

# INSTRUCTION MANUAL

Serial Number \_\_\_\_\_

**TYPE 3A1**  
**DUAL-TRACE**  
**AMPLIFIER**

*Tektronix, Inc.*

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

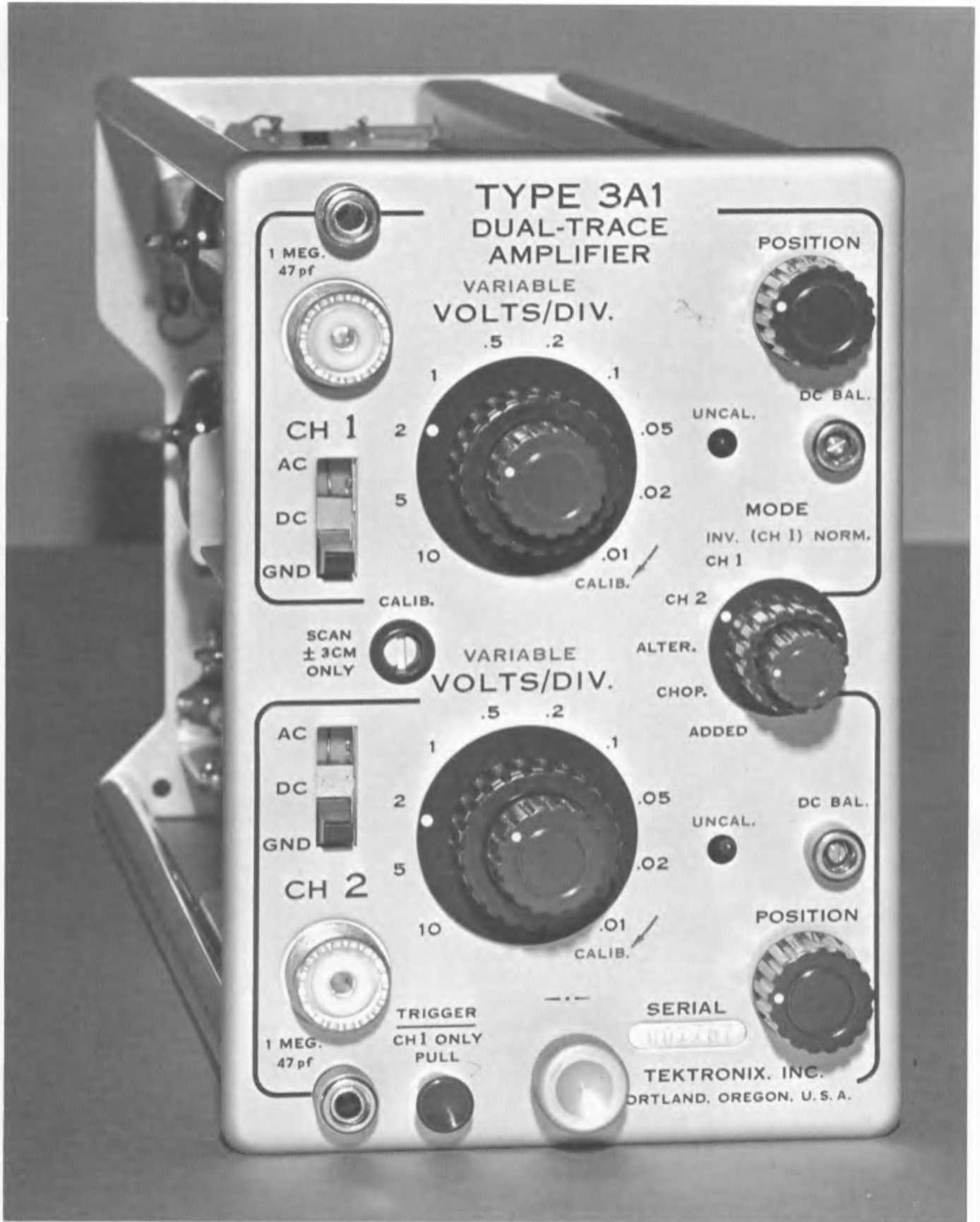


Fig. 1-1. Type 3A1 Dual-Trace Amplifier Plug-In Unit.

# SECTION 1

## CHARACTERISTICS

### General

The Type 3A1 Dual-Trace Amplifier plug-in unit is designed to operate in Tektronix 560-Series Oscilloscopes. The unit has two identical amplifier channels with a switching circuit that can select independent operation of either channel, switch back and forth between channels either at an internally set chopping rate or on alternate sweeps, or select the algebraic sum of the two inputs.

### OPERATING CHARACTERISTICS

#### Deflection Factor

Each channel has ten deflection factors from 0.01 volts/div to 10 volts/div. in a 1, 2, 5 sequence. Accuracy is  $\pm 3\%$  of indication. Each channel has a variable attenuator which may be used to introduce a continuously variable attenuation to a maximum of 2.5 X the indicated deflection factor. A warning indicator lights when the variable attenuator is not in the calibrated position.

#### Frequency Response

DC to at least 10 MHz at  $-3$  dB

#### Risetime

Equal to or less than 35 nanoseconds

#### Input Characteristics

Approximately 1 megohm, paralleled by 47 pF ( $47 \times 10^{-12}$  farads)

#### Input Coupling

AC or DC coupling of signals may be selected for either channel. A  $0.1 \mu\text{F}$  capacitor limits low-frequency response to about 2 Hz on AC coupling.

#### Operating Modes

Channel 1 only: Channel 2 will not operate.

Channel 2 only: Channel 1 will not operate.

Alternate: Electronic switching between channels at the end of each sweep.

Chopped: Electronic switching between channels at a rate of about 100 kHz, with a  $5 \mu\text{sec}$  sample of each channel. Blanking occurs while switching is taking place.

Added: The algebraic sum of both signals is displayed. When the channel 1 signal is inverted, the difference is displayed.

#### Triggering

An internal signal for triggering is fed from the Type 3A1 through the indicator unit to the time-base plug-in unit. Trigger signals may be supplied from channel 1 only, or from channel 1 and channel 2, depending on which channel is displayed.

#### Mechanical Features

Construction: Aluminum alloy chassis

#### Accessories

Information on accessories for use with this instrument is included at the rear of the mechanical parts list.



# SECTION 2

## OPERATING INSTRUCTIONS

### Introduction

The Type 3A1 is normally used with a 560-Series Oscilloscope to provide vertical deflection signals with respect to horizontal units of time provided by a time-base plug-in unit such as the Tektronix Type 2B67. In some applications, an amplifier plug-in unit instead of a time-base plug-in unit can be used to provide horizontal deflection.

The following instructions are based on using a time-base plug-in unit to provide the horizontal deflection. Typical applications of the Type 3A1 are given in Section 3 of this manual.

The operating instructions are divided into three sections: a discussion of considerations necessary before making measurements with the Type 3A1, a procedure to be followed when operating the Type 3A1 for the first time, a list of the front panel controls with a discussion of the operation of each.

### PRELIMINARY CONSIDERATIONS

Consider the following information before making the test setup.

### Connections

It is often possible to make signal connections to the Type 3A1 with short-length, unshielded test leads\*. This is particularly true for high-level, low-frequency signals. When such leads are used, you must also use a ground connection between the Type 3A1 or oscilloscope chassis ground and the chassis of the equipment under test. Position the leads away from any stray electric or magnetic field source to avoid obtaining erroneous displays.

In many low-level applications unshielded leads are unsatisfactory for making signal connections because of signal pickup resulting from nearby fields. To prevent unwanted signal pickup, use shielded (coaxial) cables. Be sure the ground conductors of the cables are connected to the chassis of both the oscilloscope and the signal source.

### Loading

As nearly as possible, simulate actual operating conditions in the equipment under test. For example, the equipment should work into a load impedance equal to that which it will see in actual use.

Consider the effect of loading on the equipment under test caused by the input circuit of the Type 3A1. The input circuit can be represented by a resistance of 1 megohm shunted by a capacitance of 47 pF. With a few feet of

shielded cable, the capacitance is increased considerably. Use a probe where the effects of resistive and capacitive loads will not affect the operation of the device under test or distort the signal.

### Use of Probes

An attenuator probe reduces both capacitive and resistive circuit loading to a minimum and, at the same time, reduces plug-in sensitivity. The attenuation introduced by the probe permits measurements of signal voltages in excess of those that can be accommodated by the Type 3A1 alone. When making amplitude measurements with an attenuator probe, be sure to multiply the observed amplitude by the probe attenuation.

To assure the accuracy of pulse or high-frequency measurements, check the probe compensation.

To adjust the probe input-compensation capacitor, set the oscilloscope calibrator control for an output signal of suitable amplitude. For the Type 567 Oscilloscope, use the calibrator jack that provides the proper output amplitude.

### First-Time Operation

The following procedure will help you become familiar with the Type 3A1 operation.

1. Preset channel 1 and channel 2 controls as follows:

AC-DC-GND switch	DC
VOLTS/DIV. switch	.5
VARIABLE VOLTS/DIV. control	CALIB.
POSITION control	Mid-range
MODE switch	CH 1
INV. (CH 1) NORM. switch	NORM.
TRIGGER	Pushed in

2. Connect a jumper from the oscilloscope calibrator to both plug-in input connectors and set the calibrator voltage to 1 volt. Adjust the time-base sweep rate for 5 msec/div and the triggering controls for a stable 2-division square wave display. Adjust the CALIB. control if necessary. Turn the channel 1 POSITION control to move the display above the center graticule line.
3. Turn the MODE switch to CH 2; a similar 2-division square wave should be seen. Turn the channel 2 POSITION control to move the display below the center graticule line.
4. Turn the MODE switch to ALTER.; the upper and lower square-wave display should be seen (The flicker depends on the setting of the time-base plug-in sweep rate).
5. Turn the MODE switch to CHOP.; the upper and lower square wave display will have less flicker than in the

\*To make it easier to connect test leads to the unit, adapters such as a single binding post fitted with a BNC plug (Tektronix Part No. 103-0033-00) are available as optional accessories. These items can be ordered through your local Tektronix Field Office.

## Operating Instructions—Type 3A1

ALTER. position. Set the time-base plug-in for  $5\ \mu\text{sec}/\text{div}$ . The individual chopped portions of the waveform will be seen.

6. Set the time-base plug-in for a 5 msec sweep rate and the Type 3A1 MODE switch to ADDED. The display should be one square wave, 4 divisions in amplitude. This is the channel 1 and 2 waveforms added together (2 divisions each). Notice that either Type 3A1 POSITION control will move the trace vertically.
7. Turn the INV. (CH 1) NORM. switch to INV. The display will be a straight line if the gain of both channels is exactly equal. Since both signals are 2 divisions, the difference between them is zero or a straight line.

## Front Panel Controls

### AC-DC-GND Switch

With this switch in the DC position, both the ac and dc components of the signal will be displayed. To remove the dc component, set the switch to the AC position. In the AC position, the dc component is blocked by a capacitor in the input circuit. The low frequency limit (3-dB point) in the AC position is about 2 Hz (about 0.2 Hz when 10X probe is used).

In the GND position, this switch grounds only the Type 3A1 input; not the input connector.

### VOLTS/DIV Switch

A ten position switch that sets the vertical sensitivity of the Type 3A1. VARIABLE VOLTS/DIV. control must be full clockwise with neon UNCAL. light extinguished for calibrated sensitivity. Range is from 0.01 volts to 10 volts/div. (100 volts/div. when 10X probe is used).

### VARIABLE VOLTS/DIV. Control

The red knob on the VOLTS/DIV. switch is a variable resistor that provides continuously variable attenuation (uncalibrated) up to about 2.5 to 1. For example, if the VOLTS/DIV. switch is in the 1 volt position, the VARIABLE VOLTS/DIV. control will vary the sensitivity between 1 volt and 2.5 volts/division (uncalibrated). When used in conjunction with the oscilloscope calibrator voltage, this control can set any specific sensitivity within the range of the instrument.

### UNCAL. Light

A neon lamp that lights when the VARIABLE VOLTS/DIV. control is not in the CALIB. position.

### POSITION Control

There are two POSITION controls; one for channel 1 and the other for channel 2. They both shift their respective channel displays in a vertical direction.

### MODE Switch

A five position switch that sets the mode of operation. The positions are as follows:

CH 1 Connects the internal circuits to operate channel 1 only. Channel 2 will not operate.

CH 2 Connects the internal circuits to operate channel 2 only. Channel 1 will not operate.

ALTER. Sets the amplifier channels to display on alternate sweeps. For example, the first sweep would be the channel 1 signal, the second sweep the channel 2 signal. The flicker between channels will depend on the sweep rate of the time-base plug-in.

CHOP. Electronically switches between channels at a 100 kHz rate with  $5\ \mu\text{sec}$  samples of each input shown on the display. The switching transients are removed by dual-trace blanking of the CRT (see oscilloscope instruction manual).

ADDED The algebraic sum of the channel 1 and channel 2 signals will be displayed with the MODE switch in this position. To measure the difference between these signals, turn the INV. (CH 1) NORM. switch to INV.

### INV. (CH 1) NORM. switch

A two position switch that presents the channel 1 signal in normal or inverted polarity.

### TRIGGER CH 1 ONLY

A push-pull switch that connects the channel or channels in use to the time-base trigger circuits when pushed in, and connects channel 1 only to the trigger circuits when pulled out. It is especially useful in Alternate and Chopped modes where triggering becomes difficult with certain waveforms.

### CALIB.

A screwdriver adjustment that sets the gain of the output amplifier. When the Type 3A1 is moved from one oscilloscope to another, adjust the gain to compensate for differences in crt sensitivities. Adjust the gain as follows:

1. Set the channel 1 AC-DC-GND switch to the DC and the MODE switch to CH 1.
2. Set the channel 1 VOLTS/DIV. switch to .05 and the VARIABLE VOLTS/DIV. control fully clockwise (CALIB.). Be sure the neon lamp (UNCAL.) is not lit.
3. Set the time-base plug-in triggering controls for a free-running sweep.
4. Connect a jumper from the oscilloscope calibrator to the channel 1 input connector. Apply a 100-millivolt signal from the calibrator.
5. SET the CALIB. control for exactly two major divisions of deflection.
6. Turn the MODE switch to CH 2 and apply the 100-millivolt signal to the channel 2 input connector. There should be two divisions of deflection. If the deflection is not two divisions, refer to the CH 2 GAIN procedure in the calibration section of this manual.



**DC BAL.**

This control is a screwdriver adjustment of the dual-range or "back lash" type. If the DC balance of a channel is not properly adjusted, the position of a no-signal trace will shift on the crt as the VARIABLE VOLTS/DIV. control of that channel is turned. To properly set the dc balance proceed as follows:

1. Set both AC-DC-GND switches to GND.
2. Turn the MODE switch to CH 1 and position a free-running trace to the center of the crt graticule.
3. Set the channel 1 DC BAL. control so there is no trace shift when the VARIABLE VOLTS/DIV. control is turned.
4. Repeat the above steps for channel 2.



# SECTION 3

## APPLICATIONS

### Voltage Measurements

To measure the potential difference between two points on a signal (such as peak-to-peak AC volts), measure the vertical distance in graticule divisions between the two points and multiply by the setting of the VOLTS/DIV. switch and the attenuation factor, if any, of the probe. Be sure the VARIABLE VOLTS/DIV. control is set in the CALIB. position.

To measure the DC level at a given point on a waveform, proceed as follows:

1. Set the VOLTS/DIV. switch so the expected voltage (at the input connector) is not more than six times the setting. Be sure the VARIABLE VOLTS/DIV. control is in the CALIB. position.

2. Set the time-base plug-in triggering controls for a free-running sweep.

3. Set the AC-DC-GND switch to GND and use the POSITION control to align the trace with one of the horizontal graticule lines. This line will be used as a ground (or zero) reference. The position of the reference line should be chosen for the polarity and amplitude of the signal to be measured. Do not move the POSITION control once the reference line has been established.

4. Move the AC-DC-GND switch to DC.

5. Apply the signal to the input connector and set the time-base plug-in triggering controls for a stable display.

6. Measure the vertical distance, in graticule divisions, from the ground (zero) reference line to the point you wish to measure on the waveform.

7. Multiply this distance by the setting of the VOLTS/DIV. switch and any probe attenuation factor. This is the instantaneous dc level of the point measured.

You can re-establish the zero reference line at any time by setting the AC-DC-GND switch to GND. It is not necessary to disconnect the signal probe from the Type 3A1. If you wish to establish a reference other than zero, set the AC-DC-GND switch to DC and touch the signal probe to the desired reference voltage, then use the POSITION control to align the trace with a reference graticule line.

### Voltage Comparison Measurements

In some applications you may want to establish a set of vertical sensitivity values other than those selected by the VOLTS/DIV. switch. This is convenient when you compare signals that are exact multiples of a given reference. To establish a set of sensitivity values based on some specific reference, proceed as follows:

1. Apply the reference signal to either input connector. Set the VOLTS/DIV. switch and VARIABLE VOLTS/DIV. control to adjust the amplitude of the display for an exact number of graticule divisions. Do not move the VARIABLE VOLTS/DIV. control after this setting.

2. Divide the amplitude of the reference signal (in volts) by the product of the deflection established in step 1 (in graticule divisions) and the setting of the VOLTS/DIV. switch. The result is the sensitivity conversion factor.

$$\text{Conversion Factor} = \frac{\text{Amplitude of Reference Signal (in volts)}}{\text{Amount of Deflection in graticule divisions} \times \text{VOLTS/DIV. Switch Setting}}$$

3. To calculate the true sensitivity at any setting of the VOLTS/DIV. switch, multiply the switch setting by the sensitivity conversion factor.

$$\text{True Sensitivity} = \text{VOLTS/DIV. Switch Setting} \times \text{Conversion Factor.}$$

This new set of sensitivity values applies to this channel only, and only as long as the VARIABLE VOLTS/DIV. control is not moved.

### Phase-Difference Measurements

A phase comparison between two sine waves of the same frequency can be made by using the dual-trace feature of the Type 3A1. To make this comparison, proceed as follows:

1. Apply one signal to each of the input connectors, and set the MODE switch to CHOP. or ALTER. Pull out TRIGGER CH 1 only switch and internally trigger the time-base plug-in.

2. With the POSITION controls, center both signals vertically on the graticule.

3. Set the time-base plug-in sweep rate so one cycle of one waveform covers exactly 9 graticule divisions horizontally. Thus, each division represents 40° of one cycle at this sweep rate.

4. Measure the horizontal distance, in graticule divisions, between the leading waveform and the lagging waveform at the horizontal center graticule line. Multiply this distance by 40° per division to obtain the phase difference between the two signals.

For more precise measurements, increase the horizontal sweep rate with the magnifier. In step 3, each division on the graticule represents 40°. If the sweep rate is increased 5 times, then each division represents 8°.



# SECTION 4

## CIRCUIT DESCRIPTION

### General

The Type 3A1 Dual-Trace Amplifier contains two identical input channels, a common output amplifier, a switching circuit, and a trigger amplifier. The output of either or both input channel amplifiers may be fed to the output amplifier, depending on the condition of the switching circuit. Thus, the switching circuit makes it possible to display one signal as a single trace on the CRT, two signals simultaneously in a dual-trace display, or the algebraic sum or difference of two signals as a single trace. Fig. 4-1 is a block diagram of the Type 3A1.

### Input Channel Amplifiers

Each input channel consists of an attenuation network, an input cathode-follower, and a three-stage amplifier with switched outputs. The input cathode-followers V113 and V123 (channel 1) and V213 and V223 (channel 2) isolate the attenuator input circuitry from emitter-followers Q133 and Q143 (channel 1) and Q233 and Q243 (channel 2). These transistors provide low-impedance drive to the next stage: Q134 and Q144 (channel 1), and Q234 and Q244 (channel 2). The output of these stages is fed to the diode gates in the switching circuits, which select the signals to be fed

to the common output amplifier. The gain of the last stages in the input amplifiers is variable, with two calibration adjustments: R149 (channel 1), and R249 (channel 2) set the gain of the stage with the VOLTS/DIV. switches in the .01 position; R147 (channel 1), and R247 (channel 2) set the gain of the stage in the remaining positions of the VOLTS/DIV. switches. The VARIABLE VOLTS/DIV. control increases cathode degeneration when moved from the CALIB. position.

