NOTE
The 5110 Oscilloscope formerly was known under another nomenclature, the 5103N/D10. This manual contains information that applies to all of these instruments.

## TEKTRONIX

## 5110 OSCILLOSCOPE

$8 i-0 f-29$

INSTRUCTION MANபAL

Tektronix, Inc.
P.O. Box 600

Beaverton, Oregon 97077
Serial Number

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## WARNING

The remaining portion of this labte of Contents ilsts servicing instructions that expose personnel to hazardous voltages. These instructions are for qualified service personnel only. To avoid personal injury, do not perform any servicing other than that containedin Operating instructions unless you are qualified to do so

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Fig. 1-1. 5110 Oscilloscope.

## OPERATING INSTRUCTIONS

This instruction manual provides both operating and servicing information for the 5110 Oscilloscope. The manual is divided into nine sections. Operating, specification, and performance check information is covered in the first two sections, and is intended for operating and service personnel. Servicing information is covered in the remaining sections of the manual, and is intended for qualified service personnel only.

## PRELIMINARY INFORMATION

## Oscilloscope Features

The oscilloscope is a solid state, light weight instrument designed for general-purpose measuring applications. This instrument has three plug-in compartments that accept plug-in units to form a complete measurement system. The two-plug-in compartments on the left are connected to the vertical deflection system. The right plug-in compartment is connected to the horizontal deflection system. Electronic switching between the vertical plug-in compartments allows a multitrace vertical display. The flexibility of this plug-in feature and the variety of plug-in units available allow this system to be used for many measurement applications.

This instrument features a large-screen, $8 \times 10$ division display; each division equals 0.5 inch ( 1.27 centimeter). Regulated dc power supplies ensure that performance is not affected by variations in line voltage and frequency, or by changes in the load due to the varying power requirements of the plug-in units.

## Safety Information

This instructlon manual contains warning information which the user must follow to ensure safe operation of the instrument. Warning information is intended to protect the operator and Caution information is intended to protect the instrument.

## WARNING

High voltage is present Inside the instrument. To avoid electric-shock hazard, operating personnel must not remove the protective instrument covers. Component replacement and internal adjustments must be made by qualified service personnel only.

## OPERATING POWER

This instrument can be operated from either a 120-volt or 240 -volt nominal line-voltage source, 48 to 440 hertz. In addition, three regulating ranges are provided for each nominal line-voltage source.

To prevent damage to the instrument, always check the line-voltage information recorded on the rear panel before applying power to the instrument.

## WARNING

This instrument is intended to be operated from a single-phase earth-referenced power source having one current-carrying conductor (the Noutral Conductor) near earth potential. Operation from power sources where both current-carrying conductors are live with respect to earth (such as phase-tophase on a three-wire system) is not recommended, since only the Line Conductor has over-current (fuse) protection within the instrument.

This instrument has a three-wire power cord with a polarized two-pole, three-terminal plug for connection to the power source and safety-earth. The safety-earth terminal of the plug is directly connected to the instrument frame. For electric-shock protection, insert this plug only in a mating outlet with a safety-earth contact.

Do not defeat the grounding connection. Any interruption of the grounding connection can create an electric-shock hazard. Before making external connections to this instrument, always ground the instrument first by connecting the power-cord to a proper mating power outlet.

## OPERATING TEMPERATURE

The instrument can be operated where the ambient air temperature is between $0^{\circ} \mathrm{C}$ and $+50^{\circ} \mathrm{C}$. The instrument can be stored in ambient temperature between $-40^{\circ} \mathrm{C}$ and $+70^{\circ} \mathrm{C}$. 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

The oscilloscope is designed to accept up to three Tektronix 5000 -series plug-in units (use only " $\mathrm{N}^{\prime \prime}$ suffix plug-in units unless otherwise specified). 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, puil the release latch on the plug-in unit to disengage it and pull the unit out of the plug-in compartment. Plug-in units should not 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 oscilloscope is adjusted in accordance with the adjustment procedure given in this manual, the vertical and horizontal gain are standardized. This allows adjusted plug-in units to be changed from one plug-in compartment to another without readjustment. However, the basic adjustment of the individual plug-in units should be checked when they are installed in this system to verify their measurement accuracy. See the plug-in unit manual for verification procedure.

## Selection

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

## NOTE

Use only " $N$ " suffix plug-in units with the oscilloscope unless otherwise specified.

To produce a single-trace display, install a singlechannel vertical unit (or dual-channel unit set for singlechannel operation) in elther 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 5 A -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.

## CONTROLS AND CONNECTORS

Controls and connectors necessary for operation of the oscllloscope are located on the front and rear panels of the instrument. To make full use of the capabilities of this instrument, the operator should be familiar with the function and use of each external control and connector. A brief description of the controls and connectors is given here. More detalled information is given under General Operating Information (later in this section). See Fig. 1-2 for the location and description of the controls and connectors.

## FIRST TIME OPERATION

The following procedure provides an operational checkout as a means of verifying instrument operation and basic calibration without removing the cabinet or making internal adjustments. Since it demonstrates the use of front-panel controls and connectors, it can also be used to provide basic training on the operation of this instrument. If recalibration of the oscilloscope or plug-ins appears to be necessary, refer the instrument system to qualified service personnel. If more familiarization with a plug-in unit is needed, see the instruction manual for the appropriate plug-in unit. Refer to Fig. 1-2 for the oscilloscope control and connector locations.


Fig. 1-2. Front-and rear-panel controls and connectors.

## Operating Instructions-5110

## CHECKOUT PROCEDURE

1. For the following procedure, an amplifier plug-in should be in one of the vertical (left or center) plug-in compartments and a time-base plug-in should be in the horizontal (right) compartment.
2. Set the POWER switch to off (pushed in) and connect the oscilloscope to a power source that meets the voltage and frequency requirements of this instrument.
3. Turn the INTENSITY control counterclockwise and pull the POWER switch out to turn the instrument on.

## Initial Control Settings

Set the front-panel controls as follows:

## NOTE

Titles for external controls of the oscilloscope are capitalized in this procedure (e.g. INTENSITY, POWER).

## AMPLIFIER PLUG-IN

| Display | On |
| :--- | :--- |
| Position | Centered |
| Volts/Div | .1 |
| Volts/Div Cal | Fully clockwise |
| Input coupling | dc |


|  | TIME-BASE PLUG-IN |
| :--- | :--- |
| Display | Chop |
| Position | Centered |
| Seconds/Div | 2 ms |
| Seconds/Div Cal | Fully clockwise |
| Swp Mag | Off |
| Triggering | + Slope, Auto Trig, |
|  | ac Coupl |
| Triggering Source | Composite |

## Intensity Adjustment

4. Advance the INTENSITY control until the trace is at the desired viewing level. Set the trace near the graticule center line.

## Focus Adjusiment

5. Adjust the FOCUS control for a sharp, well-defined trace over the entire trace length.

## Trace Alignment Adjustment

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

## Calibration Check

7. Connect a 1 X probe, or a test lead from the amplifier plug-in connector to the CALIBRATOR loop.
8. Set the time-base unit triggering level for a stable triggered display. Adjust the vertical and horizontal position controls so that the display is centered vertically and starts at the left edge of the graticule.
9. The display stould be four divisions in amplitude with approximately 2.5 complete cycles over 10 divisions (for 60-hertz line frequency) shown horizontally. An incorrect display indicates that the Oscilloscope or plugins need to be recalibrated.

## Beam Finder Check

10. Move the display off-screen with the vertical position control.
11. 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. Disconnect the 1 X probe or test lead.

## External Intensity Input

12. Connect a 5 -volt, $1-\mathrm{kHz}$ sine-wave or square-wave signal to the EXT INTENSITY INPUT connector. Also, use the signal to externally trigger the time-base plug-in.
13. Slowly rotate the 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 signal input waveform.
14. Disconnect the signal setup.

This completes the checkout procedure for the oscilloscope. Instrument operations not explained here, or operations that need further explanation, are discussed under General Operating Information.

## GENERAL OPERATING INFORMATION

## Intensity Control

The setting of the INTENSITY control may affect the correct focus of the display. Slight adjustment of the FOCUS control may be necessary when the intensity level is changed. To protect the crt phosphor, do not turn the INTENSITY control higher than necessary to provide a satisfactory display.

## WARNING

Damage to the crt phosphor can occur under adverse conditions. Avoid any condition where an extremely bright, sharply focused spot exists on the crt.

Apparent trace intensity can be improved by reducing the ambient light level or using a viewing hood. Also, be careful that the INTENSITY control is not set too high when changing the time-base unit sweep rate from a fast to a slow sweep rate, or when changing to the $X-Y$ mode of operation.

## Display Focus

If a well-defined display cannot be obtained with the FOCUS control, even at low INTENSITY control settings, re-setting of the internal astigmatism adjustment may be required (adjustment must only be made by qualified service personnel).

To check for proper setting of the astigmatism adjustment, slowly turn the FOCUS control through the optimum setting with a signal displayed on the crt screen. If the astigmatism adjustment 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 Allgnment

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

## Beam Finder

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

1. Press the BEAM FINDER switch, hold it in, then increase the vertical and horizontal deflection factors until the display is within the graticule area.
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.

## Graticule

The graticule of the oscilloscope is marked on the inside of the faceplate of the crt providing accurate, noparallax measurements. The graticule is divided into eight vertical and ten horizontal divisions; each division is 0.5 inch ( 1.27 centimeters) square. In addition, each major division is divided into five minor divisions. The vertical gain and horizontal timing of the plug-in units are calibrated to the graticule so accurate measurements can be made from the crt.

When making time measurements from the graticule, the center eight divisions provide the most accurate time measurements. Position the start of the timing area to the second vertical graticule line and set the time-base unit so the end of the timing area falls between the second and tenth vertical graticule lines.

## Calibrator Signal

The internal calibrator of the oscilloscope provides a convenient signal source for checking basic vertical gain and sweep timing. The calibrator 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.

## 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 $\pm 50$ volts. Usable frequency range of the Z -Axis circult is dc to one megahertz.

Time markers applied to tne 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.

## 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 oscilloscope 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.

Another method of obtaining an X-Y display is to install amplifier units in vertical and horizontal compartments (check amplifier unit gain as given in the amplifier unit instruction manual to obtain calibrated horizontal deflection factors). This 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 delay time, gain characteristics, input coupling, etc.

## 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 5 B series time-base unit in the left vertical compartment, 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 can be used to provide a television-type display.

## Option 7 Rear Panel Signal Outputs

Option 7 provides 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.

## Display Photography

A permanent record of the crt disolay can be obtained with an oscilloscope camera system (see the current Tektronix catalog for a complete listing of oscilloscope cameras and mounting adapters). The instruction manuals for the Tektronix oscilloscope cameras include complete instructions for obtaining waveform photographs.

The crt bezel of the oscilloscope provides integral mounting for a Tektronix oscilloscope camera. However, no voltage is provided at the bezel for camera power. The camera selected for use with the oscilloscope may require battery operation.

## Display Switching Logic

The electronic switching for time-shared displays is produced at the plug-in interface within the mainframe; however, the switching logic is selected in 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 plugins are both active in the vertical compartments, a multitrace 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.

Horlzontal 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. A vertical plug-in unit operated in the horizontal compartment has a permanent internal connection to provide a chopped display if it is required.

Swltching Sequence. Four display time slots are provided on a time-sharing basis. When two vertical plugins are active, each receives two time slots, so the switching sequence is: left, left, center, center, 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, center Channel 1, center 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 is 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 that 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, alternatemode switching becomes difficult to view.

Chopped Mode. The Chop position of the time-base unit Display switch produces a display that is electronical-
 switching sequence is 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 oscilloscope 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 $B$ timebase. This results in two displays that have completely independent vertical deflection and chopped or alternate sweep switching.

## BASIC OSCILLOSCOPE APPLICATIONS

The 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. The following information describes the 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 these units. Contact your local Tektronix Field Office or representative for additional assistance.

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

John D. Lenk, "Handbook of Oscilloscopes, Theory, and Application", Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1968.
J. Czech, "Oscilloscope Measuring Techniques", Springer-Verlag, New York, 1965.
J.F. Golding. "Measuring Oscilloscopes", Transatlantic Arts, Inc., 1971.

Charles H. Roth Jr., "Use of the Oscilloscope", A programmed Text, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1970.

## Peak-to-Peak Vollage 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 that 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 that one of the upper peaks is aligned with the center vertical reference line (see Fig. 1-3).
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.


Flg. 1-3. Measuring peak-io-peak voltage of a waveform.

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

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

## NOTE

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

## Instantaneous Voltage Measuremeni-DC

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

1. Set the input coupling of the vertical plug-in unit to Gnd and positlon 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 Postion control after this reference has been established.

## NOTE

To measure a voltage fevel 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. 1-4 the measurement is made between the reference line and point $A$.


Fig. 1-4. Measuring instantaneous de voltage with respect to : reference voltage.
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 .
$\underset{\text { Voltage }}{\text { Instantaneous }}=\begin{gathered}4.6 \\ \text { (divisions) }\end{gathered} \times \underset{\text { (Volts/Div) }}{2} \times \begin{gathered}+9.2 \\ \text { volts }\end{gathered}$

## 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 on a specific reference amolitude 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.
$\begin{gathered}\text { Deflection } \\ \text { Conversion } \\ \text { Factor }\end{gathered}=\frac{\text { reference signal amplitude (volts) }}{\substack{\text { deflection } \\ \text { (divisions) }}} \times \begin{gathered}\text { Volts/Div } \\ \text { setting }\end{gathered}$
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.

| Modified |
| :---: |
| Deflection |
| Factor |$=$| Volts/Div |
| :---: |
| setting |$\times \quad$| Deflection |
| :---: |
| Conversion |
| Factor |

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

$\underset{\text { Amplitude }}{\text { Signal }}=\underset{\text { Dactor }}{\text { Modified }}$| Deflection |
| :---: |
| Falions |

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):

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

Then, with a Volts/Div switch setting of 2 V , the Modified Deflection Factor (step 5) is:
(2 V) (1.5) $=3$ volts/division

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

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

## 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.

| Deflection |
| :---: |
| Conversion |$=-\quad$| reference signal period (seconds) |
| :---: |
| Factor |$\quad$| horizontal |
| :---: |
| deflection |
| (divisions) |$\times$| Sec/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.
$\underset{\text { Dactor }}{\text { Modified }}=\underset{\text { switch setting }}{\text { Seconds/Div }} \times \underset{\text { Factor }}{\text { Convection }}$ Fen
6. Measure the horizontal deflection in divisions and determine the period by the following formula:

Period $=$\begin{tabular}{c}
Modified <br>
Deflection <br>
Factor

$\times$

horizontal <br>
deflection <br>
(divisions)
\end{tabular}

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):

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

Then, with a Seconds/Div switch setting of $50 \mu \mathrm{~s}$, the Modified Deflection Factor (step 5) is:
$(50 \mu \mathrm{~s})(1.375)=68.75 \mathrm{mic}$ roseconds/division

To determine the time period of an applied signal which completes one cycle in seven horizontal divisions, use the Period formula (step 6):
$(68.75 \mu \mathrm{~s})(7)=481$ microseconds

This product can be converted to frequency by taking the reciprocal of the period (see application of 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 wavetorm in less than eight divisions (some non-linearity may occur in the first and last graticule divisions of display). Refer to Fig. 1-5.


Fig. 1-5. Measuring ilme duration (period) between points on a waveform.
3. Adjust the vertical Position control to move the points between which the time measurement is made to the 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:

$$
\text { Period }=\underset{\text { distance }}{\text { (divisions) }} \times \begin{aligned}
& \text { horizontal }
\end{aligned} \begin{aligned}
& \text { Sec/Div } \\
& \text { switch } \\
& \text { setting }
\end{aligned}=\langle 5)(0.1 \mathrm{~ms})=0.5 \mathrm{~ms}
$$

The period is 0.5 millisecond.

## Delermining 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. 15 , which has a period of 0.5 millisecond is:

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

## Risetime Measurement

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 exactly five 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. 1-6).


Fig. 1-6. Measuring risetime.

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5. Adjust the horizontal Position control to move the $10 \%$ point of the waveform to the second vertical line of the graticule.
6. Measure the horizontal distance between the 10\% and $90 \%$ points. Be sure the variable Seconds/Div control is in the Cal position.
7. Multiply the distance measured in step 6 by the setting of the Seconds/Div switch.

EXAMPLE: Assume that the horizontal distance between the $10 \%$ and $90 \%$ points is four divisions and the Seconds/Div switch is set to $1 \mu \mathrm{~s}$.

Using the period formula to find risetime:

$\underset{\text { period }}{\text { Risetime }}=$| horizontal |
| :---: |
| distance |
| (divisions) |$\times$| $\mathrm{Sec} / \mathrm{Div}$ |
| :---: |
| switch |
| setting |$=(4)(1 \mu \mathrm{~s})=4 \mu \mathrm{~s}$

The risetime is 4 microseconds.

## Time Difference Measurements

When used in conjunction with a calibrated time-base plug-in unit, the multi-trace feature of the 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 switch on the time-base unit to either Chop or Alt. In general, Chop is more suitable for lowfrequency signals. More information on determining the mode is given under Vertical Display Mode in this section.
3. Set the vertical plug-in triggering switches to trigger the display on Channel 1 (or left plug-in) and Channel 2 (or center plug-in).
4. Connect the reference signal to the Channel 1 input connector and the comparison signal to the Channel 2 (or center plug-in) 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, invert the Channel 2 (or center plug-in) display. (Signals may be of opposite polarity due to $180^{\circ}$ phase difference; if so, take this into account in the final calculation.)
6. Set the Volts/Div switches to produce about four divisions of display 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 (or left plug-in) waveform (reference) crosses the center horizontal line at a vertical graticule line.
10. Measure the horizontal distance between the two measurement points (see Fig. 1-7).


Fig. 1-7. Measuring time difference between two pulses.
11. Multiply the measured distance by the setting of the Seconds/Div switch.

EXAMPLE: Assume that the Seconds/Div switch is set to $50 \mu$ s and the horizontal distance between measurement points is four divisions. Using the formula:
$\left.\underset{\text { Delay }}{\text { Time }}=\begin{array}{c}\text { Sec/Div } \\ \text { switch } \\ \text { setting }\end{array} \times \begin{array}{c}\text { horizontal } \\ \text { distance } \\ \text { (divisions) }\end{array}\right)=(50 \mu \mathrm{~s})(4)=200 \mu \mathrm{~s}$

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 switch on the time-base unit to either Chop or Alt. In general, Chop is more suitable for lowfrequency 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 vertical plug-in triggering switches to trigger the display on Channel 1 (or left plug-in) and Channel 2 (or center plug-in).
4. Connect the reference signal to the Channel 1 input connector and comparison signal to the Channel 2 (or center plug-in) 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 invert the Channel 2 (or center plug-in) display. (Signals may be of opposite polarity due to $180^{\circ}$ 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.
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, or left plug-in) occupies exactly eight divisions between the second and tenth vertical lines of the graticule (see Fig. 1-8). Each division of the graticule represents $45^{\circ}$ of the cycle ( $360^{\circ}$ $\div B$ divisions $=45^{\circ} /$ division). The sweep rate can be stated in terms of degrees as $45^{\circ}$ /division.
10. Measure the horizontal difference between corresponding points on the waveforms.
11. Multiply the measured distance (in divisions) by $45^{\circ} /$ 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 $45^{\circ}$ /division as shown in Fig. $1-8$. Use the formula:


The phase difference is $27^{\circ}$.


Flg. 1-8. Measuring phase difference.

## High Resolution Phase Measurement

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.

EXAMPLE: If the sweep rate were increased 10 times with the magnifier, the magnifier sweep rate should be $45^{\circ} /$ division $\div 10=4.5^{\circ} /$ division. Figure $1-9$ shows the same signals as used in Figure 1-8, but with the Swp Mag button pushed in. With a horizontal difference of six divisions the phase difference is:

| Phase |
| :--- |
| Difference |$=$| horizontal |
| :--- |
| difference |
| (divisions) | | magnified <br> sweep rate <br> (degrees $/$ <br> division) |
| :---: |$=(6)\left(4.5^{\circ}\right)=27^{\circ}$

The phase difference is $27^{\circ}$.

rig. 1-9. High-resolution phase diflerence measurement with Increased sweep rate.

## 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. Set each amplifier unit input coupling switch to dc, and set the position controls of the selected $X$ and $Y$ channels for a spot display at graticule center.
3. Connect low-frequency sine-wave signals of the same frequency to the selected $X$ and $Y$ inputs.
4. Advance the INTENSITY control until the display is at the desired viewing level. Set the amplifier deflection factors and variable Volts/Div controls for six divisions of vertical and horizontal deflection, and set the position controls to center the display on the graticule as shown in Fig. 1-10.
5. Measure and record the overall vertical deflection (A) and the opening of the Lissajous display (B), measuring vertically at the graticule horizontal center line (see Fig. 1-10).
6. Divide B by A to obtain the trigonometric sine of the phase angle difference between the two signals. Obtain the phase angle from a trigonometric table to determine the phase angle between the $X$ and $Y$ signals. If the display appears as a diagonal straight line, the two signals are either in phase (tilted upper right to lower left), or $180^{\circ}$ out of phase (tilted upper left to lower right). If the display is a circle, the signals are $90^{\circ}$ out of phase. Fig. 1-11 shows the Lissajous displays produced between $0^{\circ}$ and $360^{\circ}$. Notice that above $180^{\circ}$ phase shift, the resultant display is the same as at some lower angle.

EXAMPLE: Assume a display as shown in Fig. 1-10 where $A$ is 6 divisions and $B$ is 0.4 division.


Fig. 1-10. Phase difference measurement from an X-Y display.

## Using the formula:

$\operatorname{Sin} \Phi=\frac{B}{A}=\frac{0.4}{6}=0.0667$

From the trigonometric tables:

$$
\Phi=\arcsin 0.0667=3.82^{\circ}
$$

The phase angle difference between the $X$ and $Y$ signals is $3.82^{\circ}$.

(A)

(B)

(C)

(D)

(E)

Fig. 1-11. Phase of a Lissajous display. (A) $0^{\circ}$ or $360^{\circ}$, (B) $30^{\circ}$ or $330^{\circ}$, (C) $90^{\circ}$ or $270^{\circ}$, (D) $150^{\circ}$ or $210^{\circ}$, and (E) $180^{\circ}$.

## SPECIFICATION AND PERFORMANCE CHECK

## SPECIFICATION

The following electrical characteristics are valid only if the instrument has been calibrated at an ambient temperature between $+20^{\circ} \mathrm{C}$ and $+30^{\circ} \mathrm{C}$, the instrument is operating at an ambient temperature between $0^{\circ} \mathrm{C}$ and $+50^{\circ} \mathrm{C}$ (unless otherwise noted), and each plug-in must be operating (fully installed) in a calibrated system.

Items listed in the Performance Requirements column of the Electrical Characteristics are verified by completing the Performance Check in this manual. Items listed in the Supplemental Information column are not verified in this manual; they are either explanatory notes or performance characteristics for which no limits are specified.

ELECTRICAL CHARACTERISTICS
Table 2-1
VERTICAL AMPLIFIER

| Characteristics | Performance Requirements | Supplemental Information |
| :---: | :---: | :---: |
| Input Signal Amplitude (Differential Input) |  | $50 \mathrm{mV} /$ displayed division. |
| Bandwidth | Dc to at least 2 MHz with a calibrated 5A18N. |  |
| Channel Switching Chop Time Segment/Channel |  | Approximately $5 \mu \mathrm{~s}(\approx 3 \mu \mathrm{~s}$ displayed, $\approx 2 \mu \mathrm{~s}$ blanked). |
| Mainframe Compartment Chop Switching Sequence |  | Left, left, center, center... |
| Amplifier Channel Chop Switching Sequence |  | 2 channel amplifier: Ch 1, Ch 2 .. 4 channel amplifier: Ch 1, Ch 2, off, off, Ch 3, Ch 4, off, off... |
| Alternate Frequency | Sweep rate (once each sweep). |  |
| Mainframe Compartment Alternate Rate | One-half sweep rate (once every two sweeps). |  |
| Amplifier Channel Alternate Rate | One-fourth sweep rate (once every four sweeps). |  |
| Signal Outputs (Option 7) |  |  |
| Left Out, Center Out Signals | Crt-related vertical signals | Derived from interface signal output pins |
| Sensitivity | $0.5 \mathrm{~V} / \mathrm{crt} \mathrm{div}, \pm 3 \%$ into $\geqslant 100 \mathrm{k} \Omega$ |  |
| DC Offset |  | $\pm 500 \mathrm{mV}$ max |
| Output Impedance | Approximately $1 \mathrm{k} \Omega$ |  |
| Dynamic Range |  | $\pm 4 \mathrm{~V}$ max |
| Amplifier Bandwidth | $\geqslant 500 \mathrm{kHz}$ up to $\pm 2 \mathrm{~V}$ output into $\leqslant 50 \mathrm{pF}$ |  |
| Common Mode Rejection Ratio |  | $\geqslant 28 \mathrm{~dB}$ at 1 kHz |
| Noise and Chop Breakthroug $f^{\circ}$ | $\leqslant 100 \mathrm{~m} \overline{\mathrm{~V}}$ at each output connector |  |

[^0]Table 2-2
HORIZONTAL AMPLIFIER

| Characteristlics | Performance Requirements | Supplemental Information |
| :---: | :---: | :---: |
| Input Signal Amplitude (Differential Input) |  | $50 \mathrm{mV} / \mathrm{displayed}$ division. |
| Horizontal Centering |  | 0.5 division or less. |
| Bandwidth | Dc to at least 2 MHz with a calibrated 5A18N. |  |
| $X-Y$ Phase Difference Between Vertical and Horizontal Compartments | $1^{\circ}$ or less to 100 kHz . | Checked with two plug-ins of the same type. |
| Signal Outputs (Option 7) Right Out Signal | Crt-related sweep signal | Derived from interface signal output pins |
| Sensitivity | $0.5 \mathrm{~V} / \mathrm{crt}$ div, $\pm 3 \%$ into $\geqslant 100 \mathrm{k} \Omega$ |  |
| Polarity and Output Voltage | Positive-going ramp, $\geqslant 5 \mathrm{~V}$ | DC offset provided by timebase position control |
| Output Impedance | Approximately $1 \mathrm{k} \boldsymbol{\Omega}$ |  |
| Gate Out Signal | Crt-related Z-axis signal | Selected by timebase |
| Output Levels | TTL compatible | Low: Sinking $1.6 \mathrm{~mA}_{1} \leqslant 0.4 \mathrm{~V}$ <br> High: Supplying $40 \mu \mathrm{~A}, \geqslant 2.4 \mathrm{~V}$ |
| Risetime |  | $\leqslant 1 \mu \mathrm{~s}$ into $\leqslant 50 \mathrm{pF}$ |
| Falltime |  | $\leqslant 200 \mathrm{~ns}$ into $\leqslant 50 \mathrm{pF}$ |
| Table 2-3 Z-AXIS AMPLIFIER |  |  |
| Characteristics | Performance Requirements | Supplemental Information |
| External Intensity Input Useful Input Voltage | +5 V will turn on display to a normal brightness level from an off level; -5 V will turn off display from a normal brightness level. |  |
| Useable Frequency Range | Dc to 1 MHz . |  |
| Input R and C |  | Approximately $10 \mathrm{k} \Omega$, paralteled by approximately 40 pF . |
| Maximum Safe Input |  | $\pm 50 \mathrm{~V}$ (dc + peak ac). |

Table 2-4
DISPLAY

| Characterisics | Performance <br> Requirements | Supplemental <br> Information |
| :--- | :--- | :--- |
| Cathode-Ray Tube <br> Deflection |  | Electrostatic. <br> Phosphor |

Table 2-4 (cont)
DISPLAY

| Characteristlcs | Performance <br> Requirements | Supplemental <br> Information |
| :--- | :--- | :--- |
| Accelerating Voltage |  | 3.5 kV. |
| Orthogonality |  | $90^{\circ}$, within $1^{\circ}$. |
| Geometry |  | 0.1 division or less. |
| Beam Finder |  | Limits display to within <br> graticule area and <br> intensifies display if <br> brightness level is low. |

Table 2-5
CALIBRATOR AND POWER INPUT

| Characteristics | Performance Requirements | Supplemental Information |
| :---: | :---: | :---: |
| Calibrator Voltage |  | 400 mV , within $1 \%$. |
| Current |  | 4 mA , within $1 \%$. |
| Frequency |  | Twice the line frequency. |
| Power Input Line Voltage (RMS) |  | Nominal $100 \mathrm{~V}, 110 \mathrm{~V}, 120 \mathrm{~V}, 200 \mathrm{~V}$, $220 \mathrm{~V}, 240 \mathrm{~V} \pm 10 \%$ ( 250 V maximum). |
| Fuse Data |  | 1.6 A slow blow ( 120 V ac). <br> 1 A slow blow ( 240 Vac ). |
| Line Frequency |  | 48 to 440 Hz . |
| Power Consumption |  | Typical: 53 W . Maximum: 75 W . |
| Insulation Voltage |  | 1500 V (RMS) minimum at 50 to 60 Hz for 10 seconds duration minimum. |
| Ground Continuity (Between Safety Ground and Instrument) |  | Less than $0.1 \Omega$. |

ENVIRONMENTAL CHARACTERISTICS
Table 2-6
ENVIRONMENTAL

| Characteristlcs | Periormance Requirements | Supplemental Information |
| :--- | :--- | :--- |
| Temperature <br> Operating | $0^{\circ} \mathrm{C} \mathrm{to}+50^{\circ} \mathrm{C}$. |  |

Table 2-6 (cont) ENVIRONMENTAL

| Charactorlstics | Performance Requirements | Supplemental Information |
| :---: | :---: | :---: |
| Shock |  |  |
| Operating and Non-Operating | 30 g 's, $1 / 2$ sine, 11 ms duration, 2 shocks in each direction along 3 major axes for a total of 12 shocks. |  |
| Transportation | Qualified under National Safe Transit Committee Test Procedure 1A, Category II. |  |

## PHYSICAL CHARACTERISTICS

Table 2-7
PHYSICAL

| Parameter | Bench Oscllloscope | Rack Oscilloscope |
| :---: | :---: | :---: |
| Overall Dimensions Height | 12.0 in. ( 30.5 cm ). | $5.2 \mathrm{in}$. ( 13.2 cm ). |
| Length | 20.4 in ( 51.8 cm ) | 20.4 in . $(51.8 \mathrm{~cm})$. Rack depth required: 19.0 in . ( 48.3 cm ). |
| Width | $8.4 \mathrm{in}(21.4 \mathrm{~cm})$. | 19.0 in ( 48.3 cm ). |
| Net Weight | Approximately 19.1 lbs . ( 8.7 kg ). | Approximately 23.1 lbs . ( 10.5 kg ). |
| Shipping Weight | Approximately 30.0 lbs . ( 13.6 kg ). | Approximately 39.0 lbs . ( 17.7 kg ). |
| Export Weight | Approximately 45.0 lbs . ( 20.4 kg ). | Approximately 59.0 lbs. ( 26.8 kg ). |
| Finish | Anodized aluminum panel and chassis. Blue-vinyl coated cabinet. |  |

## POWER TO EXTERNAL EQUIPMENT

With the plug-in units removed from the oscilloscope, the unused power capability of the oscilloscope power supplies may be used to operate external electronic equipment. The recommended access to the power supplies is through the Interface circuit board. Special equipment is available from Tektronix, Inc. to facilitate connection to the individual power supply voltages. Order the equipment through your local Tektronix Field Office or representative.

Table 2-8 lists the maximum current draw and interface pin assignment for only those power supply voltages recommended for operating external electronic equipment.

Table 2-8
POWER AVAILABLE TO EXTERNAL EQUIPMENT

| Power <br> Supply <br> Voltage | Maximum <br> Current/ <br> Compartment | MaxImum <br> Total <br> Current | Interface <br> Pin No. |
| :---: | :---: | :---: | :---: |
| +200 V | 10 mA | 30 mA | A 1 |
| +30 V | 80 mA | 240 mA | A 5 |
| +5 V | 130 mA | 390 mA | B 2 |
| -30 V | 80 mA | 240 mA | B 5 |

## PERFORMANCE CHECK

## Introduction

This procedure checks the oscilloscope for measurement accuracy against the tolerances listed as Performance Requirements that appear under Electrical Characteristics at the beginning of this section. If the instrument falls to meet the requirements given in this Performance Check, the Adjustment procedure (Section 3 in this manual) should be performed. The Performance Check can be used by an incoming inspection facility to determine acceptability of performance. It is not necessary to remove the instrument cabinet to perform this procedure, since all checks are made from the front panel.

