

TEKTRONIX®

5A13N

**DIFFERENTIAL
COMPARATOR**

INSTRUCTION MANUAL

Tektronix, Inc.
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Serial Number _____



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5A13N Differential Comparator

SECTION 1

OPERATING INSTRUCTIONS

5A13N General Description

The 5A13N Differential Comparator operates with a Tektronix 5100-series Oscilloscope. It may be used as a differential amplifier or a conventional amplifier, in addition to its use as a comparator.

As a differential comparator (observation and measurement of a signal by comparison against a calibrated internal DC source), the 5A13N has an effective offset range of 10,000 divisions. As a differential amplifier, the dynamic range allows common-mode signals up to +10 or -10 volts to be applied to the unit without attenuation. Common-mode rejection ratio of at least 10,000:1 at DC to 10 kHz permits measurements of differential signals less than 1 mV in amplitude on 1-volt common-mode signals.

The electrical characteristics given at the end of this section apply over an ambient (room) temperature range of 0°C to +50°C (+32°F to +122°F). Refer to the 5100-series Oscilloscope System manual for environmental characteristics.

PLUG-IN INSERTION AND REMOVAL

The 5A13N is calibrated and ready for use as it is received. It can be installed in any compartment of the 5100-series Oscilloscope, but it is intended for use primarily in vertical compartments (the center and left compartments). For X-Y operation, the 5A13N may also be installed in the horizontal (right) compartment (refer to the 5100-series Oscilloscope System manual for information on X-Y operation).

NOTE

If the oscilloscope system receives no DISPLAY ON logic levels from the vertical plug-ins, it is designed to display the unit in the left compartment.

To install, align the upper and lower rails of the 5A13N with the plug-in compartment tracks and fully insert it (the plug-in panel must be flush with the oscilloscope panel). To remove, pull the release latch to disengage the 5A13N from the oscilloscope.

CONTROLS AND CONNECTORS

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

DISPLAY ON	Applies and removes logic levels to the oscilloscope system to enable or disable plug-in operation. Switch is functional only when plug-in is operated in one of the vertical plug-in compartments.
POSITION	Positions display.
ZERO V_C REF	Internally disconnects both input connectors and applies ground to both amplifier inputs.
COMPARISON VOLTAGE (V_C)	Controls: Selects a comparison voltage at any point between zero and 1 or zero and 10 volts. Polarity Selector: Selects polarity (+ or -) of comparison voltage. Range Selector: Button pushed in selects zero to 10-volt range; button out selects zero to 1-volt range.
VOLTS/DIV	Selects calibrated deflection factor (volts per major graticule division) in a 1-2-5 sequence, from 1 mV/Div to 5 V/Div in 12 steps. Knob skirt is illuminated to indicate deflection factor, and X10 scaling of readout is provided automatically when a 10X coded probe is used.
Variable Volts/Div	Provides uncalibrated, continuously variable deflection factor between calibrated steps; extends range to 12.5 V/Div.
STEP ATTEN BAL	Balances the input amplifier for minimum trace shift throughout the deflection factor gain-switching range.

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BANDWIDTH LIMIT Allows reduction of the upper bandwidth limit to increase the signal-to-noise ratio for low-frequency applications. Selects upper bandwidth limit at either 2 MHz (button out) or 10 kHz (button in).

Input Coupling Pushbuttons AC-DC: Button pushed in selects capacitive coupling of signal applied to associated input connector; button out selects direct coupling of input signal.

GND: Disconnects the input signal and provides ground reference to the amplifier input stage.

PRE CHG: Both AC-DC and GND buttons pushed in permits pre-charging of the coupling capacitor to the input signal DC level.

V_C: Disconnects the input signal and applies the comparison voltage to the amplifier input stage.

+ and — Input Connectors BNC connectors for application of external voltage signals. Connector labeled + indicates that upward deflection is produced by a positive-going signal; connector labeled — indicates that downward deflection is produced by a positive-going signal. Connectors include coded-probe input rings for activation of X10 readout.

V_C OUT Jack Convenience outlet for the comparison voltage.

BASIC OPERATION

Preparation

The first few steps of the following procedure are intended to help quickly obtain a trace on the screen and prepare the instrument for immediate use. The remainder of the steps show some of the basic functions of the 5A13N. Operation of other instruments in the system are described in the instruction manuals for those units.

1. Insert the unit all the way into the oscilloscope plug-in compartment.

2. Turn the oscilloscope Intensity control fully counterclockwise and turn the oscilloscope power on. Preset the

time-base and triggering controls for a 2-millisecond/division sweep rate and automatic triggering.

3. Set the 5A13N front-panel controls as follows:

DISPLAY	ON (deflection factor illuminated)
POSITION	Midrange
COMPARISON VOLTAGE (V _C)	
Control	As is
Polarity Selector	+
Range Selector	0—1 V (button out)
VOLTS/DIV	.1 V Calibrated
STEP ATTEN BAL	Midrange
+ Input Coupling	DC, GND
— Input Coupling	DC, GND

4. Adjust the Intensity control for normal viewing of the trace. The trace should appear near the graticule center.

5. Move the trace two divisions below the graticule centerline with the POSITION control.

6. Apply a 400-millivolt peak-to-peak signal (available at the oscilloscope Calibrator loop) through a test lead or 1X probe to the + input connector.

7. For DC-coupled, single-ended operation, release the GND button associated with the + Input Coupling switch. The display should be square waves four divisions in amplitude, with the bottom of the display at the reference established in step 5. Rotate the Variable Volts/Div control counterclockwise out of its detent position, observing reduction of the display. Return the Variable control to the detent (CAL) position.

8. For AC-coupled, single-ended operation, re-position the display with the POSITION control to place the bottom of the display at the graticule centerline.

9. Push in the AC button and note that the display shifts downward about two divisions to its average level.

10. Disconnect the coaxial cable from the + input connector. Connect a dual input cable to the + and — input connectors, then connect the coaxial cable from the Calibrator to the dual input cable.

11. For AC-coupled differential operation, set the — Input Coupling to AC (AC button in, GND button out). The calibrator signal is now coupled to both inputs as a

common-mode signal. A straight line display should be observed, since the common-mode signal is being rejected.

Step Attenuator Balance

If the STEP ATTEN BAL control is not properly adjusted, the CRT zero reference point (trace or spot) will shift vertically due to differential DC imbalance in the amplifier as the VOLTS/DIV switch is rotated throughout its range. The shift is more noticeable on the most sensitive positions.

a. With the instrument operating, ground the input (GND button pushed in) and set the VOLTS/DIV switch to 5 V. Move the trace to the graticule center with the POSITION control.

b. Rotate the VOLTS/DIV switch throughout its range and adjust the STEP ATTEN BAL control for minimum trace shift.

Gain Check

The vertical and horizontal deflection systems of the 5100-series oscilloscopes are gain-standardized to permit a plug-in to moved from one oscilloscope to another (or from one compartment to another within the oscilloscope) without the need to recheck the calibration each time. However, the 5A13N gain can be checked and, if necessary, adjusted.

Calibrated Differential Comparator Operation

When one of the Input Selector switches is set to V_C and the other is set to AC or DC, the 5A13N operates as a calibrated differential comparator or slide-back voltmeter. The calibrated comparison voltage, V_C , can be added differentially to the input signal to obtain a null or to differentially offset any unwanted portion of the applied signal. This allows measurements of relatively small AC or DC signals riding on top of relatively large AC or DC signals.

The comparison voltage is established by the front-panel COMPARISON VOLTAGE (V_C) control dial and polarity and range selector switches. Either of two ranges can be chosen: zero to one volt, or zero to ten volts.

The V_C OUT jack mounted on the front panel of the 5A13N permits monitoring of the comparison voltage. For best results, use a digital voltmeter or any bridge-type meter because the loading of these devices is negligible.

GENERAL INFORMATION

Applying Signals

When measuring DC voltages, use the largest deflection factor (5 V/Div) when first connecting the 5A13N to an unknown voltage source. If the deflection is too small to make the measurement, switch to a lower deflection factor.

CAUTION

If the 5A13N input is connected to a large DC voltage source without using the pre-charge provision, the peak charging current (into a 0.1 μ F capacitor) will be limited only by the internal resistance of the signal source, and this source may be damaged.

Pre-charging. When only the AC component of a signal having both AC and DC components is to be measured, use the Input Coupling switches (AC and GND pushbuttons) to take advantage of the pre-charging circuit incorporated in the unit. The pre-charging circuit permits charging the coupling capacitor to the DC source voltage when the AC and GND buttons are pressed in. The procedure for using this circuit is as follows:

a. Before connecting the 5A13N to a signal containing a DC component, push in the AC and GND buttons. Then connect the input to the circuit under test.

b. Wait about one second for the coupling capacitor to charge.

c. Remove the ground from the coupling capacitor (GND button out). The display will remain on-screen and the AC component can be measured in the usual manner.

The above procedure should be followed whenever a signal having a different DC level is connected.

Signal Input Connectors

When connecting signals to the + and — input connectors on the 5A13N, consider the method of coupling that will be used. Sometimes unshielded test leads can be used to connect the 5A13N to a signal source, particularly when a high level, low-frequency signal is monitored at a low impedance point. However, when any of these factors is missing, it becomes increasingly important to use shielded signal cables. In all cases, the signal-transporting leads should be kept as short as practical.

When making single-ended input measurements (conventional amplifier operation), be sure to establish a common

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ground connection between the device under test and the 5A13N. The shield of a coaxial cable is normally used for this purpose.

In some cases, differential measurements require no common ground connection¹, and therefore are less susceptible to interference by ground-loop currents. Some problems with stray magnetic coupling into the signal-transporting leads can also be minimized by using a differential rather than a single-ended measurement. These considerations are discussed later in this section under Differential Operation.

It is always important to consider the signal source loading (and resulting change in the source operating characteristics) due to the signal-transporting leads and the input circuit of the 5A13N. The circuit at the input connectors can normally be represented by a 1 megohm resistance to ground paralleled by about 47 pF. A few feet of shielded cable (20 to 40 pF per foot) may increase the parallel capacitance to 100 pF or more. In many cases, the effects of these resistive and capacitive loads may be too great and it may be desirable to minimize them through the use of an attenuator probe.

Attenuator probes not only decrease the resistive capacitive loading of a signal source, but also extend the measurement range of the 5A13N to include substantially higher voltages. Passive attenuator probes having attenuation factors of 10X, 100X, and 1000X, as well as other special-purpose types, are available through your Tektronix Field Engineer or Field Office.

Some measurement situations require a high resistance input to the 5A13N with very little source loading or signal attenuation. In such situations, a passive attenuator probe cannot be used. However, this problem may be solved by using a FET Probe.

Display Polarity

Single-ended signals applied to the + input connector produce a display in phase with the input signal. Signals applied to the — input connector will be inverted.

A similar polarity relationship exists for differentially applied signals, but pertains to the direction of voltage change at one input with respect to the other, rather than with respect to chassis potential.

¹The DC plus AC voltages on the test points (with respect to the chassis potential of the 5A13N) should be limited to the levels listed under Maximum Common-Mode Input Voltage characteristics at the end of this section. Higher levels will degrade the common-mode rejection ratio and exceed the input voltage rating of the unit.

Deflection Factor

The amount of trace deflection produced by a signal is determined by the signal amplitude, the attenuation factor (if any) of the probe, the setting of the VOLTS/DIV switch, and the setting of the Variable control. The calibrated deflection factors are indicated by the VOLTS/DIV switch only when the Variable control is rotated fully clockwise in the detent position.

The range of the Variable control is at least 2.5:1. It provides uncalibrated deflection factors covering the full range between the fixed settings of the VOLTS/DIV switch. The control can be set to extend the deflection factor to at least 12.5 volts/division.

Bandwidth Limiter

The BANDWIDTH LIMIT switch provides a method of reducing interference from unwanted high-frequency signals when viewing low-frequency signals, or reducing noise when the VOLTS/DIV switch is set to the more sensitive positions. With the BANDWIDTH LIMIT switch set to FULL (button out), the full bandwidth capabilities of the amplifier are available. When set to 10 kHz (button in), the upper —3 dB bandwidth point of the amplifier is limited to about 10 kHz by an internal capacitance.

Differential Operation

Differential measurements are made by applying the signals to the + and — input BNC connectors. Both Input Coupling switches should be set to the same position (AC or DC), depending on the method of signal coupling desired. When using the 5A13N for differential operation, only the voltage difference between the two signals is amplified and displayed. Common-mode signals (signals that are common in amplitude, frequency, and phase) are rejected and not displayed.

The 5A13N differential input provision may be used to eliminate interfering signals such as AC line-frequency hum. Single-ended measurements often yield unsatisfactory information because of interference resulting from ground-loop currents between the oscilloscope and the device under test.

These limitations of single-ended measurements are virtually eliminated in differential measurements. A differential measurement is made by connecting each of the two inputs to selected points in the test circuit. Since the chassis of the 5A13N does not need to be connected in any way to the test circuit, there are few limitations to the selection of these test points.

Factors Which Affect CMRR

Frequency. Since the common-mode output voltage is affected by phase differences as well as gain between amplifier halves, the frequency of the input common-mode signal has a direct bearing on the CMRR. Generally, as the frequency of the input signal increases, the CMRR decreases.

Source Impedance. Any difference in source impedance at the two points in the source under test will degrade the rejection ratio. The source impedance and the amplifier input impedance form an RC divider which determines the portion of the signal that appears across the amplifier input, and thus determines the apparent effect on CMRR.

Probes and Signal Leads. A principal requirement for maximum CMRR is that the signals arrive at the two inputs of the amplifier with no change in phase or amplitude. Slight differences in attenuation factors or phase shift between two input attenuators may reduce the CMRR 20% or more.

Attenuator probes extend the usable voltage range of a differential amplifier by reducing the input signal level below the maximum common-mode input voltage. However, a reduction in the apparent CMRR will usually occur because of component value of differences within the probes.

Ground Connections. Proper grounding reduces signals generated from ground loop currents. It is usually best to electrically connect the probe or signal lead shields together at the probe body or signal source, but not to the instrument ground.

