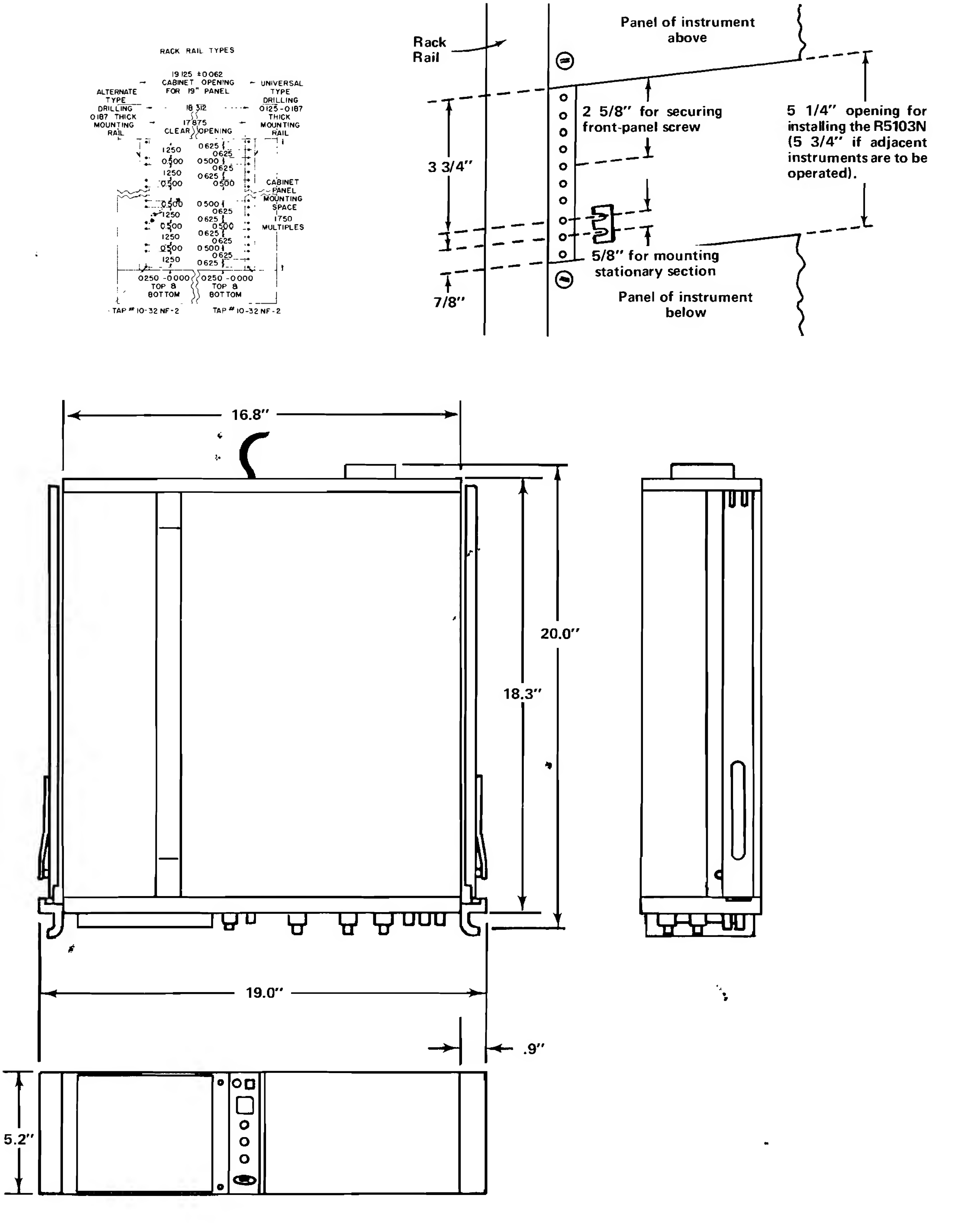


Fig. 6-2. Dimensional diagram.

with hardware provided as shown in the left or center illustration of Fig. 3-1A. Note that the rear mounting bracket can be installed either way so the slide-out tracks will fit a deep or shallow cabinet rack. Use Fig. 3-1A as a guide for mounting the right stationary section. Make sure the stationary sections are horizontally aligned so they are level and parallel with each other.

(b) If the rear rack rail holes are tapped to accept 10-32 machine screws, mount the left stationary section with hardware provided as shown in the left or center illustration of Fig. 6-1B. Note that the rear mounting bracket can be installed either way so the slide-out tracks will fit a deep or shallow cabinet rack. Use Fig. 6-1B as a guide for mounting the right stationary section. Make sure the stationary sections are horizontally aligned so they are level and parallel with each other.

R5100 Installation and Adjustment

To insert the instrument into the rack, proceed as follows:

1. Pull the slide-out track intermediate sections out to the fully extended position.

2. Insert the instrument chassis sections into the intermediate sections.

3. Press the stop latches on the chassis sections and push the instrument toward the rack until the latches snap into their holes.

4. Again press the stop latches and push the instrument into the rack.

To adjust the slide-out tracks for smooth sliding action, loosen the screws used to join the stationary sections to the rails of the rack. Center the instrument, allowing the slide-out tracks to seek the proper width, then tighten the screws.

Maintenance

The slide-out tracks require no lubrication. The special dark gray finish on the sliding parts is a permanent lubrication.

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
ASSY	ASSEMBLY
CAP	CAPACITOR
CER	CERAMIC
CKT	CIRCUIT
COMP	COMPOSITION
CONN	CONNECTOR
ELCTLT	ELECTROLYTIC
ELEC	ELECTRICAL
INCAND	INCANDESCENT
LED	LIGHT EMITTING DIODE
NONWIR	NON WIREWOUND
PLSTC	PLASTIC
QTZ	QUARTZ
RECP	RECEPTACLE
RES	RESISTOR
RF	RADIO FREQUENCY
SEL	SELECTED
SEMICOND	SEMICONDUCTOR
SENS	SENSITIVE
VAR	VARIABLE
WW	WIREWOUND
XFMR	TRANSFORMER
XTAL	CRYSTAL

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
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
23880	STANFORD APPLIED ENGINEERING, INC.	340 MARTIN AVE.	SANTA CLARA, CA 95050
28480	HEWLETT-PACKARD CO., CORPORATE HQ.	1501 PAGE MILL RD.	PALO ALTO, CA 94304
31514	STANFORD APPLIED ENGINEERING, INC. ADVANCED PACKAGING DIV.	3080 AIRWAY DRIVE	COSTA MESA, CA 92626
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
71450	CTS CORP.	905 N. WEST BLVD	ELKHART, IN 46514
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
76055	MALLORY CONTROLS, CO., DIV. OF MALLORY P. R., AND CO., INC.	STATE RD. 28 W., P O BOX 327	FRANKFORT, IN 46041
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
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601
95238	CONTINENTAL CONNECTOR CORP.	34-63 56TH ST.	WOODSIDE, NY 11377

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	670-1340-00			CKT BOARD ASSY:INTERFACE	80009	670-1340-00
C622	283-0032-00			CAP.,FXD,CER DI:470PF,5%,500V	72982	0831085Z5E00471J
C628	283-0060-00			CAP.,FXD,CER DI:100PF,5%,200V	72982	855-535U2J101J
C632	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	72982	811-546E103Z
C634	283-0060-00			CAP.,FXD,CER DI:100PF,5%,200V	72982	855-535U2J101J
C636	283-0060-00			CAP.,FXD,CER DI:100PF,5%,200V	72982	855-535U2J101J
C640	281-0519-00			CAP.,FXD,CER DI:47PF,+/-4.7PF,500V	72982	308-000C0G0470K
C642	281-0519-00			CAP.,FXD,CER DI:47PF,+/-4.7PF,500V	72982	308-000C0G0470K
C659	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C671	281-0593-00	B010100	B029999X	CAP.,FXD,CER DI:3.9PF,10%,500V	72982	301-000C0J0399C
C679	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
CR620	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR658	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR668	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR678	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR688	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
J601	131-1078-00	B010100	B089999	CONNECTOR,RCPT,:28/56 CONTACT	95238	600-1156Y256DF30
J601	131-1078-01	B090000	B092489	CONN,RCPT,ELEC:CKT BOARD,28/56 CONTACT	31514	SAM28D/2-TX
J601	131-1078-00	B092490		CONNECTOR,RCPT,:28/56 CONTACT	95238	600-1156Y256DF30
J602	131-1078-00	B010100	B089999	CONNECTOR,RCPT,:28/56 CONTACT	95238	600-1156Y256DF30
J602	131-1078-01	B090000	B092489	CONN,RCPT,ELEC:CKT BOARD,28/56 CONTACT	31514	SAM28D/2-TX
J602	131-1078-00	B092490		CONNECTOR,RCPT,:28/56 CONTACT	95238	600-1156Y256DF30
J603	131-1078-00	B010100	B089999	CONNECTOR,RCPT,:28/56 CONTACT	95238	600-1156Y256DF30
J603	131-1078-01	B090000	B092489	CONN,RCPT,ELEC:CKT BOARD,28/56 CONTACT	31514	SAM28D/2-TX
J603	131-1078-00	B092490		CONNECTOR,RCPT,:28/56 CONTACT	95238	600-1156Y256DF30
J604	131-1043-00			CONNECTOR,RCPT,:18/36 CONTACT	23880	SAC18D/4-2
Q620	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q626	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q630	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q650	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q658	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q660	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q668	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q670	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q678	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q680	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q688	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
R620	316-0102-00			RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R621	316-0222-00			RES.,FXD,CMPSN:2.2K OHM,10%,0.25W	01121	CB2221
R622	315-0223-00	B010100	B029999	RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R622	315-0163-00	B030000		RES.,FXD,CMPSN:16K OHM,5%,0.25W	01121	CB1635
R626	316-0102-00			RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R628	315-0223-00	B010100	B029999	RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R628	315-0183-00	B030000		RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R630	316-0474-00			RES.,FXD,CMPSN:470K OHM,10%,0.25W	01121	CB4741
R631	316-0332-00			RES.,FXD,CMPSN:3.3K OHM,10%,0.25W	01121	CB3321
R632	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R634	316-0103-00			RES.,FXD,CMPSN:10K OHM,10%,0.25W	01121	CB1031
R635	316-0102-00			RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R636	316-0103-00			RES.,FXD,CMPSN:10K OHM,10%,0.25W	01121	CB1031
R637	316-0102-00			RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R640	316-0562-00			RES.,FXD,CMPSN:5.6K OHM,10%,0.25W	01121	CB5621
R641	316-0561-00			RES.,FXD,CMPSN:560 OHM,10%,0.25W	01121	CB5611

INTERFACE (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R642	316-0103-00			RES.,FXD,CMPSN:10K OHM,10%,0.25W	01121	CB1031
R643	316-0102-00			RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R650	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R651	316-0103-00			RES.,FXD,CMPSN:10K OHM,10%,0.25W	01121	CB1031
R652	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R656	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R657	316-0822-00			RES.,FXD,CMPSN:8.2K OHM,10%,0.25W	01121	CB8221
R659	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R660	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R662	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R665	321-0159-00			RES.,FXD,FILM:442 OHM,1%,0.125W	91637	MFF1816G442R0F
R666	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R667	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R669	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R670	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R671	316-0331-00			RES.,FXD,CMPSN:330 OHM,10%,0.25W	01121	CB3311
R672	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R675	311-1133-00			RES.,VAR,NONWIR:10K OHM,30%,0.25W	71450	201-YA5534
R676	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R677	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R679	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R680	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R681	316-0331-00			RES.,FXD,CMPSN:330 OHM,10%,0.25W	01121	CB3311
R682	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R685	321-0159-00			RES.,FXD,FILM:442 OHM,1%,0.125W	91637	MFF1816G442R0F
R686	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R687	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
U640	156-0057-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	80009	156-0057-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A2	670-1339-00			CKT BOARD ASSY:LV POWER SUPPLY	80009	670-1339-00
C810	290-0511-00			CAP.,FXD,ELCTLT:250UF,+75-10%,250V	90201	20-35958
C815	290-0510-00			CAP.,FXD,ELCTLT:6000UF,+100-10%,15V	56289	68D10473
C820	290-0134-00			CAP.,FXD,ELCTLT:22UF,20%,15V	56289	150D226X0015B2
C822	281-0512-00			CAP.,FXD,CER DI:27PF,+/-2.7PF,500V	72982	308-000C0G0270K
C830	285-0629-00			CAP.,FXD,PLSTC:0.047UF,20%,100V	56289	410P47301
C837	290-0509-00			CAP.,FXD,ELCTLT:3000UF,+100-10%,50V	56289	68D10454
C839	290-0509-00			CAP.,FXD,ELCTLT:3000UF,+100-10%,50V	56289	68D10454
C842	290-0175-00			CAP.,FXD,ELCTLT:10UF,20%,35V	56289	150D106X0035R2
C852	281-0550-00			CAP.,FXD,CER DI:120PF,10%,500V	04222	7001-1373
C857	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C860	290-0175-00			CAP.,FXD,ELCTLT:10UF,20%,35V	56289	150D106X0035R2
C865	281-0550-00	B010100	B039999	CAP.,FXD,CER DI:120PF,10%,500V	04222	7001-1373
C865	281-0543-00	B040000		CAP.,FXD,CER DI:270PF,10%,500V	72982	301055X5P271K
C870	290-0134-00			CAP.,FXD,ELCTLT:22UF,20%,15V	56289	150D226X0015B2
C872	281-0572-00			CAP.,FXD,CER DI:6.8PF,+/-0.5PF,500V	72982	301-000C0H0689D
C875	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C881	290-0267-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	162D105X0035CD2
C883	290-0267-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	162D105X0035CD2
C890	281-0549-00			CAP.,FXD,CER DI:68PF,10%,500V	72982	301-000U2J0680K
CR810	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR811	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR812	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR813	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR815	152-0488-00			SEMICOND DEVICE:SILICON,200V,1500MA	80009	152-0488-00
CR820	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	80009	152-0066-00
CR824	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR835	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR836	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR837	152-0488-00			SEMICOND DEVICE:SILICON,200V,1500MA	80009	152-0488-00
CR841	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	80009	152-0066-00
CR842	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	80009	152-0066-00
CR850	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR851	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR860	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	80009	152-0066-00
CR865	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR870	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR875	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR885	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
F201	159-0019-00			FUSE,CARTRIDGE:3AG,1A,250V,SLOW BLOW	71400	MDL1
F810	159-0028-00			FUSE,CARTRIDGE:3AG,0.25A,250V,FAST-BLOW	71400	AGC 1/4
F835	159-0025-00			FUSE,CARTRIDGE:3AG,0.5A,250V,FAST-BLOW	71400	AGC 1/2
Q820	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q825	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q845	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q850	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q865	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q870	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q875	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q885	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
Q890	151-0341-00			TRANSISTOR:SILICON,NPN	80009	151-0341-00
R810	302-0150-00			RES.,FXD,CMPSN:15 OHM,10%,0.50W	01121	EB1501
R812	304-0683-00			RES.,FXD,CMPSN:68K OHM,10%,1W	01121	GB6831