The input attenuators are resistance dividers with capacitive compensation. The attenuators maintain an input impedance of 1 megohm paralleled by 47 pF. With the VOLTS/DIV. switch in the .01 and .02 positions, the input is fed directly to the cathode-follower stages (V113 and V213). The 10MV GAIN controls adjust the amplifier sensitivity with the VOLTS/DIV. switches in the .01 position and the 20MV GAIN controls adjust the sensitivity in the remaining positions. In the VOLTS/DIV. switch positions which provide an input deflection factor greater than 20 mV per division (.02 to 10 on VOLTS/DIV. switch), the attenuator sections are stacked. In the .05 VOLTS/DIV. switch position, the 2.5X attenuator increases the basic 20 mV per division deflection factor to 50 mV per division. The 5X attenuator is used to increase the deflection factor to 100 mV per division in the .1 VOLTS/DIV. switch position. These three positions (1X, 2.5X, and 5X) are preceded by the X10 or

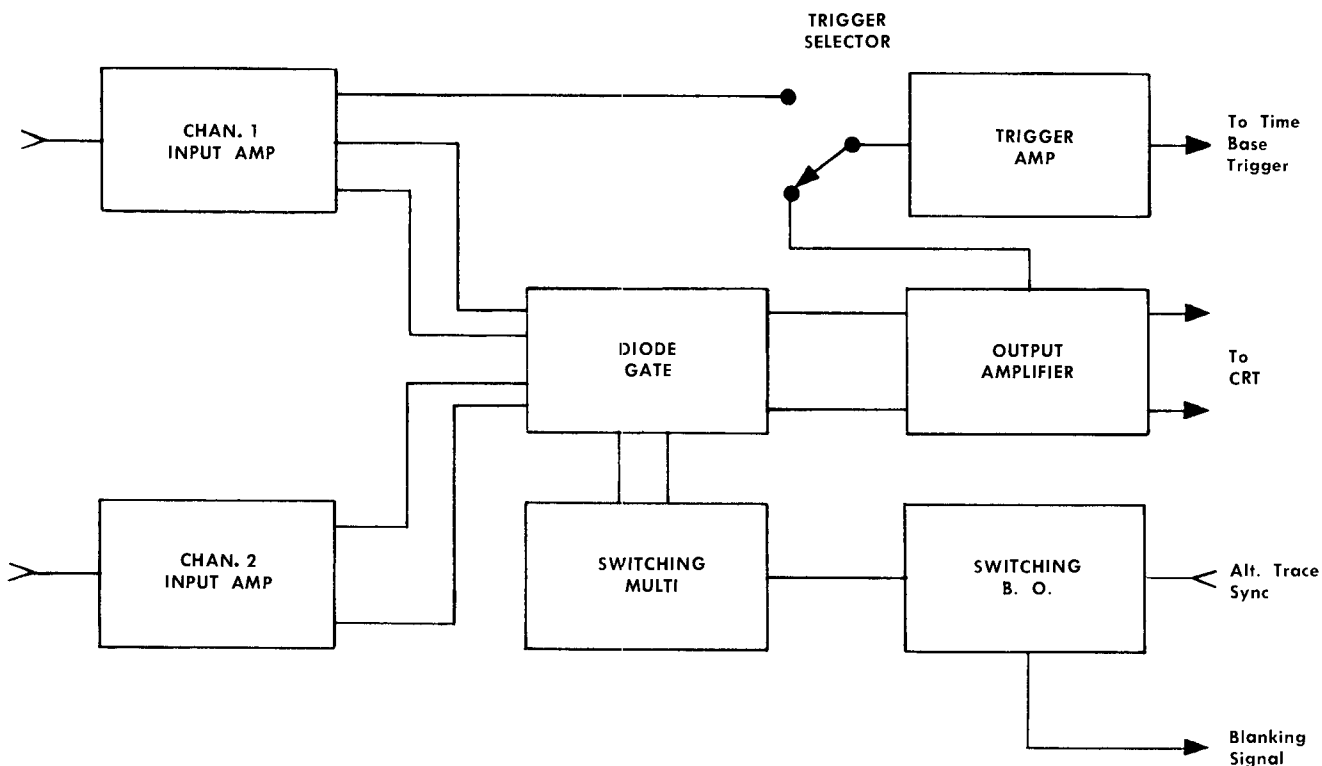


Fig. 4-1. Type 3A1 Block Diagram

## Circuit Description—Type 3A1

X100 attenuators in the higher deflection factor positions of the VOLTS/DIV. switch.

The DC BAL. controls in the grid circuit of V123 and V223 adjust the potential at both emitters of each input amplifier so no current will flow through R139 and R149 (channel 1), and R239 and R249 (channel 2) under no-signal conditions. Otherwise, the position of a no-signal trace would shift on the CRT as the VARIABLE VOLTS/DIV. control or channel Gain adjustments were turned.

In the INV. position the INV. (CH 1) NORM. switch (SW155) inverts the channel 1 output to the diode gates.

The channel 1 input amplifier contains a three-stage trigger amplifier. The first stage is an emitter-coupled paraphase amplifier (Q164 and Q174) with double-ended input and single-ended output. The DC level of the output is set by CHAN. 1 TRIG. DC LEVEL control R171. The output of this stage is fed to emitter-follower Q173. Q173 drives the third stage, Q184, which is collector-coupled to the trigger-amplifier section of the output amplifier.

## Switching Circuits

The switching circuit consists of two diode gates, a switching multivibrator, and a switching blocking oscillator which drives the multivibrator. In the following discussion, assume that the MODE switch is in the CH 1 position.

Each diode gate consists of two series diodes and two shunting diodes. When signals are to pass through the gate to the output amplifier, the series diodes are forward biased, and the shunt diodes are back biased, allowing the signal to drive the emitter of Q304 and Q314. Voltage to hold the series diodes (D155 and D158 in channel 1) in conduction is supplied through the emitter-base junctions of Q304 and Q314. Collector current for Q134 and Q144 flows through the series diodes. Shunt diodes D156 and D157 are back biased and thus cut off by MODE switch SW290, holding Q285 in the "off" state. Q275 is "off", and the junction of D156 and D157 is at  $-1.18$  volts. The DC level in the signal output lines from the channel 1 input amplifier is  $-1.65$  volts, and thus the shunt diodes are back biased.

In channel 2 diode gate, D256 and D257 are held at about  $-4.7$  volts by Q285, which is "off". This holds the channel 2 output lines at about  $-4.3$  volts. Since the outputs of the diode gates are about  $-2$  volts, D255 and D258 are back biased. With D255 and D258 cut off, the signal is not transmitted to the output amplifier. In addition, D256 and D257, when conducting, form a low-impedance path for any signals coming to the diode gate from channel 2 input amplifier.

When the MODE switch is in the CH 2 position, the conditions of the diode gates are reversed. In the channel 2 diode gate, D256 and D257 are back biased and the signal from the channel 2 input amplifier passes through D255 and D258 to the output amplifier.

When the MODE switch is in either the ALTER or CHOP positions, Q275 and Q285 operate as a common Eccles-Jordan bistable multivibrator. Positive pulses from the switch-

ing blocking oscillator pass through D278 or D288 to the collector of the "off" state transistor. This pulse is transmitted by either C277 or C287 to the base of the "on" transistor, turning it "off". The collector of the "off" transistor moves toward the  $-12.2$ -volt supply, turning the other transistor "on" because of the coupling through either C277 or C287. Resistive dividers R277-R286 and R287-R276 set the levels at the transistor bases. The levels are designed so switching action can occur when pulses are received from the blocking oscillator.

Operation of the diode gates in ALTER and CHOP is the same as described in the CH 1 and CH 2 positions of the MODE switch. However, the multivibrator is free to switch states when it receives a trigger signal, and thus operate the diode gates and transmit a signal to the output amplifier from channel 1 and channel 2 alternately. Also, in the ALTER and CHOP positions of the MODE switch, R292 is bypassed and the  $-12.2$ -volt supply is connected directly to the multivibrator circuit. In the other positions of the MODE switch, the multivibrator draws current through R292 and is not able to switch the diode gates. In the CH 1 position, additional current is supplied through R289; in the CH 2 position, current is supplied through R279.

When the MODE switch is in the ADDED position, current is supplied to the output amplifier through R293 and R294, holding the series diodes in both diode gates in conduction. Since the multivibrator transistors are both near cutoff, the diode-gate shunt diodes are back biased and thus inoperative.

In the CHOP and ALTER positions of the MODE switch, Q260 (the switching blocking oscillator) is energized, supplying pulses to the switching multivibrator. Fig. 4-2 shows the blocking oscillator waveforms with the MODE switch in the CHOP position. In the ALTER mode, the emitter of Q260 is connected to the  $-12.2$ -volt supply through R260. The base is also connected to the  $-12.2$ -volt supply through the base winding of blocking oscillator transformer T263. When a positive pulse is fed from the time-base plug-in unit through terminal 3 of the interconnecting plug, the emitter voltage rises. The transistor conducts, drawing current through the collector winding of blocking oscillator transformer T263, driving Q260 further into conduction. A normal blocking-oscillator cycle occurs with the backswing cutting the transistor off. The circuit is damped so the transistor is not turned on again until another sync pulse is received.

In the CHOP position of the MODE switch, the emitter of Q260 is connected to ground through R262. Normal blocking oscillator action occurs; however, when a cycle is completed, the base is forward biased since it is connected to the  $-12.2$ -volt supply. The blocking oscillator is thus automatically triggered and free-runs at a 150 kHz rate.

Pulses from the collector circuit of Q260 are fed to the switching multivibrator through C266. Only the positive pulses, which occur at the beginning of the blocking oscillator cycle, will switch the multivibrator. The collector pulse is also fed to pin 24 of the interconnecting plug for use as a blanking pulse in the CRT circuit of the oscilloscope.

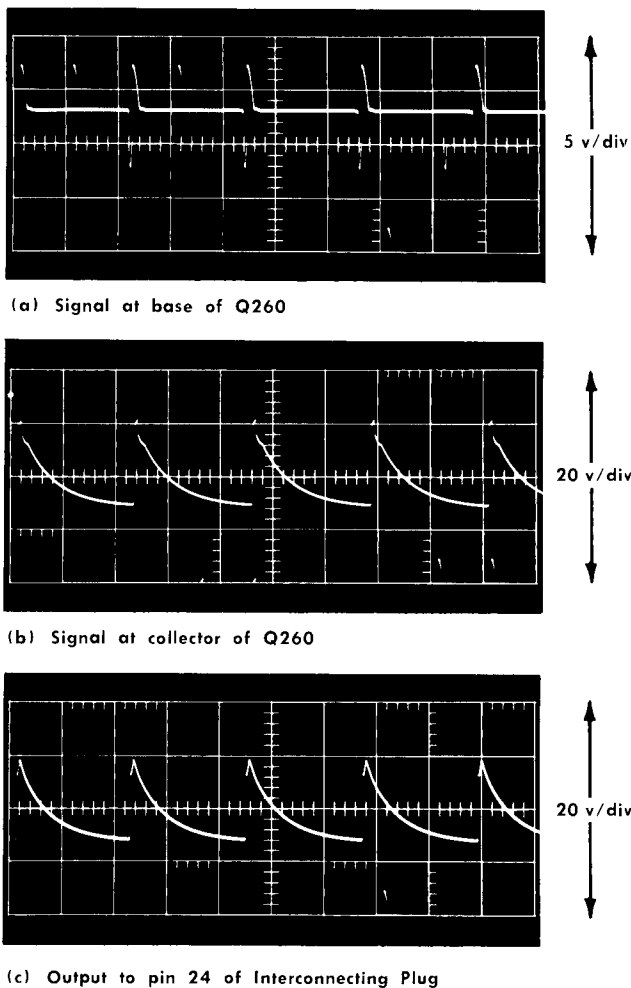


Fig. 4-2. Signals in blocking oscillator circuit. Oscilloscope AC coupled, sweep rate 2  $\mu$ sec/div.

### Output Amplifier

The output of the diode gates passes to Q304 and Q314. These transistors are arranged as a common-base push-pull amplifier. The signal passes from the collectors of these transistors to a second pair of current amplifier, Q323 and Q333. These transistors are connected as emitter-followers and couple the signal to the grids of V334. The push-pull signal drives the grids, and the output is taken from the plate circuit. V334 is stabilized against characteristic changes by 'long-tailing' through R329 and R339 to the  $-100$

volt supply. (SN 101-6729 only) "D337 and D338 in the cathode circuit improve the linearity of the amplifier near the end of its dynamic range by shunting cathode coupling resistor R337 on large signals." In the plate circuit of V334, peaking coils L326, L341, L336, and L351 improve the high-frequency response of the amplifier.

The signal is direct-coupled through parasitic suppression resistors R341 and R351 to the grids of V353. This tube is connected as a cathode-follower and because of its high input impedance, presents almost no load to the previous stages.

(SN 101-4327) The signal is coupled from the cathodes of V353 to the grids of output tubes V364 and V374. L344 and L354 in the coupling network provide additional high-frequency peaking while L345 (ferrite bead) and L355 (ferrite bead) are parasitic suppressors.

(S/N 4328-up) The signal is coupled from the cathode of V353 to the bases of feedback transistors Q364 and Q374 which in turn couple the signal to the grids of output tubes V364 and V374. The feedback from the output stage to the bases of Q364 and Q374 reduces the gain variation due to different tube transconductance (gm). This also increases the linear scan range of the output stage. Diodes D345 and D355 limit the voltage on the collectors of Q364-Q374 and therefore limit the dissipation of the transistors if one or the other of the output tubes (V364 or V374) cut off.

Output tubes V364 and V374 operate as a conventional push-pull amplifier. R374 (CALIB.) can be adjusted to match the deflection plate sensitivity of the CRT. This control varies cathode degeneration, and thus changes the output voltage swing of the amplifier. Maximum deflection occurs when this control is set for zero resistance. The two diodes D375 and D376 (D365 and D366 SN 101-4327) improve linearity on large signals by shunting R364. The two cathode resistors R367 and R377 return through R378 to Zener diode D378. This diode, together with L378 and C378, forms a  $+15$ -volt power supply that is used in the amplifier input circuit.

The plate circuits of V364 and V374 each contain two inductors: L361 and L363 in the plate of V364, and L373 and L371 in the plate of V374. These peaking coils tend to neutralize the effect of plate and distributed capacity, and thus improve the high-frequency response of the amplifier.

A portion of the output signal is picked off the center-tap of L363 and coupled to trigger amplifier V383A. This tube is connected as a cathode-follower and the signal is passed to the TRIGGER switch. In normal operation, this front-panel switch is pushed in and the trigger signal passed to the time-base plug-in comes from V383A. If the TRIGGER switch is pulled out, the trigger signal is coupled from the cathode of V383B (channel 1 signal).





# SECTION 5

## MAINTENANCE

### PREVENTIVE MAINTENANCE

#### Calibration

The Type 3A1 Dual-Trace Amplifier Plug-In Unit will not require frequent calibration. However, to insure that the unit is operating properly at all times, we suggest that you check the calibration after each 500-hours of operation (or every six months if the unit is used intermittently). A complete step-by-step procedure for calibrating the unit and checking its operation is given in the Calibration section of this manual.

The accuracy of measurements made with the Type 3A1 depends not only on the accuracy of calibration, but also on the calibration of the associated oscilloscope. It is important that the oscilloscope is in proper calibration.

#### Visual Inspection

Troubles can sometimes be found by a visual inspection of the unit. For this reason, you should perform a thorough visual check each time the instrument is calibrated or repaired. Look for such defects as loose or broken connections, damaged connectors, improperly seated tubes, scorched or burned parts, broken terminal strips, etc. The remedy for most of these troubles is apparent; however, heat-damaged parts are often the result of other, less apparent trouble. It is essential that you determine the cause of overheating before replacing heat-damaged parts.

#### Tube Checks

Tube-tester checks are not recommended. Tube testers sometimes indicate that a tube is defective when that tube operates satisfactorily in a circuit, or the tester may fail to indicate tube defects which affect the performance of the circuits. Determine the usability of a tube by whether or not it works properly in the circuit. If it does not, then it should be replaced. Unnecessary replacement of tubes is not only expensive but may also result in needless recalibration of the instrument.

### COMPONENT REPLACEMENT

#### General

The procedures for replacing most parts in the Type 3A1 are obvious. Detailed instructions for their removal are therefore not required. In some cases, however, additional information may help you. This information is contained in the following paragraphs. Because of the circuit configuration, it will be necessary to recalibrate portions of the circuit when certain parts are replaced. Refer to the Calibration section of this manual.

#### Switches

If a switch is removed, carefully note the lead connections to the switch to facilitate connecting the new switch.

Single wafers are not normally replaced on the switches used in the Type 3A1. If one wafer is defective, the entire switch should be replaced. Switches may be ordered from Tektronix either unwired or with the parts wired in place (see Electrical Parts List).

#### Soldering Precautions

In the production of Tektronix instruments, a special silver-bearing solder is used to establish a bond to the ceramic terminal strips. This bond may be broken by repeated use of ordinary tin-lead solder, or by excessive heating of the terminal strip with a soldering iron. Occasional use of ordinary 60-40 solder will not break the bond unless excessive heat is applied.

If you are responsible for the maintenance of Tektronix instruments, it is advisable to have a stock of solder containing about 3% silver. This type of solder is used in printed circuitry, and is generally available locally. It may also be purchased from Tektronix in one-pound rolls; order by part number 251-0514-00.

Because of the shape of the terminals of the ceramic terminal strips, use a wedge-shaped tip on your soldering iron. These tips allow you to apply heat directly to the solder in the terminals. It is important to use as little heat as possible while producing a full-flow joint.

The proper technique for soldering components in place requires: (1) Long-nose pliers to hold the lead securely between the component and the point where heat is applied, allowing the pliers to serve as a heat sink; (2) a hot iron applied for a short time, and (3) careful manipulation of the leads to prevent lead breakage. Use a 50- to 70-watt iron when working on ceramic strips.

#### Ceramic Terminal Strips

Damaged ceramic terminal strips are most easily removed by unsoldering all connections, then knocking the plastic yokes out of the chassis. This can be done by using a plastic or hard rubber mallet to hit the ends of the yoke protruding through the chassis. If space limitations prohibit use of the mallet directly, a plastic rod can be used between the mallet and the yoke of the strip. When the two yokes supporting the strip have been knocked out of the chassis, the strip and yokes can be removed as a unit. The spacers will probably come out with the yokes; if not, they can be removed separately.

Another way of removing the terminal strip is to cut off one side of the yoke with diagonal cutters. This permits the

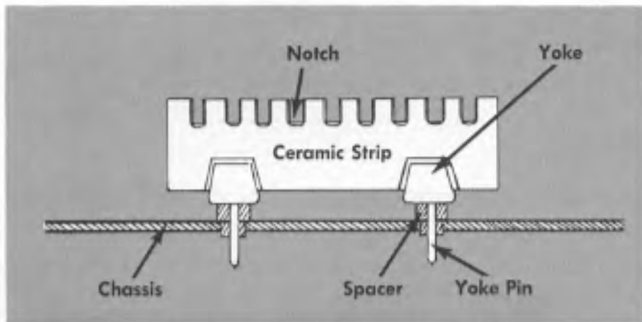


Fig. 5-1. Ceramic terminal strip installation.

strip to be removed from a difficult area where a mallet cannot be used. The remainder of the yokes and the spacers can be pulled out separately. Since a replacement strip is supplied with yokes already attached, the old yokes need not be salvaged. However, the old spacers may be used again.