Magnetic Fields. Outside influences such as magnetic fields can also degrade performance, particularly when low level signals are involved. Magnetic interference may be minimized by using identical signal-transporting leads to the two inputs and twisting the two leads together over as much of their length as possible.

Voltage Probes

In general, probes offer the most convenient means of connecting a signal to the input of the 5A13N. Tektronix probes are shielded to prevent pickup of electrostatic interference. A 10X attenuator probe offers a high input impedance and allows the circuit under test to perform very close to normal operating conditions. See your Tektronix, Inc., catalog for characteristics and compatibility of probes for use with this system.

Differential Measurements. The following adjustment procedure is recommended when preparing to use two Tektronix P6055 Probes for differential measurement.

a. Connect one probe for DC-coupled single-ended input. Obtain a triggered display of an appropriate square wave, such as that from a calibrator or square-wave generator. Adjust the probe DC Atten Calibration control for correct deflection sensitivity, then compensate the probe square-wave response.

b. Connect a second probe for DC-coupled operation. Apply the square wave to both probes at 100 volts peak to peak. Free run the sweep and adjust the DC Atten Calibration of the second probe for maximum low frequency cancellation (minimum signal amplitude or elimination of the two-trace appearance).

c. Adjust the compensation, if necessary, of the second probe to minimize the amplitude of the differential pulses on the displayed trace.

d. The above procedure matches the probes for use at any sensitivity which employs the particular 5A13N input attenuator (1X or 100X) used in steps b and c. When it is necessary to use the other input attenuator, steps b and c should be repeated for that attenuator.

e. When examining a small differential signal in the presence of relatively large common-mode components, fine adjustment of probe CMRR may be made by temporarily connecting both probes to either of the two signal sources.

f. Movement of the probes should be kept to a minimum after the adjustment.

Coded Probes. The 5A13N is designed for compatibility with coded probes, such as the Tektronix P6060 or P6052 1X/10X Passive Probe. The + and – input connectors have an outer ring to which the coding ring on the probe connector makes contact. This type of probe allows the vertical deflection factor indicated by the readout to correspond with the actual voltage at the probe tip, eliminating the need to consider the attenuation factor when measuring the signal amplitude on the graticule scale.

Attenuation on the P6052 Probe is selected by a sliding collar on the probe barrel. When the collar is pulled back (away from the probe tip), 1X attenuation is selected; when the collar is pushed forward (nearest the probe tip), 10X attenuation is selected. Input resistance for 1X attenuation

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is 1 megohm; for 10X, 10 megohms. Probe compensation is obtained in the usual manner (see probe manual for details).

ELECTRICAL CHARACTERISTICS

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

DEFLECTION FACTOR. 1 mV/div to 5 V/div. 12 calibrated steps in a 1-2-5 sequence. Accuracy is within 3%. Uncalibrated variable is continuous between steps; its minimum ratio extends deflection factor to at least 12.5 V/div.

FREQUENCY RESPONSE (6 Division Reference). For DC-coupled input, overall bandwidth is DC to 2 MHz. AC-coupled input lower bandwidth frequency is 2 Hz or less at -3 dB. 10 kHz bandwidth mode, DC to 10 kHz within 2 kHz.

INPUT R AND C. 1 M Ω paralleled by about 51 pF. Time constant normalized for 51 microseconds, within 3% between channels.

MAXIMUM SAFE INPUT VOLTAGES. For DC-coupled input, ± 350 V (DC + peak AC, 1 kHz or less). For AC-coupled input, 350 VDC.

MAXIMUM INPUT GATE CURRENT. 100 picoamperes or less at +25°C.

COMMON-MODE SIGNAL RANGE. For deflection factors 1 mV/div to 50 mV/div, at least ± 10 V; for 0.1 V/div to 5 V/div, at least ± 350 V.

OVERDRIVE RECOVERY. 1 μ s to recover to within 3.0 mV, and 0.1 ms to recover to within 1.5 mV after removal of signal between ± 10 V.

COMMON-MODE REJECTION RATIO. At least 10,000:1, DC to 10 kHz at 1 mV/div to 50 mV/div DC coupled, with up to 20-volt peak-to-peak sine wave, decreasing to 100:1 at 1 MHz. At least 400:1, DC to 10 kHz at 0.1 V/div to 5 V/div DC coupled, with up to 100-volt peak-to-peak sine wave, decreasing to 40:1 at 1 MHz. For frequencies above 5 kHz AC coupled, CMRR is the same as stated for DC coupled. Below 5 kHz AC coupled, CMRR decreases to 400:1 at 10 Hz.

POSITION RANGE. + and - approximately 8 divisions from graticule center.

INTERNAL COMPARISON VOLTAGE. Ranges, 0 V to ± 10 V, and 0 V to ± 1 V. Accuracy, within 0.2% of dial setting plus 5 mV from ± 1 V to ± 10 V; within 0.2% of dial setting plus 1 mV from ± 25 mV to ± 1 V of the 0 V to ± 1 V range. From 0 V to ± 25 mV, use the on-screen display for greater resolution.

COMPARISON VOLTAGE OUTPUT JACK. V_c OUT resistance is 15 k Ω ± 5 k Ω , electrical zero is 0.5 mV or less.

REPACKAGING FOR SHIPMENT

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

Save and re-use the package in which your instrument was shipped. If the original packaging is unfit for use or not available, repack 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 200 pounds.

SECTION 2

THEORY OF OPERATION

Introduction

This section of the manual contains an electrical description of the circuits in the 5A13N Differential Comparator. Complete schematics and an overall block diagram of the unit are given on pullout pages at the rear of this manual.

BLOCK DIAGRAM DESCRIPTION

When the DISPLAY button is pressed, a logic level is applied to the oscilloscope to enable 5A13N operation (switch function is limited to operation in a vertical compartment), and the front-panel readout lamp lights to indicate the ON mode.

Signals applied to the + and — input connectors can be passed directly to the attenuators (DC coupled) or they can be capacitively (AC) coupled to block the DC component of the signal. The GND switch disconnects the signals and applies a reference ground to the amplifier input; for AC-coupled signals, the coupling capacitor is allowed to pre-charge to the DC level of the signal, preventing a damaging current surge when the ground is removed.

The input attenuators are frequency-compensated voltage dividers. 1X attenuation is provided for the 1 mV to 50 mV positions of the VOLTS/DIV switch, and 100X attenuation is provided for the 0.1 V to 5 V positions.

The comparison voltage supply permits connecting either the + or the — input to an accurate voltage. The supply provides two ranges of comparison voltage, 0-1 V and 0-10 V, selectable in either positive or negative polarity from the front panel. The voltage is also made available to a front-panel jack for monitoring. Also, the ZERO V_c REF control permits grounding the amplifier inputs, to provide a reference.

The input source and emitter followers present a very high input impedance at the output of the attenuators. This stage incorporates circuitry to limit the common-mode and differential voltage dynamic ranges. The gain of this stage is approximately one.

The differential comparator amplifies the difference between the two inputs. The VOLTS/DIV switch changes the value of output collector-load resistors, thus providing

gains of 1, 2.5, and 5 for various deflection factors. A bootstrap supply and a feedback amplifier are incorporated to reject common-mode signals. An emitter follower output is provided for this stage, and the push-pull output signal is opposite in polarity to that applied to the inputs.

The 1X-10X gain-switching amplifier receives the differential signal from the differential comparator. The gain of this stage is changed by the VOLTS/DIV switch. An emitter follower output is provided for this stage also, and the push-pull output signal is in phase with the applied signal.

The output amplifier is operated push-pull, presenting a signal to the output terminals that is 180° out of phase with that applied to the 5A13N input. Emitter degeneration produced by the Variable Volts/Div control provides an uncalibrated deflection factor for the 5A13N. A positioning-current driver is connected across the output lines to alter the quiescent trace position.

A triggering signal is tapped from the output amplifier stage, amplified and made available to an associated time-base plug-in unit. Triggering signal amplitude is about 0.25 volt per displayed division.

CIRCUIT DESCRIPTION

Plug-In Logic

When DISPLAY button S340 is pressed, a logic level is applied to the electronic switching circuit in the oscilloscope to enable plug-in operation. Power is applied to light the front-panel knob-skirt readout lamp, indicating the ON mode.

Input Coupling

Signals applied to the front-panel + and — input connectors may be capacitive coupled (AC), direct coupled (DC), or internally disconnected (GND). Input coupling is selected by means of two pushbutton switches at each input, S1A and S1B for the + input and S21A and S21B for the — input. When the AC button is pressed, a coupling capacitor (C1 or C21) is placed in the circuit to couple signals of about 2 hertz (–3 dB point) and higher to the attenuator. When the GND button is pressed, a ground reference is provided to the input of the amplifier without the need to remove the applied signal from the input

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connector. When both the AC and GND buttons are pressed, the coupling capacitor can be pre-charged or discharged, protecting the circuit under test and the input circuit of the 5A13N from surge currents.

Input Attenuator

The input attenuators are frequency-compensated voltage dividers that provide 100X attenuation in the 0.1-volt to 5-volt positions of the VOLTS/DIV switch. For DC and low-frequency signals, the dividers are essentially resistive (attenuation ratio determined by the resistance ratio). A low-frequency common-mode signal between the attenuators of the two inputs is balanced by adjustment of R10, LF CMR. At higher frequencies where the capacitive reactance becomes effective, the attenuation ratio is determined by the impedance ratio.

Comparison Voltage

When either front-panel V_c button is pressed, the respective amplifier input stage is connected to an accurate comparison voltage. S50 permits either side of reference Zener VR50 to be tapped, providing either a positive or a negative comparison voltage. The comparison voltage is set to exactly 10 volts by adjustment of R54. S55 permits either of two ranges to be chosen, 0 to 10 volts, or 0 to 1 volt. Precise 10:1 voltage division is obtained by adjustment of R57. The exact amount of comparison voltage is dialed by the front-panel COMPARISON VOLTAGE control, R60. The comparison voltage is also available at front-panel V_c OUT jack J60 for monitoring. ZERO V_c REF switch S100 allows both amplifier input stages to be connected to ground, permitting the trace to be established as a zero reference.

Input Source and Emitter Follower

The Input Source and Emitter Follower stage provides a very high input impedance to prevent loading the passive input circuit elements. The + and – sides are identical except for the balancing components; therefore, only the + side will be described. CR102 and Q109 provide input protection as well as providing a common-mode voltage limit. Q110A is an FET source follower which drives emitter follower Q115A. Q108-Q109 provides a constant-current source for this stage, and Q114A and Q117 provide a constant-current return. Q122 and CR123 provide bootstrapping to the Q115A collector, maintaining nearly constant voltage across the transistor. Gain of this stage is X1. Coarse and Fine Input Balance controls R112 and R212 permit matching the quiescent output voltages to the input gate voltages.

Under normal operating conditions, Q120 and Q220 are biased to pass the signals to the input of the comparator stage. These transistors function as disconnect switches if an overdrive signal causes conduction of the diodes between their bases.

Differential Comparator

The Differential Comparator is composed of Q130A and Q140A connected in cascode on one side, and Q130B and Q140B connected in cascode on the other side. Q135 provides a current source for these transistors. The differential input signal is developed across R133 and R233, changing the conduction of the two halves of the amplifier. The output of this stage is a push-pull signal, opposite in polarity to that applied to the input. The gain of the stage is 1, 2.5, or 5, depending on the collector-load resistance selected by VOLTS/DIV switch S260.

A bootstrap supply and a feedback amplifier are incorporated to reject common-mode signals. A common-mode signal applied to the bases of Q130A and Q130B is sensed at the base of Q149, and then applied through emitter-follower action to the bases of Q140A and Q140B. The effect of this bootstrap supply is to maintain constant operating characteristics of the amplifier transistors. Q146 supplies a constant current to the bootstrap supply. Common-mode signals that reach the collectors of Q140A and Q140B are sensed by the base of Q158. Q155 and Q158 are connected as a paraphase amplifier, thus a signal in-phase with the common-mode signal is developed at the collector of Q155 and applied to the current-source transistor, Q135. This control of the current through the two halves of the amplifier helps to remove common-mode signals. Emitter follower Q143 maintains a constant voltage at the bases of Q146 and Q155.

The differential output signal is applied through emitter followers Q170A and Q170B to the 1X-10X Gain-Switching Amplifier. Voltage-limiting diodes are connected across the bases of the emitter followers to protect the transistors in the following stage and to ensure quick overdrive recovery.

1X-10X Gain-Switching Amplifier

The 1X-10X Gain-Switching Amplifier stage consists of push-pull amplifier Q190A-Q190B, grounded base amplifiers Q195 and Q295, and emitter followers Q300 and Q400. Q190A and Q190B are supplied by constant-current source transistor Q175. Conduction of the two halves of this amplifier is balanced by adjustment of R178, 1X-10X Bal. R180, Gain, permits adjustment of the emitter resistance, allowing the overall gain of the 5A13N to be adjusted to match the mainframe requirements. 1X-10X gain switching is achieved by changing the collector-load resistance of Q195 and Q295 with the VOLTS/DIV switch. Variable Balance control R194 is adjusted to minimize trace shift when the Variable Volts/Div control in the next stage is rotated. The output signal is passed through emitter followers Q300 and Q400.

Output Amplifier

The Output Amplifier consists of push-pull amplifier Q310-Q410. The input to this stage is diode-protected.

Variable Volts/Div potentiometer R414 allows the gain of the 5A13N to be adjustable over a 2.5 to 1 ratio.

Q330 and Q430, connected across the output lines of the 5A13N, are positioning-current drivers. POSITION control R335 provides an adjustable change in the conduction of the transistors, which provide a current to sum with the Q310-Q410 currents, controlling the quiescent vertical position of the display. S337 and S339 allow capacitors to be switched in across the output lines to limit the amplifier bandwidth.

Trigger Signal Amplifier

Differential amplifier Q320-Q420 receives the triggering signal from the emitters of Q310-Q410. The triggering signal is amplified and passed through emitter follower Q425, where it is made available to an associated time-base unit via output contact A4. The triggering signal is of the same polarity as that applied to the gate of Q110A, and has an amplitude of about 0.25 volt per displayed division.