The Electrical Characteristics in this section are valid only if the oscilloscope has been calibrated at an ambient temperature between $+20^{\circ} \mathrm{C}$ to $+30^{\circ} \mathrm{C}$ and is operating at an ambient temperature between $0^{\circ} \mathrm{C}$ to $+50^{\circ} \mathrm{C}$.

## PERFORMANCE CHECK INTERVAL

To ensure instrument accuracy, check the performance of the oscilloscope every 1000 hours of operation, or every 6 months if used infrequently.

## TEST EQUIPMENT REQUIRED

The following test equipment, or equivalent, is required to perform a performance check of the oscilloscope. The test equipment performance requirements listed are the minimum required to verify the performance of the equipment under test. Substitute equipment must meet or exceed the stated requirements. All test equipment is assumed to be operating within tolerance.

Tolerances that are specified in this Performance Check procedure apply to the instrument under test and do not include test equipment error. Limits and tolerances in this procedure are instrument performance requirements only if listed in a Performance Requirements column that appears under Electrical Characteristics at the beginning of this section; information given in the Supplemental Information column is provided for user information only, and should not be interpreted as performance requirements.

Table 2-9
LIST OF TEST EQUIPMENT REQUIREMENTS FOR PERFORMANCE CHECK

| Description | Performance Requirements | Application | Example |
| :---: | :---: | :---: | :---: |
| Amplifier Plug-in unit ${ }^{\text {l }}$ | Bandwidth, de to 2 MHz ; display modes, channel 1 and dual-trace; deflection factor, 5 mV to $5 \mathrm{~V} /$ div. | One required for all tests. Two required for steps 6, 7, 12. | a. TEKTRONIX 5A18N Dual-Trace Amplifier. |
| Time-base Plug-in unit | Sweep rate, at least $2 \mu \mathrm{~s} / \mathrm{div}$. | Steps 1 through $17,13,14$ | a. TEKTRONIX 5B10N Time-Base. |
| Calibration generator | Amplitude calibration, 5 mV to 5 V ; accuracy. $\pm 0.25 \%$ into $1 \mathrm{~m} \Omega$; output, square wave at approximately 1 kHz . | Steps 8, 10. | a. TEKTRONIX PG 506 Calibration Generator ${ }^{2}$. |
| Sine-wave generator | Frequency, 50 kHz to 2 MHz ; output amplitude. variable from 250 mV to 6 V into $50 \Omega$. | $\begin{aligned} & \text { Steps } 9,11,12, \\ & 13 . \end{aligned}$ | a. TEKTRONIX FG 503 Function Generator ${ }^{2}$. |

[^1]Table 2-9 (cont)

| Descriptlon | Performance Requirements | Application | Example |
| :---: | :---: | :---: | :---: |
| Coaxial cable | Impedance, $50 \Omega$; length, 42 inch; connectors, bnc. | Steps 8 through 13. | a. TEKTRONIX part 012-0057-01. |
| Coaxial cable | Impedance, $50 \Omega$, length, 18 inch; connectors, bnc. | Steps 12, 13. | a. TEKTRONIX part 012-0076-00. |
| 1X passive probe | Compatible with 5A-series amplifiers used in the Oscilloscope. | Step 14. | a. TEKTRONIX P6101 Probe. <br> b. TEKTRONIX P6062B Probe. |
| Termination | Impedance, $50 \Omega$; accuracy within $2 \%$; connectors, bnc. | Steps 9, 11, 12. | a. TEKTRONIX part 011-0049-01. |
| Tee connector | Connectors, bnc. | Steps 12, 13. | a. TEKTRONIX part 103-0030-00. |
| Screwdriver | Length, 3-inch shaft; bit size, $3 / 32$ inch. | Step 1. | a. Xcelite R3323. |

## PRELIMINARY PROCEDURE FOR PERFORMANCE CHECK

1. Ensure that all power switches are off.
2. Check the rear panel of the oscilloscope to ensure the indicated line voltage and the line voltage source are the same.
3. Ensure that all test equipment is suitably adapted to the line voltage to be applied.
4. If applicable, install the TM 500-series test equipment into the test equipment power module.
5. Install a dual-trace vertical amplifier unit into the left vertical compartment of the oscilloscope.
6. Install a time-base unit into the horizontal compartment of the oscilloscope.
7. Connect the equipment under test and the test equipment to a suitable line voltage source. Turn all equipment on and allow at least 20 minutes for the equipment to stabilize.

## NOTE

Titles for external controls of the oscilloscope are capitalized in this procedure (e.g. INTENSITY, POWER).

## INITIAL CONTROL SETTINGS

Set the following controls during warm-up time:

## OSCILLOSCOPE

INTENSITY, FOCUS Set for well-defined trace and normal brightness.

## AMPLIFIER PLUG-IN

| Display | On |
| :--- | :--- |
| Position | Centered |
| CH 1 Volts/Div | 1 |
| CH 1 Cal | Fully clockwise |
| CH 1 Input coupling | dc |
| Trigger | CH 1 |
| Mode | CH 1 |

## TIME BASE PLUG-IN

| Display | Chop |
| :--- | :--- |
| Position | Centered |
| Seconds/Div | 1 ms |
| Seconds/Div Cal | Fully clockwise |
| Swp Mag | Off |
| Triggering | + Slope, Auto Trig, |
|  | ac Couple |
| Triggering Source | Composite |

## PERFORMANCE CHECK PROCEDURE

## 1. Check Trace Alignment

a. Position the horizontal trace over the center horizontal graticule line.
b. Check-that the trace is parallel to the graticule line.
c. Adjust-the TRACE ROTATION control (rear-panel screwdriver adjustment) to align the trace horizontally.

## 2. Check Geometry

a. Press the POWER switch to turn off the oscilloscope.
b. Interchange the amplifier and time-base units in their respective compartments. Pull the POWER switch to on.
c. Position the vertical trace over the center vertical graticule line, extending vertically above and below the graticule area, and set the FOCUS and INTENSITY controls for a well-defined trace.
d. Check-that vertical bowing and tilt of the trace display is less than 0.1 division at the center line and when positioned horizontally across the entire graticule area.
e. Press the POWER switch to turn off the oscilloscope and interchange the amplifier and time-base units back to their usual compartments.
f. Pull the POWER switch to on.

## 3. Check Beam Finder

a. Set the INTENSITY control for a dim trace.
b. Press and hold the BEAM FINDER pushbutton in, then rotate the position control of the vertical amplifier and time-base units fully clockwise and counterclockwise.
c. Check-that the display is intensified, compressed, and remains within the graticule area.
d. Release the BEAM FINDER pushbutton and return the INTENSITY control to a normal setting.

## 4. Check Amplifier Alternate Operation

a. Push both CH 1 and CH 2 pushbuttons in and position the traces about two divisions apart.
b. Set the time-base unit Display pushbutton to Alternate.
c. Turn the time-base Seconds/Div switch throughout its range.
d. Check-for trace alternation at all sweep rates (except in amplifier positions). At faster sweep rates, alternation is not apparent; instead, the display appears as two traces on the screen.
e. Press the POWER switch to turn off the oscilloscope and change the amplifier from the vertical compartment to the center compartment.
f. Pull the POWER switch on and repeat parts $c$ and $d$ of this step.

## 5. Check Amplifier Chop Operation

a. Set the time-base unit Display pushbutton to Chop.
b. Turn the time-base Seconds/Div switch throughout its range.
c. Check-for a dual-trace display at all sweep rates (except in amplifier positions) without alternation.
d. Press the POWER switch to turn off the oscilloscope and change the amplifier from the center compartment to the left vertical compartment.
e. Pull the POWER switch to on and repeat parts b and c of this step.

## 6. Check Chop Operation Between Amplifiers

a. Press the POWER switch to turn off the oscilloscope. Install a second vertical dual-trace plug-in unit in the center plug-in compartment and set its controls for dual-trace operation. Pull the POWER switch to on.
b. Turn the time-base Seconds/Div switch throughout its range.
c. Check-for two traces for each amplifier (one for each channel) at all sweep rates.

## NOTE

If п single-channel amplifier is used instead of the second dual-trace amplifier, the single-channel trace will appear once per sweep.

## 7. Check Alternate Operation Between Amplifiers

a. Set the time-base Display pushbutton to Alternate and the Seconds/Div switch to 50 ms .
b. Check-for two traces for the left amplifier (one for each channel), then two traces for the right amplifier, alternately between amplifier units.

## NOTE

If a single-channel amplifier is used instead of a second dual-trace amplifier in the right vertical compartment, the single channel trace will appear twice for each alternation between amplifier units. To check alternate operation for the right vertical compartment, press the POWER switch to turn off the oscilloscope and interchange the two vertical amplifiers in their respective compartments. Pull the POWER switch to on and check for two traces from the dual-trace amplifier in the right vertical compartment.
c. Press the POWER switch to turn off the oscilloscope.
d. Remove the vertical amplifier from the center compartment. A dual-trace amplifier should remain installed in the left vertical compartment (install if necessary).
e. Pull the POWER switch to turn on the oscilloscope.

Set the equipment controls as follows:

AMPLIFIER PLUG-IN

| Display | On |
| :--- | :--- |
| CH 1 Volts/Div | 1 |
| CH 1 CaI | Fully Clockwise |
| CH 1 Input Coupling | dc |
| Trigger | CH 1 |
| Mode | CH 1 |

## TIME BASE PLUG-IN

| Seconds/Div | 1 ms |
| :--- | :--- |
| Seconds/Div Cal | Fully clockwise |
| Swp Mag | Off |
| Triggering | + Slope, Auto Trig, |
|  | ac couple |
| Triggering Source | Composite |

## 8. Check Vertical Gain

a. Connect a 5 volt, 1 kilohertz square wave signal of standardized amplitude from the calibration generator to the CH 1 amplifier input, using a 42 -inch coaxial cable.
b. Position the resultant 5 -division display to a convenient, centered location on the graticule. Set the INTENSITY and FOCUS controls for a well-defined display of normal brightness.
c. Check-the display for a vertical deflection of 5 divisions $\pm 0.15$ division ( $+3 \%$ ).
d. Press the POWER switch to turn off the oscilloscope and remove the amplifier from the left vertical compartment and install it in the center compartment. Pull the POWER switch to on.
e. Check-the display for a vertical deflection of 5 divisions $\pm 0.15$ division ( $\pm 3 \%$ ).
f. Disconnect the coaxial cable between the amplifier and calibration generator.

## 9. Check Vertical Bandwidth

a. Connect the sine-wave generator to the amplifier input with a 42 -inch coaxial cable and 50 ohm termination.
b. Adjust the sine-wave generator controls for a 6division display at a frequency of 50 kHz . Center the display on the graticule.
c. Without changing the output amplitude, increase the sine-wave generator frequency until the displayed amplitude is reduced to 4.2 divisions.
d. Check-the generator for a reading of at least 2 MHz .
e. Press the POWER switch to turn off the oscilloscope and install the amplifier in the left vertical compartment. Pull the POWER switch to on.
f. Repeat parts $b$ through $d$ for the left vertical compartment.
g. Disconnect the coaxial cable and termination from the amplifier input connector.

## 10. Check Horizontal Gain

a. Press the POWER switch to turn off the oscilloscope and interchange the amplifier and the time-base units in their respective compartments. Pull the POWER switch to on.
b. Connect a 5 volt, 1 kilohertz square-wave signal of standardized amplitude from the calibration generator to the amplifier input connector, using a 42 -inch coaxial cable.
c. Position the 5 -division display between the second and seventh vertical graticule lines.
d. Check-the display for a horizontal deflection of 5 divisions $\pm 0.15$ divlsion ( $\pm 3 \%$ ).
e. Disconnect the coaxial cable between the amplifier and the calibration generator.

## 11. Check Horizontal Bandwidth

a. Connect the sine-wave generator to the amplifier input, using a 42-inch coaxial cable and 50 ohm termination.
b. Adjust the sine-wave generator controls for a 6division display at a frequency of 50 kHz . Position the display between the second and eighth vertical graticule lines.
c. Without changing the output amplitude, increase the sine-wave generator frequency until the displayed amplitude is reduced to 4.2 divisions.
d. Check-the generator for a reading of at least 2 MHz .
e. Disconnect the coaxial cable and termination from the amplifier input connector.

## 12. Check X-Y Phase Difierence

a. Press the POWER switch to turn off the oscilloscope.
b. Remove the time-base unit from the vertical compartment and install the second amplifier unit in the left vertical compartment.

## NOTE

## Identical amplifier units should be installed in the

 oscilloscope.c. Connect the sine-wave generator through a 42 -inch coaxial cable, 50 ohm termination, and a tee connector, to an amplifier input. Connect an 18 -inch coaxial cable from the tee connector to the other amplifier input.
d. Pull the oscilloscope POWER switch to on.
e. Set both amplifier units for a deflection factor of $1 \mathrm{volt} / \mathrm{division}$ and dc input coupling.
f. Set the sine-wave generator for a 100 -kilohertz output.
g. Adjust the vertical and horizontal position controls to center the diagonal display, then adjust the sine-wave generator for a display amplitude of 6 divisions vertically and horizontally.
h. Check-the opening of the diagonal-loop display at the graticule center line is 0.07 division or less (measure horizontally). This indicates a phase difference of $1^{\circ}$ or less between the vertical and horizontal systems.

## 13. Check $Z$ Axis Amplifier

a. Press the POWER switch to turn off the oscilloscope.
b. Disconnect the coaxial cables, termination and tee connector between the amplfiers and sine-wave generator.
c. Remove the vertical amplifier from the horizontal compartment and install the time-base unit in that compartment. Pull the oscilloscope POWER switch to on.
d. Set the time-base unit for auto, internal triggering at a sweep rate of $20 \mu \mathrm{~s} /$ division and set the amplifier for a deflection factor of $2 \mathrm{~V} / \mathrm{division}$.
e. Connect a 50 kHz sine-wave signal from the sinewave generator through a 42 -inch coaxial cable and a tee connector to the amplifier input.
f. Set the amplifier and sine-wave generator controls to obtain a calibrated 10 volt reference display ( 5 divisions of display).
g. Set the oscilloscope INTENSITY control for a dim display,
h. Connect the signal from the output of the tee connector at the amplifier input, to the EXT INTENSITY INPUT connector on the front panel.
i. Check-the top of the waveform is intensified and the bottom portion is blanked out.
j. Temporarily disconnect the coaxial cable at only the EXT INTENSITY INPUT connector.
k. Set the time-base unit for a sweep rate of $2 \mu \mathrm{~s} /$ division, and increase the output frequency of the sine-wave generator to 1 MHz .
I. Reconnect the coaxial cable to the EXT INTENSITY INPUT connector.
m. Check-for a noticeable effect of intensification in the top portion of the displayed waveform and blanking in the bottom portion of the waveform.
n. Disconnect the coaxial cables and tee connector from the amplifier and oscilloscope.

## 14. Check Calibrator Signal

a. Connect the 1 X probe to the CH 1 input of the amplifier. Connect the probe tip to the CALIBRATOR loop.
b. Set the amplifier CH 1 Volts/Div switch to 1 , and set the time-base sweep rate to $2 \mathrm{~ms} / \mathrm{division}$.
c. Check-the display for a vertical deflection of approximately 4 divisions.
d. Check-the display for approximately 2.5 cycles in 10 divisions (based on a line frequency of 60 Hz ).
e. Disconnect the 1 X probe.

This completes the Performance Check of the oscilloscope. If the instrument has performed as given in this procedure, it is correctly calibrated and within specifications.

## WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

## ADJUSTMENT

## Introduction

This adjustment procedure is to be used to restore the oscilloscope to original performance specifications. Adjustment need not be performed unless the instrument fails to meet the requirements listed in the Speciflcation section of this manual, or the Performance Check cannot be completed satisfactorily.

Completion of all adjustment steps in this procedure ensures that the instrument will meet the performance requirements listed in the Specification section. However, to fully ensure satisfactory performance, it is recommended that the Performance Check be performed after any adjustment is made.

## Tekironix Field Service

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

## Test Equipment Required

The following test equipment, or equivalent, is required for complete adjustment of the oscilloscope. The test equipment performance requirements listed are the minimum necessary for accurate adjustment. Substitute equipment must meet or exceed the stated requirements. All test equipment is assumed to be operating within tolerance.

Table 3-1
LIST OF TEST EQUIPMENT REQUIREMENTS FOR ADJUSTMENT

| Description | Performance Requirements | Application | Example |
| :---: | :---: | :---: | :---: |
| Amplifier plug-in unit ${ }^{1}$ | Bandwidth, dc to 2 MHz ; deflection factor, 5 mV to $5 \mathrm{~V} / \mathrm{div}$. | One required for all tests. Two required for step 13. | a. TEKTRONIX 5A15N Amplifier. <br> b. TEKTRONIX 5A18N Dual-Trace Amplifier. |
| Time-base plug-in unit | Sweep rate, at least $2 \mu \mathrm{~s} / \mathrm{div}$. | Steps 1 through 12. | a. TEKTRONIX 5B10N Time-Base. |
| Calibration generator | Amplitude calibration, 5 mv to 5 V ; accuracy, $\pm 0.25 \%$ into $1 \mathrm{M} \Omega$; output, square wave at approximately 1 kHz . | Steps 10 and 12. | a. TEKTRONIX PG 506 Calibration Generator. ${ }^{2}$ |
| Sine-wave generator | Frequency, 100 kHz ; output amplitud日, variable from 250 mV to 6 V into $50 \Omega$. | Step 13. | a. TEKTRONIX FG 503 Function Generator. ${ }^{2}$ |
| Digital voltmeter | Range, zero to 250 volts; accuracy, within 0.1\%. | Steps 1 through 4. | a. TEKTRONIX DM 501 Digital Multimeter. ${ }^{2}$ |
| DC voltmeter (vom) ${ }^{3}$ | Range, zero to 4000 volts; accuracy, checked to within $1 \%$ at 3400 volts. | Step 5. | a. Triplett Model 630-NA. <br> b. Simpson Model 262. |
| Coaxial cable | Impedance, $50 \Omega$; length, 42 inch; connectors, bnc. | Steps 10, 12, and 13. | a. TEKTRONIX part 012-0057-01. |

[^2]Table 3-1 (cont)
LIST OF TEST EQUIPMENT REQUIREMENTS FOR ADJUSTMENT

| Description | Performance <br> Requirements | Application | Example |
| :--- | :--- | :--- | :--- |
| Coaxial cable | Impedance, $50 \Omega$, length, <br> 18 inch; connectors, bnc. | Step 13. | a. TEKTRONIX part <br> $012-0076-00$. |
| Termination | Impedance, $50 \Omega ;$ accuracy, <br> within $2 \%$, connectors, bnc. | Step 13. | a. TEKTRONIX part <br> $011-0049-01$. |
| Tee connector | Connectors, bnc. | Step 13. | a. TEKTRONIX part <br> 103-0030-00. |
| Insulated Screwdriver | Length, 1 1/2-inch shaft <br> or longer; plastic shaft <br> and handle with metal <br> screwdriver tip. | Recommended for <br> all adjustments. | a. TEKTRONIX part <br> 003-0000-00. |

## PRELIMINARY PROCEDURE FOR ADJUSTMENT

## NOTE

The oscilloscope must be adjusted within an ambient temperature range of $+20^{\circ} \mathrm{C}$ to $+30^{\circ} \mathrm{C}$ for best overall accuracy and to meet the electrical characteristic tolerances given as Performance Requirements in the Specification section of this manual. Information given as Supplemental Information in the Specification section is provided for user information only, and should not be interpreted as Performance Requirements.

1. Remove the cabinet sides and bottom from the oscilloscope (refer to Cabinet Removal in the Maintenance section of this manual).
2. Check the rear panel of the oscilloscope to ensure that the indicated line voltage and the line voltage source are the same (refer to Operating Voltage in the Maintenance section of this manual).
3. Ensure that all test equipment is suitably adapted to the line voltage to be applied.
4. If applicable, install the TM 500-series test equipment into the test equipment power module.
5. Install a vertical amplifier unit into the left vertical compartment of the oscilloscope.
6. Install a time-base unit into the horizontal compartment of the oscilloscope.
7. Connect the equipment under test and the test equipment to a suitable line voltage source. Turn all equipment on and allow at least 20 minutes for the equipment to stabilize.

NOTE
Titles for external controls of the oscilloscope are capitalized in this procedure (e.g. INTENSITY. POWER). Internal adjustments are initial capitalized only (e.g. Intensity Range, Vertical Gain).

## Initial Control Settings

Set the following controls during warm-up time:

## OSCILLOSCOPE

INTENSITY. FOCUS Set for well defined trace and normal brightness.

## AMPLIFIER PLUG-IN

| Display | On |
| :--- | :--- |
| Position | Centered |
| Volts/Div | 1 |
| Volts/Div Cal | Fully clockwise |
| Input coupling | dc |

TIME-BASE PLUG-IN

| Display | Chop |
| :--- | :--- |
| Position | Centered |
| Seconds/Div | 1 ms |
| Seconds/Div Cal | Fully clockwise |
| Swp Mag | Off |
| Triggering | + Slope, Auto Trig, |
|  | ac Coupl |
| Triggering Source | Composite |

## ADJUSTMENT PROCEDURE

## 1. Adjust $\mathbf{- 3 0}$ Volt Power Supply

a. Turn over the oscilloscope to lay on its left side to gain access to the LV Power Supply circuit board.
b. Connect the digital voltmeter between the -30 V test point and ground. See Fig. 3-1 for voltage test point location.
c. Check-for a meter reading of -29.89 to -30.11 volts.

## NOTE

If the -30 volt supply is within the specified tolerance, proceed with step 2. If the -30 volt adjustment is to be made, all circuits will be affected and the entire power supply adjustment procedure should be performed to verify the accuracy of the supplies.
d. Adjust- -30 V Adj R878 for a meter reading of exactly $\mathbf{- 3 0}$ volts. See Fig. 3-1 for adjustment location.

## 2. Adjust $+\mathbf{3 0}$ Volt Power Supply

a. Connect the digital voltmeter between the +30 V test point and ground. See Fig. 3-1 for voltage test point location.
b. Check-for a meter reading of +29.82 to +30.18 volts.

## NOTE

If the +30 volt supply is within the speciffed tolerance, proceed with step 3. If the +30 volts adjustment is to be made, all circuits will be affected and the entire power supply adjustment procedure should be performed to verify the accuracy of the supplies.
c. Adjust- +30 V Adj R858 for a meter reading of exactly +30 volts. See Fig. 3-1 for adjustment location.

## 3. Check Remaining Power Supply Voltages

a. Connect the digital voltmeter between the +5 V test point and ground. See Fig. 3-1 for voltage test point location.
b. Check-for a meter reading of +4.89 to +5.11 volts.
c. Connect the digital voltmeter between the +200 V test point and ground. See Fig. 3-1 for voltage test point location.
d. Check-for a meter reading of +175 to +247.5 volts.

## NOTE

Ripple and regulation of the individual supplies can be checked using the procedure given under Troubleshooting Techniques in the Maintenance section of this manual.

## 4. Check Calibrator Output Voltage

a. Connect the digital voltmeter between the CALIBRATOR current loop on the front panel, and a ground test point. See Fig. 3-1 for ground test point location.


Fig. 3-1. Locations of power-supply test points and adjustments.
b. Apply a ground connection (short circuit) between the junction of R885 and C890, and a ground test point. See Fig. 3-1 for the junction and ground test point locations.
c. Check-for a meter reading of +395 to +405 millivolts.
d. Disconnect the ground connection (short circuit) from the junction and ground test point.
e. Disconnect the digital voltmeter.

## 5. Adjust High-Voltage Power Supply

a. Press the POWER switch to turn off the oscilloscope and return the oscilloscope to its normal upright position.
b. On the rear panel of the instrument, remove the two cap nuts securing the cover over the crt socket, then remove the cover (a $5 / 16$-inch nutdriver may be needed to remove the cap nuts).
c. Set the dc voltmeter (vom) to measure at least -4000 volts dc. Remove the insulating sleeve from the probe tip of the test lead to be used for measuring the negative voltage. Connect the voltmeter leads between a convenient chassis ground and the high-voltage test point. See Fig. 3-2 for test point location. (The high-voltage lead should be fully inserted through the crt socket cover so that the lead connects to the test point without having to hold it by hand).
d. Pull the POWER switch to turn on the oscilloscope.
e. Check-for a meter reading of -3400 volts, $\pm 170$ volts.


Fig. 3-2. Location of high-voltage lest poinl.

## NOTE

If the high-voltage power supply is within the specified tolerance, proceed with part g. If the adjustment is to be made, all remaining adjustments in this procedure could be affected and should be performed to verify the accuracy of all adjustments.

## CAUTION <br> annananan

An insulated screwdriver must be used to adjust variable components in this instrument, especially in the high-voltage area, to prevent shorting voltages to ground and damaging the instrument.
f. Adjust-High Volts Adjust R275, using an insulated screwdriver, for a meter reading of exactly -3400 volts. See Fig. 3-3 for adjustment location.
g. Press the POWER switch to turn off the oscilloscope before disconnecting the voltmeter.
h. Disconnect the dc voltmeter and replace the cover over the $c$ t socket, reversing the procedure given in part $b$ of this step.

## 6. Adjust Intensity Range

a. Pull the POWER switch to turn on the oscilloscope.
b. Set the INTENSITY control fully counterclockwise.


Fig. 3-3. Locations of high-voltage, Intensity, and display adjustments.
c. Set the time-base unit Seconds/Div switch to an amplifier position or for the slowest sweep rate.
d. Turn the INTENSITY control slowly clockwise and check for a visible spot display. Note that the spot appears when the control is between its 10 and 11 o'clock position. If the spot appears when the control is within the given position, proceed with step 7 a.
e. Set the INTENSITY control to its 10 o'clock position.
f. Adjust-Intensity Range R245, using an insulated screwdriver, for a very dim spot display. See Fig. 3-3 for adjustment location.

## 7. Adjust Astigmatism

a. Set the INTENSITY control for a spot display at normal viewing level.
b. Turn the FOCUS control through its range.
c. Check-for a spot display that is nearly round in shape when defocused, and well defined when focused.
d. Adjust-Astig R286 and FOCUS control together, using an insulated screwdriver, to obtain the best definition round-spot display. See Fig. 3-3 for adjustment location.

## 8. Adjust Trace Alignment

a. Set the time-base unit for a sweep rate of 1 millisecond/division.
b. Set the INTENSITY control for a trace of normal brightness.
c. Position the horizontal trace over the center horizontal graticule line.
d. Check-that the trace is parallel to the graticule line.
e. Adjust-the TRACE ROTATION control (rear-panel screwdriver adjustment) to align the trace horizontally.

## 9. Adjusi Geometry

a. Press the POWER switch to turn off the oscilloscope.
b. Interchange the amplifier and time-base units in their respective compartments. Pull the POWER switch to on.
c. Position the vertical trace over the center vertical graticule line, extending vertically above and below the graticule area, and set the FOCUS and INTENSITY controls for a well-defined trace, if necessary.
d. Check-that vertical bowing and tilt of the trace display is less than 0.1 division at the center line and when positioned horizontally across the entire graticule area.
e. Adjust-Geom R285 for minimum bowing and tilt of the trace display at the left and right edges of the graticule. Adjustment may have to be compromised to obtain less than 0.1 division bowing and tilt everywhere within the graticule area. See Fig. 3-3 for adjustment location.
f. Press the POWER switch to turn off the oscilloscope and interchange the amplifier and time-base units back to their usual compartments.
g. Pull the POWER switch to on and check that horizontal bowing and tilt of the trace display is less than 0.1 division at the center line and when positioned vertically across the entire graticule area.

Set the equipment controls as follows:

AMPLIFIER PLUG-IN

| Display | On |
| :--- | :--- |
| Position | Centered |
| Volts/Div | 1 |
| Volts/Div Cal | Fully clockwise |
| Input Coupling | dc |

## TIME-BASE PLUG-IN

| Position | Centered |
| :--- | :--- |
| Seconds/Div | 1 ms |
| Seconds/Div Cal | Fully clockwise |
| Swp Mag | Off |
| Triggering | + Slope, Auto Trig, |
|  | ac Coupl <br> Triggering Source |
|  |  |

## 10. Adjust Vertical Gain

a. Connect a 5 -volt, 1 -kilohertz square-wave signal of standardized amplitude from the calibration generator to the amplifier input, using a 42 -inch coaxial cable.

## NOTE

Use an amplifier plug-in known to be accurately calibrated, or verify correct calibration by applying a known signal and measuring the differential output at pins A7 and B7 of the plug-in connector. The deflection factor at the output is 50 millivolts/division.
b. Position the resultant 5 -division display to a convenient, centered location on the graticule. Set the INTENSITY and FOCUS controls for a well-defined display of normal brightness.
c. Check-the display for a vertical deflection of 5 divisions, $\pm 0.15$ division ( $\pm 3 \%$ ).
d. Adjust-Vert Gain R116 for exactly 5 divisions of deflection. See Fig. 3-4 for adjustment location.
e. Press the POWER switch to turn off the oscilloscope and remove the amplifier from the left vertical compartment and install it in the center compartment. Do not disconnect the signal from the amplifier input. Pull the POWER switch to on.
f. Check-the display for a vertical deflection of 5 divisions, $\pm 0.15$ division ( $\pm 3 \%$ ). If necessary, readjust Vertical Gain R116 for the optimum gain setting. Compromise for both vertical compartments.
g. Disconnect the coaxial cable between the amplifier and calibration generator.
h. Press the POWER switch to turn off the oscilloscope and remove the amplifier from the center compartment and return it to the left vertical compartment. Pull the POWER switch to on.


Flg. 3-4. Locations of vertical and horizontal adjustments.

## 11. Adjust Horizontal Centering

a. Set the time-base unit Swp Mag control for 是 magnified sweep and position the sweep start to the center vertical graticule line.
b. Return the time-base unit Swp Mag control to unmagnified sweep position.
c. Check-that the start of the unmagnified sweep is within 0.2 division of the center vertical graticule line. If the sweep start is within the given tolerance and no adjustment is to be made, proceed with step 12 a.
d. Turn over the oscilloscope to lay on its left side to gain access to the bottom of the interface board.
e. Adjust-Hor Cent R675 to set the start of the unmagnified sweep at the center vertical graticule line. See Fig. 3-5 for adjustment location.
f. Return the oscilloscope to its normal upright position.


FIg. 3-5. Location of horizontal centering adjusiment.

## 12. Adjust Horizontal Gain

a. Press the POWER switch to turn off the oscilloscope and interchange the amplifier and the time-base units in their respective compartments. Pull the POWER switch to on.
b. Connect a 5 -volt, 1-kilohertz square-wave signal of standardized amplitude from the calibration generator to the amplifier input connector, using a 42 -inch coaxial cable.

## NOTE

Use an amplifier plug-in known to be accurately calibrated, or verify correct calibration by applying a known signal and meauring the differentialoutput at pins $A 7$ and $B 7$ of the plug-in connector. The deflection factor at the output is 50 millivolts/division.
c. Position the 5-division display between the second and seventh vertical graticule lines.
d. Check-the display for a horizontal deflection of 5 divisions, $\pm 0.15$ division ( $\pm 3 \%$ ).
e. Adjust-Hor Gain R136 for exactly 5 divisions of deflection. See Fig. 3-4 for adjustment location.
f. Disconnect the coaxial cable between the amplifier and the calibration generator.

## 13. Adjust X-Y Phase Difference

a. Press the POWER switch to turn off the oscilloscope.
b. Remove the time-base unit from the vertical compartment and install a second amplifier in the teft vertical compartment.

## NOTE

Identical amplifier units should be installed in the oscilloscope.
c. Connect the sine-wave generator through a 42 -inch coaxial cable, 50 ohm termination, and a tee connector, to an amplifier input. Connect an 18 -inc coaxial cable from the tee connector to the other amplifier input.
d. Pull the oscilloscope POWER switch to on.
e. Set both amplifier units for a deflection factor of $1 \mathrm{volt} / \mathrm{division}$ and dc input coupling.
f. Set the sine-wave generator for a 100-kilohertz output.
g. Adjust the vertical and horizontal position controls to center the diagonal display, then adjust the sine-wave generator for a display amplitude of 6 divisions vertically and horizontally.
h. Check-that any opening of the diagonal-loop display at the graticule center line is 0.07 division or less (measured horizontally). This indicates a phase difference of $1^{\circ}$ or less between the vertical and horizontal systems.
i. Adjust-Phase C116 for minimum loop opening (a straight line) in the diagonal-loop display. See Fig. 3-4 for adjustment location.
j. Press the POWER switch to turn off the oscilloscope.
k. Disconnect the coaxial cables, termination and tee connector between the amplifiers and sine-wave generator.
I. Remove the vertical amplifier from the horizontal compartment and install the time-base unit in that compartment. Pull the oscilloscope POWER switch to on. This completes the Adjustment procedure for the oscilloscope.

