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5A22N

DIFFERENTIAL AMPLIFIER

INSTRUCTION MANUAL

INSTRUCTION MANUAL

Serial Number _____

5A22N

DIFFERENTIAL AMPLIFIER

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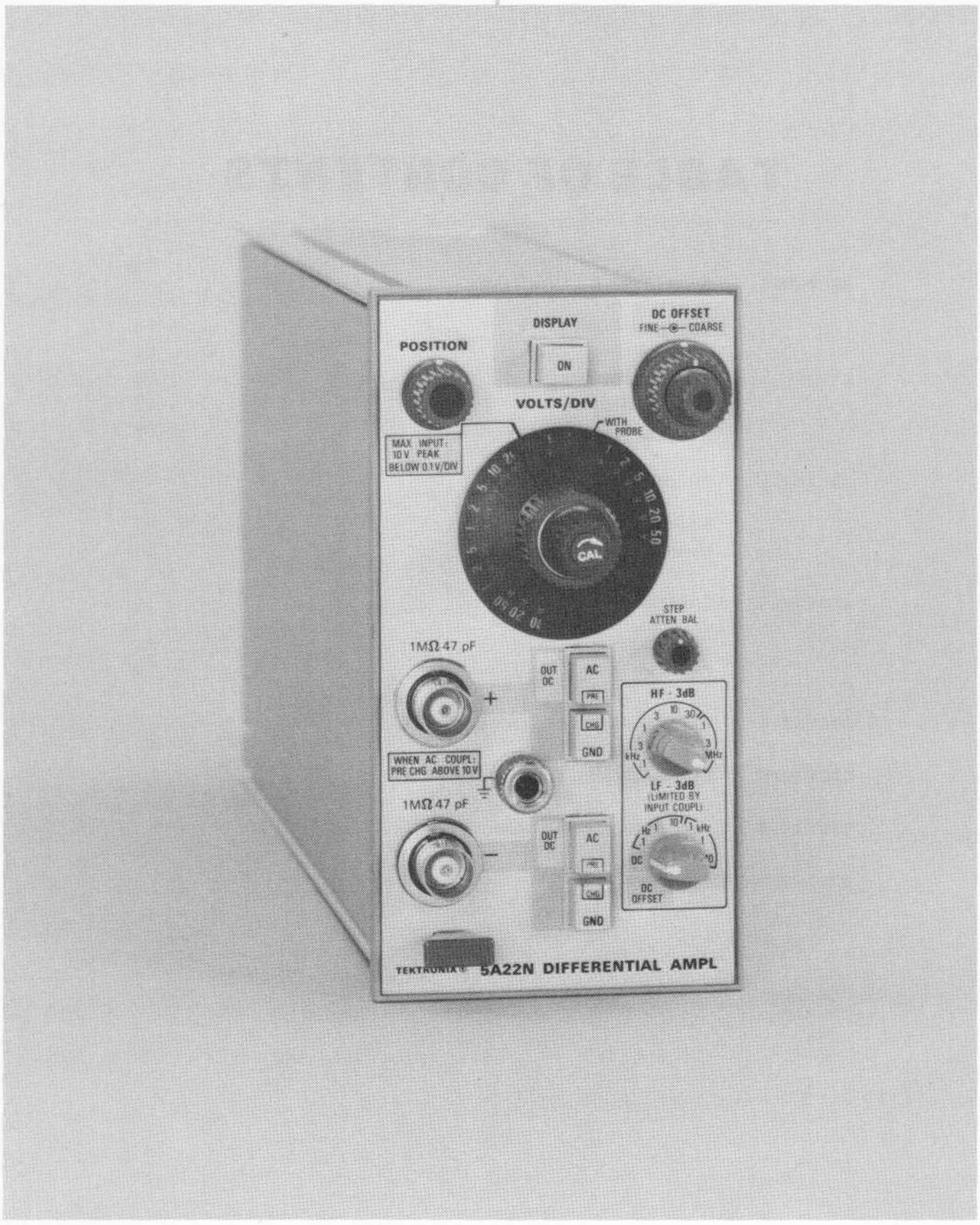


5A22N Differential Amplifier

SECTION 1
OPERATING INSTRUCTIONS

Instrument Description

The 5A22N Differential Amplifier is a high-gain differential amplifier plug-in unit for use with Tektronix 5100-Series Oscilloscopes. The unit features high sensitivity with direct-coupled inputs, high common-mode rejection, and variable DC offset. An illuminated knob skirt provides deflection factor readout. The unit has a maximum bandwidth capability of DC to one megahertz with selectable high and low-frequency limits for increasing the signal-to-noise ratio at low frequencies.

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 — 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.

HF –3 dB — Allows reduction of the upper bandwidth frequency limit to increase the signal-to-noise ratio for low-frequency applications.

LF –3 dB — Allows lower bandwidth frequency to be increased, thus reducing bandwidth and increasing the signal-to-noise ratio. Also, low-frequency drift can be reduced by restricting frequency response. When AC coupled, the lower bandwidth frequency is limited to 2 hertz by the coupling capacitor. This control also provides DC offset operation when in the DC OFFSET position.

VOLTS/DIV — Volts per major graticule division. Selects calibrated deflection factor in a 1-2-5 sequence, from 10 μV/Div to 5 V/Div in 18 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.

DC OFFSET — COARSE and FINE controls provide on-screen display of small signal variations on relatively large DC levels. LF –3 dB switch must be in the DC OFFSET position.

STEP ATTEN DC BAL — Balances the input amplifier for minimum trace shift throughout the deflection factor gain-switching range.

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

Input Coupling (cont) Pushbutton — 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 precharging of the coupling capacitor to the input signal DC level. Release GND button for measurement.

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

BASIC OPERATION

Preparation

The 5A22N is calibrated and ready for use as it is received. It can be installed in any compartment of the 5100N-Series Power Supply/Amplifier module, but it is intended for primary use in vertical compartments (the center and left compartments). For X-Y operation, the 5A22N may also be installed in the horizontal (right) compartment (refer to the Oscilloscope System instruction manual for information on X-Y operation).

NOTE

The Power Supply/Amplifier module is designed so that in the absence of DISPLAY logic levels from the vertical plug-ins, it will display the output of the unit in the left compartment.

To install, align the upper and lower rails of the 5A22N 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 5A22N from the oscilloscope.

The first few steps of the following procedure are intended to help place the trace on the screen quickly and prepare the instrument for immediate use. The remainder of the steps demonstrate some of the basic functions of the 5A22N. Operation of other instruments in the system is described in the instruction manuals for those units.

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

2. Turn the oscilloscope Intensity control fully counterclockwise and turn the oscilloscope system Power On. Preset the time-base and triggering controls for a 2-millisecond/division sweep rate and automatic triggering.

3. Set the 5A22N front-panel controls as follows:

DISPLAY

DISPLAY	ON (readout illuminates)
POSITION	Midrange
LF and HF –3 dB	Full bandwidth
VOLTS/DIV	.1 V
STEP ATTEN BAL	Midrange
+ Input Coupling	DC, GND
– Input Coupling	DC, GND

NOTE

About five minutes is sufficient time for warmup when using the 5A22N for short-term DC measurements. For long-term DC measurements using the lower deflection factors, allow at least 15 minutes.

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.

CAUTION

If the maximum input voltage rating at the gates of the input FET's is exceeded, the gates are diode-clamped at about + or – 12.0 volts. If the signal source can supply more than 1/16 A, the input protective fuse(s) will open.

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 + input GND button. The display should be a four division square wave 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 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 Adjustment

If this 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 both the + and — inputs (GND buttons pushed in), set the VOLTS/DIV switch to 5 V, and move the trace to graticule center with the POSITION control.

b. Adjust the STEP ATTEN BAL control for minimum trace shift as the VOLTS/DIV switch is rotated throughout its range.

Gain Check

Whenever the 5A22N is inserted into a plug-in compartment other than the one in which it was calibrated, the amplifier gain may be checked and, if necessary, adjusted. See the Calibration Procedure in this manual for complete instructions.

GENERAL INFORMATION

Applying Signals

CAUTION

If the 5A22N input is connected to a large DC voltage source without using the pre-charge provision, the peak charging current (into a 0.1 μF capacitor) will be limited only by the internal resistance of the signal source, and this source may be damaged.

When measuring DC voltages, use the largest deflection factor (5 V/Div) when first connecting the 5A22N to an unknown voltage source. If the deflection is too small to make the measurement, switch to a lower deflection factor. If the input stage is overdriven, a large amount of current might flow into the input and open the protective fuse. See CAUTION after item 5 of the Basic Operation.

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 5A22N 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 5A22N, consider the method of coupling that will be used. Sometimes unshielded test leads can be used to connect the 5A22N 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 ground connection between the device under test and the 5A22N. The shield of a coaxial cable is normally used for this purpose.

In some cases, differential measurements require no common ground connection,[1] 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 5A22N. The circuit at the input connectors can normally be represented by a 1 megohm resistance to ground paralleled by the 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 5A22N 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 5A22N 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 an FET Probe or the high impedance input provision of the 5A22N.

High Impedance Input

In the 50 mV through 10 μV positions of the VOLTS/DIV switch, where the input attenuator is not used, the internal gate return resistors alone establish the 1 megohm input resistance. The removal of the strap from the circuit board disconnects these resistors from ground and permits the input FET gates to float, providing a very high input impedance. The signal source must then provide a DC path for the FET gate current.

The input signal must be kept to relatively low amplitudes, since the deflection factor is restricted to 50 mV/Div through 10 μV/div, and DC coupling must be used.

[1] **The DC plus AC voltages on the test points (with respect to the chassis potential of the 5A22N) should be limited to the levels listed in Electrical Characteristics under Common-Mode Rejection. Higher levels will degrade the common-mode rejection ratio and exceed the input voltage rating of the unit.**

NOTE

In the 0.1 V to 5 V range of the VOLTS/DIV switch, the input impedance is paralleled by the resistors in the attenuator. When the link is removed, the attenuation ratio is affected, causing the deflection factors in this range to be incorrect. To determine the deflection factor, check the deflection with an input signal of known amplitude.

The signal source impedance is an important factor, since gate current will produce a DC offset. For example, a 100 picoampere gate current through 10 megohms produces a one-millivolt offset, which may result in significant error where small voltages are of concern.

The high frequency response will also depend upon the signal source impedance, since various shunt capacitances between the source and the input gate must charge and discharge through that impedance.

Gate Current Compensation

The leakage current associated with the gates of the input FETs may be as high as 100 picoamperes. This leakage current will produce an offset voltage which, at the higher input sensitivities, is not acceptable. For example, 100 picoamperes through a one-megohm input resistance to ground produces an offset voltage of 100 microvolts which could drive a display off-screen at 10 microvolts per division. To compensate this effect, the gates of the input FETs may be adjusted to zero volts by returning R120 and R126 through potentiometers R121 and R127 to a slightly negative supply voltage.

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 it pertains to the direction of voltage change at one input with respect to the other, rather than with respect to chassis potential.

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 into 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.

To reduce noise at higher frequencies and drift at lower frequencies and obtain a more usable display when the VOLTS/DIV switch is set to the more sensitive positions, reduce bandwidth with LF and HF −3 dB switches.

Voltage Comparison Measurements

Some applications require deflection factors other than the fixed values provided by the VOLTS/DIV switch. One such application is comparison of signal amplitudes by ratio rather than by absolute voltage. To accomplish this, apply a reference signal to either input of the 5A22N, and set the VOLTS/DIV switch and Variable control so that the reference display covers the desired number of graticule divisions. Do not change this setting of the Variable control throughout the subsequent comparisons. The settings of the VOLTS/DIV switch can be changed, however, to accomodate large ratios. In doing so, regard the numbers which designate the switch positions as ratio factors rather than voltages.

Differential Operation

Single-ended measurements often yield unsatisfactory results because of interference resulting from ground-loop currents between the 5A22N and the device under test. In other cases, it may be desirable to eliminate a DC voltage by means other than the use of a DC-blocking capacitor, which could limit the low-frequency response.

These limitations of single-ended measurements are effectively eliminated using differential measurements. Differential measurements are made by connecting each input (+ input and − input) to selected points in the test circuit. Since the chassis of the 5A22N need not be connected in any way to the test circuit, there are few limitations to the selection of these test points. In any case, do not exceed the maximum safe input voltages listed in Electrical Characteristics.

Both Input Coupling switches should be set to the same position, AC or DC, depending on the method of signal coupling required.

Only the voltage difference between two signals is amplified and displayed in differential measurements, while the common-mode signals (common in amplitude, frequency, and phase) are rejected. See Fig. 1-1.

The ability of the 5A22N to reject common-mode signals is indicated by the common-mode rejection ratio (CMRR). CMRR is at least 100,000:1 at the input connectors for the lower deflection factors (10 μV/DIV and 20 μV/DIV) when signals between DC and 30 kHz are DC coupled to the inputs. To illustrate this characteristic, assume that a single-ended input signal consists of an unwanted 60 Hz signal at 1 volt peak to peak, plus a desired signal at 1 mV peak to peak. If an attempt is made to display the described signal (single-ended measurements) at .2 mV/DIV, the 60 Hz signal will produce a deflection equivalent to 5000 divisions and the 1 mV signal will be lost.

If the same 1 mV signal is measured differentially with the 60 Hz signal common to both inputs, no more than one part in 100,000 of the common-mode signal will appear in the display. The desired signal will produce a display of 5 divisions, with not more than 0.1 division of display produced by the common-mode signal (CMRR not specified when residual display is 0.1 division or less).

There are a number of factors which can degrade common-mode rejection. The principal requirement for maximum rejection is for the common-mode signal to arrive at the input FET gates in precisely the same form. A difference of only 0.01% in the attenuation factors of the input attenuators may reduce the rejection ratio to 10,000:1. Likewise, any difference in source impedance at the two points in the source under test will degrade the rejection ratio. Attenuator probes which do not have adjustable R and C may reduce the rejection ratio to 100:1 or less (swapping probes may improve the rejection ratio).

Outside influences such as magnetic fields can also degrade the 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.

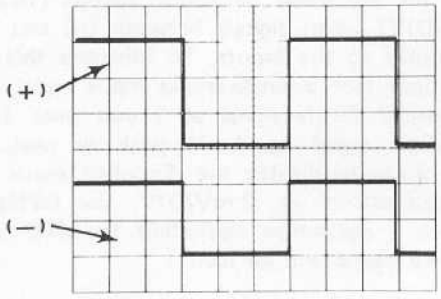
Voltage Probes

In general, probes offer the most convenient means of connecting a signal to the input of the 5A22N. 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.

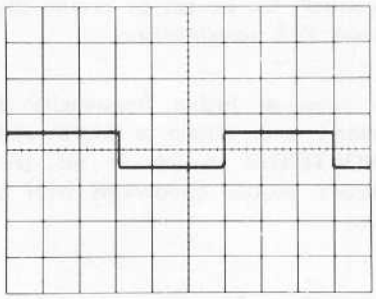
Differential Measurement. The following adjustment procedure is recommended when preparing to use two

Double exposure photographs of the waveforms applied to the (+) and (—) input connectors.

Photographs of the resultant display.

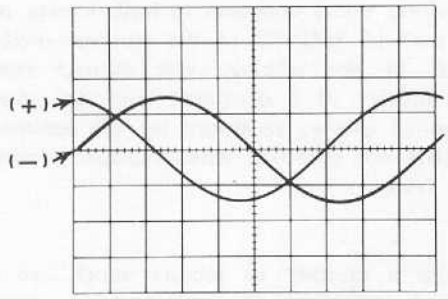


1-A

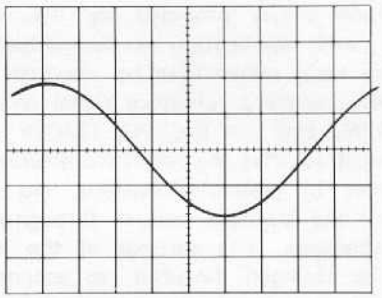


1-B

Two signals of different amplitude.

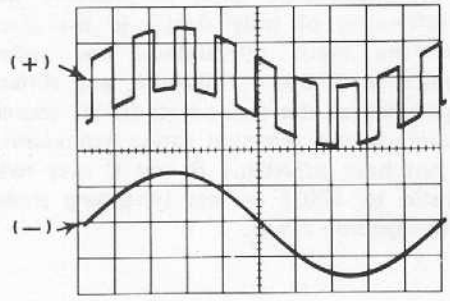


2-A

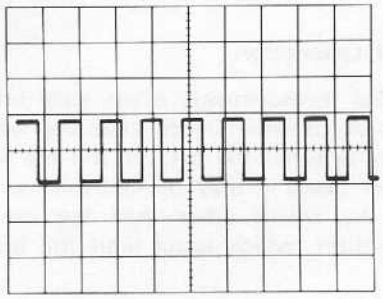


2-B

Two signals of different phase.



3-A



3-B

A composite waveform of a desired signal (square wave) with an interfering line-frequency component is applied to the (+) input. The interfering signal (sine wave) is also applied to the (—) input connector.

NOTE: The waveform of the signals applied to the (—) input connectors will appear inverted when viewed alone.

Fig. 1-1. Three examples of differential applications.

Tektronix P6023 probes for differential measurement. (This probe type does not have the coding feature to be discussed later.)

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 using the AC Fine Comp adjust and the AC Coarse Comp adjust if necessary.

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 AC Fine Comp and AC Coarse Comp, 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 5A22N 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 5A22N 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 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.

Performance Conditions

The following characteristics apply when the 5A22N is operating within the environment described in the 5100-Series Oscilloscope System manual. In addition, the 5A22N must have been calibrated at an ambient temperature between +20°C and +30°C.

Bandwidth (−3 dB)

DC (DIRECT) COUPLED: DC to at least 1 MHz independent of deflection factor. Selectable high- and low-frequency limits.

AC (CAPACITIVE) COUPLED: 2 Hz to at least 1 MHz.

High and Low −3 dB Frequencies

HF −3 dB: Selectable from 0.1 kHz to 1 MHz in a 7 step, 1-3-10 sequence.

LF −3 dB: Selectable from DC to 10 kHz in a 7 step, 1-10-100 sequence. Limited to 2 Hz when AC-coupled.

Deflection Factor

10 μV/div to 5 V/div within 2% in an 18 step, 1-2-5 sequence.

Uncalibrated, continuously variable between steps and to 12.5 V/div.

Common-Mode Rejection

DC (DIRECT) COUPLED: At least 100 dB, DC to 30 kHz at 10 μV/div to 0.1 mV/div with up to 20 V P-P sine wave, decreasing by 20 dB/decade or less on lower deflection factors up to 50 mV/div. At least 50 dB, 0.1 V/div to 5 V/div with up to 100 V P-P sine wave. At least 50 dB at any deflection factor with two P6060 probes.

AC (CAPACITIVE) COUPLED: At least 80 dB at 5 kHz and above, decreasing to 50 dB at 10 Hz.

DC Offset Range

At least + and −0.5 V from 10 μV/div to 50 mV/div. At least + and −50 V from 100 mV/div to 5 V/div.

Input RC

1 MΩ within 0.1% paralleled by ≈ 47 pF.

Overdrive Recovery

Unit recovers to within 0.5% of the quiescent level, in 5 μs after overdriving signal has been applied for 1 s.

Maximum Input Gate Current

100 pA (100 μV depending on external loading) at 25°C.

Maximum Safe Input Voltages

DC (DIRECT) COUPLED: 10 V (DC + peak AC) from 10 μV/div to 50,mV/div. 350 V (DC + peak AC) from 100 mV/div to 5 V/div.

AC (CAPACITIVE) COUPLED: 350 VDC + 10 V peak AC from 10 μV/div to 50 mV/div with coupling capacitor precharged. 350 V (DC + peak AC) from 100 mV/div to 5 V/div.

DC Stability

DRIFT WITH TEMP: 100 μV/°C.

Displayed Noise

20 μV or less measured tangentially at full bandwidth (DC to 1 MHz) with 25 Ω source resistance.

REPACKAGING FOR SHIPMENT

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

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

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

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

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

4. Seal carton with shipping tape or industrial stapler.

SHIPPING CARTON TEST STRENGTH

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

SECTION 2
THEORY OF OPERATION

Introduction

This section of the manual contains an electrical description of the circuits in the 5A22N Differential Amplifier unit. Complete schematic diagrams and an overall block diagram of the unit are given on pullout pages at the back of this manual.

BLOCK DIAGRAM DESCRIPTION

When the DISPLAY button is pressed, a logic level is applied to the oscilloscope to enable 5A22N operation (switch function is limited to operation in a vertical compartment), and the front-panel readout lamp illuminates to indicate the ON mode.

Voltage 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 DC-coupled signals and applies a reference ground to the preamplifier 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 positions 10 μV to 50 mV of the VOLTS/DIV switch, and 100X attenuation is provided for positions 0.1 V to 5 V. Balance to a low-frequency common-mode signal between the attenuators of the two inputs is set by adjustment of the ATTEN DC CMR potentiometer.

From the input attenuators, the signal is passed directly to the preamplifier. The inputs to the preamplifier are fuse- and diode-protected. The preamplifier consists of two identical operational amplifiers connected in a differential configuration. Common-mode signals between ground and the two inputs are rejected, due to a bootstrapped floating power supply that moves with the common-mode signal to maintain constant operating characteristics of the active devices. The difference between the two inputs is amplified. The output of the preamplifier stage is a push-pull signal, opposite in polarity to that applied to the input. The signal is then passed through a switchable low-frequency limiting circuit.

The gain switching stage consists of two identical operational amplifiers operating in a differential mode. The VOLTS/DIV switch changes the value of the common source/emitter resistor between the two sides, thus changing the gain for the various deflection factors.

The offset generator compensates for DC levels up to + or – 0.5 volt. The signal is then passed through an emitter-follower isolation stage to the output amplifier.

The output differential amplifier is operated push-pull, presenting a signal to the output terminals of the same polarity as that applied to the preamplifier input. Emitter degeneration produced by the Variable Volts/Div and Gain controls provides a means of varying the gain of the 5A22N. A positioning-current driver is connected to the output lines to alter the quiescent CRT beam position.

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

DETAILED CIRCUIT DESCRIPTION

Plug-In Logic

When the DISPLAY button, S108, is pressed, a logic level is applied to the electronic switching circuit in the oscilloscope to enable plug-in operation. Power is applied to illuminate 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, S110A and S110B for the + input and S140A and S140B for the – input.

Assuming that a signal is applied to the + input, the applied signal is passed directly to the attenuators when both buttons are out. When the AC button is pressed, C110 is placed in the circuit to couple signals to about two hertz (–3 dB point) and higher to the attenuator. This capacitor

blocks any DC component of the signal. 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 connector.

NOTE

When DC levels (above 10 volts) are to be blocked by AC coupling, both the AC and GND buttons should be pressed in (PRE CHG) while input connections are made or broken, or when voltage levels are changed. This will allow the coupling capacitor to charge without blowing the input fuses or overdriving the amplifier.

Input Attenuators

The input attenuators are frequency-compensated voltage dividers which provide 100X attenuation in positions 0.1 to 5 of the VOLTS/DIV switch. At DC and for low-frequency signals, the dividers are essentially resistive (attenuation ratio determined by the resistance ratio). Balance to a low-frequency common-mode signal between the attenuators of the two inputs is set by adjustment of R132, ATTEN DC CMR. At higher frequencies, the capacitive reactance becomes effective and the attenuation ratio is determined by the impedance ratio.

In addition to providing constant 100X attenuation at all frequencies within the bandwidth capabilities of the instrument, the input attenuators maintain a constant input RC characteristic (one megohm paralleled by about 47 pF) for settings 0.1 to 5 of the VOLTS/DIV switch.