Vertical Switching and Readout

The VOLTS/DIV switch, S260, is made up of a series of cam lobes, which engage and disengage various contacts at different positions of the switch. The contacts that are engaged at any given position of the switch are shown by black dots on the switch logic diagram.

Either of two lamp bulbs located behind the knob skirt of the VOLTS/DIV switch lights the selected deflection factor to provide a direct readout. Normally DS342, which is physically located behind the upper left portion of the knob skirt, is lit. Connection of a readout-coded 10X probe to either input connector automatically changes the readout by a factor of 10 (i.e., turns off DS342 and lights DS347) to indicate the correction of probe attenuation. J1 and J21, the + and — INPUT connectors, have probe rings, allowing the 10X probe to apply a ground connection to the base of Q342. Q342 turns off, allowing Q347 to turn on, switching current from DS342 to DS347.

SECTION 3

CALIBRATION

Introduction

This section of the manual contains a procedure to return the circuits of the 5A13N to within their designed operating capabilities. Calibration is generally required after a repair has been made, or after long time intervals in which normal aging of components may affect instrument accuracy. For initial operation, the Basic Operating procedure in Section 1 should be used (the instrument is checked using a minimum of peripheral equipment).

Instrument Maintenance

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

Services Available

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

TEST EQUIPMENT REQUIRED

General

The following test equipment and accessories, or the equivalent, is required for complete calibration of the 5A13N. Specifications given for the test equipment are the minimum necessary for accurate calibration. Therefore, some of the specifications listed here may be less rigorous than the actual performance capabilities of the test equipment. All test equipment is assumed to be correctly calibrated and operating within the listed specifications.

Calibration Equipment Alternatives

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

Special Calibration Fixtures

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

Test Instruments

1. 5100-series oscilloscope. For this procedure, a 5110 Oscilloscope with a 5B10N Time-Base is used.

2. Standard amplitude calibrator. Output signal, one kilohertz square wave; output amplitude, 0.2 millivolt to 100 volts; amplitude accuracy, within 0.25%. Tektronix PG 506 Calibration Generator recommended (requires a TM 500-series power module).

3. Constant-amplitude sine-wave generator. Frequency, 2 hertz to 2 megahertz; output amplitude, from about 0.5 volt to 40 volts peak to peak. For example, General Radio 1310-B Oscillator (use a GR Type 274 QBJ adapter to provide BNC output).

4. Precision DC voltmeter. Accuracy, within 0.1%; measurement range, 0 to about 12 volts. Tektronix DM 501 Digital Multimeter recommended (requires a TM 500-series power module).

5. Square-wave generator. Repetition rate, 10 Hz and 1 kHz; risetime, 60 nanoseconds; amplitude, variable between 0.5 and 10 volts. Tektronix FG 503 Function Generator recommended (requires a TM 500-series power module).

Accessories

6. Plug-In extension for the 5100-series oscilloscope. Tektronix Calibration Fixture 067-0645-03.

7. Coaxial cable (2). Impedance, 50 ohms; length, 42 inches; connectors, BNC. Tektronix Part No. 012-0057-01.

8. Dual-input cable. Provides matched signal paths to the + and - inputs; BNC connectors. Tektronix Calibration Fixture 067-0525-01 recommended.

9. Input RC Normalizer. RC time constant 51 μ s (1 M Ω times 51 pF); connectors, BNC. Tektronix Calibration Fixture 067-0541-00, adjusted to 51 pF.

Calibration—5A13N

10. In-line termination. Impedance, 50 ohms; accuracy, $\pm 2\%$; connectors, BNC. Tektronix Part No. 011-0049-01.

11. Adapter, GR to BNC female. Tektronix Part No. 017-0063-00.

CALIBRATION PROCEDURE

Preparation

NOTE

Internal adjustments should be made at an ambient temperature between $+20^{\circ}\text{C}$ and $+30^{\circ}\text{C}$ (between $+68^{\circ}\text{F}$ and $+86^{\circ}\text{F}$) for best overall accuracy.

a. Insert the 5A13N into the left plug-in compartment of a calibrated 5110 Oscilloscope. Insert a calibrated 5B10N time-base unit into the right compartment.

b. Connect the oscilloscope to a suitable power source and turn on the power.

c. Set the controls as given under Initial Control Settings. For location of internal controls, refer to the illustrations in the diagram section.

Initial Control Settings

NOTE

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

5A13N

DISPLAY	ON (readout illuminates when power is on)
POSITION	Midrange
COMPARISON VOLTAGE	
Polarity and Range	+, 0-10 V
VOLTS/DIV	50 m
Variable Volts/Div	CAL detent (fully clockwise)
STEP ATTEN BAL	Midrange
+ Input Coupling	DC, GND
— Input Coupling	DC, GND
BANDWIDTH LIMIT	2 MHz (button out)

Oscilloscope

Mainframe	
Intensity	Normal display brightness
Focus	Adjust for best focus of trace
Time Base	
Display	Alt (button out)
Position	Sweep starts at left edge of graticule

Seconds/Div	1 m
Variable Seconds/Div	Cal detent
Swp Mag	Off (button out)
Triggering Mode	Auto Trig, AC Coupling, + Slope
Triggering Level	Midrange

1. DC Balance the Amplifier

a. Use the POSITION control to obtain a trace on the screen.

b. ADJUST—While switching the VOLTS/DIV between the 10 m and 50 m positions, adjust R112, Coarse Input Balance, for minimum trace shift.

c. ADJUST—While switching the VOLTS/DIV between the 1 m and 5 m positions, adjust R212, Fine Input Balance, for minimum trace shift.

d. While switching the VOLTS/DIV between the 5 m and 10 m positions, adjust the front-panel STEP ATTEN BAL control for minimum trace shift.

e. ADJUST—While rotating the Variable Volts/Div control (red knob), adjust R194, Variable Balance, for minimum trace shift. Adjust the POSITION control as needed. After the adjustment, return the Variable Volts/Div control to the CAL detent position.

2. Adjust Amplifier Gain

a. Connect the standard amplitude calibrator output to the + INPUT connector through a coaxial cable. Set the standard amplitude calibrator for a 5-millivolt square-wave output.

b. Set the VOLTS/DIV switch to 1 mV and release the + Input Coupling GND (button out).

c. ADJUST—R180, Gain, for a display amplitude of exactly five divisions.

d. Disconnect the standard amplitude calibrator.

3. Adjust Overdrive Recovery

a. Set the VOLTS/DIV to 2, the sweep rate to 10 ms/div, and the time-base sweep mode to Normal and the triggering source to Ext.

b. Connect the square-wave generator output to the 5A13N +INPUT connector through a GR-to-BNC adapter, a coaxial cable, and a 50 Ω in-line termination. Connect another cable from the square-wave generator trigger to the time base Ext input.

c. Set the square-wave generator frequency to 10 Hz and adjust the amplitude to provide exactly 5 divisions of vertical deflection (10 volts). Switch the VOLTS/DIV to 1 m. Change the sweep rate to 20 μ s/div. Push the ZERO V_C REF button and turn the POSITION control to set the trace to the graticule center horizontal line, then release the button.

d. ADJUST—Using a plastic alignment tool, adjust C104, + Overdrive, so the trace returns to within 1.5 millivolts (1.5 divisions) of screen center in 0.1 millisecond. A final adjustment of C104 will be made in step 5.

e. Move the square-wave signal from the +INPUT to the -INPUT. Set the + Input Coupling to GND and the - Input Coupling to DC. Push the ZERO V_C REF button to check that the trace is at screen center.

f. ADJUST—C204, - Overdrive, so the trace returns to within 1.5 millivolts (1.5 divisions) of screen center in 0.1 millisecond. A final adjustment of C204 will be made in step 5.

4. Adjust Input Compensation

a. Set the VOLTS/DIV switch to .1. Set the time base Seconds/Div to 1 m, Sweep Mode to Auto Trig, and Triggering Source to Left.

b. Add a 51 pF input RC normalizer between the 50 Ω in-line termination and the -INPUT connector.

c. Set the square-wave generator to 1 kHz and adjust the amplitude control to provide about five or six divisions of vertical deflection. Position the display as needed.

d. ADJUST—C23 and C25 for minimum roll-off or overshoot of the leading corner of the square-wave display.

e. Change the VOLTS/DIV to 50 m and adjust the square-wave amplitude for five or six divisions.

f. ADJUST—C28 for minimum roll-off or overshoot of the leading corner of the square-wave display.

g. Move the RC normalizer and square-wave signal from the -INPUT to the +INPUT.

h. Set the - Input Coupling to GND and the + Input Coupling to DC. Position the display to the center of the graticule area.

i. Set the VOLTS/DIV switch to .1 and adjust the square-wave amplitude for five or six divisions.

j. ADJUST—C3 and C5 for minimum roll-off or overshoot of the leading corner of the square-wave display.

k. Change the VOLTS/DIV to 50 m and adjust the square-wave amplitude for five or six divisions.

l. ADJUST—C8 for minimum roll-off or overshoot of the leading corner of the square-wave display.

m. Disconnect the RC normalizer and the square-wave generator.

5. Adjust Low-Frequency CMR

a. Set the controls as follows:

VOLTS/DIV	5
+ and - Input Coupling	GND
Sec/Div (time base)	5 ms

b. Connect a dual input cable to the + and -INPUT connectors. Connect the sine-wave generator output to the dual input cable through a coaxial cable.

c. Set the sine-wave generator for a 100-hertz, 20-volt peak-to-peak reference signal (set the + Input Coupling to DC and obtain exactly 4 divisions of vertical deflection).

d. Set the - Input Coupling to DC (both the + and - Input Coupling switches should now be set to DC) and the VOLTS/DIV to 1 m.

e. ADJUST—Either C104 or C204 for less than 2 divisions of signal amplitude. If more than two turns are required, adjust both an equal and opposite amount and then recheck the overdrive recovery as outlined in step 3.

f. Set the VOLTS/DIV switch to 5 and the - Input Coupling to GND.

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g. Set the sine-wave generator for a 100-hertz, 40-volt peak-to-peak reference signal (set the + Input Coupling to DC and obtain exactly 8 divisions of vertical deflection).

h. Set the — Input Coupling to DC (both the + and — Input Coupling switches should now be set to DC) and the VOLTS/DIV to 0.2.

i. ADJUST—R10, LF CMR, for minimum deflection. Set the sine-wave generator frequency to one kilohertz and check for 0.2 division or less of vertical deflection. Readjust R10, if necessary, for best compromise at 100 hertz and one kilohertz.

6. Check Amplifier Bandwidth

a. Set the sine-wave generator for minimum output amplitude.

b. Change the controls as follows:

VOLTS/DIV	0.1 V
+ Input Coupling	AC
— Input Coupling	GND
Sec/Div (time base)	0.5 ms

c. Adjust the sine-wave generator for eight vertical divisions of 100 kHz display as a reference. Then slowly increase the frequency until the display amplitude is 5.66 divisions. This is the upper —3 dB point.

d. CHECK—Frequency at the upper —3 dB point is 2 MHz or greater.

e. Set the BANDWIDTH LIMIT to 10 kHz (button in), and adjust the sine-wave generator for eight vertical divisions of 1-kilohertz reference display. Then slowly increase the frequency until the display amplitude is 5.66 divisions.

f. CHECK—Frequency at the upper —3 dB point (bandwidth limit) is between 8 and 12 kilohertz.

g. Release the BANDWIDTH LIMIT switch (button out) and adjust the sine-wave generator for eight vertical divisions of 2-kilohertz reference display. Then slowly decrease the frequency until the display amplitude is 5.66 divisions. This is the lower —3 dB point when AC coupling is used (determined by the coupling capacitor). Set the time-base Sec/Div as necessary to view the signal.

h. CHECK—Frequency at the lower —3 dB point is 2 hertz or less.

i. Disconnect the sine-wave generator.

7. Check Input Gate Current

a. Position the trace to the graticule center, then change the following control settings:

VOLTS/DIV	1 mV
+ Input Coupling	DC, GND
— Input Coupling	DC, GND
Sec/Div (time base)	1 ms

b. Using the STEP ATTEN BAL control, position the trace to the graticule centerline.

c. Release the GND button of the + Input Coupling switch (DC coupled).

d. CHECK—Trace shift is less than ± 0.1 division. This indicates an FET gate current of 100 picoamperes or less.

e. Ground the + Input Coupling (GND button out) and release the GND button of the — Input Coupling switch.

f. CHECK—Trace shift is less than ± 0.1 division.

8. Adjust and Check Comparison Voltage

a. Connect a precision DC voltmeter set to measure +10.00 volts between ground and the V_c OUT jack. Be sure the COMPARISON VOLTAGE dial is set to 10.00.

b. ADJUST—R54, 0-10 V Adjust, for a voltmeter reading of exactly 10.00 volts.

c. Set the V_c Range button to 0-1 V and set the voltmeter to measure 1.000 volt.

d. ADJUST—R57, 0-1 V Adjust, for a voltmeter reading of exactly 1.000 volt.

e. Make an incremental voltage check at various points between zero and ten volts. Dial reading and voltmeter reading should match within 0.25%. Also, check the negative supply. Disconnect the voltmeter when the check is completed.

This completes the calibration procedure for the 5A13N.

PARTS LISTS AND DIAGRAMS

Symbols and Reference Designators

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

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

Resistors = Ohms (Ω).

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it goes to the low state.

Abbreviations are based on ANSI Y1.1-1972.