POWER SUPPLY (CONT)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R815	308-0685-00			RES.,FXD,WW:1.5 OHM,5%,1W	75042	BW20-1R500J
R816	321-0215-00			RES.,FXD,FILM:1.69K OHM,1%,0.125W	91637	MFF1816G16900F
R818	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R820	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R822	316-0681-00			RES.,FXD,CMPSN:680 OHM,10%,0.25W	01121	CB6811
R824	316-0822-00			RES.,FXD,CMPSN:8.2K OHM,10%,0.25W	01121	CB8221
R826	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R827	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R830	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R832	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R834	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R841	307-0300-00			RES.,FXD,FILM:150 OHM,5%,10W	76055	7MOLNF150B
R842	308-0686-00			RES.,FXD,WW:2.2 OHM,5%,2W	75042	BWH-2R200J
R846	316-0391-00			RES.,FXD,CMPSN:390 OHM,10%,0.25W	01121	CB3911
R847	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R850	316-0823-00			RES.,FXD,CMPSN:82K OHM,10%,0.25W	01121	CB8231
R851	302-0333-00			RES.,FXD,CMPSN:33K OHM,10%,0.50W	01121	EB3331
R852	316-0681-00			RES.,FXD,CMPSN:680 OHM,10%,0.25W	01121	CB6811
R853	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R857	321-0268-00			RES.,FXD,FILM:6.04K OHM,1%,0.125W	91637	MFF1816G60400F
R858	311-1120-00			RES.,VAR,NONWIR:100 OHM,30%,0.25W	71450	201-YA5531
R859	321-0268-00			RES.,FXD,FILM:6.04K OHM,1%,0.125W	91637	MFF1816G60400F
R860	308-0686-00			RES.,FXD,WW:2.2 OHM,5%,2W	75042	BWH-2R200J
R861	307-0301-00			RES.,FXD,FILM:120 OHM,5%,10W	76055	7MOLNF120B
R863	316-0273-00			RES.,FXD,CMPSN:27K OHM,10%,0.25W	01121	CB2731
R865	315-0131-00	B010100	B039999	RES.,FXD,CMPSN:130 OHM,5%,0.25W	01121	CB1315
R865	315-0301-00	B040000		RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R867	315-0621-00			RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
R868	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R869	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R870	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R872	316-0221-00			RES.,FXD,CMPSN:220 OHM,10%,0.25W	01121	CB2211
R873	316-0102-00			RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R875	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R877	321-0256-00			RES.,FXD,FILM:4.53K OHM,1%,0.125W	91637	MFF1816G45300F
R878	311-1124-00			RES.,VAR,NONWIR:250 OHM,30%,0.25W	71450	201-YA5533
R879	321-0202-00			RES.,FXD,FILM:1.24K OHM,1%,0.125W	91637	MFF1816G12400F
R880	316-0272-00			RES.,FXD,CMPSN:2.7K OHM,10%,0.25W	01121	CB2721
R881	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R883	316-0102-00			RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R885	316-0153-00			RES.,FXD,CMPSN:15K OHM,10%,0.25W	01121	CB1531
R890	322-0686-03			RES.,FXD,FILM:7.23K OHM,0.25%,0.25W	91637	MFF1421D72300C
R891	321-0097-03			RES.,FXD,FILM:100 OHM,0.25%,0.125W	91637	MFF1816D100R0C
VR850	152-0357-00			SEMICOND DEVICE:ZENER,0.4W,82V,5%	80009	152-0357-00
VR865	152-0243-00			SEMICOND DEVICE:ZENER,0.4W,15V,5%	80009	152-0243-00
VR870	152-0227-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	80009	152-0227-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				CHASSIS PARTS		
Q815	151-0331-00	B010100	B070028	TRANSISTOR:SILICON,NPN	80009	151-0331-00
Q815	151-0496-00	B070029		TRANSISTOR:SILICON,NPN	80009	151-0496-00
Q840	151-0331-00	B010100	B070028	TRANSISTOR:SILICON,NPN	80009	151-0331-00
Q840	151-0496-00	B070029		TRANSISTOR:SILICON,NPN	80009	151-0496-00
Q860	151-0331-00	B010100	B070028	TRANSISTOR:SILICON,NPN	80009	151-0331-00
Q860	151-0496-00	B070029		TRANSISTOR:SILICON,NPN	80009	151-0496-00
T801	120-0692-00	B010100	B049999	XFMR,PWR,STPDN:	80009	120-0692-00
T801	120-0704-00	B050000		XFMR,PWR,SDN & SU:	80009	120-0704-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
	670-5757-00 ----- -----	XB092712		CKT BOARD ASSY:SIGNALS OUT * OPTION 7 ONLY	80009	670-5757-00
C930	283-0002-00 ----- -----	XB092712		CAP.,FXD,CER DI:0.01UF,+80-20%,500V (C390, OPTION 7 ONLY)	72982	811-546E103Z
C931	281-0504-00 ----- -----	XB092712		CAP.,FXD,CER DI:10PF,+/-1PF,500V (C931, OPTION 7 ONLY)	72982	301-055C0G0100F
C960	283-0002-00 ----- -----	XB092712		CAP.,FXD,CER DI:0.01UF,+80-20%,500V (C960, OPTION 7 ONLY)	72982	811-546E103Z
C961	281-0504-00 ----- -----	XB092712		CAP.,FXD,CER DI:10PF,+/-1PF,500V (C961, OPTION 7 ONLY)	72982	301-055C0G0100F
C980	283-0002-00 ----- -----	XB092712		CAP.,FXD,CER DI:0.01UF,+80-20%,500V (C980, OPTION 7 ONLY)	72982	811-546E103Z
C981	281-0504-00 ----- -----	XB092712		CAP.,FXD,CER DI:10PF,+/-1PF,500V (C981, OPTION 7 ONLY)	72982	301-055C0G0100F
CR930	152-0141-02 ----- -----	XB092712		SEMICOND DEVICE:SILICON,30V,150MA (CR930, OPTION 7 ONLY)	80009	152-0141-02
CR960	152-0141-02 ----- -----	XB092712		SEMICOND DEVICE:SILICON,30V,150MA (CR960, OPTION 7 ONLY)	80009	152-0141-02
CR980	152-0141-02 ----- -----	XB092712		SEMICOND DEVICE:SILICON,30V,150MA (CR980, OPTION 7 ONLY)	80009	152-0141-02
CR990	152-0322-00 ----- -----	XB092712		SEMICOND DEVICE:SILICON,15V,HOT CARRIER (CR990, OPTION 7 ONLY)	28480	5082-2672
Q910	151-0190-00 ----- -----	XB092712		TRANSISTOR:SILICON,NPN (Q910, OPTION 7 ONLY)	80009	151-0190-00
Q915	151-0190-00 ----- -----	XB092712		TRANSISTOR:SILICON,NPN (Q915, OPTION 7, ONLY)	80009	151-0190-00
Q920	151-0190-00 ----- -----	XB092712		TRANSISTOR:SILICON,NPN (Q920, OPTION 7 ONLY)	80009	151-0190-00
Q925	151-0190-00 ----- -----	XB092712		TRANSISTOR:SILICON,NPN (Q925, OPTION 7 ONLY)	80009	151-0190-00
Q930	151-0188-00 ----- -----	XB092712		TRANSISTOR:SILICON,PNP (Q930, OPTION 7 ONLY)	80009	151-0188-00
Q940	151-0190-00 ----- -----	XB092712		TRANSISTOR:SILICON,NPN (Q940, OPTION 7 ONLY)	80009	151-0190-00
Q945	151-0190-00 ----- -----	XB092712		TRANSISTOR:SILICON,NPN (Q945, OPTTON 7 ONLY)	80009	151-0190-00
Q950	151-0190-00 ----- -----	XB092712		TRANSISTOR:SILICON,NPN (Q950, OPTION 7 ONLY)	80009	151-0190-00
Q955	151-0190-00 ----- -----	XB092712		TRANSISTOR:SILICON,NPN (Q955, OPTION 7 ONLY)	80009	151-0190-00
Q960	151-0188-00 ----- -----	XB092712		TRANSISTOR:SILICON,PNP (Q960, OPTION 7 ONLY)	80009	151-0188-00
Q967	151-0190-00 ----- -----	XB092712		TRANSISTOR:SILICON,NPN (Q967, OPTION 7 ONLY)	80009	151-0190-00
Q970	151-0190-00 ----- -----	XB092712		TRANSISTOR:SILICON,NPN (Q970, OPTION 7 ONLY)	80009	151-0190-00
Q972	151-0190-00 ----- -----	XB092712		TRANSISTOR:SILICON,NPN (Q972, OPTION 7 ONLY)	80009	151-0190-00
Q975	151-0190-00 ----- -----	XB092712		TRANSISTOR:SILICON,NPN (Q975, OPTION 7 ONLY)	80009	151-0190-00
Q980	151-0188-00 ----- -----	XB092712		TRANSISTOR:SILICON,PNP (Q980, OPTION 7 ONLY)	80009	151-0188-00
Q990	151-0190-00 ----- -----	XB092712		TRANSISTOR:SILICON,NPN (Q990, OPTION 7 ONLY)	80009	151-0190-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R910	315-0331-00	XB092712		RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
	----- -----			(R910, OPTION 7 ONLY)		
R911	315-0273-00	XB092712		RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
	----- -----			(R911, OPTION 7 ONLY)		
R912	321-0193-00	XB092712		RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
	----- -----			(R912, OPTION 7 ONLY)		
R915	321-0289-00	XB092712		RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
	----- -----			(R915, OPTION 7 ONLY)		
R916	315-0183-00	XB092712		RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
	----- -----			(R916, OPTION 7 ONLY)		
R920	315-0331-00	XB092712		RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
	----- -----			(R920, OPTION 7 ONLY)		
R921	315-0273-00	XB092712		RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
	----- -----			(R921, OPTION 7 ONLY)		
R922	321-0193-00	XB092712		RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
	----- -----			(R922, OPTION 7 ONLY)		
R925	315-0221-00	XB092712		RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
	----- -----			(R925, OPTION 7 ONLY)		
R926	321-0290-00	XB092712		RES.,FXD,FILM:10.2K OHM,1%,0.125W	91637	MFF1816G10201F
	----- -----			(R926, OPTION 7 ONLY)		
R930	315-0273-00	XB092712		RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
	----- -----			(R930, OPTION 7 ONLY)		
R931	315-0622-00	XB092712		RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
	----- -----			(R931, OPTION 7 ONLY)		
R932	315-0102-00	XB092712		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
	----- -----			(R932, OPTION 7 ONLY)		
R933	315-0101-00	XB092712		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
	----- -----			(R933, OPTION 7 ONLY)		
R940	315-0331-00	XB092712		RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
	----- -----			(R940, OPTION 7 ONLY)		
R941	315-0273-00	XB092712		RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
	----- -----			(R941, OPTION 7 ONLY)		
R942	321-0193-00	XB092712		RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
	----- -----			(R942, OPTION 7 ONLY)		
R945	321-0289-00	XB092712		RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
	----- -----			(R945, OPTION 7 ONLY)		
R946	315-0183-00	XB092712		RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
	----- -----			(R946, OPTON 7 ONLY)		
R950	315-0331-00	XB092712		RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
	----- -----			(R950, OPTION 7 ONLY)		
R951	315-0273-00	XB092712		RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
	----- -----			(R951, OPTION 7 ONLY)		
R952	321-0193-00	XB092712		RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
	----- -----			(R952, OPTION 7 ONLY)		
R955	315-0221-00	XB092712		RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
	----- -----			(R955, OPTION 7 ONLY)		
R956	321-0290-00	XB092712		RES.,FXD,FILM:10.2K OHM,1%,0.125W	91637	MFF1816G10201F
	----- -----			(R956, OPTION 7 ONLY)		
R960	315-0273-00	XB092712		RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
	----- -----			(R960, OPTION 7 ONLY)		
R961	315-0622-00	XB092712		RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
	----- -----			(R961, OPTION 7 ONLY)		
R962	315-0102-00	XB092712		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
	----- -----			(R962, OPTION 7 ONLY)		
R963	315-0101-00	XB092712		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
	----- -----			(R963, OPTION 7 ONLY)		

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R967	315-0331-00 ----- -----	XB092712		RES.,FXD,CMPSN:330 OHM,5%,0.25W (R967, OPTION 7 ONLY)	01121	CB3315
R968	315-0273-00 ----- -----	XB092712		RES.,FXD,CMPSN:27K OHM,5%,0.25W (R968, OPTION 7 ONLY)	01121	CB2735
R969	321-0193-00 ----- -----	XB092712		RES.,FXD,FILM:1K OHM,1%,0.125W (R969, OPTION 7 ONLY)	91637	MFF1816G10000F
R970	315-0331-00 ----- -----	XB092712		RES.,FXD,CMPSN:330 OHM,5%,0.25W (R970, OPTION 7 ONLY)	01121	CB3315
R971	315-0273-00 ----- -----	XB092712		RES.,FXD,CMPSN:27K OHM,5%,0.25W (R971, OPTION 7 ONLY)	01121	CB2735
R972	321-0289-00 ----- -----	XB092712		RES.,FXD,FILM:10K OHM,1%,0.125W (R972, OPTION 7 ONLY)	91637	MFF1816G10001F
R973	315-0183-00 ----- -----	XB092712		RES.,FXD,CMPSN:18K OHM,5%,0.25W (R973, OPTION 7 ONLY)	01121	CB1835
R974	321-0193-00 ----- -----	XB092712		RES.,FXD,FILM:1K OHM,1%,0.125W (R974, OPTION 7 ONLY)	91637	MFF1816G10000F
R975	315-0221-00 ----- -----	XB092712		RES.,FXD,CMPSN:220 OHM,5%,0.25W (R975, OPTION 7 ONLY)	01121	CB2215
R976	321-0290-00 ----- -----	XB092712		RES.,FXD,FILM:10.2K OHM,1%,0.125W (R976, OPTION 7 ONLY)	91637	MFF1816G10201F
R980	315-0273-00 ----- -----	XB092712		RES.,FXD,CMPSN:27K OHM,5%,0.25W (R980, OPTION 7 ONLY)	01121	CB2735
R981	315-0622-00 ----- -----	XB092712		RES.,FXD,CMPSN:6.2K OHM,5%,0.25W (R981, OPTION 7 ONLY)	01121	CB6225
R982	315-0102-00 ----- -----	XB092712		RES.,FXD,CMPSN:1K OHM,5%,0.25W (R982, OPTION 7 ONLY)	01121	CB1025
R983	315-0101-00 ----- -----	XB092712		RES.,FXD,CMPSN:100 OHM,5%,0.25W (R983, OPTION 7 ONLY)	01121	CB1015
R990	315-0273-00 ----- -----	XB092712		RES.,FXD,CMPSN:27K OHM,5%,0.25W (R990, OPTION 7 ONLY)	01121	CB2735
R991	315-0222-00 ----- -----	XB092712		RES.,FXD,CMPSN:2.2K OHM,5%,0.25W (R991, OPTION 7 ONLY)	01121	CB2225

SECTION 8

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

Electrical components shown on the diagrams are in the following units unless noted otherwise:

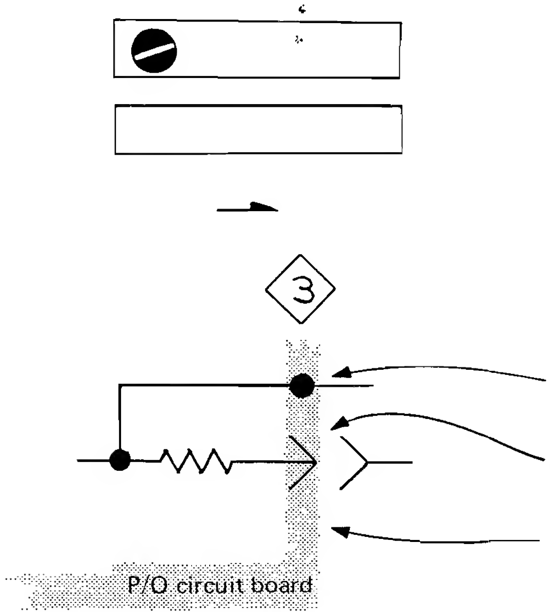
Capacitors = Values one or greater are in picofarads (pF).
Values less than one are in microfarads (μF).

Resistors = Ohms (Ω)

Symbols used on the diagrams are based on USA Standard Y32.2-1967.

Logic symbology is based on MIL-STD-806B in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The following special symbols are used on the diagrams:



External Screwdriver adjustment.