Input Protection

Input protection consists of fuses F118, F148 and diodes CR136, CR137, CR138, and CR139. If the signal should reach a level sufficient to forward bias one of the protection diodes (a potential greater than about 12.5 volts), current will be conducted through that diode, protecting the input FET's. If that current should exceed the rating of the fuse, the protective fuse(s) will open. If the signal source is not able to supply enough current to open the fuse, damage to the signal source may result.

Gate Current Compensation

The leakage current associated with the gates of the input FET's may be as high as 100 pA. This 100 pA of leakage current (through 1 megohm to ground, R120 or R126) will produce an offset of 100 μV, which at high input sensitivities is not acceptable. To compensate this effect, the gates of the input FET's may be adjusted to zero volts by returning R120, R126 through variable controls R121 and R127 to a slightly negative supply voltage.

Leakage current associated with the gates of the input FET's and the overdrive protection diodes increases rapidly with temperature, approximately doubling for every 10°C. To compensate this increase, a temperature sensitive input current balancing network is included, using thermistors as the sensing elements.

As the voltage across R120 and R126 increases due to increasing FET gate current at increased temperatures, an equal voltage change is produced in the thermistor compensating circuit, maintaining the FET gate level at zero volts.

The gate current compensation becomes inoperative if the straps are removed for high input impedance operation.

Preamplifier Stage

The preamplifier consists of two identical operational amplifiers, connected in a differential configuration. Fig. 2-1 shows a simplified block diagram of the Preamp.

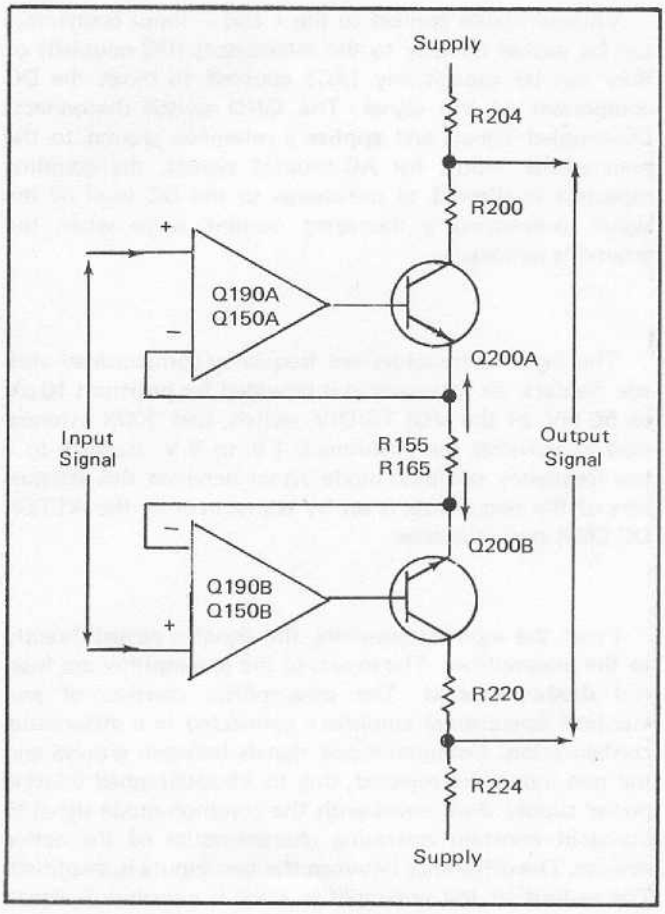


Fig. 2-1. Input Preamp detailed block diagram showing signal current paths.

The operational amplifiers are composed of Q150A, Q190A, and Q200A on one side, and Q150B, Q190B and Q200B on the other side. Q150A and Q150B provide a voltage follower input to output transistors Q200A and Q200B. Total gain of the stage is determined by the resistance between the two sides of the amplifier, and R204 and R224.

DC Offset

To amplify varying signals having other than a ground reference, and still maintain the amplifier differential capabilities, the Offset Generator is designed to cancel out small DC components of the input signal. See Fig. 2-2. This is achieved by producing a current to offset the current developed by the DC voltage. The result is that the Q150A/B drain currents remain balanced and unchanged; thus, no output is produced. In this manner, the DC component of the signal may be offset up to 0.5 volt. Due to the wide range of the Offset Generator (100,000 div at 10 μV per div), stable components are used, and circuit techniques which minimize drift and noise are employed.

The Offset Generator is essentially a voltage comparator composed of Q240 and Q246A on one side; Q244 and Q246B on the other. Q258 serves as a constant current return. When the LF −3 dB switch, S210, is in the DC OFFSET position, the DC OFFSET COARSE and FINE potentiometers, R260 and R268, tap an adjustable portion of the voltage across Zener diode VR251 and apply it to the emitter of Q246B. Divider R250/R251/R254 supplies a reference voltage for the emitter of Q246A. Any difference in the applied voltage is reproduced across resistors R246 and R248, producing an offset current which is conducted through Q240 and Q244 to the Preamp.

When the offset is not in use, the emitter of Q146B is switched to a fixed divider, R252/R253, by the LF −3 dB switch. The Q246A emitter voltage is adjustable over a small range with respect to the Q246B emitter of R250 (COARSE DC BAL) which adjusts out any initial DC unbalance in the Preamp, and brings its output to zero when the input FET gates are grounded.

Common-Mode Rejection

One of the primary functions of the preamplifier is to reject any common-mode component of the input signal and amplify only the difference. Assume that the inputs are tied together and a voltage is applied to the common input. The amplifier differential output is ideally zero, and would actually be zero provided that the characteristics of all corresponding elements on the two sides of the amplifier

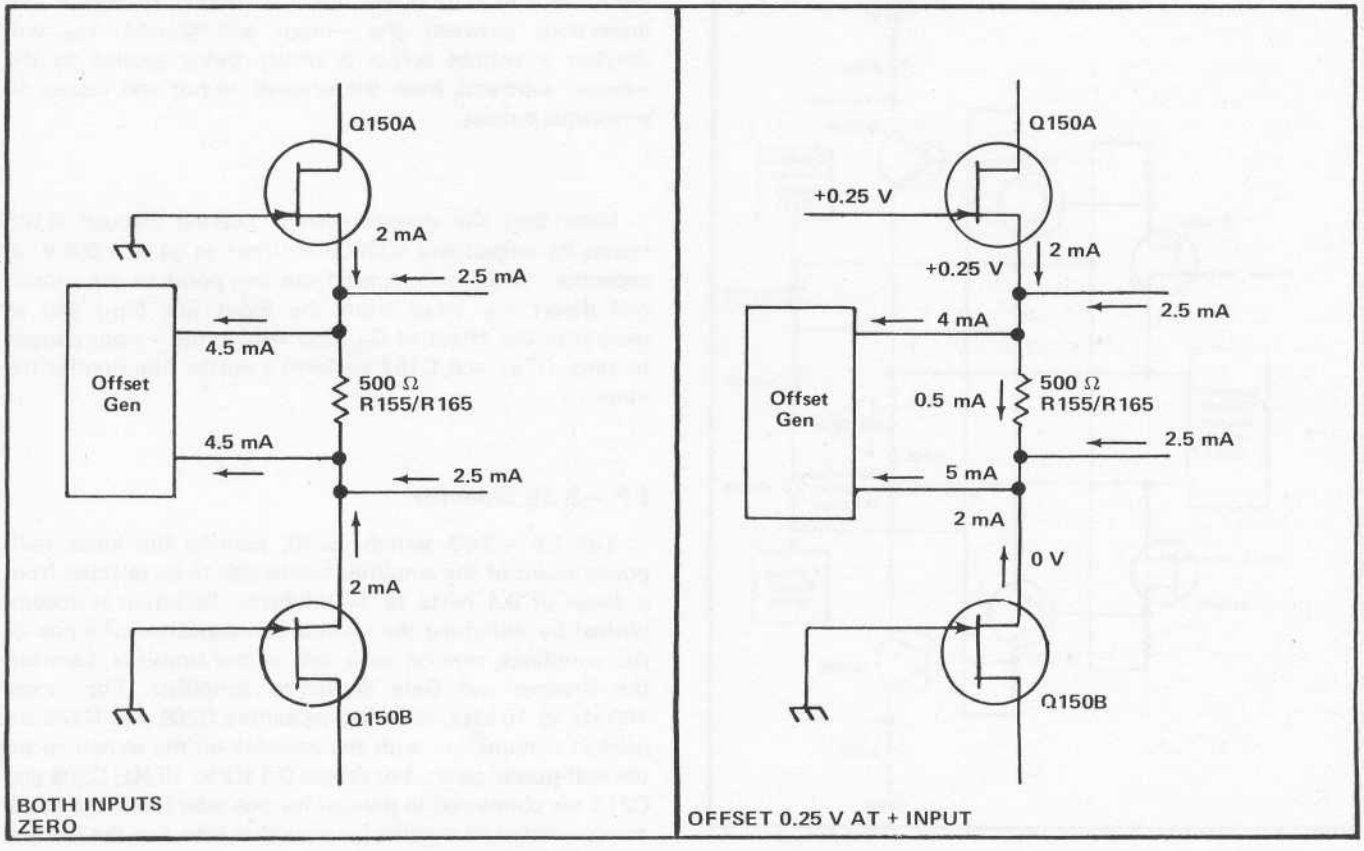


Fig. 2-2. DC Offset block diagram showing current flow with and without an offset voltage at the + input.

were matched (e.g., Q150A/B transconductance and μ, Q190A/B beta, current sources, etc.). In practice, any mismatch will cause a differential output.

Floating Power Supply

A floating power supply made up of Q170, Q176, Q180 and Zener diodes VR173, VR175 and VR176 minimizes inherent common-mode difficulties, and therefore improves the common-mode rejection ratio (refer to Fig. 2-3). Q170 and Q176 are constant current sources that drive current through Zener string VR173, VR175, and VR176 which establish the voltages for the Preamp.

The input to the bootstrap (X1 gain) amplifier is connected to the junction of R155 and R165. The bootstrap amplifier portion of the supply consists of emitter-follower Q180 and DC level-shifting Zener diodes VR173, VR175 and VR176. The collector impedance of Q176 presents minimum loading to the Q180 output and maintains the gain of the amplifier (bootstrap efficiency) very close to one.

The entire power supply and amplifier voltages move an amount equal to the common-mode voltage, maintaining a constant operating characteristic of the elements in the pre-amplifier stage. Since no signal current is developed, the output at the collectors of Q200A/B remains unchanged; that is, the common-mode signal is rejected.

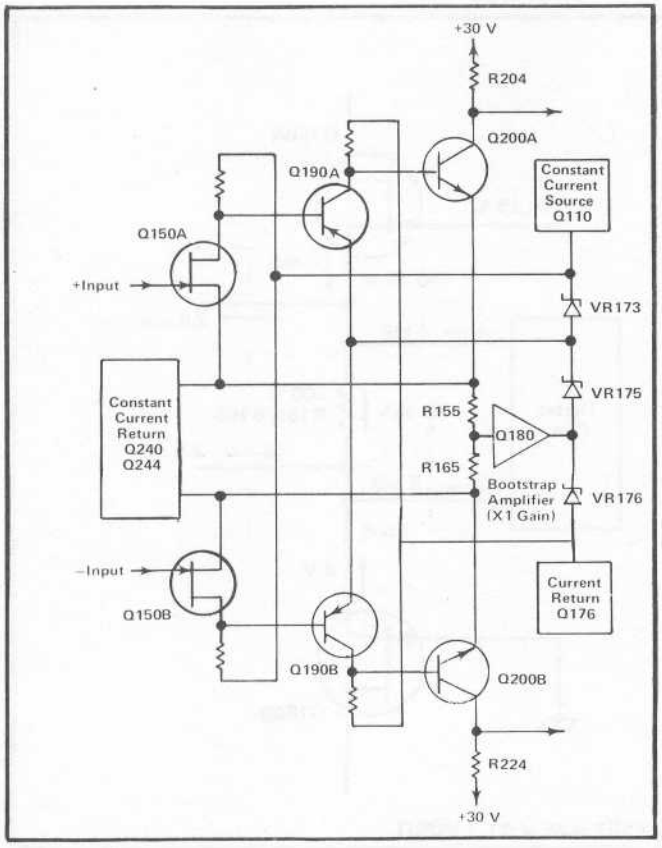


Fig. 2-3. Floating Power Supply block diagram showing standing current paths through the Preamp.

C220 (CMR 1) and C160 (CMR 2) are adjusted on high-frequency common-mode signals to normalize the effective capacitance of the active devices on one side of the amplifier to the other. C210 (CMR 3) is adjusted so that rejection is maintained in any position of the LF –3 dB switch.

Cross Neutralization

The use of a common bootstrap power supply results in an undesirable capacitive coupling between the two inputs. Consider the effect of applying +1 volt to the +input while keeping the –input at 0 volts (see Fig. 2-4).

The results are (a) an output current of 2 mA, as shown, and (b) a shift of all supply voltages and several other voltage levels by +0.5 V due to the divider action of R155/R165 operating into the bootstrapped power supply system. Specifically, the drain of Q150 also rises +0.5 V and injects a current i_{1b} through the drain to gate capacitance of Q150B and into the –input. If there is any impedance between the –input and ground, i_{1b} will develop a voltage across it which, being applied to the –input, subtracts from the original +input and causes an erroneous output.

Note that the output current flowing through R163 causes its output end (Q200B emitter) to go to –0.4 V. A capacitor, C162, connected from this point to the –input will divert i_{1b} away from the input line (i_{1b}) and so neutralize the effect of C_{dg} and reduce the –input current to zero. R152 and C152 perform a similar function for the +input.

LF –3 dB Selector

The LF –3 dB switch, S210, permits the lower half-power point of the amplifier bandwidth to be selected from a range of 0.1 hertz to 10 kilohertz. Selection is accomplished by switching the resistor and capacitor of a pair of AC couplings, one on each side of the amplifier, between the Preamp and Gain Switching Amplifier. For ranges 100 Hz to 10 kHz, coupling capacitors C208 and C228 are used in conjunction with the resistors on the switch to set the half-power point. For ranges 0.1 Hz to 10 Hz, C208 and C212 are connected in parallel for one side; C228 and C216 are connected in parallel for the other side. For the DC and DC OFFSET positions of the switch, the capacitors are shorted out to provide DC coupling.

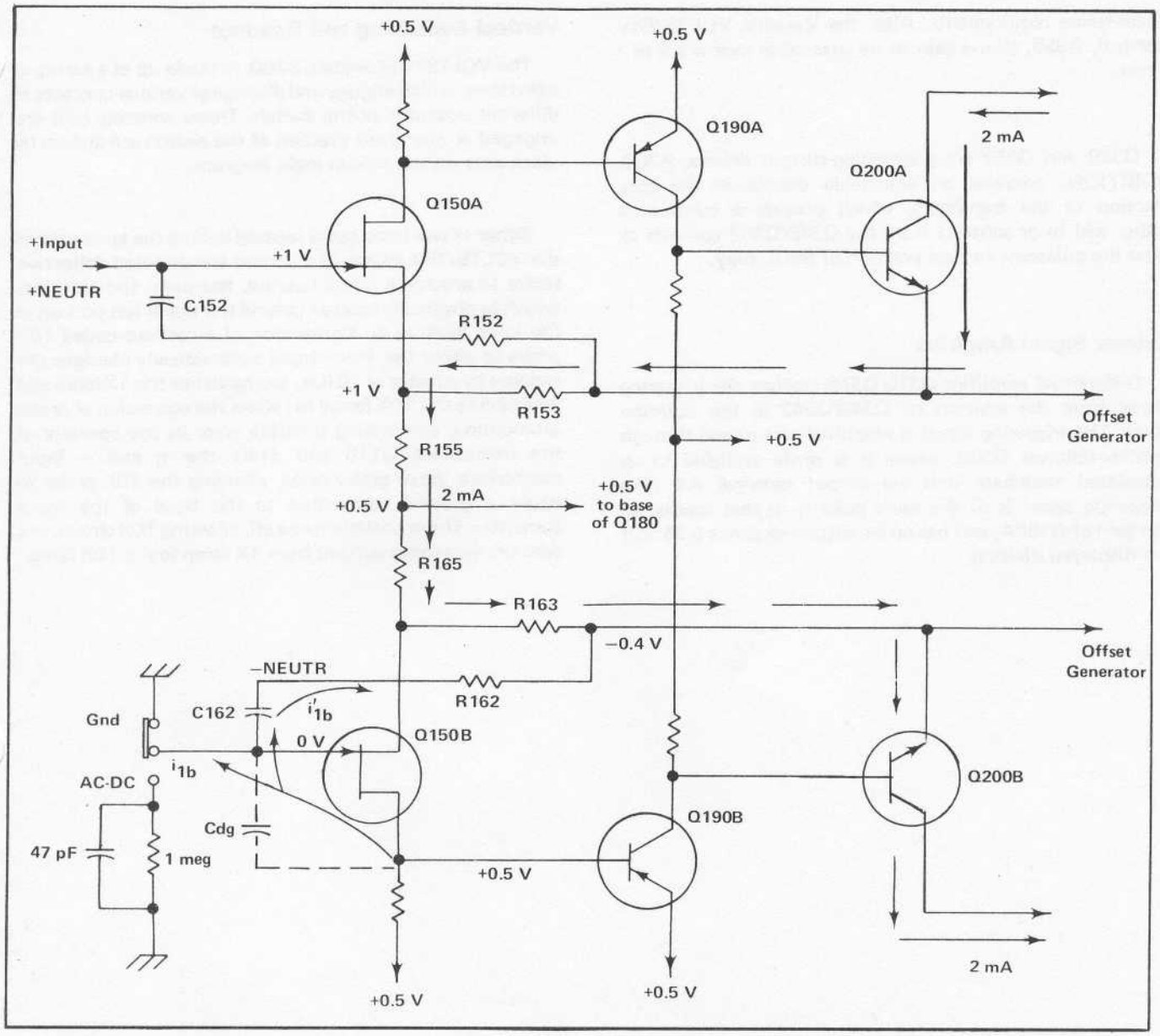


Fig. 2-4. Input cross neutralization.

Gain Switching Stage

The Gain Switching Stage consists of two identical operational amplifiers connected in a differential configuration. As in the Preamp Stage, gain is determined by the ratio of the common collector to the emitter/source resistances, i.e. R316, R318, R326 and the resistors in S280 (VOLTS/DIV). R318 (VAR BAL) divides the collector resistors so that there is no voltage difference at the output when no signal is applied to the input. R292 (AC STEP ATTEN BAL) adjusts out any unbalance between the two operational amplifiers. S330 (HF −3 dB) switches a capacitor across the output of the gain switching amplifier. The collector resistors, R316/R326 and selectable capacitors form an integrator.

Isolation Stage

The differential signal developed at the collectors of Q320A/B is passed through emitter followers Q340 and Q342 to the output amplifier. The emitter followers isolate the preamplifier from the loading of the output amplifier and trigger signal amplifier.

Output Amplifier

The output amplifier consists of push-pull amplifier Q348/Q352. With a signal applied, potentiometer R351 (GAIN) provides emitter degeneration, the gain being determined by the total emitter resistance. This allows the overall gain of the 5A22N to be adjusted to match the

main-frame requirements. Also, the Variable VOLTS/DIV control, R350, allows gain to be adjustable over a 2.5 to 1 ratio.

Q360 and Q362 are positioning-current drivers. R360, POSITION, provides an adjustable change in the conduction of the transistors, which provide a current to either add to or subtract from the Q348/Q352 currents to alter the quiescent vertical position of the display.

Trigger Signal Amplifier

Differential amplifier Q370/Q376 receives the triggering signal from the emitters of Q340/Q342 in the isolation stage. The triggering signal is amplified and passed through emitter-follower Q380, where it is made available to an associated time-base unit via output terminal A4. The triggering signal is of the same polarity as that applied to the gate of Q150A, and has an amplitude of about 0.25 volt per displayed division.

Vertical Switching and Readout

The VOLTS/DIV switch, S280, is made up of a series of cam lobes, which engage and disengage various contacts at different positions of the switch. Those 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 illuminates the selected deflection factor to provide a direct readout. Normally, the 1X lamp, which is physically located behind the upper left portion of the knob skirt, is lit. Connection of a readout-coded 10X probe to either the + or— input automatically changes the readout by a factor of 10 (i.e., extinguishes the 1X lamp and illuminates the 10X lamp) to reflect the correction of probe attenuation, eliminating possible error by the operator of the instrument. J110 and J140, the + and — input connectors, have probe rings, allowing the 10X probe to apply a ground connection to the base of the input transistor. This transistor turns off, allowing 10X circuitry to turn on, switching current from 1X lamp to the 10X lamp.

SECTION 3
CALIBRATION

Introduction

This section of the manual contains a procedure to return the circuits of the 5A22N within their designed operating capabilities. Calibration is generally required after a repair has been made, or after long time intervals in which normal aging of components may affect instrument accuracy. For initial inspection, verify instrument operation by performing the procedures described under General Information in Section 1.

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.

Service 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 5A22N. Specifications given for the test equipment are the minimum necessary for accurate calibration. Therefore, some of the specifications listed 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 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 fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

Test Instruments

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

2. Constant amplitude sine-wave generator. Frequency, 2 Hz to 1 MHz; output amplitude, about 0.5 V to at least 40 V P-P. For example, General Radio 1310-B and 1210-C Oscillator (use GR Type 274 QBJ Adapter to provide BNC output).

3. Standard amplitude calibrator. Output signal, 1 kHz square wave; output amplitude, 5 mV to at least 50 V; accuracy, within 0.25%. Tektronix PG 506 Calibration Generator recommended (requires a TM 500-series power module).

Accessories

1. Coaxial cable. Impedance, 50 Ω; length 42 inches; connectors, BNC. Tektronix Part No. 012-0057-01.

2. Dual-input cable. Provides matched signal paths to the inputs. Connectors are BNC. Tektronix Calibration Fixture 067-0525-01 recommended.

3. 1000:1 divider. Extends output range of Standard Amplitude Calibrator. Accuracy, within 0.2%. Tektronix Calibration Fixture 067-0529-00 recommended.

4. Input RC normalizer. RC time constant, 47 μs (1 MΩ X 47 pF); connectors, BNC. Tektronix Calibration Fixture 067-0541-00 recommended.

5. In-line termination. Impedance, 50 Ω; accuracy, within 2%; connectors, BNC. Tektronix Part No. 011-0049-01 recommended.

6. Plug-in extender for the 5100-series oscilloscope system. Tektronix Calibration Fixture 067-0645-03 (not mandatory for this procedure).

PROCEDURE

Preparation

1. Remove the protective cover from the left side of the 5A22N and also the left side-panel from the 5100-series oscilloscope. (If desired, the plug-in extender can be used to gain access to the internal adjustments rather than by removing the oscilloscope side-panel.) Insert the 5A22N in the center plug-in compartment, and the 5B10N into the right compartment.

2. Connect the oscilloscope to the power source for which it is wired. Set the controls as described under Initial Control Settings. Refer to Fig. 3-1 for location of internal adjustments and test points.

3. Allow 20 minutes for warmup before calibrating.

NOTE

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

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 internal controls can be set to midrange.