When the damaged strip and yoke assembly has been removed, place the spacers into the holes in the chassis. Then set the ends of the yoke pins into the spacers. Press or tap lightly directly above the yokes to drive the yoke pins down through the spacers. Be certain that the yoke pins are driven completely through the spacers. Then cut off the portion of the yoke pin protruding past the spacers. Fig. 5-1 shows how the ceramic strip parts fit together.

## TROUBLESHOOTING

### General Troubleshooting Information

This portion of the manual is intended to help you troubleshoot the Type 3A1 in the event of trouble.

Since the Type 3A1 derives all of its operating voltages from the oscilloscope, and depends on the oscilloscope for its display, you must be sure that the oscilloscope is not the cause of trouble. Trouble can usually be isolated to either the oscilloscope or plug-in unit by substituting another plug-in for the suspected one and checking for proper operation. Or you can insert the suspected Type 3A1 in another oscilloscope and check for proper operation.

If trouble occurs in the Type 3A1, try to isolate it by quick operational and visual checks. First check the settings of all controls. Then operate the controls to see what effect, if any, they have on the trouble. The normal or abnormal operation of each control may help you to establish the trouble symptoms. (The cause of trouble which occurs only in certain positions of a control can usually be determined immediately from the trouble symptoms.)

After the trouble symptoms are established, look first for simple causes. Check to see that the pilot light of the oscilloscope is on, feel for any irregularities in the operation of the controls, listen for any unusual sound, see that the tube filaments are lit, and visually check the entire instrument. The type of symptom will generally indicate the checks to make.

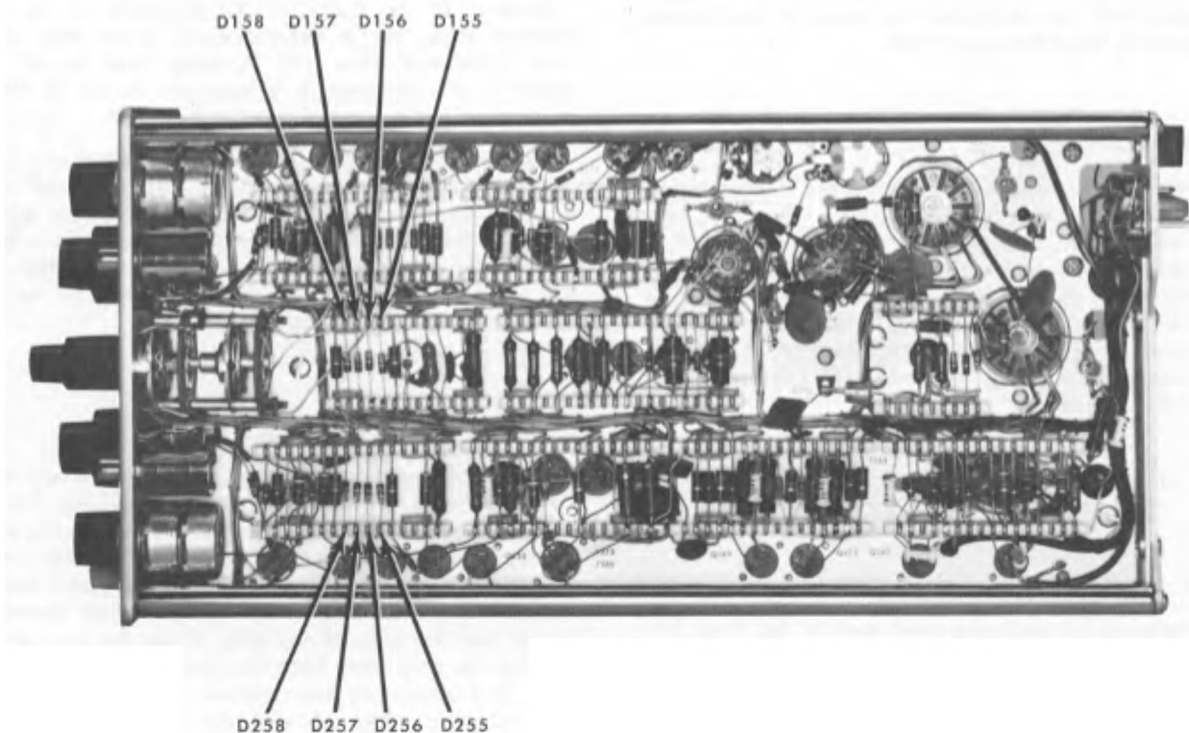


Fig. 5-2. Location of Type 3A1 major components.

In general, a troubleshooting procedure consists of two parts: circuit isolation and circuit troubleshooting. After isolating the circuit, you can then troubleshoot in the circuit to find the cause of the trouble.

Most troubles are caused by tube or semiconductor failures. Therefore, when trouble has been isolated to a circuit, the tubes and semiconductors in that circuit should be checked (by substitution). Be sure to return tubes or transistors found to be good to their original socket.

Switch wafers shown with the circuit diagrams are coded to indicate the position of the wafer on the switches. The number portion of the code refers to the wafer number on the switch assembly. Wafers are numbered from the front of the switch to the rear. The letters F and R indicate whether the front or the rear of the wafer is used to perform the particular switching function.

### Test Points

Major components in the unit are shown on the schematics and in Fig. 5-2. A test point is indicated by a number with

a line indicating the location of the test point in the circuit. Test points are used as an aid in troubleshooting and calibrating the unit, and the reference to these points is made in Table 5-1 and in the Calibration section of this manual.

Voltages are shown at many test points on the schematics. When necessary, the conditions under which the voltages were obtained also appear on the schematics.

### NOTE

Because the output amplifier is completely balanced, a bad tube or transistor will usually shift the trace off the CRT. If the vertical signal is low or absent, but the trace is normal, the trouble symptom will be caused by some component that is common to both transistors or tubes in an amplifier pair.

TABLE 5-1

TROUBLE SYMPTOM	PROBABLE CAUSE	CHECK
1. No spot or trace on either channel.	Output amplifier not balanced. Bad tube or transistor in output amplifier.	Connect a short across the vertical deflection pins on the CRT. If a trace appears, the vertical amplifier is unbalanced. Check for voltage difference across each pair of amplifiers.
2. No vertical signal on CRT from either channel.	Defective component in one of the balanced amplifiers.	Check plate voltage of V364 and V374.
3. Vertical signal only on one channel. POSITION control of defective channel does not operate but trace is normal.	Shorted multivibrator transistor. Shorted or open diode in diode gates.	Check Q275 and Q285. Check diodes in diode gate of defective channel (D155 and D158, D255 and D258).
4. Sweep will not alternate. (ALTER. mode)	Blocking oscillator Q260 not operating. Diodes D278 or D288 open or shorted. Multivibrator not operating.	Check for sync pulse at the emitter and collector of Q260. Check diodes. Check multivibrator transistors Q275 and Q285, and diodes D278 and D288.
5. Sweep will not operate in the CHOP. mode.	Blocking oscillator not operating.	Check blocking oscillator Q260 for trigger waveform to multivibrator (Q275 and Q285).
6. Sweep will not trigger in either position of TRIGGER CH 1 ONLY switch.	Multivibrator not operating. Trigger cathode-follower not operating.	Check multivibrator transistors Q275 and Q285, and diodes D278 and D288. Check V383.
7. Sweep will not trigger when TRIGGER CH 1 ONLY switch is pulled out.	Channel 1 trigger amplifier. CHAN. 1 TRIG. DC LEVEL R171 not correctly set.	Check Q164, Q174, Q173, and Q183. Check calibration procedure for correct settings of R171.
8. DC reference-level shift. Trace shifts when AC-DC-GND switch is changed from DC to GND.	DC BAL. (R119 and R219), not adjusted correctly. Input cathode-follower tubes gassy.	Refer to calibration procedure for adjustment of DC BAL controls. Check V123 and V223.



# SECTION 6

## PERFORMANCE CHECK

### Introduction

This section of the manual provides a means of rapidly checking the performance of the Type 3A1. It is intended to check the calibration of the instrument without the need for performing the complete Calibration Procedure. The Performance Check does not provide for the adjustment of any internal controls. Failure to meet the requirements given in this procedure indicates the need for internal checks or adjustments, and the user should refer to the Calibration Procedure in this manual.

### Recommended Equipment

The following equipment is recommended for a complete performance check. Specifications given are the minimum necessary to perform this procedure. All equipment is assumed to be calibrated and operating within the original specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

For the most accurate and convenient performance check, special calibration fixtures are used in this procedure. These calibration fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. Test oscilloscope. Tektronix Type 561A, 564, 565, or 567 recommended.
2. Time base plug-in, Tektronix Type 2B67, 3B1, 3B3, or 3B4 recommended.
3. Square-wave generator. Frequency, 250 Hz, 1 kHz, 100 kHz, and 300 kHz; risetime, 20 nanoseconds maximum; maximum output amplitude, 40 volts into 50 ohms. Tektronix Type 106 Square-Wave Generator recommended.
4. Constant amplitude sine-wave generator. Frequency, 50 kHz and 10 MHz; output amplitude, 5 volts; amplitude accuracy;  $\pm 3\%$ . Type 191 Constant Amplitude Signal Generator recommended.
5. Standard amplitude calibrator. Amplitude accuracy, within 0.25%; signal amplitude, 20 millivolts to 50 volts; output signal, 1 kHz. Tektronix calibration fixture 067-0502-00 recommended.
6. Input RC standardizer. Time constant, 1 megohm  $\times$  47 pF; attenuation, 2 $\times$ ; connectors, BNC. Tektronix Part No. 011-0068-00.
7. Termination. Impedance, 50 ohm; accuracy,  $\pm 3\%$ ; connectors, BNC. Tektronix Part No. 011-0049-00.
8. 5 $\times$  attenuator. Impedance, 50 ohm; accuracy,  $\pm 3\%$ ; connectors, BNC. Tektronix Part No. 011-0060-00.
9. BNC T connector. Tektronix Part No. 103-0030-00.
10. Cable. Impedance, 50 ohm; length, 42 inches; connectors, BNC. Tektronix Part No. 012-0057-00.
11. Dual input coupler. Matched signal transfer to each input. Tektronix calibration fixture 067-0525-00.

### PERFORMANCE CHECK PROCEDURE

#### General

In the following procedure, test equipment connections or control settings should not be changed except as noted. If only a partial check is desired, refer to the preceding step(s) for setup information.

The following procedure uses the equipment listed under Recommended Equipment. If substitute equipment is used, control settings or setup must be altered to meet the requirements of the equipment used.

#### Preliminary Procedure

1. Install the Type 3A1 and a time base plug-in into the test oscilloscope, then connect the test oscilloscope to a line voltage within the regulating range of its power supplies.

2. Set the Type 3A1, time base plug-in and test oscilloscope controls as follows:

#### Test Oscilloscope

Calibrator	50 mVolts
Intensity	Adjusted for normal display brightness
Focus	Adjusted for a well defined display

#### Time Base Plug-In

Mode	Normal or automatic
Time/Div	1 ms
Triggering Level	Centered or rotated to Automatic
Slope	+
Coupling	AC or Automatic
Source	Internal

#### Type 3A1 (both channels)

POSITION	Centered
AC-DC-GND	GND
VOLTS/DIV	.01
VARIABLE	CALIB
MODE	CH 1
INV (CH 1) NORM	NORM
TRIGGER CH 1 ONLY	Pushed in

3. Set the test oscilloscope Power switch to On. Allow at least 20 minutes warm up at 25° C,  $\pm 5^\circ$ , for checking the Type 3A1 to the given accuracies.

#### 1. Adjust CH 1 DC Balance

a. Requirement—Control must be capable of adjusting for no trace movement.

## Performance Check—Type 3A1

b. Position the trace to the graticule horizontal centerline with the CH 1 POSITION control.

c. Check—Balance by rotating the VARIABLE (Volts/Div) control through its range, checking for no vertical trace movement.

d. Adjust—DC BAL control, as follows for no vertical trace movement.

1. Rotate the DC BAL control to bring the trace near the center horizontal graticule line.

2. Turn the VARIABLE (Volts/Div) control full counter-clockwise and return the trace to the center horizontal graticule line with the POSITION control.

3. Return the VARIABLE (Volts/Div) control to its CALIB position. Note the distance the trace is displaced from the center horizontal graticule line.

4. Rotate the DC BAL control so as to position the trace one-half the distance measured in part d-1 above past the center horizontal graticule line.

### NOTE

The DC BAL controls are backlash type potentiometers. To adjust these controls, turn the control just past the desired point of adjustment, then turn the control in the opposite direction to obtain the exact setting.

5. Repeat parts d-1 through d-4 until there is no trace movement as the VARIABLE (Volts/Div) control is rotated through its range.

## 2. Adjust CH 2 DC Balance

a. Requirement—Control must be capable of adjusting for no trace movement.

b. Set the MODE switch to CH 2.

c. Position the trace to the graticule horizontal centerline with the CH 2 POSITION control.

d. Check—Balance by rotating the VARIABLE (Volts/Div) control through its range, checking for no vertical trace movement.

e. Adjust—DC BAL control as follows for no vertical trace movement.

1. Rotate the DC BAL control to bring the trace near the center horizontal graticule line.

2. Turn the VARIABLE (Volts/Div) control full counter-clockwise and return the trace to the center horizontal graticule line with the POSITION control.

3. Return the VARIABLE (Volts/Div) control to its CALIB position. Note the distance the trace is displaced from the center horizontal graticule line.

4. Rotate the DC BAL control so as to position the trace one-half the distance measured in part e-1 above past the center horizontal graticule line.

### NOTE

The DC BAL controls are backlash type potentiometers. To adjust these controls, turn the control just past the desired point of adjustment, then turn the control in the opposite direction to obtain the exact setting.

5. Repeat parts e-1 through e-4 until there is no trace movement as the VARIABLE (Volts/Div) control is rotated through its range.

## 3. Check Chopped Mode Operation

a. Requirement—The time duration of one complete cycle must be less than  $12\ \mu\text{s}$ . All chopping transients must be blanked when test oscilloscope CRT Cathode Selector is set to Chopped Blanking.

b. Set the MODE switch to CHOP.

c. Using the POSITION controls, position the CH 1 trace 1 cm above the graticule centerline and CH 2 trace 1 cm below the graticule centerline.

d. Set the time base plug-in Time/Div switch for a sweep rate of  $2\ \mu\text{s}$  and adjust the time-base plug-in triggering controls for a stable display.

e. Check—That time duration of one complete cycle, disregarding the first  $\frac{1}{2}$  cycle, is less than 6 major divisions (see Fig. 6-1).

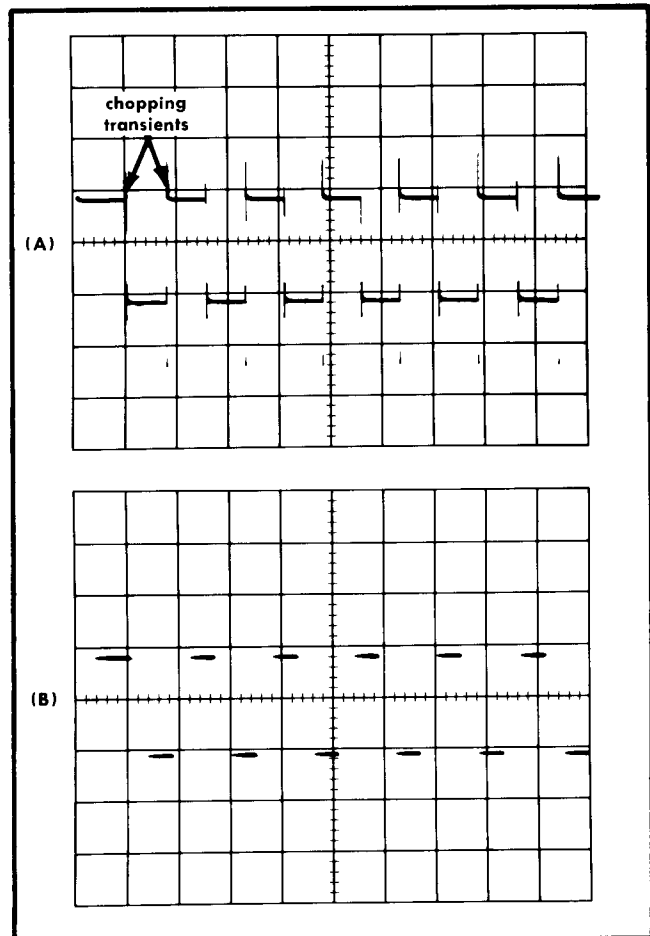


Fig. 6-1. Waveform showing (A) unblanked chopped transients and (B) blanked transients.

f. Set the Test oscilloscope CRT Cathode Selector switch to Chopped Blanking.

g. Check—To see that the chopping transients are blanked out.

h. Return the test oscilloscope CRT Cathode Selector switch to its up position and adjust the time base plug-in triggering controls for a free-running sweep.

#### 4. Check Alternate Mode Operation

- a. Requirement—Traces must alternate at all sweep rates.
- b. Set the MODE switch to ALTER.
- c. Using the POSITION controls, position the CH 1 trace 1 cm above the graticule centerline and CH 2 trace 1 cm below the graticule centerline.
- d. Check—For alternating traces at all time base plug-in sweep rates.
- e. Return the time base plug-in Time/Div switch to 1 ms.

#### 5. Check Range of CALIB Control and Rejection Ratio of Amplifiers

- a. Requirement—The CALIB Control must be capable of calibrating the Type 3A1 to the oscilloscope it is being used in. The amplifier rejection ratio must be at least 25:1.
- b. Set the MODE switch to CH 1 and both AC-DC-GND switches to DC.
- c. Connect 50 mvolts of square-wave signal from the Standard Amplitude Calibrator through a 50 ohm coaxial cable and the dual input coupler to both CH 1 and CH 2 input connectors.
- d. Check—For a display amplitude of 5 major divisions.
- e. Adjust—CALIB control for exactly 5 major divisions of display amplitude.
- f. Set the MODE switch to ADDED, the INV (CH 1) NORM switch to INV and both Volts/Div switches to .02.
- g. Increase the Standard Amplitude Calibrator output signal amplitude to 0.5 volts.
- h. Check—For less than 1 major division of deflection.
- i. Set the INV (CH 1) NORM switch to NORM and both VOLTS/DIV switches to .01.

#### 6. Check Range of VARIABLE (Volts/Div) Controls

- a. Requirement—When rotated fully counterclockwise the VARIABLE (VOLTS/DIV) must attenuate the signal at least 2.5 times. The UNCAL light must be lit when the VARIABLE (Volts/Div) control is in any position except its fully clockwise (CALIB) position. The control must have smooth electrical and mechanical operation.
- b. Set MODE switch to CH 1 and the Standard Amplitude Calibrator for an output signal amplitude of 50 mvolts.
- c. Check—For a display amplitude of 5 major divisions.
- d. Rotate the VARIABLE control to its fully counterclockwise position checking for smooth mechanical and electrical operation.
- e. Check—For a display amplitude that must be less than 2 major divisions.
- f. Check that the UNCAL light is lit.
- g. Return the VARIABLE control to its CALIB position.

- h. Check that the UNCAL light is no longer lit.
- i. Set the MODE switch to CH 2 and repeat parts c through h of this step for channel 2.

#### 7. Check Compression and/or Expansion

- a. Requirement—Must be less than 1 minor division of compression or expansion anywhere in the graticule area.
- b. Set CH 2 Input selector switch to GND, and the MODE switch to CH 1.
- c. Set the Standard Amplitude Calibrator for an output signal amplitude of 20 mVolts.
- d. Position the display to the center of the graticule area.
- e. Check—For exactly 2 major division display amplitude.
- f. Position the top of the display to the top graticule line.
- g. Check—That the amplitude of the display is within  $\pm 1$  minor division of being 2 major divisions.
- h. Position the bottom of the display to the bottom graticule line.
- i. Check—That the amplitude of the display is within  $\pm 1$  minor division of being 2 major divisions.
- j. Set the MODE switch to CH 2, CH 1 Input switch to GND and CH 2 Input switch to DC.
- k. Repeat parts d through j of this step for channel 2.