External control or connector.

Clockwise control rotation in direction of arrow.

Refer to diagram number indicated in diamond.

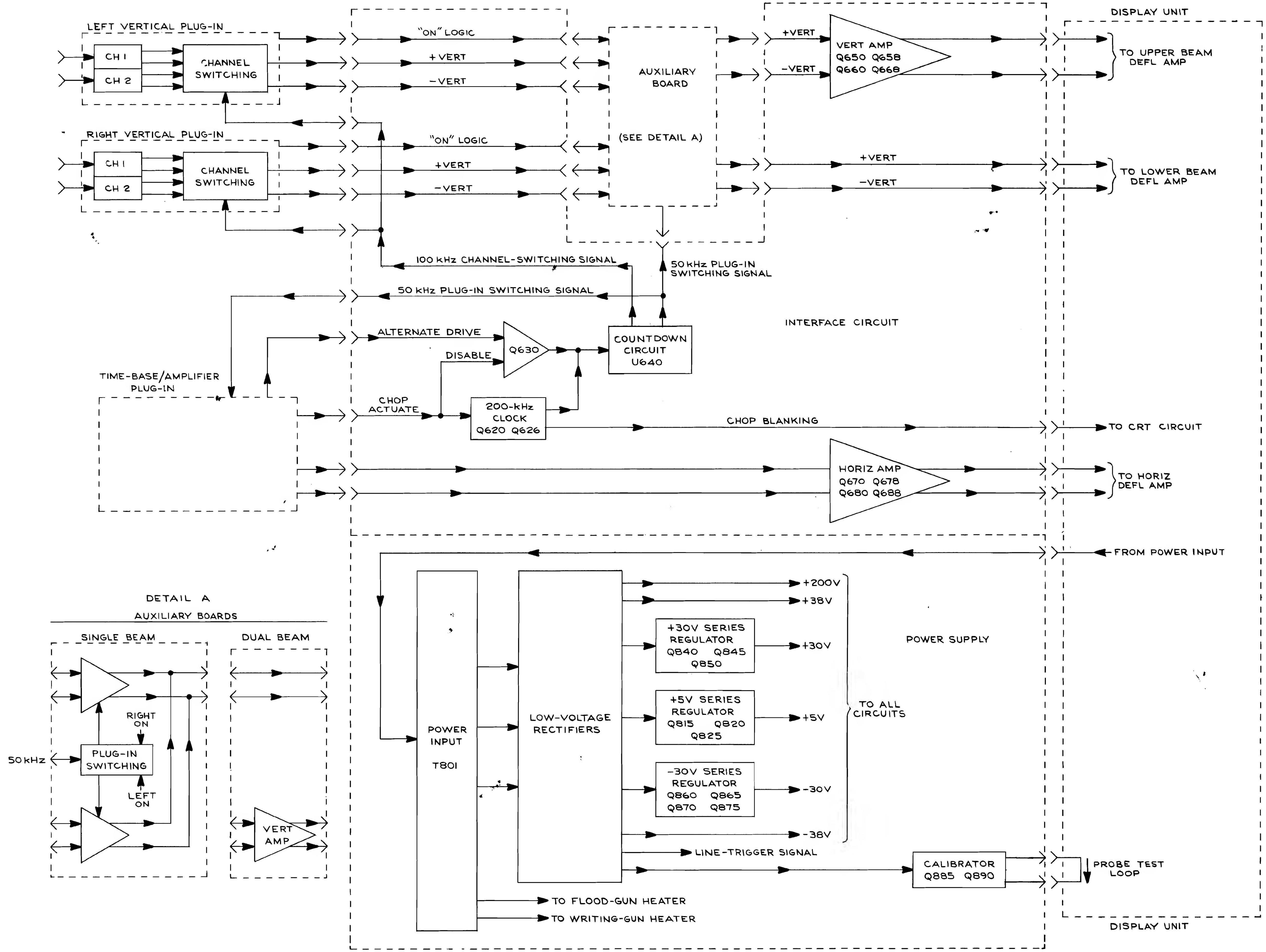
Connection soldered to circuit board.

Connection made to circuit board with interconnecting pin.

Blue tint encloses components located on circuit board.

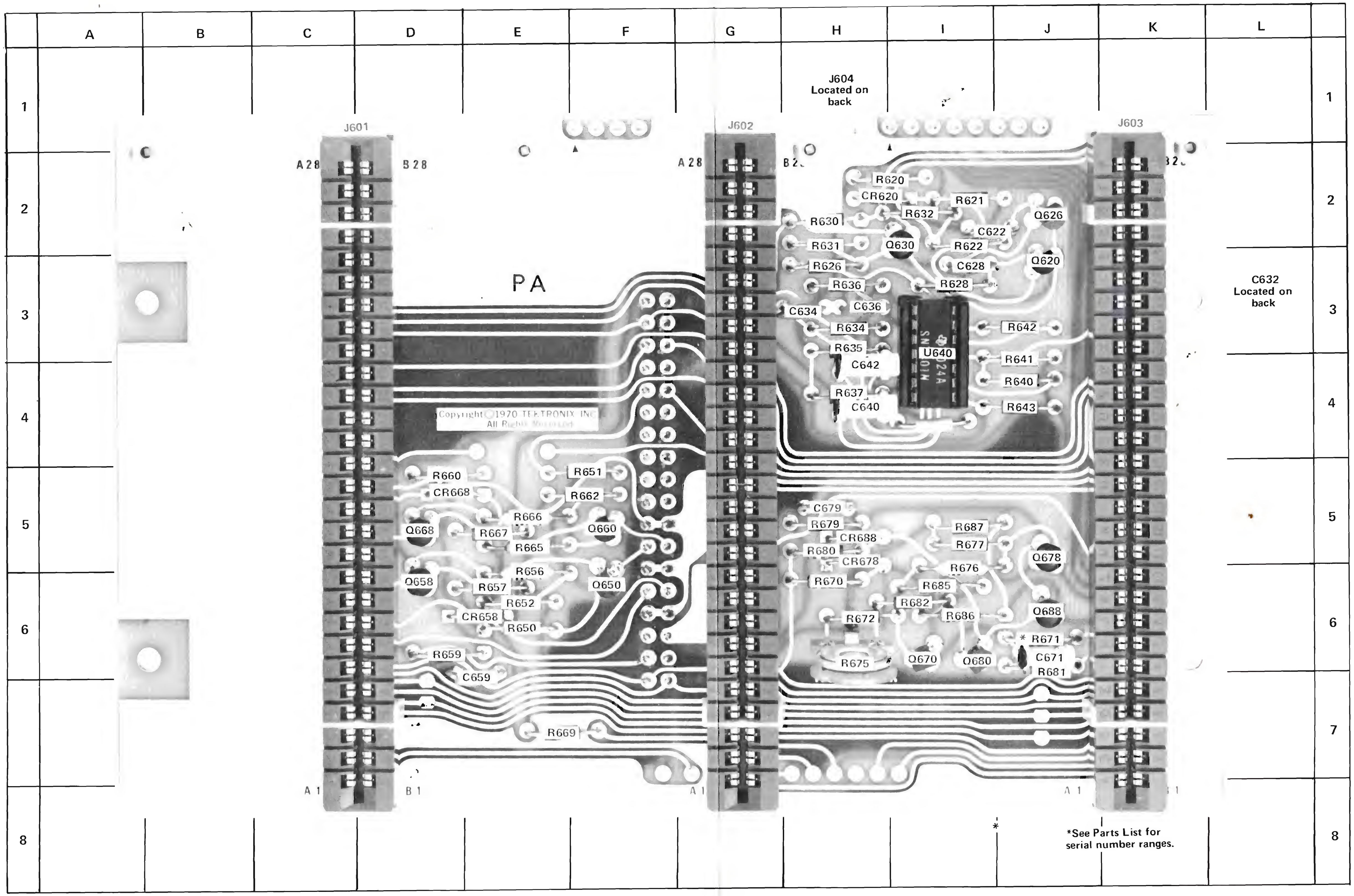
The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

- A Assembly, separable or repairable (circuit board, etc.)
- AT Attenuator, fixed or variable
- B Motor
- BT Battery
- C Capacitor, fixed or variable
- CR Diode, signal or rectifier
- DL Delay line
- DS Indicating device (lamp)
- F Fuse
- FL Filter
- H Heat dissipating device (heat sink, heat radiator, etc.)
- HR Heater
- J Connector, stationary portion
- K Relay
- L Inductor, fixed or variable
- LR Inductor/resistor combination
- M Meter
- Q Transistor or silicon-controlled rectifier
- P Connector, movable portion
- R Resistor, fixed or variable
- RT Thermistor
- S Switch
- T Transformer
- TP Test point
- U Assembly, inseparable or non-repairable (integrated circuit, etc.)
- V Electron tube
- VR Voltage regulator (zener diode, etc.)
- Y Crystal


LEFT VERTICAL PLUG-IN
CH 1
CH 2
CHANNEL SWITCHING
RIGHT VERTICAL PLUG-IN
CH 1
CH 2
CHANNEL SWITCHING
"ON" LOGIC
+VERT
−VERT
"ON" LOGIC
+VERT
−VERT
AUXILIARY BOARD
(SEE DETAIL A)
+VERT
−VERT
VERT AMP
Q650 Q658
Q660 Q668
+VERT
−VERT
DISPLAY UNIT
TO UPPER BEAM DEFL AMP
TO LOWER BEAM DEFL AMP
100 kHz CHANNEL-SWITCHING SIGNAL
50 kHz PLUG-IN SWITCHING SIGNAL
50 kHz PLUG-IN SWITCHING SIGNAL
INTERFACE CIRCUIT
ALTERNATE DRIVE
DISABLE
Q630
COUNTDOWN CIRCUIT
U640
TIME-BASE/AMPLIFIER PLUG-IN
CHOP ACTUATE
200-kHz CLOCK
Q620 Q626
CHOP BLANKING
TO CRT CIRCUIT
HORIZ AMP
Q670 Q678
Q680 Q688
TO HORIZ DEFL AMP
FROM POWER INPUT
DETAIL A
AUXILIARY BOARDS
SINGLE BEAM
DUAL BEAM
RIGHT ON
50 kHz
PLUG-IN SWITCHING
LEFT ON
VERT AMP
POWER INPUT
T801
LOW-VOLTAGE RECTIFIERS
+200V
+38V
+30V SERIES REGULATOR
Q840 Q845
Q850
+30V
+5V SERIES REGULATOR
Q815 Q820
Q825
+5V
−30V SERIES REGULATOR
Q860 Q865
Q870 Q875
−30V
−38V
TO ALL CIRCUITS
POWER SUPPLY
LINE-TRIGGER SIGNAL
CALIBRATOR
Q885 Q890
PROBE TEST LOOP
TO FLOOD-GUN HEATER
TO WRITING-GUN HEATER
DISPLAY UNIT

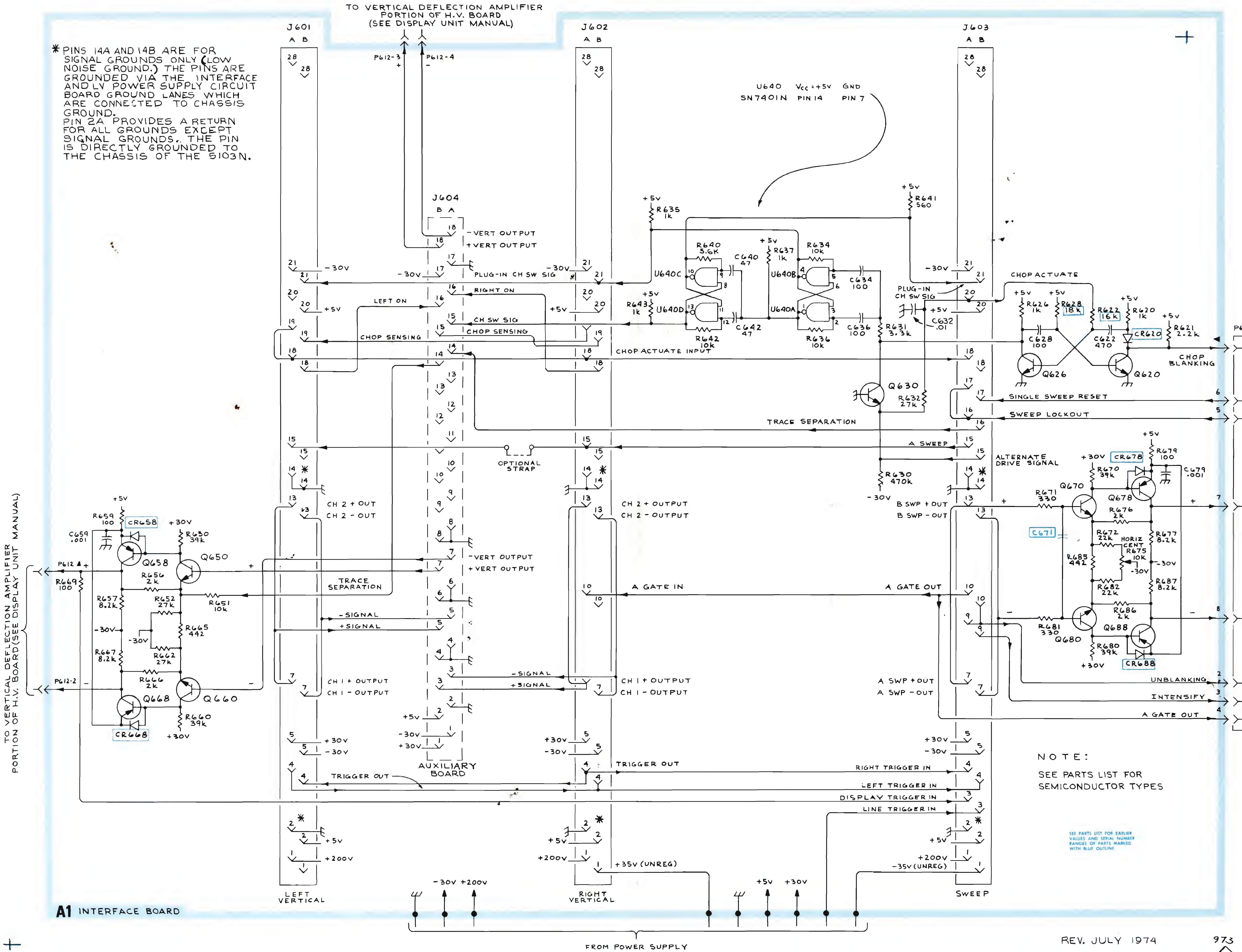
5103N

INTERFACE BOARD PARTS LOCATION GRID



CKT NO	GRID LOC	CKT NO	GRID LOC
C622	J-2	R670	H-6
C628	I-3	R671	J-6
C634	H-3	R672	H-6
C636	H-3	R675	H-6
C640	H-4	R676	I-6
C642	H-4	R677	I-5
C659	E-7	R679	H-5
C671	J-6	R680	H-5
C679	H-5	R681	J-7
		R682	I-6
		R685	I-6
		R686	I-6
CR620	H-2	R687	I-5
CR658	E-6		
CR668	D-5		
CR678	H-5		
CR688	H-5	U640	I-3
Q620	J-3		
Q626	J-2		
Q630	I-2		
Q650	F-6		
Q658	D-6		
Q660	F-5		
Q668	D-5		
Q670	I-6		
Q678	J-5		
Q680	I-6		
Q688	J-6		
R620	I-2		
R621	I-2		
R622	I-2		
R626	H-3		
R628	I-3		
R630	H-2		
R631	H-2		
R632	I-2		
R634	H-3		
R635	H-3		
R636	H-3		
R637	H-4		
R639	I-4		
R640	J-4		
R641	J-4		
R642	J-3		
R643	J-4		
R650	E-6		
R651	F-5		
R652	E-6		
R656	E-6		
R657	E-6		
R659	D-6		
R660	D-5		
R662	F-5		
R665	E-5		
R666	E-5		
R667	E-5		
R669	E-7		