5A22N	
DISPLAY	ON
POSITION	Midrange
LF –3 dB	1 Hz
HF –3 dB	1 MHz
VOLTS/DIV	50 m
Variable (CAL)	Fully cw (detent)
DC STEP ATTEN BAL	Midrange
+ and – Input Coupling	GND

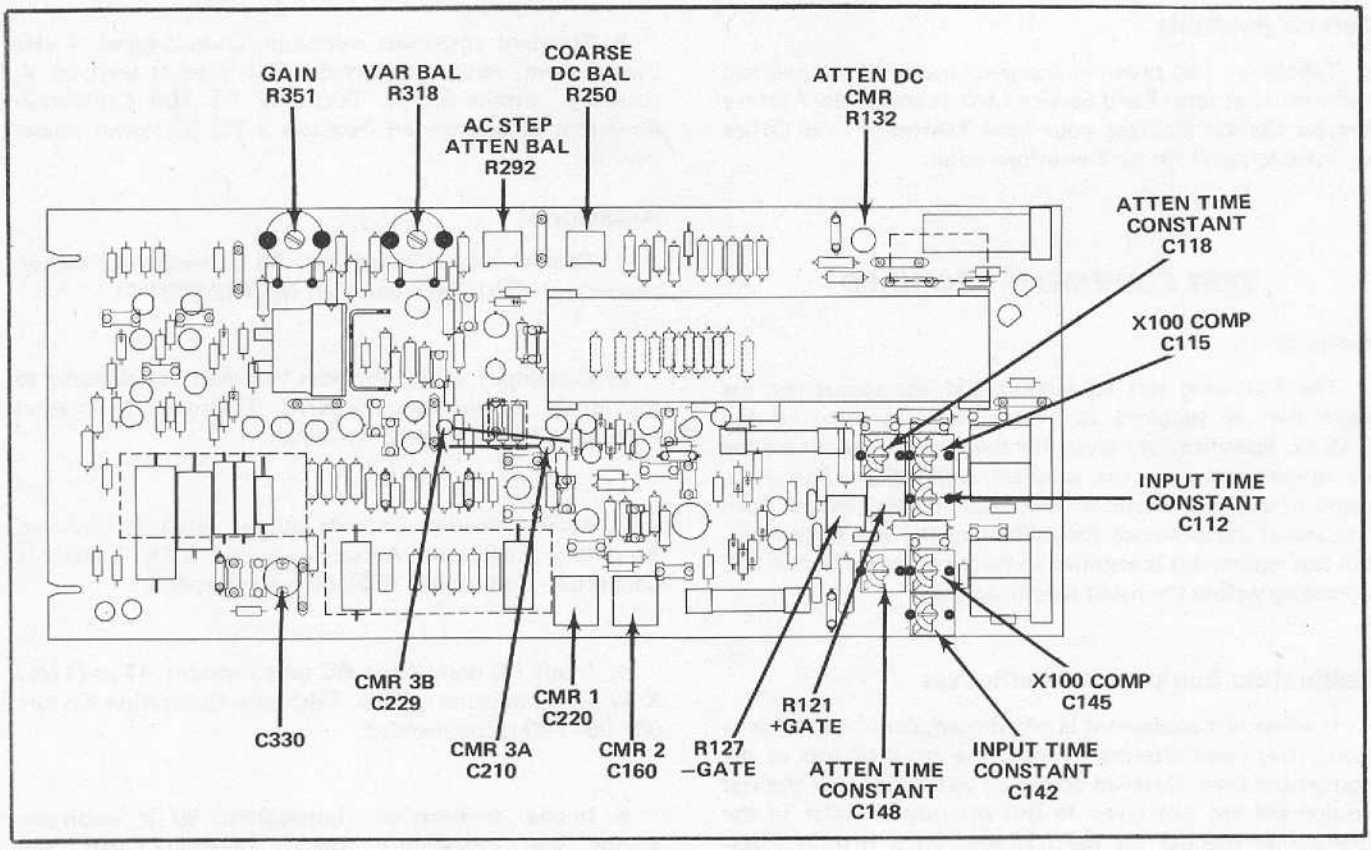


Fig. 3-1. Internal adjustment locations.

Time Base (5B10N)

Position	Sweep starts at left edge of graticule
Seconds/Div	1 m
Triggering Mode	Auto Trig, + Slope, AC Couple
Triggering Source	Composite
Triggering Level	Midrange
All other pushbuttons	Out

1. Step Attenuator Balance

a. Adjust R292 (AC STEP ATTEN BAL) for minimum trace shift while switching the VOLTS/DIV from 50 m to .1 and back.

b. Adjust R318 (VAR BAL) for minimum trace shift while turning the Variable VOLTS/DIV (CAL) from fully cw to fully ccw.

c. Set LF −3 dB to DC and adjust R250 (COARSE DC BAL) for minimum trace shift while switching the VOLTS/DIV from 50 m to .1 and back.

d. Center the trace with the POSITION control. Set the VOLTS/DIV to 50 μ and the LF −3 dB to 1 Hz and reposition the trace to graticule center with R292 (AC STEP ATTEN BAL).

e. Set the LF −3 dB to DC and again position the trace to graticule center with R250 (COARSE DC BAL).

f. Set the VOLTS/DIV to 10 μ and check that the trace is on screen.

g. Set the LF −3 dB to 1 Hz and check that the trace is within the center 2 graticule divisions.

2. Gate Current

a. Connect the 50 Ω In-Line Termination to the + input. Set LF −3 dB to DC and release the + GND button. Adjust R121 (+ GATE CURRENT) for minimum trace shift while switching the + AC button in and out.

b. Connect the 50 Ω In-Line Termination to the − input. Press the + GND button and release the − GND button. Adjust R127 (− GATE CURRENT) for minimum trace shift while switching the − AC button in and out.

3. Attenuator DC Common-Mode Rejection Ratio

a. Release the + and − GND buttons and set the VOLTS/DIV to .1.

b. Apply a 50 V squarewave from the Standard Amplitude Calibrator through the Dual-Input Cable to the + and − input.

c. Adjust R132 (ATT DC CMR) for minimum display amplitude.

d. Remove the Standard Amplitude Calibrator and apply a 50 kHz, 40 V P-P signal from the constant Amplitude Sine-Wave Generator through the Dual-Input cable to the + and − input.

e. Adjust C145 (X100 comp) for minimum display amplitude.

4. Input Compensation

a. Press the − GND button and set the VOLTS/DIV to 50 m. Apply a 0.5 V squarewave from the Standard Amplitude Calibrator through the Input RC Normalizer to the + input. Adjust Time Base Level for a stable display.

b. Adjust C118 (ATTEN TIME CONSTANT) for the best square front corner on the display.

c. Apply a 1 V squarewave from the Standard Amplitude Calibrator and set the VOLTS/DIV to .1. Adjust C115 (X100 COMP) and C112 (INPUT TIME CONSTANT) for the best square front corner on the display.

d. Repeat the preceding procedure for the − input. Adjust C148 then C145 and C142 for the best square front corner on the display.

5. Amplifier Gain

a. Set the VOLTS/DIV to 10 m and apply a 50 mV squarewave from the Standard Amplitude Calibrator to the + input.

b. Adjust R351 (GAIN) for exactly 5 divisions of display amplitude.

c. Turn Variable VOLTS/DIV (CAL) fully ccw and check that the display amplitude is less than 2 divisions. Return CAL to detent (fully cw).

6. VOLTS/DIV Accuracy

a. Set the VOLTS/DIV to 5 and apply a 20 V squarewave from the Standard Amplitude Calibrator through the 1000:1 Divider (X1 position) to the + input.

b. Switch the VOLTS/DIV down through each position while also switching the Standard Amplitude Calibrator to maintain either 4 or 5 divisions of display amplitude. Check that the display amplitude is within 2% of the VOLTS/DIV setting.

c. When at the 5 m position of the VOLTS/DIV switch, set the 1000:1 Divider to the X1000 position and adjust the Standard Amplitude Calibrator for a 20 V squarewave. Set the HF –3 dB to 10 kHz and the Time Base Triggering Source to Line. Repeat step b. Return the HF –3 dB to 1 MHz.

7. Common-Mode Rejection Ratio

a. Release – GND button and set the VOLTS/DIV to 10 m. Apply a 20 V P-P, 50 kHz signal from the Constant Amplitude Sine-Wave Generator through the Dual-Input Cable to the + and – inputs.

b. Adjust C160 (CMR 2) for minimum display amplitude. Set the VOLTS/DIV to 50 μ, Time Base Seconds/Div to 10 μ, and Triggering Source to Composite. Adjust Level for a stable display.

c. Adjust C220 (CMR 1) for minimum display amplitude. Set the LF –3 dB to .1 kHz.

d. Adjust C210 and C229 (CMR 3A and 3B) for minimum display amplitude. Repeat steps b. and c. until there is minimum interaction.

8. Bandwidth

a. Press the – GND button. Set the VOLTS/DIV to 1 m, LF –3 dB to DC, and Time Base Seconds/Div to 1 m.

b. Apply a 1 kHz, 8 division signal from the Constant Amplitude Sine-Wave Generator to the + input. Set Generator for a 1 MHz output.

c. Adjust C330 for a 5.6 division display amplitude.

NOTE

Some drift due to heating may occur if the 5A22N has been operating for a time with two other plug-ins. If so, recheck the Step Attenuator Balance and repeat the procedure outlined in step 1.

This completes the 5A22N calibration procedure.

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http://www.aa4df.com

REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

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

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

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

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

SPECIAL NOTES AND SYMBOLS

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

ITEM NAME

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

ABBREVIATIONS

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

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P O BOX 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
02111	SPECTROL ELECTRONICS CORPORATION	17070 EAST GALE AVENUE	CITY OF INDUSTRY, CA 91745
03508	GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR PRODUCTS DEPARTMENT	ELECTRONICS PARK	SYRACUSE, NY 13201
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
14433	ITT SEMICONDUCTORS	3301 ELECTRONICS WAY P O BOX 3049	WEST PALM BEACH, FL 33402
14552	MICRO SEMICONDUCTOR CORP.	2830 F FAIRVIEW ST.	SANTA ANA, CA 92704
15454	RODAN INDUSTRIES, INC.	2905 BLUE STAR ST.	ANAHEIM, CA 92806
22229	SOLITRON DEVICES, INC., DIODES, INTEGRATED CIRCUITS AND CMOS	8808 BALBOA AVENUE	SAN DIEGO, CA 92123
24546	CORNING GLASS WORKS, ELECTRONIC COMPONENTS DIVISION	550 HIGH STREET	BRADFORD, PA 16701
24931	SPECIALITY CONNECTOR CO., INC.	2620 ENDRESS PLACE	GREENWOOD, IN 46142
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
32293	INTERSIL, INC.	10900 N. TANTAU AVE.	CUPERTINO, CA 95014
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
34263	CTS OF BROWNSVILLE, INC.	1100 ROOSEVELT ST.	BROWNSVILLE, TX 78520
53944	ELT INC., GLOW LITE DIVISION	BOX 698	PAULS VALLEY, OK 73075
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
71450	CTS CORP.	905 N. WEST BLVD	ELKHART, IN 46514
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
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
80740	BECKMAN INSTRUMENTS, INC.	2500 HARBOR BLVD.	FULLERTON, CA 92634
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601
92966	SYLVANIA MINIATURE LIGHTING PRODUCTS, INC., SUB OF GTE SYLVANIA, LIGHT. PROD.	526 ELM STREET	KEARNY, NJ 07032

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	670-1894-00	B010100	B042583	CKT BOARD ASSY:DATA FORMATTER	80009	670-1894-00
A1	670-1894-01	B042584	B049999	CKT BOARD ASSY:MAIN	80009	670-1894-01
A1	670-1894-02	B050000	B059999	CKT BOARD ASSY:MAIN	80009	670-1894-02
A1	670-1894-03	B060000		CKT BOARD ASSY:MAIN	80009	670-1894-03
C103	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	72982	811-546E103Z
C108	283-0002-00	B010100	B049999X	CAP.,FXD,CER DI:0.01UF,+80-20%,500V	72982	811-546E103Z
C110	295-0155-00			CAP.,SET,MTCHD:(2) 0.1UF,1%	80009	295-0155-00
	----- -----			(FURN AS A MATCHED PAIR WITH C140)		
C112	281-0081-00			CAP.,VAR,AIR DI:1.8-13PF,375VDC	74970	189-0506-005
C113	281-0503-00			CAP.,FXD,CER DI:8PF,+/-0.5PF,500V	72982	301-000C0H0809D
C115	281-0078-00			CAP.,VAR,AIR DI:1.4-7.3PF,750V	74970	189-503-005
C116	281-0509-00			CAP.,FXD,CER DI:15PF,+/-1.5PF,500V	72982	301-000C0G0150K
C118	281-0081-00			CAP.,VAR,AIR DI:1.8-13PF,375VDC	74970	189-0506-005
C119	281-0501-00			CAP.,FXD,CER DI:4.7PF,+/-1PF,500V	72982	301-000S2H0479F
C131	283-0626-00			CAP.,FXD,MICA D:1800PF,5%,500V	00853	D195E182J0
C133	283-0626-00			CAP.,FXD,MICA D:1800PF,5%,500V	00853	D195E182J0
C135	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C138	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C140	295-0155-00			CAP.,SET,MTCHD:(2) 0.1UF,1%	80009	295-0155-00
	----- -----			(FURN AS A MATCHED PAIR WITH C110)		
C142	281-0081-00			CAP.,VAR,AIR DI:1.8-13PF,375VDC	74970	189-0506-005
C143	281-0503-00			CAP.,FXD,CER DI:8PF,+/-0.5PF,500V	72982	301-000C0H0809D
C145	281-0078-00			CAP.,VAR,AIR DI:1.4-7.3PF,750V	74970	189-503-005
C146	281-0621-00			CAP.,FXD,CER DI:12PF,1%,500V	72982	301-000C0G0120F
C148	281-0081-00			CAP.,VAR,AIR DI:1.8-13PF,375VDC	74970	189-0506-005
C150	281-0604-00			CAP.,FXD,CER DI:2.2PF,+/-0.25PF,500V	72982	301-000C0J0229C
C152	281-0542-00			CAP.,FXD,CER DI:18PF,10%,500V	72982	301-002C0G0180K
C154	281-0534-00			CAP.,FXD,CER DI:3.3PF,+/-0.25PF,500V	72982	301-000C0J0339C
C160	281-0114-00			CAP.,VAR,AIR DI:1.3-5.4PF,750V	74970	189-7752-075
C162	281-0542-00			CAP.,FXD,CER DI:18PF,10%,500V	72982	301-002C0G0180K
C170	281-0501-00			CAP.,FXD,CER DI:4.7PF,+/-1PF,500V	72982	301-000S2H0479F
C171	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C173	290-0535-00			CAP.,FXD,ELCTLT:33UF,20%,10V	56289	196D336X0010KA1
C175	290-0535-00			CAP.,FXD,ELCTLT:33UF,20%,10V	56289	196D336X0010KA1
C176	290-0535-00			CAP.,FXD,ELCTLT:33UF,20%,10V	56289	196D336X0010KA1
C182	283-0648-00			CAP.,FXD,MICA D:10PF,5%,100V	00853	D151C100D0
C190	281-0501-00			CAP.,FXD,CER DI:4.7PF,+/-1PF,500V	72982	301-000S2H0479F
C192	281-0501-00			CAP.,FXD,CER DI:4.7PF,+/-1PF,500V	72982	301-000S2H0479F
C200	281-0503-00			CAP.,FXD,CER DI:8PF,+/-0.5PF,500V	72982	301-000C0H0809D
C208	283-0594-00			CAP.,FXD,MICA D:0.001UF,1%,100V	00853	D151F102F0
C210	281-0064-00			CAP.,VAR,PLSTC:0.25-1.5PF,600V	72982	530-002
C212	285-0809-00			CAP.,FXD,PLSTC:1UF,10%,50V	56289	LP66A1A105K
C214	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	72982	811-546E103Z
C216	285-0809-00			CAP.,FXD,PLSTC:1UF,10%,50V	56289	LP66A1A105K
C220	281-0114-00			CAP.,VAR,AIR DI:1.3-5.4PF,750V	74970	189-7752-075
C221	281-0503-00			CAP.,FXD,CER DI:8PF,+/-0.5PF,500V	72982	301-000C0H0809D
C224	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	72982	811-546E103Z
C228	283-0594-00			CAP.,FXD,MICA D:0.001UF,1%,100V	00853	D151F102F0
C229	281-0064-00			CAP.,VAR,PLSTC:0.25-1.5PF,600V	72982	530-002
C240	281-0552-00			CAP.,FXD,CER DI:25PF,5%,500V	72982	301-000P2G0250J
C244	281-0552-00			CAP.,FXD,CER DI:25PF,5%,500V	72982	301-000P2G0250J
C246	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N031Z5U0105Z
C256	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	72982	811-546E103Z
C257	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	72982	811-546E103Z
C270	281-0604-00			CAP.,FXD,CER DI:2.2PF,+/-0.25PF,500V	72982	301-000C0J0229C
C290	281-0604-00			CAP.,FXD,CER DI:2.2PF,+/-0.25PF,500V	72982	301-000C0J0229C
C301	281-0572-00			CAP.,FXD,CER DI:6.8PF,+/-0.5PF,500V	72982	301-000C0H0689D

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C302	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	72982	811-546E103Z
C303	281-0572-00			CAP.,FXD,CER DI:6.8PF,+/-0.5PF,500V	72982	301-000C0H0689D
C330	281-0571-00			CAP.,FXD,CER DI:82PF,20%,500V	72982	308-016S2L0820M
C333	283-0604-00			CAP.,FXD,MICA D:304PF,2%,300V	00853	D153F3040G0
C334	283-0594-00			CAP.,FXD,MICA D:0.001UF,1%,100V	00853	D151F102F0
C335	285-0627-00			CAP.,FXD,PLSTC:0.0033UF,5%,100V	56289	410P33251
C336	285-0569-00			CAP.,FXD,PLSTC:0.01UF,20%,200V	56289	410P101
C337	285-0628-00			CAP.,FXD,PLSTC:0.033UF,20%,300V	56289	410P33303
C338	285-0622-00			CAP.,FXD,PLSTC:0.1UF,20%,100V	56289	410P10401
C339	285-0633-00			CAP.,FXD,PLSTC:0.22UF,20%,100V	56289	410P22491
C348	281-0552-00			CAP.,FXD,CER DI:25PF,5%,500V	72982	301-000P2G0250J
C352	281-0552-00			CAP.,FXD,CER DI:25PF,5%,500V	72982	301-000P2G0250J
C370	281-0604-00			CAP.,FXD,CER DI:2.2PF,+/-0.25PF,500V	72982	301-000C0J0229C
C390	290-0534-00	B010100	B059999	CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C390	290-0522-00	B060000		CAP.,FXD,ELCTLT:1UF,20%,50V	56289	196D105X0050HA1
C394	290-0534-00	B010100	B059999	CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C394	290-0522-00	B060000		CAP.,FXD,ELCTLT:1UF,20%,50V	56289	196D105X0050HA1
CR136	152-0323-00			SEMICOND DEVICE:SILICON,35V,0.1A	80009	152-0323-00
CR137	152-0323-00			SEMICOND DEVICE:SILICON,35V,0.1A	80009	152-0323-00
CR138	152-0323-00			SEMICOND DEVICE:SILICON,35V,0.1A	80009	152-0323-00
CR139	152-0323-00			SEMICOND DEVICE:SILICON,35V,0.1A	80009	152-0323-00
CR348	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR352	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
DS103	150-0111-00	B010100	B049999	LAMP,GLOW:NEON,1.2MA	53944	A1B-3
DS103	150-0130-00	B050000		LAMP,INCAND:5V,60MA	92966	34254-TINNED
DS105	150-0111-00	B010100	B049999	LAMP,GLOW:NEON,1.2MA	53944	A1B-3
DS105	150-0130-00	B050000		LAMP,INCAND:5V,60MA	92966	34254-TINNED
F118	159-0024-00			FUSE,CARTRIDGE:3AG,0.062A,250V,0.3 SEC	71400	AGC 1/16
F148	159-0024-00			FUSE,CARTRIDGE:3AG,0.062A,250V,0.3 SEC	71400	AGC 1/16
J110	131-0679-00	B010100	B041450	CONNECTOR,RCPT,:BNC,MALE,3 CONTACT	24931	28JR168-1
J110	131-0679-02	B041451		CONNECTOR,RCPT,:BNC,MALE,3 CONTACT	24931	28JR270-1
J140	131-0679-00	B010100	B041450	CONNECTOR,RCPT,:BNC,MALE,3 CONTACT	24931	28JR168-1
J140	131-0679-02	B041451		CONNECTOR,RCPT,:BNC,MALE,3 CONTACT	24931	28JR270-1
LR112	108-0565-00	XB040000		COIL,RF:FIXED,5UH	80009	108-0565-00
LR142	108-0565-00	XB040000		COIL,RF:FIXED,5UH	80009	108-0565-00
Q101	151-0192-00	XB060000		TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q103	151-0347-00	B010100	B049999	TRANSISTOR:SILICON,NPN	04713	SPS7951
Q103	151-0281-00	B050000	B059999	TRANSISTOR:SILICON,NPN	03508	X16P4039
Q103	151-0190-00	B060000		TRANSISTOR:SILICON,NPN	07263	S032677
Q105	151-0347-00	B010100	B049999	TRANSISTOR:SILICON,NPN	04713	SPS7951
Q105	151-0281-00	B050000	B059999	TRANSISTOR:SILICON,NPN	03508	X16P4039
Q105	151-0190-00	B060000		TRANSISTOR:SILICON,NPN	07263	S032677
Q150A,B	151-1027-00			TRANSISTOR:SILICON,JFE,N-CHAN	80009	151-1027-00
Q170	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
Q176	151-0341-00			TRANSISTOR:SILICON,NPN	07263	S040065
Q180	151-0292-00			TRANSISTOR:SILICON,NPN	80009	151-0292-00
Q190A,B	151-0354-00	B010100	B042583	TRANSISTOR:SILICON,PNP,DUAL	32293	ITS1200A
Q190A,B	151-0261-00	B042584	B064719	TRANSISTOR:SILICON,PNP,DUAL	80009	151-0261-00
Q190A,B	151-0261-01	B064720		TRANSISTOR:SILICON,PNP,DUAL,LOW NOISE	80009	151-0261-01
Q200A,B	151-0353-00			TRANSISTOR:SILICON,NPN	32293	ITS1251
Q240, Q244	151-1042-00	B010100	B029999	SEMICOND DVC SE:MATCHED PAIR FET	27014	SF50031
Q240, Q244	151-1070-00	B030000		TRANSISTOR:SILICON,FE,N-CHANNEL	80009	151-1070-00
Q246A,B	151-0354-00	B010100	B042583	TRANSISTOR:SILICON,PNP,DUAL	32293	ITS1200A