#### 8. Check Input Selector Switch AC-DC Operation

- a. Requirement—Waveform must shift downward so its average DC level is at the point on the graticule which is at zero volts when the input is DC coupled.
- b. Set both Input selector switches to DC and position the bottom of the display to the graticule centerline.
- c. Set CH 2 Input selector switch to AC and note the shift of the waveform.
- d. Check—That the waveform shifts downward so its average DC level point is now at the graticule horizontal centerline.
- e. Set the MODE switch to CH 1.
- f. Set both Input selector switches to DC and position the bottom of the display to the graticule horizontal centerline.
- g. Set CH 1 Input selector switch to AC and note the shift of the waveform.
- h. Check—That the waveform shifts downward so its average DC level point is now at the graticule horizontal center.
- i. Remove the Standard Amplitude Calibrator signal from the Type 3A1 Input connectors.

#### 9. Check Grid Current

- a. Requirement—Total trace shift due to grid current must be less than 2 minor divisions.

## Performance Check—Type 3A1

- b. Set both CH 1 and CH 2 VOLTS/DIV switches to 0.2, both VARIABLE controls to CALIB, both Input selector switches to GND and the MODE switch to ALT.
- c. Position the traces 2 major divisions apart.
- d. Switch CH 1 Input selector switch from GND to AC and note the amount of trace shift.
- e. Check—That the trace does not shift more than 2 minor divisions.
- f. Return the CH 1 Input selector switch to GND.
- g. Switch CH 2 Input selector switch from GND to AC and note the amount of trace shift.
- h. Check—That the trace does not shift more than 2 minor divisions.

### 10. Check CH 1 and CH 2 Volts/Div Compensation

- a. Requirement—Waveform must not have more than 4% of rolloff or overshoot.
- b. Apply the output of the square-wave signal generator through a 50  $\Omega$  coaxial cable, a 5 $\times$  attenuator and a 47 pF input RC standardizer to the CH 1 input connector.
- c. Set the square-wave signal generator for an output frequency of 1 kHz.
- d. Set the CH 1 Input selector switch to DC, the CH 1 VOLTS/DIV switch to .01 and the MODE switch to CH 1.
- e. Adjust the square-wave signal generator for a display amplitude of 4 major divisions.
- f. Set the time base plug-in Time/Div switch to .2ms and adjust the triggering controls for a stable display.
- g. Check—For a waveform having not more than 4% of rolloff or overshoot. See Fig. 6-2.
- h. Set CH 1 VOLTS/DIV switch to .02 and increase the output of the square-wave signal generator to maintain the 4 major division display amplitude.

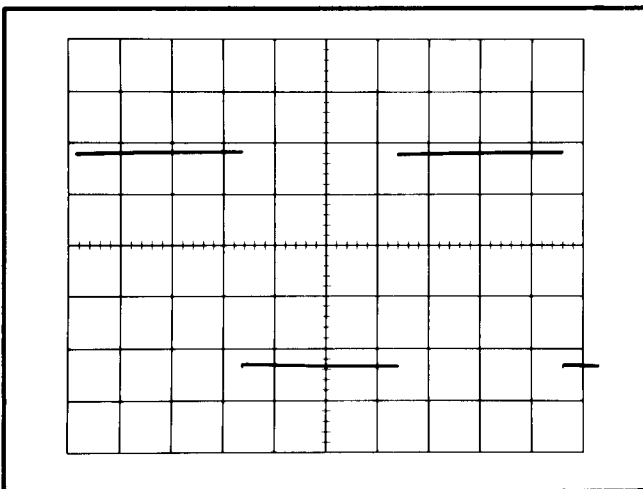


Fig. 6-2. Waveform obtained for each VOLTS/DIV switch setting when compensation is correct.

- i. Check—For a waveform having not more than 4% of rolloff or overshoot.
- j. Remove the signal from CH 1 Input connector and reconnect it to CH 2 Input connector.
- k. Set the MODE switch to CH 2, CH 2 Input selector switch to DC and CH 2 VOLTS/DIV switch to .01.
- l. Adjust the square-wave signal generator for a display amplitude of 4 major divisions.
- m. Check—For a waveform having not more than 4% of rolloff or overshoot.
- n. Set the CH 2 VOLTS/DIV switch to .02 and adjust the output of the square-wave generator to maintain the 4 major division signal amplitude.

- o. Check—For a waveform having not more than 4% of rolloff or overshoot.
- p. Set CH 2 VOLTS/DIV switch to .05 and increase the output of the square-wave signal generator to maintain the 4 major division display amplitude.
- q. Check—For a waveform having not more than 4% of rolloff or overshoot.
- r. Set CH 2 VOLTS/DIV switch to .1 and increase the output of the square-wave signal generator to maintain the 4 major division display amplitude.
- s. Check—For a waveform having not more than 4% of rolloff or overshoot.
- t. Set the CH 2 VOLTS/DIV switch to .2 and adjust the output of the square-wave generator to maintain the 4 major division signal amplitude.
- u. Check for a waveform having not more than 4% of rolloff or overshoot.
- v. Set the CH 2 VOLTS/DIV switch to .2 and adjust the output of the square-wave generator to maintain the 4 major division signal amplitude. The  $\times 5$  attenuator may have to be removed to obtain enough vertical deflection.

- w. Check—For a waveform having not more than 4% of rolloff or overshoot.
- x. Remove the signal from CH 2 Input connector and reconnect it to CH 1 Input connector.
- y. Set the MODE switch to CH 1 and CH 1 VOLTS/DIV switch to .05.
- z. Adjust the square-wave signal generator for a display amplitude of 4 major divisions.
- aa. Check—For a waveform having not more than 4% of rolloff or overshoot.

- ab. Set CH 1 VOLTS/DIV switch to .1 and increase the output of the square-wave signal generator to maintain the 4 major division display amplitude.

- ac. Check—For a waveform having not more than 4% of rolloff or overshoot.



ad. Set the CH 1 VOLTS/DIV switch to .2 and adjust the output of the square-wave generator to maintain the 4 major division signal amplitude.

ae. Check—For a waveform having not more than 4% of rolloff or overshoot.

af. Set CH 1 VOLTS/DIV switch to .2 and increase the output of the square-wave signal generator to maintain the 4 major division display amplitude. The 5× attenuator may have to be removed to obtain enough vertical deflection.

ag. Check—For a waveform having not more than 4% of rolloff or overshoot.

ah. Disconnect the square-wave signal generator from the Type 3A1 CH 1 Input connector.

### 11. Check High Frequency Compensation

a. Requirement—Waveform must have a flat top with not more than 5% of overshoot or ringing.

b. Set both CH 1 and CH 2 VOLTS/DIV switches to .01, set the MODE switch to CH 1 and the time base plug-in Time/Div switch to the .5 μs position.

c. Connect the output of the square-wave signal generator through a 50 ohm coaxial cable, a 5× attenuator and a 50 ohm termination to CH 1 Input connector.

d. Set the output frequency of the square-wave signal generator to 300 kHz and adjust its output signal amplitude for a 4 major division display.

e. Adjust the triggering controls of the time base plug-in for a stable display.

f. Check—For a waveform having a flat top with not more than 5% of overshoot or ringing (see Fig. 6-3).

g. Disconnect the square-wave signal generator from the Type 3A1.

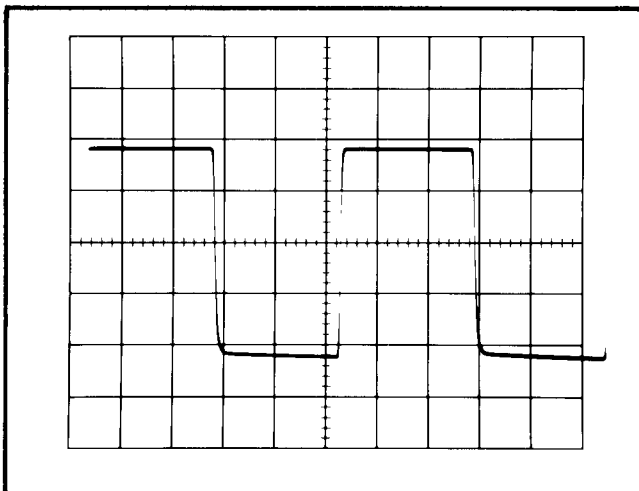


Fig. 6-3. Waveform obtained when compensation is correct.

### 12. Check VOLTS/DIV Attenuation Accuracy

a. Requirement—Attenuator accuracy must be within ±3% for all positions.

b. Apply 50 mvolts of Standard Amplitude Calibrator signal through a 50 ohm coaxial cable to the CH 1 Input connector.

c. Set the time base plug-in Time/Div switch to 5 ms.

d. Check—For the amount of vertical deflection as indicated in Table 6-1 for each position of the CH 1 VOLTS/DIV switch using the correct amount of calibrator signal.

e. Set the MODE switch to CH 2 and connect the output of the Standard Amplitude Calibrator to CH 2 Input connector.

f. Check—For the amount of vertical deflection as indicated in Table 6-1 for each position of the CH 2 VOLTS/DIV switch, using the correct amount of calibrator signal.

g. Disconnect the Standard Amplitude Calibrator from the Type 3A1.

TABLE 6-1

VOLTS/DIV Switch Setting	Standard Amplitude Calibrator Output (peak to peak)	Vertical Deflection in Divisions
.01	50 mVolts	5
.02	.1 Volts	5
.05	.2 Volts	4
.1	.5 Volts	5
.2	1 Volts	5
.5	2 Volts	4
1	5 Volts	5
2	10 Volts	5
5	20 Volts	4
10	50 Volts	5

### 13. Check Channel Isolation

a. Requirement—Channel isolation should be at least 50,000:1.

b. Set the CH 1 VOLTS/DIV switch to 10, CH 2 VOLTS/DIV switch to .01. MODE switch to CH 1 and the time base plug-in Time/Div switch to 10 μs.

c. Connect the output of the square-wave signal generator through a 50 ohm coaxial cable to CH 1 Input connector.

d. Set the square-wave signal generator for an output frequency of 100 kHz.

e. Adjust the square-wave signal generator output signal amplitude control for a 5 major division display.

f. Adjust the time base plug-in triggering controls for a stable display.

g. Set the MODE switch to CH 2.

## Performance Check—Type 3A1

h. Check—That the displayed amplitude does not exceed  $\frac{1}{2}$  minor division (isolation or 50,000:1).

### 14. Check Trigger CH 1 ONLY Operation

a. Requirement—Channel 1 display must be stable as long as the displayed amplitude of the channel 1 signal is at least 1 minor division. Channel 2 must not be stable.

b. Set the square-wave signal generator for an output frequency of 250 hertz.

c. Set the MODE switch to ALTER and pull out the TRIGGER CH 1 ONLY switch.

d. Apply 10 mvolts of Standard Amplitude Calibrator square wave signal through a 50 ohm coaxial cable to CH 2 Input connector.

e. Set the time base plug-in Time/Div switch to 1 ms and adjust the triggering controls for a stable display.

f. Reduce the output signal from the square-wave signal generator until a display 1 minor division high is displayed.

g. Readjust the time-base plug-in controls to obtain a stable display for part of the display.

h. Check—That the channel 1 display is stable, while the channel 2 display is drifting.

i. Remove the two signal generator signals from the Type 3A1.

### 15. Check High Frequency Response

a. Requirement—The bandwidth at  $-3$ dB must be at least 10 MHz.

b. Set the time base plug-in Time/Div switch to .1 ms and adjust the triggering controls for a free running display.

c. Connect the output of the Constant-Amplitude signal generator to CH 2 Input.

d. Set the MODE switch to CH 2, and both VOLTS/DIV switches to .01.

e. Set the constant-amplitude signal generator for an output frequency of 50 kHz and adjust the signal generator output amplitude for a display amplitude of 6 major divisions.

f. Increase the output frequency of the constant-amplitude signal generator to 10 MHz.

g. Check—For a display whose amplitude is at least 4.2 major divisions high.

h. Set the CH 2 VOLTS/DIV switch to .02 and repeat parts e through g of this step.

i. Set the MODE switch to CH 1.

j. Remove the constant-amplitude signal generator from CH 2 Input connector and connect it to the CH 1 Input connector.

k. Repeat parts e through g.

l. Set the CH 1 VOLTS/DIV switch to .02 and repeat parts e through g of this step.

### 16. Check Bandwidth of CH 1 Trigger

a. Requirement—CH 1 trigger must provide a signal to the time base plug-in that will allow a stable display to be obtained of a 10 MHz waveform 1 minor division in amplitude.

#### NOTE

To obtain the proper results, this step must be accomplished with either a 3B1, 3B3 or 3B4 time-base plug-in unit. Other plug-ins may not trigger on a 10MHz signal.

b. Set the Time/Div switch of the time base plug-in to .5  $\mu$ s.

c. Set the CH 1 VOLTS/DIV switch to 1.

d. Set the output frequency of the Constant-Amplitude signal generator to 10 MHz, then adjust the signal generator output amplitude for a displayed amplitude of 1 minor division.

e. Check—That a stable display can be obtained by adjusting the time base plug-in triggering controls.

f. Disconnect the constant-amplitude signal generator.

### 17. Check Added Operation

a. Requirement—Added in phase and equal amplitude signals must be twice the amplitude of the original signal  $\pm 2.5\%$ . When the MODE SWITCH is changed from ALTER to ADDED, the display position must be within  $\pm 3$  major divisions of the position the display occupied in the ALTER mode. When the INV (CH 1) NORM switch is changed from NORM to INV the Channel 1 display position must not shift more than 1 major division.

b. Set the MODE switch to ALTER and both VOLTS/DIV switches to 1.

c. Apply 2 volts of Standard Amplitude Calibrator signal through a 50 ohm cable and the dual input coupler to both CH 1 and CH 2 input connectors.

d. Note the display amplitude for each channel.

e. Set the MODE switch to ADDED.

f. Check—For twice the display amplitude,  $\pm 2.5\%$  noted for each channel in part d.

g. Disconnect the Standard Amplitude Calibrator.

h. Set both AC-DC-GND switches to GND.

i. Position both traces to the horizontal graticule center-line.

## Performance Check—Type 3A1

- j. Change the MODE switch from ALTER to ADDED.
- k. Check—For not more than 3 major divisions of shift in the trace positions as the MODE switch was changed.
- l. Set the MODE switch to CH 1.
- m. Position the channel 1 trace to the horizontal graticule centerline.
- n. Change the INV (CH 1) NORM switch to INV.
- o. Check—For not more than 1 major division of shift in the trace position as the INV (CH 1) NORM switch was changed.

This completes the performance check procedure for the Type 3A1. Disconnect all test equipment. If the instrument has met all performance requirements given in this procedure, it is correctly calibrated and within the specified tolerances.



# SECTION 7

## CALIBRATION

### Introduction

This calibration procedure can be used either for complete calibration of the Type 3A1 to return it to original performance, or as an operational check of instrument performance. Completion of every step in this procedure returns the Type 3A1 to original factory performance standards. If it is desired to merely touch up the calibration, perform only those steps entitled Adjust . . .

#### NOTE

The Adjust . . . steps provide a check of instrument performance before the adjustment is made. To prevent recalibration of other circuits when performing a partial calibration, readjust only if the listed tolerance is not met.

### General Information

Any needed maintenance should be performed before proceeding with calibration. Troubles which become apparent during calibration should be corrected using the techniques given in the Maintenance section of the Instruction Manual.

This procedure is arranged in a sequence which allows this instrument to be calibrated with the least interaction of adjustments and reconnection of equipment. If desired, the steps may be performed out of sequence or a step may be done individually. However, some adjustments affect the calibration of other circuits within the instrument. In this case, it will be necessary to check the operation of other parts of the instrument. When a step interacts with others, the steps which need to be checked will be noted.

The location of test points and adjustments is shown in each step. Waveforms which are helpful in determining the correct adjustment or operation are also shown.

Where references are made to divisions of deflection, the indication will be major divisions.

### EQUIPMENT REQUIRED

(see Fig. 7-1)

#### General

The following equipment, or its equivalent, is required for complete calibration of the Type 3A1. Specifications given are the minimum necessary for accurate calibration of this instrument. All test equipment is assumed to be correctly calibrated and operating within the original specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

#### Special Test Equipment

For the quickest and most accurate calibration, special calibration fixtures are used where necessary. All calibration fixtures listed under equipment required can be obtained

from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. Test oscilloscope. Tektronix Type 561A, 564, 565, or 567 recommended.

2. Time base plug-in, Tektronix Type 2B67, 3B1, 3B3, or 3B4 recommended.

3. DC voltmeter. Minimum sensitivity, 20,000 ohms/volt; accuracy, checked to within 1% at 190 volts. For example, Simpson Model 262.

4. Square-wave generator. Frequency, 250 Hz, 1 kHz, 100 kHz and 300 kHz risetime, 20 nanoseconds maximum; maximum output amplitude, 40 volts into 50 ohms. Tektronix Type 106 Square-Wave Generator recommended.

5. Constant amplitude sine-wave generator. Frequency, 50 kHz and 10 MHz; output amplitude, 5 volts; amplitude accuracy;  $\pm 3\%$ . Type 191 Constant Amplitude Signal Generator recommended.

6. Standard amplitude calibrator. Amplitude accuracy, within 0.25%; signal amplitude, 20 millivolts to 50 volts; output signal, 1 kHz. Tektronix calibration fixture 067-0502-00 recommended.

7. Input RC standardizer. Time constant, 1 megohm  $\times$  47 pF; attenuation, 2 $\times$ ; connectors, BNC. Tektronix Part No. 011-0068-00.

8. Termination. Impedance, 50 ohm; accuracy,  $\pm 3\%$ ; connectors, BNC. Tektronix Part No. 011-0049-00.

9. 5 $\times$  attenuator. Impedance, 50 ohm; accuracy,  $\pm 3\%$ ; connectors, BNC. Tektronix Part No. 011-0060-00.

10. BNC T connector. Tektronix Part No. 103-0030-00.

11. Cable. Impedance, 50 ohm; length, 42 inches; connectors, BNC. Tektronix Part No. 012-0057-00.

12. Dual input coupler. Matched signal transfer to each input. Tektronix calibration fixture 067-0525-00.

13. Adjustment tools.

a. Insulated screwdriver 1 $\frac{1}{2}$  inch shaft, non-metallic. Tektronix Part No. 003-0000-00.

b. Tuning rod, 5 inches. Tektronix Part No. 003-0301-00.

### CALIBRATION RECORD AND INDEX

This Abridged Calibration Procedure is provided to aid in checking the operation of the Type 3A1. It may be used as a calibration guide by the experienced calibrator, or it may be used as a calibration record. Since the step numbers and titles used here correspond to those used in the complete Calibration Procedure, the following procedure serves as an index to locate a step in the complete Calibration Procedure.