Ⓐ



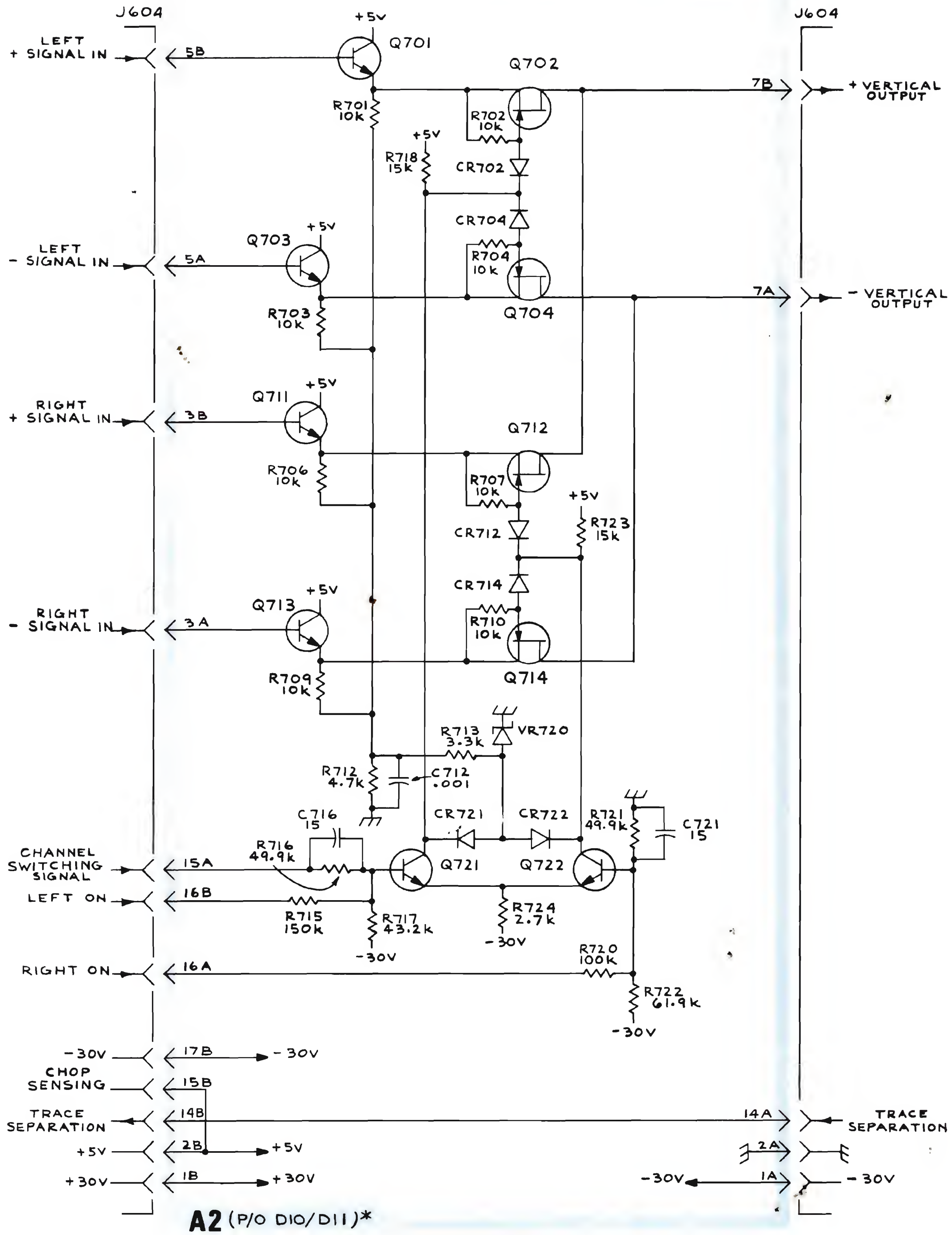
INTERFACE

5103N

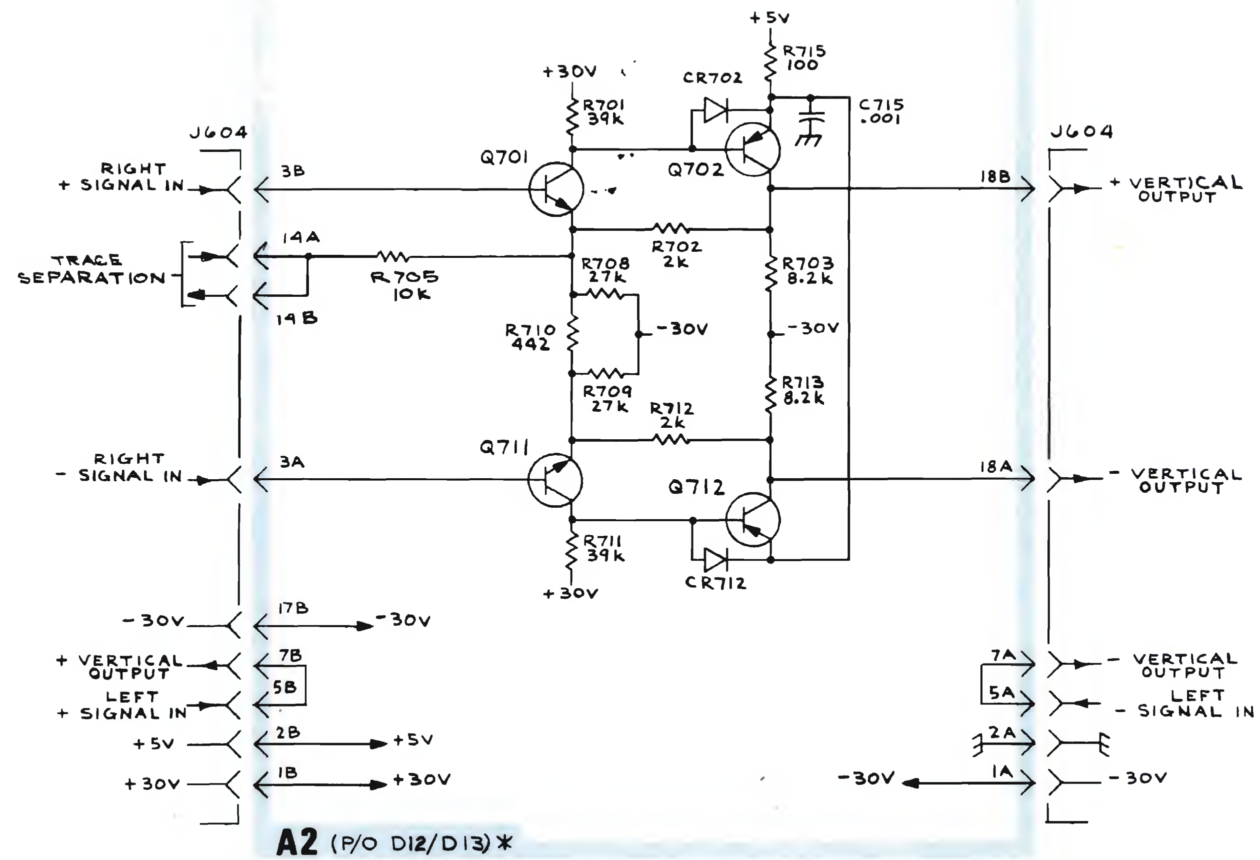
REV. JULY 1974

973

INTERFACE CIRCUIT (1)



SINGLE BEAM

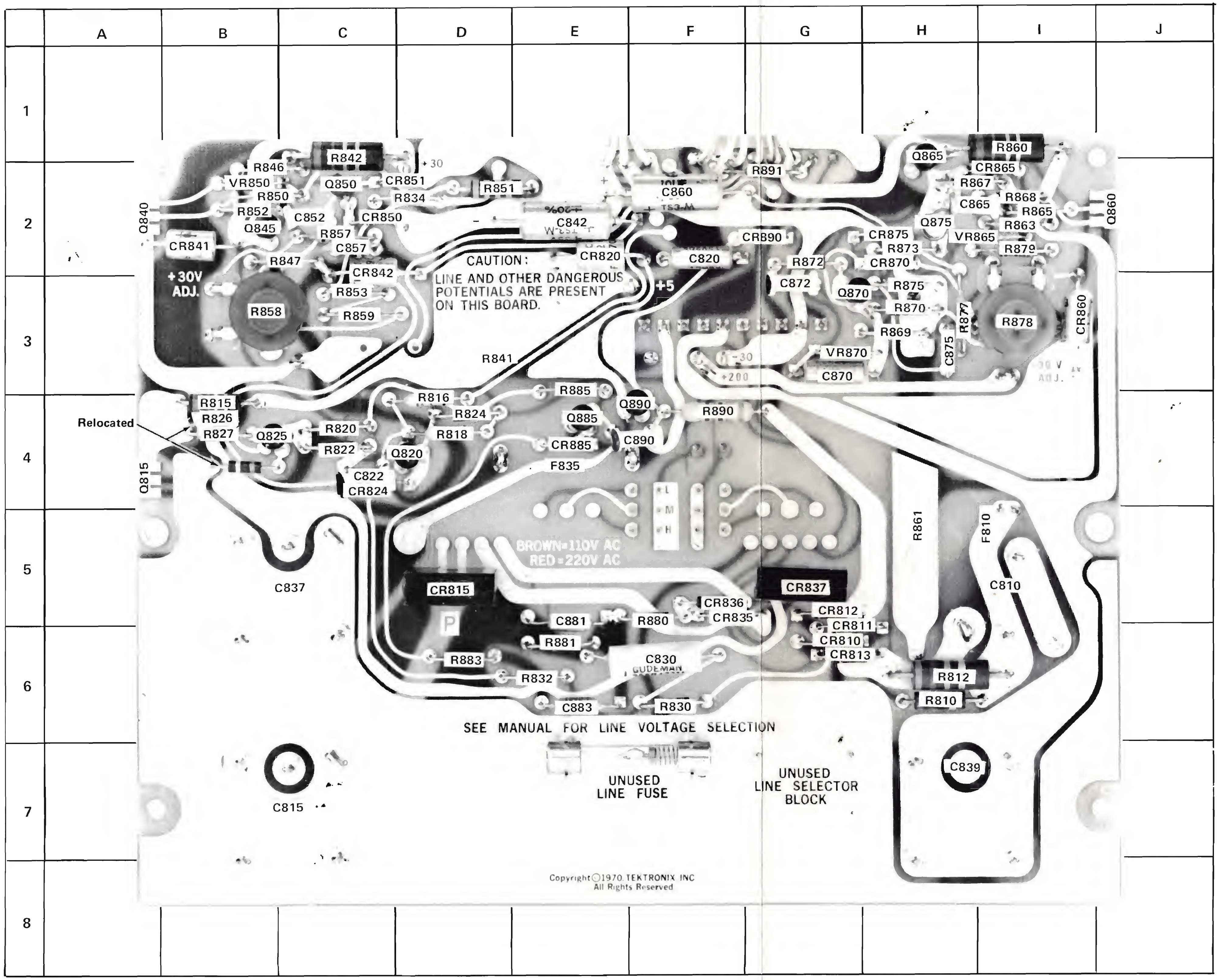


DUAL BEAM

NOTE:

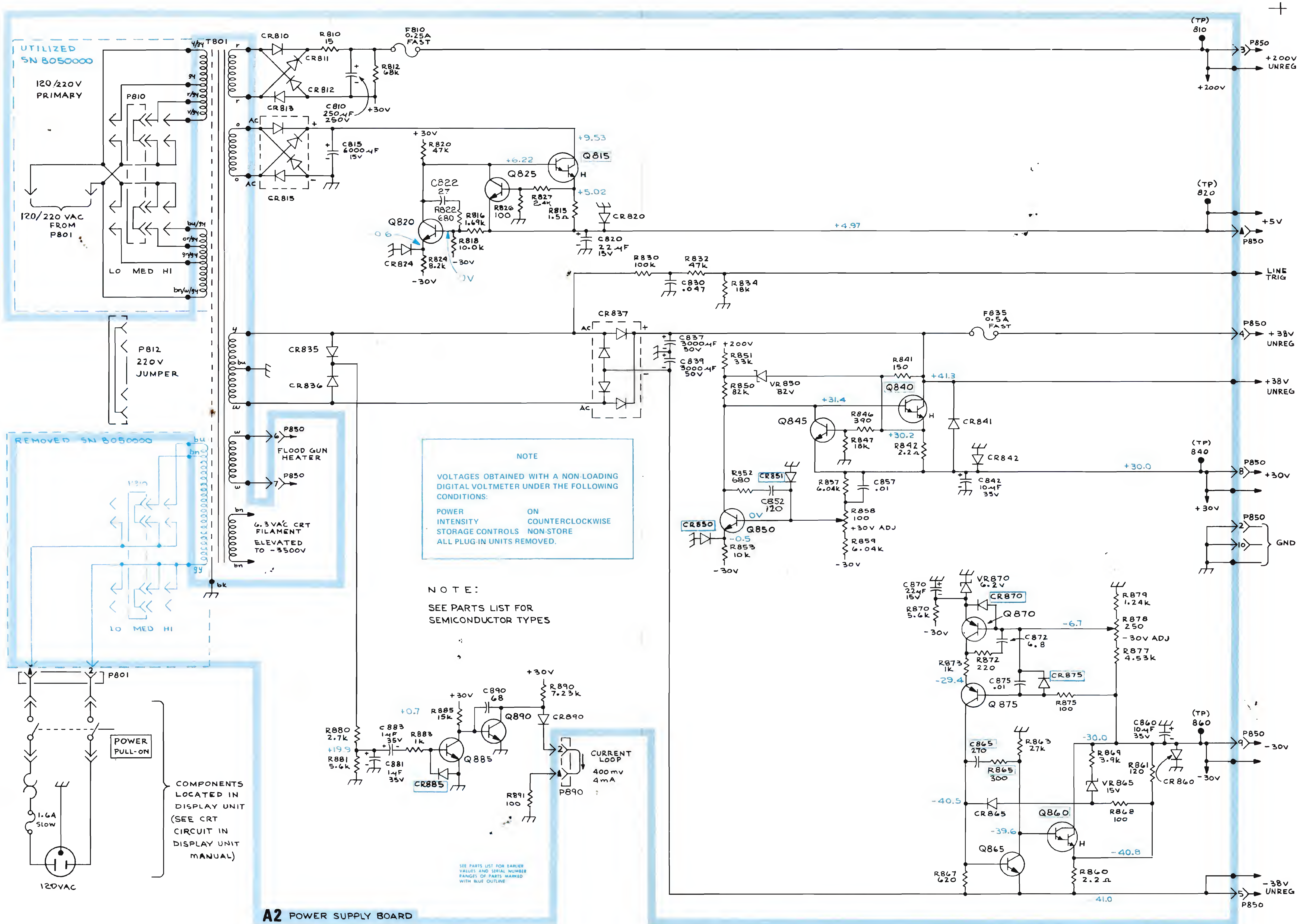
*DIAGRAMS ARE PRESENTED HERE FOR CONVENIENCE. PARTS LIST, BOARD PHOTOS, AND COMPONENT LOCATION GRIDS LOCATED IN THE DISPLAY UNIT MANUALS.