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Q246A,B	151-0261-00	B042584	B064719	TRANSISTOR:SILICON,PNP,DUAL	80009	151-0261-00
Q246A,B	151-0261-01	B064720		TRANSISTOR:SILICON,PNP,DUAL,LOW NOISE	80009	151-0261-01
Q258	151-0341-00			TRANSISTOR:SILICON,NPN	07263	S040065
Q270A,B	151-1050-00			TRANSISTOR:SILICON,FET,N-CHANNEL,DUAL	22229	FD1632
Q302A,B	151-0354-00	B010100	B042583	TRANSISTOR:SILICON,PNP,DUAL	32293	ITS1200A
Q302A,B	151-0261-00	B042584	B064719	TRANSISTOR:SILICON,PNP,DUAL	80009	151-0261-00
Q302A,B	151-0261-01	B064720		TRANSISTOR:SILICON,PNP,DUAL,LOW NOISE	80009	151-0261-01
Q320A,B	151-0353-00			TRANSISTOR:SILICON,NPN	32293	ITS1251
Q340	151-0341-00			TRANSISTOR:SILICON,NPN	07263	S040065
Q342	151-0341-00			TRANSISTOR:SILICON,NPN	07263	S040065
Q348	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
Q352	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
Q360	151-0341-00			TRANSISTOR:SILICON,NPN	07263	S040065
Q362	151-0341-00			TRANSISTOR:SILICON,NPN	07263	S040065
Q370	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
Q376	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
Q380	151-0341-00			TRANSISTOR:SILICON,NPN	07263	S040065
R101	315-0272-00	XB060000		RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R102	316-0154-00	B010100	B054640	RES.,FXD,CMPSN:150K OHM,10%,0.25W	01121	CB1541
R102	315-0154-00	B054641	B059999	RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R102	315-0274-00	B060000		RES.,FXD,CMPSN:270K OHM,5%,0.25W	01121	CB2745
R103	316-0124-00	B010100	B049999	RES.,FXD,CMPSN:120K OHM,10%,0.25W	01121	CB1241
R103	315-0154-00	B050000	B059999	RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R103	315-0431-00	B060000		RES.,FXD,CMPSN:430 OHM,5%,0.25W	01121	CB4315
R104	315-0122-00	XB060000		RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R105	316-0124-00	B010100	B049999	RES.,FXD,CMPSN:120K OHM,10%,0.25W	01121	CB1241
R105	315-0100-00	B050000	B059999	RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R105	315-0431-00	B060000		RES.,FXD,CMPSN:430 OHM,5%,0.25W	01121	CB4315
R106	315-0112-00	XB060000		RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
R107	315-0242-00	XB060000		RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R108	316-0103-00	B010100	B049999X	RES.,FXD,CMPSN:10K OHM,10%,0.25W	01121	CB1031
R108	315-0100-00	XB060000		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R110	316-0105-00	B010100	B054640	RES.,FXD,CMPSN:1M OHM,10%,0.25W	01121	CB1051
R110	315-0105-00	B054641		RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R112	316-0270-00	B010100	B039999X	RES.,FXD,CMPSN:27 OHM,10%,0.25W	01121	CB2701
R115	322-0624-07			RES.,FXD,FILM:990K OHM,0.1%,0.25W	75042	CEBT0-9903B
R118	316-0470-00	B010100	B054640	RES.,FXD,CMPSN:47 OHM,10%,0.25W	01121	CB4701
R118	315-0470-00	B054641		RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R120	322-0481-07			RES.,FXD,FILM:1M OHM,0.1%,0.25W	91637	MFF1421C1003B
R121	311-1223-00			RES.,VAR,NONWIR:TRMR,250 OHM,0.5W	02111	63M251T602
R122	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R123	307-0181-00			RES.,THERMAL:100K OHM,10%,4MW/DEG C	15454	1DE104-K-220EC
R126	322-0481-07			RES.,FXD,FILM:1M OHM,0.1%,0.25W	91637	MFF1421C1003B
R127	311-1223-00			RES.,VAR,NONWIR:TRMR,250 OHM,0.5W	02111	63M251T602
R128	316-0100-00	B010100	B054640	RES.,FXD,CMPSN:10 OHM,10%,0.25W	01121	CB1001
R128	315-0100-00	B054641		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R129	315-0363-00			RES.,FXD,CMPSN:36K OHM,5%,0.25W	01121	CB3635
R130	307-0181-00			RES.,THERMAL:100K OHM,10%,4MW/DEG C	15454	1DE104-K-220EC
R130	307-0181-00			RES.,THERMAL:100K OHM,10%,4MW/DEG C	15454	1DE104-K-220EC
R131	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	91637	MFF1816D10001C
R132	311-0605-00			RES.,VAR,NONWIR:TRMR,200 OHM,0.5W	80740	62-54-3
R133	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	91637	MFF1816D10001C
R135	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R137	316-0105-00	B010100	B054640	RES.,FXD,CMPSN:1M OHM,10%,0.25W	01121	CB1051
R137	315-0105-00	B054641		RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R140	316-0105-00	B010100	B054640	RES.,FXD,CMPSN:1M OHM,10%,0.25W	01121	CB1051
R140	315-0105-00	B054641		RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055

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R142	316-0270-00	B010100	B039999X	RES.,FXD,CMPSN:27 OHM,10%,0.25W	01121	CB2701
R145	322-0624-07			RES.,FXD,FILM:990K OHM,0.1%,0.25W	75042	CEBT0-9903B
R148	316-0470-00	B010100	B054640	RES.,FXD,CMPSN:47 OHM,10%,0.25W	01121	CB4701
R148	315-0470-00	B054641		RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R150	321-0244-00			RES.,FXD,FILM:3.4K OHM,1%,0.125W	91637	MFF1816G34000F
R152	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R153	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
R155	321-0135-00	B010100	B059999	RES.,FXD,FILM:249 OHM,1%,0.125W	91637	MFF1816G249R0F
R155	321-0928-07	B060000		RES.,FXD,FILM:250 OHM,0.1%,0.125W	91637	MFF1816C250R0B
R162	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R163	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
R165	321-0135-00	B010100	B059999	RES.,FXD,FILM:249 OHM,1%,0.125W	91637	MFF1816G249R0F
R165	321-0928-07	B060000		RES.,FXD,FILM:250 OHM,0.1%,0.125W	91637	MFF1816C250R0B
R169	321-0244-00			RES.,FXD,FILM:3.4K OHM,1%,0.125W	91637	MFF1816G34000F
R171	316-0270-00	B010100	B054640	RES.,FXD,CMPSN:27 OHM,10%,0.25W	01121	CB2701
R171	315-0270-00	B054641		RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
R172	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R173	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R177	321-0201-00			RES.,FXD,FILM:1.21K OHM,1%,0.125W	91637	MFF1816G12100F
R178	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R179	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R180	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R181	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R182	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R190	321-0276-00			RES.,FXD,FILM:7.32K OHM,1%,0.125W	91637	MFF1816G73200F
R192	321-0276-00			RES.,FXD,FILM:7.32K OHM,1%,0.125W	91637	MFF1816G73200F
R200	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R202	315-0200-00			RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
R204	321-0193-00	B010100	B059999	RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R204	321-0193-07	B060000		RES.,FXD,FILM:1K OHM,0.1%,0.125W	91637	MFF1816C10000B
R206	321-0220-00			RES.,FXD,FILM:1.91K OHM,1%,0.125W	91637	MFF1816G19100F
R208	316-0475-00	B010100	B019999X	RES.,FXD,CMPSN:4.7M OHM,10%,0.25W	01121	CB4751
R210	311-0881-00			RES.,VAR,NONWIR:20K OHM,10%,0.50W	01121	W7674
R212	301-0165-00			RES.,FXD,CMPSN:1.6M OHM,5%,0.50W	01121	EB1655
R213	321-0408-00			RES.,FXD,FILM:174K OHM,1%,0.125W	91637	MFF1816G17402F
R214	321-0303-00			RES.,FXD,FILM:14K OHM,1%,0.125W	91637	MFF1816G14001F
R216	301-0165-00			RES.,FXD,CMPSN:1.6M OHM,5%,0.50W	01121	EB1655
R217	321-0408-00			RES.,FXD,FILM:174K OHM,1%,0.125W	91637	MFF1816G17402F
R218	321-0303-00			RES.,FXD,FILM:14K OHM,1%,0.125W	91637	MFF1816G14001F
R220	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R222	315-0200-00			RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
R224	321-0193-00	B010100	B059999	RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R224	321-0193-07	B060000		RES.,FXD,FILM:1K OHM,0.1%,0.125W	91637	MFF1816C10000B
R240	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R244	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R246	321-0164-00	B010100	B059999	RES.,FXD,FILM:499 OHM,1%,0.125W	91637	MFF1816G499R0F
R246	321-0961-07	B060000		RES.,FXD,FILM:500.5 OHM,0.1%,0.125W	24546	NE55E500R5B
R248	321-0164-00	B010100	B059999	RES.,FXD,FILM:499 OHM,1%,0.125W	91637	MFF1816G499R0F
R248	321-0961-07	B060000		RES.,FXD,FILM:500.5 OHM,0.1%,0.125W	24546	NE55E500R5B
R249	315-0204-00			RES.,FXD,CMPSN:200K OHM,5%,0.25W	01121	CB2045
R250	311-1223-00			RES.,VAR,NONWIR:TRMR,250 OHM,0.5W	02111	63M251T602
R251	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R252	321-0114-00			RES.,FXD,FILM:150 OHM,1%,0.125W	91637	MFF1816G150R0F
R253	321-0114-00			RES.,FXD,FILM:150 OHM,1%,0.125W	91637	MFF1816G150R0F
R254	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R255	321-0112-00			RES.,FXD,FILM:143 OHM,1%,0.125W	91637	MFF1816G143R0F
R256	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R257	321-0189-00			RES.,FXD,FILM:909 OHM,1%,0.125W	91637	MFF1816G909R0F
R258	321-0198-00			RES.,FXD,FILM:1.13K OHM,1%,0.125W	91637	MFF1816G11300F
R260	311-0889-00			RES.,VAR,WW:PNL,5K OHM,1W	02111	162-214
R261	321-0242-00			RES.,FXD,FILM:3.24K OHM,1%,0.125W	91637	MFF1816G32400F
R262	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R263	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R264	321-0242-00			RES.,FXD,FILM:3.24K OHM,1%,0.125W	91637	MFF1816G32400F
R267	321-0481-00			RES.,FXD,FILM:1M OHM,1%,0.125W	24546	NA4D1004F
R268	311-0887-00			RES.,VAR,NONWIR:50K OHM,10%,0.50W	80009	311-0887-00
R270	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R271	321-0630-00	B010100	B059999	RES.,FXD,FILM:6.81K OHM,0.5%,0.125W	91637	MFF1816G68100D
R271	321-0670-00	B060000		RES.,FXD,FILM:6.81K OHM,0.5%,0.125W	24546	NC55C6811D
R272	321-0038-00			RES.,FXD,FILM:24.3 OHM,1%,0.125W	91637	MFF1816G24R30F
R273	316-0335-00	XB020000	B054640	RES.,FXD,CMPSN:3.3M OHM,10%,0.25W	01121	CB3351
R273	315-0335-00	B054641		RES.,FXD,CMPSN:3.3M OHM,5%,0.25W	01121	CB3355
R275	321-0413-00			RES.,FXD,FILM:196K OHM,1%,0.125W	91637	MFF1816G19602F
R276	321-0959-03			RES.,FXD,FILM:24.0K OHM,0.25%,0.125W	91637	MFF1816D24011C
R277	321-0958-03			RES.,FXD,FILM:9.673K OHM,0.25%,0.125W	91637	MFF1816D96730C
R278	321-0957-03			RES.,FXD,FILM:4.408K OHM,0.25%,0.125W	91637	MFF1816D44080C
R279	321-0956-03			RES.,FXD FILM:1.674K OHM,0.25%,0.125W	91637	MFF1816D44080C
R280	321-0955-03			RES.,FXD,FILM:823 OHM,0.25%,0.125W	24546	NC55C8230C
R281	321-0912-03			RES.,FXD,FILM:408 OHM,0.25%,0.125W	24546	NC55C4080C
R282	321-0954-03			RES.,FXD,FILM:162.5 OHM,0.25%,0.125W	91637	MFF1816D162R5C
R283	321-0953-03			RES.,FXD,FILM:81 OHM,0.25%,0125W	24546	NC55C81R0C
R284	321-0952-03			RES.,FXD,FILM:40.5 OHM,0.25%,0.125W	24546	NC55C40R5C
R285	321-0021-03			RES.,FXD,FILM:16.2 OHM,0.25%,0.125W	24546	NC55C16R2C
R286	321-0021-03			RES.,FXD,FILM:16.2 OHM,0.25%,0.125W	24546	NC55C16R2C
R290	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R291	321-0630-00	B010100	B059999	RES.,FXD,FILM:6.81K OHM,0.5%,0.125W	91637	MFF1816G68100D
R291	321-0670-00	B060000		RES.,FXD,FILM:6.81K OHM,0.5%,0.125W	24546	NC55C6811D
R292	311-1222-00			RES.,VAR,NONWIR:100 OHM,20%,0.50W	32997	3386F-T04-101
R294	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R302	321-0288-00			RES.,FXD,FILM:9.76K OHM,1%,0.125W	91637	MFF1816G97600F
R304	321-0288-00			RES.,FXD,FILM:9.76K OHM,1%,0.125W	91637	MFF1816G97600F
R313	321-0327-03			RES.,FXD,FILM:24.9K OHM,0.25%,0.125W	24546	NC55C2492C
R315	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R316	321-0299-00			RES.,FXD,FILM:12.7K OHM,1%,0.125W	91637	MFF1816G12701F
R318	311-1124-00			RES.,VAR,NONWIR:250 OHM,30%,0.25W	71450	201-YA5533
R319	321-0216-00			RES.,FXD,FILM:1.74K OHM,1%,0.125W	91637	MFF1816G17400F
R321	321-0327-03			RES.,FXD,FILM:24.9K OHM,0.25%,0.125W	24546	NC55C2492C
R325	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R326	321-0229-00			RES.,FXD,FILM:2.37K OHM,1%,0.125W	91637	MFF1816G23700F
R340	316-0223-00	B010100	B054640	RES.,FXD,CMPSN:22K OHM,10%,0.25W	01121	CB2231
R340	315-0223-00	B054641		RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R342	316-0223-00	B010100	B054640	RES.,FXD,CMPSN:22K OHM,10%,0.25W	01121	CB2231
R342	315-0223-00	B054641		RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R348	321-0225-00			RES.,FXD,FILM:2.15K OHM,1%,0.125W	91637	MFF1816G21500F
R349	321-0169-00			RES.,FXD,FILM:562 OHM,1%,0.125W	91637	MFF1816G562R0F
R350	311-1121-00	B010100	B059999	RES.,VAR,NONWIR:2K OHM,20%,0.5W	34263	A45-CPS
R350	311-1990-00	B060000		RES.,VAR,NONWIR:PNL,2.5K OHM,20%,0.5W	01121	17M654
	----- -----			(FURNISHED AS A UNIT WITH S350)		
R351	311-1124-00			RES.,VAR,NONWIR:250 OHM,30%,0.25W	71450	201-YA5533
R352	321-0225-00			RES.,FXD,FILM:2.15K OHM,1%,0.125W	91637	MFF1816G21500F
R360	311-0994-00	B010100	B029999	RES.,VAR,NONWIR:2.5K OHM,10%,0.50W	01121	WA1G048S252UA
R360	311-1484-00	B030000		RES.,VAR,NONWIR:PNL,2.5K OHM,1W	01121	11M110
R361	315-0752-00	B010100	B039999	RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R361	321-0276-00	B040000		RES.,FXD,FILM:7.32K OHM,1%,0.125W	91637	MFF1816G73200F

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R362	315-0752-00	B010100	B039999	RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R362	321-0276-00	B040000		RES.,FXD,FILM:7.32K OHM,1%,0.125W	91637	MFF1816G73200F
R363	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R365	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R366	316-0102-00	B010100	B054640	RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R366	315-0102-00	B054641		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R367	321-0179-00			RES.,FXD,FILM:715 OHM,1%,0.125W	91637	MFF1816G715R0F
R368	316-0102-00	B010100	B054640	RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R368	315-0102-00	B054641		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R369	321-0179-00			RES.,FXD,FILM:715 OHM,1%,0.125W	91637	MFF1816G715R0F
R370	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R371	316-0102-00	B010100	B054640	RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R371	315-0102-00	B054641		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R372	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R373	315-0112-00			RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
R376	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R377	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R378	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R380	315-0362-00			RES.,FXD,CMPSN:3.6K OHM,5%,0.25W	01121	CB3625
R381	316-0181-00	B010100	B054640	RES.,FXD,CMPSN:180 OHM,10%,0.25W	01121	CB1811
R381	315-0181-00	B054641		RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
R383	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R390	316-0100-00	B010100	B054640	RES.,FXD,CMPSN:10 OHM,10%,0.25W	01121	CB1001
R390	315-0100-00	B054641		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R394	316-0100-00	B010100	B054640	RES.,FXD,CMPSN:10 OHM,10%,0.25W	01121	CB1001
R394	315-0100-00	B054641		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
S108	260-1209-00			SWITCH,PUSH:4PDT,1A,25VDC	80009	260-1209-00
S110A S110B S140A	260-1207-00			SWITCH,PUSH:2 MODULE	80009	260-1207-00
S140B	260-1207-00			SWITCH,PUSH:2 MODULE	80009	260-1207-00
S210	105-0310-00			ACTR ASSY,CAM S:LOW FREQ	80009	105-0310-00
S280	105-0309-00			ACTR ASSY,CAM S:VOLTS/DIV	80009	105-0309-00
S330	105-0311-00			ACTR ASSY,CAM S:HIGH FREQ 3DBSEL	80009	105-0311-00
S350	----- -----			(FURNISHED AS A UNIT WITH R350)		
VR135	152-0520-00			SEMICOND DEVICE:ZENER,1W,12V,5%	14433	1N4742A
VR138	152-0520-00			SEMICOND DEVICE:ZENER,1W,12V,5%	14433	1N4742A
VR173	152-0166-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZ11738
VR175	152-0166-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZ11738
VR176	152-0166-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZ11738
VR251	152-0226-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	14552	TD3810980
VR302	152-0166-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZ11738
VR383	152-0166-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZ11738

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

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

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

Resistors = Ohms (Ω).

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

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

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

Abbreviations are based on ANSI Y1.1-1972.

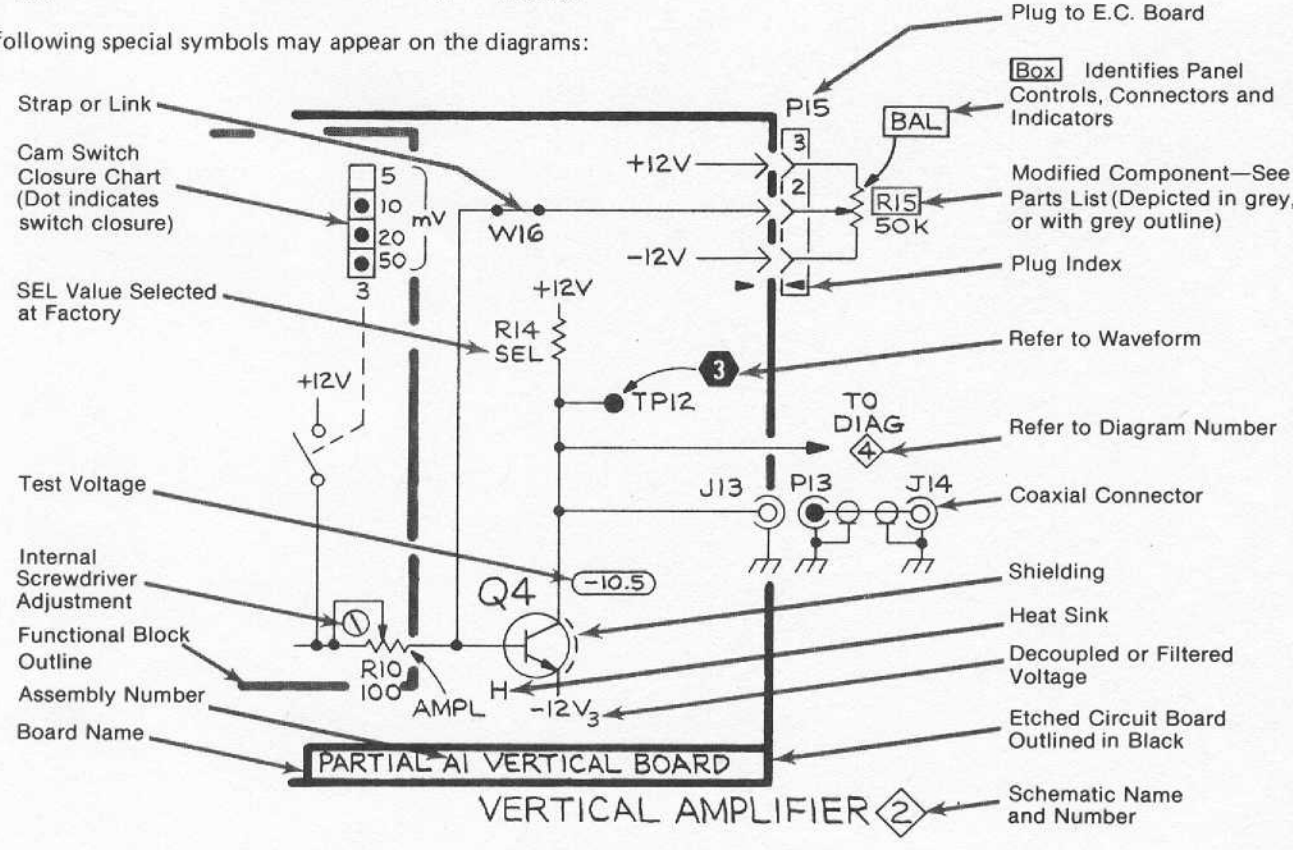
Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

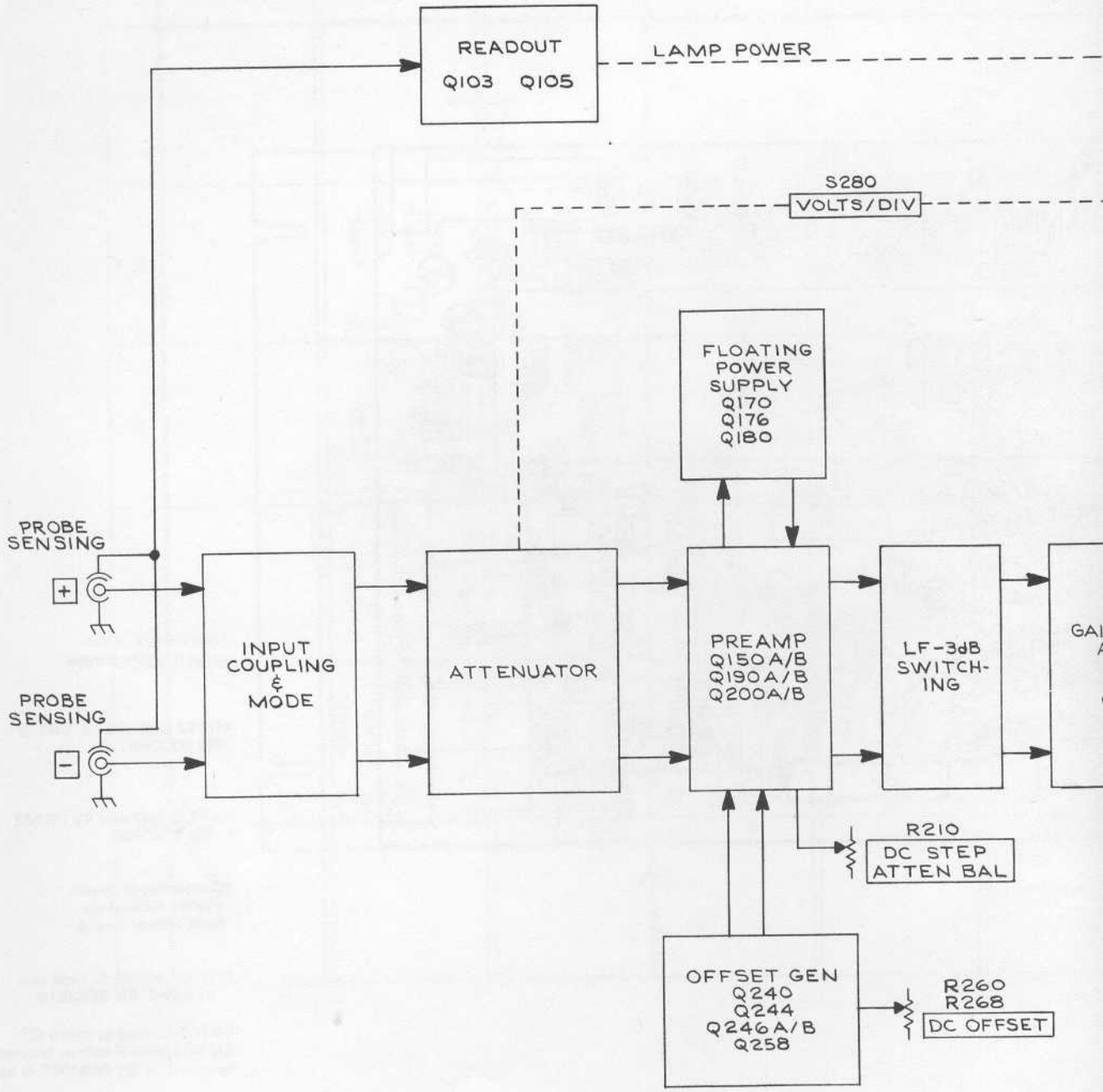
Y14.15, 1966	Drafting Practices.
Y14.2, 1973	Line Conventions and Lettering.
Y10.5, 1968	Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