## MAINTENANCE

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

## PREPARATION FOR USE AND RESHIPMENT

The following information provides detailed installation and operating voltage instructions for the oscilloscope.

## DETAILED OPERATING POWER INFORMATION

This instrument can be operated from either a 120 -volt or 240 -volt nominal line-voltage source, 48 to 440 hertz . In addition, three regulating ranges are provided for each nominal line-voltage source.


To prevent damage to the instrument, always check the line-voltage information recorded on the rear panel before applying power to the instrument.

## Power Cord Information

## warning

This instrument is intended to be operated from a single-phase earth-referenced power source having one current-carrying conductor (the Neutral Conductor) near earth potential. Operation from power sources where both current-carrying conductors are live with respect to earth (such as phase-tophase on a three-wire system) is not recommended, since only the Line Conductor has over-current (fuse) protection within the instrument.

This instrument has a three-wire power cord with a polarized two-pole, three-terminal plug for connection to the power source and safety-earth. The safety-earth terminal of the plug is directly connected to the instrument frame. For electric-shock protection, insert this plug only in a mating outlet with a safety-earth contact.

Do not defeat the grounding connection. Any interruption of the grounding connection can create an electric-shock hazard. Before making external connections to this instrument, always ground the instrument first by connecting the power-cord to a proper mating power outlet.

The color coding of the cord conductors may be in accordance with the following table.

Table 4-1
POWER COAD CONDUCTOR IDENTIFICATION

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

## Line-Voltage and Regulating-Range Selection

This instrument can be operated from either a 120 -volt or a 240 -volt nominal line-voltage source with power-line frequencies of 48 to 440 hertz. In addition, three operating ranges can be selected within each nominal line-voltage source. This permits the oscilloscope transformer to operate from 100 -volt, 110 -volt, 120 -volt, 200 -volt, 220 volt, and 240 -volt sources. The nominal voltage and regulating range for which the instrument is currently set, is marked on the rear panel of the instrument. Before connecting the oscilloscope to line-voltage power, always check the rear panet to see if the voltage marked there complies with the expected line-voltage usage. If the voltage marked is proper, a change of line voltage or regulating range will not be necessary.

To select a different operating range, use the following procedure to obtain correct instrument operation from the line voltage available:

1. Disconnect the instrument from the power source.
2. Remove the bottom cabinet panel of the instrument (see Cabinet Removal in this section) to gain access to the LV Power Supply circuit board.
3. In Table 4-2, select the desired regulating range for the nominal line voltage that will operate the oscilloscope. For that voltage, note the recommended primary-tap pins from Table 4-2 (note L, M, or H)

Table 4-2
REGULATING RANGE AND FUSE DATA

| Primary Tap <br> Pins Selected | Regulating Range |  |
| :--- | :--- | :--- |
|  | $120-\mathrm{V}$ Nominal <br> (Brown Plug) | 240-V Nominal <br> (Red Plug) |
| L (low) | $100 \mathrm{~V} \pm 10 \%$ | $200 \mathrm{~V} \pm 10 \%$ |
| M (medium) | $110 \mathrm{~V} \pm 10 \%$ | $220 \mathrm{~V} \pm 10 \%$ |
| H (high, typical setting) | $120 \mathrm{~V} \pm 10 \%$ | $240 \mathrm{~V} \pm 10 \%$ |
| Line Fuse | 1.6 A slow-blow | 1 A slow-blow |

4. In the instrument, select the proper line-voltage selector block (see Fig. 4-1 for line-selector block locations). Select the brown block for 120 -volt operation or select the red block for 240 -volt operation. Install the block on the row of primary-tap pins noted from Table 4-2 in the previous step (either $\mathrm{L}, \mathrm{M}$, or H ).


Damage to the instrument may result if the lineselector block is used incorrectly (e.g., if the 120-volt


Fig. 4-1. Locations of the line-selector blocks on the LV Power Supply clrcult board.
block is used and the instrument is then connected to 240 -volt power).
5. Install the unused block on the unused line-selector block pins (see Fig. 4-1 for pin location).
6. Remove the line fuse from the fuse holder and check for the correct rating. Replace it with one having the correct rating, if necessary. Refer to Table 4-2 for line fuse information.

## NOTE

An unused line fuse, intended for the line-voltage source for which the oscilloscope was not set when shipped from the factory, is clipped to the LV Power Supply circuit board (see Fig. 4-1). Return the resultant unused fuse to the unused fuse clips.
7. If appropriate, change the line-cord plug to match the power source receptacle or use a suitable adapter.
8. Change the nominal line-voltage information recorded on the rear panel. Use a non-abrasive eraser to remove previous data, and mark on the new data with a pencil.
9. Replace the bottom cabinet panel and apply power to the oscilloscope.

## INSTRUMENT CONVERSION

The oscilloscope can be separated into two parts; 马 power supply/amplifier module, and a display module. These can be fastened together stacked or side by side; this permits operation as a bench oscilloscope, or in a standard 19 -inch rack. The two modules can quickly be converted from a bench model to a rackmount model, or vice versa. Field conversion kits, including the necessary parts, and instructions are available from Tektronix, Inc.

## NOTE

Before attempting to operate the oscilloscope after an instrument conversion, be sure the module wiring interconnections are correct. If display modules have been changed, check that the correct auxiliary board is installed in the socket on the plug-in interface board.

## RACKMOUNTING

The rackmount version of the oscilloscope is designed for operation in a standard 19 -inch wide rack that has Universal, EIA, RETMA, or Western Electric hole spacing. When properly mounted, this instrument will meet all electrical and environmental specifications given in Section 2 of this manual.

## Mounting Method

This instrument will fit most 19 -inch wide racks whose front and rear holes conform to Universal hole spacing, some drilling may be required on racks having EIA, RETMA, or Western Electric 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 slideout 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 oscilloscope, 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 the untapped front rall as shown in Fig. 4-2A. if the front rails are tapped, and the stationary section is mounted in front of the front rail as shown in Fig. 4-2B, 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 destrable to operate the oscilloscope in the futly extended position, usecables that are long enough to reach from the signal source to the instrument.

## Installing The Sllde-Out Tracks

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 most standard 19 -inch rack rails having this compatibility.

## NOTE

1. Front and rear rails holes must be large enough to allow inserting a $10-32$ screw through the rail mounting hole if the rails are untapped (see Fig. 4$2 A)$.
2. Or, front and rear rail holes must be tapped to accept a 10-32 screw if Fig. 4-2B mounting method is used. Note in Fig. 4-2B right illustration that a No. 10 washer (not supplied) may be added to provide increased bearing surface for the slide-out track stationary section front flange.

Because of the above compatiblity, 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.

Mouniling Procedure. Use the following procedure to mount both sides. See Fig. 4-2 for installation details.

1. To mount the instrument directly above or below another instrument in a cabinet rack, select the ap-
propriate holes in the front rack rails for the stationary sections, using Fig. 4-3 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. 4-2A 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. 4-2B 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, if 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.


Fig. 4-2. Mounting the left stationary section (with Its matched intermediate section, not shown In Illustrations $A$ and $B$ ) to the rack ralls.


Fig. 4-3. Dimensional diagram.
3. Mount the stationary slide-out sections to the rear rack rails using either of these methods.
(a) If the rear rail holes are not tapped to accept 1032 machine screws, mount the left stationary section with hardware provided as shown in the left or center illustration of Fig. 4-2A. 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. 42A as a guide for mounting the right stationary section. Make sure that 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 1032 machine screws, mount the left stationary section with hardware provided as shown in the left or center illustration of Fig. 4-2B. Note that the rear mounting bracket can be installed either way so the slide-out tracks will fit a deep or shallow cabinet rack stationary section. Make sure the stationary sections are horizontally aligned so they are level and parallel with each other.

## 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.

To secure the instrument front-panel to the rack, the rack must either have universal hole spacing, or a hole must be drilled and tapped for a 10-32 screw, see Fig. 4-3. Using the hardware (not furnished) indicated in Fig. 4-3, secure the instrument to the front rails of the rack.

## Slide-Out Track Maintenance

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

## Ventilation Requirements

When the oscilloscope is mounted in a rack with other equipment, it is important that the ambient temperature surrounding it does not exceed $+50^{\circ} \mathrm{C}$. Additional clearance or forced ventilation methods (fan) may need to be employed to maintain ambient temperatures below $+50^{\circ} \mathrm{C}$. Reliability and performance of the oscilloscope will be affected if the ventilation holes in the protective panels are obstructed, or If it is operated at an ambient temperature higher than $+50^{\circ} \mathrm{C}$.

## REPACKAGING FOR RESHIPMENT

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. Include 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.

## PREVENTIVE MAINTENANCE

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

## CABINET REMOVAL

## warning

Dangerous voltages exist at several points throughout this instrument. When the instrument is operated with the covers removed, do not touch exposed connections or components. Some transistors have voltages present on their cases. Disconnect power before cleaning the instrument or replacing parts.

The cabinet sides are held in place by four latches. To remove the cabinet sides, turn the latches 90 degrees and pull the sides away from the carrying handle; then, lift the cabinet sides away from the instrument. The cabinet bottom is held in place with four latches and four screws.

The cabinet sides protect this instrument from dust in the interior, and also provide protection to personnel from the operating voltages present. They also reduce the electromagnetic radiation from this instrument or interference to the display due to other equipment.

## CLEANING

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


Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Use a non-residue type of cleaner, preferably isopropyl alcohol, total denatured ethyl alcohol, or TP35.

## Exterior

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

## Interior

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

## Switch Contacts

Swltch contacts and pads are designed to operate dry for the life of the switch. However, as the switches are not sealed, dust attracted to the contact area may cause switch contacts to become electrically noisy. Cleaning may be accomplished by flushing the contact area with isopropyl alcohol or kelite ( 1 part kelite to 20 parts water). Do not use chemical cleaning agents that leave a film or that might damage plastic parts. Do not use cotton swabs or similar applicators to apply cleaning agents, as they tend to snag and leave strands of cotton on switch contacts. Should it become necessary to remove a switch for replacement or cleaning, refer to Component Removal and Replacement in this section.

## VISUAL INSPECTION

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

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

## LUBRICATION

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

## Cam Switch Lubrication

In most cases, factory lubrication should be adequate for the life of the instrument. However, if the switch has been disassembled for replacement of switch sub-parts, a lubrication kit containing the necessary lubricating materials and instructions is available through any Tektronix Field Office. General Electric Versilube ${ }^{\left({ }^{(1)}\right.}$ is a recommended silicone grease and should be applied sparingly so that the lubricant does not get on the contacts. Refer to Fig. 4-4 for lubrication instructions.

## SEMICONDUCTOR CHECKS

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

(1)

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

Apply lubricant to the wear surface of the index wheel
(3)

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

Ensure that some lubricant is present at the interface between the bearing and retainer clip.
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Fig. 4-4. Lubrication procedure for a typical cam switch.

## PERFORMANCE CHECK AND ADJUSTMENT INTERVAL

To ensure accurate measurements, perform the Performance Check procedure on this instrument after each 1000 hours of operation or every 6 months if used infrequently. In addition, replacement of components may necessitate performing the Adjustment procedure to calibrate the affected circuits. The Adjustment procedure can also be helpful in localizing certain troubles in the instrument. In some cases, minor troubles may be revealed or corrected by performing the Adjustment procedure.

## TROUBLESHOOTING

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

## TROUBLESHOOTING AIDS

## Diagrams

Circuit diagrams are given on foldout pages in Section 7. The component number and electrical value of each component in this instrument is shown on the diagrams.

## Circuit-Board Illustrations

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

## Wiring Color Code

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

## Semiconductor Basing

Figure 4-5 illustrates the basing configurations for semiconductors that may appear in this instrument. Some plastic-case transistors have lead configurations that do not agree with those shown here. If a replacement transistor is made by a different manufacturer than the original, check the manufacturer's basing diagram. All transistor sockets in this instrument are wired for the standard basing used for metal-case transistors.


Fig. 4-5. Lead configuration data ior semiconductor devices.

## Multi-Pin Connector Holders

Multi-pin connectors mate with groups of pins soldered to circuit boards. Pln number 1 is indicated with a triangular mark on the holder and is indexed with a triangular mark on the circuit board, as shown In Fig. 4-6.

## TROUBLESHOOTING EQUIPMENT

The following equipment, in addition to that listed in Table 2-9 (list of test equipment required for performance check in Section 2 of this manual) is useful for troubleshooting.

## Semiconductor Tester

Description: Dynamic-type tester.

Purpose: To test the semiconductors used in this instrument.

Recommended Type: TEKTRONIX 576 Curve Tracer or TEKTRONIX 577/177 Curve Tracer system, 7CTIN Curve Tracer unit and a 7000 -series oscilloscope system, or a 5CTIN Curve Tracer unit and a 5000-series oscilloscope.


Fig. 4-6. Mulit-pin connector holder orientation.

## Multimeter

Description: Voltmeter, 10 megohm input impedance and 0 to 250 volts range; accuracy, within $0.1 \%$. Ohmmeter, 0 to 20 megohms; accuracy, within 3\%. Test probes must be insulated to prevent accidental shoting.

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

Recommended Type: TEKTRONIX DM 501 Digital Multimeter (requires a TM 500-series power module).

## Test Oscilloscope

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

Purpose: To check operating waveforms and for general troubleshooting.

Recommended Type: TEKTRONIX 5110, 5A13N, 5B10N oscilloscope system or equivalent. Use a TEKTRONIX P6108 or P6062A Probe.

## TROUBLESHOOTING TECHNIQUES

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

## Troubleshooting Procedure

1. Check Control Seltings: 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 Fig. 1-2 in the Operating Instructions section.
2. Check Associated Equipment. Before trouble shooting, check that the equipment used with thls instrument is properly connected and that the interconnecting cables are not defective. Also, check the power source.
3. Visual Check. Visually check the portion of the instrument in which the trouble is located. Many troubles can be located by visible indications such as unsoldered connections, broken wires, damaged circuit boards, damaged components, etc.
4. Isolate Trouble to a Circult. To isolate trouble to a circuit, note the trouble symptom. The symptom often Identifies the circuit in which the trouble is located. When trouble symptoms appear in more than one circuit, check the affected circuits by taking voltage and waveform readings. Incorrect operation of all circuits often indicates trouble in the power supply. Check first for correct voltages of the individual supplies. See Table 4-3. 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 4-3

| POWER SUPPLY OUTPUT VOLTAGES |  |  |
| :---: | :---: | :---: |
| Power <br> Supply | Output Voltage Range | Typical <br> 120 Hz <br> Ripple |
| +200 V | +175 V to +247.5 V | 3 V or less |
| +30 V | +29.82 V to +30.18 V | 3 mV or less |
| +5 V | +4.89 V to +5.11 V | 2 mV or less |
| -30 V | -29.89 V to -30.11 V | 2 mV or less |

5. Check Voltages and Waveforms. Often the defective component can be located by checking for the correct voltages and waveforms in the circuit.
6. Check Insirument Adjusiment. Check the adjustment of this instrument, or the affected circuit if the trouble appears in one circuit. The apparent trouble may be the result of misadjustment. Complete adjustment instructions are given in Section 3.
7. Check Individual Components. The following procedures describe methods for checking individual components. Two-lead components that are soldered in place are best checked by first disconnecting one end. This isclates the measurement from the effects of surrounding circuitry.

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

TRANSISTORS. The best check of transistor operation is actual performance under operating conditions. A transistor can be most effectively checked by substituting a new component or one that has been checked previously. However, be sure that circuit conditions are 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.

INTEGRATED CIRCUITS. IC's can be checked with it voltmeter, test oscilloscope, or by direct substitution. A good understanding of circuit operation is desirable when troubleshooting circuits using IC's. Use care when checking voltages and waveforms around the IC's so that adjacent leads are not shorted together. A convenient means of clipping a test probe to the 14 - and 16-pin IC's is with an IC test clip. This device also serves as an extraction tool.

## CAUTION

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

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

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

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

CAPACITORS. A leaky or shorted capacitor can usually be detected by checking resistance with an ohmmeter on the highest scale. Do not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open capacitor can best be detected with a capacitance meter or by checking that the capacitor passes ac signals.
8. Repair and Adjustment. If any defective parts are located, follow the replacement procedures given in Corrective Maintenance. Be sure to check the performance of any circuit that has been repaired or had any electrical components replaced.

## CORRECTIVE <br> MAINTENANCE

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

## OBTAINING REPLACEMENT PARTS

## Standard Parts

All electrical and mechanical part replacements can be obtained through your local Tektronix Field Office or representative. However, many of the 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 Replaceable Electrical Parts list in Section 6 for value, tolerance, rating and description. To determine the manufacturer of a part, note the number listed under Mfg. Code in the Parts List and refer to a Cross Index Mfr. Code Number to Manufacturer listing at the beginning of the Parts List.

## NOTE

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

## Special Parts

In addition to the standard electronic components, some special parts are used in this instrument. These parts are manufactured or selected by Tektronix, Inc. in accordance with our specifications. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

## Ordering Parts

When ordering replacement parts from Tektronix, Inc., it is imperative that all of the following information be included in the order to ensure receiving the proper parts.

1. Instrument type ( $5110,5 \mathrm{~A} 18 \mathrm{~N}, 5 \mathrm{~B} 10 \mathrm{~N}$, etc.).
2. Instrument serial number.
3. A description of the part (if electrical, include the circuit number).
4. Tektronix part number.

## SOLDERING TECHNIQUES

## WARNING

High voltage and current levels are present in this instrument. To avoid electrical shock, disconnect the instrument from the power source before soldering.

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


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

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

The following technique should be used to replace a component on a circuit board. Most components can be replaced without removing the boards from the instrument.

1. Grip the component lead with long-nose pliers. Touch the soldering iron to the lead at the solder connection. Do not lay the iron directly on the board, as it may damage the board.
2. When the solder begins to melt, pull the lead out gently. If unable to pull the lead without using force, try removing the other end of the component as it may be more easily removed.

## NOTE

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

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

Unsolder the component from the circuit board, using heat on the component lead so that the solder will stay behind the board. If it is desired to remove solder from a circuit-board hole for easier installation of a new component, use a vacuum-type desoldering tool or a solderremoving wick.
3. Bend the leads of the new component to fit the holes in the hoard. If the component is replaced while the board is mounted in the instrument, cut the leads so they will just protrude through the board. Insert the leads into the holes in the board so the component is firmly seated against the board (or as positioned originally). If it does not seat properly, heat the solder and gently press the component into place.
4. Touch the iron to the connection and apply a small amount of solder to make a firm solder joint. To protect heat-sensitive components, hold the lead between the component body and the solder joint with a pair of longnose pliers or other heat sink.
5. Clip the excess lead that protrudes through the board (if not clipped in step 3).
6. Clean the area around the solder connection with a flux remover solvent. Be careful not to remove information printed on the board.

## COMPONENT REMOVAL AND REPLACEMENT

## WARNING

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

## Semiconductor Replacement

Transistors should not be replaced unless actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement of transistors may affect the calibration of this instrument. When transistors are replaced, check the performance of the part of the instrument which may be affected.


Power must be disconnected before removing or replacing semiconductors to avoid component damage.

Replacement semiconductors should be of the original type or a direct replacement. The lead configuration of most semiconductors used in this instrument are shown in Fig. 4-5. Some plastic case transistors have lead configurations which do not agree with those shown here. If a replacement transistor is made by a different manufacturer than the original, check the manufacturer's basing diagram for correct basing. All transistor sockets in this instrument are wired for the standard basing used for metal-case transistors. Transistors which have heat radiators, or are mounted on the chassis, use silicone grease to increase heat transfer. Replace the silicone grease when replacing these transistors.

## WARNING

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

An extraction tool should be used to remove the 14-and 16 -pin integrated circuits to prevent damage to the pins. This tool is available from Tektronix, Inc. Order through your local field office or representative. If an extraction tool is not available when removing one of these integrated circuits, pull slowly and evenly on both ends of the device. Try to avoid having one end of the integrated circuit disengage from the socket before the other, as the pins may be damaged.

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.

## Switch Replacement

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


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

## A. CAM SWITCHES

Cam switch repair kits are available from Tektronix, Inc. Order through your local field office or representative.

One switch kit is used to repair the cam switches in most time-base plug-in units and some vertical plug-in units. Another kit is used to repair the cam switches using the high-frequency contact, which is used in several vertical plug-in units.

The cam-type switches consist of rotating cam drums which are turned by front-panel knobs, and sets of springleaf contacts mounted on adjacent circuit boards. The contacts are actuated by lobes on the cams. In the
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.

## Circuit Board Replacement

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

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 on one side by a slotted plastic bar in addition to the screws; for these, remove the screws, then pull the circuit board from its slot to free the board. Also, remove any obstructions 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, the pin connectors may be damaged.

## Circuit-Board Pin Replacement



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

A circuit-board pin replacement kit including the necessary tools, instructions, and replacement pins is available from Tektronix, Inc. Order through your local Tektronix Field Office or representative. Replacement of circuit-board pins on multi-layer boards is not recommended; refer such repairs to your local Tektronix Field Office or representative.

To replace a pin which is mounted on a circuit board, first disconnect any pin connectors. Unsolder the damaged pin and pull it out of the circuit board with a pair of pliers (see Soldering Techniques, in this section, for recommended soldering and unsoldering procedures). Be careful not to damage the wiring on the board with too much heat. The ferrule on the pin may or may not disconnect from the hole with the damaged pin. If the ferrule remains in the circuit board, remove the ferrule from the replacement pin and press the new pin into the hole in the circuit board. If the original ferrule is removed with the damaged pin, clean out the hole using solderingiron heat, a solder-removing wick, and a scribe. Press the replacement pin with attached ferrule into the circuitboard hole. Position the replacement pin in the same manner as the removed pin. Solder the pin to the circuit board on each side of the board. If the removed pin was bent at an angle to mate with a connector, carefully bend the new pin to the same angle. Replace the pin connector.

## Cathode-Ray Tube Replacement

The following procedure outlines the removal and replacement of the cathode-ray tube. Refer to Fig. 4-7

## 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.)


Fig. 4-7. Replacing the cathode-ray tube.
2. Remove the crt base cover on the rear panel of the instrument.
3. Remove the crt base socket.
4. 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 positloning screws, and clamptightening hardware).

## note

The red and black wires entering the crt shield are connected to the trace-rotation coil inside the shield. They will not hamper crit removal and need not be unsoldered.
5. With one hand on the crt faceplate. push on the crt base (and neck shield). Slide the crt and neck shield forward, and 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. 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.
7. Replacing the crt will require partial instrument adjustment. Refer to the Adjustment section of this manual.

## Bulb Replacement

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

## NOTE

To gain access to bulbs on some instruments, it may be necessary to remove circuit boards and pushbutton switch extension shafts. Extension shafts are removed and installed by pulling straight off and pushing straight on.

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 transiormer only with a direct replacement transformer. When removing the transformer, be sure to mark the leads to aid in connecting the new transformer. After the transformer has been replaced, check the performance of the complete instrument using the procedure given in the Adjustment section.

## Fuse Replacement

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

Table 4-4
FUSE RATING, LOCATION AND FUNCTION

| Circult <br> Number | Rating | Function | Locatlon |
| :---: | :--- | :--- | :--- |
| F201 | 1.6 A Slow- <br> blow | 110 V Line- <br> voltage input | Rear panel |
| F201 | 1 A Slow- <br> blow | 220 V Line- <br> voltage input | Rear panel |
| F810 | 0.25 A Fast- <br> blow | +200 V Unrgltd <br> supply | Rear, LV Power <br> Supply board |
| F835 | 0.5 A Fast- <br> blow | +38 V Unrgltd <br> supply | Rear, LV Power <br> Supply board |

## ADJUSTMENT AFTER REPAIR

After any electrical component has been replaced, the adjustment of that particular circuit should be checked, as well as other closely related circuits. See Section 3 for a complete adjustment procedure.

## MODIFICATIONS TO PRE-OPTION 7 AMPLIFIER PLUG-INS (OPTION 7 ONLY)

The channel switching amplifier plug-ins that are recommended for use with 5100-series mainframes ( $5 \mathrm{~A} 14 \mathrm{~N}, 5 \mathrm{~A} 18 \mathrm{~N}, 5 \mathrm{~A} 26$ ) 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 5 A 14 N (SN B063288 and below only) change R513, R523, and R533 on the Main circuit board to a $100 \mathrm{k} \Omega, 5 \%, 0.25 \mathrm{~W}$ composition resistor, Tektronix Part No. 315-0104-00. Cut the board run (at both components) that connect 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 $20 \mathrm{k} \Omega, 5 \%, 0.25 \mathrm{~W}$ composition resistor, Tektronix Part No. 315-0203-00.

To modify a 5 A 18 N (SN B049999 and below only) change R301 on the Main Amplifier circuit board to a $20 \mathrm{k} \Omega, 5 \%, 0.25 \mathrm{~W}$ composition resistor, Tektronix Part No. 315-0203-00. Also, change R302 and R303 to a $10 \mathrm{k} \Omega, 1 \%$, 0.125 W 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 $20 \mathrm{k} \Omega, 5 \%, 0.25 \mathrm{~W}$ composition resistor, Tektronix Part No. 315-0203-00. Also, change Q386 to a NPN silicon transistor, 2N3565, TO-106 case, Tektronix Part No. 151-0341-00.

## CIRCUIT DESCRIPTION

This section of the manual contains a description of the circuitry used in the oscilloscope. Individual descriptions are separated into the following parts: Block Diagram, Interface, Auxiliary Board, Vertical and Horizontal Deflection Amplifiers, CRT Circuit, and last, Low-Voltage Power Supply and Calibrator. Refer to the appropriate diagrams in the Diagrams section of this manual while reading the circuit descriptions.

## BLOCK DIAGRAM DESCRIPTION

Vertical signals to be displayed on the cathode-ray tube are applied through the Interface circuit to the Auxiliary board from both vertical plug-in compartments. The Interface circuit determines whether the signal from the left or right vertical unit is displayed. The Vertical Amplifier circuit provides intermediate amplification between the vertical plug-in units and the Vertical Deflection Amplifier.

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 Horizontal Deflection Amplifier.

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 oscilloscope.

The Vertical and Horizontal Deflection Amplifiers provide final amplification for the signals from the plug-in units. They produce push-pull outputs suitable to drive the crt vertical and horizontal deflection plates. Beam-finding circuitry is incorporated to limit the display within the screen area when the front-panel BEAM FINDER button is pressed.

The CRT circuit produces the high voltage (about -3.4 kilovolts) and contains the controls necessary for operation of the cathode-ray tube. The CRT circuit also contains the Z-Axis Amplifier, which provides the drive signal to control the intensity level of the display.

The Low-Voltage Power Supply 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 signal at the front panel. The output has an accurate amplitude which can be used to check vertical deflection factor accuracy and probe compensation.

## INTERFACE

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 slgnals. 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 plugins 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 tevel 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 to blank the chop-switching transients.

## Countdown Circuit

The Countdown circuit produces the displayswitching 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 B 21 of J 601 and J 602 to the channelswitching 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-beamdisplay 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.

## Circult Descriplion-5110

## Verlical 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, Q66B, 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 813 of J603. The two halves of this amplifier are balanced in the quiescent condition by adjustment of R675, Hor. Cent. The output of the Horizontal Amplifier Is sent to the horizontal deflection amplifier.

## AUXILIARY BOARD

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 highimpedance 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.

## VERTICAL AND HORIZONTAL DEFLECTION AMPLIFIERS

## Verlical Deflection Amplifier

The Vertical Deflection Amplifier provides the final amplification of signals applied to the vertical plug-in units. It produces a push-pull output sufficient to drive the crt vertical deflection plates. The amplifier consists of Q104, Q106, Q114, and Q116, connected in a differential configuration.

The input signal arrives via P612 from the Interface circuit. The output signal is developed across the collector-load resistors, R104 and R114, and is about 50 times the magnitude of the input signal. Resistor R116 Vert Gain, provides Q106-Q116 emitter degeneration to set the gain of the stage 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 Amplifier just described. It provides final amplification of signals from the horizontal plug-in unit, which arrive via P6II. The gain of the stage is set by Hor. Gain R136 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 S125, allowing current through R125 into the emitter circuits of both deflection amplifiers. R125 limits the current available to the transistor, 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.

Also, when the BEAM FINDER switch is pressed, the $\mathbf{Z}$ Axis Amplifier in the crt circuit senses the slight increase in voltage level at the R108-R118-R128-R138 junction. The $Z$ Axis Amplifier produces a slight increase in crt beam intensity, allowing the trace to be displayed even though the INTENSITY control may be fully counterclockwise.

## X-Y Phasing

Variable capacitor C116, Phase, is connected across the Input emitters of the Vertical Deflection Amplifier. This capacitor is adjusted to eliminate the inherent phase difference between the vertical and horizontal deflection systems when operating in the $X-Y$ mode.

## CRT CIRCUIT

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 ZAxis Amplifier stage to set the intensity of the crt display.

## Z-Axis Amplifier

The Z-Axis Amplifier is a current driven shunt-feedback operational amplifier with a voltage output, and consists of Q222, Q226, and Q234. The feedback path is from the collectors of Q226 and Q234 through R227-C227 to the base of Q222. Q226 and Q234 are connected as a collector-coupled complementary amplifier to provide a fast, linear output signal while consuming minimum quiescent power. The output voltage provides the drive signal to control the crt intensity level through the Control-Grid Supply.

The output level of the Z-Axis Amplifier is established by the voltage drop across R227 in reference to virtual ground at the base of Q222 (the operational amplifier summing point). The current through R227 is determined by the input current from any combination of several sources, such as from the front-panel INTENSITY control, plug-in interface (blanking intensification, etc.), and from Q214. Q214 is an operational amplifier with two inputs; one from the front-panel EXT INTENSITY INPUT connector and the other from the front-panel BEAM FINDER switch. It sets those input signals to a level suitable for proper response by the Z-Axis Amplifier.

## High-Voltage Regulator

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 positivegoing 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 voltage from another feedback winding at the gate of Q278 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 initally, R262 provides base drive for Q252, causing it to deliver current to T240 primary. As Q252 conducts, the increasing current through the primary winding induces a voltage into the secondaries. The gate of Q278 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 Q278 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 low-voltage levels through the voltage divider consisting of resistors R272B-E, R275, and R276 to establish the dc level at the gate of Q278. 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 Q27B rises.

A new point is selected on the varying ac component to cause switching of Q262-Q264 later and hence increase 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 Q278 is adjusted by High Volts Adjust R275 to set the output at exactly -3400 volts.

## High Voltage Outputs

Transformer T240 has two high-voltage output windings which provide the potentials required for the crt cathode and control grid supplies. The -3400 -volt accelerating potential for the cathode is supplied by halfwave rectifier CR247. The cathode heater is elevated to the cathode potential through R273.

Half-wave rectifier CR241 provides about -3450 volts to establlsh bias voltage on the crt control grid. This voltage (and hence the crt beam cuprent) is dynamically controlled by the Z-Axis Amplifier, which contains the INTENSITY control, blanking inputs, and intensification inputs. Intensity Range R245 provides a fine adjustment of the quiescent grid voltage to bias the crt just below cutoff when the Z-Axis Amplifier output is at its minimum quiescent lęvel (INTENSITY control counterclockwise and no intensifying or blanking inputs).

Neon bulbs DS271, DS272, and DS273 provide protection to the crt if the voltage difference between the control grid and the cathode exceeds about 180 volts.

## Crt Control Circuits

In addition to the INTENSITY control discussed previously, front-panel FOCUS and internal Astigmatism controls have been incorporated for arriving at an optimum crt display. FOCUS control R295 provides the correct voltage for the second anode in the crt. Proper voltage for the third anode is obtained by adjusting Astig control R286. In order to obtain optimum spot size and shape, both the FOCUS and Astig controls are adjusted to provide the proper electrostatic lens configuration in the crt.

The Geometry adjustment R285 varies the positive level on the horizontal deflection plate shields to control the overall geometry of the display. The TRACE ROTATION control R291, permits adjustment of the dc current through beam-rotation coil L291 to align the display with the horizontal graticule lines.