POWER SUPPLY BOARD PARTS LOCATION GRID



CKT NO	GRID LOC
C810	I-5
C815	C-5
C820	F-2
C822	C-4
C830	F-6
C837	C-7
C839	H-7
C842	E-2
C852	C-2
C857	C-2
C860	F-2
C865	H-2
C870	G-3
C872	G-3
C875	H-3
C881	E-5
C883	E-6
C890	F-4
CR810	G-6
CR811	G-6
CR812	G-5
CR813	G-6
CR815	G-5
CR820	E-2
CR824	C-4
CR835	F-5
CR836	F-5
CR837	D-5
CR841	B-2
CR842	C-2
CR850	C-2
CR851	D-2
CR860	I-3
CR865	I-2
CR870	H-2
CR875	H-2
CR885	E-4
CR890	G-2
VR850	B-2
VR865	I-2
VR870	G-3
F810	I-5
F835	E-4
Q815	A-4
Q820	D-4
Q825	B-4
Q840	A-2
Q845	B-2
Q850	C-2
Q860	J-2
Q865	H-1
Q870	G-3

CKT NO	GRID LOC
Q875	H-2
Q885	E-4
Q890	F-4
R810	H-6
R812	H-6
R815	B-4
R816	D-4
R818	D-4
R820	C-4
R822	C-4
R824	D-4
R826	B-4
R827	B-4
R830	F-6
R832	E-6
R834	D-2
R841	D-3
R842	C-1
R846	B-2
R847	C-2
R850	B-2
R851	D-2
R852	B-2
R853	C-3
R857	C-2
R858	B-3
R859	C-3
R860	I-1
R861	H-5
R863	I-2
R865	I-2
R867	H-2
R868	I-2
R869	H-3
R870	H-3
R872	G-2
R873	H-2
R875	H-3
R877	H-3
R878	I-3
R879	I-2
R880	F-5
R881	E-6
R883	D-6
R885	E-3
R890	F-4
R891	G-2


UTILIZED SN B050000
120/220V PRIMARY
120/220 VAC FROM P801
LO MED HI
T801
P810
P812 220V JUMPER
REMOVED SN B050000
FLOOD GUN HEATER
6.3VAC CRT FILAMENT ELEVATED TO -3500V
NOTE
VOLTAGES OBTAINED WITH A NON-LOADING DIGITAL VOLTMETER UNDER THE FOLLOWING CONDITIONS:
POWER ON
INTENSITY COUNTERCLOCKWISE
STORAGE CONTROLS NON-STORE
ALL PLUG IN UNITS REMOVED.
NOTE:
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
POWER PULL-ON
COMPONENTS LOCATED IN DISPLAY UNIT (SEE CRT CIRCUIT IN DISPLAY UNIT MANUAL)
120VAC
1.6A SLOW
CURRENT LOOP
400mv 4mA
P890
A2 POWER SUPPLY BOARD
+200V UNREG
+5V
LINE TRIG
+38V UNREG
+30V
GND
-30V
-38V UNREG
P850

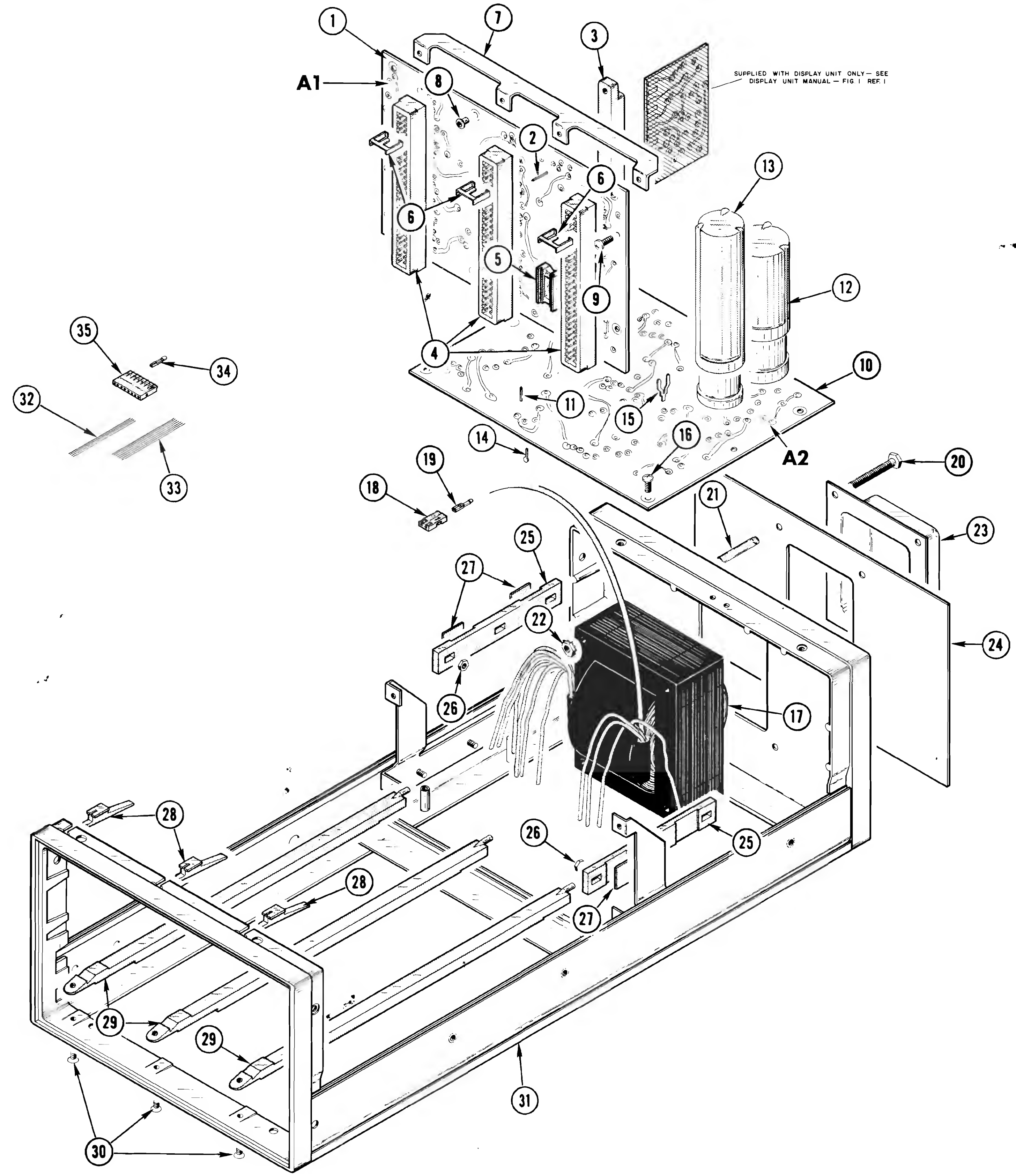
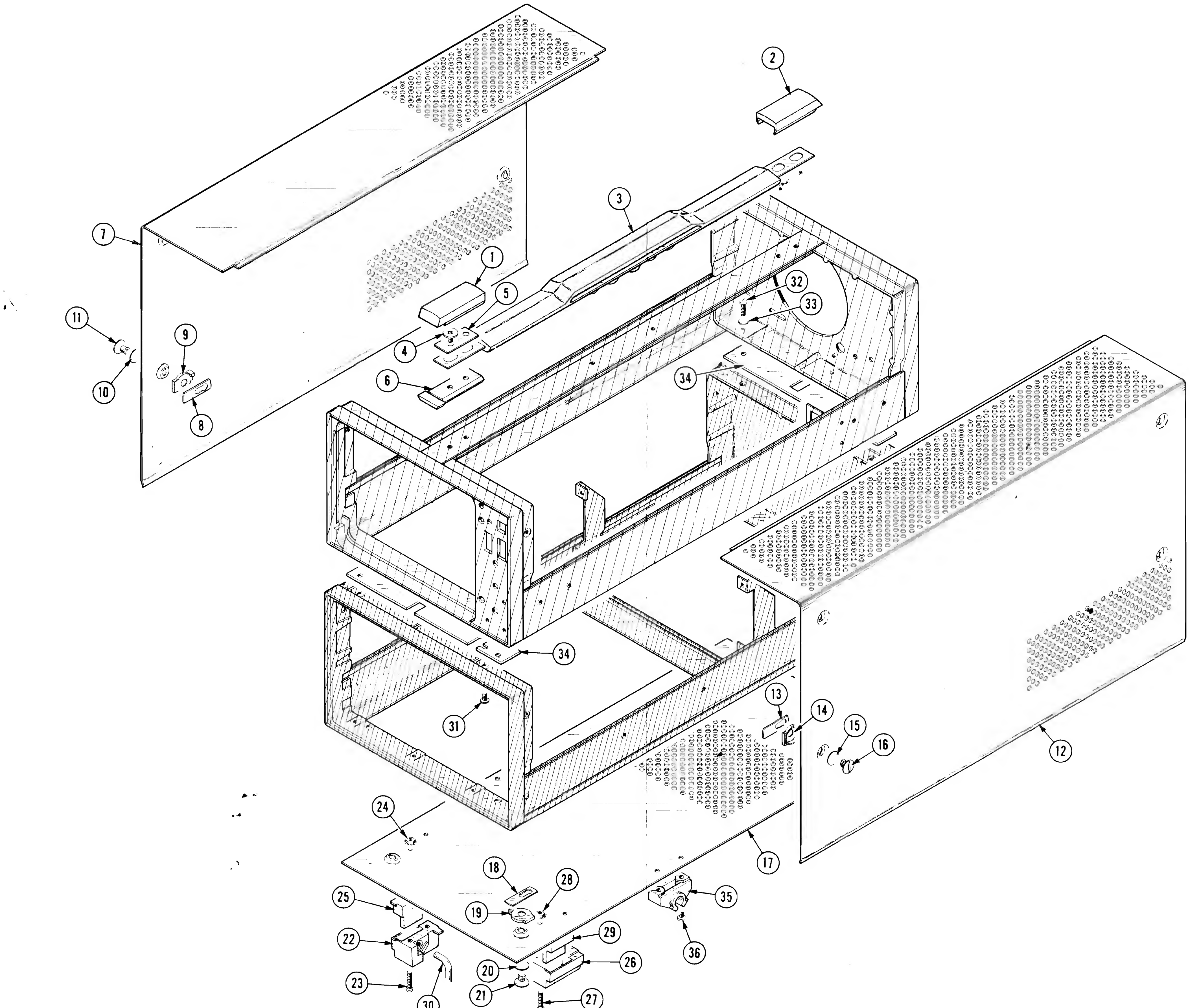

A1
SUPPLIED WITH DISPLAY UNIT ONLY— SEE DISPLAY UNIT MANUAL — FIG 1 REF 1
A2

FIG. 2 BENCH CABINET



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	ELCTRN	ELECTRON	IN	INCH	SE	SINGLE END
#	NUMBER SIZE	ELEC	ELECTRICAL	INCAND	INCANDESCENT	SECT	SECTION
ACTR	ACTUATOR	ELCTLT	ELECTROLYTIC	INSUL	INSULATOR	SEMICOND	SEMICONDUCTOR
ADPTR	ADAPTER	ELEM	ELEMENT	INTL	INTERNAL	SHLD	SHIELD
ALIGN	ALIGNMENT	EPL	ELECTRICAL PARTS LIST	LPHLDR	LAMPHOLDER	SHLDR	SHOULDERED
AL	ALUMINUM	EQPT	EQUIPMENT	MACH	MACHINE	SKT	SOCKET
ASSEM	ASSEMBLED	EXT	EXTERNAL	MECH	MECHANICAL	SL	SLIDE
ASSY	ASSEMBLY	FIL	FILLISTER HEAD	MTG	MOUNTING	SLFLKG	SELF-LOCKING
ATTEN	ATTENUATOR	FLEX	FLEXIBLE	NIP	NIPPLE	SLVG	SLEEVING
AWG	AMERICAN WIRE GAGE	FLH	FLAT HEAD	NON WIRE	NOT WIRE WOUND	SPR	SPRING
BD	BOARD	FLTR	FILTER	OBD	ORDER BY DESCRIPTION	SQ	SQUARE
BRKT	BRACKET	FR	FRAME or FRONT	OD	OUTSIDE DIAMETER	SST	STAINLESS STEEL
BRS	BRASS	FSTNR	FASTENER	OVH	OVAL HEAD	STL	STEEL
BRZ	BRONZE	FT	FOOT	PH BRZ	PHOSPHOR BRONZE	SW	SWITCH
BSHG	BUSHING	FXD	FIXED	PL	PLAIN or PLATE	T	TUBE
CAB	CABINET	GSKT	GASKET	PLSTC	PLASTIC	TERM	TERMINAL
CAP	CAPACITOR	HDL	HANDLE	PN	PART NUMBER	THD	THREAD
CER	CERAMIC	HEX	HEXAGON	PNH	PAN HEAD	THK	THICK
CHAS	CHASSIS	HEX HD	HEXAGONAL HEAD	PWR	POWER	TNSN	TENSION
CKT	CIRCUIT	HEX SOC	HEXAGONAL SOCKET	RCPT	RECEPTACLE	TPG	TAPPING
COMP	COMPOSITION	HLCPS	HELICAL COMPRESSION	RES	RESISTOR	TRH	TRUSS HEAD
CONN	CONNECTOR	HLEXT	HELICAL EXTENSION	RGD	RIGID	V	VOLTAGE
COV	COVER	HV	HIGH VOLTAGE	RLF	RELIEF	VAR	VARIABLE
CPLG	COUPLING	IC	INTEGRATED CIRCUIT	RTNR	RETAINER	W/	WITH
CRT	CATHODE RAY TUBE	ID	INSIDE DIAMETER	SCH	SOCKET HEAD	WSHR	WASHER
DEG	DEGREE	IDENT	IDENTIFICATION	SCOPE	OSCILLOSCOPE	XFMR	TRANSFORMER
DWR	DRAWER	IMPLR	IMPELLER	SCR	SCREW	XSTR	TRANSISTOR