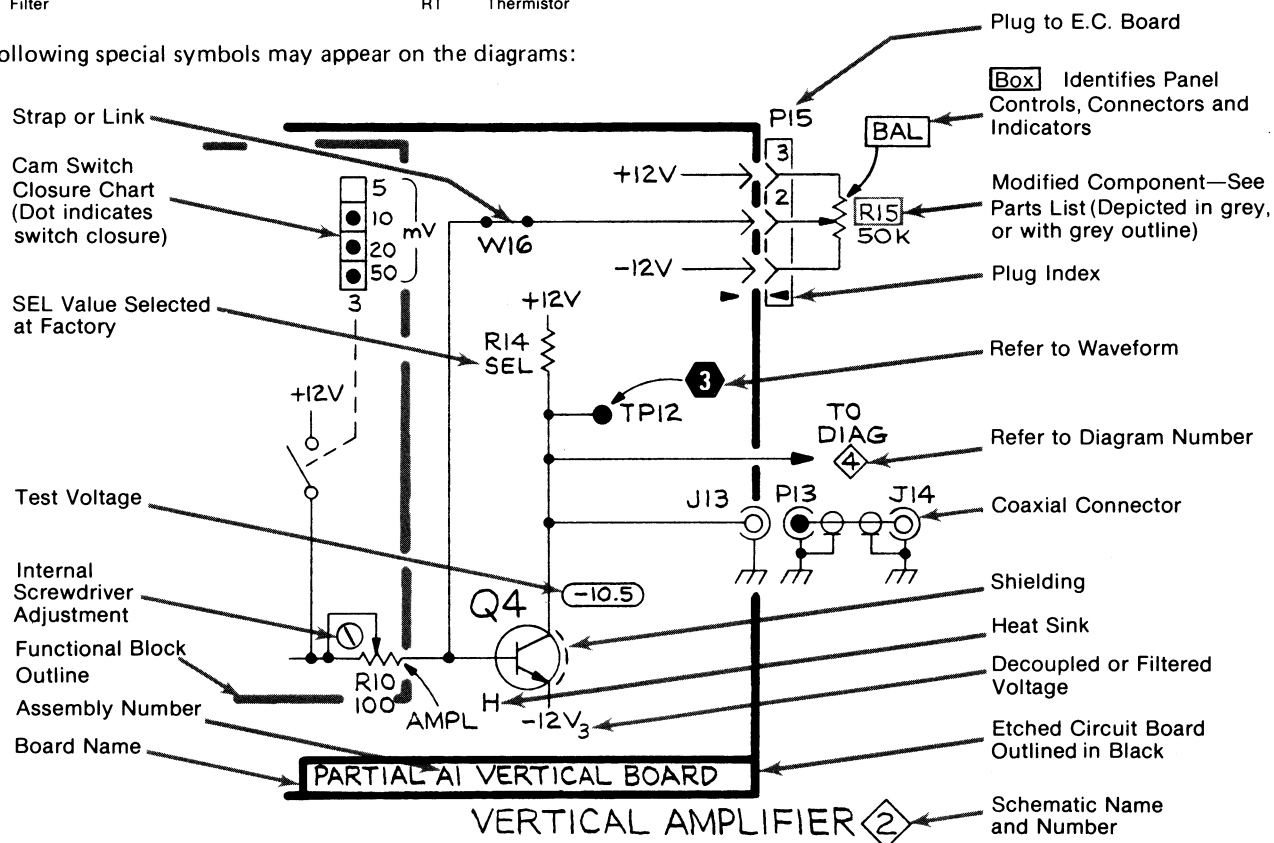
Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

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

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

A	Assembly, separable or repairable (circuit board, etc)	H	Heat dissipating device (heat sink, heat radiator, etc)	S	Switch or contactor
AT	Attenuator, fixed or variable	HR	Heater	T	Transformer
B	Motor	HY	Hybrid circuit	TC	Thermocouple
BT	Battery	J	Connector, stationary portion	TP	Test point
C	Capacitor, fixed or variable	K	Relay	U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
CB	Circuit breaker	L	Inductor, fixed or variable	V	Electron tube
CR	Diode, signal or rectifier	M	Meter	VR	Voltage regulator (zener diode, etc.)
DL	Delay line	P	Connector, movable portion	W	Wirestrap or cable
DS	Indicating device (lamp)	Q	Transistor or silicon-controlled rectifier	Y	Crystal
E	Spark Gap, Ferrite bead	R	Resistor, fixed or variable	Z	Phase shifter
F	Fuse	RT	Thermistor		
FL	Filter				

The following special symbols may appear on the diagrams:



REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number
00X Part removed after this serial number

ITEM NAME

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

ABBREVIATIONS

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

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P O BOX 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
02111	SPECTROL ELECTRONICS CORPORATION	17070 EAST GALE AVENUE	CITY OF INDUSTRY, CA 91745
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	MURTL BEACH, SC 29577
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD, PO BOX 20923	PHOENIX, AZ 85036
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
07910	TELEDYNE SEMICONDUCTOR	12515 CHADRON AVE.	HAWTHORNE, CA 90250
08806	GENERAL ELECTRIC CO., MINIATURE LAMP PRODUCTS DEPARTMENT	NELA PARK	CLEVELAND, OH 44112
24931	SPECIALTY CONNECTOR CO., INC.	3560 MADISON AVE.	INDIANAPOLIS, IN 46227
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
53944	ELT INC., GLOW LITE DIVISION	BOX 698	PAULS VALLEY, OK 73075
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
74970	JOHNSON, E. F., CO.	299 10TH AVE. S. W.	WASECA, MN 56093
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Discont	Name & Description	Mfr Code	Mfr Part Number
A1	670-1895-00	B010100	B039999	CKT BOARD ASSY:MAIN	80009	670-1895-00
A1 ¹	670-1895-01	B040000		CKT BOARD ASSY:MAIN	80009	670-1895-01
A2	670-1896-00			CKT BOARD ASSY:+ INPUT COUPLING	80009	670-1896-00
C1	295-0054-00			CAP.,MATCHED:0.1UF,600V	80009	295-0054-00
C3	281-0131-00			CAP.,VAR,AIR DI:2.4-24.5PF,250V	74970	189-509-5
C4	281-0503-00			CAP.,FXD,CER DI:8PF,+/-0.5PF,500V	72982	301-000C0H0809D
C5	281-0081-00			CAP.,VAR,AIR DI:1.8-13PF,375VDC	74970	189-6-5
C8	281-0078-00			CAP.,VAR,AIR DI:1.4-7.3PF,800V	74970	189-0003-075
C9	283-0626-00			CAP.,FXD,MICA D:1800PF,5%,500V	00853	D195E182J0
C21 ¹	295-0054-00			CAP.,MATCHED:0.1UF,600V	80009	295-0054-00
C23	281-0081-00			CAP.,VAR,AIR DI:1.8-13PF,375VDC	74970	189-6-5
C24	281-0503-00			CAP.,FXD,CER DI:8PF,+/-0.5PF,500V	72982	301-000C0H0809D
C25	281-0081-00			CAP.,VAR,AIR DI:1.8-13PF,375VDC	74970	189-6-5
C28	281-0078-00			CAP.,VAR,AIR DI:1.4-7.3PF,800V	74970	189-0003-075
C29	283-0626-00			CAP.,FXD,MICA D:1800PF,5%,500V	00853	D195E182J0
C63	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C64	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C65	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
C101	285-0879-00			CAP.,FXD,PLSTC:0.01UF,5%,400V	56289	LP66A1E103J002
C104	281-0064-00			CAP.,VAR,PLSTC:0.25-1.5PF,600V	72982	530-002
C113	281-0562-00			CAP.,FXD,CER DI:39PF,10%,500V	72982	301-000U2J0390K
C146	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	56289	36C600
C156	281-0544-00			CAP.,FXD,CER DI:5.6PF,10%,500V	72982	301-000C0H0569D
C163	281-0578-00			CAP.,FXD,CER DI:18PF,5%,500V	72982	301-050C0G0180J
C164	281-0602-00			CAP.,FXD,CER DI:68PF,5%,500V	72982	308-000P2G0680J
C184	281-0605-00			CAP.,FXD,CER DI:200PF,10%,500V	04222	7001-1375
C191	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C195	281-0550-00			CAP.,FXD,CER DI:120PF,10%,500V	04222	7001-1373
C201	285-0879-00			CAP.,FXD,PLSTC:0.01UF,5%,400V	56289	LP66A1E103J002
C204	281-0064-00			CAP.,VAR,PLSTC:0.25-1.5PF,600V	72982	530-002
C213	281-0562-00			CAP.,FXD,CER DI:39PF,10%,500V	72982	301-000U2J0390K
C291	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C310	283-0028-00			CAP.,FXD,CER DI:0.0022UF,20%,50V	56289	19C606
C313	281-0562-00			CAP.,FXD,CER DI:39PF,10%,500V	72982	301-000U2J0390K
C314	281-0602-00			CAP.,FXD,CER DI:68PF,5%,500V	72982	308-000P2G0680J
C323	281-0524-00			CAP.,FXD,CER DI:150PF,+/-30PF,500V	04222	7001-1381
C333	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C337	285-0702-00			CAP.,FXD,PLSTC:0.033UF,5%,100V	56289	410P111
C341	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C350	283-0068-00	B010100	B039999X	CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
C410	283-0028-00			CAP.,FXD,CER DI:0.0022UF,20%,50V	56289	19C606
C433	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C440	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C441	290-0525-00			CAP.,FXD,ELCTLT:4.7UF,20%,50V	56289	196D475X0050K1
C444	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C446	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C447	290-0525-00			CAP.,FXD,ELCTLT:4.7UF,20%,50V	56289	196D475X0050K1
C448	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
CR102	152-0249-00			SEMICON D DEVICE:SILICON,ASSEMBLY	80009	152-0249-00
CR115	152-0178-00			SEMICON D DEVICE:SILICON,ASSEMBLY	80009	152-0178-00
CR122	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152
CR123	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152
CR124	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152

¹C1 and C21 furnished as a unit.

Replaceable Electrical Parts—5A13N

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
CR125	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152
CR126	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152
CR165	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152
CR166	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152
CR202	152-0249-00			SEMICON D DEVICE:SILICON,ASSEMBLY	80009	152-0249-00
CR222	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152
CR223	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152
CR224	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152
CR225	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152
CR226	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152
CR265	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152
CR266	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152
CR307	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152
CR308	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152
CR407	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152
CR408	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152
CR441	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152
CR442	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	07910	1N4152
DS342	150-0111-00	B010100	B039999	LAMP,GLOW:NEON,1.2MA	53944	AlB-3
DS342	150-0130-00	B040000		LAMP,INCAND:5V,60MA	08806	2200DX
DS347	150-0111-00	B010100	B039999	LAMP,GLOW:NEON,1.2MA	53944	AlB-3
DS347	150-0130-00	B040000		LAMP,INCAND:5V,60MA	08806	2200DX
J1	131-0679-00	B010100	B029999	CONNECTOR,RCPT,:BNC W/HARDWARE	24931	28JR168-1
J1	131-0679-02	B030000		CONNECTOR,RCPT,:BNC W/HARDWARE	24931	28JR270-1
J21	131-0679-00	B010100	B029999	CONNECTOR,RCPT,:BNC W/HARDWARE	24931	28JR168-1
J21	131-0679-02	B030000		CONNECTOR,RCPT,:BNC W/HARDWARE	24931	28JR270-1
J60	136-0140-00			JACK,TIP:BANANA STYLE,CHARCOAL GRAY CA	80009	136-0140-00
K100	148-0080-00			RELAY,ARMATURE:5VDC,65 OHM,200MW	80009	148-0080-00
Q108	151-0219-00			TRANSISTOR:SILICON,PNP	80009	151-0219-00
Q109	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q110A,B	151-1049-00			TRANSISTOR:SILICON,JFE,N-CHANNEL,DUAL	80009	151-1049-00
Q114A,B	151-0232-00			TRANSISTOR:SILICON,NPN,DUAL	80009	151-0232-00
Q115A,B	151-0261-00			TRANSISTOR:SILICON,PNP,DUAL	80009	151-0261-00
Q117	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q120	151-0190-02			TRANSISTOR:SILICON,NPN	80009	151-0190-02
Q122	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q130A,B	151-0232-00			TRANSISTOR:SILICON,NPN,DUAL	80009	151-0232-00
Q135	151-0341-00			TRANSISTOR:SILICON,NPN	07263	S040065
Q140A,B	151-0232-00			TRANSISTOR:SILICON,NPN,DUAL	80009	151-0232-00
Q143	151-0341-00			TRANSISTOR:SILICON,NPN	07263	S040065
Q146	151-0219-00			TRANSISTOR:SILICON,PNP	80009	151-0219-00
Q149	151-0219-00			TRANSISTOR:SILICON,PNP	80009	151-0219-00
Q155	151-0219-00			TRANSISTOR:SILICON,PNP	80009	151-0219-00
Q158	151-0219-00			TRANSISTOR:SILICON,PNP	80009	151-0219-00
Q170A,B	151-0232-00			TRANSISTOR:SILICON,NPN,DUAL	80009	151-0232-00
Q175	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q190A,B	151-0261-00			TRANSISTOR:SILICON,PNP,DUAL	80009	151-0261-00
Q195	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q208	151-0219-00			TRANSISTOR:SILICON,PNP	80009	151-0219-00
Q209	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q217	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q220	151-0190-02			TRANSISTOR:SILICON,NPN	80009	151-0190-02