## LOW-VOLTAGE POWER SUPPLY AND CALIBRATOR

The Low-Voltage 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-amplitude square-wave output.

## Power Input

Power is applied to the primary of transtormer T801 through fuse F201, thermal cutout S200, and Power switch S201, and the line-selector block, P80t. 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 oscittoscope system or for regulation by the Low-Voltage Regulators. The unregulated outputs are +200 volts, +38 volts, and -38 volts. The +200 -volt and +38 -volt outputs to the instrument 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.

## Calibrator

The Calibrator circuit composed of Q885, Q890, and their associated passive components produces a squarewave 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 4milliampere (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.

# REPLACEABLE <br> ELECTRICAI- PARTIS 

## 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 devoloped in our engineering department. It is therefore important, when ordering parts, to inciude 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 <br> x000 Part first added at this serial number <br> 00 X 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 EMITTJNG OIODE | 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 0 BOX 128 | PICKENS, SC 29671 |
| 01121 | ALLEN-BRADLEY COMPANY | 1201 2ND STREET SOUTH | MILWAUKEE, WI 53204 |
| 01295 | TEXAS INSTRUMENTS, INC., SEMICONDUCTOR | P O Box 5012 , 13500 n CENTRAL |  |
|  | Group | EXPRESSWAY | DALLAS, TX 75222 |
| 03508 | GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR |  |  |
|  | PRODUCTS DEPARTMENT | ELECTRONICS PARK | SYRACUSE, NY 13201 |
| 04222 | AVX CERAMICS, DIVISION OF AVX CORP. | P O BOX 867, 19TH AVE. SOUTH | MYRTLE BEACH, SC 29577 |
| 04713 | MOTOROLA, INC., SEMICONDUCTOR PROD. DIV. | 5005 E MCDOWELL RD, PO BOX 20923 | PHOENIX, AZ 85036 |
| 07263 | FAIRCHILD SEMICONDUCTOR, A DIV. OF |  |  |
|  | FAIRCHILD CAMERA AND INSTRIMENT CORP. | 464 ELLIS STREET | MOUNTALN VIEW, CA 94042 |
| 08806 | general electric co., miniature |  |  |
|  | LAMP PRODUCTS DEPARTMENT | NELA PARK | CLEVELAND, OH 44112 |
| 09023 | CORNELL-DUBILIER ELECTRONLC DIVISION |  |  |
|  | Federal pacific electric co. | 2652 DALRYMPLE ST, | SANFORD, NC 27330 |
| 10582 | CTS OF ASHEVILLE, INC. | MLLLS GAP ROAD | SKYLAND, NC 28776 |
| 12697 | CLAROSTAT MFG. CO., INC. | LOWER WASHINGTON STREET | DOVER, NH 03820 |
| 12954 | SIEMENS CORPORATION, COMPONENTS GROUP | 8700 E THOMAS RD, P 0 BOX 1390 | SCOTTSDALE, AZ 85252 |
| 12969 | UNITRODE CORPORATION | 580 PLEASANT StREET | WATERTOWN, MA 02172 |
| 13511 | AMPHENOL CARDRE DIV., BUNKER RAMO CORP. |  | LOS GAtos, CA 95030 |
| 14433 | ITT SEMICONDUCTORS | 3301 ELECTRONICS WAY |  |
|  |  | P 0 Box 3049 | WEST PALM BEACH, FL 33402 |
| 14552 | MICRO SEMICONDUCTOR CORP. | 2830 F FAIRVIEW ST, | SANTA ANA, CA 92704 |
| 14936 | general instrument corp., SEmiconductor |  |  |
|  | PRODUCTS GROUP | P.O. BOX 600,600 W. JOHN ST, | HICKSVILLE, NY 11802 |
| 23880 | STANFORD APPLIED ENGINEERING, INC. | 340 MARTIN AVE. | SANTA Clara, ca 95050 |
| 24546 | CORNING GLASS WORKS, ELECTRONIC |  |  |
|  | COMPONENTS DIVISION | 550 HIGH STREET | BRADFORD, PA 16701 |
| 31514 | STANFORD APPLIED ENGINEERING, INC. |  |  |
|  | advanced packaging div. | 3080 AIRWAY DRIVE | Costa mesa, ca 92626 |
| 50434 | hewlett-packard company | 640 Page MILL ROAD | Palo alto, CA 94304 |
| 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- |  |  |
| 71450 | CTS CORP. | 905 N . WEST BLVD | ELKHART, IN 46514 |
| 72982 | erie technological products, inc. | 644 W .12 TH ST. | ERIE, PA 16512 |
| 73138 | BECRMAN 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 |
| 80009 | tektronix, inc. | P 0 BOX 500 | BEAVERTON, OR 97077 |
| 81073 | GRAYHILL, INC. | 561 HILLGROVE AVE, , FO BOX 373 | La grange, [l 60525 |
| 81439 | THERM-O-DISC, INC. | 1320 S MAIN, P O BOX 1538 | MANSFIELD, OH 44907 |
| 90201 | MALLORY CAPACITOR CO., DIV. OF | 3029 E. WASHINGTON STREET |  |
|  | P. R. Mallory and co., inc. | 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. | $34-6356 \mathrm{TH}$ ST. | WOODSIDE, NY 11377 |

Tektronix Serial/Model No. Mfr

|  | Tektronix | Serial/Model No |  | Mfr |
| :--- | :--- | :--- | :--- | :--- |
| Ckt No. | Part No. | Eff | Dscont | Name $\&$ Description |


| Al | 670-1433-00 | B010100 | 8029999 | CKT Board assy;high voltage deflection | 80009 | 670-1433-00 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Al | 670-1433-01 | B030000 | B049999 | CKT board assy:high voltage deflection | 80009 | 670-1433-01 |
| A. 1 | 670-1433-02 | 8050000 | B119999 | CKT BOARD ASSY; HIGH VOLTAGE DEFLECTION | 80009 | 670-1433-02 |
| A1 | 670-1433-03 | B120000 |  | GKT board assy: High voltage deflection | 80009 | 670-1433-03 |
| A2 | 670-1454-00 |  |  | CKT board assy:single beam aux | 80009 | 670-1454-00 |
| A3 | 670-1340-00 |  |  | CKT BOARD ASSY: INTEREACE | 80009 | 670-1340-00 |
| A4 | 670-1339-00 |  |  | CKT board assy:lv Power supply | 80009 | 670-1339-00 |
| A5 | 670-5757-00 | X8109310 |  | CKT BOARD ASSY:SIGNAL OUT (OPTLON 7 ONLY) | 80009 | 670-5757-00 |
| C106 | 283-0684-00 | B010100 | B049999 | CAP., FXD,MICA D:620PF, 20\%, 300V | 00853 | D153E6:1G0 |
| C106 | 283-0596-00 | B050000 |  | GAP., FXD, MICA D; 528PF, 1\%,300V | 00853 | D153F5280F0 |
| 0115 | 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 | 09023 | CD15EC(253)J03 |
| C116 | 281-0180-00 | B050000 |  | CAP., VAR, MICA D: 18-115PF,175V | 52769 | CMD20600 |
| C126 | 283-0596-00 |  |  | CAP., FXD, MICA D:528PF, 1\%,300V | 00853 | D153F5280F0 |
| C136 | 283-0672-00 |  |  | CAP., FXD, MICA D: 200PF, 1\%,500V | 00853 | D155F2010F0 |
| C224 | 283-0065-00 | B010100 | B119999 | CAP., FXD, CER DI:0.001UF,5\%,100V | 72982 | 805-518-25D0102J |
| G224 | 283-0051-00 | B120000 |  | CAP., FXD, CER DI:0.0033UF,5\%,100V | 72982 | 8131N145C0G033AJ |
| c227 | 281-0537-00 | B010100 | B119999X | CAP., FXD, CER DI:0.68PF, 20\%,600V | 80009 | 281-0537-00 |
| C236 | 285-0526-00 |  |  | CAP., FXD, PLSTC:0.1UF,20\%,400V | 56289 | 410P10404 |
| C241 | 283-0270-00 | 8010100 | B119999 | CAP., FXD, CER DI: $0.0068 \mathrm{UF},+80 /-20 \%, 4000 \mathrm{~V}$ | 56289 | 45 Cl 7 |
| C241 | 283-0071-00 | B120000 |  | CAP., FXD, CER DI: $0.0068 \mathrm{UF},+80-30 \%, 5000 \mathrm{~V}$ | 56289 | 45Cl0AI |
| c 242 | 283-0261-00 | B010100 | B119999 | CAP., FXD, CER DI: $0.01 \mathrm{UF}, 20 \%, 4000 \mathrm{~V}$ | 56289 | 575 Clal |
| C242 | 283-0071-00 | B120000 |  | CAP., FXD, CER DI: $0.0068 \mathrm{UF},+80-30 \%, 5000 \mathrm{~V}$ | 56289 | 45C10AL |
| C248 | 283-0270-00 | 8010100 | B119999 | CAP., FXD, CER DI: 0.0068 UF, +80/-20\%,4000V | 56289 | 45 Cl 7 |
| C248 | 283-0071-00 | B120000 |  | CAP., FXD, CER DI: $0.0068 \mathrm{UF},+80-30 \%, 5000 \mathrm{~V}$ | 56289 | 45Cl0AI |
| C249 | 283-0270-00 | B010100 | B119999 | CAP., FXD, CER DI: $0.0068 \mathrm{UF},+80 /-20 \%, 4000 \mathrm{~V}$ | 56289 | 45C17 |
| C249 | 283-0071-00 | B120000 |  | CAP., FXD, CER DL: $0.0068 \mathrm{UF},+80-30 \%, 5000 \mathrm{~V}$ | 56289 | 45C10Al |
| C251 | 290-0194-00 |  |  | CAP., FXD, ELCTLT: $100 \mathrm{~F},+50-10 \%, 100 \mathrm{~V}$ | 56289 | 30D106F100DC4 |
| C252 | 283-0617-00 |  |  | CAP., FXD, MICA D: $4700 \mathrm{PF}, 10 \%, 300 \mathrm{~V}$ | 00853 | D193F472K0 |
| C253 | 283-0003-00 |  |  | CAP, FXD, CER DL: $0.01 \mathrm{UF},+80-20 \%, 150 \mathrm{~V}$ | 72982 | 855-558z50-103z |
| C254 | 283-0059-00 |  |  | CAP., FXD, CER DI:1UF, $+80-20 \%, 25 \mathrm{~V}$ | 72982 | 8131N0312500105z |
| C258 | 283-0059-00 |  |  | CAP., FXD, CER DI: $1 \mathrm{UF}, \mathbf{+ 8 0 - 2 0 \% , 2 5 V}$ | 72982 | 8131N0312500105Z |
| C259 | 283-0198-00 | B010100 | B120979 | CAP., FXD, CER DI:0.22UF, 20\%, 50V | 72982 | $8121 \mathrm{NOB3Z500224M}$ |
| C259 | 283-0164-00 | B120979 |  | CAP., FXD, CER DI: $2.2 \mathrm{UF}, 20 \%, 25 \mathrm{~V}$ | 72982 | 8141N0372500225M |
| C272 | 283-0021-00 |  |  | CAP., FXD, CER DI: $0.001 \mathrm{UF}, 20 \%, 5000 \mathrm{~V}$ | 72982 | 848-556-Y5S-102M |
| C273 | 283-0208-00 |  |  | CAP., FXD, CER DI: $0.22 \mathrm{UF}, 10 \%, 200 \mathrm{~V}$ | 72982 | 8151N230 C 224K |
| C274 | 283-0104-00 | B010100 | B039999 | CAP., FXD, CER DI: $2000 \mathrm{PF}, 5 \%, 500 \mathrm{~V}$ | 72982 | 811-5658202J |
| C274 | 283-0142-00 | B040000 | Bl19999x | CAP., FXD, CER DI:0.0027UF, $5 \%, 200 \mathrm{~V}$ | 72982 | B75-571-Y5E0272J |
| C279 | 283-0065-00 | B010100 | B119999X | CAP., FXD, CER DL:0.001UF, $5 \%, 100 \mathrm{~V}$ | 72982 | 805-518-2500102J |
| C281 | 283-0003-00 |  |  | CAP., FXD, CER DI: $0.01 \mathrm{UF},+80-20 \%, 150 \mathrm{~V}$ | 12982 | 855-55825U-103Z |
| C622 | 283-0032-00 |  |  | CAP., FXD, CER DI:470PF, $5 \%, 500 \mathrm{~V}$ | 72982 | 0831085Z5E00471J |
| C628 | 283-0060-00 |  |  | CAP., FXD, CER DL: $100 \mathrm{PF}, 5 \mathrm{~F}, 200 \mathrm{~V}$ | 72982 | 855-53502J101J |
| C632 | 283-0002-00 |  |  | CAP., FXD, CER DI: $0.01 \mathrm{UF},+80-20 \%, 500 \mathrm{~V}$ | 72982 | 811-546E103z |
| C634 | 283-0060-00 |  |  | CAP., FKD, CER DI: $100 \mathrm{PF}, 5 \%, 200 \mathrm{~V}$ | 72982 | B55-53502J101J |
| C636 | 283-0060-00 |  |  | CAP., FXD, CER DI: $100 \mathrm{PF}, 5 \%, 200 \mathrm{~V}$ | 72982 | 855-535U2J101J |
| C640 | 281-0519-00 |  |  | CAP., FXD, CER DI:47PF, +/-4.7PF, 500V | 72982 | 308-000C0G0470K |
| C642 | 281-0519-00 |  |  | CAP., FKD, CER DI:47PF,+/-4.7PF, 500V | 72982 | 308-000C0G0470K |
| C659 | 283-0000-00 |  |  | CAP., FXD, CER DI: $0.001 \mathrm{UF},+100-0 \%, 500 \mathrm{~V}$ | 72982 | 831-516E102P |
| C671 | 281-0593-00 | B010100 | B029999x | CAP., FXD, GER DI: $3.9 \mathrm{PF}, 10 \%, 500 \mathrm{~V}$ | 72982 | 301-000C0J0399C |
| C679 | 283-0000-00 |  |  | CAP., FXD, CER DI: $0.0010 \mathrm{~F},+100-0 \%, 500 \mathrm{~V}$ | 72982 | 831-516E102P |
| C712 | 283-0000-00 |  |  | CAP., FXD, CER DI:0.001UF, +100-0\%, 500V | 72982 | B31-516E102P |
| C714 | 281-0628-00 |  |  | CAP., FXD, CER DI: $15 \mathrm{PF}, 5 \%, 500 \mathrm{~V}$ | 72982 | 301-000C0G0150J |
| C716 | 281-0628-00 |  |  | CAP.,FXD, CER DI: $15 \mathrm{PF}, 5 \%$,500V | 72982 | 301-000 $00 \mathrm{COL50J}$ |
| c721 | 281-0628-00 |  |  | CAP., FXD, CER DI: $15 \mathrm{PF}, 5 \%, 500 \mathrm{~V}$ | 72982 | 301-000C060150J |
| C810 | 290-0511-00 |  |  | CAP., FXD, ELCTLT: 250UF + + $75-10 \%, 250 \mathrm{~V}$ | 90201 | 20-35958 |
| c815 | 290-0510-00 |  |  | CAP., FXD, ELCTLT : $6000 \mathrm{HF},+100-10 \%, 15 \mathrm{~V}$ | 56289 | 68 D 10473 |


|  | Tektronix | Serial/Model No. |  | Name \& Description |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Ckt No. | Part No. | Eff | Dscont |  | Code | Mfr Part Number |
| C820 | 290-0134-00 |  |  | CAP., FXD, ELCTLT: 22UF, 20\%, 15v | 56289 | 1500226x001582 |
| C822 | 281-0512-00 |  |  | CAP., FXD, CER DI: 27PF, +/-2.7PF, 500V | 72982 | 308-000C060270K |
| C830 | 285-0629-00 |  |  | CAP.,FXD, PLSTC:0.047UF, 20\%, 100v | 56289 | 410 P 47301 |
| 6837 | 290-0509-00 |  |  | CAP. , FXD, ELCTLT: $3000 \mathrm{UF},+100-10 \%, 50 \mathrm{~V}$ | 56289 | 68D10454 |
| C839 | 290-0509-00 |  |  | CAP., FXD, ELCTLT: 3000UF, $+100-10 \%, 50 \mathrm{~V}$ | 56289 | 68D10454 |
| C842 | 290-0175-00 |  |  | CAP., FXD, ELCTLT: $100 \mathrm{~F}, 20 \%$, 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, $+80-20 \%, 150 \mathrm{~V}$ | 72982 | 855-55825U-103z |
| C860 | 290-0175-00 |  |  | CAP., FXD, ELCTLT : $10 \mathrm{OF}, 20 \%, 35 \mathrm{~V}$ | 56289 | 150D106x0035R2 |
| C865 | 281-0550-00 | 8010100 | B039999 | CAP., FXD, CER DI: $120 \mathrm{PF}, 10 \%$, 500V | 04222 | 7001-1373 |
| C865 | 281-0543-00 | B040000 |  | CAP, , FXD, CER DI: $270 \mathrm{PF}, 10 \%$, 500 V | 72982 | 301055X5P271K |
| C870 | 290-0134-00 |  |  | CAP. , FXD, ELCTLT : 22UF, 20\%, 15 V | 56289 | 1500226x0015B2 |
| C872 | 281-0572-00 |  |  | CAP., FXD, CER DI: $6.8 \mathrm{BPF},+/-0.5 \mathrm{PF}, 500 \mathrm{~V}$ | 72982 | 301-000C0H0689D |
| C875 | 283-0003-00 |  |  | CAP., FXD, CER DI: $0.01 \mathrm{UF},+80-20 \%, 150 \mathrm{~V}$ | 72982 | 855-558z5u-1032 |
| C881 | 290-0267-00 |  |  | CAP., FXD, ELCTLT: 1UF, 20\%, 35V | 56289 | $1620105 \times 0035 \mathrm{CD} 2$ |
| C883 | 290-0267-00 |  |  | CAP., FXD, ELCTLT : $1 \mathrm{UF}, 20 \%$, 35V | 56289 | 162D105K0035CD2 |
| C890 | 281-0549-00 |  |  | CAP., FXD, CER DI:68PF, $10 \%, 500 \mathrm{~V}$ | 72982 | 301-000ษ2J0680K |
| C930 | 283-0002-00 | XB109310 |  | ```CAP.,FXD,CER DI:0.O1UF,+80-20%,500V (OPTION 7 ONLY)``` | 72982 | 811-546E103z |
| C931 | 281-0504-00 | XB109310 |  | ```CAP.,FXD,CER DI:10PF,+/-1PF,500V (OPTION 7 ONLY)``` | 72982 | 301-055c0G0100F |
| C960 | 283-0002-00 | XB109310 |  | ```CAP., FXD,CER DI:0.O1UF, +80-20%,500V (OPTION 7 ONLY)``` | 72982 | 811-546E1032 |
| C961 | 281-0504-00 | XB109310 |  | CAP., FXD, CER DI: $10 \mathrm{PF},+/-1 \mathrm{PF}, 500 \mathrm{~V}$ (OPTION 7 ONLY) | 72982 | 301-055C0G0100F |
| c980 | 283-0002-00 | XB109310 |  | $\begin{aligned} & \text { CAP., FXD, CER DI: } 0.01 \mathrm{UF},+80-20 \%, 500 \mathrm{~V} \\ & \text { (OPTION } 7 \text { ONLY) } \end{aligned}$ | 72982 | 811-546E103Z |
| C981 | 281-0504-00 | XB109310 |  | $\begin{aligned} & \text { CAP., FXD, CER DI: } 10 \mathrm{OF},+/-1 \mathrm{PF}, 500 \mathrm{~V} \\ & \text { (OPTION } 7 \text { ONLY) } \end{aligned}$ | 72982 | 301-055c060100F |
| CR209 | 152-0061-00 |  |  | SEMICOND DEVICE:SILICON, 175V,100MA | 07263 | FDH2161 |
| GR211 | 152-0061-00 |  |  | SEMICOND DEVICE:SILICON,175V,100MA | 07263 | FDH2161 |
| CR214 | 152-0141-02 |  |  | SEMICOND DEVICE:SILICON, 30V,50NA | 01295 | 1N4152R |
| CR215 | 152-0061-00 |  |  | SEMICOND DEVICE: SILICON, $175 \mathrm{~V}, 100 \mathrm{MA}$ | 07263 | FDH2161 |
| CR222 | 152-0141-02 | XB120000 |  | SEMICOND DEVICE:SILICON, 30V,50NA | 01295 | 1N4152R |
| CR224 | 152-0061-00 |  |  | SEMICOND DEVICE:SILICON,175V,100MA | 07263 | FDH2161 |
| CR226 | 152-0061-00 | XB120000 |  | SEMICOND DEVICE:SILICON, 175v,100MA | 07263 | FDH2161 |
| CR234 | 152-0061-00 | XB120000 |  | SEMICOND DEVICE:SILICON, 175v,100MA | 07263 | FDH2161 |
| GR238 | 152-0061-00 | XB120000 |  | SEMICOND DEVICE:SILICON, 175v,100MA | 07263 | FDH2161 |
| CR239 | 152-0061-00 | B010100 | B119999X | SEMICOND DEVICE:SILICON, 175V,100MA | 07263 | FDH2161 |
| CR240 | 152-0242-00 | XB120000 |  | SEMICOND DEVICE:SILICON, $225 \mathrm{~V}, 200 \mathrm{MA}$ | 07263 | FDH5004 |
| CR241 | 152-0409-00 |  |  | SEMICOND DEVICE:SILICON, 12,000V, 5MA | 80009 | 152-0409-00 |
| CR247 | 152-0409-00 |  |  | SEMICOND DEVICE:SILICON, 12,000V,5MA | 80009 | 152-0409-00 |
| CR253 | 152-0414-00 |  |  | SEMICOND DEVICE:SILICON, 200V,0.75A | 12969 | UTR308 |
| CR255 | 152-0141-02 |  |  | SEMICOND DEVICE:SILICON, 30V,50NA | 01295 | 1N4152R |
| CR256 | 152-0061-00 |  |  | SEMICOND DEVICE:SILICON, $175 \mathrm{~V}, 100 \mathrm{MA}$ | 07263 | FDH2161 |
| CR262 | 152-0141-02 |  |  | SEMLCOND DEVICE:SILICON, $30 \mathrm{~V}, 50 \mathrm{NA}$ | 01295 | 1N4152R |
| CR264 | 152-0141-02 |  |  | SEMICOND DEVICE:SILICON, $30 \mathrm{~V}, 50 \mathrm{NA}$ | 01295 | 1N4152R |
| CR269 | 152-0061-00 | B010100 | B119999 | SEMLCOND DEVICE:SILICON, 175V,100MA | 07263 | FDH2161 |
| CR269 | 152-0586-00 | B120000 |  | SEMICOND DEvICE:SILICON, $600 \mathrm{~V}, 500 \mathrm{MA}$ | 14936 | RGP10J |
| CR270 | 152-0586-00 | XB120000 |  | SEMICOND DEVICE:SILICON, 600V,500MA | 14936 | RGP10J |
| CR620 | 152-0141-02 |  |  | SEMICOND DEVICE:SILICON, 30V, 50 NA | 01295 | 1N4152R |
| CR658 | 152-0141-02 |  |  | SEMICOND DEVICE:SILICON, 30V,50NA | 01295 | 1N4152R |
| CR668 | 152-0141-02 |  |  | SEMICOND DEVICE:SILICON, 30V,50NA | 01295 | 1N4152R |
| CR678 | 152-0141-02 |  |  | SEMICOND DEVICE:SILICON,30V,50NA | 01295 | 1N4152R |
| CR688 | 152-0141-02 |  |  | SEMICOND DEVICE:SILICON, $30 \mathrm{~V}, 50 \mathrm{NA}$ | 01295 | 1N4152R |
| CR702 | 152-0141-02 |  |  | SEMICOND DEVICE; SLLICON, 30V,50NA | 01295 | 1N4152R |
| CR704 | 152-0141-02 |  |  | SEMICOND DEVICE:SILICON, 30V,50NA | 01295 | 1N4152R |


| Ckt No. | Tektronix Part No | Serial/Mod Fff | el No. Oscont | Name \& Description | Mfr Code | Mfr Part Number |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CR712 | 152-0141-02 |  |  | SEMICOND DEVICE:SILICON, 30V, 50 NA | 01295 | 1N4152R |
| CR714 | 152-0141-02 |  |  | SEMICOND DEVICE:SILICON, 30V,50NA | 01295 | IN4152R |
| CR721 | 152-0141-02 |  |  | SEMICOND DEVICE:SILICON, 30V,50NA | 01295 | 1N4152R |
| CR722 | 152-0141-02 |  |  | SEMICOND DEVICE:SILICON, 30V,50NA | 01295 | 1 N4152R |
| CR810 | 152-0107-00 |  |  | SEMICOND DEVICE:SILICON, $400 \mathrm{~V}, 400 \mathrm{MA}$ | 01295 | 6727 |
| CR811 | 152-0107-00 |  |  | SEMICOND DEVICE:SILICON,400V,400MA | 01295 | G727 |
| CR812 | 152-0107-00 |  |  | SEMICOND DEVICE:SILICON,400V,400MA | 01295 | G727 |
| CR813 | 152-0107-00 |  |  | SEMICOND DEVICE:SILICON, $400 \mathrm{~V}, 400 \mathrm{MA}$ | 01295 | G727 |
| CR815 | 152-0488-00 |  |  | SEMICOND DEVICE:SILICON, 200V,1500MA | 04713 | 3N55 FAMILY |
| CR820 | 152-0066-00 |  |  | SEMICOND DEVICE:SILICON, $400 \mathrm{~V}, 750 \mathrm{MA}$ | 14433 | LG4016 |
| CR824 | 152-0141-02 |  |  | SEMICOND DEVICE: SILICON, 30V,50NA | 01295 | 1N4152R |
| CR835 | 152-0107-00 |  |  | SEMICOND DEVICE:SILICON, 400V,400MA | 01295 | 6727 |
| CR836 | 152-0107-00 |  |  | SEMICOND DEVICE:SILICON, $400 \mathrm{~V}, 400 \mathrm{MA}$ | 01295 | 6727 |
| CR837 | 152-0488-00 |  |  | SEMICOND DEVICE:SILICON, 200V, 1500MA | 04713 | 3N55 FAMILY |
| CR841 | 152-0066-00 |  |  | SEMICOND DEVICE:SILICON,400V,750MA | 14433 | LG4016 |
| CR842 | 152-0066-00 |  |  | SEMICOND DEVICE:SILICON, 400V,750MA | 14433 | LG4016 |
| cr8so | 152-0141-02 |  |  | SEMICOND DEVICE:SILIICON, 30V,50NA | 01295 | 1N4152R |
| CR851 | 152-0141-02 |  |  | SEMICOND DEVICE:SILICON, 30v,50NA | 01295 | 1N4152R |
| CR860 | 152-0066-00 |  |  | SEMICOND DEVICE:SILICON, 400V,750MA | 14433 | LG4016 |
| CR865 | 152-0141-02 |  |  | SEMICOND DEVICE:SILICON, 30V,50NA | 01295 | 1N4152R |
| CR870 | 152-0141-02 |  |  | SEMICOND DEVICE:SILICON, 30V,50NA | 01295 | 1N4152R |
| CR875 | 152-0141-02 |  |  | SEMICOND DEVICE:SILICON, 30V,50NA | 01295 | IN4152R |
| CR885 | 152-0141-02 |  |  | SEMICOND DEVICE:SILICON, 30V,50NA | 01295 | 1N4152R |
| CR890 | 152-0141-02 |  |  | SEMICOND DEVICE:SILICON, 30V, 50NA | 01295 | 1N4152R |
| CR930 | 152-0141-02 | XB109310 |  | ```SEMICOND DEVICE:SILICON,30V,50NA (OPTION 7 ONLY)``` | 01295 | 1N4152R |
| CR960 | 152-0141-02 | XB109310 |  | SEMICOND DEVICE: SILICON, 30V,50NA (OPTION 7 ONLY) | 01295 | 1N4152R |
| CR980 | 152-0141-02 | XB109310 |  | SEMICOND DEVICE:SILICON, 30V,50NA (OPTION 7 ONLY) | 01295 | 1N4152R |
| CR990 | 152-0322-00 | XB109310 |  | SEMICOND DEVICE:SILICON,15v, HOI CARRIER (OPTION 7 ONLY) | 50434 | 5082-2672 |
| D5271 | 150-0030-00 |  |  | LAMP, GLOW : NEON, T-2,60 TO 90 VOLTS | 08806 | A2B-T |
| DS272 | 150-0030-00 |  |  | LAMP, GLOW : NEON, T-2,60 T0 90 VOLTS | 08806 | A2B-T |
| DS273 | 150-0030-00 |  |  | LAMP, GLOW: NEON,T-2,60 TO 90 VOLTS | 08806 | A2B-T |
| DS274 | 150-0030-00 | XB120000 |  | LAMP, GLOW: NEON, T-2,60 TO 90 VOLTS | 08806 | A2B-T |
| F201 | 159-0003-00 |  |  | FUSE, CARTRIDGE: 3AG, $1.6 \mathrm{~A}, 250 \mathrm{~V}$, SLOW-BLOW (DOMESTIC (120V NOMINAL LINE) | 71400 | MDX $16 / 10$ |
| F201 | 159-0019-00 |  |  | FUSE, CARTRIDGE: 3AG, 1A, 250V, SLOW BLOW (EXPORT (240V NOMINAL LINE) | 71400 | MDLI |
| F810 | 159-0028-00 |  |  | FUSE, CARTRIDGE: 3AG, $0.25 \mathrm{~A}, 250 \mathrm{~V}$, FAST-BLOW | 71400 | AGC $1 / 4$ |
| F835 | 159-0025-00 |  |  | FUSE, CARTRIDGE: 3AG, 0. 5A, 250V, FAST-BLOW | 71400 | AGC $1 / 2$ |
| J210 | 131-0955-00 |  |  | CONNECTOR, RCPT, :CKT BD, 28/56 CONTACT | 13511 | 31-279 |
| J601 | 131-1078-00 | B010100 | B099999 | CONNECTOR, RCPT, :28/56 CONTACT | 95238 | 600-1156Y256DF30 |
| J601 | 131-1078-01 | B100000 | B106746 | CONN, RCPT, ELEC:CKT CARD, 28/56 CONTACT | 31514 | SAM28D/2-TX |
| J601 | 131-1078-00 | B106747 |  | CONNECTOR, RCPT, $: 28 / 56$ CONTACT | 95238 | 600-1156Y256DF30 |
| J602 | 131-1078-00 | B010100 | B099999 | CONNECTOR, RCPT, $: 28 / 56$ CONTACT | 95238 | 600-1156Y256DF30 |
| J602 | 131-1078-01 | B100000 | B106746. | CONN, RCPT, ELEC: CKT CARD, 28/56 CONTACT | 31514 | SAM28D/2-TX |
| J602 | 131-1078-00 | B106747 |  | CONNECTOR, RCPT, $: 28 / 56$ CONTACT | 95238 | 600-1156Y256DF30 |
| J603 | 131-1078-00 | B010100 | B105856 | CONNECTOR, RCPT,:28/56 CONTACT | 95238 | 600-1156Y256DF30 |
| J603 | 131-1078-01 | B105857 | B099999 | CONN, RCPT, ELEC: CKT CARD, $28 / 56$ CONTACT | 31514 | SAM28D/2-TX |
| $J 603$ | 131-1078-00 | B100000 |  | CONNECTOR, RCPT, $: 28 / 56$ CONTACT | 95238 | 600-1156Y256DF30 |
| J604 | 131-1043-00 |  |  | CONNECTOR, RCPT, $: 18 / 36$ CONTACT | 23880 | SAC18D/4-2 |
| L259 | 108-0564-00 |  |  | COIL, RF: FLXED, 740 H | 80009 | 108-0564-00 |
| L291 | 108-0644-00 |  |  | COIL, TUBE DEFLE:TRACE ROTATOR | 80009 | 108-0644-00 |