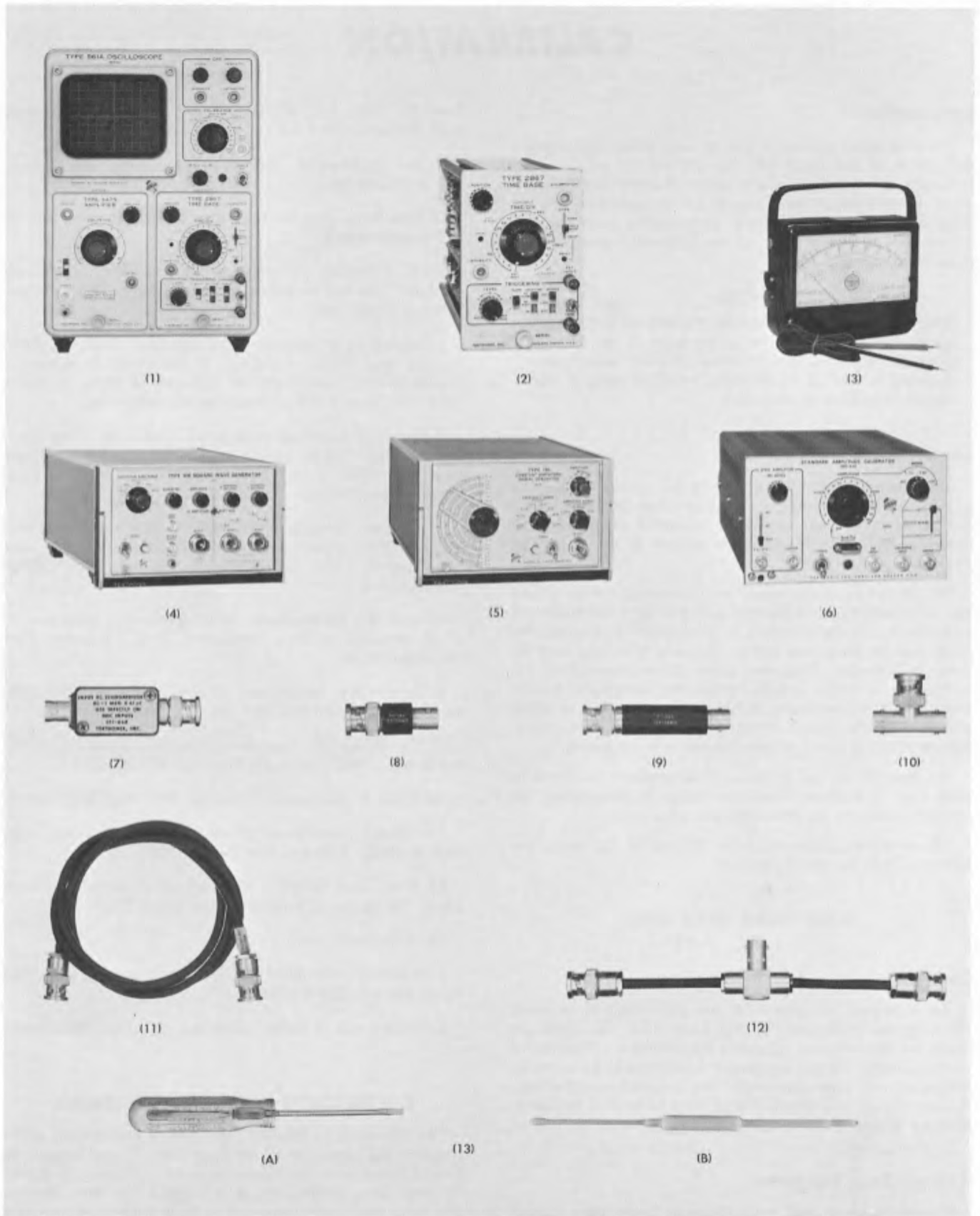


Fig. 7-1. Recommended calibration equipment.

Characteristics are those listed in the Characteristics section of the Instruction Manual.

Type 3A1, Serial No. \_\_\_\_\_

Calibration Date \_\_\_\_\_

- 1. Adjust CH 1 DC Balance (Page 7-4)  
Adjusted for no trace movement as VARIABLE (Volts/Div) control is rotated.
- 2. Adjust CH 2 DC Balance (Page 7-5)  
Adjusted for no trace movement as VARIABLE (Volts/Div) is rotated.
- 3. Check Chopped Mode Operation (Page 7-5)  
The time for one cycle must be less than 12  $\mu$ s. Chopping transients must be blanked out when oscilloscope CRT cathode selector switch is set to chopped blanking.
- 4. Check alternate Mode Operation (Page 7-6)  
Alternating traces must appear for all sweep rates.
- 5. Adjust OUTPUT DC LEVEL, R328 (Page 7-7)  
Adjust for a DC voltage of +190 volts between each CRT vertical deflection plate and ground.
- 6. Adjust CHAN 1 TRIG DC LEVEL, R171 (Page 7-8)  
Adjust for a DC voltage of zero volts between the junction of R389-pin 11 of the interconnecting plug and ground.
- 7. Adjust CALIB Control and CH 1 10 mV GAIN and 20 mV GAIN Controls (Page 7-10)  
With an input of 50 mvolts the 10 mV GAIN control is adjusted for a display 6 major divisions high. The CALIB control is now adjusted for a display, 5 major divisions high. With an input of 100 mvolts the 20 mV GAIN control is adjusted for a display, 5 major division high.
- 8. Adjust CH 2 10 mV GAIN and 20 mV GAIN Controls (Page 7-11)  
10 mV GAIN adjusted for less than 1 minor division of amplitude with Type 3A1 set up as a differential amplifier. 20 mV GAIN adjusted for less than 1.25 minor divisions of amplitude with Type 3A1 set up as a differential amplifier.
- 9. Check Range of VARIABLE (Volts/Div) Controls (Page 7-11)  
Control must attenuate signal 2.5 times when rotated fully counterclockwise. The control must have smooth electrical and mechanical operation. UNCAL light must be lit when control is not set at its CALIB position.
- 10. Check Compression and/or Expansion (Page 7-11)  
Must be less than  $\pm 1/2$  minor division anywhere in the graticule area when a 2 major division high signal is used for checking.
- 11. Check Input Selector Switch AC DC Operation (Page 7-12)  
When the Input Selector switch is changed from DC to AC the waveform must shift so its average DC level point now occupies the zero volt DC reference point.

- 12. Check Grid Current (Page 7-12)  
Less than 2 minor division shift when Input Selector switch is changed from GND to AC.
- 13. Adjust CH 1 and CH 2 Input Capacitance (Page 7-13)  
Adjust C111-C112 (CH 1) and C211-C212 (CH 2) for an optimum flat-topped waveform.
- 14. Adjust CH 1 and CH 2 VOLTS/DIV Compensation (Page 7-14)

VOLTS/ DIV Switch Setting	Channel 1 Adjust for Optimum		Channel 2 Adjust for Optimum	
	Square Corner	Flat Top	Square Corner	Flat Top
.05	C103C	C103B	C203C	C203B
.1	C105C	C105B	C205C	C205B
.2	C107C	C107B	C207C	C207B
2	C109C	C109B	C209C	C209B

- 15. Adjust High Frequency Compensation (Page 7-16)  
Adjust L361 and L371 for a waveform having an optimum square corner with minimum overshoot on the leading edge.
- 16. Check VOLTS/DIV Attenuation Accuracy (Page 7-19)

VOLTS/DIV Switch Setting	Standard Amplitude Calibrator Output (peak to peak)	Vertical Deflection in Divisions
.01	50 mVolts	5
.02	.1 Volts	5
.05	.2 Volts	4
.1	.5 Volts	5
.2	1 Volts	5
.5	2 Volts	4
1	5 Volts	5
2	10 Volts	5
5	20 Volts	4
10	50 Volts	5

- 17. Check Channel Isolation (Page 7-20)  
Less than 1 mm of deflection (isolation of 50,000:1).
- 18. Check TRIGGER CH 1 ONLY Operation (Page 7-21)  
Check that channel one display can be triggered (stable display) that channel two display cannot be triggered (drifting display).
- 19. Check High Frequency Response (Page 7-22)  
Starting with a 6 major division high display of 50 kHz signal, check for at least 4.2 major divisions of display when the signal frequency is increased to 10 MHz.
- 20. Check the Bandwidth of CH 1 Trigger (Page 7-23)

**NOTE**

To obtain the proper results, this step must be accomplished with either a 3B1, 3B3 or 3B4 time-base plug-in unit. Other plug-ins may not trigger on a 10 MHz signal.

A stable display must be obtained with a 10 MHz input signal 1 minor division high.

## CALIBRATION PROCEDURE

### General

In the following calibration procedure, a test equipment setup is shown for each major setup change. Complete control settings are listed beneath the picture. If only a partial calibration is performed, start with the nearest setup preceding the desired portion.

#### NOTE

When performing a complete recalibration, best performance will be provided if each adjustment is made to the exact setting, even if the Check is within the allowable tolerance.

The following procedure uses the equipment listed under Equipment Required. If substitute equipment is used, control settings or setup must be altered to meet the requirements of the equipment used.

### Preliminary Procedure

1. Remove both side panels from the test oscilloscope.
2. Install a time base plug-in into the left hand plug-in compartment.
3. Install the Type 3A1 into the right hand plug-in compartment.
4. Connect the test oscilloscope to a suitable power source.
5. Set the test oscilloscope Power Switch to On. Allow at least 20 minutes warm up at 25° C, ±5° C, for checking the instrument to the given accuracy.

#### Test Oscilloscope

Calibrator	50 mVolts
Intensity	Adjusted for normal displayed brightness
Focus	Adjusted for a well defined display.

#### Time Base Plug-In

Mode	Normal or Automatic
Time/Div	1 ms
Triggering Level	Centered or rotated to Automatic
Slope	+
Coupling	AC or Automatic
Source	Internal

#### Type 3A1 (both channels)

POSITION	Centered
AC-DC-GND	GND
VOLTS/DIV	.01
VARIABLE	CALIB



Fig. 7-2. Location of CH 1 DC BAL control.

MODE	CH 1
INV (CH 1) NORM	NORM
TRIGGER CH 1 ONLY	Pushed in

### 1. Adjust CH 1 DC Balance

- a. Position the trace to the graticule horizontal center-line with the CH 1 POSITION control.
- b. Check—Balance by rotating the VARIABLE (Volts/Div) control through its range, checking for no vertical trace movement.
- c. Adjust—DC BAL control, see Fig. 7-2, as follows for no vertical trace movement.

1. Rotate the DC BAL control to bring the trace near the center horizontal graticule line.

2. Turn the VARIABLE (Volts/Div) control full counter-clockwise and return the trace to the center horizontal graticule line with the POSITION control.

3. Return the VARIABLE (Volts/Div) control to its CALIB position. Note the distance the trace is displaced from the center horizontal graticule line.

4. Rotate the DC BAL control so as to position the trace one-half the distance measured in part c-1 above past the center horizontal graticule line.

#### NOTE

The DC BAL controls are backlash type potentiometers. To adjust these controls, turn the control just past the desired point of adjustment, then turn the control in the opposite direction to obtain the exact setting.

5. Repeat parts c-1 through c-4 until there is no trace movement as the VARIABLE (Volts/Div) control is rotated through its range.



## 2. Adjust CH 2 DC Balance

- Set the MODE switch to CH 2.
- Position the trace to the graticule horizontal centerline with the CH 2 POSITION control.
- Check—Balance by rotating the VARIABLE (Volts/Div) control through its range checking for no vertical trace movement.



Fig. 7-3. Location of CH 2 DC BAL control.

- Adjust—DC BAL control, see Fig. 7-3, as follows for no vertical trace movement.

- Rotate the DC BAL control to bring the trace near the center horizontal graticule line.
- Turn the VARIABLE (Volts/Div) control full counter-clockwise and return the trace to the center horizontal graticule line with the POSITION control.
- Return the VARIABLE (Volts/Div) control to its CALIB position. Note the distance the trace is displaced from the center horizontal graticule line.
- Rotate the DC BAL control so as to position the trace one-half the distance measured in part d-1 above past the center horizontal graticule line.

### NOTE

The DC BAL controls are backlash type potentiometers. To adjust these controls, turn the control just past the desired point of adjustment, then turn the control in the opposite direction to obtain the exact setting.

- Repeat parts d-1 through d-4 until there is no trace movement as the variable (Volts/Div) control is rotated through its range.

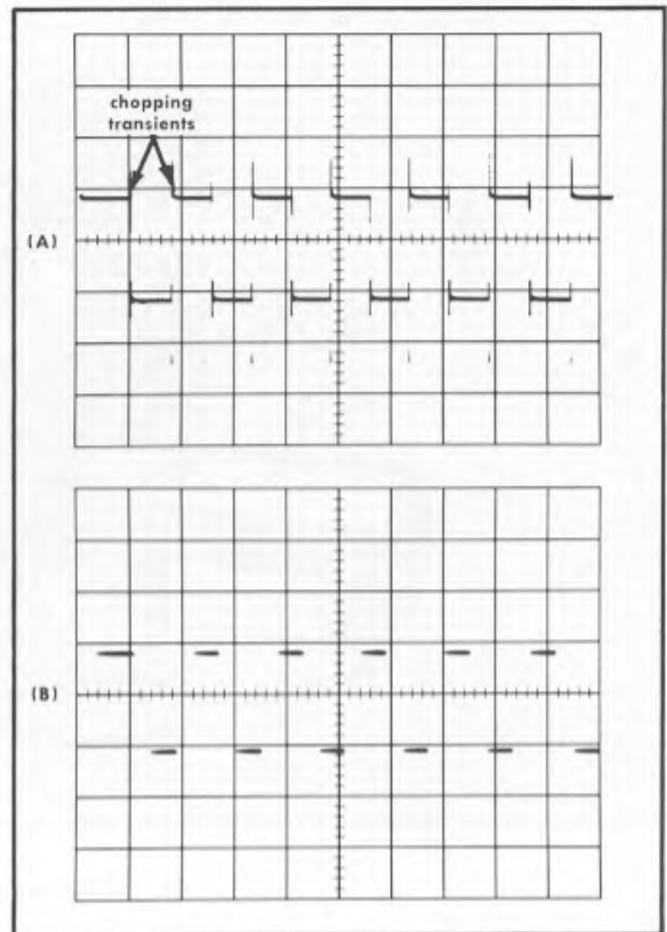


Fig. 7-4. Waveform showing (A) unblanked chopping transients and (B) blanked transients.

## 3. Check Chopped Mode Operation

- Set the MODE switch to CHOP.
- Using the POSITION controls, position the CH 1 trace 1 major division above the graticule centerline and CH 2 trace 1 major division below the graticule centerline.
- Set the time base plug-in Time/Div switch for a sweep rate of  $2 \mu\text{s}$  and adjust the time-base plug-in triggering controls for a stable display.
- Check —That time duration of one complete cycle, disregarding the first  $\frac{1}{2}$  cycle, is less than 6 major divisions.
- Set the test oscilloscope CRT Cathode Selector switch to Chopped Blanking.
- Check—To see that the chopping transients are blanked out (see Fig. 7-4).
- Return the test oscilloscope CRT Cathode Selector switch to its up position and adjust the time base plug-in triggering controls for a free-running sweep.



Fig. 7-5. Test equipment setup for step 5.

#### 4. Check Alternate Mode Operation

- Set the MODE switch to ALTER.
- Using the POSITION controls, position the CH 1 trace 1 major division above the graticule centerline and CH 2 trace 1 major division below the graticule centerline.
- Check—For alternating traces at all time base plug-in sweep rates.
- Return the time base plug-in Time/Div switch to 1 ms.

##### Test Oscilloscope

Calibrator	50 mVolts
Intensity	Adjusted for normal display brightness
Focus	Adjusted for a well defined display

##### Time Base Plug-In

<b>Mode</b>	<b>Normal or Free Run</b>
Time/Div	1 ms
<b>Triggering Level</b>	<b>Free Run or fully clockwise</b>
Slope	+
Coupling	AC
Source	Internal

##### Type 3A1 (both channels)

POSITION	Centered
AC-DC-GND	GND
VOLTS/DIV	.01
VARIABLE	CALIB
MODE	CH 1
INV (CH 1) NORM	NORM
TRIGGER CH 1 ONLY	Pushed in

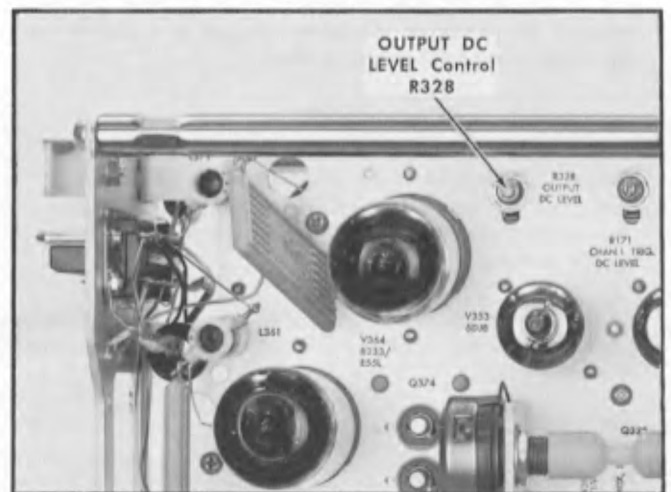


Fig. 7-6. Location of OUTPUT DC LEVEL control.



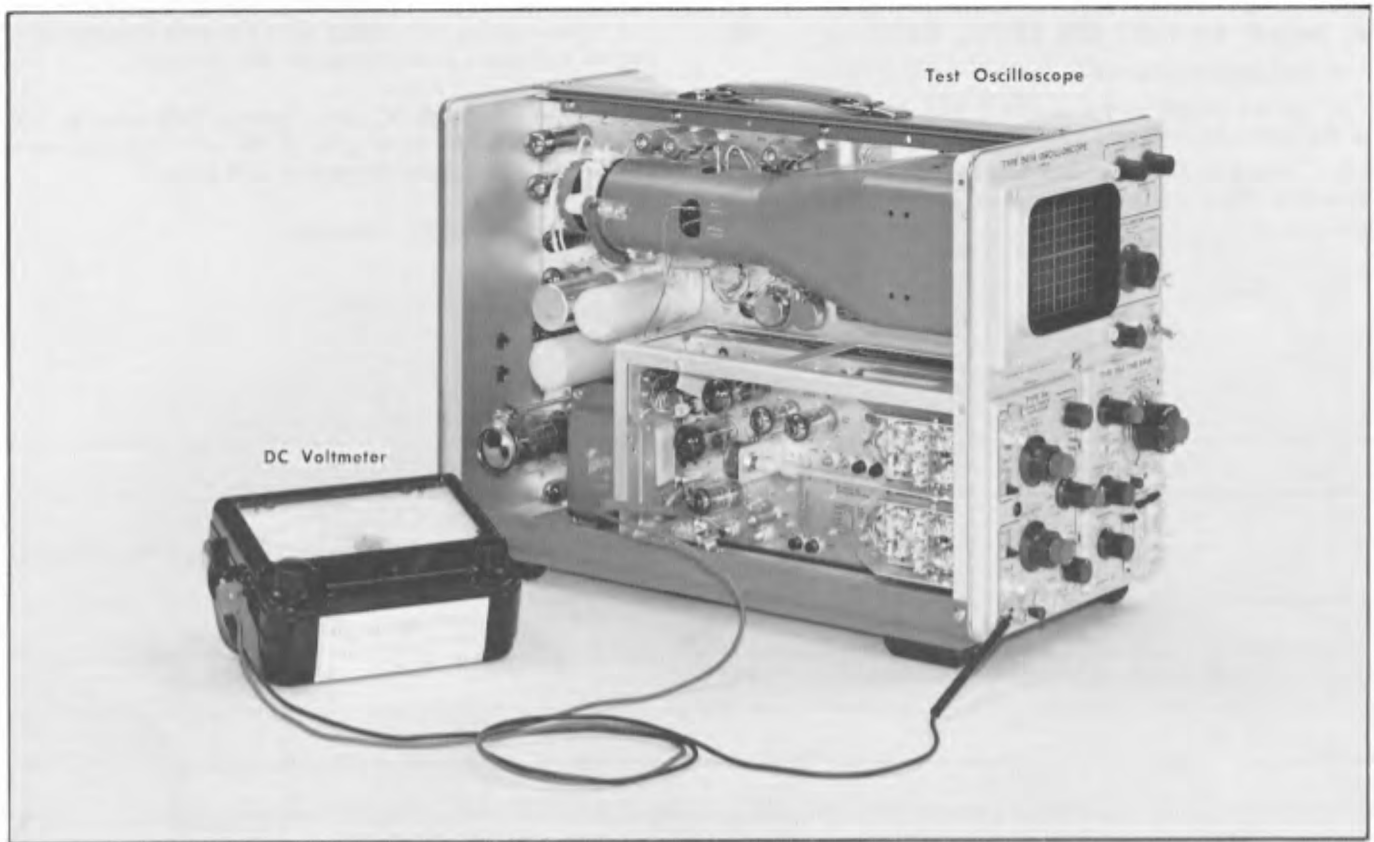


Fig. 7-7. Test equipment setup for step 6.