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Discont	Name & Description	Mfr Code	Mfr Part Number
Q222	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q295	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q300	151-0219-00			TRANSISTOR:SILICON,PNP	80009	151-0219-00
Q310	151-0341-00			TRANSISTOR:SILICON,NPN	07263	S040065
Q320	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q330	151-0219-00			TRANSISTOR:SILICON,PNP	80009	151-0219-00
Q342	151-0347-00	B010100	B039999	TRANSISTOR:SILICON,NPN	80009	151-0347-00
Q342	151-0281-00	B040000		TRANSISTOR:SILICON,NPN	03508	X16P4039
Q347	151-0347-00	B010100	B039999	TRANSISTOR:SILICON,NPN	80009	151-0347-00
Q347	151-0281-00	B040000		TRANSISTOR:SILICON,NPN	03508	X16P4039
Q400	151-0219-00			TRANSISTOR:SILICON,PNP	80009	151-0219-00
Q410	151-0341-00			TRANSISTOR:SILICON,NPN	07263	S040065
Q420	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q425	151-0341-00			TRANSISTOR:SILICON,NPN	07263	S040065
Q430	151-0219-00			TRANSISTOR:SILICON,PNP	80009	151-0219-00
R1	316-0105-00			RES.,FXD,CMPSN:1M OHM,10%,0.25W	01121	CB1051
R3	316-0470-00			RES.,FXD,CMPSN:47 OHM,10%,0.25W	01121	CB4701
R4	322-0624-07			RES.,FXD,FILM:990K OHM,0.1%,0.25W	75042	CEBT0-9903B
R5	322-0481-07			RES.,FXD,FILM:1M OHM,0.1%,0.25W	91637	MFF1421C10003B
R9	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	91637	MFF1816D10001C
R10	311-1223-00			RES.,VAR,NONWIR:250 OHM,10%,0.50W	32997	3386F-T04-251
R21	316-0105-00			RES.,FXD,CMPSN:1M OHM,10%,0.25W	01121	CB1051
R23	317-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.125W	01121	BB4705
R24	322-0624-07			RES.,FXD,FILM:990K OHM,0.1%,0.25W	75042	CEBT0-9903B
R25	322-0481-07			RES.,FXD,FILM:1M OHM,0.1%,0.25W	91637	MFF1421C10003B
R29	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	91637	MFF1816D10001C
R50	323-0225-00			RES.,FXD,FILM:2.15K OHM,1%,0.50W	91637	MFF1226C21500F
R51	323-0225-00			RES.,FXD,FILM:2.15K OHM,1%,0.50W	91637	MFF1226C21500F
R53	321-0187-00			RES.,FXD,FILM:866 OHM,1%,0.125W	91637	MFF1816G866ROF
R54	311-1226-00			RES.,VAR,NONWIR:2.5K OHM,20%,0.50W	32997	3386F-T04-252
R55	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	91637	MFF1816G90900F
R56	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R57	311-1223-00			RES.,VAR,NONWIR:250 OHM,10%,0.50W	32997	3386F-T04-251
R60	311-1324-00			RES.,VAR,WW:10K OHM,5%,2W	02111	534-9572 103J
R62	316-0102-00			RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R63	316-0102-00			RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R64	316-0103-00			RES.,FXD,CMPSN:10K OHM,10%,0.25W	01121	CB1031
R100	316-0221-00			RES.,FXD,CMPSN:220 OHM,10%,0.25W	01121	CB2211
R101	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R104	317-0107-00			RES.,FXD,CMPSN:100M OHM,5%,0.125W	01121	BB1075
R108	321-0219-00			RES.,FXD,FILM:1.87K OHM,1%,0.125W	91637	MFF1816G18700F
R110	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R112	311-1223-00			RES.,VAR,NONWIR:250 OHM,10%,0.50W	32997	3386F-T04-251
R114	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R115	321-0205-00			RES.,FXD,FILM:1.33K OHM,1%,0.125W	91637	MFF1816G13300F
R117	321-0188-00			RES.,FXD,FILM:887 OHM,1%,0.125W	91637	MFF1816G887ROF
R120	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R121	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R122	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R130	315-0683-00			RES.,FXD,CMPSN:68K OHM,5%,0.25W	01121	CB6835
R133	321-0155-00			RES.,FXD,FILM:402 OHM,1%,0.125W	91637	MFF1816G402ROF
R136	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R139	321-0155-00			RES.,FXD,FILM:402 OHM,1%,0.125W	91637	MFF1816G402ROF

Replaceable Electrical Parts—5A13N

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R140	316-0100-00		RES.,FXD,CMPSN:10 OHM,1%,0.25W	01121	CB1001
R142	321-0187-00		RES.,FXD,FILM:866 OHM,1%,0.125W	91637	MFF1816G866ROF
R143	321-0194-00		RES.,FXD,FILM:1.02K OHM,1%,0.125W	91637	MFF1816G10200F
R144	321-0293-00		RES.,FXD,FILM:11K OHM,1%,0.125W	91637	MFF1816G11001F
R146	321-0189-00		RES.,FXD,FILM:909 OHM,1%,0.125W	91637	MFF1816G909ROF
R148	321-0197-00		RES.,FXD,FILM:1.1K OHM,1%,0.125W	91637	MFF1816G11000F
R149	316-0101-00		RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R150	316-0681-00		RES.,FXD,CMPSN:680 OHM,10%,0.25W	01121	CB6811
R152	316-0103-00		RES.,FXD,CMPSN:10K OHM,10%,0.25W	01121	CB1031
R154	315-0222-00		RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R156	315-0223-00		RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R157	316-0472-00		RES.,FXD,CMPSN:4.7K OHM,10%,0.25W	01121	CB4721
R158	315-0123-00		RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
R160	321-0206-02		RES.,FXD,FILM:1.37K OHM,0.5%,0.125W	91637	MFF1816D13700D
R162	321-0291-00		RES.,FXD,FILM:10.5K OHM,1%,0.125W	91637	MFF1816G10501F
R163	321-0830-03		RES.,FXD,FILM:2.41K OHM,0.25%,0.125W	91637	MFF1816D24100C
R164	321-0716-01		RES.,FXD,FILM:606 OHM,0.5%,0.125W	91637	MFF1816G606ROD
R169	316-0101-00		RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R170	316-0470-00		RES.,FXD,CMPSN:47 OHM,10%,0.25W	01121	CB4701
R171	316-0273-00		RES.,FXD,CMPSN:27K OHM,10%,0.25W	01121	CB2731
R175	321-0127-00		RES.,FXD,FILM:205 OHM,1%,0.125W	91637	MFF1816G205ROF
R177	321-0185-00		RES.,FXD,FILM:825 OHM,1%,0.125W	91637	MFF1816G825ROF
R178	311-1116-00		RES.,VAR,NONWIR:100 OHM,20%,0.50W	01121	WA1G032S101MA
R179	321-0185-00		RES.,FXD,FILM:825 OHM,1%,0.125W	91637	MFF1816G825ROF
R180	311-1223-00		RES.,VAR,NONWIR:250 OHM,10%,0.50W	32997	3386F-T04-251
R182	321-0157-00		RES.,FXD,FILM:422 OHM,1%,0.125W	91637	MFF1816G422ROF
R191	321-0250-00		RES.,FXD,FILM:3.92K OHM,1%,0.125W	91637	MFF1816G39200F
R194	311-1221-00		RES.,VAR,NONWIR:50 OHM,20%,0.50W	32997	3386F-T04-500
R195	321-0609-07		RES.,FXD,FILM:480 OHM,0.1%,0.125W	91637	MFF1816C480ROB
R196	321-0293-03		RES.,FXD,FILM:11K OHM,0.25%,0.125W	91637	MFF1816D11001C
R198	321-0776-03		RES.,FXD,FILM:3.501K OHM,0.25%,0.125W	91637	MFF1816D35010C
R200	316-0101-00		RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R201	315-0104-00		RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R204	317-0107-00		RES.,FXD,CMPSN:100M OHM,5%,0.125W	01121	BB1075
R208	321-0219-00		RES.,FXD,FILM:1.87K OHM,1%,0.125W	91637	MFF1816G18700F
R210	316-0101-00		RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R211	316-0100-00		RES.,FXD,CMPSN:10 OHM,10%,0.25W	01121	CB1001
R212	311-1221-00		RES.,VAR,NONWIR:50 OHM,20%,0.50W	32997	3386F-T04-500
R213	315-0121-00		RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
R214	321-0260-00		RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R215	321-0205-00		RES.,FXD,FILM:1.33K OHM,1%,0.125W	91637	MFF1816G13300F
R217	321-0188-00		RES.,FXD,FILM:887 OHM,1%,0.125W	91637	MFF1816G887ROF
R220	315-0223-00		RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R221	316-0101-00		RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R222	316-0101-00		RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R230	315-0683-00		RES.,FXD,CMPSN:68K OHM,5%,0.25W	01121	CB6835
R233	321-0155-00		RES.,FXD,FILM:402 OHM,1%,0.125W	91637	MFF1816G402ROF
R239	321-0155-00		RES.,FXD,FILM:402 OHM,1%,0.125W	91637	MFF1816G402ROF
R240	316-0100-00		RES.,FXD,CMPSN:10 OHM,10%,0.25W	01121	CB1001
R260	321-0206-02		RES.,FXD,FILM:1.37K OHM,0.5%,0.125W	91637	MFF1816D13700D
R262	321-0291-00		RES.,FXD,FILM:10.5K OHM,1%,0.125W	91637	MFF1816G10501F
R269	316-0101-00		RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R270	316-0470-00		RES.,FXD,CMPSN:47 OHM,10%,0.25W	01121	CB4701

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Discont	Name & Description	Mfr Code	Mfr Part Number
R271	316-0273-00			RES.,FXD,CMPSN:27K OHM,10%,0.25W	01121	CB2731
R291	321-0250-00			RES.,FXD,FILM:3.92K OHM,1%,0.125W	91637	MFF1816G39200F
R294	315-0240-00			RES.,FXD,CMPSN:24 OHM,5%,0.25W	01121	CB2405
R295	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R297	315-0240-00			RES.,FXD,CMPSN:24 OHM,5%,0.25W	01121	CB2405
R298	321-0776-03			RES.,FXD,FILM:3.501K OHM,0.25%,0.125W	91637	MFF1816D35010C
R300	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R301	316-0470-00			RES.,FXD,CMPSN:47 OHM,10%,0.25W	01121	CB4701
R304	316-0103-00			RES.,FXD,CMPSN:10K OHM,10%,0.25W	01121	CB1031
R305	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R310	321-0136-00			RES.,FXD,FILM:255 OHM,1%,0.125W	91637	MFF1816G255ROF
R311	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R312	321-0227-00			RES.,FXD,FILM:2.26K OHM,1%,0.125W	91637	MFF1816G22600F
R314	321-0140-00			RES.,FXD,FILM:280 OHM,1%,0.125W	91637	MFF1816G280ROF
R315	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R318	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	91637	MFF1816G90900F
R319	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R321	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	91637	MFF1816G40200F
R323	315-0131-00			RES.,FXD,CMPSN:130 OHM,5%,0.25W	01121	CB1315
R330	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R331	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R333	321-0256-00			RES.,FXD,FILM:4.53K OHM,1%,0.125W	91637	MFF1816G45300F
R335 ¹	311-1318-00			RES.,VAR, NONWIR:2K OHM,20%,1W	01121	10176A
R341	316-0474-00	B010100	B029999	RES.,FXD,CMPSN:470K OHM,10%,0.25W	01121	CB4741
R341	316-0475-00	B030000	B039999	RES.,FXD,CMPSN:4.7M OHM,10%,0.25W	01121	CB4751
R341	315-0154-00	B040000		RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R342	316-0105-00	B010100	B039999X	RES.,FXD,CMPSN:1M OHM,10%,0.25W	01121	CB1051
R345	316-0105-00	B010100	B039999	RES.,FXD,CMPSN:1M OHM,10%,0.25W	01121	CB1051
R345	315-0154-00	B040000		RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R349	315-0124-00	B010100	B039999	RES.,FXD,CMPSN:120K OHM,5%,0.25W	01121	CB1245
R349	315-0100-00	B040000		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R350	316-0103-00	B010100	B039999X	RES.,FXD,CMPSN:10K OHM,10%,0.25W	01121	CB1031
R400	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R401	316-0470-00			RES.,FXD,CMPSN:47 OHM,10%,0.25W	01121	CB4701
R404	316-0103-00			RES.,FXD,CMPSN:10K OHM,10%,0.25W	01121	CB1031
R405	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R410	321-0136-00			RES.,FXD,FILM:255 OHM,1%,0.125W	91637	MFF1816G255ROF
R411	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R412	321-0227-00			RES.,FXD,FILM:2.26K OHM,1%,0.125W	91637	MFF1816G22600F
R413	315-0823-00			RES.,FXD,CMPSN:82K OHM,5%,0.25W	01121	CB8235
R414	311-1317-00			RES.,VAR, NONWIR:1K OHM,20%,1W	01121	10M625
R415	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R418	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	91637	MFF1816G90900F
R419	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R421	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	91637	MFF1816G40200F
R425	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R426	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R428	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R433	321-0256-00			RES.,FXD,FILM:4.53K OHM,1%,0.125W	91637	MFF1816G45300F
R440	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R444	316-0472-00			RES.,FXD,CMPSN:4.7K OHM,10%,0.25W	01121	CB4721
R445	316-0472-00			RES.,FXD,CMPSN:4.7K OHM,10%,0.25W	01121	CB4721
R446	316-0102-00			RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021

¹Furnished as a unit with S100.