| Ckt No. | Tektronix Part No. | Serial/Mod <br> Eff | No. Dscont | Name \& Description | Mtr Code | Mfr Part Number |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Q104 | 151-0279-00 | B010100 | B079999 | TRANSISTOR:SILICON, NPN | 80009 | 151-0279-00 |
| Q104 | 151-0150-00 | B080000 | Bl19999 | TRANSISTOR:SILICON,NPN | 80009 | 151-0150-00 |
| Q104 | 151-0615-00 | B120000 |  | TRANSISTOR:SILICON,NPN | 80009 | 151-0615-00 |
| Q106 | 151-0190-02 | B010100 | B069999 | TRANSISTOR: SILICON, NPN | 80009 | 151-0190-02 |
| Q106 | 151-0190-00 | B070000 |  | TRANSISTOR:SILICON,NPN | 07263 | 5032677 |
| Q114 | 151-0279-00 | B010100 | B079999 | TRANSISTOR:SILICON, NPN | 80009 | 151-0279-00 |
| Q114 | 151-0150-00 | 8080000 | B119999 | TRANSISTOR:SILICON, NPN | 80009 | 151-0150-00 |
| Q114 | 151-0615-00 | B120000 |  | TRANSISTOR: SILICON, NPN | 80009 | 151-0615-00 |
| Q116 | 151-0190-02 | B010100 | B069999 | TRANSISTOR:SILICON, NPN | 80009 | 151-0190-02 |
| Q116 | 151-0190-00 | B070000 |  | TRANSISTCR:SILICON, NPN | 07263 | 5032677 |
| Q124 | 151-0279-00 | B010100 | B079999 | TRANSISTOR: SILICON, NPN | 80009 | 151-0279-00 |
| Q124 | 151-0150-00 | B080000 | B119999 | TRANSISTCR:SILICON, NPN | 80009 | 151-0150-00 |
| Q124 | 151-0615-00 | B120000 |  | TRANSISTOR: SILICON, NPN | 80009 | 151-0615-00 |
| Q126 | 151-0190-02 | B010100 | B069999 | TRANSISTOR:SILICON, NPN | 80009 | 151-0190-02 |
| Q126 | 151-0190-00 | B070000 |  | TRANSISTOR: SILICON, NPN | 07263 | 5032677 |
| Q134 | 151-0279-00 | B010100 | B079999 | TRANSISTOR: SILICON, NPN | 80009 | 151-0279-00 |
| Q134 | 151-0150-00 | B080000 | B119999 | TRANSISTCR: SILICON, NPN | 80009 | 151-0150-00 |
| Q134 | 151-0615-00 | B120000 |  | TRANSISTOR:SILICON, NPN | 80009 | 151-0615-00 |
| Q136 | 151-0190-02 | B010100 | B069999 | TRANSISTOR:SILICON, NPN | 80009 | 151-0190-02 |
| Q136 | 151-0190-00 | B070000 |  | TRANSISTOR:SILICON, NPN | 07263 | 5032677 |
| 0138 | 151-0341-00 | XB050000 | B119999X | TRANSISTOR:SILICON, NPN | 07263 | \$040065 |
| Q214 | 151-0341-00 |  |  | TRANSISTOR:SILICON, NPN | 07263 | S040065 |
| Q222 | 151-0190-00 |  |  | TRANSISTOR: SIL.ICON, NPN | 07263 | S032677 |
| Q226 | 151-0179-00 | B010100 | 8069999 | TRANSISTOR:SILICON, NPN | 80009 | 151-0179-00 |
| Q226 | 151-0347-00 | B070000 | B119999 | TRANSISTOR: SILICON, NPN | 04713 | SPS 7951 |
| Q226 | 151-0407-00 | B120000 |  | TRANSISTOR:SILICON, NPN | 04713 | SS2456 |
| Q234 | 151-0228-00 | B010100 | B069999 | TRANSISTOR:SILICON, PNP, SEL FROM 2 N 4888 | 80009 | 151-0228-00 |
| Q234 | 151-0350-00 | B070000 | B072987 | TRANSISTOR: SILICON, PNP | 04713 | SPS6700 |
| Q234 | 151-0406-00 | B072988 |  | TRANSISTOR:SILICON, PNP | 01295 | SGC7282 |
| 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, PNF | 07263 | S035928 |
| Q278 | 151-1005-00 | B010100 | B119999 | TRANSISTOR: SILICON,JFE, N-CHANSEL | 80009 | 151-1005-00 |
| Q278 | 151-0254-00 | B120000 |  | TRANSISTOR:SILICON, NPN | 80009 | 151-0254-00 |
| Q620 | 151-0190-00 |  |  | TRANSISTOR:SILICON,NPN | 07263 | S032677 |
| Q626 | 151-0190-00 |  |  | TRANSISTOR: SILICON,NPN | 07263 | S032677 |
| Q630 | 151-0341-00 |  |  | TRANSISTOR: SILICON, NPN | 07263 | 5040065 |
| Q650 | 151-0192-00 |  |  | TRANSISTOR:SILICON, NPN, SEL FROM MPS6521 | 04713 | SPS8801 |
| Q658 | 151-0220-00 |  |  | TRANSISTOR: SILICON, PNP | 07263 | 5036228 |
| Q660 | 151-0192-00 |  |  | TRANSISTOR:SILICON, NPN, SEL FROM MPS6521 | 04713 | SPS8801 |
| Q668 | 151-0220-00 |  |  | TRANSISTOR: SILICON, PNP | 07263 | 5036228 |
| Q670 | 151-0192-00 |  |  | TRANSISTOR:SILICON, NPN, SEL FROM MPS6521 | 04713 | SPS8801 |
| Q678 | 151-0220-00 |  |  | TRANSISTOR: SILICON, PNF | 07263 | S036228 |
| Q680 | 151-0192-00 |  |  | TRANSISTOR:SILICON, NPN, SEL FROM MPS6521 | 04713 | SPS8801 |
| Q688 | 151-0220-00 |  |  | TRANSISTOR:SILICON, PNP | 07263 | S036228 |
| Q701 | 151-0341-00 |  |  | TRANSISTOR:SILICON, NPN | 07263 | S040065 |
| Q702 | 151-1005-00 |  |  | TRANSISTOR:SILICON, JFE, N-CHANNEL | 80009 | 151-1005-00 |
| Q703 | 151-0341-00 |  |  | TRANSISTOR:SILICON, NPN | 07263 | S040065 |
| Q704 | 151-1005-00 |  |  | TRANSISTOR:SILICON, JFE, N-CHANNEL | 80009 | 151-1005-00 |
| Q711 | 151-0341-00 |  |  | TRANSISTOR:SILICON,NPN | 07263 | S040065 |
| Q712 | 151-1005-00 |  |  | TRANSISTOR: SILICON, JFE, N-CHANNEL | 80009 | 151-1005-00 |
| Q713 | 151-0341-00 |  |  | TRANSISTOR:SILICON,NPN | 07263 | S040065 |
| Q714 | 151-1005-00 |  |  | TRANSISTOR: SILICON, JFE, N-CHANNEL | 80009 | 151-1005-00 |
| Q721 | 151-0192-00 |  |  | TRANSISTOR:SILICON, NPN, SEL FROM MPS6521 | 04713 | SPS8801 |
| Q722 | 151-0192-00 |  |  | TRANSISTOR:SILICON,NPN,SEL FROM MPS6521 | 04713 | SPS8801 |
| Q815 | 151-0331-00 | B010100 | B070028 | TRANSISTOR:SILICON, NPN | 03508 | X40C115 |
| Q815 | 151-0496-00 | B070029 |  | TRANSISTOR:SILICON,NPN | 80009 | 151-0496-00 |


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| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Q820 | 151-0341-00 |  |  | TRANSISTOR:SILICON, NPN | 07263 | 5040065 |
| Q825 | 151-0341-00 |  |  | TRANSISTOR: SILICON, NPN | 07263 | 5040065 |
| Q840 | 151-0331-00 | B010100 | B070028 | TRANSISTOR:SILICON, NPN | 03508 | X40C115 |
| Q840 | 151-0496-00 | B070029 |  | TRANSISTOR:SILICON,NPN | 80009 | 151-0496-00 |
| Q845 | 151-0341-00 |  |  | TRANSISTOR: SILICON,NPN | 07263 | S040065 |
| Q850 | 151-0190-00 |  |  | TRANSISTOR: SILICON, NPN | 07263 | S032677 |
| Q860 | 151-0331-00 | B010100 | B070028 | TRANSISTOR:SILICON, NPN | 03508 | X400115 |
| Q860 | 151-0496-00 | B070029 |  | TRANSISTOR: SILICON, NPN | 80009 | 151-0496-00 |
| Q865 | 151-0341-00 |  |  | TRANSISTOR:SILICON, NPN | 07263 | 5040065 |
| Q870 | 151-0220-00 |  |  | TRANSISTOR:SILICON, PNP | 07263 | 5036228 |
| Q875 | 151-0301-00 |  |  | TRANSISTOR:SILICON, PNP | 04713 | 2N2907A |
| Q885 | 151-0341-00 |  |  | TRANSISTOR:SILICON, NPN | 07263 | S040065 |
| Q890 | 151-0341-00 |  |  | TRANSISTOR: SILICON, NPN | 07263 | S040065 |
| Q910 | 151-0190-00 | XB109310 |  | TRANSISTOR:SILICON,NPN (OPTION 7 ONLY) | 07263 | 8032677 |
| Q915 | 151-0190-00 | XB109310 |  | TRANSISTOR:SILICON,NPN (OPTION 7 ONLY) | 07263 | 5032677 |
| Q920 | 151-0190-00 | XB109310 |  | TRANSISTOR: SILICON, NPN (OPTION 7 ONLY) | 07263 | 5032677 |
| Q925 | 151-0190-00 | XB109310 |  | TRANSISTOR:SILICON,NPN (OPTION 7 ONLY) | 07263 | 5032677 |
| Q930 | 151-0188-00 | XB109310 |  | TRANSISTOR:SILICON, PNP (OPTION 7 ONLY) | 04713 | SPS6868K |
| Q940 | 151-0190-00 | XB109310 |  | TRANSISTOR:STLICON,NPN (OPTION 7 ONLY) | 07263 | S032677 |
| Q945 | 151-0190-00 | XB109310 |  | TRANSISTOR:SILICON,NPN (OPTION 7 ONLY) | 07263 | 5032677 |
| Q950 | 151-0190-00 | XB109310 |  | TRANSISTOR:SILICON, NPN (OPTION 7 ONLY) | 07263 | 5032677 |
| Q955 | 151-0190-00 | XB109310 |  | TRANSISTOR:SILICON,NPN (OPTION 7 ONLY) | 07263 | 5032677 |
| Q960 | 151-0188-00 | XB109310 |  | TRANSISTOR:SILICON, PNP (OPTION 7 ONLY) | 04713 | SPS6868K |
| Q967 | 151-0190-00 | XB109310 |  | TRANSISTOR:SILICON, NPN (OPTION 7 ONLY) | 07263 | 5032677 |
| Q970 | 151-0190-00 | XB109310 |  | TRANSISTOR:SILICON,NPN (OPTION 7 ONLY) | 07263 | 5032677 |
| Q972 | 151-0190-00 | XB109310 |  | TRANSISTOR:SILICON,NPN (OPTION 7 ONLY) | 07263 | 5032677 |
| Q975 | 151-0190-00 | XB109310 |  | TRANSISTOR:SILICON,NPN (OPTION 7 ONLY) | 07263 | S032677 |
| Q980 | 151-0188-00 | XB109310 |  | TRANSISTOR:SILICON, PNP (OPTION 7 ONLY) | 04713 | SPS6868K |
| Q990 | 151-0190-00 | XB109310 |  | TRANSISTOR:SILICON, NPN (OPTION 7 ONLY) | 07263 | S032677 |
| R101 | 315-0101-00 |  |  | RES. , FXD, CMPSN: 100 OHM , 5\%,0.25W | 01121 | CB1015 |
| R102 | 316-0470-00 | 8010100 | B029999 | RES., FXD, CMPSN: 47 OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB4701 |
| R102 | 316-0221-00 | B030000 | 8119999 | RES., FXD, CMPSN: 220 OHM, 10\%, 0.25w | 01121 | CB2211 |
| R102 | 315-0221-00 | B120000 |  | RES., FXD, CMPSN: 220 OHM, 5\%,0.25W | 01121 | CB2215 |
| R103 | 316-0390-00 | XB030000 | B119999 | RES., FXD, CMPSN: 39 OHM, 10\%, 0.25 W | 01121 | CB3901 |
| R103 | 315-0390-00 | B120000 |  | RES. , FXD, CMPSN: 39 OHM $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB3905 |
| R104 | 308-0668-00 |  |  | RES., FXD, WW:6.2K OHM, 3\%,7W | 00213 | 1600562000H |
| R106 | 321-0128-00 |  |  | RES., FXD, FILM : 210 OHM, 1\%,0.125W | 91637 | MFF1816G210R0F |
| R108 | 308-0539-00 |  |  | RES., FXD, WW: 2.25 K OHM, $0.5 \%, 3 \mathrm{~W}$ | 91637 | RS2BK22500D |
| R112 | 316-0470-00 | B010100 | B029999 | RES, , FXD, CMPSN: 47 OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB4701 |
| R112 | 316-0221-00 | 8030000 | B119999 | RES., FXD, CMPSN: 220 OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB2211 |
| R112 | 315-0221-00 | B120000 |  | RES., FXD, CMPSN: 220 OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | C82215 |


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| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Eff | Dscont |  |  |  |
| R113 | 316-0390-00 | xb030000 | B119999 | RES., FXD, CMPSN: 39 OHM, 10\%,0.25W | 0121 | св3901 |
| R113 | 315-0390-00 | B120000 |  | RES., FXD, CMPSN: 39 OHM, 5\%,0.25W | 01121 | CB3905 |
| R114 | 308-0668-00 |  |  | RES., FXD, WW:6. 2 K О $\mathrm{HM}, 3 \%, 7 \mathrm{~W}$ | 00213 | 1600862000H |
| R115 | 316-0470-00 | x8030000 | B049999x | RES., FXD, CMPSN: 47 OHM, 10\%,0.25w | 01121 | C84701 |
| R116 | 311-1132-00 | в010100 | B119999 | RES., VAR, NONWIR: TRMR, 100 OHM, 0.50 W | 73138 | 91-66-0 |
| R116 | 311-1567-00 | B120000 |  | RES., VAR, NONWIR: TRMR, 100 OHM, 0.50 W | 73138 | 91-89-0 |
| R118 | 308-0539-00 |  |  | RES. , FXD, WW: 2.25 K OHM, 0.5\%, 3W | 91637 | RS2bk22500d |
| R122 | 316-0470-00 | в010100 | в029999 | RES., FXD, CMPSN: 47 OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | C84701 |
| R122 | 316-0221-00 | в030000 | B119999 | RES., FXD, CMPSN: 220 OHM, 10\%,0.25W | 01121 | Cb2211 |
| R122 | 315-0221-00 | 8120000 |  | RES., FXD, CMPSN: 220 OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB2215 |
| R123 | 316-0390-00 | xb030000 | B119999 | RES., FXD, CMPSN: 39 OHM, 10\%,0.25w | 01121 | CB3901 |
| R123 | 315-0390-00 | B120000 |  | RES., FXD, CMPSN: 39 OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB3905 |
| R124 | 308-0668-00 |  |  | Res., FXD, wW:6.2K ӧm, 3\%,7w | 00213 | 1600562000H |
| R125 | 303-0751-00 |  |  | RES. , FXD, CMPSN: 750 OHM, 5\%, 1 W | 01121 | GB7515 |
| R126 | 321-0128-00 |  |  | RES., FXD, FILM: $2100 \mathrm{HM}, 18,0.125 \mathrm{~W}$ | 91637 | MFF1816G210ROF |
| R128 | 308-0539-00 |  |  | RES., FXD, WW:2.25K OHM, $0.5 \%$, 3W | 91637 | RS2BK22500D |
| R132 | 316-0470-00 | B010100 | в029999 | RES., FKD, CMPSN: 47 OHM, 10\%, 0.25 W | 01121 | CB4701 |
| R132 | 316-0221-00 | в030000 | B119999 | RES., FXD, CMPSN: 220 OHM, 10\%,0.25W | 01121 | CB2211 |
| R132 | 315-0221-00 | B120000 |  | RES., FXD, CMPSN: 220 OHM, 5\%,0.25W | 01121 | CB2215 |
| R133 | 316-0390-00 | xb030000 | 3119999 | RES., FXD, CMPSN: 39 OHM, 10\%,0.25W | 01121 | CB3901 |
| R133 | 315-0390-00 | B120000 |  | RES., FXD, CMPSN: 39 оНм, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB3905 |
| R134 | 308-0668-00 |  |  | RES., FXD, WW: 6.2 K оНм, $3 \mathrm{z}, 7 \mathrm{~W}$ | 00213 | 1600s62000H |
| R135 | 316-0470-00 | x8030000 | 3049999x | RES., EXD, CMPSN: 47 OHM, 10\%, 0.25 W | 01121 | CB4701 |
| R135 | 316-0390-00 | X2080000 | в119999 | RES. , FXD, CMPSN: 39 OHM, 10\%,0.25W | 01121 | Св 3901 |
| R135 | 315-0390-00 | B120000 |  | RES., FXD, CMPSN: 39 OHM, 5\%,0.25W | 01121 | CB3905 |
| R136 | 311-1132-00 | B010100 | B119999 | RES. , VAR, NONWIR: TRMR, 100 OHM, 0.50W | 73138 | 91-66-0 |
| R136 | 311-1567-00 | B120000 |  | RES., VAR, NONWIR: TRMR, 100 OHM, 0.50 W | 73138 | 91-89-0 |
| R138 | 308-0539-00 |  |  | RES., FXD, WW: 2.25 K OHM, $0.5 \%$, 3W | 91637 | RS2BK22500D |
| R140 | 316-0225-00 | xB050000 | B119999X | RES., FXD, CMPSN: $2.2 \mathrm{M} \mathrm{OHM}, 10 \%, 0.25 \mathrm{~W}$ | 01121 | CB2251 |
| R200 | 311-1160-00 | b010100 | B108289 | RES., VAR, NONWIR: $100 \mathrm{~K} 0 \mathrm{HM}, 20 \%$, 1 W | 80009 | 311-1160-00 |
| R200 | 311-1961-00 | B108290 |  | RES., VAR, NONWIR: PANEL, IOOK OHM, 20\%,0.75W (FURNISHED AS A UNIT WITH Sl25) | 01121 | 17M025 |
| R202 | 315-0563-00 |  |  | RES., FXD, CMPSN: 56R OHM , 5\% , 0.25W | 01121 | CB5635 |
| R203 | 316-0103-00 | B010100 | B119999 | RES., FXD, CMPSN: 10 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB1031 |
| R203 | 315-0103-00 | B120000 |  | RES., FXD, CMPSN: 10R OHM, 5\%, 0.25W | 01121 | CB1035 |
| R206 | 315-0682-00 |  |  | RES., FXD, CMPSN: 6, BK OHM, 5\%,0.25W | 01121 | C86825 |
| R207 | 316-0822-00 | в010100 | B119999 | RES.,FXD, CMPSN: 8.2 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB8221 |
| R207 | 315-0822-00 | B120000 |  | RES., FXD, CMPSN; $8,2 \mathrm{~K}$ OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB8225 |
| R208 | 316-0473-00 | B010100 | B119999 | RES., FXD, CMPSN:47K OHM, 10\%, 0.25 W | 01121 | CB4731 |
| R208 | 315-0473-00 | B120000 |  | RES., FXD, CMPSN: 47 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB4735 |
| R209 | 316-0224-00 | xB050000 | B119999 | RES.,FXD, GMPSN: 220 K OHM, 10\%,0.25 | 01121 | CB2241 |
| R209 | 315-0224-00 | B120000 |  | RES., FXD, CMPSN: 220 K ОНM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB2245 |
| R211 | 316-0103-00 | B010100 | 8119999 | RES., FXD, CMPSN: 10 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB1031 |
| R211 | 315-0103-00 | B120000 |  | RES., FXD, CMPSN: 10 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB1035 |
| R213 | 315-0623-00 |  |  | RES., FXD, CMPSN: 62K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | C36235 |
| R215 | 316-0103-00 | B010100 | B119999 | RES., FXD, CMPSN: 10 OR OHM, 10\%, 0.25 W | 01121 | CB1031 |
| R215 | 315-0103-00 | B120000 |  | RES., FXD, CMPSN: 10 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | 681035 |
| 8216 | 315-0153-00 |  |  | RES., FXD, CMPSN: 15 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB1535 |
| R217 | 316-0103-00 | B010100 | 8119999 | RES., FXD, CMPSN: 10 K OHM $, 10 \%, 0.25 \mathrm{~W}$ | 01121 | C31031 |
| R217 | 315-0103-00 | B120000 |  | RES., FXD, CMPSN: 10 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB1035 |
| R218 | 316-0183-00 | B010100 | B119999 | RES., FXD, CMPSN: 18 K OHM, 10\%, 0.25 W | 01121 | CB1831 |
| R218 | 315-0183-00 | B120000 |  | RES., PKD, CMPSN: 18 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB1835 |
| R219 | 315-0683-00 |  |  | RES., PXD, CMPSN: 68K OHM, 5\%,0.25W | 01121 | C86835 |
| R222 | 316-0102-00 | в010100 | B119999 | RES., FXD, CMPSN: 1 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB1021 |
| R222 | 315-0102-00 | B120000 |  | RES., EXD, CMPSN: 1 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB 1025 |
| R223 | 316-0472-00 | b010100 | B119999 | RES., FXD, CMPSN: 4.7 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB4721 |
| R223 | 315-0472-00 | B120000 |  | RES., FXD, CMPSN: 4.7 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB4725 |


| Ckt No. | Tektronix Part No. | Serial/Mod Eff | No. Dscont | Name \& Description | Mit Code | Mfr Part Number |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| R226 | 316-0101-00 | XB050000 | B119999 | RES., FXD, GMPSN: 100 OHM, 10\%,0.25 W | 01121 | CB1011 |
| R226 | 315-0101-03 | B120000 |  | RES. , FXD, CMPSN: $1000 \mathrm{HM}, 5 \%, 0.25 \mathrm{~W}$ | 01121 | CB1015 |
| R227 | 321-0399-00 |  |  | RES., FXD, FILM: 140 K OHM, $1 \%, 0.125 \mathrm{~W}$ | 91637 | MPF1816G14002F |
| R231 | 316-0472-00 | B010100 | B119999 | RES., FXD, CMPSN:4.7K OHM, 10\%,0.25W | 01121 | CB4721 |
| R231 | 315-0103-00 | B120000 |  | RES., FXD, GMPSN: 10K OHM, 5\%,0.25W | 01121 | CB1035 |
| R232 | 316-0274-00 | B010100 | B119999 | RES., FXD, GMPSN: 270 K OHM, 10\%,0.25W | 01121 | CB2741 |
| R232 | 315-0.154-00 | B120000 |  | RES., FXD, CMPSN: 150 K OHM,5\%,0.25w | 01121 | CB1545 |
| R234 | 304-0223-00 | B010100 | B119999 | RES.,FXD,CMPSN: 22 K OHM, 10\%,1W | 01121 | GB2231 |
| R234 | 305-0223-00 | B120000 |  | RES., FXD, CMPSN: 22 K OHM, 5\%,2W | 01121 | HB2235 |
| R236 | 315-0101-00 | B010100 | B119999 | RES. , FXD, CMPSN: $100 \mathrm{OHM}, 5 \%, 0.25 \mathrm{~W}$ | 01121 | CB1015 |
| R236 | 315-0152-00 | B120000 | B121979 | RES. ,FXD, CMPSN:1.5K OHM,5\%,0.25W | 01121 | CB1525 |
| R236 | 315-0821-00 | B121980 |  | RES. , FXD, CMPSN: 820 OHM, 5\%,0.25W | 01121 | CB8215 |
| R239 | 315-0101-00 | B010100 | B119999X | RES . FXD, CMPSN: 100 OHM, 5\%,0.25W | 01121 | CB1015 |
| R240 | 315-0335-03 | XB120000 |  | RES., FXD, CMPSN: 3.3M OHM, 5\%, 0.25 W | 01121 | CB3355 |
| R242 | 316-0223-00 | B010100 | B119999 | RES, FXD, CMPSN: 22 K OHM, 10\%, 0.25 W | 01121 | CB2231 |
| R242 | 315-0223-03 | B120000 |  | RES.,FXD, CMPSN: 22 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB2235 |
| R243 | 316-0105-00 | B010100 | B119999 | RES., FXD, CMPSN: 1M OHM, 10\%,0.25W | 01121 | C81051 |
| R243 | 315-0105-03 | B120000 |  | RES., FXD, CMPSN:IM OHM, 5\%,0.25W | 01121 | CB1055 |
| R244 | 315-0331-03 | XB120000 |  | RES. , FXD, CMPSN: 330 OHM , 5\%,0.25 W | 01121 | CB3315 |
| R245 | 311-1135-00 | B010100 | B029999 | RES. , VAR, NONWIR:TRMR, IM OHM, 0.25W | 71450 | Ya5535 |
| R245 | 311-1205-00 | B030000 | B119999 | RES. , VAR, NONWIR ; TRMR, 2 M OHM, 0.25 W | 71450 | Ya5545 |
| R245 | 311-1135-00 | B120000 |  | RES. , VAR, NONWIR : TRMR, 1M OHM, 0.25W | 71450 | YA5535 |
| R248 | 316-0223-00 | B01.01.00 | B119999 | RES., FXD,CMPSN: 22 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB2231 |
| R248 | 315-0103-03 | B120000 | B120979 | RES., FXD, CMPSN: 10 K OHM, 5\%,0.25W | 01121 | CB1035 |
| R248 | 315-0562-03 | B120980 |  | RES, , FXD, CMPSN: 5.6 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB5625 |
| R249 | 315-0471-03 | XB120000 |  | RES. , FXD, CMPSN: 470 OHM, 5\%,0.25w | 01121 | CB4715 |
| 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 | 308-0690-00 | B010100 | B120979 | RES., FXD, WW: $30 \mathrm{HM}, 10 \%$, 3 W | 91637 | CW2B-3R000X |
| R254 | 308-0365-00 | B120980 |  | RES., FXD, WW: 1.5 OHM, 5\%, 3W | 91637 | CW2B-18500J |
| R257 | 306-0104-00 | B010100 | B119999 | RES.,FXD, GMPSN:I00K OHM, $10 \%$, 2 W | 01121 | H81041 |
| R257 | 305-0104-00 | B120000 | B120979X | RES., FXD, CMPSN: 100 R OHM, $5 \%, 2 \mathrm{~W}$ | 01121 | HB1045 |
| R262 | 302-0472-00 | B010100 | B119999 | RES., FXD, CMPSN:4.7K OHM, 10\%,050W | 01121 | EB4721 |
| R262 | 301-0472-00 | B120000 |  | RES, , FXD, CMPSN:4.7K OHM, $5 \%, 0.50 \mathrm{~W}$ | 01121 | EB4725 |
| R263 | 316-0183-00 | B010100 | B119999 | RES.,FXD, CMPSN: 18 K OHM, 10\%,0.25W | 01121 | CB1831 |
| R263 | 315-0183-00 | B120000 | B121803 | RES., FXD, CMPSN: 18 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB1835 |
| R263 | 315-0912-00 | B121804 |  | RES., FXD, CMPSN: 9.IK OHM, 5\%,0.25W | 01121 | CB9125 |
| R266 | 316-0334-00 | B010100 | B119999 | RES., FXD, CMPSN: 330X OHM, 10\%,0.25W | 01121 | CB3341 |
| R266 | 315-0334-00 | B120000 |  | RES., FXD, CMPSN: 330X OHM $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB3345 |
| R267 | 316-0333-00 | B010100 | B119999 | RES., FXD, CMPSN: 33 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB3331 |
| R267 | 315-0333-00 | B120000 |  | RES., FXD, CMPSN: 33 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB3335 |
| R268 | 316-0103-00 | B010100 | B119999 | RES., FXD, CMPSN:10X OHM, 10\%,0.25W | 01121 | CB1031 |
| R268 | 315-0103-03 | B120000 |  | RES., FXD, CMPSN:10K OHM, 5\%,0.25W | 01121 | CB1035 |
| R269 | 315-0101-00 | B010100 | B119999X | RES. , FXD, CMPSN: 100 ORM, 5\%,0,25W | 01121 | CB1015 |
| R270 | 316-0223-00 | XB060000 | Bl19999X | RES., FXD, CMPSN: 22 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB2231 |
| R271 | 316-0395-00 | B010100 | B119999 | RES. , FXD, GMPSN: 3.9M OHM, 10\%,0.25W | 01121 | CB3951 |
| R271 | 315-0395-00 | B120000 |  | RES. . FXD, CMPSN: 3.9M OHM , 5\%,0.25W | 01121 | CB3955 |
| $\begin{aligned} & \text { R272A } \\ & \text { R272B } \end{aligned}$ |  |  |  |  |  |  |
| $\begin{aligned} & \text { R272C } \\ & \text { R272D } \\ & \text { R272E } \end{aligned}$ | 307-0296-00 |  |  | RES., FXD, FILM:FOR D10\& Dll | 80009 | 307-0296-00 |
| R273 | 315-0104-00 | B010100 | B119999 | RES., FXD, CMPSN: 100 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB1045 |
| R273 | 315-0104-03 | B120000 |  | RES., FXD CMPS : 100 K OHM $, 5 \%, 0.25 \mathrm{~W}$ | 01121 | CE1045 |
| R274 | 316-0105-00 | B010100 | B119999 | RES., FXD, CMPSN: 1 M OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB1051 |
| R274 | 315-0105-03 | B120000 |  | RES., FXD, CMPSN: 1 M OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB1055 |
| R275 | 311-1136-00 |  |  | RES.,VAR, NONWIR: 100 K OHM, $30 \%, 0.25 \mathrm{~W}$ | 71450 | 201-YA5536 |