<b>Test Oscilloscope</b>	
Calibrator	50 mVolts
Intensity	Adjusted for normal display brightness
Focus	Adjusted for a well defined display

<b>Time Base Plug-In</b>	
Mode	Normal or Free Run
Time/Div	1 ms
Triggering Level	Free Run or fully clockwise
Slope	+
Coupling	AC
Source	Internal

**Type 3A1 (both channels)**

POSITION	Centered
AC-DC-GND	GND
VOLTS/DIV	.01

VARIABLE	CALIB
MODE	CH 1
INV (CH 1) NORM	NORM
<b>TRIGGER CH 1 ONLY</b>	<b>Pulled out</b>

**6. Adjust CHAN 1 TRIG DC LEVEL, R171** 

- a. Test equipment setup is shown in Fig. 7-7.
- b. Pull TRIGGER CH 1 ONLY switch out.
- c. Connect a DC voltmeter between the junction of R389-pin 11 of the interconnecting plug (see Fig. 7-8) and ground.
- d. Check—For a DC voltmeter reading of zero volts.
- e. Adjust—CHAN 1 TRIG DC LEVEL control, R171 (see Fig. 7-9) for a DC voltmeter reading of zero volts.
- f. Push in the TRIGGER CH 1 ONLY switch.
- g. Disconnect the DC voltmeter.
- h. Interaction—Interacts with step 1.



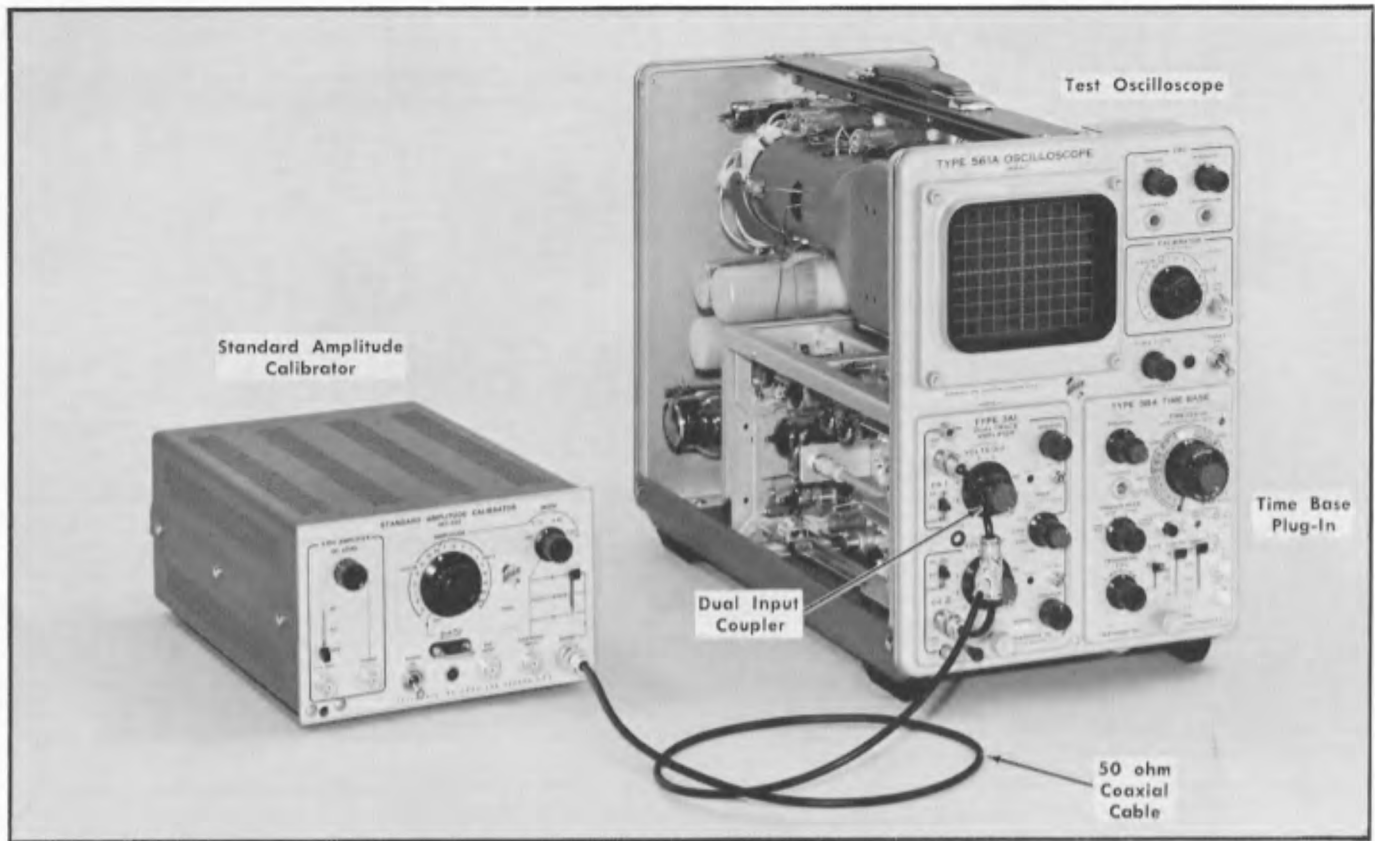


Fig. 7-10. Test equipment setup for steps 7 through 11.

	<b>Test Oscilloscope</b>
Calibrator	50 mVolts
Intensity	Adjusted for normal display brightness
Focus	Adjusted for a well defined display

	<b>Time Base Plug-In</b>
<b>Mode</b>	<b>Free Run</b>
Time/Div	1 ms
Triggering Level	Free Run or fully clockwise
Slope	+
Coupling	AC
Source	Internal

	<b>Type 3A1</b>
POSITION (Both channels)	Centered
AC-DC-GND (Channel 1)	DC
VOLTS/DIV (Both channels)	.01
VARIABLE (Both channels)	CALIB
INV (CH 1) ONLY	NORM
TRIGGER CH 1 ONLY	Pulled out

## 7. Adjust CALIB Control and CH 1 10 mV GAIN and 20 mV GAIN Controls

- a. Test equipment setup is shown in Fig. 7-10.
- b. Set the CH 1 AC-DC-GND switch to DC.
- c. Connect 50 mvolts of square-wave signal from the Standard Amplitude Calibrator through a 50 ohm coaxial cable and the dual input coupler to both CH 1 and CH 2 input connectors.
- d. Rotate the front panel CALIB control (see Fig. 7-11) fully clockwise.
- e. Check—For a display amplitude of exactly 6 major divisions.
- f. Adjust—10 MV GAIN control, R149 (see Fig. 7-12) for a display amplitude of exactly 6 major divisions.
- g. Check—That the CALIB control varies the display from 6 to less than 4 major divisions.
- h. Adjust—CALIB control for exactly 5 major divisions of display amplitude.
- i. Change the CH 1 VOLTS/DIV switch to .02 and the Standard Amplitude Calibrator output signal amplitude to 100 mvolts.
- j. Check—For a display amplitude of exactly 5 major divisions.
- k. Adjust—20 MV GAIN control, R147 (see Fig. 7-12) for a display amplitude of exactly 5 major divisions.

### 8. Adjust CH 2 10 mV GAIN and 20 mV GAIN Controls

- a. Test equipment setup is shown in Fig. 7-10.
- b. Reset the following Type 3A1 controls.
 

AC-DC-GND (Both channels)	DC
VOLTS/DIV (Both channels)	.02
MODE	ADDED
INV (CH 1) NORM	INV
- c. Set the Standard Amplitude Calibrator for an output signal amplitude of 0.5 volts.
- d. Check—For a display amplitude of not more than 1.25 minor divisions.
- e. Adjust—20 MV GAIN control, R247 (see Fig. 7-13) for minimum display amplitude (1.25 minor divisions or less).
- f. Set both CH 1 and CH 2 VOLTS/DIV switches to .01.
- g. Set the Standard Amplitude Calibrator for an output signal amplitude of 0.2 volts.
- h. Check—For a display amplitude of not more than 1 minor division.



Fig. 7-11. Location of front panel CALIB control.

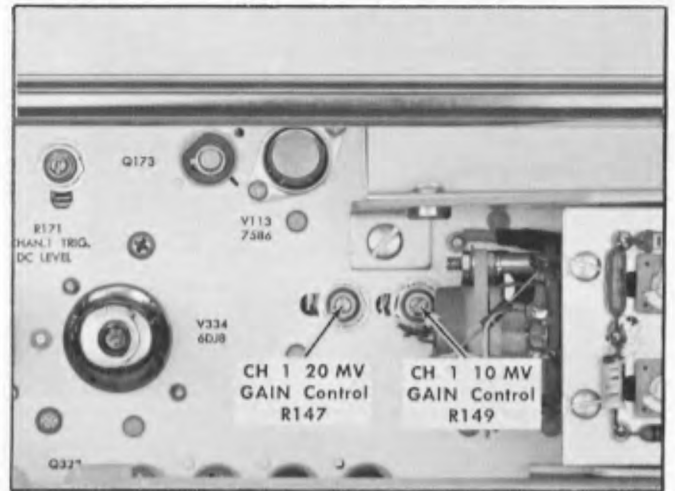


Fig. 7-12. Location of CH 1 10 MV GAIN and 20 MV GAIN controls.

- i. Adjust—10 MV GAIN control, R249 (see Fig. 7-13) for minimum display amplitude (1 minor division or less).
- j. Return the INV (CH 1) NORM switch to the NORM position.

### 9. Check Range of VARIABLE (Volts/Div) Controls

- a. Test equipment setup is shown in Fig. 7-10.
- b. Set MODE switch to CH 1 and the Standard Amplitude Calibrator for an output signal amplitude of 50 mvolts.
- c. Check—For a display amplitude of 5 major divisions.
- d. Rotate the VARIABLE control to its fully counterclockwise position checking for smooth mechanical and electrical operation.
- e. Check—For a display amplitude that must be less than 2 major divisions.
- f. Check that the UNCAL light is lit.
- g. Return the VARIABLE control to its CALIB position.
- h. Check that the UNCAL light is no longer lit.
- i. Set the MODE switch to CH 2 and repeat parts c through h of this step for channel 2.

### 10. Check Compression and/or Expansion

- a. Test equipment setup is shown in Fig. 7-10.
- b. Set CH 2 Input selector switch to GND, and the MODE switch to CH 1.
- c. Set the Standard Amplitude Calibrator for an output signal amplitude of 20 mvolts.
- d. Position the display to the center of the graticule area.

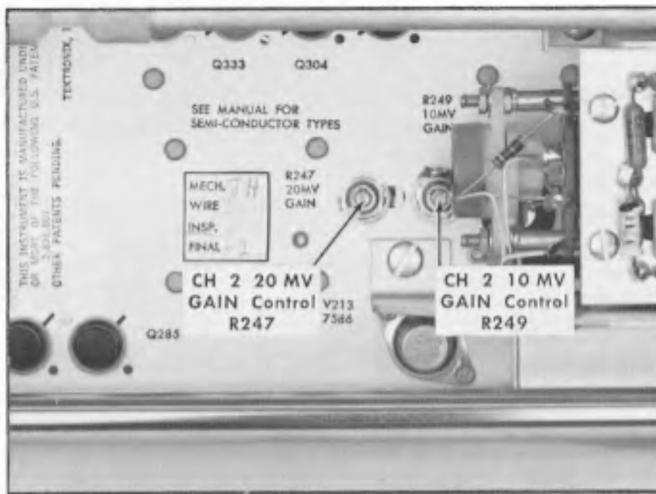


Fig. 7-13. Location of CH 2 10 MV GAIN and 20 MV GAIN controls.

- e. Check—For exactly 2 major division display amplitude.
- f. Position the top of the display to the top graticule line.
- g. Check—That the amplitude of the display is within  $\pm 1/2$  minor division of being 2 major divisions.
- h. Position the bottom of the display to the bottom graticule line.
- i. Check—That the amplitude of the display is within  $\pm 1/2$  minor division of being 2 major divisions.
- j. Set the MODE switch to CH 2, CH 1 Input selector switch to GND and CH 2 Input switch to DC.
- k. Repeat parts d through j of this step for channel 2.

### 11. Check Input Selector Switch AC-DC Operation

- a. Test equipment setup is shown in Fig. 7-10.
- b. Set both Input selector switches to DC and position the bottom of the display to the graticule centerline.

- c. Set CH 2 Input selector switch to AC and note the shift of the waveform.
- d. Check—That the waveform shifts downward so its average DC level point is now at the graticule horizontal centerline.
- e. Set MODE switch to CH 1.
- f. Set both Input selector switches to DC and position the bottom of the display to the graticule horizontal centerline.
- g. Set CH 1 Input selector switch to AC and note the shift of the waveform.
- h. Check—That the waveform shifts downward so its average DC level point is now at the graticule horizontal center.
- i. Remove the Standard Amplitude Calibrator signal from the Type 3A1 Input connectors.

### 12. Check Grid Current

- a. Set both CH 1 and CH 2 VOLTS/DIV switches to 0.2, both VARIABLE controls to CALIB, both Input selector switches to GND and the MODE switch to ALT.
- b. Position the traces 2 major divisions apart.
- c. Switch CH 1 Input selector switch from GND to AC and note the amount of trace shift.
- d. Check—That the trace does not shift more than 2 minor divisions.
- e. Return the CH 1 Input selector switch to GND.
- f. Switch CH 2 Input selector switch from GND to AC and note the amount of trace shift.
- g. Check—That the trace does not shift more than 2 minor divisions.

### NOTES

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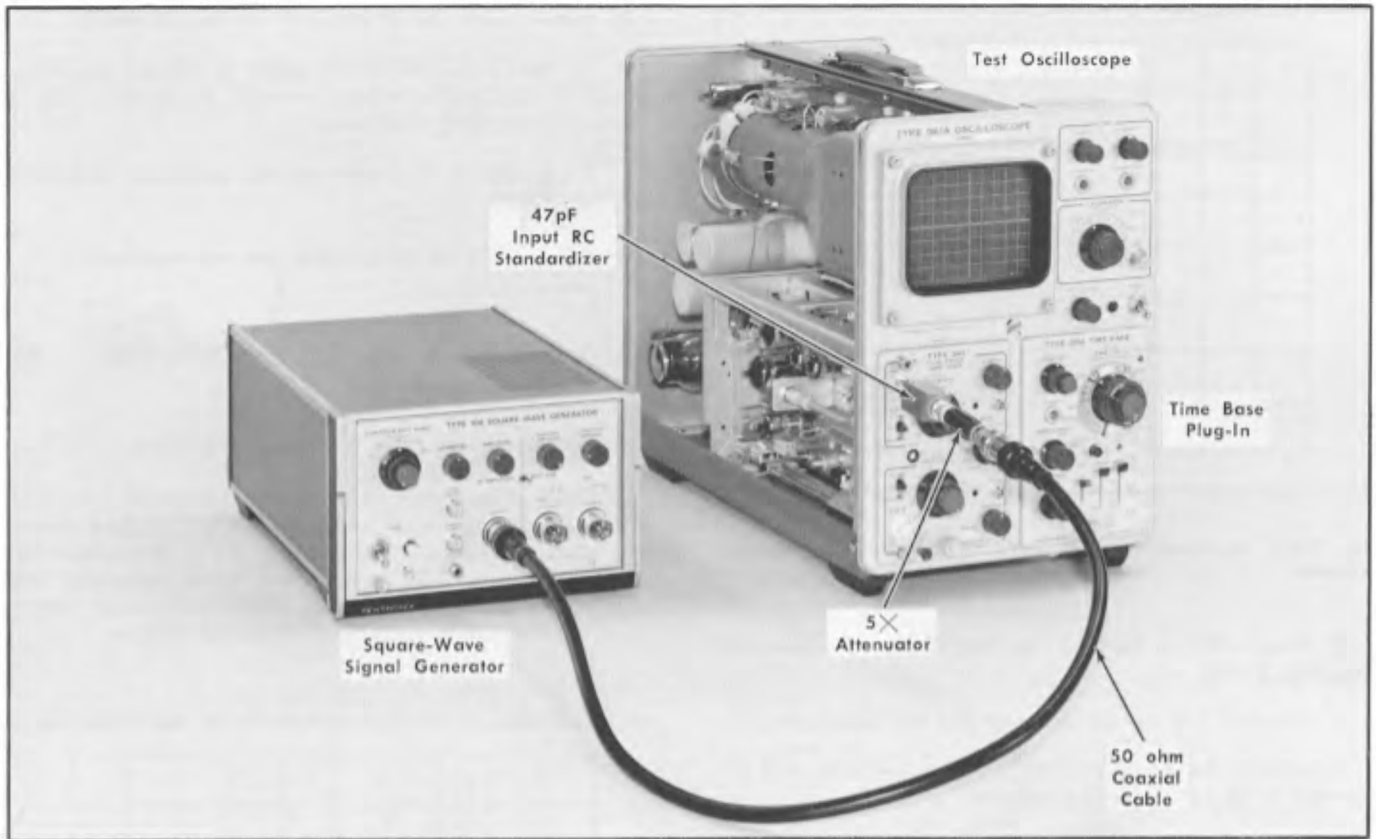


Fig. 7-14. Test equipment setup for steps 13 and 14.

**Test Oscilloscope**

Calibrator	50 mVolts
Intensity	Adjusted for normal display brightness
Focus	Adjusted for a well defined display

**Time Base Plug-In**

Mode	Normal or Free Run
<b>Time/Div</b>	<b>.1 ms</b>
Triggering Level	Free Run or fully clockwise
Slope	+
Coupling	AC
Source	Internal

**Type 3A1 (both channels)**

POSITION	Centered
AC-DC-GND	DC
VOLTS/DIV	.01
VARIABLE	CALIB
MODE	CH 1
INV (CH 1) NORM	NORM
<b>TRIGGER CH 1 ONLY</b>	<b>Pushed In</b>

**13. Adjust CH 1 and CH 2 Input Capacitance**

- a. Test equipment setup is shown in Fig. 7-14.
- b. Apply the output of the square-wave signal generator through a 50 Ω coaxial cable, a 5× attenuator and a 47 pF input RC standardizer to the CH 1 input connector.
- c. Set the square-wave signal generator for an output frequency of 1 kHz.
- d. Set the CH 1 Input selector switch to DC, the CH 1 VOLTS/DIV switch to .01 and the MODE switch to CH 1.
- e. Adjust the square-wave signal generator for a display amplitude of 4 major divisions.
- f. Set the time base plug-in Time/Div switch to .2 ms and adjust the triggering controls for a stable display.
- g. Check—For a flat top on the displayed waveform (see Fig. 7-15A).
- h. Adjust—C111 for an optimum flat-top waveform.
- i. Set CH 1 VOLTS/DIV switch to .02 and increase the output of the square-wave signal generator to maintain the 4 major division display amplitude.