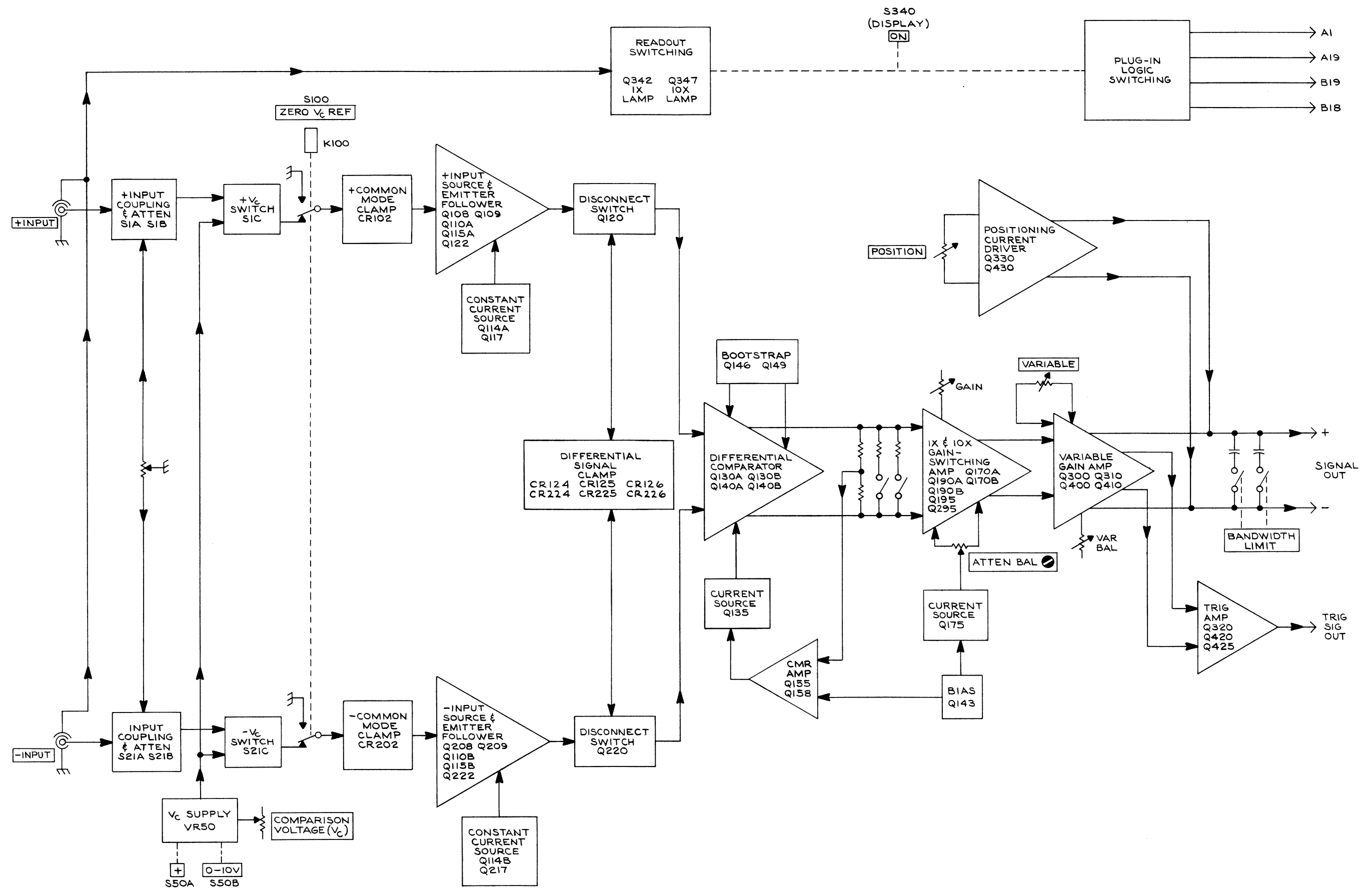
Replaceable Electrical Parts—5A13N

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R448	307-0103-00		RES., FXD, CMPSN: 2.7 OHM, 5%, 0.25W	01121	CB27G5
S1A) S1B) S1C)	260-1354-00		SWITCH, PUSH: DPDT, 3 BUTTON, INTERLOCK	80009	260-1354-00
S21A) S21B) S21C)	260-1354-00		SWITCH, PUSH: DPDT, 3 BUTTON, INTERLOCK	80009	260-1354-00
S50A,B S100 ¹	260-1353-00		SWITCH, PUSH: 2 BUTTON	80009	260-1353-00
S260	105-0300-00		ACTR ASSY, CAM S:	80009	105-0300-00
S337	260-1211-00		SWITCH, PUSH: DPDT, PUSH-PUSH	80009	260-1211-00
S340	260-1209-00		SWITCH, PUSH: 4PDT	80009	260-1209-00
VR50	152-0171-00		SEMICONV DEVICE: ZENER, 0.5W, 11.7V, 5%	80009	152-0171-00
VR440	152-0149-00		SEMICONV DEVICE: ZENER, 0.4W, 10V, 5%	04713	1N961B
VR447	152-0217-00		SEMICONV DEVICE: ZENER, 0.4W, 8.2V, 5%	80009	152-0217-00
VR448	152-0175-00		SEMICONV DEVICE: ZENER, 0.4W, 5.6V, 5%	80009	152-0175-00

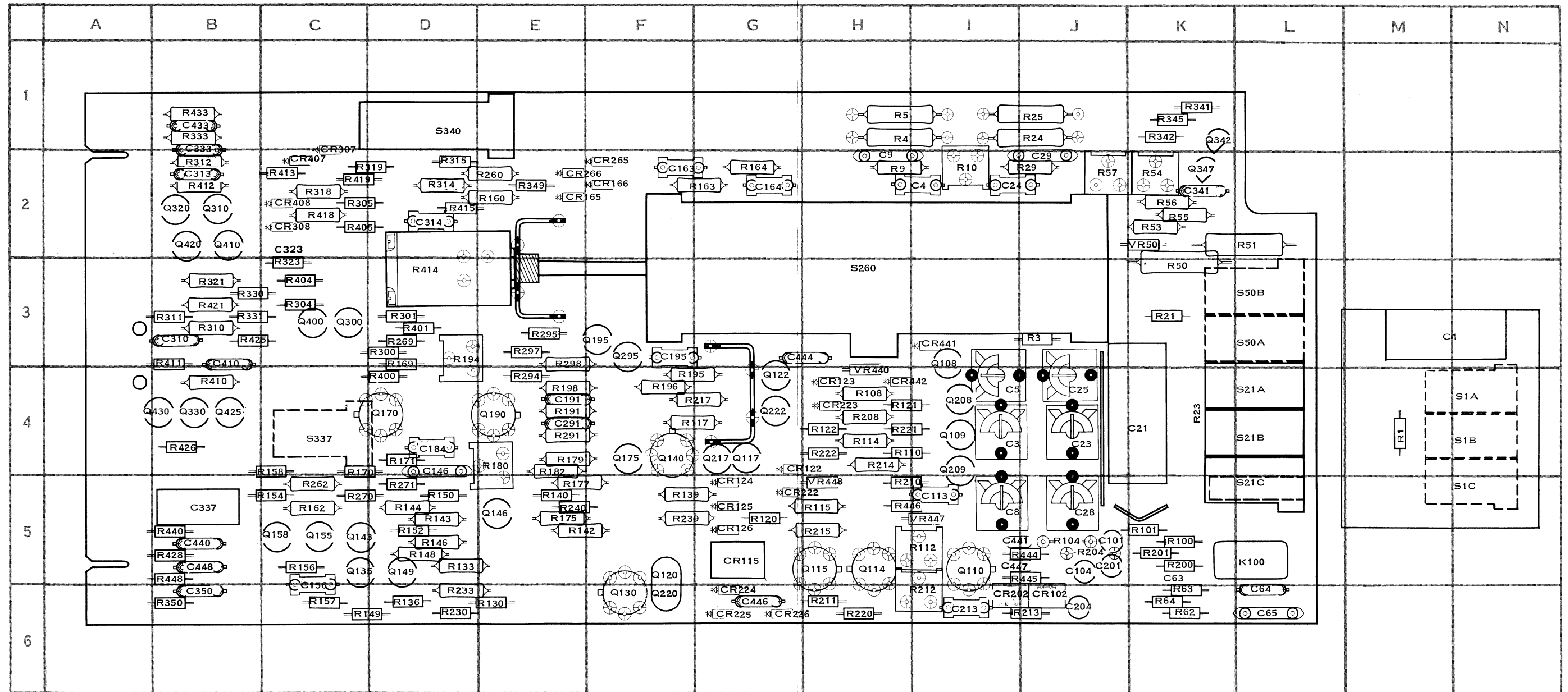
¹Furnished as a unit with R335.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C1	M3	CR265	F2	R54	K2	R215	H5	S1A	N4
C3	I4	CR266	E2	R55	K2	R217	G4	S1B	N4
C4	I2	CR307	C1	R56	K2	R220	H6	S1C	N5
C5	I4	CR308	C2	R57	J2	R221	H4	S21A	L4
C8	I5	CR407	C2			R222	H4	S21B	L4
C9	H2	CR408	C2	R62	K6			S21C	L5
C21	K4	CR441	I3	R63	K6	R230	D6	S50A,B	L3
C23	J4	CR442	H4	R64	K6	R233	D6	S260	H3
C24	I2	K100	L5	R100	K5	R239	F5	S337	C4
C25	J4	Q108	I3	R101	K5	R240	E5	S340	D1
		Q109	I4	R104	J5	R260	E2		
C28	J5	Q110A,B	I5	R108	H4			VR50	K2
C29	J2	Q114A,B	H5	R110	H4	R262	C5	VR440	H4
C63	K5	Q115A,B	H5	R112	I5	R269	D3	VR447	I5
C64	L6	Q117	G4	R114	H4	R270	C5	VR448	H5
C65	L6	Q120	F5	R115	H5	R271	D5		
C101	J5	Q122	G4	R117	G4	R291	E4		
C104	J5			R120	G5	R294	E4		
C113	I5	Q130A,B	F6			R295	E3		
C146	D4			R121	H4	R297	E3		
C156	C5	Q135	C5	R122	H4	R298	E3		
C163	F2	Q140A,B	F4						
C164	G2			R130	E6	R300	D3		
C184	D4	Q143	C5	R133	D5	R301	D3		
C191	E4	Q146	E5	R136	D6	R304	C3		
C195	F3	Q149	D5	R139	F5	R305	C2		
C201	J5	Q155	C5	R140	E5	R310	B3		
C204	J6	Q158	C5	R142	E5	R311	B3		
C213	I6	Q170A,B	D4	R143	D5	R312	B2		
				R144	D5	R314	D2		
C291	E4			R146	D5	R315	D2		
C310	B3	Q175	F4	R148	D5	R318	C2		
C313	B2	Q190A,B	E4	R149	C6	R319	C2		
		Q195	F3	R150	D5	R321	B3		
C314	D2	Q208	I4	R152	D5	R323	C3		
C323	C2	Q209	I4	R154	C5	R330	B3		
C333	B1	Q217	G4	R156	C5	R331	B3		
C337	B5	Q220	F6	R157	C6	R333	B1		
C341	K2	Q222	G4	R158	C4	R341	K1		
C350*	B6			R160	E2	R342*	K1		
C410	B3	Q295	F3	R162	C5	R345	K1		
C433	B1	Q300	C3	R163	F2	R349	E2		
C440	B5	Q310	B2	R164	G2	R350*	B6		
C441	I5	Q320	B2	R169	D3				
C444	H3	Q330	B4			R400	D4		
C446	G6	Q342	K1	R170	C4	R401	D3		
C447	I5	Q347	K2	R171	D4	R404	C2		
C448	B5	Q400	C3	R175	E5	R405	C2		
		Q410	B2	R177	E5	R410	B4		
		Q420	B2	R179	E4	R411	B3		
		Q425	B4	R180	E4	R412	B2		
CR102	J6	Q430	B4	R182	E4	R413	C2		
CR115	G5			R191	E4	R414	D3		
CR122	G4	R1	M4			R415	D2		
CR123	H4	R3	J3	R194	D3	R418	C2		
CR124	G5	R4	H1	R195	F4				
CR125	G5	R5	H1	R196	F4	R419	C2		
CR126	G5	R9	H2	R198	E4	R421	B3		
		R10	I2			R425	B3		
CR165	E2	R21	K3	R200	K5	R426	B4		
CR166	F2	R23	K4	R201	K5	R428	B5		
		R24	J1	R204	J5	R433	B1		
CR202	I6	R25	J1	R208	H4	R440	B5		
CR222	G5	R29	J2	R210	H5	R444	J5		
CR223	H4			R211	H6	R445	J5		
CR224	G5	R50	K3	R212	I6	R446	H5		
CR225	G5	R51	L2	R213	J6	R448	B5		
CR226	G5	R53	K2	R214	H4				

*See Parts List for
serial number ranges.

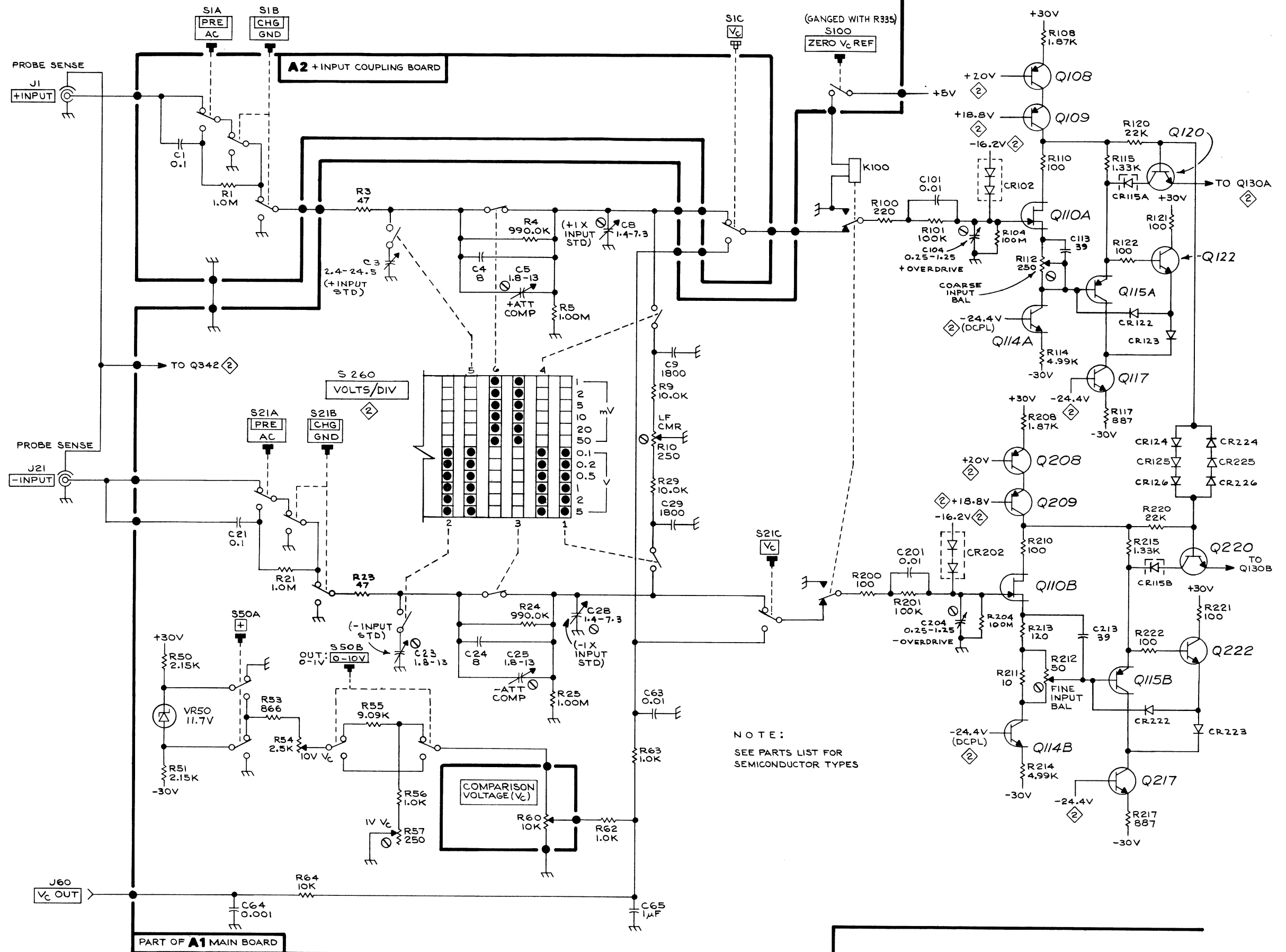


BLOCK DIAGRAM



NOTE. COMPONENTS SHOWN WITH DASHED LINES ARE LOCATED ON BACK SIDE OF BOARD.