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
06666	GENERAL DEVICES CO., INC.	525 S. WEBSTER AVE.	INDIANAPOLIS, IN 46219
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
23880	STANFORD APPLIED ENGINEERING, INC.	340 MARTIN AVE.	SANTA CLARA, CA 95050
31514	STANFORD APPLIED ENGINEERING, INC. ADVANCED PACKAGING DIV.	3080 AIRWAY DRIVE	COSTA MESA, CA 92626
45722	USM CORP., PARKER-KALON FASTENER DIV.		CAMPBELLSVILLE, KY 42718
57771	STIMPSON, EDWIN B., CO., INC.	900 SYLVAN AVENUE	BAYPORT, NY 11705
71785	TRW, CINCH CONNECTORS	1501 MORSE AVENUE	ELK GROVE VILLAGE, IL 60007
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
77250	PHEOLL MANUFACTURING CO., DIVISION OF ALLIED PRODUCTS CORP.	5700 W. ROOSEVELT RD.	CHICAGO, IL 60650
77820	BENDIX CORP., THE, ELECTRICAL COMPONENTS DIVISION	SHERMAN AVE.	SIDNEY, NY 13838
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
86445	PENN FIBRE AND SPECIALTY CO., INC.	2032 E. WESTMORELAND ST.	PHILADELPHIA, PA 19134
93907	CAMCAR SCREW AND MFG. CO.	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	----- -----			1	CKT BOARD ASSY:INTERFACE(SEE A1 EPL)		
-2	131-0608-00			12	. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-3	131-1043-00			1	. CONNECTOR,RCPT,:18/36 CONTACT	23880	SAC18D/4-2
-4	----- -----			3	. CONNECTOR,RCPT,:(SEE J601,J602,J603 EPL)		
-5	136-0269-00			1	. SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE	71785	133-59-02-073
-6	214-2627-00			6	. KEY,CONN PLZN:CKT BOARD CONN	31514	Q07900
-7	386-1938-00			1	. REINF,CKT BD:INTERFACE	80009	386-1938-00
					(ATTACHING PARTS)		
-8	210-0777-00			4	. RIVET,BLIND:0.125 DIA GRIP,AL	45722	AD42AB5
					- - - * - - -		
					(ATTACHING PARTS FOR CKT BD ASSY)		
-9	213-0146-00			4	SCR,TPG,THD FOR:6-20 X 0.313 INCH,PNH STL	83385	OBD
					- - - * - - -		
	----- -----	XB092712		1	CKT BOARD ASSY:SIGNALS OUT(SEE A6 EPL)		
	----- -----			-	* OPTION 7 ONLY		
	129-0259-00	XB092712		3	. POST,ELEC-MECH:4-40 X 0.187 OD X 0.39" LG	80009	129-0259-00
	----- -----			-	. * OPTION 7 ONLY		
	131-0589-00	XB092712		20	. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
	----- -----			-	. * OPTION 7 ONLY		
	198-4025-00	XB092712		1	. WIRE SET,ELEC:	80009	198-4025-00
	----- -----			-	. * OPTION 7 ONLY		
	131-0707-00	XB092712		12	. . CONNECTOR,TERM.:22-26 AWG,BRS& CU BE GOLD	22526	47439
	----- -----			-	. . * OPTION 7 ONLY		
	175-0825-00	XB092712		FT	. . WIRE,ELECTRICAL:2 WIRE RIBBON	80009	175-0825-00
	----- -----			-	. . * OPTION 7 ONLY		
	175-0829-00	XB092712		FT	. . WIRE,ELECTRICAL:6 WIRE RIBBON	08261	SS-0626-710610C
	----- -----			-	. . * OPTION 7 ONLY		
	352-0164-00	XB092712		1	. . CONN BODY,PL,EL:6 WIRE BLACK	80009	352-0164-00
	----- -----			-	. . * OPTION 7 ONLY		
	352-0169-02	XB092712		1	. . CONN BODY,PL,EL:2 WIRE RED	80009	352-0169-00
	----- -----			-	. . * OPTION 7 ONLY		
	352-0169-03	XB092712		1	. . CONN BODY,PL,EL:2 WIRE ORANGE	80009	352-0169-03
	----- -----			-	. . * OPTION 7 ONLY		
	352-0169-09	XB092712		1	. . CONN BODY,PL,EL:2 WIRE WHITE	80009	352-0169-09
	----- -----			-	. . * OPTION 7 ONLY		
					(ATTACHING PARTS FOR CRT BD ASSY)		
	211-0116-00	XB092712		1	. . SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
	----- -----			-	. . * OPTION 7 ONLY		
					- - - * - - -		
-10	----- -----			1	CKT BOARD ASSY:POWER SUPPLY(SEE A2 EPL)		
-11	131-0608-00			14	. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
	131-0589-00			14	. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-12	200-0293-00			1	. SHLD,CAPACITOR:2.563 INCHES LONG	80009	200-0293-00
-13	200-0294-00	B010100	B043669	2	. SHLD,CAPACITOR:	80009	200-0294-00
	200-0294-00	B043670		1	. SHLD,CAPACITOR:	80009	200-0294-00
-14	214-0579-00			4	. TERM.,TEST PT:BRS CD PL	80009	214-0579-00
-15	344-0154-00			6	. CLIP,ELECTRICAL:FOR 0.25 INCH DIA FUSE	80009	344-0154-00
					(ATTACHING PARTS FOR CKT BD ASSY)		
-16	211-0504-00			6	SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL	83385	OBD
					- - - * - - -		
-17	----- -----			1	TRANSFORMER:(SEE T801 EPL)		
-18	352-0198-00			1	. HLDR,TERM CONN:2 WIRE BLACK	80009	352-0198-00
-19	131-0622-00			2	. CONTACT,ELEC:0.577"L,28-32 AWG WIRE	22526	46241
					(ATTACHING PARTS FOR XFMR)		
-20	212-0516-00	B010100	B049999	4	SCREW,MACHINE:10-32 X 2 INCH,HEX HD STL	77250	OBD
	212-0522-00	B050000		4	SCREW,MACHINE:10-32 X 2.50",HEX HD STL	83385	OBD
	210-0812-00	XB062200		4	WASHER,NONMETAL:#10,FIBER	86445	OBD
-21	166-0226-00	B010100	B049999	4	INS SLV,ELEC:1.125 INCHES LONG	80009	166-0226-00
	166-0457-00	B050000		4	INSUL SLVG,ELEC:0.19 ID X 1.875"LONG MYLAR	80009	166-0457-00
-22	220-0410-00			4	NUT,EXTENDED WA:10-32 X 0.375 INCH,STL	83385	OBD
					- - - * - - -		
-23	200-0772-02			1	COVER,ELEC XFMR:3.125 X 3.75 X 0.875	80009	200-0772-02
	131-0126-00	XB092712		4	CONNECTOR,RCPT,:BNC,FEMALE	77820	9663-1 NT-34
	----- -----			-	* OPTION 7 ONLY		
-24	333-1425-00	B010100	B089999	1	PANEL,REAR:	80009	333-1425-00

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-	333-1426-06	B090000		1	PANEL,REAR:	80009	333-1425-06
	333-1425-07	XB092712		1	PANEL,REAR:	80009	333-1425-07
	----- -----			-	* OPTION 7 ONLY		
-25	343-0315-00			2	CLAMP,XSTR:	80009	343-0315-00
					(ATTACHING PARTS)		
-26	210-0407-00			6	NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS	73743	3038-0228-402
					- - - * - - -		
-27	342-0082-00			3	INSULATOR,PLATE:0.52 SQ X 0.015 INCH THK,AL	80009	342-0082-00
-28	351-0293-00			3	GUIDE,SLIDE:BLUE	80009	351-0293-00
-29	351-0286-00	B010100	B039999	3	GUIDE,PL-IN UNI:	80009	351-0286-00
	351-0286-01	B040000	B062225	3	GUIDE,PL-IN UNI:	80009	351-0286-01
	351-0286-02	B062226	B065347	3	GUIDE,PL-IN UNI:	80009	351-0286-02
	351-0286-04	B065348		3	GUIDE,SLIDE:BLACK	80009	351-0286-04
					(ATTACHING PARTS)		
-30	211-0105-00			3	SCREW,MACHINE:4-40 X 0.188"100 DEG,FLH STL	83385	OBD
					- - - * - - -		
-31	426-0738-00			1	FR ASSY,PWR-AMP:	80009	426-0738-00
	210-0617-00	XB030000		3	. EYELET,METALLIC:0.089 OD X 0.125" L,BRASS	57771	G53-4
	131-1254-01	XB030000		3	. CONTACT,ELEC:GROUNDING	80009	131-1254-01
-32	175-0826-00			FT	WIRE,ELECTRICAL:3 WIRE RIBBON	80009	175-0826-00
-33	175-0829-00			FT	WIRE,ELECTRICAL:6 WIRE RIBBON	08261	SS-0626-710610C
	131-1896-00			1	LINK,TERM. CONN:8,22 AWG,1.5 L	80009	131-1896-00
-34	131-0707-00			2	. CONNECTOR,TERM.:22-26 AWG,BRS& CU BE GOLD	22526	47439
-35	352-0166-02			1	. CONN BODY,PL,EL:8 WIRE RED	80009	352-0166-02
	131-1895-00			1	LINK,TERM. CONN:8,22 AWG,1.5 L	80009	131-1895-00
	131-0707-00			2	. CONNECTOR,TERM.:22-26 AWG,BRS& CU BE GOLD	22526	47439
	352-0166-01			1	. CONN BODY,PL,EL:8 WIRE BROWN	80009	352-0166-01
	198-4024-00	XB092712		1	WIRE SET,ELEC:	80009	198-4024-00
	----- -----			-	* OPTION 7 ONLY		
	131-0707-00	XB092712		8	. CONNECTOR,TERM.:22-26 AWG,BRS& CU BE GOLD	22526	47439
	----- -----			-	. * OPTION 7 ONLY		
	175-0857-00	XB092712		FT	. WIRE,ELECTRICAL:8 WIRE RIBBON	08261	SS-0822-1910610C
	----- -----			-	. * OPTION 7 ONLY		
	352-0166-04	XB092712		1	. CONN BODY,PL,EL:8 WIRE YELLOW	80009	352-0166-04
	----- -----			-	. * OPTION 7 ONLY		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
2-1	200-0728-01	B010100	B089999	1	COV,HANDLE END:	80009	200-0728-01
	200-0728-06	B090000		1	COVER,HDL END:	80009	200-0728-06
-2	200-0728-00			1	COV,HANDLE END:	80009	200-0728-00
-3	367-0116-00			1	HANDLE,CARRYING:	80009	367-0116-00
					(ATTACHING PARTS)		
-4	212-0597-00			4	SCREW,MACHINE:10-32 X 0.50 INCH,STL	93907	OBD
-5	386-1624-00			2	PLATE,HDL RTNG:STAINLESS STEEL	80009	386-1624-00
-6	386-1283-00			2	PLATE,HDL MTG:FRONT	80009	386-1283-00
					- - - * - - -		
-7	390-0193-00			1	COVER,SCOPE:LEFT SIDE	80009	390-0193-00
	390-0193-01	XB092405	B092472	1	COVER,SCOPE:LEFT SIDE	80009	390-0193-01
	----- -----			-	* OPTION 2 ONLY		
	390-0471-00	B092473		1	COVER,DISPLAY:LEFT SIDE BENCH W/LATCH	80009	390-0471-00
	----- -----			-	* OPTION 2 ONLY		
	214-0812-00			4	. FASTENER,PAWL:	80009	214-0812-00
-8	386-0226-00			1	. . CLAMP,RIM CLENC:SPG STL CD PL	80009	386-0226-00
-9	386-0227-00			1	. . STOP,CLP,RIM CL:ACETAL	80009	386-0227-00
-10	214-0604-00			1	. . WASH.,SPG TNSN:0.26 ID X 0.47 INCH OD	80009	214-0604-00
-11	214-0603-01			1	. . PIN,SECURING:0.27 INCH LONG	80009	214-0603-01
-12	390-0192-00			1	COVER,SCOPE:RIGHT SIDE	80009	390-0192-00
	390-0192-01	XB092405	B092472	1	COVER,SCOPE:RIGHT SIDE	80009	390-0192-01
	----- -----			-	* OPTION 2 ONLY		
	390-0471-01	B092473		1	COVER,DISPLAY:RIGHT SIDE BENCH W/LATCH	80009	390-0471-01
	----- -----			-	* OPTION 2 ONLY		
	214-0812-00			4	. FASTENER,PAWL:	80009	214-0812-00
-13	386-0226-00			1	. . CLAMP,RIM CLENC:SPG STL CD PL	80009	386-0226-00
-14	386-0227-00			1	. . STOP,CLP,RIM CL:ACETAL	80009	386-0227-00
-15	214-0604-00			1	. . WASH.,SPG TNSN:0.26 ID X 0.47 INCH OD	80009	214-0604-00
-16	214-0603-01			1	. . PIN,SECURING:0.27 INCH LONG	80009	214-0603-01
-17	390-0190-00	B010100	B092405	1	COVER,SCOPE:BOTTOM	80009	390-0190-00
	390-0470-00	B092406		1	CAB.BOT,DSPL:BOTTOM	80009	390-0470-00
	214-0812-00			4	. FASTENER,PAWL:	80009	214-0812-00
	----- -----			-	. . EACH LATCH ASSEMBLY INCLUDES:		
-18	386-0226-00			1	. . CLAMP,RIM CLENC:SPG STL CD PL	80009	386-0226-00
-19	386-0227-00			1	. . STOP,CLP,RIM CL:ACETAL	80009	386-0227-00
-20	214-0604-00			1	. . WASH.,SPG TNSN:0.26 ID X 0.47 INCH OD	80009	214-0604-00
-21	214-0603-01			1	. . PIN,SECURING:0.27 INCH LONG	80009	214-0603-01
-22	348-0073-00			2	. . SPT PIVOT,FLIP:LEFT FRONT AND RIGHT REAR	80009	348-0073-00
					(ATTACHING PARTS)		
-23	211-0532-00			4	. . SCREW,MACHINE:6-32 X 0.75 INCH,FILH STL	83385	OBD
-24	210-0457-00			4	. . NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-25	348-0208-00			2	. FOOT,CABINET:LEFT FRONT AND RIGHT REAR	80009	348-0208-00
-26	348-0074-00			2	. SPT PIVOT,FLIP:RIGHT FRONT AND LEFT REAR	80009	348-0074-00
					(ATTACHING PARTS FOR EACH)		
-27	211-0532-00			2	. SCREW,MACHINE:6-32 X 0.75 INCH,FILH STL	83385	OBD
-28	210-0457-00			2	. NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
					- - - * - - -		
-29	348-0207-00			2	FOOT,CABINET:RIGHT FRONT AND LEFT REAR	80009	348-0207-00
-30	348-0275-00			1	FLIPSTAND,CAB.:	80009	348-0275-00
-31	212-0105-00			2	SCREW,EXT RLV:8-32 X 0.312 INCH,HEX HD STL	80009	212-0105-00
-32	212-0008-00			2	SCREW,MACHINE:8-32 X 0.500 INCH,PNH STL	83385	OBD
-33	210-0008-00			2	WASHER,LOCK:INTL,0.172 ID X 0.331"OD,STL	78189	1208-00-00-0541C
-34	361-0388-00			2	SPACER,PLATE:	80009	361-0388-00
-35	343-0256-00			2	RTNR BLK,SCOPE:	80009	343-0256-00
					(ATTACHING PARTS)		
-36	211-0531-00			4	SCREW,MACHINE:6-32 X 0.375,FIL,STL	83385	OBD
					- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
3-1	351-0195-00			1	SLIDE,DWR,EXT:SLIDE,PAIR(RACKMOUNT ONLY)	06666	C719
-2	351-0104-00			1	SLIDE SECT.,DWR:PAIR	06666	C-720-2
					(ATTACHING PARTS)		
-3	212-0004-00			6	SCREW,MACHINE:8-32 X 0.312 INCH,PNH STL	83385	OBD
	210-0858-00			6	WASHER,FLAT:0.500 OD X 0.171 ID X 0.063 THK	80009	210-0858-00
					- - - * - - -		
-4	407-0899-02	B010100	B089999	1	BRACKET,RACK MT:RIGHT,ALUMINUM	80009	407-0899-02
	407-0899-00	B090000		1	BRACKET,RACK MT:ALUMINUM	80009	407-0899-00
					(ATTACHING PARTS)		
-5	212-0040-00			2	SCREW,MACHINE:8-32 X 0.375 100 DEG,FLH STL	83385	OBD
					- - - * - - -		
-6	407-0899-00			1	BRACKET,RACK MT:ALUMINUM	80009	407-0899-00
					(ATTACHING PARTS)		
-7	212-0040-00			2	SCREW,MACHINE:8-32 X 0.375 100 DEG,FLH STL	83385	OBD
					- - - * - - -		
-8	390-0191-00	B010100	B092405	1	COVER,SCOPE:RIGHT SIDE	80009	390-0191-00
	390-0503-00	B092406		1	CAB.SIDE,DSPL:LEFT,RACK	80009	390-0503-00
	214-0812-00			4	. FASTENER,PAWL:	80009	214-0812-00
-9	386-0226-00			1	. . CLAMP,RIM CLENC:SPG STL CD PL	80009	386-0226-00
-10	386-0227-00			1	. . STOP,CLP,RIM CL:ACETAL	80009	386-0227-00
-11	214-0604-00			1	. . WASH.,SPG TNSN:0.26 ID X 0.47 INCH OD	80009	214-0604-00
-12	214-0603-01			1	. . PIN,SECURING:0.27 INCH LONG	80009	214-0603-01
-13	390-0194-00	B010100	B092405	1	COVER,SCOPE:LEFT SIDE	80009	390-0194-00
	390-0502-00	B092406		1	CAB.SIDE,DSPL:RIGHT,RACK	80009	390-0502-00
	214-0812-00			2	. FASTENER,PAWL:	80009	214-0812-00
-14	386-0226-00			1	. . CLAMP,RIM CLENC:SPG STL CD PL	80009	386-0226-00
-15	386-0227-00			1	. . STOP,CLP,RIM CL:ACETAL	80009	386-0227-00
-16	214-0604-00			1	. . WASH.,SPG TNSN:0.26 ID X 0.47 INCH OD	80009	214-0604-00
-17	214-0603-01			1	. . PIN,SECURING:0.27 INCH LONG	80009	214-0603-01
-18	390-0222-00	B010100	B092405	2	COVER,SCOPE:BOTTOM	80009	390-0222-00
	390-0505-00	B092406		2	CAB.BOT,SCOPE:	80009	390-0505-00
	214-0812-00			4	. FASTENER,PAWL:	80009	214-0812-00
-19	386-0226-00			1	. . CLAMP,RIM CLENC:SPG STL CD PL	80009	386-0226-00
-20	386-0227-00			1	. . STOP,CLP,RIM CL:ACETAL	80009	386-0227-00
-21	214-0604-00			1	. . WASH.,SPG TNSN:0.26 ID X 0.47 INCH OD	80009	214-0604-00
-22	214-0603-01			1	. . PIN,SECURING:0.27 INCH LONG	80009	214-0603-01
-23	212-0103-00			3	SCREW,MACHINE:8-32 X 0.375 HEX HD,STL	77250	OBD
	212-0104-00			3	SCREW,MACHINE:8-32,0.75 HEXSTL	80009	212-0104-00
-24	210-0008-00			10	WASHER,LOCK:INTL,0.172 ID X 0.331"OD,STL	78189	1208-00-00-0541C
-25	361-0389-00			1	SPACER,PLATE:	80009	361-0389-00