## Calibration—Type 3A1

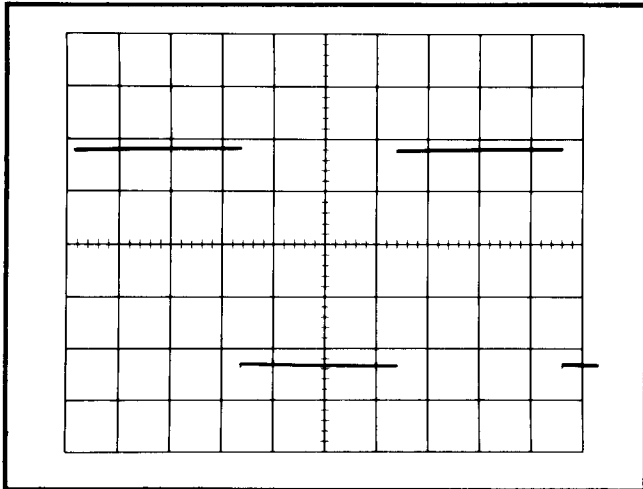


Fig. 7-15. Waveform obtained when C111 and C112 correctly adjusted.

- j. Check—For a flat top on the displayed waveform (see Fig. 7-15B).
- k. Adjust—C112 for an optimum flat top waveform.
- l. Remove the signal from CH 1 Input connector and re-connect it to CH 2 Input connector.
- m. Set the MODE switch to CH 2, CH 2 Input selector switch to DC and CH 2 VOLTS/DIV switch to .01.
- n. Adjust the square-wave signal generator for a display amplitude of 4 major divisions.
- o. Check—For a flat top on the displayed waveform (see Fig. 7-16A).

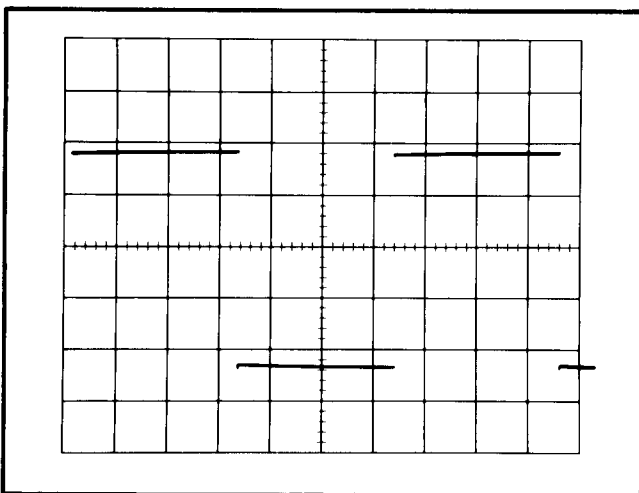


Fig. 7-16. Waveform obtained when C211 and C212 correctly adjusted.

- p. Adjust—C211 for an optimum flat top waveform.

q. Set the CH 2 VOLTS/DIV switch to .02 and adjust the output of the square-wave generator to maintain the 4 major division signal amplitude.

r. Check—For a flat top on the displayed waveform (see Fig. 7-16B).

- s. Adjust C212 for an optimum flat top waveform.

## 14. Adjust CH 1 and CH 2 VOLTS/DIV Compensation ①

- a. Test equipment setup is shown in Fig. 7-14.

b. Check—The waveform presented at each CH 2 VOLTS/DIV switch setting listed in Table 7-1 for optimum square leading corner and flat top (see Fig. 7-17). The output signal amplitude of the square-wave signal generator will have to be adjusted for each VOLTS/DIV switch setting so as to maintain a 4 major division high display.

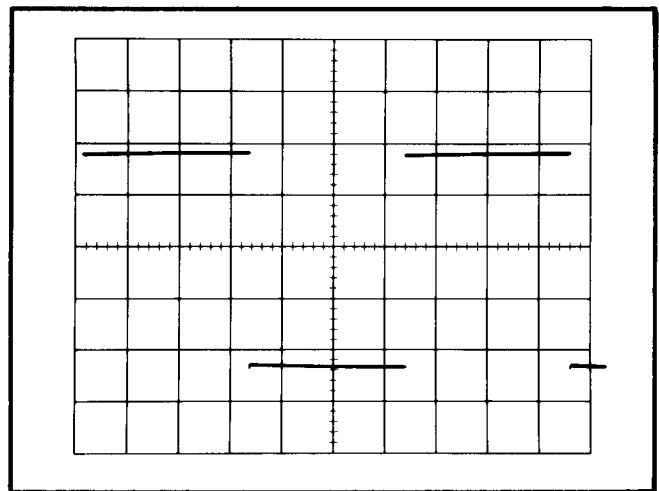


Fig. 7-17. Waveform obtained for each VOLTS/DIV switch setting when compensation adjustments are correctly made.

c. Adjust—Indicated components in Table 7-1 for each CH 2 VOLTS/DIV switch position so the waveform presented has an optimum square leading corner and a flat top. See Fig. 7-17. It will be necessary to readjust the square-wave signal generator after each VOLTS/DIV switch change to maintain 4 major divisions of display.

- d. Set the MODE switch to CH 1.

e. Remove the signal from CH 2 Input connector and reconnect it to CH 1 Input connector.



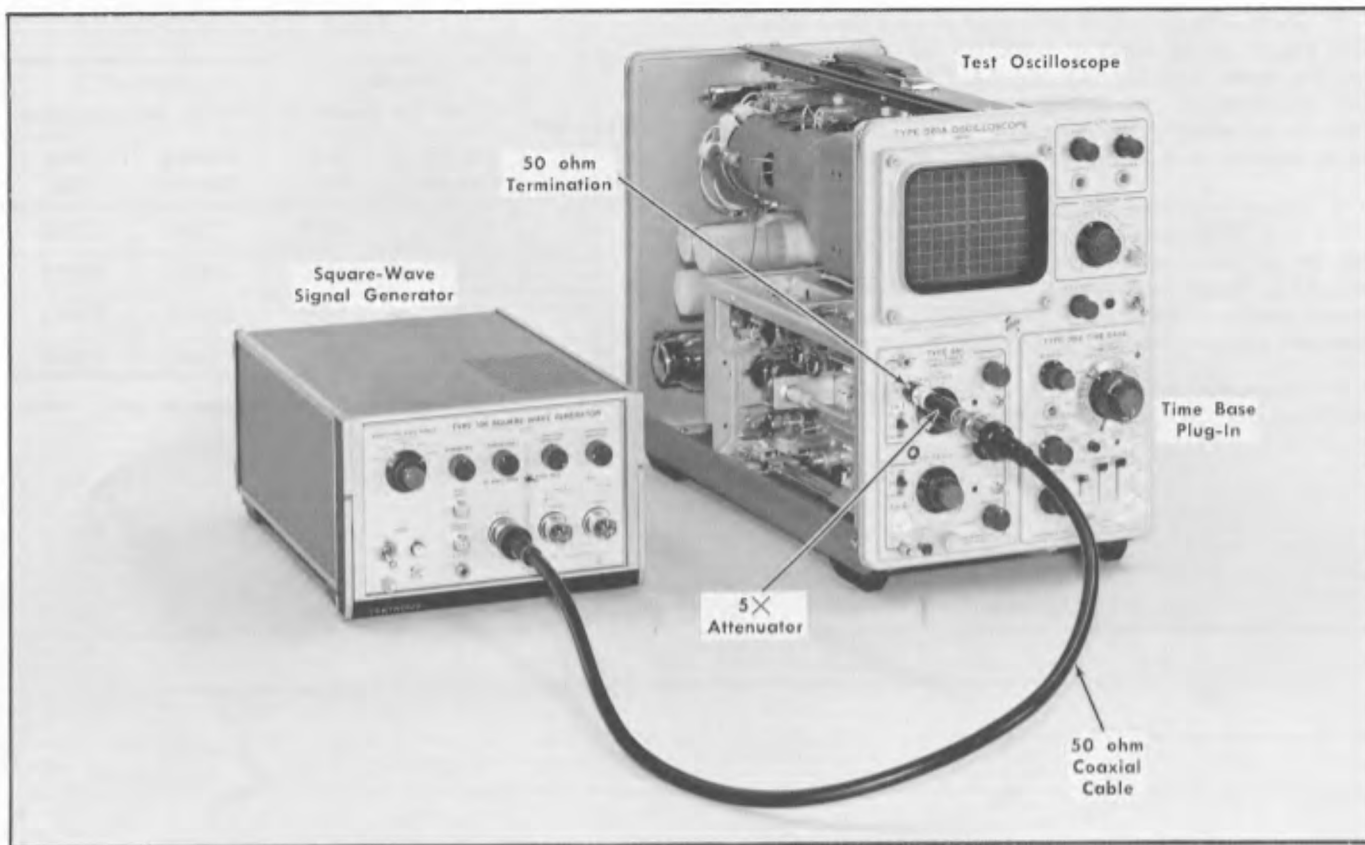


Fig. 7-18. Test equipment setup for step 15.

**Test Oscilloscope**

Calibrator	50 mVolts
Intensity	Adjusted for normal display brightness
Focus	Adjusted for a well defined display

**Time Base Plug-In**

Mode	Normal or Free Run
<b>Time/Div</b>	<b>.5 <math>\mu</math>s</b>
Triggering Level	Free Run or fully clockwise
Slope	+
Coupling	AC
Source	Internal

**Type 3A1 (both channels)**

POSITION	Centered
AC-DC-GND	DC
VOLTS/DIV	.01
VARIABLE	CALIB
MODE	CH 1
INV (CH 1) NORM	NORM
TRIGGER CH 1 ONLY	Pushed in

**15. Adjust High Frequency Compensation** ❶

a. Test equipment setup is shown in Fig. 7-18.

b. Set both CH 1 and CH 2 VOLTS/DIV switches to .01, set the MODE switch to CH 1 and the time base plug-in Time/Div switch to the .5  $\mu$ s position.

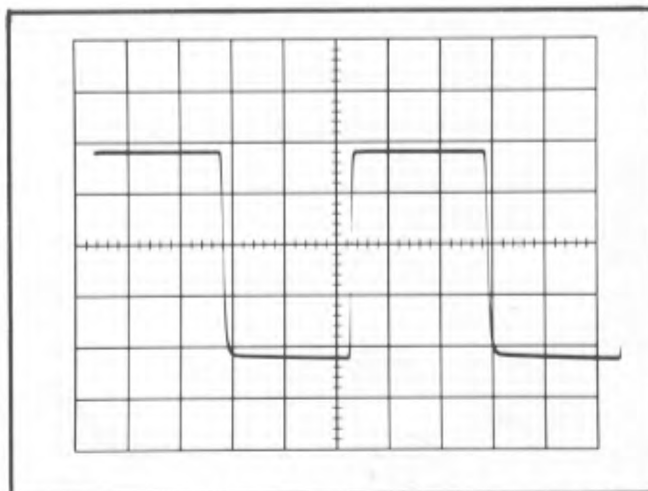


Fig. 7-19. Displayed waveform when L361 and L371 are correctly adjusted.



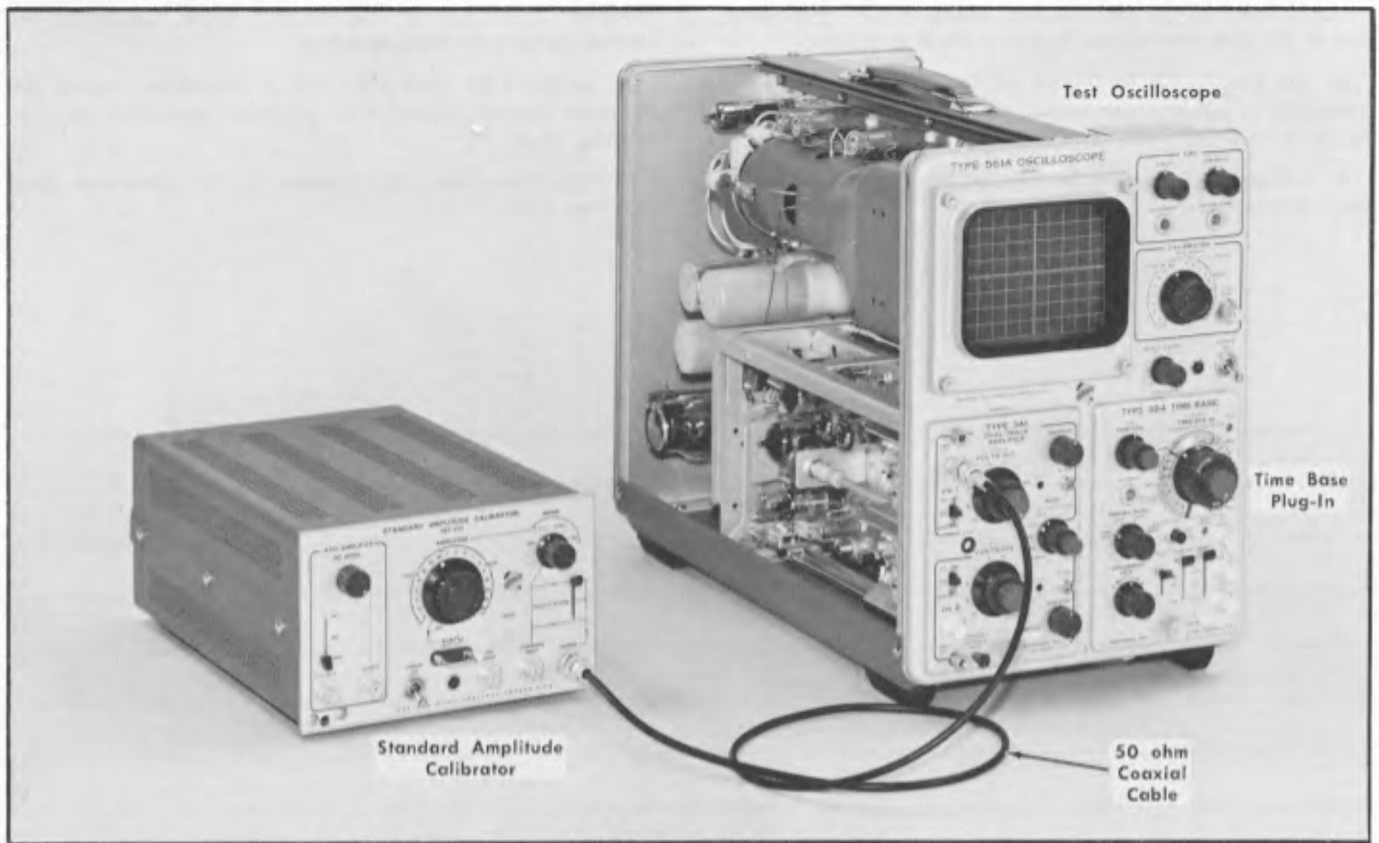


Fig. 7-20. Test equipment setup for step 16.

**Test Oscilloscope**

Calibrator            50 mVolts

Intensity            Adjusted for normal display brightness

Focus                Adjusted for a well defined display

**Time Base Plug-In**

Mode                Normal or Free Run

**Time/Div**            **5 ms**

Triggering Level    Free Run or fully clockwise

Slope                +

Coupling            AC

Source               Internal

**Type 3A1 (both channels)**

POSITION            Centered

AC-DC-GND        DC

VOLTS/DIV         .01

VARIABLE           CALIB

MODE                CH 1

INV (CH 1) NORM    NORM

TRIGGER CH 1 ONLY Pushed in

TABLE 7-2

VOLTS/DIV Switch Setting	Standard Amplitude Calibrator Output (peak to peak)	Vertical Deflection in Divisions
.01	50 mVolts	5
.02	.1 Volts	5
.05	.2 Volts	4
.1	.5 Volts	5
.2	1 Volts	5
.5	2 Volts	4
1	5 Volts	5
2	10 Volts	5
5	20 Volts	4
10	50 Volts	5



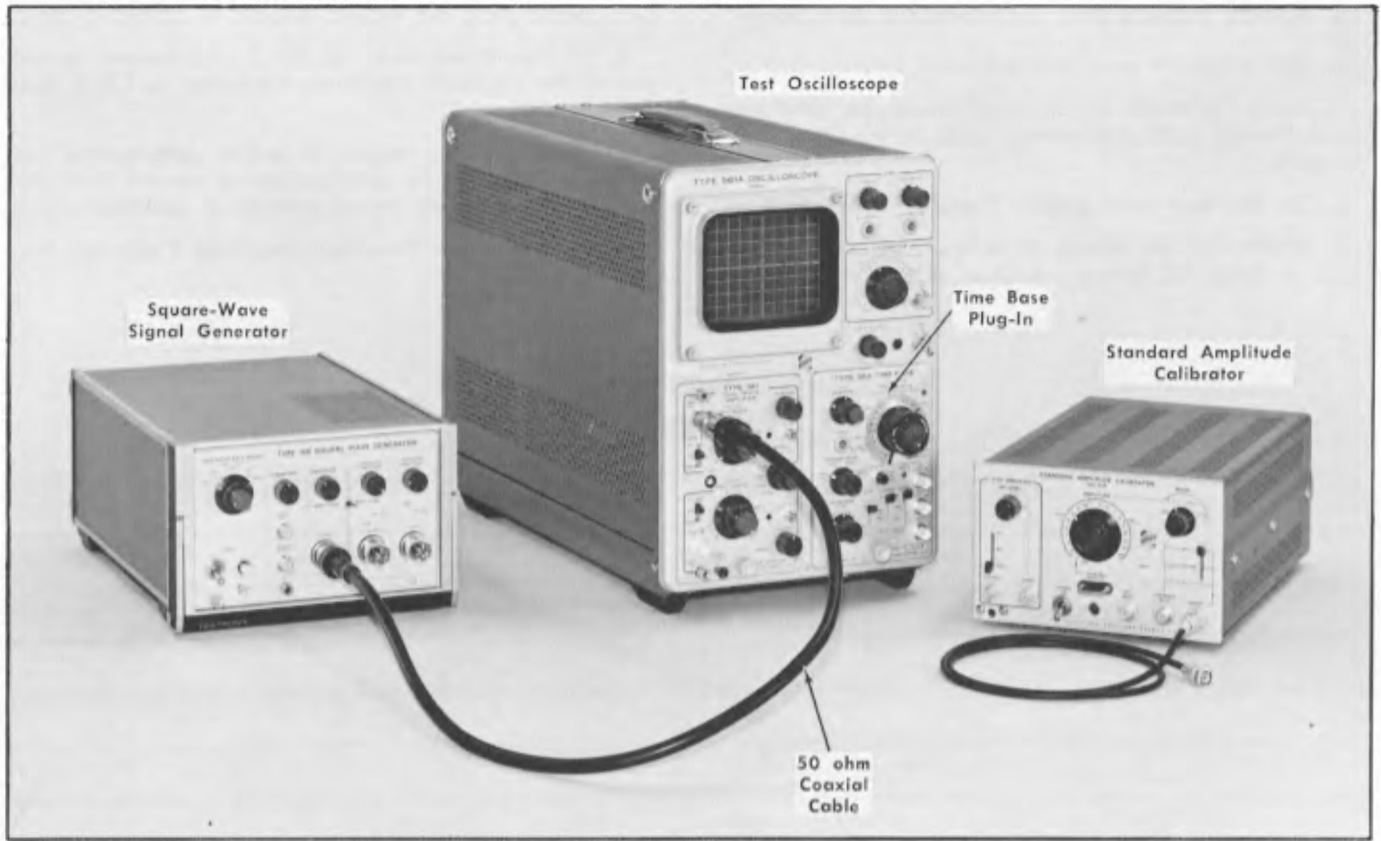


Fig. 7-21. Test equipment setup for steps 17 and 18.