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

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

The following special symbols may appear on the diagrams:

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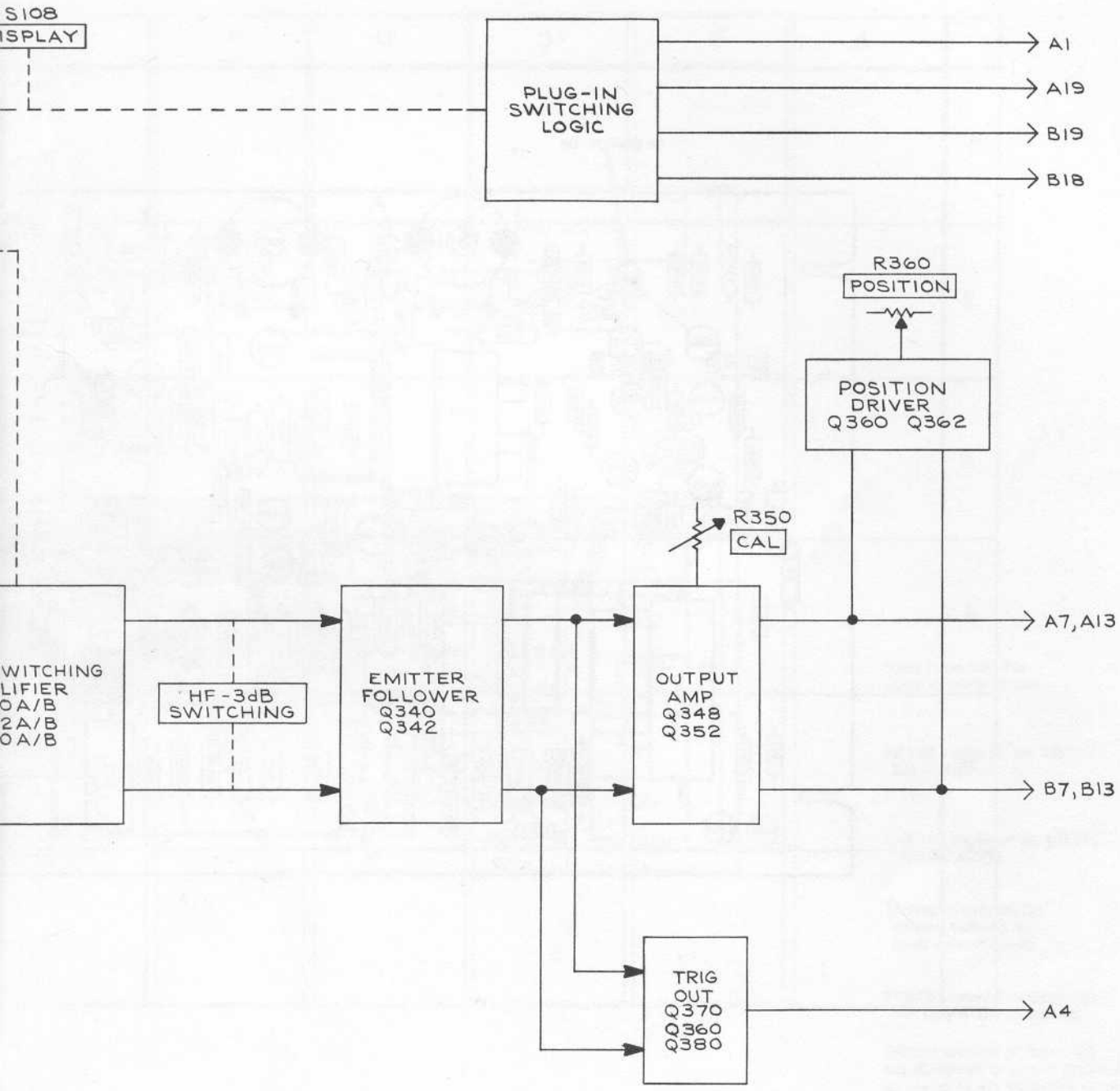
LAMP POWER
S280
VOLTS/DIV
FLOATING
POWER
SUPPLY
Q170
Q176
Q180
PROBE
SENSING
+
PROBE
SENSING
−
INPUT
COUPLING
&
MODE
ATTENUATOR
PREAMP
Q150A/B
Q190A/B
Q200A/B
LF-3dB
SWITCH-
ING
R210
DC STEP
ATTEN BAL
OFFSET GEN
Q240
Q244
Q246A/B
Q258
R260
R268
DC OFFSET

5A22N



BLOCK DIAGRAM GRS 1071

CKT NO	GR LO
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C108*	
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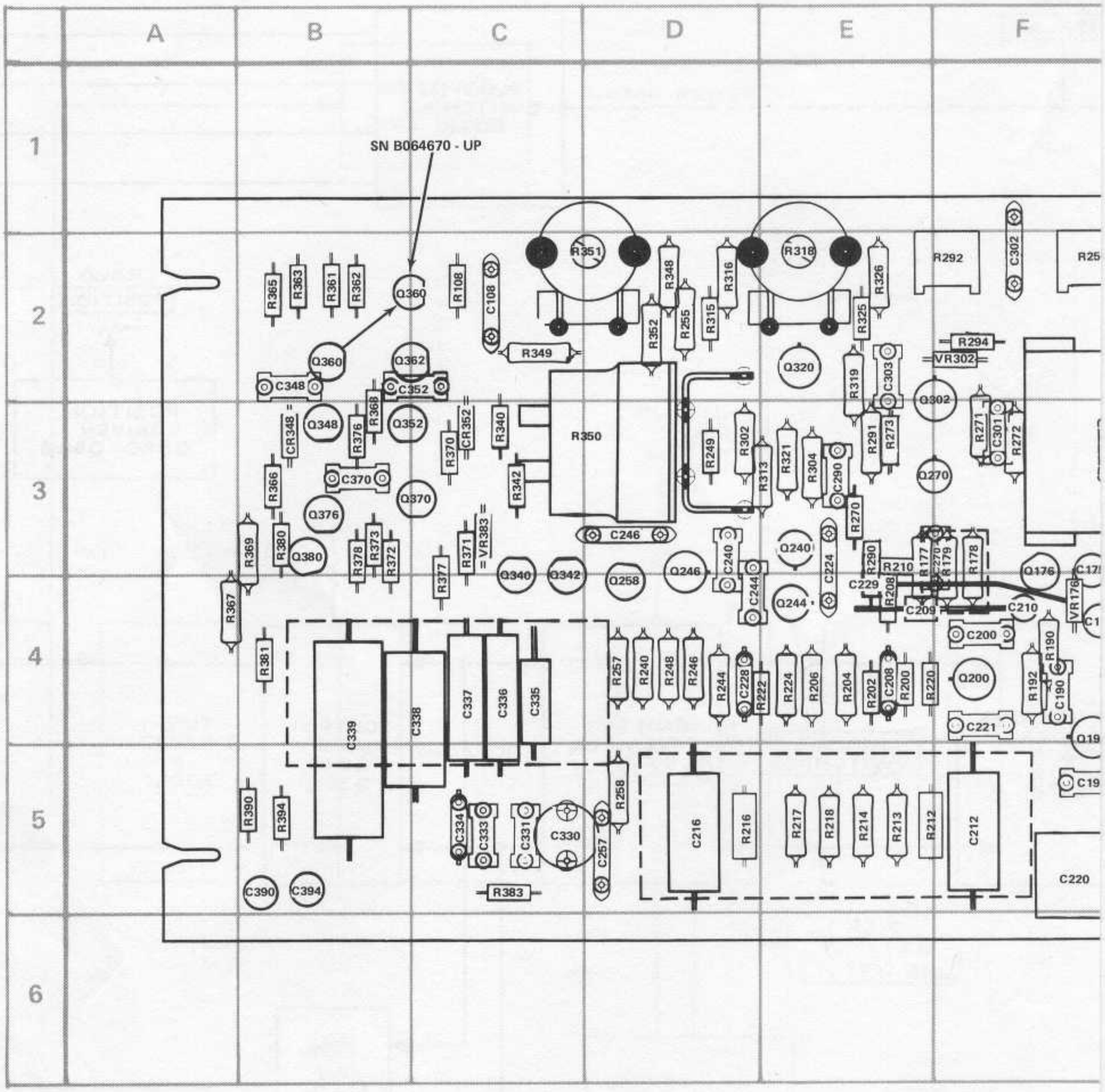
CR137	
CR138	



A
B
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R365
R363
R361
R362
Q360
R108
C108
R351
R348
R316
R318
R326
R292
C302
R25
R352
R255
R315
R325
R349
Q360
Q362
C348
C352
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CR352
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R304
C290
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R273
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C301
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Q270
R366
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Q376
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R210
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R179
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Q176
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Q342
Q258
Q246
C244
Q244
C229
R208
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C200
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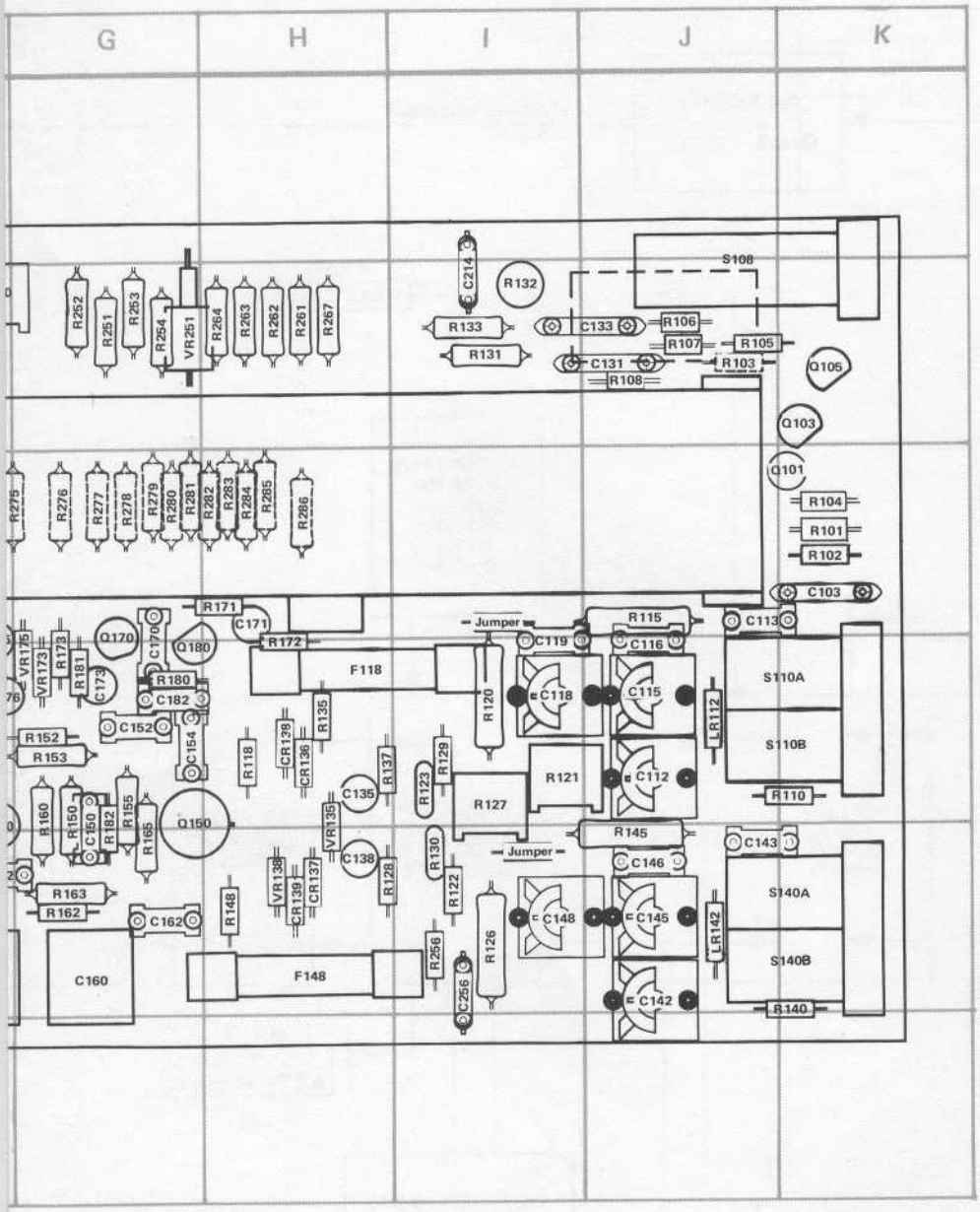
C394
R383



*See Parts List for serial number ranges.

★R112 replaced by LR112 SN B040000

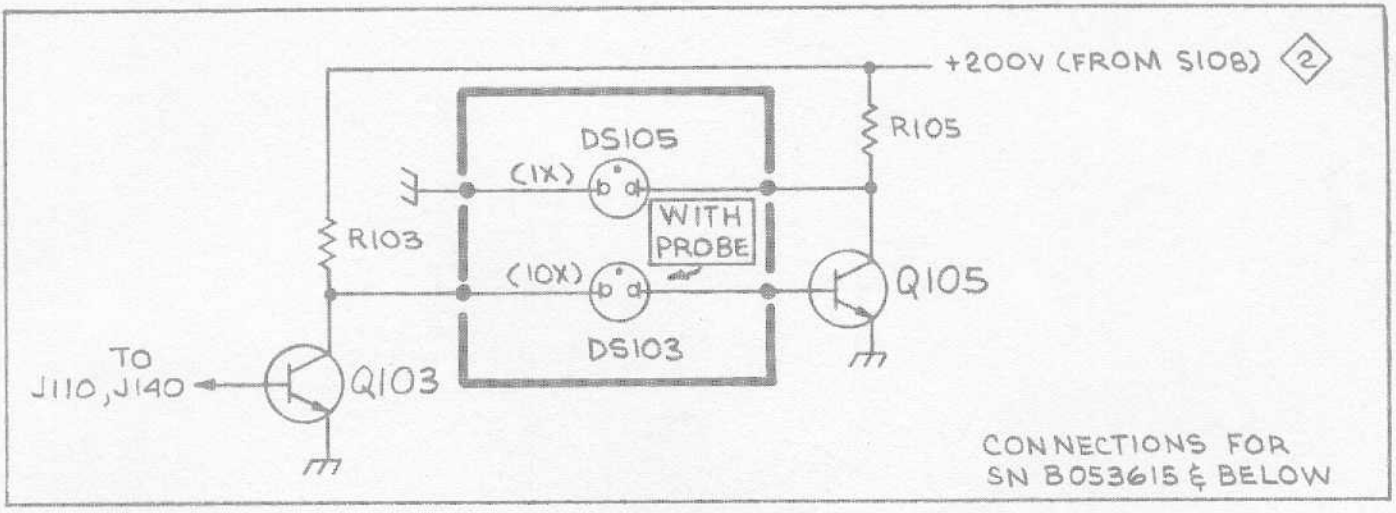
★★R142 replaced by LR142 SN B040000

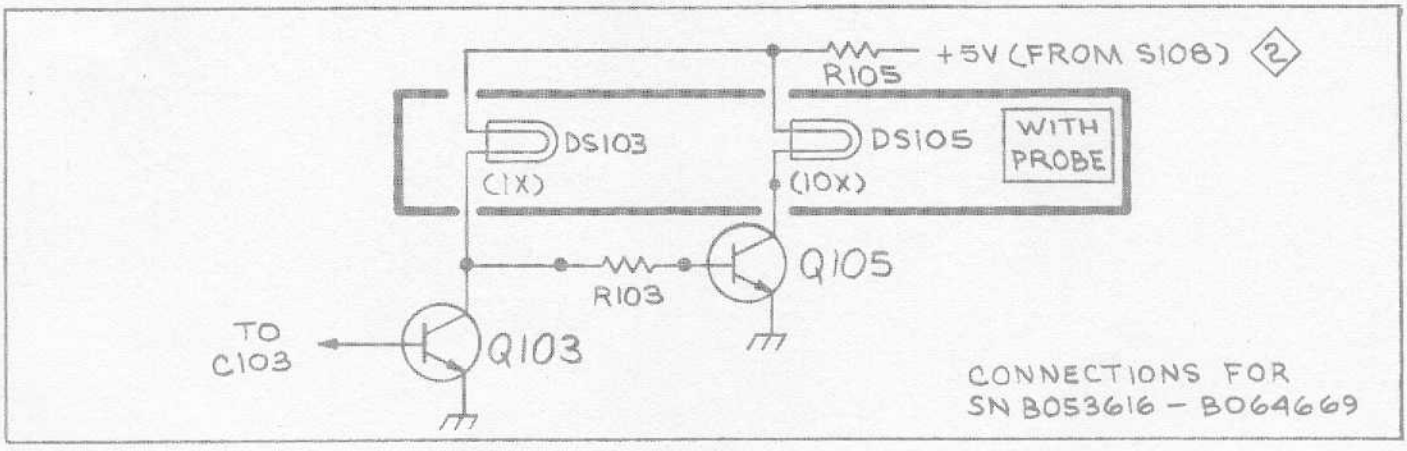
†Components shown dashed located on back side of board.

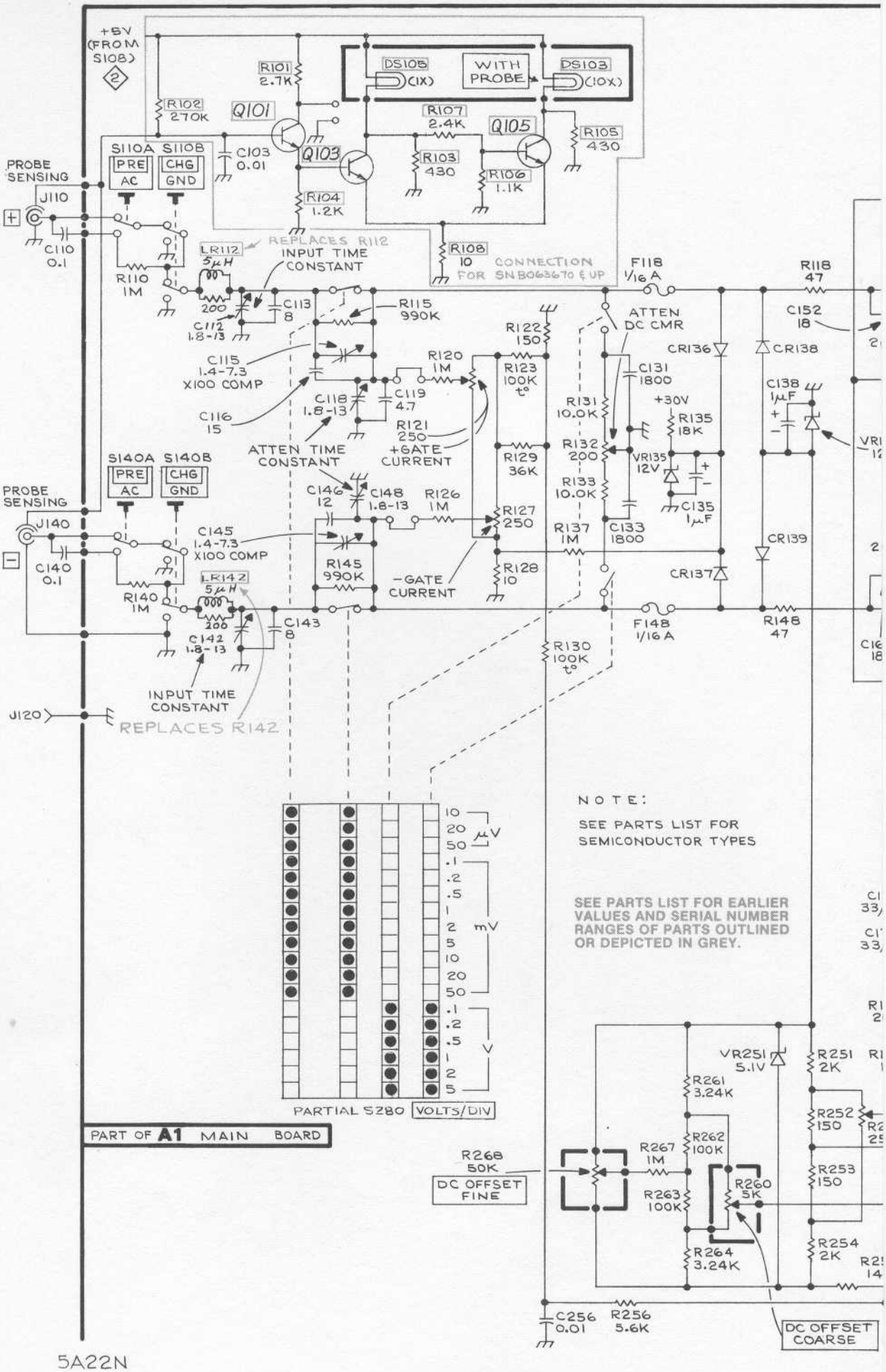
††R103 moved to back side of board SN B053616.

§R108 located at coord C2 SN B049999 & below, located at coord J2 SN B064670 & up.