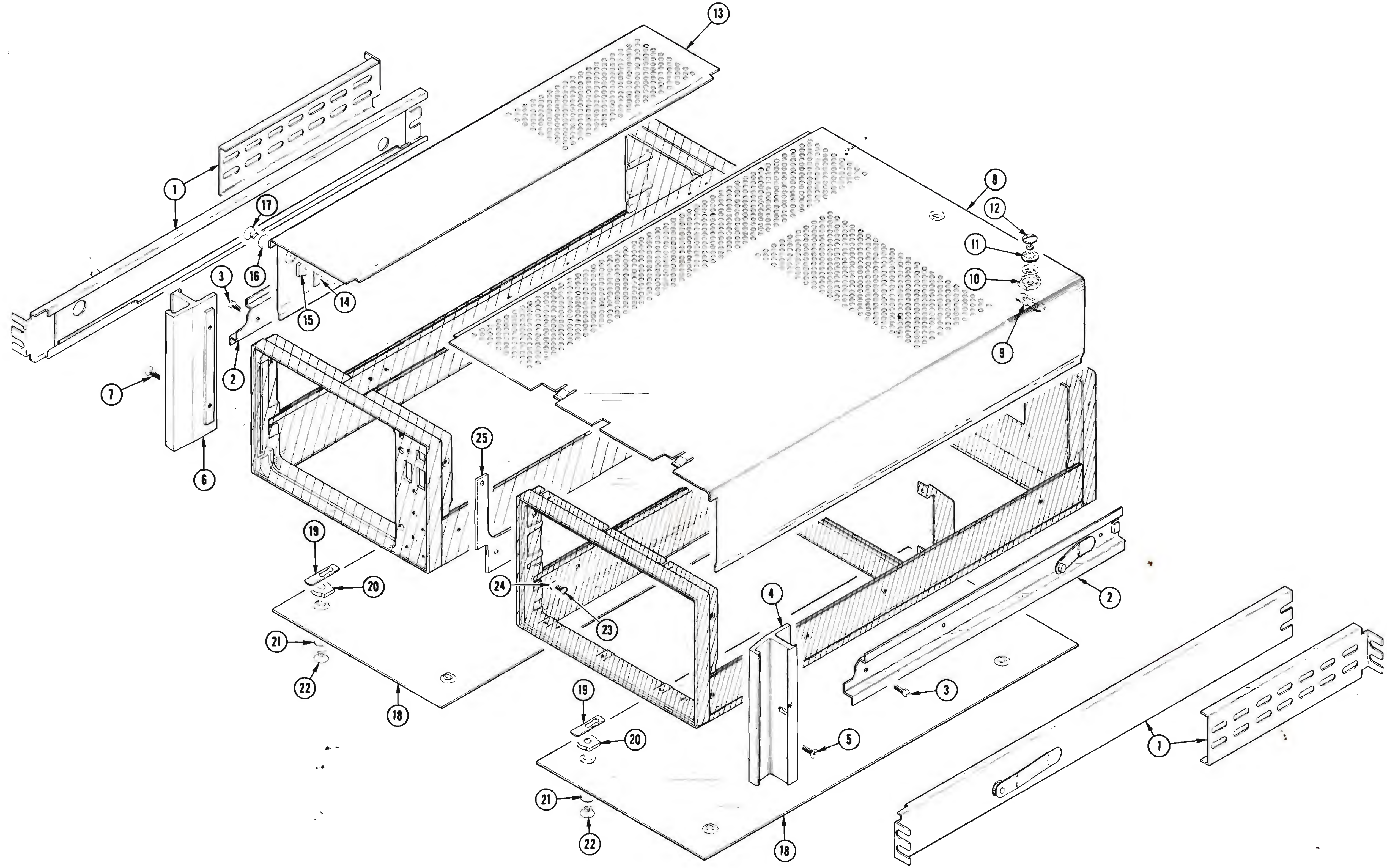


FIG. 3 RACKMOUNT CABINET

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
	070-1143-00			1	MANUAL:INSTRUCTION(NOT SHOWN)		

ACCESSORIES

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.

SERVICE NOTE

Because of the universal parts procurement problem, some electrical parts in your instrument may be different from those described in the Replaceable Electrical Parts List. The parts used will in no way alter or compromise the performance or reliability of this instrument. They are installed when necessary to ensure prompt delivery to the customer. Order replacement parts from the Replaceable Electrical Parts List.

CALIBRATION TEST EQUIPMENT REPLACEMENT

Calibration Test Equipment Chart

This chart compares TM 500 product performance to that of older Tektronix equipment. Only those characteristics where significant specification differences occur, are listed. In some cases the new instrument may not be a total functional replacement. Additional support instrumentation may be needed or a change in calibration procedure may be necessary.

Comparison of Main Characteristics

DM 501 replaces 7D13		
PG 501 replaces 107	PG 501 - Risetime less than 3.5 ns into 50 Ω.	107 - Risetime less than 3.0 ns into 50 Ω.
108	PG 501 - 5 V output pulse; 3.5 ns Risetime	108 - 10 V output pulse 1 ns Risetime
PG 502 replaces 107		
108	PG 502 - 5 V output	108 - 10 V output
111	PG 502 - Risetime less than 1 ns; 10 ns Pretrigger pulse delay	111 - Risetime 0.5 ns; 30 to 250 ns Pretrigger pulse delay
PG 508 replaces 114, 115, 2101	Performance of replacement equipment is the same or better than equipment being replaced.	
PG 506 replaces 106	PG 506 - Positive-going trigger output signal at least 1 V; High Amplitude output, 60 V.	106 - Positive and Negative-going trigger output signal, 50 ns and 1 V; High Amplitude output, 100 V.
067-0502-01	PG 506 - Does not have chopped feature.	0502-01 - Comparator output can be alternately chopped to a reference voltage.
SG 503 replaces 190, 190A, 190B	SG 503 - Amplitude range 5 mV to 5.5 V p-p.	190B - Amplitude range 40 mV to 10 V p-p.
191		
067-0532-01	SG 503 - Frequency range 250 kHz to 250 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
SG 504 replaces 067-0532-01	SG 504 - Frequency range 245 MHz to 1050 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
067-0650-00		
TG 501 replaces 180, 180A	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	180A - Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be generated simultaneously.
181		181 - Multiple time-marks
184	TG 501 - Trigger output-slaved to market output from 5 sec through 100 ns. One time-mark can be generated at a time.	184 - Separate trigger pulses of 1 and 0.1 sec; 10, 1, and 0.1 ms; 10 and 1 μs.
2901	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	2901 - Separate trigger pulses, from 5 sec to 0.1 μs. Multiple time-marks can be generated simultaneously.

NOTE: All TM 500 generator outputs are short-proof. All TM 500 plug-in instruments require TM 500-Series Power Module.

IMPORTANT NOTE

This instrument is fitted with a power cord which complies with B.S. 4743/I.E.C. 348 specifications.

The connections are as follows:-

Green/Yellow	EARTH
Brown	LIVE
Blue	NEUTRAL

Ensure that the correctly rated fuse is selected for your operating range. (Refer to OPERATING INSTRUCTIONS section at front of manual).

Unless otherwise stated your instrument is shipped ready for operation from a 240V nominal line-voltage source and fitted with the appropriate fuse.

Please amend your manual to reflect the above changes, the new power cord part number is 161-0086-02, except in the type 7704A instrument where it is 161-0086-01.

If a separate power cord retainer is required order part number 343-0170-00.

G5/773

Addendum to G5/773

In the type 7704A instrument from serial number 100180 upwards the part number of the detached power cord is 161-0100-00.

GUERNSEY TYPE 5112 - TENTATIVE S/N 100155
GUERNSEY TYPE 5113 - TENTATIVE S/N 100247

ELECTRICAL PARTS LIST CORRECTION

(A3 HIGH VOLTAGE Circuit Board Assembly)

CHANGE TO -

R248	301-0273-00	27 kΩ, $\frac{1}{2}$W, 5%

M2400/773

GUERNSEY TYPE 5112 - TENTATIVE S/N 100293
GUERNSEY TYPE 5113 - TENTATIVE S/N 100531

ELECTRICAL PARTS LIST CHANGE

C269 becomes selectable from .1 μF to .3 μF but the nominal installed value will remain .22 μF.

M2930/675

GUERNSEY TYPE 5112 - TENTATIVE S/N 103581
GUERNSEY TYPE 5113 - TENTATIVE S/N 104771

ELECTRICAL PARTS LIST CHANGE

CHANGE TO -

C872	281-0628-00	CAP., FXD., CER. DI. 15 pF

3287/877

GUERNSEY TYPE 5112 - TENTATIVE S/N 103581
GUERNSEY TYPE 5113 - TENTATIVE S/N 104791

ELECTRICAL PARTS LIST CHANGE

CHANGE TO -

C269	283-0211-00	CAP., FXD., CER DI : 0.1 µF 200 V 10%

3335/1277

GUERNSEY TYPE 5112 - TENTATIVE S/N 103641

ELECTRICAL PARTS LIST CHANGE

CHANGE TO -

C269	283-0208-00	CAP., FXD., CER., DI : 0.22 uF 200 V

3475/978

TEKTRONIX®
committed to technical excellence

MANUAL CHANGE INFORMATION

PRODUCT 5113/R Option 3
070-2137-00

CHANGE REFERENCE C1/278
DATE 2-16-78

CHANGE:	DESCRIPTION

EFF ALL Serial Numbers

OPTION 3
FAST WRITING SPEED CRT

The purpose of OPTION 3 is to change to a cathode-ray tube with fast writing speed capabilities.

SPECIFICATION

Writing speed is at least 200 (150 for SN B079999 and below) divisions per millisecond using the center 6 x 8 divisions of the graticule.

ELECTRICAL PARTS LIST

Ckt No	Tektronix Part No.	Serial/Model No. Eff	Dscont.	Description
V291	154-0636-02	B010100	B079999	Electron Tube: CRT
V291	154-0636-12	B080000		Electron Tube: CRT

PERFORMANCE CHECK

Check Storage Operation

a. Set the time-base for a sweep rate of 50 μs/div.

b. Adjust the sine-wave generator controls for a 3.2 division display at a frequency of 20 kHz (15 kHz for SN B079999 and below). Center the display on the graticule.

c. Adjust the time-base unit for a stable-triggered display.

d. Slowly advance the INTENSITY control to the point where the display begins to defocus, then set the time-base unit for single-sweep operation.

e. Press the STORE buttons (both UPR and LWR) to their on position. Press the ERASE select buttons (both UPR and LWR) to their on position. Adjust the BRIGHTNESS (Y-T) control fully clockwise to MAX position.

f. Press the ERASE button to remove the stored display, then press the reset button on the time-base unit to store a single-sweep display.

g. Check - the center 6 x 8 divisions of the graticule for a stored display with breaks in the trace not exceeding 0.025 inch. This indicates a writing speed of at least 200 div/ms (150 div/ms for SN B079999 and below).

PRODUCT 5113/R Option 3 CHANGE REFERENCE C1/278 DATE 2-16-78

CHANGE:	DESCRIPTION
	NOTE If breaks in the trace appear to exceed 0.025 inch, adjust the INTENSITY control for a slightly higher brightness level or examine the trace breaks more closely for lower luminance (acceptable). Repeat parts f and g if necessary.

MANUAL CHANGE INFORMATION

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PRODUCT 5112/R, 5113/R

CHANGE REFERENCE C2/1178

DATE 11-9-78

CHANGE:	DESCRIPTION

EFF ALL Serial Numbers

5112/R (070-2136-00)

5113/R (070-2137-00)

REPLACEABLE ELECTRICAL PARTS LIST CHANGES

CHANGE TO:

CR204	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA,1N4152
CR208	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA,1N4152
CR224	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA,1N4152
CR255	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA,1N4152
CR256	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA,1N4152
CR262	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA,1N4152
CR264	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA,1N4152
CR404	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA,1N4152
CR408	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA,1N4152
CR424	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA,1N4152

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MANUAL CHANGE INFORMATION

PRODUCT 5110/R, 5111/R, 5112/R, 5113/R, 5115/R	CHANGE REFERENCE M33117
	DATE 6-29-78

CHANGE:	DESCRIPTION

5110/R 070-2134-01
5111/R 070-2135-01
5112/R 070-2136-00
5113/R 070-2137-00
5115/R 070-2138-01

OPTION 7

REAR PANEL SIGNAL OUTPUTS

The purpose of OPTION 7 is to provide cathode-ray tube-related signals to standard connectors at the rear of the instrument. This option is particularly well suited for use in the physical life sciences. By using differential amplifiers, the oscilloscope can become a signal conditioner for other devices. Outputs may be used for driving counters or X-Y plotters in conjunction with the oscilloscope.

SPECIFICATIONS		
PARAMETER	PERFORMANCE LIMITS	MAINTENANCE & OPERATION
Signal Outputs(Option 7)		
Left Out, Center Out Signals	Crt-related vertical signals	Derived from interface signal output pins
Sensitivity	0.5 V/crt div,±3% into ≥100 kΩ	
DC Offset		±500 mV max
Output Impedance	Approximately 1 kΩ	
Dynamic Range		±4 V max
Amplifier Bandwidth	≥500 kHz up to ±2 V output into ≤50 pF	
Common Mode Rejection Ratio		≥28 dB at 1 kHz
Noise and Chop Breakthrough*	≤100 mV at each output connector	
Right Out Signal	Crt-related sweep signal	Derived from interface signal output pins
Sensitivity	0.5 V/crt div,±3% into ≥100 kΩ	
Polarity and Output Voltage	Positive-going ramp, ≥5 V	DC offset provided by timebase position control
Output Impedance	Approximately 1 kΩ	
Gate Out Signal	Crt-related Z-axis signal	Selected by timebase
Output Levels	TTL compatible	Low:Sinking 1.6mA,≤0.4 V High:Supplying 40μA,≥2.4V
Risetime		≤1 μs into ≤50 pF
Falltime		≤200 ns into ≤50 pF

*If excessive noise and chop breakthrough occur, refer to the following discussion, Modifications To Early Version Plug-Ins.