| Ckt $N$ No. | Tektronix Part No. | Serial/Mod Eff | No. Dscont | Name * Description | Mfr Code | Mitr Part Number |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| R276 | 316-0105-00 | B010100 | B119999 | RES., FXD, CMPSN: 1 M OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB1051 |
| R276 | 315-0105-03 | B120000 |  | RES., FXD, CMPSN: 1M OHM, 5\%, 0. 25W | 01121 | CB1055 |
| R278 | 316-0562-00 | B010100 | B119999 | RES., FXD, CMPSN: 5.6 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB5621 |
| R278 | 315-0562-00 | B120000 |  | RES., FXD, CMPSN:5.6K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | C85625 |
| R279 | 315-0104-00 | B010100 | B119999X | RES., FXD, CMPSN: 100 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB1045 |
| R282 | 315-0163-00 | B010100 | B119999 | RES., FXD, CMPSN: 16X OHM, 5\%,0.25W | 01121 | CB1635 |
| R282 | 315-0163-01 | B120000 |  | RES., EXD, CMPSN: 16 K OHM $, 5 \%, 0.25 \mathrm{~W}$ | 01121 | CB1635 |
| R285 | 311-1136-00 | B010100 | Bl19999 | RES. ,VAR, NONWIR: 100 K OHM, 30\%,0.25W | 71450 | 201-YA5536 |
| R285 | 311-1555-00 | B120000 |  | RES., VAR, NONWIR: 100 K OHM, $20 \%, 0,5 \mathrm{~W}$ | 73138 | 91-77-0 |
| R286 | 311-1136-00 | 8010100 | B119999 | RES. , VAR, NONWIR: 100 K OHM, 30\%, 0.25 W | 71450 | 201-YA5536 |
| R286 | 311-1555-00 | B120000 |  | RES., VAR, NONWIR: 100 K OHM, $20 \%, 0.5 \mathrm{~W}$ | 73138 | 91-77-0 |
| R287 | 301-0183-00 |  |  | RES. , FXD, CMPSN: 18K OHM, $5 \%, 0.50 \mathrm{~W}$ | 01121 | EB1835 |
| R291 | 311-1189-00 |  |  | RES. , VAR, WW: PNL, 5K OHM, 2 W | 10582 | AW3349 |
| R295 | 311-0254-00 |  |  | RES., VAR, NONWIR: 5 M OHM, 10\%,1W | 12697 | CM29709 |
| R620 | 316-0102-00 | B010100 | 8121189 | RES., EXD, CMPSN: 1 K OHM, 10\%,0.25 | 01121 | CB1021 |
| R620 | 315-0102-00 | B121190 |  | RES., FXD, CMPSN: 1K OHM, 5\%,0.25W | 01121 | CB1025 |
| R621 | 316-0222-00 | B010100 | B121189 | RES., FXD, GMPSN: 2.2 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB2221 |
| R621 | 315-0222-00 | B121190 |  | RES.,FXD, GMPSN: 2.2 K OHM, 5\%,0.25W | 01121 | CB2225 |
| R622 | 315-0223-00 | 8010100 | B029999 ${ }^{\text {. }}$ | RES., FXD, GMPSN: 22K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB2235 |
| R622 | 315-0163-00 | B030000 |  | RES., EXD, CMPSN: 16 K OHM,5\%,0.25W | 01121 | CB1635 |
| R626 | 316-0102-00 | B010100 | B121189 | RES., FXD, CMPSN: 1 K OHM, 10\%,0.25W | 01121 | CB1021 |
| R626 | 315-0102-00 | B121190 |  | RES., FXD, CMPSN: IX OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB1025 |
| R628 | 315-0223-00 | B010100 | 8029999 | RES.,FXD, CMPSN: 22 K OHM,5\%,0.25W | 01121 | CB2235 |
| R628 | 315-0183-00 | B030000 |  | RES., PXD, CMPSN: 18 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | C81835 |
| R630 | 316-0474-00 | 8010100 | B121189 | RES., FXD, CMPSN:470K OHM, 10\%,0.25W | 01121 | C34741 |
| R630 | 315-0474-00 | B12490 |  | RES., FXD, CMPSN: 470 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB4745 |
| R631 | 316-0332-00 | B010100 | B121189 | RES. , FXD, CMPSN: 3.3K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB3321 |
| R631 | 315-0332-00 | B121190 |  | RES., EXD, GMPSN: 3.3K OHM, 5\%, 0.25W | 01121 | CB3325 |
| R632 | 315-0273-00 |  |  | RES., FXD, CMPSN: 27 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB2735 |
| R634 | 316-0103-00 | 8010100 | B121189 | RES., FXD, GMPSN: 10 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | C31031 |
| R634 | 315-0103-00 | B121190 |  | RES , FXX, CMPSN: 10 KK OHM , 5\%,0.25W | 01121 | CB1035 |
| R635. | 316-0102-00 | B010100 | B121189 | RES., FXD, CMPSN:1K OHM, 10\%,0.25W | 01121 | CB1021 |
| R635 | 315-0102-00 | B121190 |  | RES., FXD, CMPSN: 1 K OHM, 5\%,0.25W | 01121 | CB1025 |
| R636 | 316-0103-00 | B010100 | B121189 | RES., FXD, CMPSN: 10 K OHM, 10\%,0.25W | 01121 | CB1031 |
| R636 | 315-0103-00 | B121190 |  | RES. , FXD, CMPSN: 10K OHM, 5\%,0.25W | 01121 | CB1035 |
| $\mathrm{R637}$ | 316-0102-00 | B010100 | B121189 | RES., FXD, CMPSN: 1 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB1021 |
| R637 | 315-0102-00 | B121190 |  | RES., FXD, CMPSN: IK OHM, 5\%,0.25W | 01121 | CB1025 |
| R640 | 316-0562-00 | B010100 | B121189 | RES., FXD, CMPSN: 5.6 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB5621 |
| R640 | 315-0562-00 | B121190 |  | RES., FXD, CMPSN: 5,6K OHM, 5\%,0.25W | 01121 | CB5625 |
| R641 | 316-0561-00 | B010100 | B121189 | RES., FXD, CMPSN: 560 OHM , 10\%, 0.25 W | 01121 | CB5611 |
| R641 | 315-0561-00 | B121190 |  | RES. , FXD, CMPSN: 560 OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB5615 |
| R642 | 316-0103-00 | B010100 | B121189 | RES., FXD, CMPSN: 10 K OHM, 10\%,0.25W | 01121 | CB1031 |
| R642 | 315-0103-00 | 8121190 |  | RES. , FXD, CMPSN: 10K OHM, 5\%, 0.25 W | 01121 | CB1035 |
| R643 | 316-0102-00 | B010100 | B121189 | RES., FXD, CMPSN: 1 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB1021 |
| R643 | 315-0102-00 | B121190 |  | RES., FXD, CMPSN: 1K OHM, 5\%,0.25W | 01121 | CB1025 |
| R650 | 315-0393-00 |  |  | RES., EXD, CMPSN: 39K OHM, 5\%,0.25W | 01121 | CB3935 |
| R651 | 316-0103-00 | B010100 | B121189 | RES., EXD, CMPSN: 10 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB1031 |
| R65 ${ }^{\text {b }}$ | 315-0103-00 | 8121190 |  | RES., FXD, CMPSN: 10 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CBI035 |
| R652 | 315-0273-00 |  |  | RES., FXD, CMPSN: 27 K OHM, 5\%,0.25W | 01121 | CB2735 |
| R656 | 321-0222-00 |  |  | RES., FXD, FILM: 2 K OHM, $1 \mathrm{\%}, 0.125 \mathrm{~W}$ | 91637 | MFF1816G20000F |
| R657 | 315-0822-00 |  |  | RES.,FXD, CMPSN: 8.2K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB8225 |
| R659 | 316-0101-00 | B010100 | B121189 | RES., FXD, CMPSN: 100 OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB1011 |
| R659 | 315-0101-00 | B121190 |  | RES. , FXD, CMPSN: $1000 \mathrm{OM}, 5 \%, 0.25 \mathrm{~W}$ | 01121 | CB1015 |
| R660 | 315-0393-00 |  |  | RES., FXD, CMPSN: 39 K 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: 2 K OHM, $1 \%, 0.125 \mathrm{~W}$ | 91637 | MFF1816G20000F |


| Ckt No. | Tektronix Part No. | Serial/Mo Eff | el No. Dscont | Name \& Description | Mir Code | Mir Part Number |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| R667 | 315-0822-00 |  |  | RES., FXD, CMPSN: 8.2 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB8225 |
| R669 | 316-0101-00 | B010100 | B121189 | RES., FXD,CMPSN: 100 OHM, 10\%,0.25W | 01121 | CB1011 |
| R669 | 315-0101-00 | B121190 |  | RES., FXD, CMPSN: 100 OHM, 5\%,0.25W | 01121 | CB1015 |
| R670 | 315-0393-00 |  |  | RES., FXD, CMPSN: 39K OHM , 5\%,0.25w | 01121 | CB3935 |
| R671 | 316-0331-00 | B010100 | B121190 | RES., FXD, CMPSN: 330 OHM, 10\%,0.25w | 01121 | CB3311 |
| R671 | 315-0331-00 | B121190 |  | RES., FXD, CMPSN: $330 \mathrm{OHM}, 5 \%, 0.25 \mathrm{~W}$ | 01121 | CB3315 |
| R672 | 315-0223-00 |  |  | RES. , FXD, CMPSN: 22 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | C82235 |
| R675 | 311-1133-00 |  |  | RES., VAR, NONWIR: 10 K OHM, $30 \%, 0.25 \mathrm{~W}$ | 71450 | 201-YA5534 |
| R676 | 321-0222-00 |  |  | RES., FXD, FILM: 2 K OHM, $1 \%, 0.125 \mathrm{~W}$ | 91637 | MPF1816G20000F |
| R677 | 315-0822-00 |  |  | RES., FXD,CMPSN: 8.2 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB8225 |
| R679 | 316-0101-00 | B010100 | B121189 | RES., FXD,CMPSN: 100 OHM, 10\%,0.25W | 01121 | CB1011 |
| R679 | 315-0101-00 | B121190 |  | RES., FXD, CMPSN: 100 OHM, 5\%,0.25w | 01121 | CB1015 |
| R680 | 315-0393-00 |  |  | RES, ,FXD,CMPSN: 39 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 0121 | CB3935 |
| R681 | 316-0331-00 | B010100 | B121189 | RES., FXD, CMPSN: 330 OHM, 10\%, 0.25 W | 01121 | CB3311 |
| R681 | 315-0331-00 | B121190 |  | RES., FXD, CMPSN: 330 OHM, 5\%,0.25W | 01121 | CB3315 |
| R682 | 315-0223-00 |  |  | RES.,FXD, CMPSN: 22 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB2235 |
| R685 | 321-0159-00 |  |  | RES., FXD, FILM: 442 OHM, 1\%,0.125 | 91637 | MFF1816G442R0F |
| R686 | 321-0222-00 |  |  | RES.,FXD, FILM: 2 K OHM, $1 \%, 0.125 \mathrm{~W}$ | 91637 | MFF1816G20000F |
| R687 | 315-0822-00 |  |  | RES.,FXD,CMPSN:8.2K OHM, 5\%,0.25w | 0121 | CB8225 |
| R701 | 316-0103-00 |  |  | RES. , FXD, CMPSN: 10 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB1031 |
| R702 | 316-0103-00 |  |  | RES., FXD, CMPSN: 10 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB1031 |
| R703 | 316-0103-00 |  |  | RES., FXD, CMPSN: 10 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB1031 |
| R704 | 316-0103-00 |  |  | RES., FXD, CMPSN: 10 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB1031 |
| R706 | 316-0103-00 |  |  | RES., FXD, CMPSN: 10 K OHM, 10\%, O . 25 W | 01121 | CB1031 |
| R707 | 316-0103-00 |  |  | RES., FXD, CMPSN: 10 K OHM, 10\%,0.25w | 01121 | CB1031 |
| R709 | 316-0103-00 |  |  | RES., FXD, CMPSN: 10 K ОНM, $10 \%, 0.25 \mathrm{w}$ | 01121 | CB1031 |
| R710 | 316-0103-00 |  |  | RES., FXD, CMPSN: 10 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB1031 |
| R712 | 316-0472-00 |  |  | RES., FXD, CMPSN:4.7K OHM, 10\%,0.25 | 01121 | C34721 |
| R713 | 316-0332-00 |  |  | RES., FKD, CMPSN: 3.3K OHM, 10\%,0.25w | 01121 | CB3321 |
| R715 | 321-0402-00 |  |  | RES., FXD, FILM: 150 K OHM, $1 \%, 0.125 \mathrm{~W}$ | 24546 | NAS501503F |
| R716 | 321-0356-00 |  |  | RES., FXD, FILM:49.9K OHM, 18,0.125 | 91637 | MFF1816G49901F |
| R717 | 321-0350-00 |  |  | RES., FXD,FILM:43.2K OHM, 1\%,0.125 | 91637 | MFF1816G43201F |
| R718 | 316-0153-00 |  |  | RES., FXD, CMPSN: 15 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB1531 |
| R720 | 321-0385-00 |  |  | RES., FXD, FILM: 100 K OHM, 1\%,0.125 | 91637 | MFF1816G10002F |
| R721 | 321-0356-00 |  |  | RES., FXD, FILM:49.9K ОНM, 1\%,0.125 | 91637 | MFF1816G49901F |
| R722 | 321-0365-00 |  |  | RES.,FXD,FILM:61.9K OHM, 1\%,0.125 | 91637 | MFF1816G61901F |
| R723 | 316-0153-00 |  |  | RES., FXD, CMPSN: 15K OHM, 10\%,0.25w | 01121 | CB1531 |
| R724 | 316-0272-00 |  |  | RES., FXD, CMPSN: 2.7 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB2721 |
| R810 | 302-0150-00 |  |  | RES., FXD, CMPSN: 15 OHM, 10\%,0.50W | 01121 | Ebi501 |
| R812 | 304-0683-00 |  |  | RES., FXD, CMPSN: 68 K OHM, $10 \%, 1 \mathrm{~W}$ | 01121 | Gb6831 |
| R815 | 308-0685-00 |  |  | RES., FXD, WW: 1.5 OHM, $5 \%$, 1W | 75042 | BW20-18500J |
| R818 | 321-0289-00 |  |  | RES., FXD, FILM: 10 K OHM, 1\%,0,125W | 91637 | MFF1816G10001F |
| R820 | 315-0473-00 |  |  | RES., FXD, CMPSN:47K OHM, 5\%,0.25w | 01121 | CB4735 |
| R822 | 316-0681-00 | B010100 | 8121189 | RES., FXD, CMPSN: 680 OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | C66811 |
| R822 | 315-0681-00 | в121190 |  | RES., FXD, CMPSN: 680 OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB6815 |
| R824 | 316-0822-00 | в010100 | B121189 | RES., FXD, CMPSN: 8.2 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB8221 |
| R824 | 315-0822-00 | B121190 |  | RES., FXD,CMPSN: 8.2 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | C88225 |
| R826 | 315-0101-00 |  |  | RES., FXD, CMPSN: 100 OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB1015 |
| R827 | 315-0242-00 |  |  | RES., FXD, CMPSN: 2.4 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB2425 |
| R830 | 315-0104-00 |  |  | RES., FXD, CMPSN: $100 \mathrm{~K} 0 \mathrm{OH}, 5 \%, 0.25 \mathrm{~W}$ | 01121 | CB1045 |
| R832 | 315-0473-00 |  |  | RES., FXD, CMPSN: 47 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 0121 | CB4735 |
| R834 | 315-0183-00 |  |  | RES.,FXD,CMPSN:18R OHM, 5\%,0.25W | 01121 | CB1835 |
| R841 | 307-0300-00 |  |  | RES., FXD, FILM:150 OHM, 5\%, 10 W | 24546 | FP10 150 онм 5\% |
| R842 | 308-0686-00 |  |  | RES. , FXD, WW: 2.2 OHM, $5 \%, 2 \mathrm{~W}$ | 75042 | EWH-2R200J |
| 8846 | 316-0391-00 | B010100 | 8121189 | RES., FXD, CMPSN: 390 OHM, 10\%, 0.25 W | 01121 | С83911 |
| R846 | 315-0391-00 | B121190 |  | RES., FXD, CMPSN: 390 OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB3915 |
| R847 | 315-0183-00 |  |  | RES.,FXD,CMPSN:18K OHM, $5 \%, 0,25 \mathrm{w}$ | 01121 | CB1835 |


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| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| R850 | 316-0823-00 | B010100 | B121189 | RES.,FXD, CMPSN: 82K OHM, 10\%,0.25w | 01121 | CB8231 |
| R850 | 315-0823-00 | B121190 |  | RES.,FXD, CMPSN:82K OHM, 5\%,0.25W | 01121 | CB8235 |
| R851 | 302-0333-00 |  |  | RES., FXD, CMPSN: 33K OHM, 10\%,0.50W | 01121 | EB3331 |
| R852 | 316-0681-00 | 3010100 | B121189 | RES., FXD, GMPSN: 680 OHM, 10\%, 0.25 W | 01121 | CB6811 |
| R852 | 315-0681-00 | 8121190 |  | RES., FXD, CMPSN: 680 OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB6815 |
| R853 | 315-0103-00 |  |  | RES., FXD, GMPSN: 10 K 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: 6.04 K OHM, $1 \%, 0.125 \mathrm{~W}$ | 91637 | MFF1816G60400F |
| R860 | 308-0686-00 |  |  | RES., FXD, WW: 2.2 OHM, 5\%, 2 W | 75042 | BWH-2R200J |
| R861 | 307-0301-00 |  |  | RES., FXD, FILM: 120 OHM, $5 \%, 10 \mathrm{~W}$ | 24546 | FP10 120 OHM 5\% |
| R863 | 316-0273-00 | B010100 | B121189 | RES.,FXD, GMPSN: 27 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB2731 |
| R863 | 315-0273-00 | B121190 |  | RES., FXD, CMPSN: 27 K OHM, $57,0.25 \mathrm{~W}$ | 01121 | CB2735 |
| 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 | B010100 | B121189 | RES. , FXD, CMPSN: 220 OHM, 10\%, 0.25W | 01121 | CB221] |
| R872 | 315-0221-00 | B121190 |  | RES. , FXD, CMPSN: 220 OHM, 5\%,0.25W | 01121 | CB2215 |
| R873 | 316-0102-00 | B010100 | B121189 | RES., FXD, CMPSN: 1 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB1021 |
| R873 | 315-0102-00 | B121190 |  | RES., FXD, CMPSN: 1 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB1025 |
| R875 | 315-0101-00 |  |  | RES., FXD, CMPSN: 100 OHM , 5\%, 0.25 W | 01121 | CB1015 |
| R877 | 321-0256-00 |  |  | RES., FXD, FILM 4.4 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: 1.24 K OHM, $1 \%, 0.125 \mathrm{~W}$ | 91637 | MFF1816G12400F |
| R880 | 316-0272-00 | B010100 | B121189 | RES., FXD, CMPSN: 2.7 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB272] |
| R880 | 315-0272-00 | B121190 |  | RES., FXD, CMPSN: 2.7R OHM, 5\%,0.25W | 01121 | CB2725 |
| R881 | 315-0562-00 |  |  | RES., FXD, CMPSN: 5.6 K OHM, $5 \%, 0.25 \mathrm{~W}$ | 01121 | CB5625 |
| R883 | 316-0102-00 | B010100 | B121189 | RES., FXD, CMPSN: 1 K OHM, $10 \%, 0.25 \mathrm{~W}$ | 01121 | CB1021 |
| R883 | 315-0102-00 | B121190 |  | RES., FXD, CMPSN:1K OHM, 5\%,0.25W | 01121 | CB1025 |
| R885 | 316-0153-00 | B010100 | B121189 | RES., FXD, CMPSN: 15K OHM, 10\%, 0.25 W | 01121 | CB1531 |
| R885 | 315-0153-00 | B121190 |  | RES., FXD, CMPSN: 15 K OHM, 5\%,0.25W | 01121 | CB1535 |
| R890 | 322-0686-03 |  |  | RES., FXD, FILM: 7.23 K OHM $, 0.25 \%, 0.25 \mathrm{~W}$ | 91637 | MFF1421D72300C |
| R891 | 321-0097-03 |  |  | RES. , FXD, FILM: 100 OHM, $0.25 \%, 0.125 \mathrm{~W}$ | 91637 | MFF1816D100ROC |
| R910 | 315-0331-00 | XB109310 |  | ```RES., FXD,CMPSN: 330 OHM,5%,0.25W (OPTION 7 ONLY)``` | 01121 | CB3315 |
| R911 | 315-0273-00 | Xb 109310 |  | RES.,FXD,CMPSN: 27K OHM,5\%,0.25W (OPTION 7 ONLY) | 01121 | CB2735 |
| R912 | 321-0193-00 | XB109310 |  | ```RES.,FXD,FILM:IK OHM,1%,0.125W (OPTION 7 ONLY)``` | 91637 | MFF1816G10000F |
| $R 915$ | 321-0289-00 | X8109310 |  | ```RES.,FXD,FILM:10K OHM, 1%,0.125W (OPTION 7 ONLY)``` | 91637 | MFFIB16G10001F |
| R916 | 315-0183-00 | XB109310 |  | RES., FXD, CMPSN: 18K OHM,5\%,0.25W (OPTION 7 ONLY) | 01121 | CB1835 |
| R920 | 315-0331-00 | XB109310 |  | RES., FXD, CMPSN: 330 OHM, 5\% , 0.25 W (OPTION 7 ONLY) | 01121 | CB3315 |
| R921 | 315-0273-00 | Xb109310 |  | RES., FXD, GMPSN: 27R OHM, 5\%,0.25W (OPTION 7 ONLY) | 01121 | CB2735 |
| R922 | 321-0193-00 | Xb109310 |  | ```RES.,FXD,FILM:1K OHM,1%,0.125W (OPTION 7 ONLY)``` | 91637 | MFF1816G10000F |
| R925 | 315-0221-00 | XB109310 |  | RES., FXD, CMPSN: 220 OHM, 5\%,0.25W (OPTION 7 ONLY) | 01121 | CB2215 |
| R926 | 321-0290-00 | XB109310 |  | ```RES.,FXD,FILM:10.2K OHM,1%,0.125W (OPTION 7 ONLY)``` | 91637 | MFF1816G10201F |
| R930 | 315-0273-00 | Xb109310 |  | RES., FXD, CMPSN: 27 K OHM, $5 \%, 0.25 \mathrm{~W}$ (OPTION 7 ONLY) | 01121 | CB2735 |


| Ckt No. | Tektronix Part No. | $\begin{array}{ll}\text { Serial/Model No. } \\ \text { Eff } & \text { Dscont }\end{array}$ | Name \& Description | Mfr Code | Mir Part Number |
| :---: | :---: | :---: | :---: | :---: | :---: |
| R931 | 315-0622-00 | XB109310 | RES.,FXD, CMPSN: 6.2K OHM, 5\%,0.25W (OPTION 7 ONLY) | 01121 | CB6225 |
| R932 | 315-0102-00 | XB109310 | RES., FXD, CMPSN: 1K OHM,5\%,0.25W (OPTION 7 ONLY) | 01121 | CB1025 |
| 8933 | 315-0101-00 | XB109310 | ```RES., FXD, CMPSN: 100 OHM,5%,0.25W (OPTION 7 ONLY)``` | 01121 | CB1015 |
| $R 940$ | 315-0331-00 | XB109310 | $\begin{aligned} & \text { RES. FXD, CMPSN: } 330 \text { OHM, } 5 \%, 0.25 \mathrm{~W} \\ & \text { (OPTION } 7 \text { ONLY) } \end{aligned}$ | 01121 | CB3315 |
| R941 | 315-0273-00 | XB109310 | ```RES.,FXD,CMPSN;27K OHM,5%,0.25W (OPTLON 7 ONLY)``` | 01121 | CB2735 |
| R942 | 321-0193-00 | XB109310 | ```RES.,FXD,FILM:IK OHM,1%,0.125W (OPTION 7 ONLY)``` | 91637 | MFF1816G10000F |
| $R 945$ | 321-0289-00 | XB109310 | ```RES., FXD,FILM:1OK OHM, 1%,0.125W (OPTION 7 ONLY)``` | 91637 | MFF1816G10001F |
| R946 | 315-0183-00 | X 8109310 | $\begin{aligned} & \text { RES., FXD, CMPSN: } 18 \mathrm{KK} \text { OHM, } 5 \%, 0.25 \mathrm{~W} \\ & \text { (OPTION } 7 \text { ONLY) } \end{aligned}$ | 01.121 | CB1835 |
| R950 | 315-0331-00 | XB109310 | RES., FXD, CMPSN: 330 OHM,5\%,0.25W (OPTION 7 ONLY) | 01121 | CB3315 |
| R951 | 315-0273-00 | XB109310 | RES.,FXD, CMPSN: 27K OHM,5\%,0.25W (OPTION 7 ONLY) | 01121 | CB2735 |
| R952 | 321-0193-00 | XB109310 | ```RES.,FXD,FILM:1K OHM, 1%,0.125W (OPTION 7 ONLY)``` | 91637 | MFF1816G10000F |
| R955 | 315-0221-00 | XB109310 | ```RES.,FXD,CMPSN: 220 OHM,5%,0.25W (OPTION 7 ONLY)``` | 01121 | CB2215 |
| R956 | 321-0290-00 | XB109310 | $\begin{aligned} & \text { RES., FXD, FLLM: } 10.2 \mathrm{~K} \text { OHM, } 1 \%, 0.125 \mathrm{~W} \\ & \text { (OPTION } 7 \text { ONLY) } \end{aligned}$ | 91637 | MFF1816G10201F |
| R960 | 315-0273-00 | XB109310 | ```RES,,FXD,CMPSN: 27K OHM,5%,0.25W (OPTION }7\mathrm{ ONLY)``` | 01121 | CB2735 |
| R961 | 315-0622-00 | XB109310 | ```RES., FXD,CMPSN:6.2K OHM,5%,0.25W (OPTION 7 ONLY)``` | 01121 | CB6225 |
| R962 | 315-0102-00 | XB109310 | ```RES.,FXD,CMPSN:1K OHM,5%,0.25W (OPTION 7 ONLY)``` | 01121 | CB1025 |
| $R 963$ | 315-0101-00 | XB109310 | RES., FXD, CMPSN: 100 OHM, 5\%, 0.25 W (OPTION 7 ONLY) | 01121 | CB1015 |
| R967 | 315-0331-00 | XB109310 | RES., FXD, CMPSN: 330 OHM, 5\%, 0.25W (OPTION 7 ONLY) | 01121 | CB3315 |
| R968 | 315-0273-00 | XB109310 | ```RES.,FXD,CMPSN:27K OHM,5%,0.25W (OPTION 7 ONLY)``` | 01121 | CB2735 |
| R969 | 321-0193-00 | XB109310 | ```RES.,FXD,FILM:IK OHM,1%,0.125W (OPTION 7 ONLY)``` | 91637 | MFF1816G10000F |
| R970 | 315-0331-00 | XB109310 | ```RES,,FXD, CMPSN: 330 OHM, 5%,0.25W (OPTION 7 ONLY)``` | 01121 | CB3315 |
| R971 | 315-0273-00 | X8109310 | RES., FKD, CMPSN: 27 K OHM, $5 \%, 0,25 \mathrm{~W}$ (OPTION 7 ONLY) | 01121 | CB2735 |
| R972 | 321-0289-00 | XB109310 | $\begin{aligned} & \text { RES., FXD,FILM:1OK OHM, } 1 \%, 0.125 \mathrm{~W} \\ & \text { (OPTION } 7 \text { ONLY) } \end{aligned}$ | 91637 | MFF1816G10001F |
| R973 | 315-0183-00 | XB109310 | RES., FXD, CMPSN: 18K OHM, 5\%,0.25W (OPTION 7 ONLY) | 01121 | CB1835 |
| R974 | 321-0193-00 | XB109310 | RES. , FXD, FILM: 1K OHM, 1\%,0.125W (OPTION 7 ONLY) | 91637 | MFF1816G10000F |
| R975 | 315-0221-00 | XB109310 | RES. , FXD, CMPSN: 220 OHM, 5\%, 0.25W (OPTION 7 ONLY) | 01121 | C82215 |
| R976 | 321-0290-00 | x8109310 | RES., FXD, FILM: 10.2 K OHM, $1 \%, 0.125 \mathrm{~W}$ (OPTION 7 ONLY) | 91637 | MFFIB16G1020IF |
| R980 | 315-0273-00 | XB109310 | RES., FXD,CMPSN: 27 K OHM,5\%,0.25W (OPTION 7 ONLY) | 01121 | CB2735 |


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| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| R981 | 315-0622-00 | XB109310 |  | RES., FXD, CMPSN: 6.2 K OHM, $5 \%, 0.25 \mathrm{~W}$ (OPTION 7 ONLY) | 01121 | CB6225 |
| R982 | 315-0102-00 | XB109310 |  | RES., FXD, CMPSN:1K OHM,5\%,0.25W (OPTION 7 ONLY) | 01121 | CB1025 |
| R983 | 315-0101-00 | XB109310 |  | RES. , FXD, CMPSN: 100 OHM, $5 \%, 0.25 \mathrm{~W}$ (OPTION 7 ONLY) | 01121 | CB1015 |
| R990 | 315-0273-00 | XB109310 |  | RES., FXD, CMPSN: 27 K OHM, $5 \%, 0.25 \mathrm{~W}$ (OPTION 7 ONLY) | 01121 | CB2735 |
| R99] | 315-0222-00 | XB109310 |  | ```RES.,FXD,CMPSN: 2.2K OHM,5%,0,25W (OPTION 7 ONLY)``` | 01121 | CB2225 |
| 5125 | 260-1238-00 | B010100 | B108289 | SWITCH, PUSH:0.5A AT 115VAC | 81073 | 39YY2084 |
| S125 | 311-1961-00 | B108290 |  | RES., VAR, NONWIR: PANEL, 100K OHM, 20\%,0.75W (FURNISHED AS A UNIT WITH R200) | 01121 | $17 \mathrm{MO25}$ |
| 5200 | 260-0227-00 |  |  | SWITCH, THRMSTC: NC, OPEN 73.9,CL 51.7,10 A | 81439 | 36 T 21 S\#3776 |
| S201 | 260-1222-00 |  |  | SWITCH, PUSH-PUL: 10A, 250VAC | 91929 | 2DM301 |
| T240 | 120-0705-01 | B010100 | B049999 | XFMR, PWR, STU: | 80009 | 120-0705-01 |
| T240 | 120-0761-00 | B050000 | B119999 | XFMR, PWR, STU: HV | 80009 | 120-0761-00 |
| T240 | 120-1230-00 | B120000 |  | XFMR, PWR,STU:HIGH VOLTAGE | 80009 | 120-1230-00 |
| 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 |
| U640 | 156-0057-00 |  |  | MICROCIRCUIT, DI: Quad 2-INPUT NAND GATE | 01295 | SN7401N OR J |
| V291 | 154-0633-00 | B010100 | B069999 | ELECTRON TUBE:CRT, P31, int scale | 80009 | 154-0633-00 |
| V291 | 154-0633-05 | B070000 | B103610 | ELECTRON TUBE:CRT, P31, int scale | 80009 | 154-0633-05 |
| V291 | 154-0633-10 | B103611 |  | ELECTRON TUBE:CRT, P31,INT SCALE | 80009 | 154-0633-10 |
| V291 | 154-0633-08 | B010100 | B103610 | ELECTRON TUBE:CRT, P7,INT SCALE (OPTION 76 ONLY) | 80009 | 154-0633-08 |
| V291 | 154-0633-13 | 8103611 |  | ELECTRON TUBE:CRT,P7 <br> (OPTION 76 ONLY) | 80009 | 154-0633-13 |
| V291 | 154-0633-09 | B010100 | B103610 | ELECTRON TUBE:CRT,Pl1,INT SCALE (OPTION 78 ONLY) | 80009 | 154-0633-09 |
| V291 | 154-0633-14 | B103611 |  | ELECTRON TUBE:CRT,P1I (OPTION 78 ONLY) | 80009 | 154-0633-14 |
| VR237 | 152-0283-00 | B010100 | 8119999 | SEMICOND DEVICE:ZENER,0.4W,43V,5\% | 12954 | DZ750903B1N976B |
| VR237 | 152-0284-00 | B120000 |  | SEMICOND DEVICE:ZENER,0.4W, 47V,5\% | 80009 | $152-0284-00$ |
| VR239 | 152-0101-00 | XB120000 |  | SEMICOND DEVICE:ZENER,1W, 75v, $5 \%$ | 04713 | 1N3041B |
| VR258 | 152-0438-00 |  |  | SEMICOND DEVICE:ZENER,3W, 9.1V,5\% | 12969 | UZ1364 |
| vR281 | 152-0357-00 | B010100 | B119999 | SEMICOND DEVICE:ZENER,0.4W, 82V,5\% | 04713 | SZ12461KRL |
| VR28! | 152-0285-00 | B120000 |  | SEMICOND DEVICE:ZENER, $0.4 \mathrm{~W}, 62 \mathrm{~V}, 5 \%$ | 80009 | 152-0285-00 |
| VR282 | 152-0255-00 | B010100 | B119999 | SEMICOND DEVICE:ZENER,0.4W, 51V,5\% | 80009 | 152-0255-00 |
| VR282 | 152-0285-00 | B120000 |  | SEMICOND DEVICE:ZENER,0.4W,62V,5\% | 80009 | 152-0285-00 |
| VR720 | 152-0149-00 |  |  | SEMICOND DEVICE:ZENER,0.4W, 10V,5\% | 80009 | 152-0149-00 |
| VR850 | 152-0357-00 |  |  | SEMICOND DEVICE:ZENER, $0.4 \mathrm{~W}, 82 \mathrm{~V}, 5 \%$ | 04713 | SZ12461KRL |
| VR865 | 152-0243-00 |  |  | SEMICOND DEVICE; ZENER, 0.4W, 15V, 5\% | 14552 | 1 N965s |
| VR870 | 152-0227-00 |  |  | SEMICOND DEVICE:ZENER, $0.4 \mathrm{~W}, 6.2 \mathrm{~F}, 5 \%$ | 04713 | SZ13903 |

## INSTRUMENT OPTIONS

Your instrument may be equipped with one or more options. A brief description of each available option is given in this section.

Conversion kits (cabinet-to-rackmount, rackmount-to-cabinet), for most options, are available and can be installed at a later time. For further information on instrument options, see your Tektronix Catalog or contact your Tektronix Field Office.

## OPTION 2

## PROTECTIVE PANEL COVER

The purpose of OPTION 2 is to provide a protective front-panel cover for bench cabinet models only. The cover protects the front panel and knobs during transportation and storage. The cabinet sides have been modified by the addition of a retaining hook for the protective cover. The Tektronix part number for the cabinet sides are listed in Section 8, Replaceable Mechanical Parts (see the listing for bench cabinet).

## 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. The Tektronix part numbers for the electrical parts are listed in Section 6, Replaceable Electrical Parts.

## OPTION 76

## P7 PHOSPHOR

The purpose of OPTION 76 is to provide a cathode-ray tube with P7 phosphor, which is excellent for long-persistence display requirements. The Tektronix part number for the tube is listed in Section 6, Replaceable Electrical Parts (see V291).