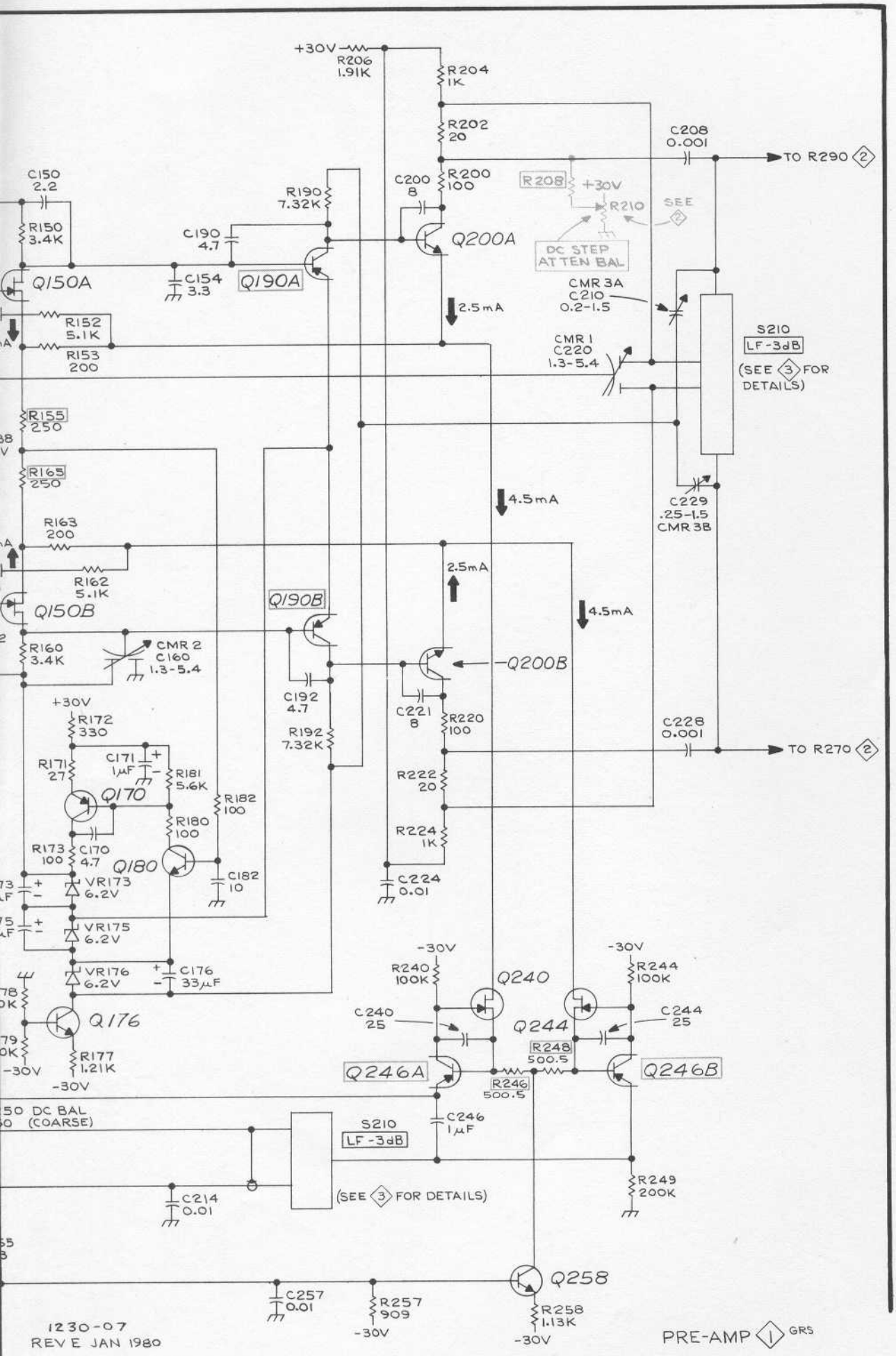
CKT NO	GRID LOC
C103	K3
C108*	C2
C112	J4
C113	J3
C115	J4
C116	J3
C118	I4
C119	I3
C131	I2
C133	I2
C135	H4
C142	J5
C143	J5
C145	J5
C146	J5
C148	I5
C150	G4
C152	G4
C154	G4
C160	G5
C162	G5
C170	G3
C171	H3
C173	G4
C175	F3
C176	F4
C182	G4
C190	F4
C192	F5
C200	F4
C208	E4
C209	E4
C210	F4
C212	F5
C214	I2
C216	D5
C220	F5
C224	E3
C228	D4
C240	D3
C244	D4
C246	D3
C256	I5
C257	D5
C270	E3
C290	E3
C301	F3
C302	F2
C303	E2
C330	C5
C331	C5
C333	C5
C334	C5
C335	C4
C336	C4
C337	C4
C338	B4
C339	B4
C348	B2
C352	B2
C370	B3
C390	B5
C394	B5
CR136	H4
CR137	H5
CR138	H4
CR139	H5
CR348	B3
CR352	C3
F118	H4
F148	H5
LR112*	J4
LR142**	J5
Q101*	K3
Q103	J2
Q105	K2
Q150	G4
Q170	G3
Q176	F3
Q180	G3
Q190	F4
Q240	E3
Q244	E4
Q246	D3
Q258	D3
Q270	E3
Q302	E2
Q320	E2
Q340	C3
Q342	C3
Q348	B3
Q352	B3
Q360	B2
Q362	B2
Q370	B3
Q380	B3
R101*	K3
R102	K3
R103††	J2
R104*	K3
R105	J2
R106*	J2
R108*§	J2
R110	J4
R115	J3
R118	H4
R120	I4
R121	I4
R122	I5
R123	I4
R126	I5
R127	I4
R128	H5
R129	I4
R130	I5
R131	I2
R132	I2
R133	I2
R135	H4
R137	H4
R140	J5
R145	J4
R148	H5
R150	G4
R152	G4
R153	G4
R155	G4
R160	G4
R162	G5
R163	G5
R165	G5
R171	G3
R172	H3
R173	G4
R177	E3
R178	F3
R179	F3
R180	G4
R181	G4
R182	G4
R190	F4
R192	F4
R200	E4
R202	E4
R204	E4
R206	E4
R208*	E4
R210	E3
R212	E5
R213	E5
R214	E5
R216	D5
R217	E5
R218	E5
R220	E4
R222	D4
R224	E4
R229	E4
R240	D4
R244	D4
R246	D4
R248	D4
R249	D3
R250	F2
R251	G2
R252	G2
R253	G2
R254	G2
R255	D2
R256	I5
R257	D4
R258	D5
R261	H2
R262	H2
R263	H2
R264	G2
R267	H2
R270	E3
R271	F3
R272	F3
R275†	F3
R276†	G3
R277†	G3
R278†	G3
R279†	G3
R280†	G3
R281†	G3
R282†	G3
R283†	H3
R284†	H3
R285†	H3
R286†	H3
R290	E3
R292	E2
R294	F2
R302	D3
R304	E3
R313	D3
R315	D2
R316	D2
R318	E2
R319	E2
R321	E3
R326	E2
R340	C3
R342	C3
R348	D2
R349	C2
R350	C3
R351	C2
R352	D2
R361	B2
R362	B2
R363	B2
R365	B2
R366	B3
R367	A4
R369	B3
R370	C3
R371	C3
R372	B3
R373	B3
R376	B3
R377	C3
R378	B3
R380	B3
R381	B4
R383	C5
R390	B5
R394	B5
S108	J2
S110A	J4
S110B	J4
S140A	J5
S140B	J5
VR135	H4
VR138	H5
VR173	G4
VR175	F4
VR176	F4
VR251	G2
VR302	F2
VR383	C3

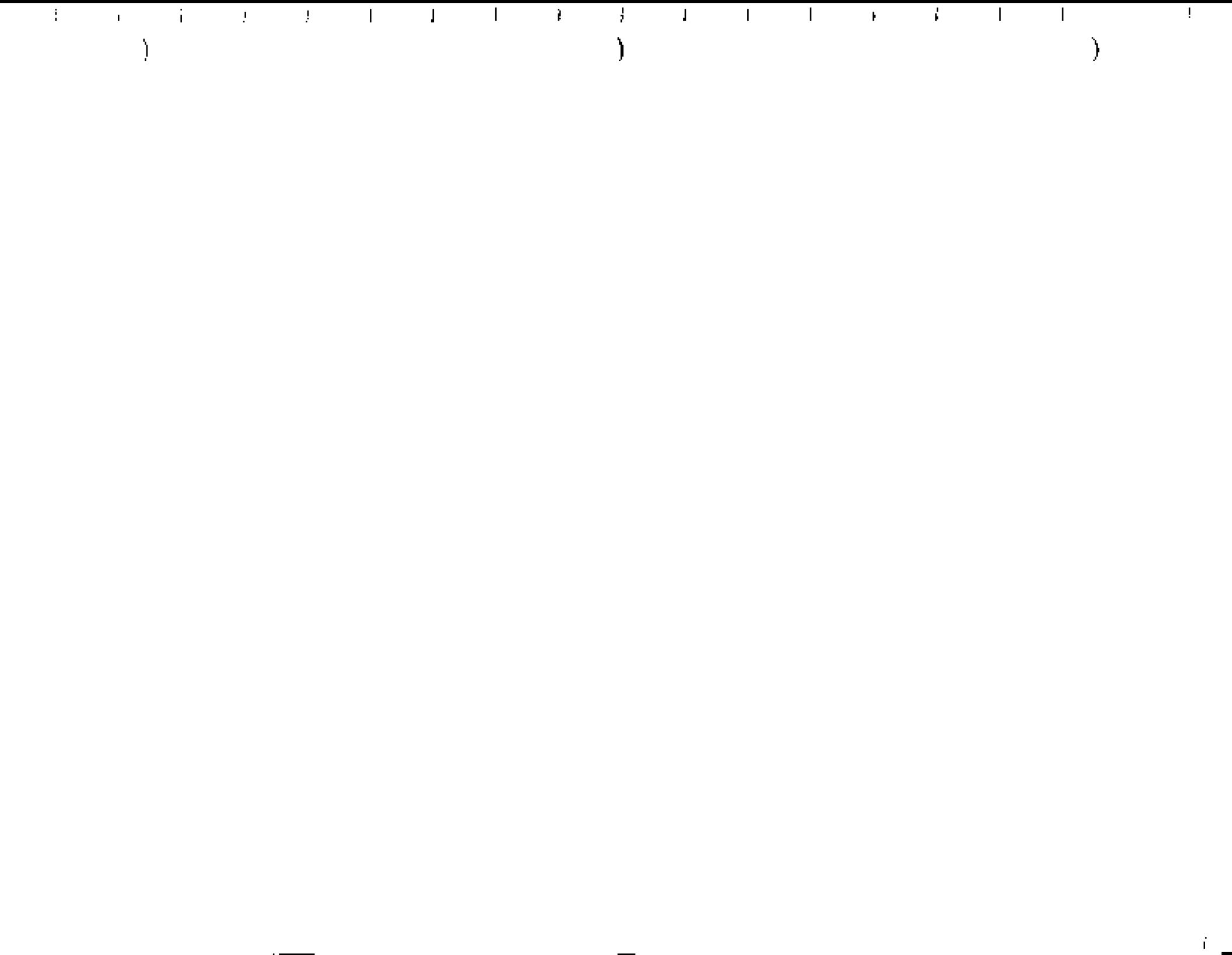

+200V (FROM S108)
2
R105
DS105
(1X)
WITH PROBE
R103
(10X)
Q105
DS103
TO J110, J140
Q103
CONNECTIONS FOR SN B053615 & BELOW

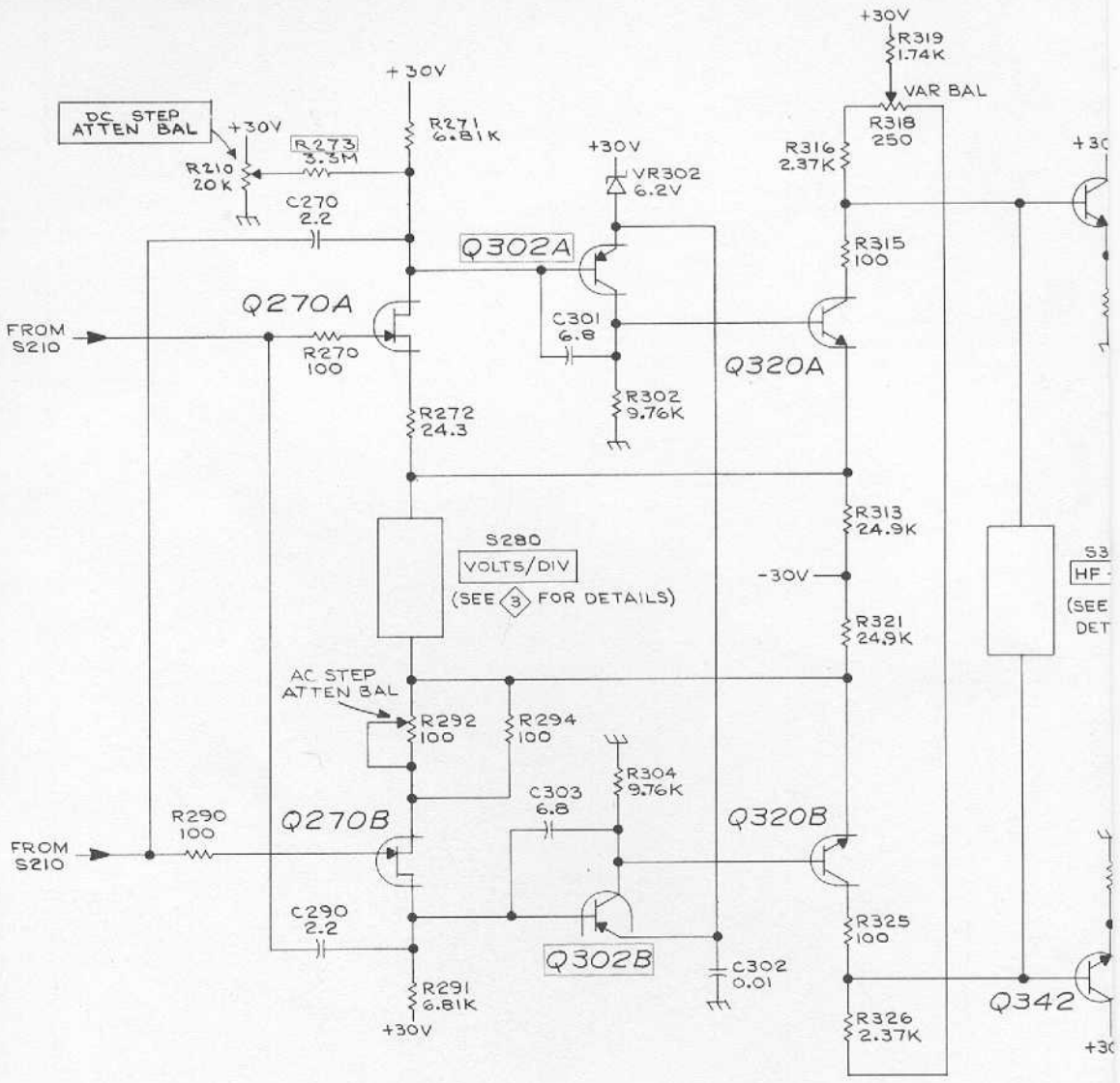

+5V (FROM S108)
2
R105
DS103
(1X)
DS105
(10X)
WITH PROBE
Q105
R103
TO C103
Q103
CONNECTIONS FOR SN B053616 – B064669


+5V (FROM S108)
R101 2.7K
DS105 (1X)
WITH PROBE
DS103 (10X)
R102 270K
Q101
R107 2.4K
Q105
R105 430
S110A S110B
PRE AC
CHG GND
C103 0.01
Q103
R103 430
R106 1.1K
PROBE SENSING
J110
R104 1.2K
REPLACES R112
INPUT TIME CONSTANT
R108 10
CONNECTION FOR SN B063670 & UP
F118 1/16 A
R118 47
C110 0.1
R110 1M
LR112 5μH
200
C112 1.8-13
C113 8
R115 990K
ATTEN DC CMR
C152 18
CR136
CR138
R122 150
C115 1.4-7.3 X100 COMP
R120 1M
R123 100K t°
C131 1800
C138 1μF
C116 15
C118 1.8-13
C119 4.7
R131 10.0K
+30V
R135 18K
R121 250
+GATE CURRENT
R129 36K
R132 200
VR135 12V
ATTEN TIME CONSTANT
S140A S140B
PRE AC
CHG GND
C146 12
C148 1.8-13
R126 1M
R133 10.0K
C135 1μF
PROBE SENSING
J140
R127 250
R137 1M
C133 1800
CR139
C145 1.4-7.3 X100 COMP
C140 0.1
R145 990K
-GATE CURRENT
R128 10
CR137
R140 1M
LR142 5μH
200
C142 1.8-13
C143 8
F148 1/16 A
R148 47
R130 100K t°
INPUT TIME CONSTANT
J120
REPLACES R142
10
20
50
μV
.1
.2
.5
1
2
5
10
20
50
mV
.1
.2
.5
1
2
5
V
PARTIAL S280 VOLTS/DIV
NOTE:
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.
PART OF A1 MAIN BOARD
VR251 5.1V
R251 2K
R261 3.24K
R252 150
R262 100K
R267 1M
R253 150
R268 50K
DC OFFSET FINE
R263 100K
R260 5K
R264 3.24K
R254 2K
C256 0.01
R256 5.6K
DC OFFSET COARSE

5A22N


+30V
R206 1.91K
R204 1K
R202 20
C208 0.001
TO R290 2
C150 2.2
R150 3.4K
Q150A
R152 5.1K
R153 200
R190 7.32K
C190 4.7
C154 3.3
Q190A
C200 8
R200 100
Q200A
R208
+30V
R210
SEE 2
DC STEP ATTEN BAL
2.5mA
CMR 3A C210 0.2-1.5
CMR 1 C220 1.3-5.4
S210 LF-3dB
(SEE 3 FOR DETAILS)
R155 250
R165 250
4.5mA
C229 .25-1.5 CMR 3B
R163 200
R162 5.1K
Q150B
Q190B
2.5mA
4.5mA
R160 3.4K
CMR 2 C160 1.3-5.4
C192 4.7
R192 7.32K
Q200B
C221 8
R220 100
C228 0.001
TO R270 2
+30V
R172 330
R171 27
C171 1μF
R181 5.6K
R182 100
Q170
R180 100
R222 20
R224 1K
R173 100
C170 4.7
Q180
C182 10
VR173 6.2V
VR175 6.2V
C224 0.01
VR176 6.2V
C176 33μF
-30V
R240 100K
Q240
R244 100K
C240 25
Q244
C244 25
Q176
R177 1.21K
R248 500.5
Q246A
Q246B
R246 500.5
C246 1μF
S210 LF-3dB
(SEE 3 FOR DETAILS)
R249 200K
C214 0.01
Q258
C257 0.01
R257 909
R258 1.13K
1230-07
REV E JAN 1980
PRE-AMP 1 GRS



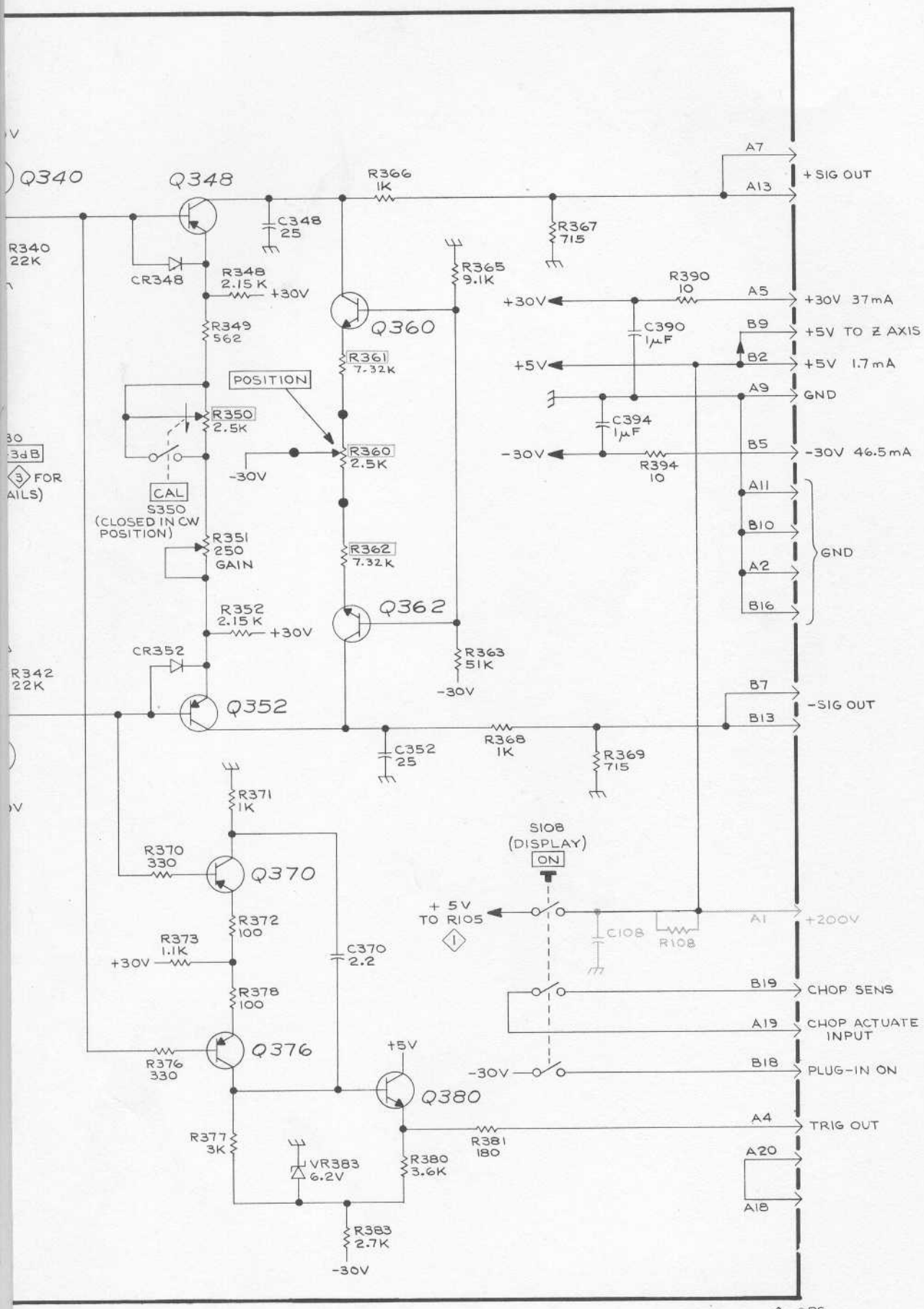


NOTE:

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

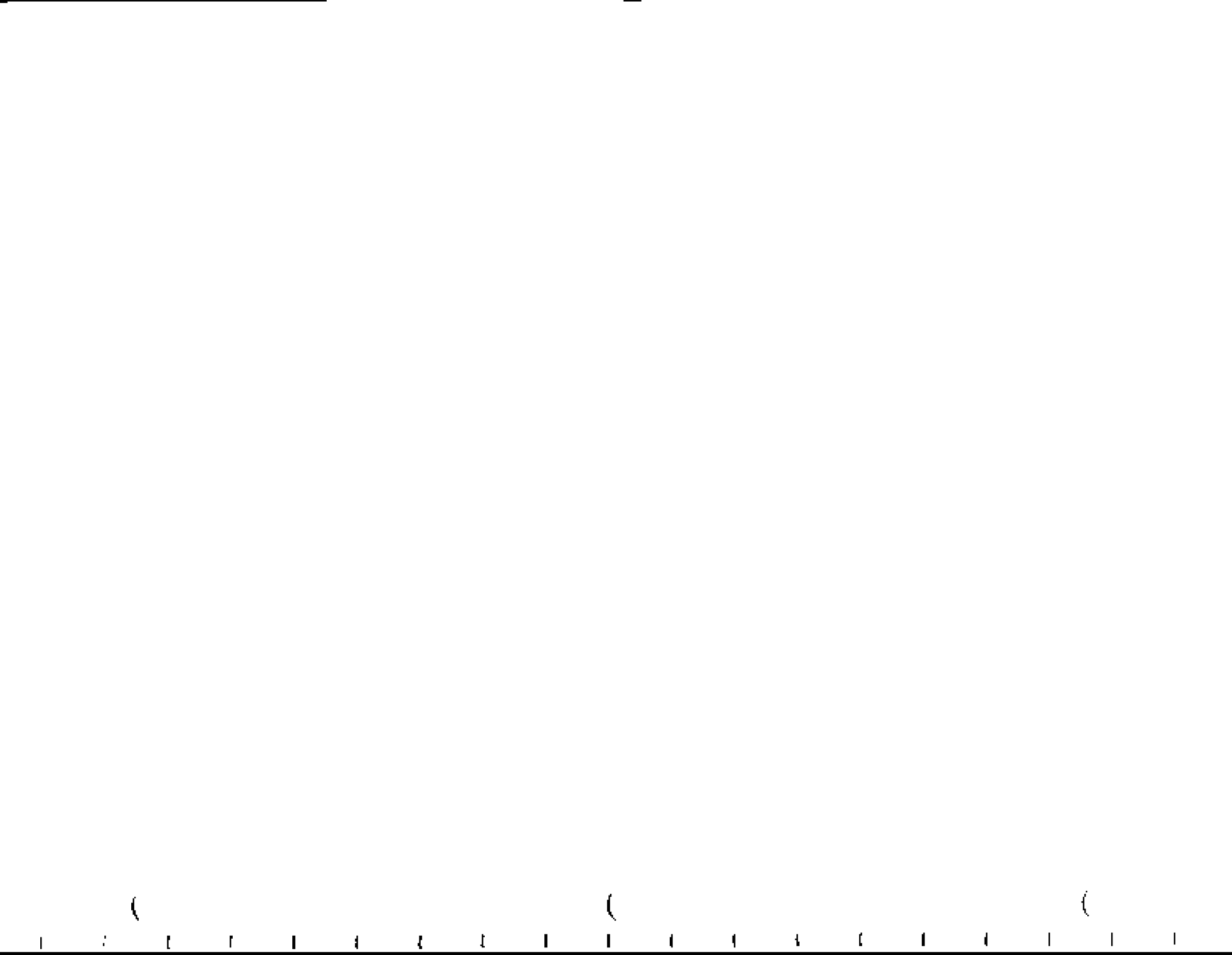
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