MODIFICATION TO EARLY VERSION PLUG-INS

The channel switching amplifier plug-ins that are recommended for use with 5100-series mainframes (5A14N, 5A18N, 5A26) have been modified to reduce display noise and chop breakthrough when used in an option 7 mainframe. If any of the mentioned amplifier plug-ins cause the noise and chop breakthrough specification to be exceeded, an earlier version (before option 7) of the plug-in is probably being used. The following information is provided to explain how to modify earlier version plug-ins for reduced display noise and chop breakthrough.

To modify a 5A14N (SN B063288 and below only) change R513, R523, and R533 on the Main circuit board to a 100 k ohm, 5%, 0.25W composition resistor, Tektronix part no. 315-0104-00. Cut the board run (at both components) that connects Q540 and R542, so as to remove electrically, the run from the front side of the board. Connect an insulated wire strap between Q540 and R542, on the back side of the board so as to replace the board run removed from the front.

To modify a 5A18N (SN B050000 to SN B099999 only) change R301 on the Main Amplifier circuit board to a 20 k ohm, 5%, 0.25W composition resistor, Tektronix part no. 315-0203-00.

To modify a 5A18N (SN B049999 and below only) change R301 on the Main Amplifier circuit board to a 20 k ohm, 5%, 0.25W composition resistor, Tektronix part no. 315-0203-00. Also, change R302 and R303 to a 10 k ohm, 1%, 0.125W film resistor, Tektronix part no. 321-0289-00.

To modify a 5A26 (SN B029000 and below only) change R289 on the Main circuit board to a 20 k ohm, 5%, 0.25W composition resistor, Tektronix part no. 315-0203-00. Also,change Q386 to a NPN silicon transistor, 2N 3565, TO - 106 case, Tektronix part no. 151-0341-00.

CHANGE:	DESCRIPTION

REPLACEABLE ELECTRICAL PARTS

ADD:

A5 (5110/R) A6 (5111/R) A6 (5112/R) A5 (5113/R) A6 (5115/R)	670-5757-00	CKT BOARD ASSY:SIGNALS OUT
C930	283-0002-00	CAP.,FXD,CER DI:0.01UF,+80-20%,500V
C931	281-0504-00	CAP.,FXD,CER DI:10PF,+/-1PF,500V
C960	283-0002-00	CAP.,FXD,CER DI:0.01UF,+80-20%,500V
C961	281-0504-00	CAP.,FXD,CER DI:10PF,+/-1PF,500V
C980	283-0002-00	CAP.,FXD,CER DI:0.01UF,+80-20%,500V
C981	281-0504-00	CAP.,FXD,CER DI:10PF,+/-1PF,500V
CR930	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA
CR960	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA
CR980	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA
CR990	152-0322-00	SEMICOND DEVICE:SILICON,15V
Q910	151-0190-00	TRANSISTOR:SILICON,NPN
Q915	151-0190-00	TRANSISTOR:SILICON,NPN
Q920	151-0190-00	TRANSISTOR:SILICON,NPN
Q925	151-0190-00	TRANSISTOR:SILICON,NPN
Q930	151-0188-00	TRANSISTOR:SILICON,PNP
Q940	151-0190-00	TRANSISTOR:SILICON,NPN
Q945	151-0190-00	TRANSISTOR:SILICON,NPN
Q950	151-0190-00	TRANSISTOR:SILICON,NPN
Q955	151-0190-00	TRANSISTOR:SILICON,NPN
Q960	151-0188-00	TRANSISTOR:SILICON,PNP
Q967	151-0190-00	TRANSISTOR:SILICON,NPN
Q970	151-0190-00	TRANSISTOR:SILICON,NPN
Q972	151-0190-00	TRANSISTOR:SILICON,NPN
Q975	151-0190-00	TRANSISTOR:SILICON,NPN
Q980	151-0188-00	TRANSISTOR:SILICON,PNP
Q999	151-0190-00	TRANSISTOR:SILICON,NPN

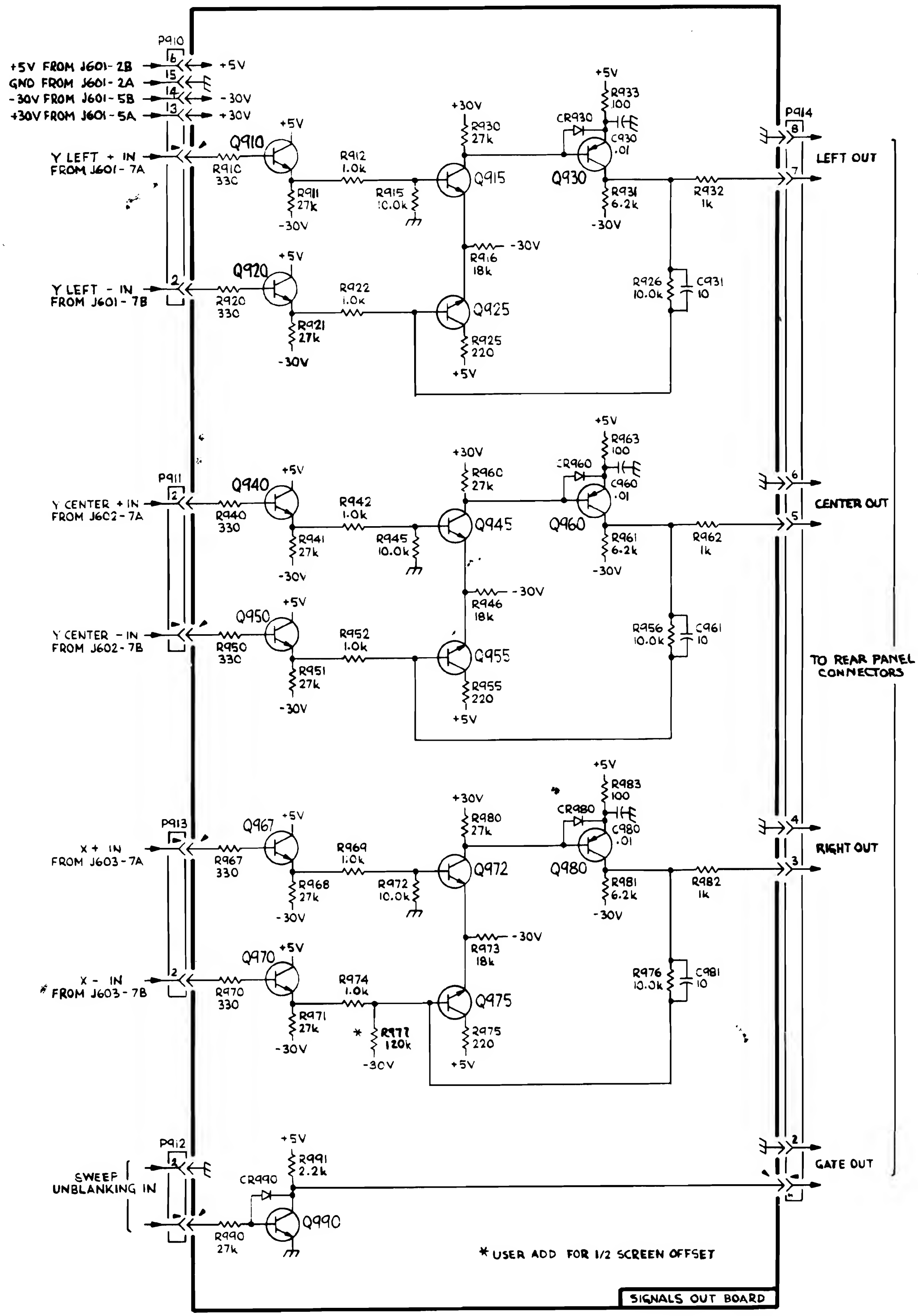
CHANGE:		DESCRIPTION
R910	315-0331-00	RES.,FXD,CMPSN:330 OHM,5%,0.25W
R911	315-0273-00	RES.,FXD,CMPSN:27K OHM,5%,0.25W
R912	321-0193-00	RES.,FXD,FILM:1K OHM,1%,0.125W
R915	321-0289-00	RES.,FXD,FILM:10.0K OHM,1%,0.125W
R916	315-0183-00	RES.,FXD,CMPSN:18K OHM,5%,0.25W
R920	315-0331-00	RES.,FXD,CMPSN:330 OHM,5%,0.25W
R921	315-0273-00	RES.,FXD,CMPSN:27K OHM,5%,0.25W
R922	321-0193-00	RES.,FXD,FILM:1K OHM,1%,0.125W
R925	315-0221-00	RES.,FXD,CMPSN:220 OHM,5%,0.25W
R926	321-0289-00	RES.,FXD,FILM:10.0K OHM,1%,0.125W
R930	315-0273-00	RES.,FXD,CMPSN:27K OHM,5%,0.25W
R931	315-0622-00	RES.,FXD,CMPSN:6.2K OHM,5%,0.25W
R932	315-0102-00	RES.,FXD,CMPSN:1K OHM,5%,0.25W
R933	315-0101-00	RES.,FXD,CMPSN:100 OHM,5%,0.25W
R940	315-0331-00	RES.,FXD,CMPSN:330 OHM,5%,0.25W
R942	321-0193-00	RES.,FXD,FILM:1K OHM,1%,0.125W
R945	321-0289-00	RES.,FXD,FILM:10.0K OHM,1%,0.125W
R946	315-0183-00	RES.,FXD,CMPSN:18K OHM,5%,0.25W
R950	315-0331-00	RES.,FXD,CMPSN:330 OHM,5%,0.25W
R951	315-0273-00	RES.,FXD,CMPSN:27K OHM,5%,0.25W
R952	321-0193-00	RES.,FXD,FILM:1K OHM,1%,0.125W
R955	315-0221-00	RES.,FXD,CMPSN:220 OHM,5%,0.25W
R956	321-0289-00	RES.,FXD,FILM:10.0K OHM,1%,0.125W
R960	315-0273-00	RES.,FXD,CMPSN:27K OHM,5%,0.25W
R961	315-0622-00	RES.,FXD,CMPSN:6.2K OHM,5%,0.25W
R962	315-0102-00	RES.,FXD,CMPSN:1K OHM,5%,0.25W
R963	315-0101-00	RES.,FXD,CMPSN:100 OHM,5%,0.25W
R967	315-0331-00	RES.,FXD,CMPSN:330 OHM,5%,0.25W
R968	315-0273-00	RES.,FXD,CMPSN:27K OHM,5%,0.25W
R969	321-0193-00	RES.,FXD,FILM:1K OHM,1%,0.125W
R970	315-0331-00	RES.,FXD,CMPSN:330 OHM,5%,0.25W
R971	315-0273-00	RES.,FXD,CMPSN:27K OHM,5%,0.25W
R972	321-0289-00	RES.,FXD,FILM:10.0K OHM,1%,0.125W
R973	315-0183-00	RES.,FXD,CMPSN:18K OHM,5%,0.25W
R974	321-0193-00	RES.,FXD,FILM:1K OHM,1%,0.125W

PRODUCT 5100-Series Option 7 CHANGE REFERENCE M33117 DATE 6-29-78

CHANGE:	DESCRIPTION	
R975	315-0221-00	RES.,FXD,CMPSN:220 OHM,5%,0.25W
R976	321-0289-00	RES.,FXD,FILM:10.0K OHM,1%,0.125W
R980	315-0273-00	RES.,FXD,CMPSN:27K OHM,5%,0.25W
R981	315-0622-00	RES.,FXD,CMPSN:6.2K OHM,5%,0.25W
R982	315-0102-00	RES.,FXD,CMPSN:1K OHM,5%,0.25W
R983	315-0101-00	RES.,FXD,CMPSN:100 OHM,5%,0.25W
R990	315-0273-00	RES.,FXD,CMPSN:27K OHM,5%,0.25W
R991	315-0222-00	RES.,FXD,CMPSN:2.2K OHM,5%,0.25W

PRODUCT 5100-Series Option 7 CHANGE REFERENCE M33117 DATE 6-29-78

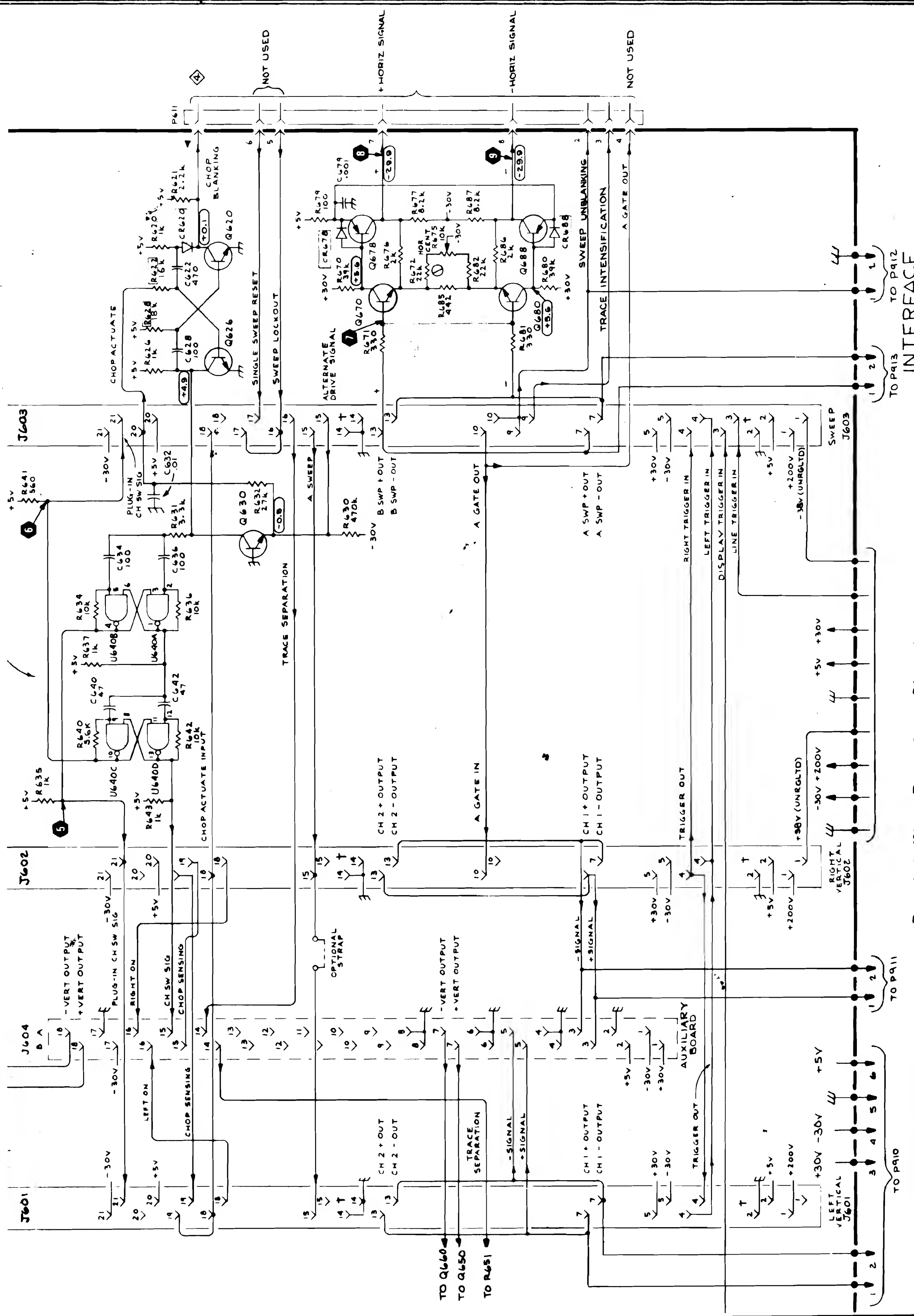
CHANGE:	DESCRIPTION



SIGNALS OUT
OPTION 7

PRODUCT 5100-Series Option 7 CHANGE REFERENCE M33117 DATE 6-29-78

CHANGE:	DESCRIPTION



Partial View Interface Circuit