## OPTION 78

## P11 PHOSPHOR

The purpose of OPTION 78 is to provide a cathode-ray tube with P11 phosphor, which is best suited for waveform photography. The Tektronix part number for the tube is listed in Section 6, Replaceable Electrical Parts (see V291).

## 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 $(p F)$. Values less than one are in microfarads ( $\mu \mathrm{F}$ ).
Resistors $=$ Ohms $(\Omega)$.
Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.
Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

Abbreviations are based on ANSI Y1.1-1972.
Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

| Y14.15, 1966 | Drafting Practices. |
| :--- | :--- |
| Y14.2,1973 | Line Conventions and Lettering. |
| Y10.5, 1968 | Letter Symbols for Ouantities Used in Electrical Science and |
|  | Electrical Engineering. |

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

| A | Assembly, separable or repairable (circuit board, etc) | H | Heat dissipating device (hent sink: heat radiator, etc) | $\begin{aligned} & \mathrm{S} \\ & \mathrm{~T} \end{aligned}$ | Switch or contactor Transiormer |
| :---: | :---: | :---: | :---: | :---: | :---: |
| AT | Attemuator, fixed or variabla | HR | Heater | TC | Thermocouple |
| B | Molor | HY | Hybrid circuli | TP | Test point |
| BT | Batiery | J | Connector, stationary portion | U | Assembly, inseparable or non-repairable |
| C | Capacitor, fixed or variable | K | Relay |  | (indegrated circuit, etc.) |
| CB | Circuit breaker | L | Inductor, fixed or variable | $V$ | Electron tube |
| CR | Diode, signal or rectifier | M | Meter | $V R$ | Voltage regulator (zener diode, etc.) |
| DL | Delay line | P | Connector, movable portion | W | Wirestrap or cable |
| DS | Indicating device (lamp) | 0 | Transistar or silican-controlled | Y | Crystal |
| E | Spark Gap, Ferrite bead |  | rectifier | Z | Phase shilter |
| F | Fuse | A | Resistor, fixed or variable |  |  |
| FL | Filter | RT | Th |  |  |

The following special symbols may appear on the diagrams:






## VOLTAGE AND WAVEFORM CONDITIONS

## WARNING

Dangerous potentials exist at several points throughout this instrument. When the instrument is operated with the covers removed, do not touch exposed connections or components. Some transistors have voltages present on their cases. Disconnect the power source before replacing parts.

RECOMMENDED TEST EQUIPMENT

| Item | Specifications | Recommended Type |
| :---: | :---: | :---: |
| Test oscilloscope system | Deflection factor, 1 mV to $50 \mathrm{~V} /$ div; input impedance, 1 megohm; frequency response, dc to 2 MHz . Probe: 10 X attenuation probe compatible with vertical input. | Tektronix 5110, 5A13N, 5B10N oscilloscope system or equiv. Use a Tektronix P6108 or P6062A Probe. |
| Voltmeter (Non-Ioading digital multimeter) | Range, 0 to 250 V ; input impedance, 10 megohms. | Tektronix DM 501 Digital Multimeter with power module. |

## VOLTAGE CONDITIONS

Voltage measurements on this dlagram were made under the following conditions:
An amplifier unit is installed in the left vertical compartment (for power supply loading). INTENSITY control is set fully ccw. Voltmeter common is connected to chassis ground.

## WAVEFORM CONDITIONS

OSCILLOSCOPE UNDER TEST. Install an amplifier unit in the left vertical compartment and a time-base unit in the horizontal compartment. Connect the CALIBRATOR output signal to the amplifier unit (set vertical input coupling to de and volts/div for a 2-division display). Set the time-base unit for internal auto-trigger, $2 \mathbf{m s} /$ division sweep rate.

TEST OSCILLOSCOPE. Set the test oscilloscope triggering for auto mode with ac coupling from the internal source and set vertical input coupling to ac. Connect a $10 \times$ Probe to the vertical input. Position the display as necessary.

## NOTE

The waveforms shown are actual waveform photographs taken with a Tektronix Oscilloscope Camera System and Projected Graticule. Vertical deflection factor shown on the waveform is the actual deflection factor from the probe tip. Voltages and waveforms on the diagrams are not absolute and may vary between instruments because of component tolerances, internal calibration, or front-panel settings. Readouts are simulated in larger-than-normal type.


(5)


8


3


6

(9)

stem and probe tip. mponent



## VOLTAGE AND WAVEFORM CONDITIONS

## WARNING

Dangercus potentials exist at several points throughout this instrument. When the instrument is operated with the covers removed, do not touch expesed connections or components. Some transistors have voltages present on their cases. Disconnect the power source before replacing parts.
fecommended test equipment

| Item | Speclicallona | Fecommended Type |
| :---: | :---: | :---: |
| Test oscilloscope system | Deflection factor, 1 mV to $50 \mathrm{~V} / \mathrm{div}$; input impedance, 1 megohm; frequency response, dc to 2 MHz . Probe: 10x attenuation probe compatible with vertical input. | Tektronix $5110,5 A 13 N, 5 B 10 \mathrm{~N}$ oscilloscope system or equiv. Use a Tektronix P610日 or P6062A Probe. |
| Voltmeter (Non-Ioading digital multimeter) | Range, 0 to 250 V ; input impedance, 10 megohms. | Tektronix DM 501 Digital Multimeter with power module. |

## voltage conditions

Voltage measurements on this diagram were made under the following conditions:
An amplifier unit is installed in the left vertical compartment (for power supply loading). INTENSITY control is set fully cow. Volimeter common is connected to chassis ground.

## WAVEFORM CONDITIONS

OSCILLOSCOPE UNDER TEST. Install an amplifier unit in the left vertical compartment and a time-base unit in the horizontal compartment Connect the CALIBRATOR output signal to the amplifier unit (set vertical input coupling to do and volts/div for a 2 -division diaplay). Sel the time-base unit for internal auto-trigger, $2 \mathrm{~ms} / \mathrm{division}$ sweep rate.

TEST OSCILLOSCOPE. Set the test oscilloscope triggering for suto mode with ac coupling from the internal source and set vertical input coupling to ac. Connect a $10 \times$ Probe to the verical input. Position the display as necessary.

## NOTE

The waveforms shown are actual waveiorm photographs taken with a Tektronix Oscilloscope Camera System and Projected Graticule. Vertical deflection factor shown on the waveform is the actual deflection factor from the probe tip. Voltages and waveforms on the diagrams are not absolute and may vary between instruments because of component folerances, internal calibration, or front-panel settings. Peadouts are simulated in larger-than-normal type.



A2-Single Beam Auxiliary circuít hnard.

| $\begin{aligned} & \text { CKT } \\ & \text { NO } \end{aligned}$ | $\begin{aligned} & \text { GRID } \\ & \text { LOC } \end{aligned}$ | $\begin{aligned} & \text { CKT } \\ & \text { NO } \end{aligned}$ | $\begin{aligned} & \text { GRID } \\ & \text { LOC } \end{aligned}$ |
| :---: | :---: | :---: | :---: |
| C712 | C-1 | 0721 | B-2 |
| c714 $\dagger$ | C-3 | 0722 | C-2 |
| C716 | B-2 |  |  |
| C 721 | C-2 | R 701 | B-3 |
|  |  | R 702 | B-3 |
| CR702 | C-3 | R703 | B-3 |
| CR704 | C-3 | R704 | B-4 |
| CR712 | B-3 | R706 | B-3 |
| CR714 | B-3 | R707 | B-3 |
| CR721 | C-2 | R 709 | B-4 |
| CR722 | C-2 | R710 | B-3' |
|  |  | R712 | C-1 |
| VR720 | C-2 | R 713 | C-1 |
|  |  | R715 | B-1 |
| 0701 | B-3 | R716 | B-2 |
| 0702 | C-3 | R717 | B-2 |
| 0703 | 8-3 | R718 | B-4 |
| 0704 | C-4 | R720 | E-2 |
| 0711 | 日-3 | R721 | C-2 |
| 0712 | C-3 | R722 | B-2 |
| 0713 | 日-4 | R 723 | B-2 |
| 0714 | c-3 | R724 | B-2 |

+Lacated on back of hoard.

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eand
'stem and probe tip. mponent


A2-Single Beam Auxiliary circuit board.

| $\begin{aligned} & \text { CKT } \\ & \text { NO } \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { GRID } \\ & \text { LOC } \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { CKT } \\ & \text { NO } \end{aligned}$ | GRID LOC |
| :---: | :---: | :---: | :---: |
| C712 | C-1 | 0721 | B-2 |
| C714t | c-3 | 0722 | C-2 |
| C716 | B-2 |  |  |
| C721 | C. 2 | A701 | B-3 |
|  |  | R702 | B-3 |
| CR702 | C. 3 | R703 | B-3 |
| CR704 | C-3 | A704 | B-4 |
| CR712 | E-3 | ค706 | B-3 |
| CR714 | E. 3 | R707 | $8 \cdot 3$ |
| CR721 | C-2 | R709 | B-4 |
| CR722 | C-2 | A710 | B-3' |
|  |  | R712 | C-1 |
| VR720 | c. 2 | R713 | C. 1 |
|  |  | R715 | B-1 |
| 0701 | B-3 | R716 | B-2 |
| 0702 | C-3 | R717 | B-2 |
| 0703 | 日-3 | R778 | B-4 |
| 0704 | C-4 | R720 | B-2 |
| 0711 | B-3 | R721 | C-2 |
| 0712 | C-3 | R722 | B-2 |
| 0713 | B-4 | R723 | B-2 |
| 0714 | C-3 | R724 | B. 2 |

$\dagger$ Lacated on back of hoard.



A1-High Voltage-Defilection circuit board ISN E120000 \& above).

| $\begin{aligned} & \hline \text { CKT } \\ & \text { NO } \end{aligned}$ | $\begin{aligned} & \hline \text { GRID } \\ & \hline \text { LOC } \end{aligned}$ | $\begin{array}{\|l\|} \hline \text { CKT } \\ \text { NO } \\ \hline \end{array}$ | GAID <br> LOC | $\begin{aligned} & \text { CKT } \\ & \text { NO } \end{aligned}$ | $\begin{aligned} & \text { GRID } \\ & \text { LOC } \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { CKT } \\ & \text { NO } \\ & \hline \end{aligned}$ | GRID LOC | $\begin{aligned} & \text { CKT } \\ & \text { NO } \end{aligned}$ | GRID LOC | $\begin{aligned} & \hline \text { CKT } \\ & \text { NO } \\ & \hline \end{aligned}$ | $\begin{gathered} \text { GRID } \\ \text { LOG } \end{gathered}$ | $\begin{aligned} & \hline \text { CKT } \\ & \text { NO } \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline \text { GAID } \\ & \text { LOC } \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline \text { CKT } \\ & \text { NO } \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline \text { GRID } \\ & \text { LOC } \end{aligned}$ | $\begin{aligned} & \hline \text { CKT } \\ & \text { NO } \end{aligned}$ | GRID LOC | $\begin{aligned} & \hline \text { CKT } \\ & \text { NO } \end{aligned}$ | GRID LOC | $\begin{aligned} & \hline \text { CKT } \\ & \text { NO } \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { GRID } \\ & \text { LOC } \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline \text { CKT } \\ & \text { NO } \end{aligned}$ | $\begin{aligned} & \text { GRID } \\ & \text { LOC } \\ & \hline \end{aligned}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| C106 | c3 | C254 | H5 | CR226 | 05 | DS271 | G2 | 0134 | E3 | R101 | D4 | R124† | D2 | R203 | C4 | R222 | 05 | R248 | G2 | R272 | G3 | T240 | 13 |  |
| ${ }^{2} 116$ | ${ }^{\text {c3 }}$ | C258 | H5 | CR234 | E4 | -S5272 | G2 | ${ }^{1136}$ | E4 | A102 | 明 | ${ }^{8125}$ | 84 | ${ }^{\text {R2206 }}$ | c4 | ${ }^{\text {R2233 }}$ | 05 | R249 | ${ }_{5} 4$ | ${ }^{\text {R273 }}$ | F2 |  |  |  |
| ${ }^{\text {c } 126}$ | E3 | C259 | ${ }^{14}$ | CA238 | ${ }_{\text {P4 }}$ | DS273 | G2 | ${ }^{\text {Q1394* }}$ | 184 $C 5$ | ${ }^{\text {R103 }}$ | ${ }^{\text {c }}$ | F126 R128 | E3 | ${ }^{\text {R207 }}$ | ${ }_{6} 4$ | ${ }_{\text {P228 }}$ | E5 | R251 R252 | G5 | ${ }^{\text {R2274 }}$ | ${ }^{55}$ | VR237 | ${ }_{54}{ }^{\text {F }}$ |  |
| ${ }^{\text {c12 }}$ | ${ }_{\text {E3 }}$ | ${ }^{\text {c272 }}$ | ${ }_{\text {F5 }}$ | ${ }_{\text {CR2 }}$ | 12 | - 5274 | F2 | ${ }_{022}$ | $\mathrm{CS}_{5}$ | ${ }^{\text {H10 }} 106$ | ${ }^{2}$ | ${ }_{\text {- }}$ | E3 | ${ }_{\text {R209 }}$ | ${ }_{C 4}$ | ${ }_{\text {R }}$ | Es | ${ }_{\text {R254 }}$ | H5 | ${ }_{\text {a }}$ | ${ }_{\text {F4 }}$ | VR239 | ${ }_{14}{ }_{4}$ |  |
| c236 | E5 | C281 | E4 | CR247 | 12 | L259 $\dagger$ | 14 | 0226 | Es | R108 | c3 | ${ }^{\text {R133 }}$ | 04 | *211 | 45 | ${ }^{2} 232$ | E5 | R257+ | 12 | A276 | Fs | VR2a | fa |  |
| ${ }^{\text {c241 }}$ | H3 |  |  | CR253 | ${ }_{4}$ |  |  | ${ }^{0} 234$ | 15 | ${ }_{\text {R }}^{\text {R112 }}$ | ${ }^{C 3}$ | ${ }_{\text {R134 }}$ | E2 | ${ }_{\text {R213 }}$ | 85 | R234 8236 | ${ }_{\text {F4 }}$ | ${ }_{\text {R262 }}$ | G5 | R292\% | ${ }_{\text {F }}^{\text {F }}$ | VR282 | F3 |  |
| (1242 | ${ }_{63}$ | CR211 | $\mathrm{C}_{5}$ | ${ }_{\text {CR256 }}$ | ${ }^{\text {ja }}$ | 8106 | ${ }_{83}$ | ${ }^{265}$ | G5 | -114t | ${ }^{2} 2$ | A136 | E3 | ${ }^{2} 216$ | ${ }_{5}$ | ${ }^{\sim} 240$ | F4 | ${ }^{4} 266$ | 65 | ${ }_{\text {R206 }}$ | E2 |  |  | arts List 1 |
| C249 | F3 | CR214 | C5 | CR262 | G5 | 0114 | $\mathrm{C}_{2}$ | ${ }^{2} 264$ | 95 | ${ }^{\text {R11 }} 16$ | C2 | ${ }^{\text {R138 }}$ | Es | ${ }^{\text {R217 }}$ | ${ }^{4}$ | ${ }^{\text {R2424 }}$ | H4 | ${ }^{1267}$ | G5 | -287 | E4 |  |  | number range |
| C251 | G5 | CA215 | D4 | CR264 | G5 | 0116 | $\mathrm{Ca}^{2}$ | ${ }^{\text {Q278 }}$ | G5 | ${ }^{\text {R112 }}$ | ${ }^{\text {c }}$ | R140* | C5 | ${ }_{\text {R218 }}^{\text {R218 }}$ | ${ }_{C 5}$ | R243 | ${ }_{\text {H2 }}$ | ${ }_{\text {R267 }}$ | F5 |  |  |  |  |  |
| [252 | ${ }_{45}$ | ${ }_{\text {CR222 }}$ | ${ }_{0}{ }^{\text {O }}$ | CR2699 | F5 | $\begin{aligned} & 0124 \\ & 0126\end{aligned}$ | ${ }_{0}^{\mathrm{D} 2}$ |  |  | ( ${ }_{\text {R122 }}$ | 893 | H202 | c5 | R219 | c5 | + ${ }^{\text {R244 }}$ | $\mathrm{H}_{2}$ | ${ }_{\text {H271 }}$ | F5 |  |  |  |  | col boa |

## VOLTAGE AND WAVEFORM CONDITIONS

## WARNING

Dangerous potentials exist at several points throughout this instrument. When the instrument is operated with the covers removed, do not touch exposed connections or components. Some transistors have voltages present on their cases. Disconnect the power source before replacing parts.

RECOMMENDED TEST EQUIPMENT

| Item | Specifications | Recommended Type |
| :---: | :---: | :---: |
| Test oscilloscope system | Deflection factor, 1 mV to $50 \mathrm{~V} /$ div; input impedance, 1 megohm; frequency response, dc to 2 MHz . Probe: 10 X attenuation probe compatible with vertical input. | Tektronix 5110, 5A13N, 5B10N oscilloscope system or equiv. Use a Tektronix P6108 or P6062A Probe. |
| Voltmeter (Non-loading digital multimeter) | Range, 0 to 250 V ; input impedance, 10 megohms. | Tektronix DM 501 Digital Multimeter with power module. |

## VOLTAGE CONDITIONS

Voltage measurements on this diagram were made under the following conditions:
An amplifier unit is installed in the left vertical compartment (for power supply loading). INTENSITY control is set fully ccw. Voltmeter common is connected to chassis ground.

## WAVEFORM CONDITIONS

OSCILLOSCOPE UNDER TEST. Install an amplifier unit in the left vertical compartment and a time-base unit in the horizontal compartment. Connect the CALIBRATOR output signal to the amplifier unit (set vertical input coupling to dc. and volts/div for a 2 -division display). Set the time-base unit for internal auto-trigger, $2 \mathrm{~ms} / \mathrm{division}$ sweep rate.

TEST OSCHLLOSCOPE. Set the test oscilloscope triggering for auto mode with ac coupling from the internal source and set vertical input coupling to ac. Connect a 10 X Probe to the vertical input. Position the display as necessary.

## NOTE

The waveforms shown are actual waveform photographs taken with a Tektronix Oscilloscope Camera System and Projected Graticule. Vertical deflection factor shown on the waveform is the actual deflection factor from the probe tip. Voltages and waveforms on the diagrams are not absolute and may vary between instruments because of component tolerances, internal calibration, or front-panel settings. Readouts are simulated in larger-than-normal type.



## VOLTAGE AND WAVEFORM CONDITIONS

## WARNINE

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RECOMMENDED TEST EQUIPMENT

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| :---: | :---: | :---: |
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| Voltmeter (Non-loading digital multimeter) | Range, 0 to 250 V ; input impedance, 10 megohms. | Tektronix DM 501A Option 02 Digital Multimeter with power module. |

## VOLTAGE CONDITIONS

Voltage measurements on this diagram were made under the following conditions:
An amplifier unit is installed in the left veitical compartment (for power supply loading). INTENSITY control is set fully ccw. Voltmeter common is connected to chassis ground.

## WAVEFORM CONDITIONS

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TEST OSCILLOSCOPE. Set the test oscilloscope triggering for auto mode with ac coupling from the internal source and set vertical input coupling to ac. Connect a 10X Probe to the vertical input. Position the display as necessary.

## NOTE

The waveforms shown are actual waveform photographs taken with a Tektronix Oscilloscope Camera System and Projected Graticule. Vertical deflection factor shown on the waveform is the actual deflection factor from the probe tip. Voltages and waveforms on the diagrams are not absolute and may vary between instruments because of component tolerances, internal calibration, or front-panel settings. Readouts are simulated in larger-than-normal type.



11


## 12



13



5110


A1 - High Voltage-Deflection circuit hoard(SN B050000 to B119999)


| $\begin{aligned} & \text { CKT } \\ & \mathrm{NOT} \end{aligned}$ | $\begin{aligned} & \text { GRID } \\ & \text { LOC } \end{aligned}$ | $\begin{aligned} & \text { CKT } \\ & \text { NO } \end{aligned}$ | GRID LOC | $\left.\right\|_{\mathrm{NKT}} ^{\mathrm{ckt}}$ | $\begin{aligned} & \hline \text { GRID } \\ & \hline \mathbf{L O C} \\ & \hline \end{aligned}$ | $\begin{array}{\|l\|} \mathrm{cKT} \\ \mathrm{NO} \end{array}$ | GFID LOC |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| c106 | 8. 3 | c251 | H-5 | CR209 | E-5 | cR262 | G-5 |
| c115 | A. 2 | c252 | H-6 | CR211 | c-5 | CR264 | G-5 |
| c116 | c. 3 | c253 | 1-5 | CR214 | D-5 | CR269 | F-4 |
| c126 | E.3 | c254 | H-5 | CR215 | D-5 |  |  |
| c136 | E. 3 | C258 | 1.5 | CR224 | F-5 |  |  |
| c.224 | E.5 | c259 | J. 4 | CR239 | F-4 |  |  |
| C227 | E-5 | c272 | G-3 | CR241 | 1.2 |  |  |
| C236 | F-5 | C273 | c-4 | CR247 | 1.2 |  |  |
| c241 | G-3 | c274 | G-3 | CR252 | H-5 |  |  |
| C242 | F.3 | c279 | H-4 | CR253 | H-5 |  |  |
| C248 | H-3 | C281 | F-3 | CR255 | J-4 |  |  |
| C249 | G.3 |  |  | CR256 | H-5 |  |  |


to B1 19999).

| $\begin{aligned} & \text { inID } \\ & \text { oc } \end{aligned}$ | $\begin{aligned} & \text { CKT } \\ & \text { NO } \end{aligned}$ | $\begin{aligned} & \text { GRID } \\ & \text { LOC } \end{aligned}$ | $\begin{aligned} & \text { CKT } \\ & \text { NO } \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline \text { GRID } \\ & \text { LOC } \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { cKт } \\ & \text { NO } \end{aligned}$ | $\begin{aligned} & \text { GRID } \\ & \text { LOCC } \end{aligned}$ | $\begin{array}{\|c} \text { CKT } \\ \text { NO } \end{array}$ | $\begin{gathered} \text { GRID } \\ \text { LOC } \\ \hline \end{gathered}$ | $\begin{aligned} & \text { скт } \\ & \text { No } \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { GRID } \\ & \text { LOC } \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 4 | R124+ | D-2 | R206 | C-5 | R223 | E.5 | R25 | G. 5 | ${ }^{\text {R273 }}$ | 6. 2 |
| -3 | R125 | B. 4 | R207 | C-5 | R226 | F-4 | R252 | H.5 | ${ }^{\text {R274 }}$ | G-4 |
| -4 | H 126 | E-2 | R209 | c.5 | R227 | E.5 | H254 | H.5 | 1275 | ${ }^{\text {d }} 1$ |
| -2 | (128 | D-3 | R209 | D. 5 | ค231 | F. 4 | R2574 | d-2 | ${ }^{1276}$ | H-4 |
| -2 | R 132 | E-3 | R211 | c.5 | R232 | F-5 | R262 | G-5 | R278 | G-5 |
| -3 | H133 | E-4 | R213 | D. 6 | ¢234 | F. 5 | н263 | G-5 | R279 | H.4 |
| - | R134 $\dagger$ | E-2 | R215 | D-5 | п236 | F-4 | R266 | G-5 | R282 | F.3 |
| 4 | R135 | E-3 | R216 | 0.5 | F239 | F-4 | +267 | G.5 | R285 | E-4 |
| -2 | R136 | E-2 | R217 | D-5 | ¢242 | G-4 | R268 | G. 4 | ${ }^{\text {R286 }}$ | E-2 |
| -2 | R138 | E-3 | R218 | D-5 | \%243 | G-2 | -269 | c-4 | R287 | E. 3 |
| -3 | R140 | C-4 | H219 | C. 5 | 7245 | H-2 | H27] | G. 2 | T240 | J-2 |
| $1-3$ | R202 | c-5 | \|R222 | E-5 | п2ая | H.2 | R271 | G.4 |  |  |
| 1.4 | H203 | D-5 |  |  |  |  | н272 | H-3 |  |  |



A1-High Voliage-Defiection cireuit board (SN B049999 \& below).

| $\begin{aligned} & \hline \text { CKTT } \\ & \text { NO } \end{aligned}$ | GRID LOC | $\begin{aligned} & \text { CKT } \\ & \text { NOT } \end{aligned}$ | $\begin{aligned} & \text { GRID } \\ & \text { LOC } \end{aligned}$ | CKT | $\begin{aligned} & \text { GRID } \\ & \text { LOC } \end{aligned}$ | CKT | GRID LOC | ckt | GRID | ${ }_{\text {cki }}^{\text {cko }}$ | $\begin{aligned} & \text { GRID } \\ & \text { LOC } \end{aligned}$ | ckt | $\begin{aligned} & \text { GRID } \\ & \hline \text { LOC } \end{aligned}$ |  | $\begin{aligned} & \text { GRID } \\ & \text { LOC } \end{aligned}$ | N0 ${ }^{\text {ck }}$ | GRID | $\begin{array}{\|c\|c\|} c k T \\ \hline \end{array}$ | GRID | NKT | GHID | N0 ${ }_{\text {ck }}$ | GRID LOC | $\begin{array}{\|c\|} \hline \text { NKT } \end{array}$ | GFID LOC | $\begin{array}{\|c\|c\|} \hline \text { cKT } \end{array}$ | GRID LOC |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| C106 | 8.3 | C251 | H.5 | CR209 | E-5 | CR262 | 6-5 | va237 | E-5 | DS271 | c-2 | 0104 | B-2 | 0252 |  | R101 | D-4 | F122 | - 3 | H202 | c-5 | R222 | E.5 | R251 | -5 | ${ }^{1273}$ | G-2 |
| C115 | A. 2 | C252 | H5 | CR211 | C.5 | CR264 | G-5 | VR258 | ${ }_{1} 5$ | DS272 | G. 2 | 0106 | B. 3 | 0262 | G-5 | R102 | 8. 3 | R123 | D-4 | R203 | D-5 | R223 | E.5 | R252 | H-5 | R274 | F-4 |
| C116 | C-3 | C253 | 1.5 | CP214 | D-5 | CR269 | F.4 | VR281 | F-3 | DS273 | G-2 | 0114 | c-2 | 0264 | G5 | R103 | c. 4 | R124 | D-2 | R206 | c-5 | R227 | E-5 | R25 | ${ }^{\text {H-5 }}$ | 5 | J-1 |
| C126 | E.3 | C254 | H-5 | CR215 | D. 5 |  |  | vR282 | F-3 |  |  | 0116 | c-3 | 0278 | G-4 | R104 | - 2 | R125 | B-4 | R207 | c-5 | R231 | F. 4 | R25 | J-2 | ${ }^{\text {F276 }}$ | H-4 |
| c136 | E-3 | C259 | $1-5$ | CR224 | F-5 |  |  |  |  |  |  | O124 | D-2 |  |  | $R 106$ | c. 2 | F126 | E-2 | R208 | c. 5 | R232 | F-5 | R262 | G. 5 | ${ }^{1278}$ | F-5 |
| C224 | E 5 | C259 | J. | CR239 | F. 4 |  |  |  |  | L259 | 1.4 | 0126 | D. 3 |  |  | R108 | B. 3 | R128 | D. 3 | R211 | C-5 | R234 | F-5 | H26 | G-5 | ${ }^{1279}$ | G 4 |
| C227 | E.5 | C272 | G-3 | CR241 | 1-2 |  |  |  |  |  |  | 0134 | E. 2 |  |  | R112 | c-3 | ${ }^{\text {p1 }} 132$ | E.3 | ${ }^{\text {R } 213}$ | D-5 | R236 | F.4 | ค266 | 6.5 | R292 | F-3 |
| c236 | F-5 | c273 | G-4 | CR247 | 1.2 |  |  |  |  |  |  | ${ }^{1} 136$ | E. 3 |  |  |  | c 4 | ${ }^{\text {P133 }}$ | D.4 | R215 | D. 5 | R239 | F-4 | R267 | G 5 | R285 | E-4 |
| c241 | G-3 | c274 | G-3 | CR252 | н. 5 |  |  |  |  |  |  | 0214 | D. 5 |  |  | R114 | c-2 | R134 | E. 2 | R216 | 0.5 | R242 | F. 4 | R268 | G. 4 | ¢286 | E-2 |
| C242 | F-3 | c279 | $\mathrm{H}^{4}$ | CR253 | H.5 |  |  |  |  |  |  | 0222 | E.5 |  |  | R115 |  | ${ }^{\text {R } 135}$ | E-3 | R217 | -5 | R243 | C-2 | ${ }^{\text {R269 }}$ | G. 4 | -297 |  |
| ${ }_{\text {c }}^{\text {c248 }}$ | ${ }_{\text {H-3 }}$ | c281 | F-3 | CR255 | $\text { J. } 4$ |  |  |  |  |  |  |  |  |  |  |  |  | $\left\lvert\, \begin{gathered} \mathrm{H} 136 \\ \mathrm{R136} \end{gathered}\right.$ | E-3 | H218 | D-5 c-5 | R245 R248 | ${ }_{\text {H-2 }}$ | R271 | C.4 | T240 | J.3 |

REV A JUL 1980

## VOLTAGE AND WAVEFORM CONDITIONS

## WARNING

Dangerous potentials exist at several points throughout this instrument. When the instrument is operated with the covers removed, do not touch exposed connections or components. Some transistors have voltages present on their cases. Disconnect the power source before replacing parts.

RECOMMENDED TEST EQUIPMENT

| Item | Specifications | Recommended Type |
| :---: | :---: | :---: |
| Test oscilloscope system | Deflection factor, 1 mV to $50 \mathrm{~V} / \mathrm{div}$; input impedance, $\uparrow$ megohm; frequency response, dc to 2 MHz . Probe: 10 X attenuation probe compatible with vertical input. | Tektronix 5110, 5A13N, 5B10N oscilloscope system or equiv. Use a Tektronix P6108 or P6062B Probe. |
| Voltmeter (Non-loading digital multimeter) | Fange, 0 to 250 V ; input Impedance, 10 megohms. | Tektronix DM 501A Option 02 Digital Multimeter with power module. |

## VOLTAGE CONDITIONS

Voltage measurements on this diagram were made under the following conditions:
An amplifier unit is installed in the left vertical compartment (for power supply loading). INTENSITY control is set fully ccw. Voltmeter common is connected to chassis ground.

## WAVEFORM CONDITIONS

OSCILLOSCOPE UNDER TEST. Install an amplifier unit in the left vertical compartment and a time-base unit in the horizontal compartment. Connect the CALIBRATOR output signal to the amplifier unit (set vertical input coupling to de and volts/div for a 2-division display). Set the time-base unit for internal auto-trigger, $2 \mathrm{~ms} / \mathrm{division}$ sweep rate.

TEST OSCILLOSCOPE. Set the test oscilloscope triggering for auto mode with ac coupling from the internal source and set vertical input coupling to ac. Connect a $10 \times$ Probe to the vertical input. Position the display as necessary.

## NOTE

The waveforms shown are actual waveform photographs taken with a Tektronix Oscilloscope Camera Systern and Projected Graticule. Vertical deflection factor shown on the waveform is the actual deflection factor from the probe tip. Voltages and waveforms on the diagrams are not absolute and may vary between instruments because of component tolerances, internal calibration, or front-panel settings. Readouts are simulated in larger-than-normal type.


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|  | $\begin{aligned} & \text { 䍖受 } \\ & \text { 罗 } \end{aligned}$ |  |  <br>  |  <br>  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

## VOLTAGE AND WAVEFORM CONDITIONS

## WARNING

Dangerous potentials exist at several points throughout this instrument. When the instrument is operated with the covers removed, do not touch exposed connections or components. Some transistors have voltages present on their cases. Disconnect the power source before replacing parts.

RECOMMENDED TEST EQUIPMENT

| Item | Specilications | Recommended Type |
| :---: | :---: | :---: |
| Test oscilloscope system | Deflection factor, 1 mV to $50 \mathrm{~V} / \mathrm{div}$; input impedance, 1 megohm; frequency response, dc to 2 MHz . Probe: 10 X attenuation probe compatible with vertical input. | Tektronix $5110,5 \mathrm{~A} 13 \mathrm{~N}, 5 \mathrm{~B} 10 \mathrm{~N}$ oscilloscope system or equiv. Use a Tektronix P6108 or P6062A Probe. |
| Voltmeter (Non-loading digital multimeter) | Range, 0 to 250 V ; input impedance, 10 megohms. | Tektronix DM 501 Digital Multimeter with power module. |

## VOLTAGE CONDITIONS

Voltage measurements on this diagram were made under the following conaitions:
An amplifier unit is installed in the left vertical compartment (for power supply loading). INTENSITY control is set fully ccw. Voltmeter common is connected to chassis ground.