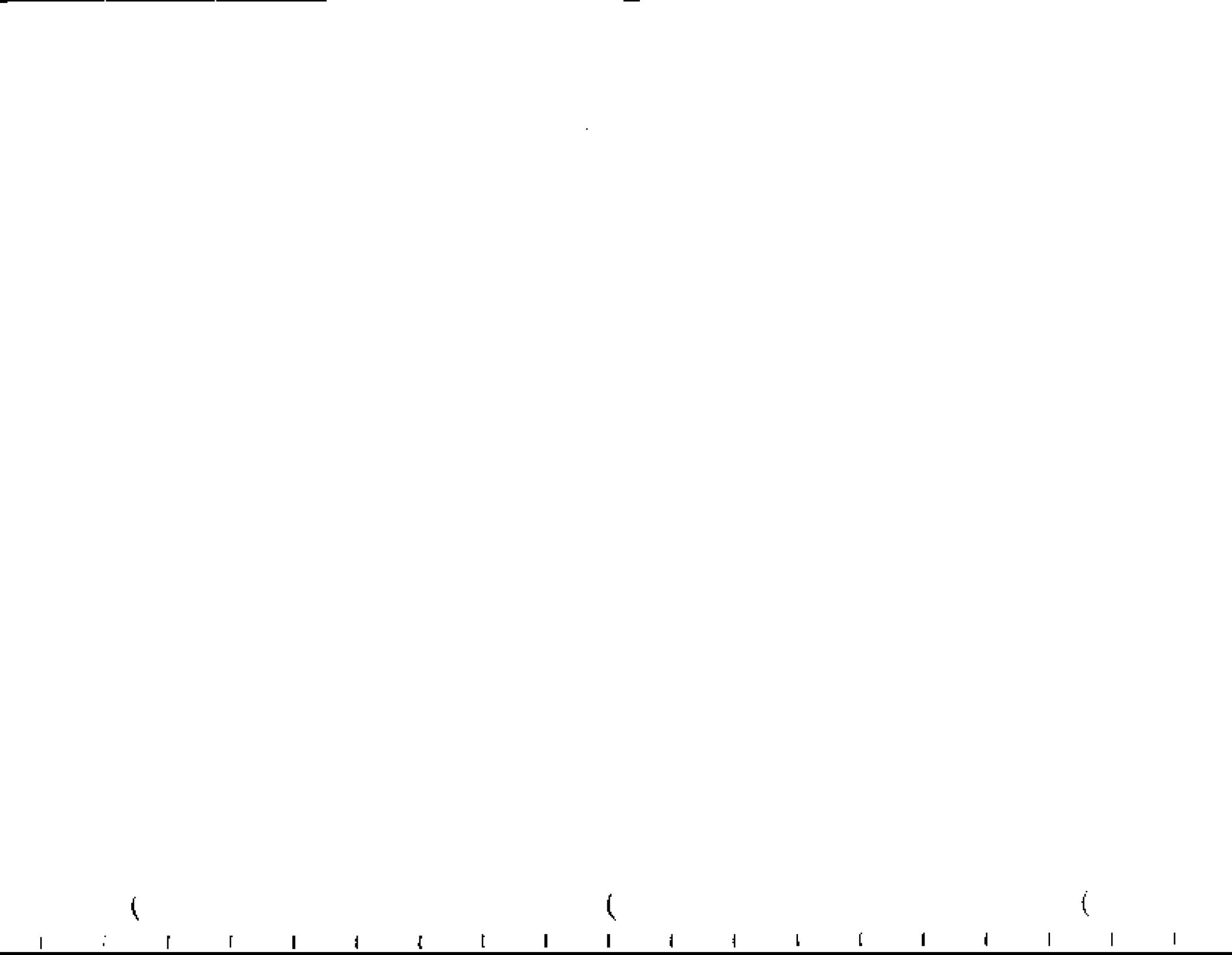
Digitally signed by
http://www.aa4df.com

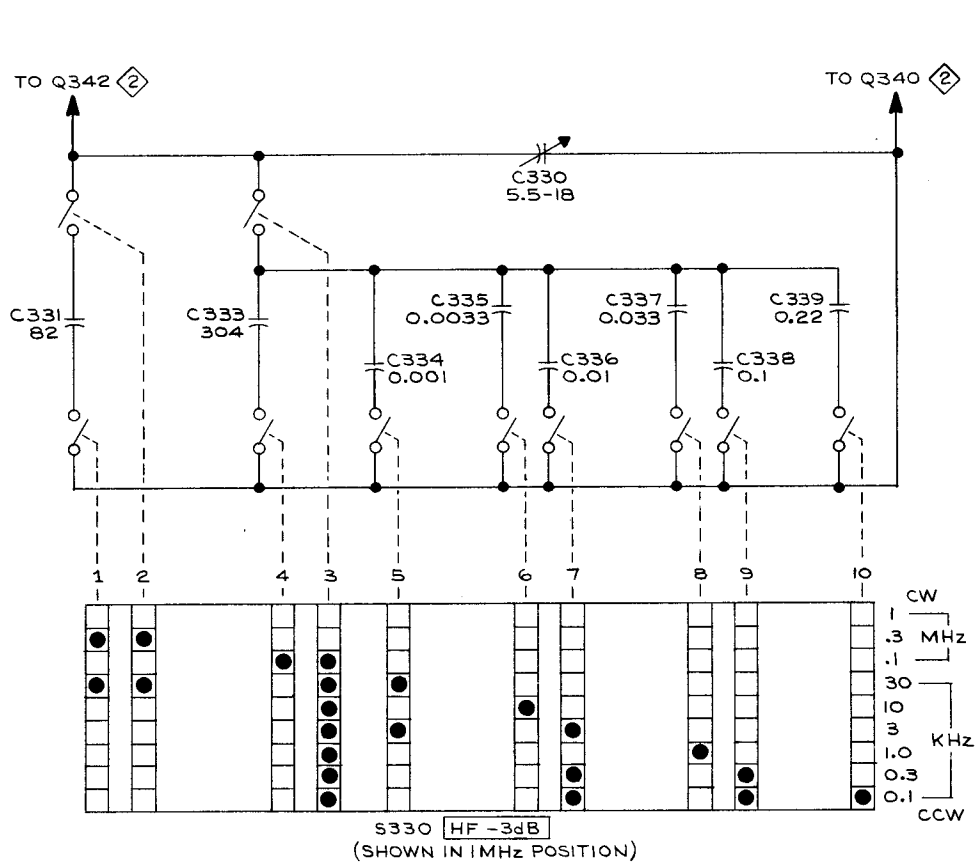


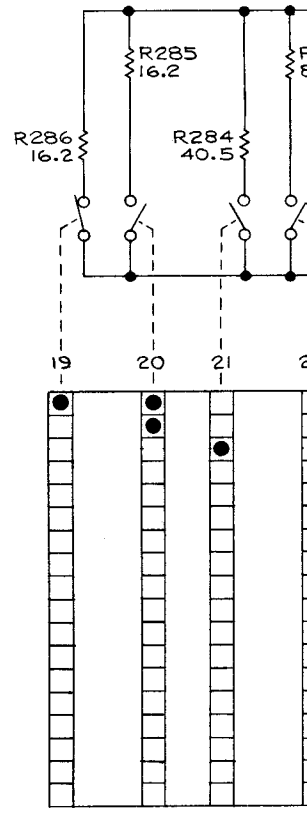
1230-08
REV H MAY 1980

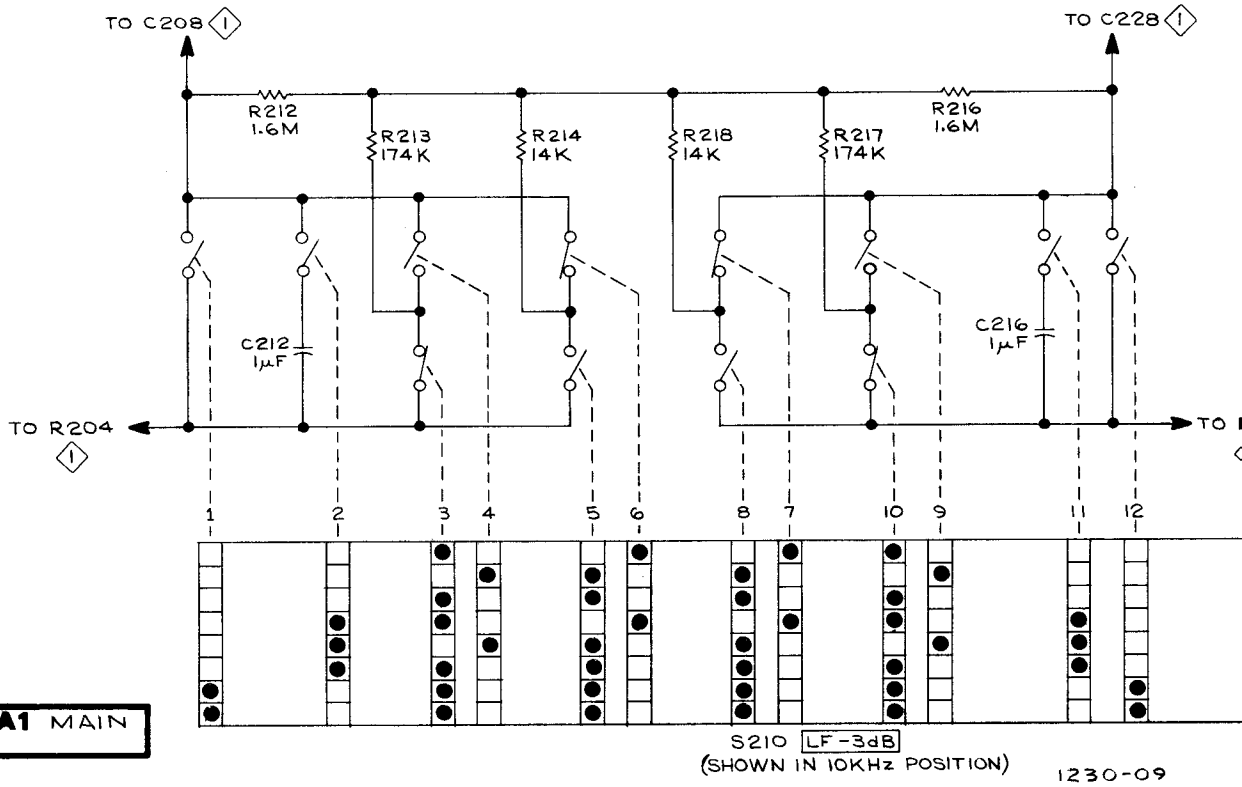
OUTPUT AMPLIFIER 2 GRS







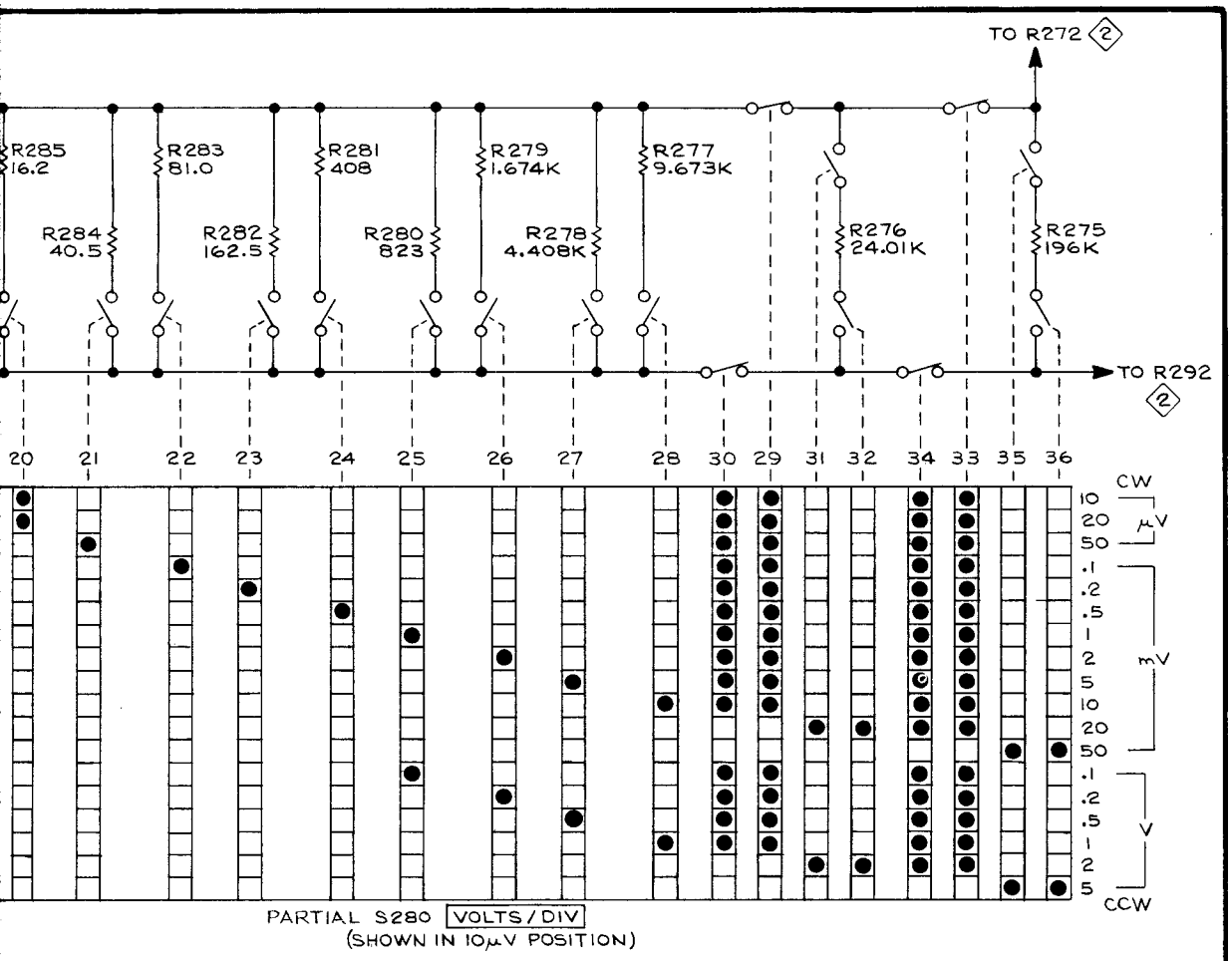




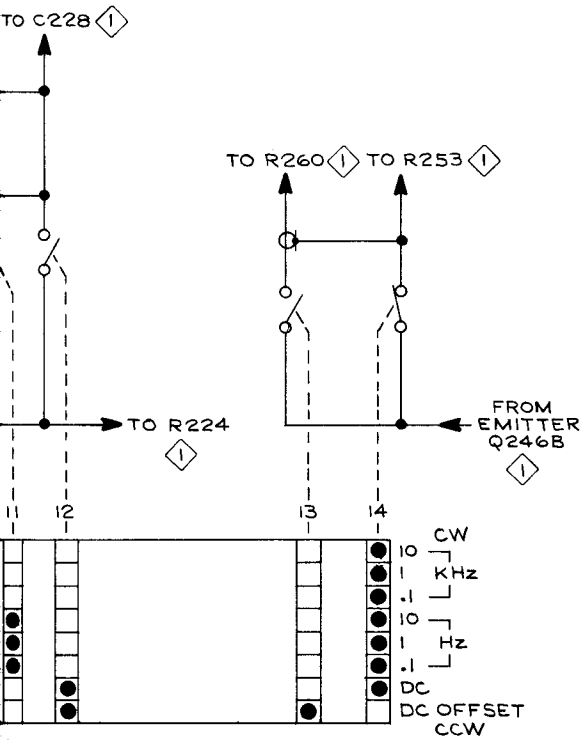
PART OF **A1** MAIN BOARD

5A22N

1230-09
REV C JAN 198

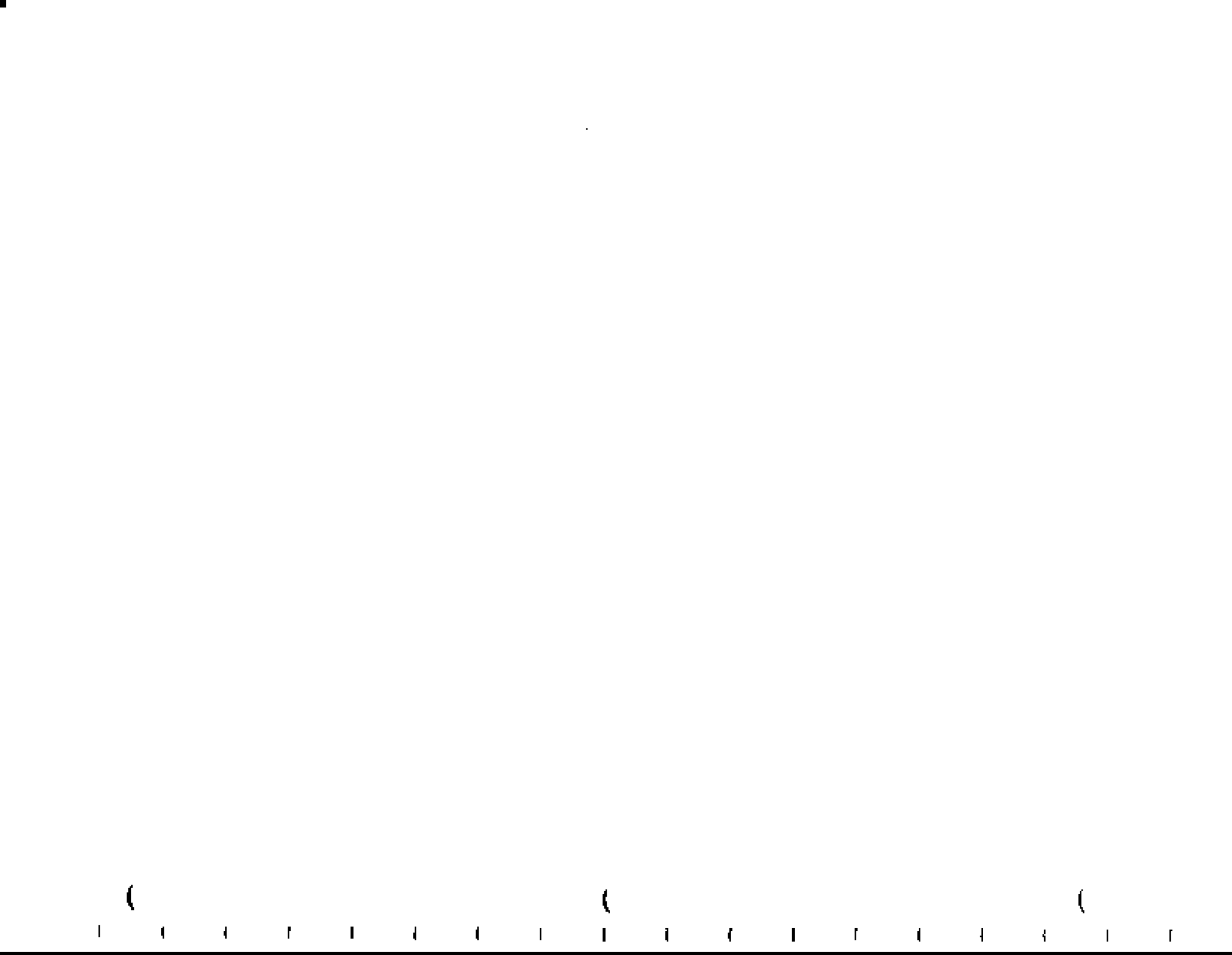


PARTIAL S280 VOLTS/DIV
(SHOWN IN 10μV POSITION)



230-09
EV C JAN 1980

SWITCHING DETAILS ◇3 GRS 1071



REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

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

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

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

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

SPECIAL NOTES AND SYMBOLS

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

FIGURE AND INDEX NUMBERS

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

INDENTATION SYSTEM

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

1 2 3 4 5 Name & Description

Assembly and/or Component
Attaching parts for Assembly and/or Component
- - - * - - -
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
- - - * - - -
Parts of Detail Part
Attaching parts for Parts of Detail Part
- - - * - - -

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

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

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

ABBREVIATIONS

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

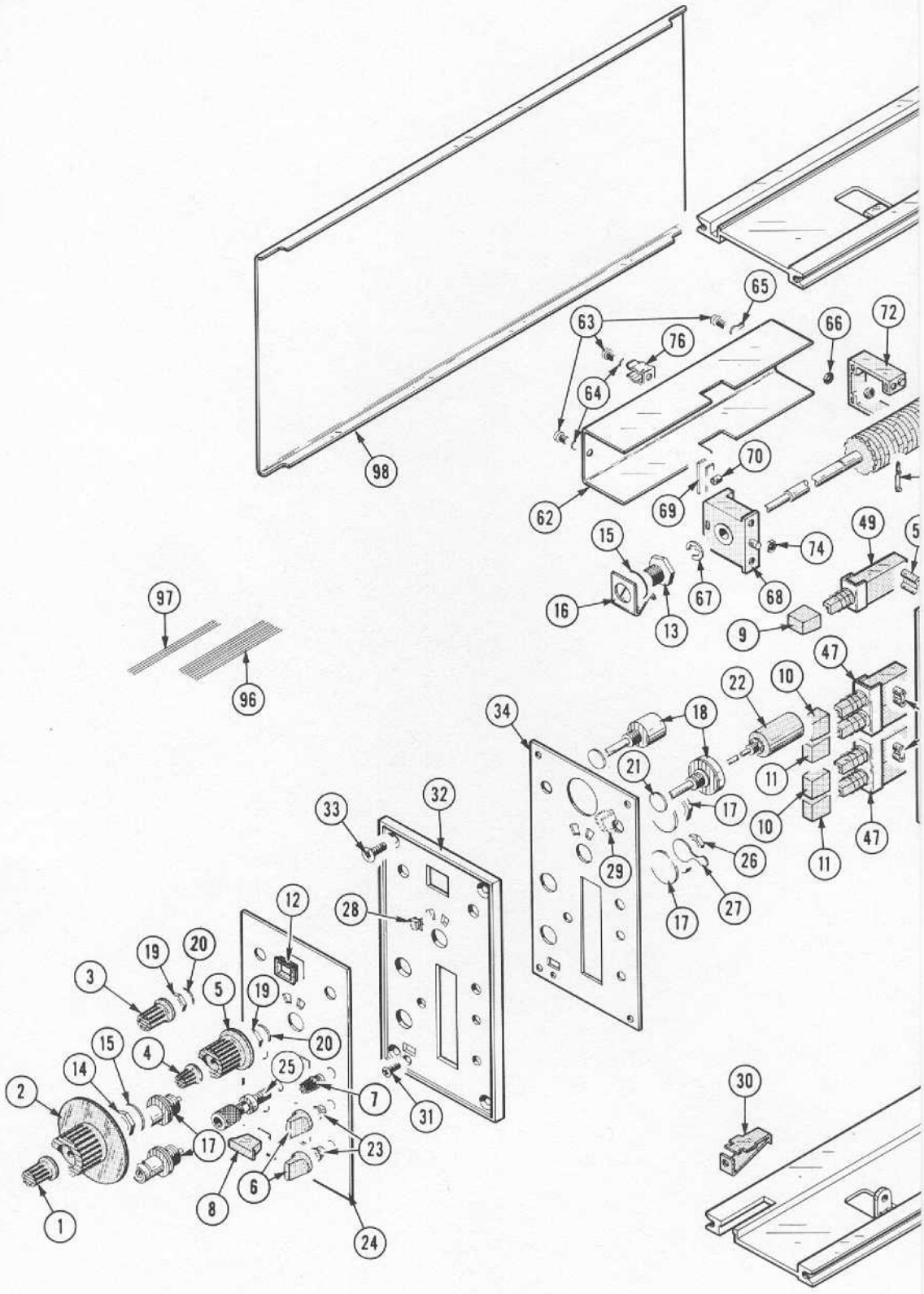
CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P O BOX 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
02111	SPECTROL ELECTRONICS CORPORATION	17070 EAST GALE AVENUE	CITY OF INDUSTRY, CA 91745
03508	GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR PRODUCTS DEPARTMENT	ELECTRONICS PARK	SYRACUSE, NY 13201
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
14433	ITT SEMICONDUCTORS	3301 ELECTRONICS WAY P O BOX 3049	WEST PALM BEACH, FL 33402
14552	MICRO SEMICONDUCTOR CORP.	2830 F FAIRVIEW ST.	SANTA ANA, CA 92704
15454	RODAN INDUSTRIES, INC.	2905 BLUE STAR ST.	ANAHEIM, CA 92806
22229	SOLITRON DEVICES, INC., DIODES, INTEGRATED CIRCUITS AND CMOS	8808 BALBOA AVENUE	SAN DIEGO, CA 92123
24546	CORNING GLASS WORKS, ELECTRONIC COMPONENTS DIVISION	550 HIGH STREET	BRADFORD, PA 16701
24931	SPECIALITY CONNECTOR CO., INC.	2620 ENDRESS PLACE	GREENWOOD, IN 46142
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
32293	INTERSIL, INC.	10900 N. TANTAU AVE.	CUPERTINO, CA 95014
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
34263	CTS OF BROWNSVILLE, INC.	1100 ROOSEVELT ST.	BROWNSVILLE, TX 78520
53944	ELT INC., GLOW LITE DIVISION	BOX 698	PAULS VALLEY, OK 73075
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
71450	CTS CORP.	905 N. WEST BLVD.	ELKHART, IN 46514
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
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
80740	BECKMAN INSTRUMENTS, INC.	2500 HARBOR BLVD.	FULLERTON, CA 92634
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601
92966	SYLVANIA MINIATURE LIGHTING PRODUCTS, INC., SUB OF GTE SYLVANIA, LIGHT. PROD.	526 ELM STREET	KEARNY, NJ 07032