Fig. 4-1. Component location grid. See parts list for coordinates.



5A13N

REV. C, SEP 1978

INPUT CIRCUIT & V_c SUPPLY 1 GRS 1171

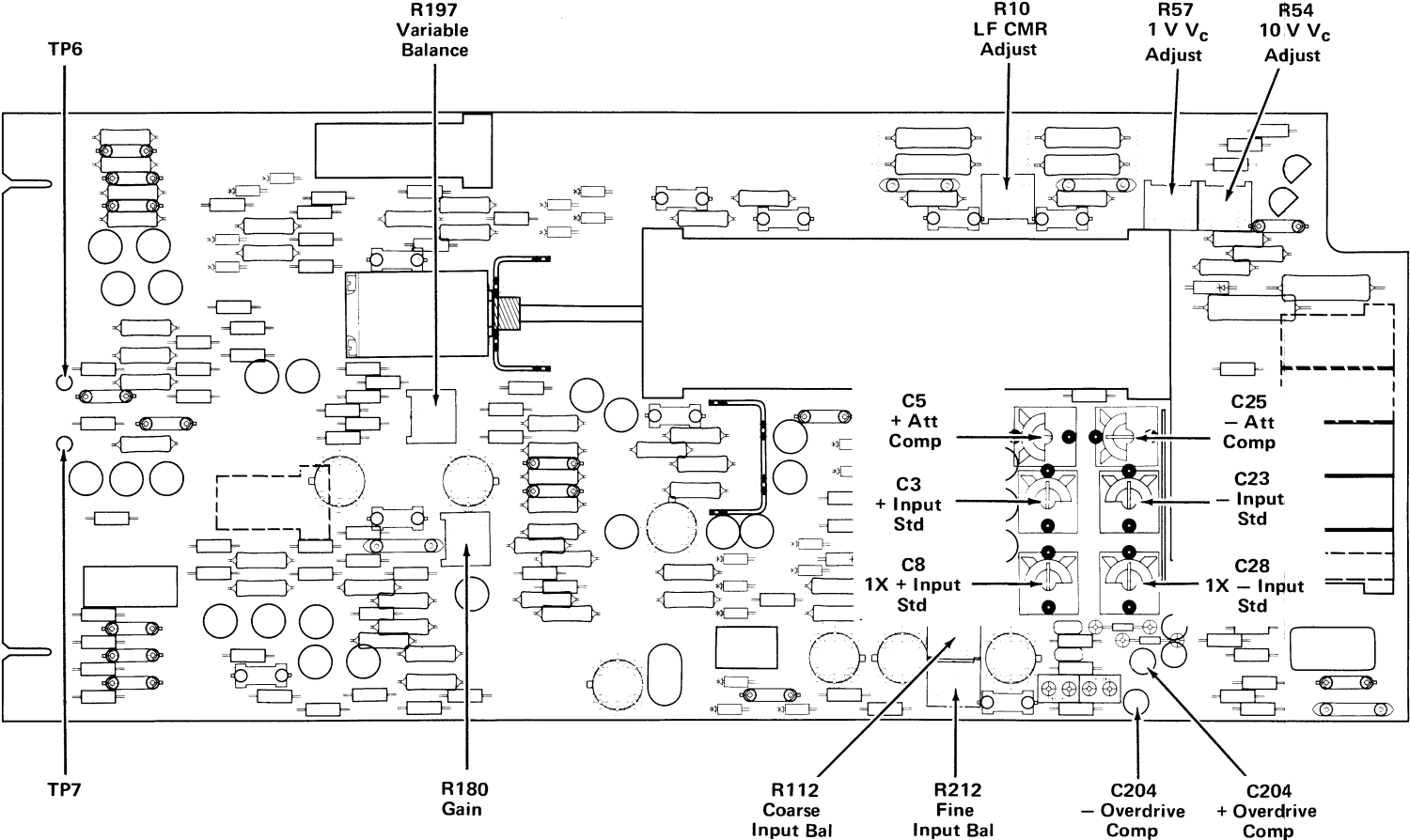
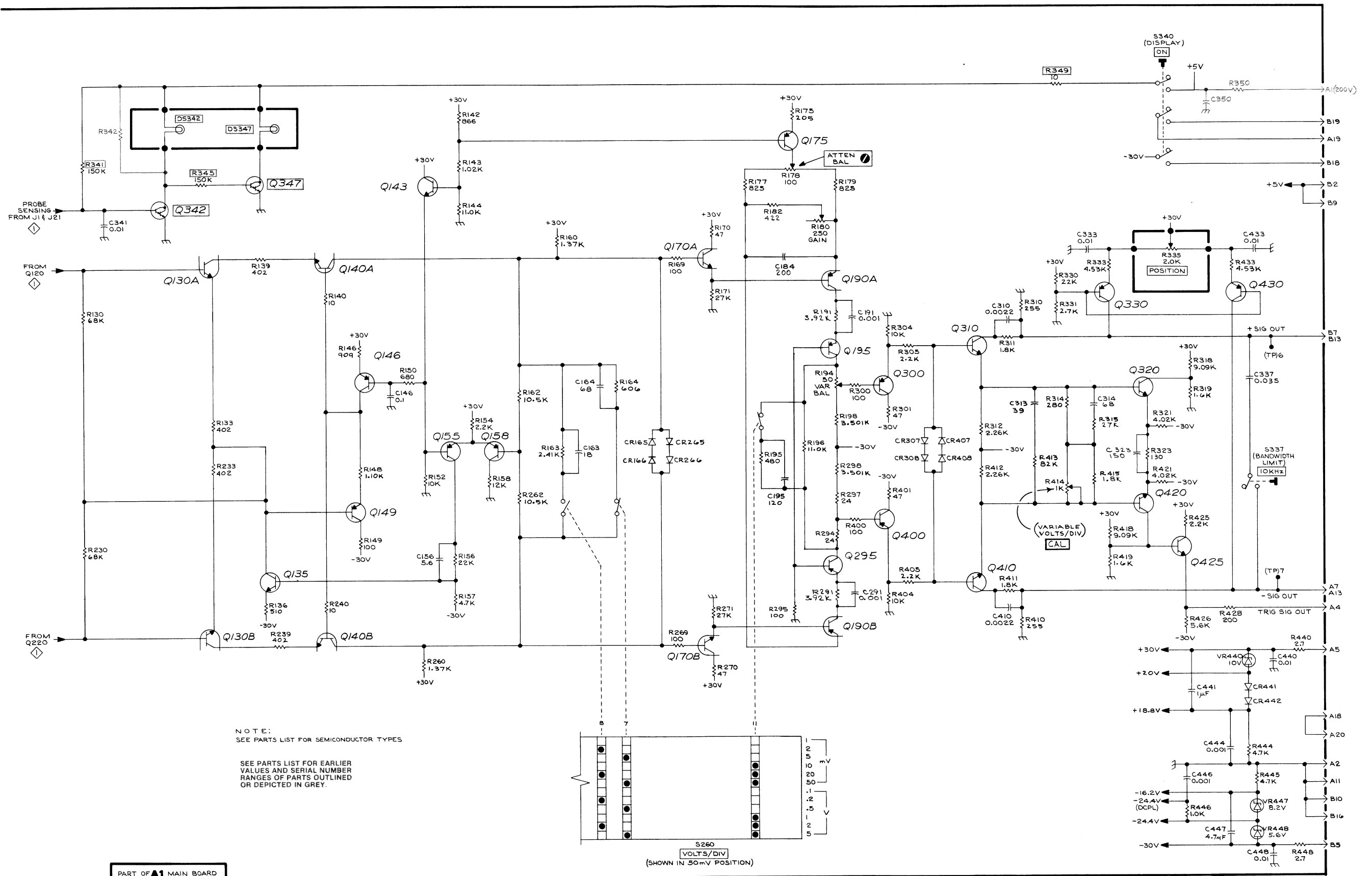


Fig. 4-2. Location of internal controls and test points.



REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number
00X Part removed after this serial number

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

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

```

1 2 3 4 5           Name & Description
Assembly and/or Component
Attaching parts for Assembly and/or Component
    --- * ---
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
    --- * ---
Parts of Detail Part
Attaching parts for Parts of Detail Part
    --- * ---
  
```

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol --- * --- indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

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

ABBREVIATIONS

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

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

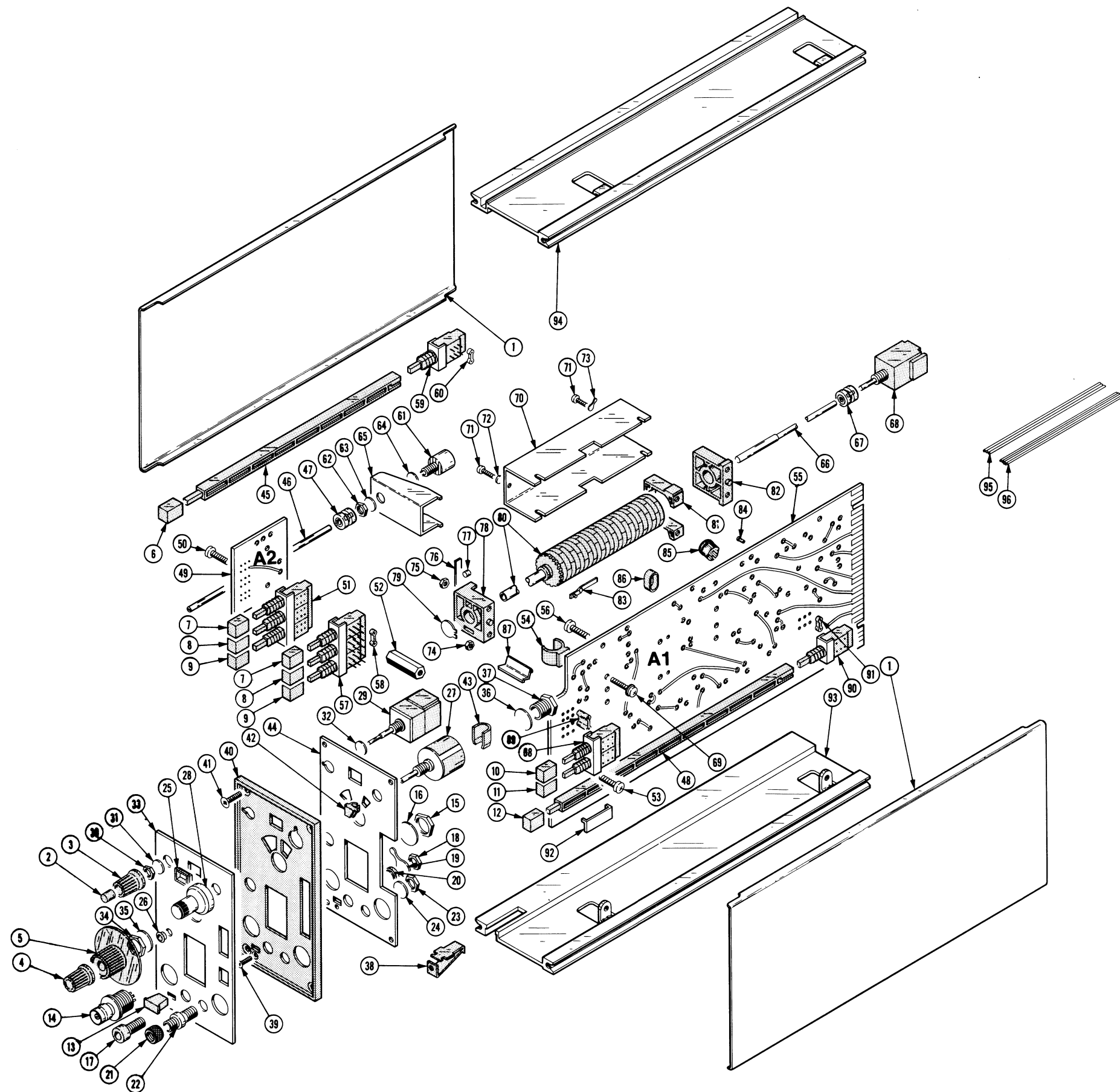
Mfr. Code	Manufacturer	Address	City, State, Zip
05129	KILO ENGINEERING COMPANY	2015 D	LA VERNE, CA 91750
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
24931	SPECIALTY CONNECTOR CO., INC.	3560 MADISON AVE.	INDIANAPOLIS, IN 46227
45722	USM CORP., PARKER-KALON FASTENER DIV.		CAMPBELLSVILLE, KY 42718
71785	TRW, CINCH CONNECTORS	1501 MORSE AVENUE	ELK GROVE VILLAGE, IL 60007
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
74445	HOLO-KROME CO.	31 BROOK ST. WEST	HARTFORD, CT 06110
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
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
86928	SEASTROM MFG. COMPANY, INC.	701 SONORA AVENUE	GLENDALE, CA 91201