## WAVEFORM CONDITIONS

OSCILLOSCOPE UNDER TEST. Install an amplifier unit in the left vertical compartment and a time-base unit in the horizontal compartment.. Connect tine CALIBRATOR output signal to the amplifier unit (set vertical input coupling to dc and volts/div for a 2 -division display). Set the time-base unit for internal auto-trigger, $2 \mathrm{~ms} /$ division sweep rate.

TEST OSCILLOSCOPE. Set the test Oscilloscope triggering for auto mode with ac coupling from the internal source and set vertical input coupling to ac. Connect a 10 X Probe to the vertical input. Position the display as necessary.

## NOTE

The waveforms shown are actual waveform photographs taken with a Tektronix Oscilloscope Camera System and Projected Graticule. Vertical deflection factor shown on the waveform is the actual deflection factor from the probe tip. Voltages and waveforms on the diagrams are not absolute and may vary between instruments because of component tolerances, internal calibration, or front-panel settings. Readouts are simulated in larger-than-normal type.




## VOLTAGE AND WAVEFORM CONDITIONS

## WARNING

Dangerous potentials exist at several points throughout this instrument. When the instrument is operaied with the covers removed, do not touch exposed connections or components. Some transistors have voltages present on their cases. Disconnect the power source before replacing parts.

RECOMMENDED TEST EQUIPMENT

| Item | Specllications | Recommended Type |
| :---: | :---: | :---: |
| Test oscilloscope system | Deflection factor, 1 mV to $50 \mathrm{~V} /$ div; input impedance, 1 megohm; frequency response, dc to 2 MHz . Probe: 10X attenuation probe compatible with vertical input. | Tektronix 5110, 5A13N, 5A18N, 5B10N oscilloscope system or equiv. Use a Tektronix P6108 or P6062B Probe. |
| Voltmeter (Non-Ioading digital multimeter) | Range, 0 to 250 V input impedance, 10 megohms. | Tektronix DM 501 Digital Multimeter with power module. |

## voltage conditions

Voltage measurements on this diagram were made under the following conditions:
An amplifier unit is installed in both vertical compartments. A time-base unit is installed in the horizontal compartment (set for external volts/div). INTENSITY control is set fully cow.
Voltmeter common is connected to chassis ground.

## WAVEFORM CONDITIONS

OSCILLOSCOPE UNDER TEST. Install an amplifier unit in both vertical compartments and a time-base unit in the horizontal compartment. Connect the CALIBRATOR output signal to the amplifier units (set vertical input coupling to dc and volts/div for a 2-division display). Set the time-base unit for internal auto-trigger, $2 \mathrm{~ms} / \mathrm{division}$ sweep rate.
TEST OSCILLOSCOPE. Set the test oscilloscope triggering for auto mode with ac coupling from the internal source and set vertical input coupling to ac. Connect a $10 \times$ Probe to the vertical input. Position the display as necessary.

## NOTE

The waveforms shown are actual waveform photographs taken with a Tektronix Oscilloscope Camera System and Projected Graticule. Vertical deflection factor shown on the waveform is the actual deflection factor from the probe tip. Voltages and waveforms on the diagrams are not absolute and may vary between instruments because of component tolerances, internal calibration, or front-panel settings. Readouts are simulated in larger-thannormal type.


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A5-Signala Out circuit board

| $\begin{aligned} & \text { CKT } \\ & \text { NO } \end{aligned}$ | GRID <br> LOC | $\begin{aligned} & \text { CKT } \\ & \text { NO } \end{aligned}$ | $\begin{aligned} & \text { GRID } \\ & \text { LOC } \end{aligned}$ | $\begin{aligned} & \text { CKT } \\ & \text { NO } \end{aligned}$ | GRID <br> LOC | $\begin{aligned} & \text { CKT } \\ & \text { NO } \end{aligned}$ | GRID <br> LOC |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| C930 | 40 | 0972 | 1 D | R950 | 6B | R991 | 2B |
| C931 | 5 E | 0975 | 20 | R951 | 6 B |  |  |
| C960 | 4 C | 0980 | 2 D | R952 | 58 | P914 | 10 |
| C961 | 5 B | 0.990 | 1 B | R955 | 5 B |  |  |
| C980 | 3E |  |  | R956 | 58 |  |  |
| C981 | 2 C | R9910 | 3E | R960 | 3C |  |  |
|  |  | A911 | $4 E$ | R961 | 58 |  |  |
| CR930 | 3 D | R912 | 4 E | R962 | 5 B |  |  |
| CR960 | 4 C | R915 | 4 E | R963 | 4 C |  |  |
| CR980 | 2 E | R916 | 4 E | R967 | 28 |  |  |
| CR980 | 2 B | A920 | 6 E | R968 | 1C |  |  |
|  |  | R921 | $5 E$ | R969 | 2 C |  |  |
| 0910 | 3E | R 922 | $5 E$ | 月970 | 38 |  |  |
| 0915 | 4E | R925 | 4 E | R971 | 2 C |  |  |
| 0920 | 5 D | R926 | 5 E | ค972 | 2 C |  |  |
| 0925 | $5 F$ | R930 | 30 | R973 | 2 E |  |  |
| 0930 | 40 | R931 | 4 D | R974 | 2 C |  |  |
| C940 | 3 B | R932 | $4 D$ | R975 | $2 E$ |  |  |
| 0945 | 4日 | R933 | 4 D | R976 | 2 C |  |  |
| 0960 | 6 C | R940 | 4A | R980 | $1 E$ |  |  |
| 0965 | 5 A | R941 | 4 A | R981 | 3 C |  |  |
| 0960 | 4 C | R942 | 44 | R982 | 3 C |  |  |
| 0967 | 18 | R945 | 4A | R983 | 2E |  |  |
| 0970 | 2B | H946 | 54 | R990 | 18 |  |  |




# REPLACEABIE 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 SYMEOLS

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 SYSTE゙M

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

```
12345
Name \& Description
```

Assembly and/or Component
Attaching parts tor Assembly and/or Component
...*...
Detall Part of Assembly and/or Component Attaching parts for Detail Part

$$
\text { - . } \cdot \text {. }
$$

Parts of Detail Part
Aftaching parts for Parts of Detail Part

$$
\ldots
$$

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 specifled.

## ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an them Name may sometimes appear as incomplete. For further ftem Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

## ABBREVIATIONS

| \% | INCH | ELCTAN | ELECTRON | IN | 1 NCH | SE | SINGLE END |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 生 | NuMber Size | ELEC | ELECTRICAL | INGAND | INCANDESCENT | SECT | SECTION |
| ACTR | ACTUATOR | ELCTLT | ELECTROLYTIC | iNSUL | INSULATOA | SEMICOND | SEMICONDUCTOA |
| ADPTA | ADAPTER | ELEM | ELEMENT | 1 NTL | INTERNAL | SHLD | SHIELD |
| ALIGN | ALIGNMENT | EPL | ELECTRICAL PARTS LIST | LPHLDA | LAMPHDLDER | SHLDA | SHOULDEFED |
| AL | ALUMINUM | EQPT | EQUIPMENT | MACH | MACHINE | SKT | SOCKET |
| ASSEM | ASSEMBLED | EXT | EXTERNAL | MECH | MECHANICAL | SL | St.IDE |
| ASSY | ASSEMELY | FIL | Filtister head | MTG | MOUNTING | SLFLKG | SELF-LOCKING |
| ATTEN | ATTENUATOF | FLEX | FLEXIBLE | NIP | NIPPLE | sLVG | SLEEVING |
| AWG | AMERICAN WIRE GAGE | FLH | FIAT HEAD | NON WIRE | NOT WIRE WOUND | SPA | SPRING |
| 80 | BCARD | FLTA | FIt.TER | OBD | ORDER BY DESCRIPTION | 50 | SQUARE |
| ERKT | BRACKET | FR | FRAME or FRONT | 0 O | OUTSIDE DIAMETER | SST | STAINLESS STEEL |
| ERS | BRASS | FSTNA | FASTENEA | 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 | CAPACITOA | HDL | HANDLE | PN | PART NUMEEA | THD | THPEA[ |
| 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 | PECEPTACLE | TPG | TAPPING |
| COMP | COMPOSITION | HLCPS | HELICAL COMPRESSION | RES | RESISTOA | TRH | TRUSS HEAD |
| CONN | CONNECTOR | HLEXT | HELICAL EXTENSION | RGD | RIGID | $V$ | voltage |
| cov | COVER | Hv | HIGH VOLTAGE | RLF | RELIEF | VAA | Variable |
| CPLG | COUPLING | 16 | INTEGRATED CIRCUIT | RTNR | RETAINER | W/ | WITH |
| CRT | CATHODE RAY TUEE | 10 | Insicde diameter | SCH | SOCKET HEAD | WShR | WASHER |
| DEG | degree | IDENT | IDENTIFICATION | SCOPE | OSCILIOSCOPE | XFMR | TRANSFORMER |
| DWR | DRAWER | INPLR | IMPELLER | SCR | SCREW | XSTA | TAANSISTOR |

## CROSS INDEX—MFR. CODE NUMBER TO MANLIFACTURER

| Mfr. Code | Manufacturer | Address | City, State, Zip |
| :---: | :---: | :---: | :---: |
| 000CY | NORTHWEST FASTENER SALES, INC. | 7923 sw CIRRUS DRIVE | BEAVERTON, OREGON 97005 |
| 00779 | AMP, INC. | P 0 BOX 3608 | HARRISBURG, PA 17105 |
| 05820 | WAKEFIELD ENGINEERING, INC. | AUDUBON ROAD | WAREFIELD, MA 01880 |
| 06666 | GENERAL DEVICES CO., INC. | 525 S. WEBSTER AVE. | INDIANAPOLIS, IN 46219 |
| 08261 | SPECTRA-STRIP CORP. | 7100 LAMPSON AVE. | GARDEN GROVE, CA 92642 |
| 12136 | PHILADELPHIA HANDLE COMPANY, INC. | 1643 HadDon Avenue | CAMDEN, NJ 08103 |
| 12327 | FREEWAY CORPORATION | 9301 ALLEN DRIVE | CLEVELAND, OH 44125 |
| 12697 | CLAROSTAT MFG. CO., INC. | LOWER WASHLNGTON STREET | DOVER, NH 03820 |
| 13511 | AMPHENOL CARDRE DIV., BUNKER RAMO CORP. |  | LOS GATOS, CA 95030 |
| 16428 | BElden corp. | P. O. BOX 1331 | R1CHMOND, IN 47374 |
| 22526 | berg electronics, inc. | YOUK EXPRESSWAY | NEW CUMBERLAND, PA 17070 |
| 23880 | STANFORD APPLIED ENGINEERING, INC. | 340 Martin ave. | SANTA CLARA, CA 95050 |
| 24618 | TRANSCON MFG. CO . | 2655 PERTH ST. | DALLAS, TX 75220 |
| 28520 | HE YMAN MFG. CO. | 147 N. MICHIGAN AVE. | KENILWORTH, NJ 07033 |
| 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 |
| 55210 | GETTIG ENG. AND MFG. COMPANY | PO BOX 85, OFF ROUTE 45 | SPRING MILLS, PA 16875 |
| 57771 | STIMPSON, EDWIN B., CO., INC, | 900 sylvan avenue | BAYPORT, FY 11705 |
| 70318 | ALlMETAL SCREW PRODUCTS CO., INC. | 821 STEWART AVE. | GARDEN CITY, NY 11530 |
| 70485 | ATLANTIC INDIA RUBBER WORKS, INC. | 571 W. POLK ST. | CHICAGO, IL 60607 |
| 71785 | TRW, GINCH CONNECTORS | 1501 MORSE AVENUE | ELK GROVE VILLAGE, Il 60007 |
| 73743 | FISCHER SPECIAL MFG. CO . | 446 MORGAN ST. | CINCINNATI, OH 45206 |
| 73803 | TEXAS INSTRUMENTS, INC., METALLURGICAL Materials div. | 34 FOREST STREET | ATTLEBORO, MA 02703 |
| 74921 | ITEN FIBRE CO., | 4001 BENEFIT AVE., P O BOX 9 | ASHTABCLA, OH 44004 |
| 75915 | LITTELFUSE, INC. | 800 E. NORTHWEST HWY | des PLAINES, IL 60016 |
| 77250 | PHEOLL MANUFACTURING CO., DIVISION OF ALIIED 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 |
| 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 |
| 80710 | AlLEGHENY LUDLUM STEEL CORP., A DIVISION OF ALLEGHENY LUDLUM INDUSTRIES, INC. | BRaCKENRIDGE WORKS, RIVER AVE. | BRACKENRIDGE, PA 15014 |
| 83385 | CENTRAL SCREW CO. | 2530 CRESCENI DR. | BROADVIEW, IL 60153 |
| 86445 | PENN FIBRE AND SPECIALTY CO., INC. | 2032 E. WESTMORELAND ST. | PHILADELPHLA, PA 19134 |
| 86928 | SEASTROM MFG, COMPANY, INC. | 701 SONORA AVENUE | GLENDALE, CA 91201 |
| 90484 | ITT, SURPRENANT DIV. | 172 STERLING STREET | CLINTON, MA 01510 |
| 91886 | MALCO A MICRODOT CO. | 12 PROGRESS DRIVE | MONTGOMERYVILLE, PA 18936 |
| 93907 | CAMCAR SCREW AND MFG. CO. | 600 18TH AVE. | ROCKFORD, IL 61101 |

Fig. \&

| Index | Tektronix | Serial/Model No. |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| No. | Part No. | Eff | Dscont | Oty | 12345 | Name \& Description | Code |


| 1-1 | ----- ----- |  | 1 | CKT board assy: Single beam aux (see ar epl) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| -2 | 200-1218-00 |  | I | RTNR,CRT SCALE:6.814 X 5.125,NYLON <br> (ATTACHING PARTS) | 80009 | 200-1218-00 |
| -3 | 211-0188-00 | 2 SCREW, MACHINE:4-40 ${ }^{\text {P }} 0.30$ INCH, SST |  |  | 83385 | OBD |
| -4 | 354-0233-00 | B010100 B072526x | 2 | RING,RETAINING: 0.100 ID X 0.203 INCH OD | 79136 | 5133-14PP |
| -5 | 337-1440-00 | B010100 B104588 | 1 | SHLD, IMPLOSION: | 80009 | 337-1440-00 |
|  | 337-1440-00 |  | 1 | SHLD, IMPLOSION: | 80009 | 337-1440-00 |
|  |  |  | - | (OPTION 76 INSTRLPENTS ONLY) |  |  |
|  | 337-1440-01 | B104589 | 1 | SHLD, IMPLOSION: GREEN | 80009 | 337-1440-01 |
|  |  |  | - | (OPTION 76 INSTRUMENTS ONLY) |  |  |
| -6 | 386-1946-00 |  | , | SUPPORT, CRT: FRONT | 80009 | 386-1946-00 |
| -7 | 348-0279-00 |  | 2 | PAD, CUSHIONING:G (CUT TO FIT) | 80009 | 348-0279-00 |
| -8 | 348-0070-01 |  | 3 | PAD,CUSHIONING:0.69 INCH, RUBBER | 80009 | 348-0070-01 |
| -9 | 348-0145-00 |  | 2 | GROMMET, PLASTIC:U-SHP, 1.0 X 0.42 INCH | 80009 | 348-0145-00 |
| -10 | 334-1379-00 |  | , | LABEL:CRT, ADHESIVE BACK | 80009 | 334-1379-00 |
| -11 | 337-1419-00 | B010100 B069999 | 1 | SHIELD, GRT: | 80009 | 337-1419-00 |
|  | 337-1419-05 | B070000 | , | SHIELD SECT, CRT: | 80009 | 337-1419-05 |
| -12 | 337-1420-00 |  | 1 | SHIELD SECT, CRT: | 80710 | 337-1420-00 |
| -13 | 354-0409-00 | (ATTACHING PARTS) |  |  |  |  |
| -14 | 211-0632-00 |  | 1 | SCREW, MACHINE: 6-32X2. 250 INCH, FILH, STL | 83385 | OBD |
| -15 | 343-0123-01 |  | 2 | CLAMP, RET., ELEC:CRT, REAR | 80009 | 343-0123-01 |
| -16 | 220-0444-00 |  | 1 | NUT, PLAIN, SQ:6-32 X 0.250 INCH, STL | 70318 | OBD |
| -17 | 211-0507-00 |  | 2 | SCREW,MACHINE:6-32 X 0.312 INCH, PNH STL | 83385 | OBD |
| -18 | 407-0922-00 |  | 1 | BRACKET,CRT CLP: ALUMINUM | 80009 | 407-0922-00 |
| -19 | 384-1064-00 |  | 1 | KNOB: $10.185 \mathrm{~L} X 0.1250 \mathrm{O}, 5-40 \mathrm{THD}$ | 80009 | 384-1064-00 |
| -20 | 119-0238-00 | B010100 B090724 | 1 | COIL, CAL : | 80009 | 119-0238-00 |
|  | 119-0373-00 | B090725 | 1 | COIL, CAL : | 80009 | 119-0373-00 |
|  |  | (ATTACHING Parts) |  |  |  |  |
|  | 210-0442-00 |  | 2 | NUT, PLALN, $\mathrm{HEX}$. : $3-48 \times 0.187$ INCH, CD PL BRS | 73743 | 3014-402 |
|  | 210-0004-00 |  | 2 | WASHER, LOCK: 44 INTL, $0.015 \mathrm{THK}, \mathrm{STL}$ CD PL | 78189 | 1204-00-00-0541C |
|  | 210-0994-00 |  | 2 | WASHER, Fl,AT: 0.125 ID X $0.25^{\prime \prime}$ OD, S'TL | 86928 | 5714-147-20N |
|  | 210-0935-00 |  | 2 | WASHER, NONMETAL: FIBER, 0.14 IDX 0.375'OD | 74921 | OBD |
| -21 | 361-0059-01 |  | 1 | INSULATOR, PLATE: $1.093 \times 0.343 \times 0.125$ 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 00 | 80009 | 358-0216-00 |
| -24 | 366-0494-00 | B0:10100 B108289 | 1 | KNOB:GRAY WITH SETSCREW | 80009 | 366-0494-00 |
|  | 366-1059-00 | B108290 | 1 | PUSH BUTTON:GRAY | 80009 | 366-1059-00 |
|  | 366-1077-00 | XB108290 | 1 | KNOB: GRAY | 80009 | 366-1077-00 |
|  | 213-0153-00 |  | 1 | . SETSCREW:5-40 X 0.125,STL BK OXD, HEX | 000cy | OBD |
| -25 | 366-0494-00 |  | 1 | KNOB:GRAY WITH SETSCREW | 80009 | 366-0494-00 |
|  | 213-0153-00 |  | 1 | . SETSCREW:5-40 X 0.125, STL BK OXD, HEX | 000cy | OBD |
| -26 | 131-0955-00 | (ATTACEING PARTS) |  |  |  |  |
| -27 | 210-0255-00 |  | 1 | TERMINAL,LUG:0.391" ID INT TOOTH | 80009 | 210-0255-00 |
| -28 | ---------- |  | 1 | SWITCH, PUSH: (SEE S125 EPL) |  |  |
| -29 | - ------ |  | 2 | RESISTOR,VAR: (SEE R200 AND R295 EPL) (ATTACHING PARTS) |  |  |
| -30 | 210-0583-00 |  | 2 | NUT, PLAIN, HEX. $00.25-32 \times 0.312$ INCH, BRS | 73743 | 2X20317-402 |
| -31 | 210-0940-00 |  | 2 | WASHER, FLAT:0.25 ID X 0.375 INCH OD, STL | 79807 | OBD |
| -32 | 210-0046-00 |  | 2 | WASHER, LOCK: 0.261 ID, INTL, 0.018 THK, BRS | 78189 | 1214-05-00-0541C |
| -33 | 200-0608-00 |  | 1 | COVER, VAR RES.:PLASTIC | 80009 | 200-0608-00 |
| -34 | 333-1409-00 | B010100 B099999 | I | PANEL, FRONT: | 80009 | 333-1409-00 |
|  | 333-1409-01 | B100000 BI08289 | I | PANEL, FRONT: | 80009 | 333-1409-01 |
|  | 333-1409-03 | B108290 | 1 | PANEL, FRONT: | 80009 | 333-1409-03 |
| -35 | 337-1421-00 |  | (ATTACHING PARTS) |  | 80009 | 337-1421-00 |
| -36 | 211-0504-00 |  | 3 | SCREW, MACHINE:6-32 x 0.25 INCH, PNH STL | 83385 | OBD |

Fig. \&

| Index No. | Tektronix Part No. | Serial/Model No. Eff Dscont | Qty | 12345 Name \& Description | Mfr Code | Mfr Part Number |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1-37 | 348-0115-00 |  | 3 | GROMMET, PLASTIC: U-SHP, $0.548 \mathrm{x0.462}$ INCH | 80009 | 348-0115-00 |
| -38 | 407-0896-00 |  | 1 | bracket, CHASSIS: ALUMINUM (attaching parts) | 80009 | 407-0896-00 |
| -39 | 211-0541-00 |  | 1 | SCREW,MACHINE:6-32 X 0.25 " 100 DEG, FLH STL | 83385 | OBD |
| -40 |  | ${ }_{\text {B010100 }} \mathbf{8 0 9 1 6 1 6}$ | 1 | SWITCH, PUSH-PUL: (SEE S201 EPL) |  |  |
|  | 407-0895-00 |  | 1 |  |  |  |
|  | 407-0895-01 |  | 1 | BRACKET, ELEC SW: ALUMINUM | 80009 | 407-0895-01 |
| -41 | 376-0127-00 |  | 1 | COUPLER, SHAFT: PLASTIC | 80009 | 376-0127-00 |
| -42 | - --- | (ATTACHING PARTS) |  |  |  |  |
| -43 | 358-0029-00 |  | 1 | BSHG, MACH. THD: HEX, $0.375-32 \times 0.438$ "LONG | 80009 | 358-0029-00 |
| -44 | 210-0978-00 |  | 1 | WASHER, FLAT: 0.375 ID X 0.50 INCH OD, STL | 78471 | ORD |
| -45 | 210-0421-00 |  | 1 | NUT, PLAIN, HEX. $00.375-32 \times 0.50$ INCH, AL | 80009 | 210-0421-00 |
| -46 | 210-0012-00 |  | 2 | WASHER, LOCK: INTL, 0.375 ID x 0.50 " OD STL | 78189 | 1220-02-00-0541C |
| -47 | 210-0207-00 |  | 1 | TERMINAL, LUG: 0.375 INCH DtAMETER | 12697 | 01136902 |
| -48 | 200-1204-01 | cover, crt: rear aluminum, Pid blue <br> (ATTACHING PARTS) |  |  |  |  |
| -49 | 210-0401-00 |  | 2 | NUT, PLAIN, heX. : 6-32 X 0.312 INCH, CD PLATED | 73743 | 93262-02 |
|  | 006-0531-00 | xB108068 | 1 | Strap, TIEdown, E: blue plastic beaded | 24618 | 700-3688 |
| -50 | 161-0033-08 |  | 1 | CABLE ASSY, PWR, : | 16428 | OBD |
| -51 | 358-0366-00 |  | 1 | bShG, Strain rlf : | 80009 | 358-0366-00 |
|  | 358-0365-00 |  | 1 | bSHG, STRAIN RLF: | 80009 | 358-0365-00 |
| -52 | 200-1004-00 |  | 1 | CABLE, NIP., ELEC: 0.265 ID x 0.38"OD W/FLG | 80009 | 200-1004-00 |
| -53 | 352-0076-00 | ${ }_{\text {B01010 }} \mathrm{B0105882}$ B0105881 | 1 | FUSEHOLDER: W/HARDWARE | 75915 | 342012-L |
|  | 352-0362-00 | (attaching parts) |  |  |  |  |
| -54 | 210-0873-00 |  | 1 | WASHER, NONMETAL:0.5 ID X 0.688 INCH OD, NPRN | 70485 | OBD |
| -55 | 210-0201-00 | B010100 B106650 | 1 | terminal, LUG: SE \# ${ }^{\text {a }}$ | 86928 | A373-157-2 |
|  | 210-0202-00 | B106651 | 1 | TERMINAL, LUG:0.146 ID, LOCKING, BRZ TINNED (attaching parts) | 78189 | 2104-06-00-2520N |
| -56 | 210-0586-00 | B106650 | 1 |  | 83385 | 211-041800-00 |
|  | 210-0457-00 | B106651 | 1 | NUT, PL, ASSEM WA: $6-32 \times 0.312 \mathrm{INCH}, \mathrm{STL}$ | 83385 | OBD |
| -57 | 333-1429-00 | 8010100 B099999 | 1 | panel, rear: | 80009 | 333-1429-00 |
|  | 333-1429-01 | B109889 | 1 | PANEL, Rear : | 80009 | 333-1429-01 |
|  | 333-1429-02 |  | 1 | Panel, rear: | 80009 | 333-1429-02 |
|  | 334-2154-01 | XB122930 | 1 | MARKER, IDENT:MKD CAUTION | 80009 | 334-2154-01 |
| -58 | 441-0991-00 | B010100 B107632 | 1 | CHAS, dSPl Unit:main | 80009 | 441-0991-00 |
|  | 441-0991-02 | B107633 B119999 | 1 | CHAS, DSPL UNIT:MAIN | 80009 | 441-0991-02 |
|  | 441-0991-03 | B120000 | 1 | Chas, dSPl Unit: Main | 80009 | 441-0991-03 |
|  | 407-2270-00 | XB120000 | (attaching parts) |  |  |  |
|  | 211-0504-00 | xB120000 | 3 | SCREW, MACHINE: $6-32 \times 0.25$ Inch, PNA STL | 83385 | OBD |
|  | 210-0005-00 | XB120000 | 1 | WASHER, LOCK: EXT \#\#6 | 78189 | 1106-00 |
|  | 210-04.57-00 | XB120000 | 2 | NUT, PL, ASSEM WA:6-32 x 0.312 INCH, STL | 83385 | OBD |
| -60 | 210-0659-01 |  | 4 | . Eyelet, metallic:0.121 od x 0.156 inch long | 80009 | 210-0659-01 |
|  | 344-0131-00 | (attaching parts for chassis) |  |  |  |  |
| -61 | 211-0504-00 |  | 2 | SCREW, MACHINE:6-32 $\times 0.25$ INCH, PNH STL | 83385 | OBD |
| -62 | 211-0538-00 |  | 2 | SCREW,MACHINE:6-32 $\times 0.312^{\prime \prime} 100 \mathrm{DEG}, \mathrm{FLH}$ STL | 83385 | OBD |
|  | 210-0457-00 |  | 2 | NUT, PL, ASSEM WA: $6-32 \times 0.312$ INCH, STL - - * - - | 83385 | OBD |
| -64 | -- ----- |  | 1 | SWITCH, THERMOSTATLC:(SEE S200 EPL) <br> (ATTACHING PaRTS) |  |  |
| -65 | 210-0586-00 |  | 2 | Clip, cable: $-\ldots *$ | 83385 | 211-041800-00 |
| -66 | 344-0225-00 |  | 2 |  | 80009 | 344-0225-00 |
| -67 | 348-0067-00 | B010100 B104185 | 1 | GROMMET, PLASTIC:0.312 INCH DIA | 80009 | 348-0067-00 |
|  | 348-0516-00 | B104186 | 1 | GROMMET, PLASTIC: BLACK, ROUND, 0.188 Id | 28520 | SB312-3 |

Fig. \&


Fig. \&

| Index No. | Tektronix Part No. | Serial/Model No. Eff Dscont | Qty | 12345 Name \& Description | Mfr Code | Mir Part Number |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $1-$ | 198-2028-00 | B010100 B108289 | 1 | WIRE SET, ELEC: | 80009 | 198-2028-00 |
|  | 198-3879-00 | B108290 B119999 | 1 | WIRE SET, ELEC: | 80009 | 198-3879-00 |
|  | 198-3879-01 | B120000 | 1 | WIRE SET, ELEC: | 80009 | 198-3879-01 |
|  | 131-0677-00 |  | 2 | - CONNECTOR, TERM:18 AWG | 91886 | 122-0192-019 |
|  | 131-0621-00 |  | 2 | - CONNECTOR, TERM: 22-26 AWG, BRSE CU BE GOLD | 22526 | 46231 |
|  | 131-0707-00 |  | 2 | . CONNECTOR, TERM + :22-26 AWG, BRS\& CU BE GOLD | 22526 | 47439 |
|  | 131-2065-00 |  | 3 | - TERM, QIK DISC:18-22 AWG, BRASS TIN PLATED | 00779 | 2-350799-2 |
|  | 175-0828-00 |  | FT | - WIRE, ELECTRICAL:5 WIRE RIbBon | 08261 | SS-0526-710610c |
|  | 175-0863-00 |  | FT | - Wire, electrical: 2 WIRE RIbBON | 08261 | S\$-0222-1910610c |
|  | 175-1020-00 |  | FT | - CABLE, RF:50 OHM COAX, WHT POLYTHN JKT | 90484 | DAB70JAAAWHITE |
|  | 352-0161-00 |  | 1 | - HLDR, TERM CONN: 3 WIRE BLACK | 80009 | 352-0161-00 |
|  | 352-0198-00 |  | 1 | - HLDR, TERM CONN: 2 WIRE BLACK | 80009 | 352-0198-00 |
|  | 198-2752-00 | B010100 B104832 | 1 | WIRE SET, ELEC: | 80009 | 198-2752-00 |
|  | 198-2752-01 | B014833 | 1 | WIRE SET, El, EC: | 80009 | 198-2752-01 |
|  | 131-0621-00 |  | 18 | - CONNEGTOR, TERM:22-26 AWG, BRSE CU BE GOLD | 22526 | 46231 |
|  | 175-0855-00 |  | FT | - WIRE, Electrical: 10 WIRE RIbBon | 08261 | SS-1022(1061)0C |
|  | 175-0859-00 |  | FT | - WIRE, ELECTRICAL: 6 WIRE RIBBON | 08261 | Ss-0622-1910610c |
|  | 175-0863-00 |  | FT | - WIRE, ELECTRICAL: 2 WIRe Ribbon | 08261 | SS-0222-1910610C |
|  | 352-0198-00 |  | 1 | - HLDR, TERM CONN: 2 WIRE BLACK | 80009 | 352-0198-00 |
|  | 352-0204-00 |  | 1 | - CONN BODY, PL, EL: 8 WIRE BLACK | 80009 | 352-0204-00 |
|  | 352-0206-00 |  | 1 | - HLDR, TERM CONN: 10 WIRE BLACK | 80009 | 352-0206-00 |


fig. 2 mainframe





Fig. \&





5110 OSCILLOSCOPE


Fig. \&


## ACCESSORIES

Fig．\＆


## 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 chenge 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 rellability 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 Yektronix 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.

|  |
| :--- |
| DM 501 replaces 7D13 Comparison of Main Characteristics |


| DM 501 replaces 7D13 |  |  |
| :---: | :---: | :---: |
| PG 501 replaces 107 | PG 501-Risetime less than |  |
|  | 3.5 ns into $50 \Omega$. | 107 - Risetime less than |
| 3.0 ns into $50 \Omega$. |  |  |
|  | PG 501-5 V output pulse; | 3.5 ns Risetime |



NOTE: All Th 500 generator outputs are short-proof. All This 500 plug-in Instruments require TM 500-Serles Power Module. REV B, JUN 1978


[^0]:    ${ }^{\text {a }}$ If excessive nolse and chop breakthrough occur, refer to Modifications To Pre-Option 7 Amplifler Plug-Ins in Section 4 Malntenance.

[^1]:    'Two dual-trace amplifiers are required to check vertical alternate and chop operation. Two identical amplitiers are required to check $x-y$ phase difference.
    ${ }^{2}$ Requires a TM 500-series power module.

[^2]:    ${ }^{1}$ Two identical amplifiers are required to adjust $x-y$ phase difference.
    ${ }^{2}$ Requires a TM 500-series power module.
    ${ }^{3}$ A high-voltage probe can be used with the DM 501 Digital Multimeter In lieu of the DC voltmeter. See the Tektronlx Catalog for a list ol DM 501 optional accessorles.