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	366-1317-00			1		KNOB:RED	80009	366-1317-00
	213-0153-00			1		. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-2	366-1366-00			1		KNOB:GY,V/DIV,0.252ID X 1.475 OD X0.52 H	80009	366-1366-00
	213-0153-00			2		. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-3	366-0494-00			1		KNOB:GRAY	80009	366-0494-00
	213-0153-00			1		. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-4	366-1084-00			1		KNOB:GRAY	80009	366-1084-00
-5	366-1101-00			1		KNOB:GRAY	80009	366-1101-00
	213-0153-00			1		. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-6	366-1163-00			2		KNOB:LIGHT GRAY	80009	366-1163-00
	213-0153-00			1		. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-7	366-1036-01			1		KNOB:GY,0.125 ID X0.307 OD X 0.562	80009	366-1036-01
-8	366-1286-00	B010100	B029999	1		KNOB:SIL GY,0.5 X 0.2 X 0.375	80009	366-1286-00
	366-1286-03	B030000	B054430	1		KNOB:SIL GY,0.5 X 0.2 X 0.375	80009	366-1286-03
	366-1690-00	B054431		1		KNOB,LATCH:SIL GY,0.53 X0.23 X 1.059	80009	366-1690-00
						(ATTACHING PARTS)		
	214-1840-00	XB030000	B054430X	1		PIN,KNOB SECRG:0.094 OD X 0.120 INCH LONG	80009	214-1840-00
						- - - * - - -		
-9	366-1257-14			1		PUSH BUTTON:GRAY--ON	80009	366-1257-14
-10	366-1257-11			2		PUSH BUTTON:GRAY--AC PRE	80009	366-1257-11
-11	366-1257-12			2		PUSH BUTTON:GRAY--CHG GND	80009	366-1257-12
-12	426-0681-00			5		FR,PUSH BUTTON:GRAY PLASTIC	80009	426-0681-00
-13	358-0029-00			1		BSHG,MACH.THD:HEX,0.375-32 X 0.438"LONG	80009	358-0029-00
						(ATTACHING PARTS)		
-14	210-0590-00			1		NUT,PLAIN,HEX.:0.375 X 0.438 INCH,STL	73743	2X28269-402
-15	210-0978-00			2		WASHER,FLAT:0.375 ID X 0.50 INCH OD,STL	78471	OBD
						- - - * - - -		
-16	344-0195-01			1		CLIP,ELECTRICAL:CAM SHAFT	80009	344-0195-01
-17	----- -----			2		CONNECTOR,RCPT,:(SEE J110 & J140)		
						(ATTACHING PARTS)		
	220-0497-00	XB041451		2		NUT,PLAIN,HEX.:0.5-28 X 0.562 INCH HEX,BRS	73743	OBD
	210-1039-00	XB041451		2		WASHER,LOCK:INT,0.521 ID X 0.625 INCH OD	24931	OBD
						- - - * - - -		
-18	----- -----			2		RES.,VAR,NONWIR:(SEE R360 & R260 EPL)		
						(ATTACHING PARTS)		
-19	210-0538-00			4		NUT,HEX:0-32 X 0.312 INCH	72962	68C1-62
-20	210-0940-00			4		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
-21	210-0046-00	B010100	B029999	4		WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
	210-0046-00	B030000		2		WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
						- - - * - - -		
	358-0251-00	XB054002		1		INSERT,SCR THD:0.25-32 X 0.424 INCH LONG	80009	358-0251-00
	214-2652-00	XB054002		1		DRAG,SHAFT:VARIABLE RESISTOR,0.079 ID	80009	214-2652-00
						(ATTACHING PARTS)		
	210-0583-00	XB054002		1		NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
						- - - * - - -		
-22	----- -----			1		RES.,VAR,NONWIR:(SEE R268 EPL)		
-23	358-0378-00	B010100	B054171	2		BUSHING,SLEEVE:PRESS MOUNT	80009	358-0378-00
	358-0599-00	B054172		2		BUSHING,SLEEVE:0.125 ID X 0.234 THK,PLSTC	28520	B-187-125
-24	333-1519-00			1		PANEL,FRONT:	80009	333-1519-00
-25	129-0103-00			1		POST,BDG,ELEC:ASSEMBLY	80009	129-0103-00
	129-0077-00			1		. STUD,SHOULDERED:0.938 INCH LONG,BRASS	80009	129-0077-00
	200-0103-00			1		. NUT,PLAIN,KNURL:0.25-28 X 0.375" OD,BRASS	80009	200-0103-00
						(ATTACHING PARTS)		
-26	210-0538-00			1		NUT,HEX:0-32 X 0.312 INCH	72962	68C1-62
						- - - * - - -		
-27	210-0223-00			1		TERMINAL,LUG:0.25 INCH DIA,SE	86928	A313-136
-28	136-0431-00			2		LIGHT,INDICATOR:U/W 0.244 OD LAMP	80009	136-0431-00
-29	337-1430-00			2		SHIELD,LIGHT:LAMP	80009	337-1430-00
-30	214-1513-00	B010100	B029999	1		LCH,PL-IN RTNG:PLASTIC	80009	214-1513-00
	214-1513-01	B030000	B054430	1		LCH,PLUG-IN RET:	80009	214-1513-01
	105-0719-00	B054431		1		LATCH,RETAINING:PLUG-IN	80009	105-0719-00
						(ATTACHING PARTS)		
-31	213-0254-00			1		SCREW,TPG,TF:2-32 X 0.250,100 DEG,FLH	45722	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-	105-0718-01	XB054431		1		BAR,LATCH RLSE:	80009	105-0718-01
-32	386-1914-00			1		SUBPANEL,FRONT:	80009	386-1914-00
						(ATTACHING PARTS)		
-33	213-0229-00			4		SCR,TPG,THD FOR:6-20 X0.375"100 DEG,FLH STL	93907	OBD
						- - - * - - -		
-34	337-1540-00			1		SHIELD,ELEC:REAR	80009	337-1540-00
-35	376-0051-00	B010100	B039999	1		CPLG,SHAFT,FLEX:FOR 0.125 INCH DIA SHAFTS	80009	376-0051-00
	376-0051-01	B040000		1		CPLG,SHAFT,FLEX:0.127 ID X 0.375 OD	80009	376-0051-01
	376-0049-01			1		. CPLG,SHAFT,FLEX:0.127 ID X 0.375 OD,PP	80009	376-0049-01
	354-0251-00			2		. RING,COUPLING:0.251 ID X 0.375 INCH OD,AL	80009	354-0251-00
	213-0048-00	B010100	B039999	4		. SETSCREW:4-40 X 0.125 INCH,HEX SOC STL	74445	OBD
	213-0178-00	B040000		4		. SETSCREW:4-40 X 0.125 INCH,HEX,SOC STL	74445	OBD
-36	384-1135-00			1		EXTENSION SHAFT:5.25 INCH LONG X 0.125 OD	80009	384-1135-00
-37	384-1155-00			1		EXTENSION SHAFT:3.76 L X 0.249 OD SST	80009	384-1155-00
-38	384-0264-00			1		EXTENSION SHAFT:6.184 L X 0.187 OD STL,CD	80009	384-0264-00
-39	----- -----			1		CKT BOARD ASSY:MAIN(SEE A1 EPL)		
-40	131-0566-00			2		. BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
-41	131-0604-00			46		. CONTACT,ELEC:CKT BD SW,SPR,CU BE	80009	131-0604-00
-42	136-0252-04	B010100	B041240	42		. SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
	136-0252-07	B041241		36		. SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
	136-0220-00	XB041241		2		. SKT,PL-IN ELEK:TRANSISTOR 3 CONTACT,PCB MT	71785	133-23-11-034
-43	136-0235-00			1		. SOCKET,PLUG-IN:6 CONTACT,ROUND	71785	133-96-12-062
-44	200-0687-01			1		. COV,TRANSISTOR:0.438 DIA X 0.47 INCH H	80009	200-0687-01
-45	214-0579-00			9		. TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-46	344-0154-00			4		. CLIP,ELECTRICAL:FUSE,CKT BD MT	80009	344-0154-00
-47	----- -----			2		. SWITCH,PUSH:(SEE S110 & S140 EPL)		
-48	361-0384-00			8		. SPACER,PB SW:0.133 INCH LONG	80009	361-0384-00
-49	----- -----			1		. SWITCH,PUSH:(SEE S108 EPL)		
-50	361-0383-00			2		. SPACER,PB SW:CHARCOAL,0.33 INCH LONG	80009	361-0383-00
-51	----- -----			1		. RES.,VAR,NONWIR:(SEE R350 EPL)		
						(ATTACHING PARTS)		
-52	210-0590-00	B010100	B059999X	1		. NUT,PLAIN,HEX.:0.375 X 0.438 INCH,STL	73743	2X28269-402
-53	210-0978-00	B010100	B059999X	1		. WASHER,FLAT:0.375 ID X 0.50 INCH OD,STL	78471	OBD
-54	210-0012-00	B010100	B059999X	1		. WASHER,LOCK:INTL,0.375 ID X 0.50" OD STL	78189	1220-02-00-0541C
						- - - * - - -		
	376-0051-00	XB060000		1		. CPLG,SHAFT,FLEX:FOR 0.125 INCH DIA SHAFTS	80009	376-0051-00
-55	407-0894-00	B010100	B059999X	1		. BRACKET,ELEC SW:BRASS	80009	407-0894-00
-56	384-1055-00	B010100	B059999	1		. EXTENSION SHAFT:8.543 INCHES L	80009	384-1055-00
	384-1220-00	B060000		1		. EXTENSION SHAFT:0.125 DIA X 8.038 INCH L	80009	384-1220-00
						(ATTACHING PARTS)		
-57	213-0075-00			2		. SETSCREW:4-40 X 0.094,STL BK OXD,HEX SKT	000BK	OBD
						- - - * - - -		
-58	----- -----			1		. VAR.,RES NONWIRE:		
						(ATTACHING PARTS)		
-59	210-0583-00			1		. NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-60	210-0940-00			1		. WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
						- - - * - - -		
-61	386-2273-00			1		. PL,VAR RES MTG:HORIZONTAL CKT BD	80009	386-2273-00
	105-0309-00			1		. ACTR ASSY,CAM S:VOLTS/DIV	80009	105-0309-00
-62	200-0943-01			1		. . COVER,CAM SW:36 ELEMENTS	80009	200-0943-01
						(ATTACHING PARTS)		
-63	211-0022-00			4		. . SCREW,MACHINE:2-56 X 0.188 INCH,PNH STL	83385	OBD
-64	210-0001-00			3		. . WASHER,LOCK:INTL,0.092 ID X 0.18"OD,STL	78189	1202-00-00-0541C
-65	210-0259-00			1		. . TERMINAL,LUG:0.099"ID INT TOOTH,SE	80009	210-0259-00
-66	210-0405-00			4		. . NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	2X12157-402
						- - - * - - -		
	334-3448-00	XB054541		1		. . MARKER,IDENT:MARKED NOTICE	80009	334-3448-00
-67	354-0219-00			1		. . RING,RETAINING:FOR 0.25 INCH SHAFT	79136	5103-25-MD-R
-68	401-0057-00			1		. . BEARING,CAM SW:FRONT	80009	401-0057-00
-69	214-1139-00			1		. . SPRING,FLAT:0.885 X 0.156CU BE GLD CLR	80009	214-1139-00
	----- -----			-		. . (REPL ONLY WITH PART BEARING THE SAME COLOR		
	----- -----			-		. . CODE AS THE ORIG PART IN YOUR INSTRUMENT)		
	214-1139-02	B010100	B064827X	1		. . SPRING,FLAT:GREEN COLORED	80009	214-1139-02
	----- -----			-		. . (REPLACE WITH SAME COLOR AS ORIGINAL)		
	214-1139-03	B010100	B064827	1		. . SPRING,FLAT:RED COLORED	80009	214-1139-03
	----- -----			-		. . (REPLACE WITH SAME COLOR AS ORIGINAL)		
	214-1139-03	B064828		2		. . SPRING,FLAT:RED COLORED	80009	214-1139-03
	----- -----			-		. . (REPLACE WITH SAME COLOR AS ORIGINAL)		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-70	214-1127-00			1	. . ROLLER,DETENT:0.125 DIA X 0.125 INCH L	80009	214-1127-00
-71	105-0331-00			1	. . ACTUATOR,CAM SW:VOLTS/DIV	80009	105-0331-00
-72	407-0653-00			1	. . BRACKET,COVER:CAM SWITCH,DELRIN	80009	407-0653-00
-73	401-0056-00			1	. . BEARING,CAM SW:REAR	80009	401-0056-00
-74	210-0406-00			6	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
					(ATTACHING PARTS FOR DRUM ASSY)		
-75	211-0116-00			6	. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
					- - - * - - -		
-76	344-0002-00			2	. CLIP,ELECTRICAL:	75915	OBD
	105-0310-00			1	. ACTR ASSY,CAM S:LOW FREQ	80009	105-0310-00
-77	200-1351-00			1	. . COVER,CAM SW:ALUMINUM	80009	200-1351-00
-78	354-0219-00			1	. . RING,RETAINING:FOR 0.25 INCH SHAFT	79136	5103-25-MD-R
-79	401-0155-00			1	. . BEARING,CAM SW:FRONT	80009	401-0155-00
-80	214-1704-00			-	. . SPRING,FLAT:CAM SW DETENT,0.006 INCH THK	80009	214-1704-00
	----- -----			-	. . (REPL ONLY WITH PART BEARING THE SAME COLOR		
	----- -----			-	. . CODE AS THE ORIG PART IN YOUR INSTRUMENT)		
	214-1704-01			-	. . SPRING,FLAT:CAM SW DETENT,0.008 INCH THK	80009	214-1704-01
	----- -----			-	. . (REPLACE WITH SAME COLOR AS ORIGINAL)		
	214-1704-02			-	. . SPRING FLAT:0.52 X 0.125 X 0.01,CU BE	80009	214-1704-02
	----- -----			-	. . (REPLACE WITH SAME COLOR AS ORIGINAL)		
	214-1127-00			-	. . ROLLER,DETENT:0.125 DIA X 0.125 INCH L	80009	214-1127-00
-81	105-0332-00			1	. . ACTUATOR,CAM SW:LOW FREQ	80009	105-0332-00
-82	401-0156-00			1	. . BEARING,CAM SW:REAR	80009	401-0156-00
-83	131-1248-00			1	. . CONTACT,ELEC:SHAFT GND,NI BE	80009	131-1248-00
-84	210-0406-00			4	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
					(ATTACHING PARTS FOR DRUM ASSY)		
-85	211-0116-00			4	. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
					- - - * - - -		
	105-0311-00			1	. ACTR ASSY,CAM S:HIGH FREQ 3DBSEL	80009	105-0311-00
-86	200-1332-00			1	. . COVER,CAM SW:	80009	200-1332-00
	354-0219-00			1	. . RING,RETAINING:FOR 0.25 INCH SHAFT	79136	5103-25-MD-R
-87	401-0155-00			1	. . BEARING,CAM SW:FRONT	80009	401-0155-00
-88	214-1704-00			-	. . SPRING,FLAT:CAM SW DETENT,0.006 INCH THK	80009	214-1704-00
	----- -----			-	. . (REPLACE WITH SAME COLOR AS ORIGINAL)		
	214-1704-01			-	. . SPRING,FLAT:CAM SW DETENT,0.008 INCH THK	80009	214-1704-01
	----- -----			-	. . (REPLACE WITH SAME COLOR AS ORIGINAL)		
	214-1704-02			-	. . SPRING FLAT:0.52 X 0.125 X 0.01,CU BE	80009	214-1704-02
	----- -----			-	. . (REPLACE WITH SAME COLOR AS ORIGINAL)		
-89	214-1127-00			1	. . ROLLER,DETENT:0.125 DIA X 0.125 INCH L	80009	214-1127-00
-90	105-0333-00			1	. . ACTUATOR,CAM SW:HIGH FREQ/3DBSEL	80009	105-0333-00
-91	401-0156-00			1	. . BEARING,CAM SW:REAR	80009	401-0156-00
	131-1248-00			1	. . CONTACT,ELEC:SHAFT GND,NI BE	80009	131-1248-00
	210-0406-00			4	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
					(ATTACHING PARTS FOR DRUM ASSY)		
-92	211-0116-00			4	. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
					- - - * - - -		
					(ATTACHING PARTS FOR CKT BD ASSY)		
-93	213-0146-00			4	SCR,TPG,THD FOR:6-20 X 0.313 INCH,PNH STL	83385	OBD
					- - - * - - -		
-94	426-0724-00			1	FR SECT,PLUG-IN:BOTTOM	80009	426-0724-00
-95	426-0725-00			1	FR SECT,PLUG-IN:TOP	80009	426-0725-00
-96	175-0831-00			FT	WIRE,ELECTRICAL:8 WIRE RIBBON	08261	OBD
-97	175-0826-00			FT	WIRE,ELECTRICAL:3 WIRE RIBBON	80009	175-0826-00
-98	337-1399-00			2	SHLD,ELECTRICAL:SIDE	80009	337-1399-00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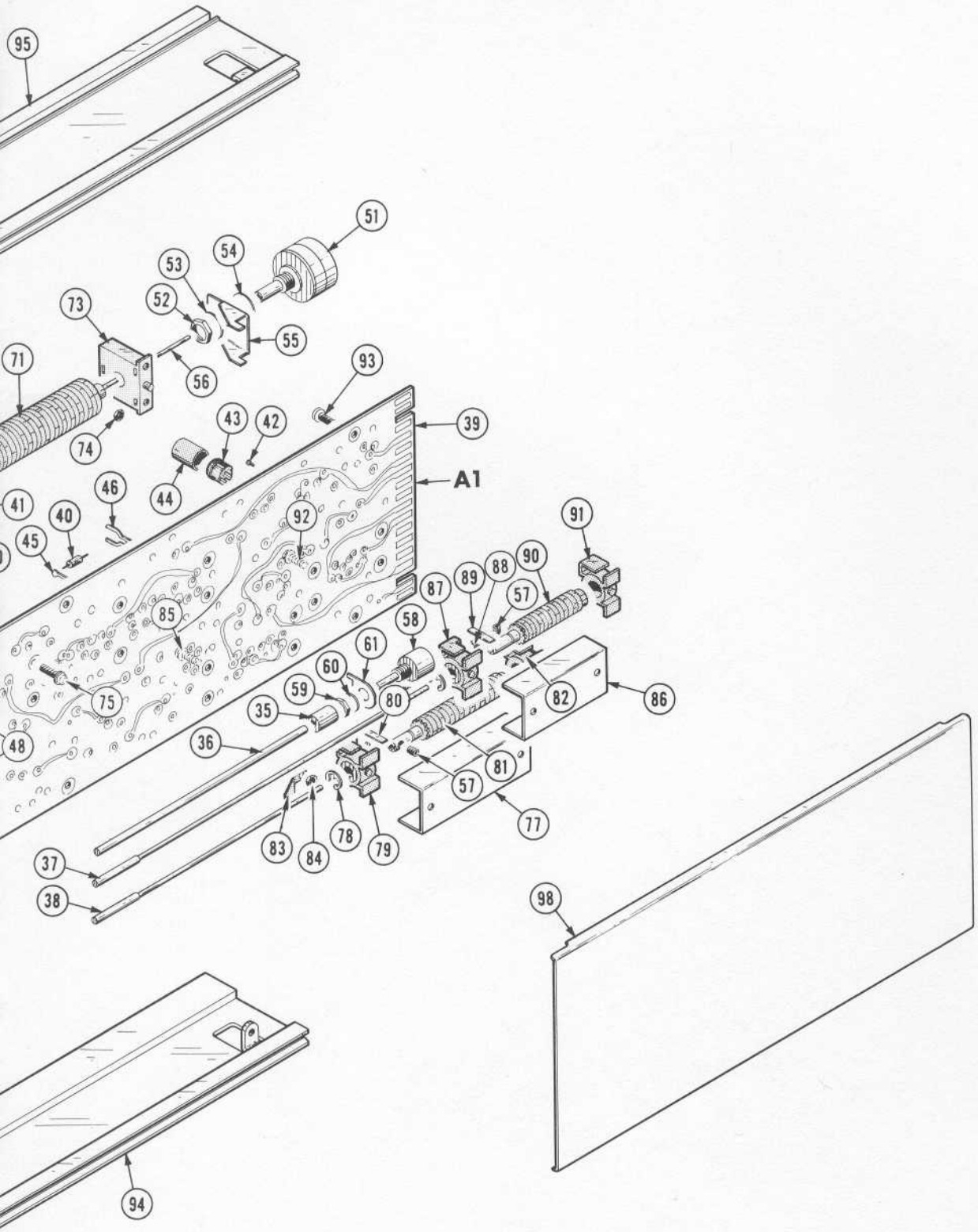

5A22N DIFFERENTIAL AMPLIFIER

STANDARD ACCESSORIES

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
	070-1230-00			1		MANUAL,TECH:INSTRUCTION	80009	070-1230-00

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 market output from 5 sec through 100 ns. One time-mark can be generated at a time.	184 - Separate trigger pulses of 1 and 0.1 sec; 10, 1, and 0.1 ms; 10 and 1 μs.
2901	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	2901 - Separate trigger pulses, from 5 sec to 0.1 μs. Multiple time-marks can be generated simultaneously.

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