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-1	337-1399-00		2		SHLD,ELECTRICAL:SIDE	80009	337-1399-00
-2	366-1059-00		1		PUSH BUTTON:GRAY	80009	366-1059-00
-3	366-1077-00		1		KNOB:GRAY	80009	366-1077-00
	213-0153-00		1		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-4	366-1317-00		1		KNOB:RED	80009	366-1317-00
	213-0153-00		1		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-5	366-1390-00		1		KNOB:GRAY W/SKIRT	80009	366-1390-00
	213-0153-00		2		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-6	366-1257-14		1		PUSH BUTTON:GRAY--ON	80009	366-1257-14
-7	366-1257-11		2		PUSH BUTTON:GRAY--AC PRE	80009	366-1257-11
-8	366-1257-12		2		PUSH BUTTON:GRAY--CHG GND	80009	366-1257-12
-9	366-1257-75		2		PUSH BUTTON:GRAY-- VC	80009	366-1257-75
-10	366-1257-78		1		PUSH BUTTON:GRAY-- 0-10V	80009	366-1257-78
-11	366-1257-79		1		PUSH BUTTON:GRAY-- +	80009	366-1257-79
-12	366-1257-77		1		PUSH BUTTON:GRAY	80009	366-1257-77
-13	366-1286-00	B010100 B029999	1		KNOB:LATCH	80009	366-1286-00
	366-1286-03	B030000 B039999	1		KNOB:LATCH,SILVER	80009	366-1286-03
	366-1690-00	B040000	1		KNOB,LATCH:	80009	366-1690-00
					(ATTACHING PARTS)		
	214-1840-00	XB030000 B039999X	1		PIN,KNOB SECRG:0.094 OD X 0.120 INCH LONG	80009	214-1840-00
					- - - * - - -		
-14	131-0679-00	B010100 B030467	2		CONNECTOR,RCPT,:BNC W/HARDWARE	24931	28JR168-1
	131-0679-02	B030468	2		CONNECTOR,RCPT,:BNC W/HARDWARE	24931	28JR270-1
					(ATTACHING PARTS FOR EACH)		
-15	220-0497-00	XB030468	1		NUT,PLAIN,HEX.:0.5-28 X 0.562 INCH HEX,BRS	73743	OBD
-16	210-1039-00	XB030468	1		WASHER,LOCK:INT,0.521 ID X 0.625 INCH OD	24931	OBD
					- - - * - - -		
-17	136-0140-00		1		JACK,TIP:BANANA STYLE,CHARCOAL GRAY CA	80009	136-0140-00
					(ATTACHING PARTS)		
-18	210-0583-00		1		NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-19	210-0223-00		1		TERMINAL,LUG:0.25 INCH DIA,SE	86928	A313-136
-20	210-0895-00		1		WSHR,SHOULDERED:0.375 OD X 0.105 INCH THK	80009	210-0895-00
					- - - * - - -		
	129-0103-00		1		POST,BDG,ELEC:ASSEMBLY	80009	129-0103-00
-21	200-0103-00		1		. NUT,PLAIN,KNURL:0.25-28 X 0.375" OD,BRASS	80009	200-0103-00
-22	129-0077-00		1		. STUD,SHOULDERED:0.938 INCH LONG,BRASS	80009	129-0077-00
					(ATTACHING PARTS)		
-23	210-0583-00		1		. NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-24	210-0046-00		1		. WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
					- - - * - - -		
-25	426-0681-00		10		FR,PUSH BUTTON:GRAY PLASTIC	80009	426-0681-00
-26	358-0378-00		1		BUSHING,SLEEVE:PRESS MOUNT	80009	358-0378-00
-27	-----		1		RES.,VAR:COMPARISON VOLTAGE,(SEE R60 EPL)		
					(ATTACHING PARTS)		
-28	331-0247-00		1		DIAL,CONTROL:10 TURN	05129	771-S-1
					- - - * - - -		
-29	-----		1		RES.,VAR:POSOTION(SEE R335/S100 EPL)		
					(ATTACHING PARTS)		
-30	210-0583-00		1		NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-31	210-0940-00		1		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
-32	210-0046-00		1		WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
					- - - * - - -		
-33	333-1502-00		1		PANEL,FRONT:	80009	333-1502-00
					(ATTACHING PARTS)		
-34	210-0590-00		1		NUT,PLAIN,HEX.:0.375 X 0.438 INCH,STL	73743	2X28269-402
-35	210-0978-00		1		WASHER,FLAT:0.375 ID X 0.50 INCH OD,STL	78471	OBD
-36	210-0012-00		1		WASHER,LOCK:INTL,0.375 ID X 0.50" OD STL	78189	1220-02-00-0541C
-37	358-0029-00		1		BSHG,MACH.THD:HEX,0.375-32 X 0.438"LONG	80009	358-0029-00
					- - - * - - -		
-38	214-1513-00	B010100 B029999	1		LCH,PLUG-IN RET:	80009	214-1513-00
	214-1513-01	B030000 B039999	1		LCH,PLUG-IN RET:	80009	214-1513-01

Replaceable Electrical Parts—5A13N

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-	105-0719-00	B040000	1		LATCH,RETAINING:PLUG-IN (ATTACHING PARTS)	80009	105-0719-00
-39	213-0254-00		1		SCR,TPG,THD CTG:2-32 X 0.250,100 DEG,FLH - - - * - - -	45722	OBD
	105-0718-00	B040000	1		RELEASE,LATCH:	80009	105-0718-00
-40	386-2110-00		1		SUBPANEL,FRONT: (ATTACHING PARTS)	80009	386-2110-00
-41	213-0229-00		4		SCR,TPG,THD FOR:6-20 X0.375"100 DEG,FLH STL - - - * - - -	83385	OBD
-42	136-0429-00		2		RETAINER,LAMP:CAM SWITCH	80009	136-0429-00
-43	337-1430-00		2		SHIELD,LIGHT:LAMP	80009	337-1430-00
-44	337-1526-00		1		SHIELD,ELEC:REAR SUBPANEL	80009	337-1526-00
-45	384-1059-00		1		EXTENSION SHAFT:6.58 INCH LONG	80009	384-1059-00
-46	384-1131-00		1		EXTENSION SHAFT:0.125 ID X 4.70 INCH LONG	80009	384-1131-00
-47	376-0051-00		1		CPLG,SHAFT,FLEX:FOR 0.125 INCH DIA SHAFTS	80009	376-0051-00
	213-0022-00		4		. SETSCREW:4-40 X 0.188 INCH,HEX SOC STL	74445	OBD
-48	384-1058-00		1		EXTENSION SHAFT:8.157 INCH LONG	80009	384-1058-00
-49	-----		1		CKT BOARD ASSY:+INPUT CPLG,(SEE A2 EPL) (ATTACHING PARTS)		
-50	211-0504-00		2		SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL - - - * - - -	83385	OBD
	-----		-		. CKT BOARD ASSY INCLUDES:		
-51	-----		1		. SWITCH,PUSH:+INPUT MODE,(SEE S1A,B,C EPL)		
-52	129-0295-00		2		SPACER,POST:0.250 HEX X 0.894 INCH L,AL (ATTACHING PARTS FOR EACH)	80009	129-0295-00
-53	211-0504-00		1		SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL - - - * - - -	83385	OBD
-54	344-0120-00		2		CLIP,SPR TNSN:CAPACITOR MTG	80009	344-0120-00
-55	-----		1		CKT BOARD ASSY:MAIN(SEE A1 EPL) (ATTACHING PARTS)		
-56	213-0146-00		4		SCR,TPG,THD FOR:6-20 X 0.313 INCH,PNH STL - - - * - - -	83385	OBD
	-----		-		. CKT BOARD ASSY INCLUDES:		
-57	-----		1		. SWITCH,PUSH:-INPUT MODE,(SEE S21A,B,C EPL)		
-58	361-0384-00		6		. SPACER,PB SW:0.133 INCH LONG	80009	361-0384-00
-59	-----		1		. SWITCH,PUSH:DISPLAY-ON(SEE S340 EPL)		
-60	361-0383-00		2		. SPACER,PB SW:CHARCOAL,0.33 INCH LONG	80009	361-0383-00
-61	-----		1		. RES.,VAR:STEP/ATTEN BAL(SEE R178 EPL) (ATTACHING PARTS)		
-62	210-0583-00		1		. NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-63	210-0940-00		1		. WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
-64	210-0046-00		1		. WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL - - - * - - -	78189	1214-05-00-0541C
-65	407-0991-00		1		. BRACKET,CMPT:VARIABLE RESISTOR MTG	80009	407-0991-00
-66	384-1127-00		1		. EXTENSION SHAFT:7.5 INCH L X 0.125 INCH OD	80009	384-1127-00
-67	376-0051-00		1		. CPLG,SHAFT,FLEX:FOR 0.125 INCH DIA SHAFTS	80009	376-0051-00
	213-0022-00		4		. . SETSCREW:4-40 X 0.188 INCH,HEX SOC STL	74445	OBD
-68	-----		1		. RES.,VAR:VOLT/DIV CAL,(SEE R414 EPL)		
	105-0300-00		1		. ACTR ASSY,CAM S:VOLTS/DIVISON(S260) (ATTACHING PARTS)	80009	105-0300-00
-69	211-0116-00		6		. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS - - - * - - -	83385	OBD
	-----		-		. . ACTUATOR ASSY INCLUDES:		
-70	200-0940-01		1		. . COVER,CAM S: (ATTACHING PARTS)	80009	200-0940-01
-71	211-0022-00		4		. . SCREW,MACHINE:2-56 X 0.188 INCH,PNH STL	83385	OBD
-72	210-0001-00		3		. . WASHER,LOCK:INTL,0.092 ID X 0.18"OD,STL	78189	1202-00-00-0541C
-73	210-0259-00		1		. . TERMINAL,LUG:0.099"ID INT TOOTH,SE - - - * - - -	80009	210-0259-00
	131-1219-00		1		. . CONTACT,ELEC:GROUNDING	80009	131-1219-00
-74	210-0406-00		2		. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-75	220-0636-00		1		. . NUT,PLAIN,HEX.:2-56 X 0.188 INCH HEX,BRS	73743	OBD

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty.	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
1-76	214-1139-02			1	.	.	.	SPRING,FLAT:GREEN COLORED		80009	214-1139-02	
	214-1139-03			1	.	.	.	SPRING,FLAT:RED COLORED		80009	214-1139-03	
-77	214-1127-00			1	.	.	.	ROLLER,DETENT:0.125 DIA X 0.125 INCH L		80009	214-1127-00	
-78	401-0057-00			1	.	.	.	BEARING,CAM SW:FRONT		80009	401-0057-00	
								(ATTACHING PARTS)				
-79	354-0219-00			1	.	.	.	RING,RETAINING:FOR 0.25 INCH SHAFT		79136	5103-25-MD-R	
					-	-	-	* - - -				
-80	105-0299-00			1	.	.	.	ACTUATOR,CAM S:W/SHAFTS		80009	105-0299-00	
-81	407-0653-00			1	.	.	.	BRACKET,COVER:CAM SWITCH		80009	407-0653-00	
	210-0406-00			2	.	.	.	NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS		73743	2X12161-402	
	220-0636-00			2	.	.	.	NUT,PLAIN,HEX.:2-56 X 0.188 INCH HEX,BRS		73743	OBD	
-82	401-0056-00			1	.	.	.	BEARING,CAM SW:REAR		80009	401-0056-00	
	210-0406-00			2	.	.	.	NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS		73743	2X12161-402	
	220-0636-00			1	.	.	.	NUT,PLAIN,HEX.:2-56 X 0.188 INCH HEX,BRS		73743	OBD	
-83	131-0604-00			11	.	.	.	CONTACT,ELEC:CKT CD SW,SPR		80009	131-0604-00	
-84	136-0252-04	B010100 B030411		8	.	.	.	SOCKET,PIN TERM:0.188 INCH LONG		22526	75060	
	136-0337-00	B030412		1	.	.	.	SOCKET,PLUG-IN:8 PIN RELAY		80009	136-0337-00	
-85	136-0235-00			7	.	.	.	SOCKET,PLUG-IN:6 CONTACT,ROUND		71785	133-96-12-062	
	214-0579-00			4	.	.	.	TERM.,TEST PT:0.40 INCH LONG		80009	214-0579-00	
-86	200-0715-00			1	.	.	.	COVER,HT STABILIZ:TRANSISTOR,DUAL		80009	200-0715-00	
-87	337-1640-00			1	.	.	.	SHIELD,ELEC:CAPACITOR		80009	337-1640-00	
-88	-----			1	.	.	.	SWITCH,PUSH:POLARITY/RANGE,(SEE S50A,B EPL)				
-89	361-0382-00			4	.	.	.	SPACER,PB SW:BROWN,0.275 INCH LONG		80009	361-0382-00	
-90	-----			1	.	.	.	SWITCH,PUSH:B/W LIMIT,(SEE S337 EPL)				
-91	361-0384-00			2	.	.	.	SPACER,PB SW:0.133 INCH LONG		80009	361-0384-00	
-92	337-1642-00			1	.	.	.	SHIELD,ELEC:INPUT,BRASS		80009	337-1642-00	
-93	426-0724-00			1	FR	SECT,	PLUG-IN:BOTTOM			80009	426-0724-00	
-94	426-0725-01			1	FR	SECT,	PLUG-IN:TOP			80009	426-0725-01	
-95	175-0826-00			FT	WIRE,	ELECTRICAL:3	WIRE RIBBON,3.75 INCHES			80009	175-0826-00	
-96	175-0827-00			FT	WIRE,	ELECTRICAL:4	WIRE RIBBON,14.5 INCHES			80009	175-0827-00	



MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

SERVICE NOTE

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

CALIBRATION TEST EQUIPMENT REPLACEMENT

Calibration Test Equipment Chart

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

Comparison of Main Characteristics

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

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