	<b>Test Oscilloscope</b>	<b>VOLTS/DIV</b>	<b>.01</b>
Calibrator	50 mVolts	<b>(Channel 2)</b>	
Intensity	Adjusted for normal display brightness	VARIABLE	CALIB
Focus	Adjusted for a well defined display	MODE	CH 1
		INV (CH 1) NORM	NORM
		TRIGGER CH 1 ONLY	Pushed in

	<b>Time Base Plug-In</b>
Mode	Normal or Free Run
<b>Time/Div</b>	<b>10 <math>\mu</math>s</b>
Triggering Level	Free Run or fully clockwise
Slope	+
Coupling	AC
Source	Internal

	<b>Type 3A1</b>
POSITION (Both channels)	Centered
AC-DC-GND (Both channels)	DC
<b>VOLTS/DIV (Channel 1)</b>	<b>10</b>

**17. Check Channel Isolation**

- a. Test equipment setup is shown in Fig. 7-21.
- b. Set the CH 1 VOLTS/DIV switch to 10, CH 2 VOLTS/DIV switch to .01. MODE switch to CH 1 and the time base plug-in Time/Div switch to 10  $\mu$ s.
- c. Re-install both side panels onto the test oscilloscope.
- d. Connect the output of the square-wave signal generator through a 50 ohm coaxial cable to CH 1 Input connector.
- e. Set the square-wave signal generator for an output frequency of 100 kHz.
- f. Adjust the square-wave signal generator output signal amplitude control for a 5 major division display.





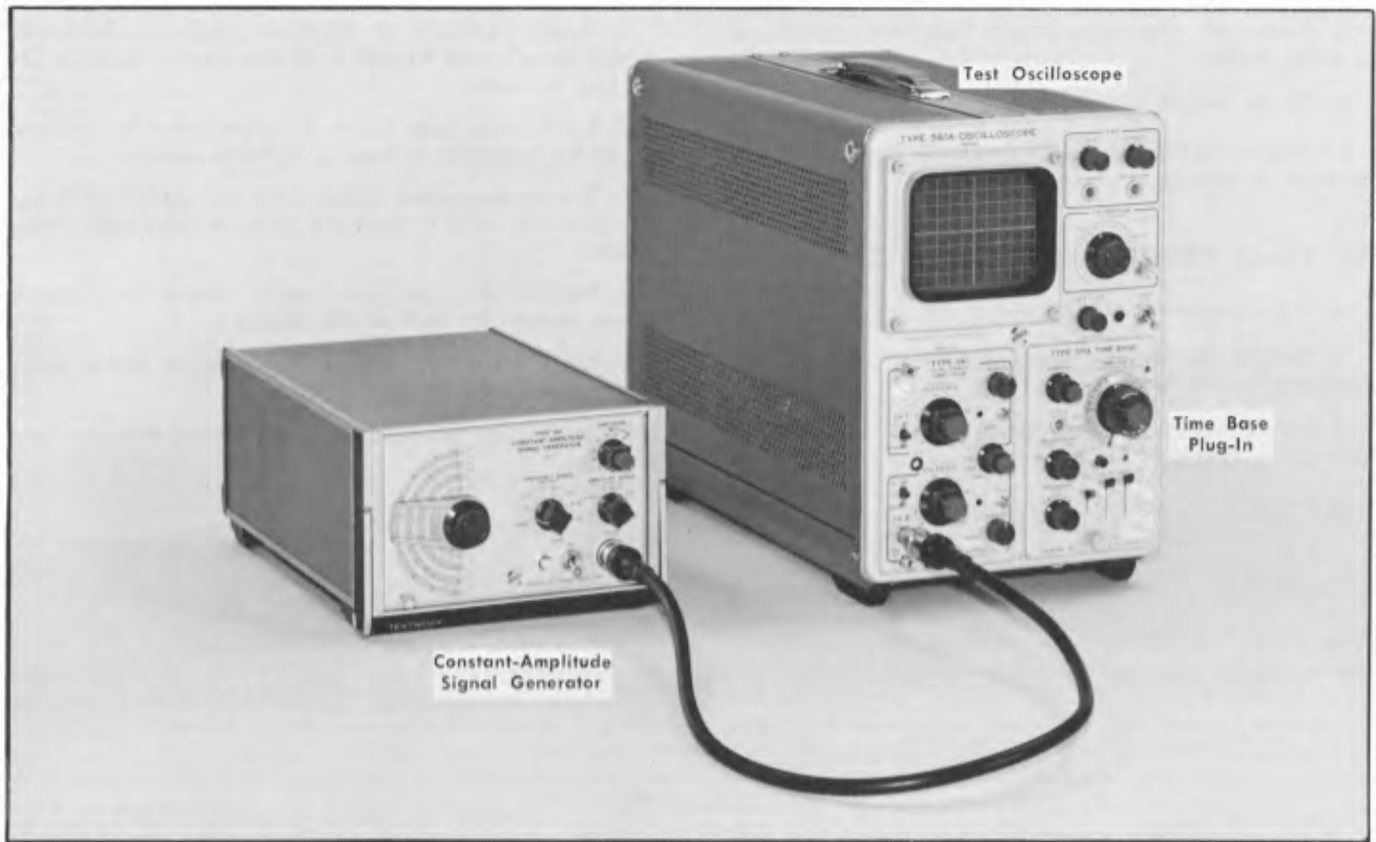


Fig. 7-22. Test equipment setup for steps 19 and 20.

<b>Test Oscilloscope</b>	
Calibrator	50 mVolts
Intensity	Adjusted for normal display brightness
Focus	Adjusted for a well defined display

<b>Time Base Plug-In</b>	
Mode	Normal or Free Run
<b>Time/Div</b>	<b>1 ms</b>
Triggering Level	Free Run or fully clockwise
Slope	+
Coupling	AC
Source	Internal

<b>Type 3A1 (both channels)</b>	
POSITION	Centered
AC-DC-GND	DC
<b>VOLTS/DIV</b>	<b>.01</b>
VARIABLE	CALIB
<b>MODE</b>	<b>CH 2</b>

INV (CH 1) NORM  
TRIGGER CH 1 ONLY      NORM  
Pushed in

### 19. Check High Frequency Response

- a. Test equipment setup is shown in Fig. 7-22.
- b. Set the time base plug-in Time/Div switch to .1 ms and adjust the triggering controls for a free running display.
- c. Connect the output of the constant-amplitude signal generator to CH 2 Input.
- d. Set the MODE switch to CH 2.
- e. Set the constant-amplitude signal generator for an output frequency of 50 kHz and adjust the signal generator output amplitude for a display amplitude of 6 major divisions.
- f. Increase the output frequency of the constant-amplitude signal generator to 10 MHz.
- g. Check—For a display whose amplitude is at least 4.2 major divisions high.
- h. Set the CH 2 VOLTS/DIV switch to .02 and repeat parts e through g of this step.







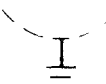
## PARTS ORDERING INFORMATION

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 or model 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.

## SPECIAL NOTES AND SYMBOLS

- |   |   |
|---|---|
| ×000  | Part first added at this serial number  |
| 00×   | Part removed after this serial number   |
| *000-0000-00  | Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components. |
| Use 000-0000-00   | Part number indicated is direct replacement.  |
|  | Screwdriver adjustment.   |
|  | Control, adjustment or connector.   |
|  | Heat sink.  |

## ABBREVIATIONS AND SYMBOLS

A or amp	amperes	$\lambda$	lambda—wavelength
AC or ac	alternating current	<	less than
AF	audio frequency	LF	low frequency
$\alpha$	alpha—common-base current amplification factor	lg	length or long
AM	amplitude modulation	LV	low voltage
$\approx$	approximately equal to	M	mega or $10^6$
$\beta$	beta—common-emitter current amplification factor	m	milli or $10^{-3}$
BHB	binding head brass	M $\Omega$ or meg	megohm
BHS	binding head steel	$\mu$	micro or $10^{-6}$
BNC	baby series "N" connector	mc	megacycle
X	by or times	met.	metal
C	carbon	mm	millimeter
C	capacitance	ms	millisecond
cap.	capacitor	—	minus
cer	ceramic	mtg hdw	mounting hardware
cm	centimeter	n	nano or $10^{-9}$
comp	composition	no. or #	number
conn	connector	ns	nanosecond
$\sim$	cycle	OD	outside diameter
c/s or cps	cycles per second	OHB	oval head brass
CRT	cathode-ray tube	OHS	oval head steel
csk	countersunk	$\Omega$	omega—ohms
		$\omega$	omega—angular frequency
dB	decibel	p	pico or $10^{-12}$
dBm	decibel referred to one milliwatt	/	per
DC or dc	direct current	%	percent
DE	double end	PHB	pan head brass
$^{\circ}$	degrees	$\phi$	phi—phase angle
$^{\circ}$ C	degrees Celsius (degrees centigrade)	$\pi$	pi—3.1416
$^{\circ}$ F	degrees Fahrenheit	PHS	pan head steel
$^{\circ}$ K	degrees Kelvin	+	plus
dia	diameter	$\pm$	plus or minus
$\div$	divide by	PIV	peak inverse voltage
div	division	plstc	plastic
		PMC	paper, metal cased
EHF	extremely high frequency	poly	polystyrene
EMC	electrolytic, metal cased	prec	precision
EMT	electrolytic, metal tubular	PT	paper, tubular
$\epsilon$	epsilon—2.71828 or % of error	PTM	paper or plastic, tubular, molded
$\geq$	equal to or greater than	pwr	power
$\leq$	equal to or less than		
ext	external	RC	resistance capacitance
F or f	farad	RF	radio frequency
F & I	focus ond intensity	RFI	radio frequency interference
FHB	flat head brass	RHB	round head brass
FHS	flat head steel	$\rho$	rho—resistivity
Fil HB	fillister head brass	RHS	round head steel
Fil HS	fillister head steel	r/min or rpm	revolutions per minute
FM	frequency modulation	RMS	root mean square
ft	feet or foot		
		s or sec.	second
G	gigo or $10^9$	SE	single end
g	acceleration due to gravity	Si	silicon
Ge	germanium	SN or S/N	serial number
GMV	guaranteed minimum value		
GR	General Radio	T	tera or $10^{12}$
>	greater than	TC	temperature compensated
H or h	henry	TD	tunnel diode
h	height or high	THB	truss head brass
hex.	hexagonal	$\theta$	theto—angular phase displacement
HF	high frequency	thk	thick
HHB	hex head brass	THS	truss head steel
HHS	hex head steel	tub.	tubular
HSB	hex socket brass		
HSS	hex socket steel	UHF	ultra high frequency
HV	high voltage	V	volt
Hz	hertz (cycles per second)	VAC	volts, alternating current
		var	variable
ID	inside diameter	VDC	volts, direct current
IF	intermediate frequency	VHF	very high frequency
in.	inch or inches	VSWR	voltage standing wave ratio
incd	incandescent		
$\infty$	infinity	W	watt
int	internal	w	wide or width
$\int$	integral	w/	with
		w/o	without
k	kilohms or kilo ( $10^3$ )	WW	wire-wound
k $\Omega$	kilohm		
kc	kilocycle	xmfr	transformer

# SECTION 8

## ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Description	S/N Range
<b>Bulbs</b>			
B113	150-027	Neon, NE-23	X1710-up
B150	Use 150-027	Neon, NE-23	UNCALIBRATED 101-10649
B150	150-0030-00	Neon, NE-2V	10650-up
B213	150-027	Neon, NE-23	X1710-up
B250	Use 150-027	Neon, NE-23	UNCALIBRATED 101-10649
B250	150-0030-00	Neon, NE-2V	10650-up

### Capacitors

Tolerance  $\pm 20\%$  unless otherwise indicated.

Tolerance of all electrolytic capacitors as follows (with exceptions):

3 V — 50 V =  $-10\%$ ,  $+250\%$   
 51 V — 350 V =  $-10\%$ ,  $+100\%$   
 351 V — 450 V =  $-10\%$ ,  $+50\%$

C101	*285-609	.1 $\mu$ f	MT	600 v	10%	
C102	281-0626-00	3.3 pf	Cer.	500 v	5%	X10280-up
C103A	281-501	4.7 pf	Cer.	500 v	$\pm 1$ pf	X6940-up
C103B	281-061	5.5-18 pf	Cer.	Var.		101-6939
C103B	281-103	1.8-13 pf	Air	Var.		6940-up
C103C	281-061	5.5 18 pf	Cer.	Var.		101-6939
C103C	281-103	1.8-13 pf	Air	Var.		6940-up
C103D	281-541	6.8 pf	Cer.	500 v	10%	X6940-up
C105A	281-501	4.7 pf	Cer.	500 v	$\pm 1$ pf	X6940-up
C105B	281-061	5.5-18 pf	Cer.	Var.		101-6939
C105B	281-103	1.8-13 pf	Air	Var.		6940-up
C105C	281-060	2-8 pf	Cer.	Var.		101-6939
C105C	281-101	1.5-9.1 pf	Air	Var.		6940-up
C105E	281-503	8 pf	Cer.	500 v	$\pm 0.5$ pf	
C107A	281-504	10 pf	Cer.	500 v	10%	101-6939
C107A	281-509	15 pf	Cer.	500 v	10%	6940-up
C107B	281-061	5.5-18 pf	Cer.	Var.		101-6939
C107B	281-103	1.8-13 pf	Air	Var.		6940-up
C107C	281-060	2-8 pf	Cer.	Var.		101-6939
C107C	281-101	1.5-9.1 pf	Air	Var.		6940-up
C107E	281-579	21 pf	Cer.	500 v		101-6939
C107E	281-513	27 pf	Cer.	500 v		6940-up
C109A	281-504	10 pf	Cer.	500 v	10%	101-6939
C109A	281-509	15 pf	Cer.	500 v	10%	6940-up
C109B	281-061	5.5-18 pf	Cer.	Var.		101-6939
C109B	281-103	1.8-13 pf	Air	Var.		6940-up
C109C	281-060	2-8 pf	Cer.	Var.		101-6939
C109C	281-101	1.5-9.1 pf	Air	Var.		6940-up
C109E	283-541	500 pf	Mica	500 v	10%	
C110	281-509	15 pf	Cer.	500 v	10%	X3075-up
C111	281-061	5.5-18 pf	Cer.	Var.		101-6939
C111	281-103	1.8-13 pf	Air	Var.		6940-up

Electrical Parts List—Type 3A1

Capacitors (Cont'd)

Ckt. No.	Tektronix Part No.		Description			S/N Range
C112	281-060	2-8 pf	Cer.	Var.		101-6939
C112	281-101	1.5-9.1 pf	Air	Var.		6940-up
C113	283-068	.01 $\mu$ f	Disc Type		500 v	
C114	281-500	2.2 pf	Cer.		500 v	$\pm 0.5$ pf X3075-up
C115	Use 283-057	.1 $\mu$ f	Disc Type		200 v	
C123	283-003	.01 $\mu$ f	Disc Type		150 v	
C125	283-003	.01 $\mu$ f	Disc Type		150 v	
C132	283-0059-00	1 $\mu$ f	Disc Type		25 v	X9300-up
C137	281-549	68 pf	Cer.		500 v	10%
C167	281-524	150 pf	Cer.		500 v	
C185	281-543	270 pf	Cer.		500 v	10%
C187	281-528	82 pf	Cer.		500 v	10%
C201	*285-609	.1 $\mu$ f	MT		600 v	10%
C202	281-0626-00	3.3 pf	Cer.		500 v	5%
C203A	281-501	4.7 pf	Cer.		500 v	$\pm 1$ pf X10280-up
C203B	281-061	5.5-18 pf	Cer.	Var.		X6940-up
C203B	281-103	1.8-13 pf	Air	Var.		101-6939
C203C	281-061	5.5-18 pf	Cer.	Var.		6940-up
C203C	281-103	1.8-13 pf	Air	Var.		X6940-up
C203D	281-541	6.8 pf	Cer.		500 v	10%
C205A	281-501	4.7 pf	Cer.		500 v	$\pm 1$ pf X6940-up
C205B	281-061	5.5-18 pf	Cer.	Var.		101-6939
C205B	281-103	1.8-13 pf	Air	Var.		6940-up
C205C	281-060	2-8 pf	Cer.	Var.		101-6939
C205C	281-101	1.5-9.1 pf	Air	Var.		6940-up
C205E	281-503	8 pf	Cer.		500 v	$\pm 0.5$ pf
C207A	281-504	10 pf	Cer.		500 v	10% 101-6939
C207A	281-509	15 pf	Cer.		500 v	10% 6940-up
C207B	281-061	5.5-18 pf	Cer.	Var.		101-6939
C207B	281-103	1.8-13 pf	Air	Var.		6940-up
C207C	281-060	2-8 pf	Cer.	Var.		101-6939
C207C	281-101	1.5-9.1 pf	Air	Var.		6940-up
C207E	281-579	21 pf	Cer.		500 v	5% 101-6939
C207E	281-513	27 pf	Cer.		500 v	6940-up
C209A	281-504	10 pf	Cer.		500 v	10% 101-6939
C209A	281-509	15 pf	Cer.		500 v	10% 6940-up
C209B	281-061	5.5-18 pf	Cer.	Var.		101-6939
C209B	281-103	1.8-13 pf	Air	Var.		6940-up
C209C	281-060	2-8 pf	Cer.	Var.		101-6939
C209C	281-101	1.5-9.1 pf	Air	Var.		6940-up
C209E	283-541	500 pf	Mica		500 v	10%
C210	281-509	15 pf	Cer.		500 v	10% X3075-up
C211	281-061	5.5-18 pf	Cer.	Var.		101-6939
C211	281-103	1.8-13 pf	Air	Var.		6940-up
C212	281-060	2-8 pf	Cer.	Var.		101-6939
C212	281-101	1.5-9.1 pf	Air	Var.		6940-up
C213	283-068	.01 $\mu$ f	Disc Type		500 v	



Capacitors (Cont'd)

Ckt. No.	Tektronix Part No.	Description	S/N Range
C214	281-500	2.2 pf Cer.	500 v ±0.5 pf X3075-up
C215	Use 283-057	.1 μf Disc Type	200 v
C223	283-003	.01 μf Disc Type	150 v
C225	283-003	.01 μf Disc Type	150 v
C232	283-0059-00	1 μf Cer.	25 v X9300-up
C237	281-549	68 pf Cer.	500 v 10%
C260	283-067	.001 μf Disc Type	200 v 10% 101-7069
C260	283-104	2000 pf Disc Type	500 v 5% 7070-up
C261	281-523	100 pf Cer.	350 v
C263	283-003	.01 μf Disc Type	150 v
C266	281-513	27 pf Cer.	500 v
C268	283-003	.01 μf Disc Type	150 v
C277	281-523	100 pf Cer.	350 v
C287	281-523	100 pf Cer.	350 v
C291	283-003	.01 μf Disc Type	150 v
C307	283-003	.01 μf Disc Type	150 v
C327	283-000	.001 μf Disc Type	500 v
C340	283-002	.01 μf Disc Type	500 v
C360	283-006	.02 μf Disc Type	600 v
C364	281-0600-00	35 pf Cer.	10% X9183-up
C366	283-002	.01 μf Disc Type	500 v
C369	283-002	.01 μf Disc Type	500 v
C373	281-526	1.5 pf Cer.	500 v ±0.5 pf
C376	283-002	.01 μf Disc Type	500 v
C378	283-026	.2 μf Disc Type	25 v
C381	281-526	1.5 pf Cer.	500 v ±0.5 pf
C385	283-003	.01 μf Disc Type	150 v
C387	281-528	82 pf Cer.	500 v 10%
C391	283-003	.01 μf Disc Type	150 v
C395	283-026	.2 μf Disc Type	25 v
C396	Use 290-134	22 μf EMT	15 v
C397	283-003	.01 μf Disc Type	150 v
C398	283-003	.01 μf Disc Type	150 v
C399	283-006	.02 μf Disc Type	600 v

Diodes

D130	152-008	Germanium	T12G
D131	152-008	Germanium	T12G
D132	152-008	Germanium	T12G
D140	152-008	Germanium	T12G
D155	152-071	Germanium	ED2007
D156	152-071	Germanium	ED2007
D157	152-071	Germanium	ED2007
D158	152-071	Germanium	ED2007
D230	152-008	Germanium	T12G
D231	152-008	Germanium	T12G
D232	152-008	Germanium	T12G
D240	152-008	Germanium	T12G

## Electrical Parts List—Type 3A1

### Diodes (Cont'd)

Ckt. No.	Tektronix Part No.	Description	S/N Range
D255	152-071	Germanium	ED2007
D256	152-071	Germanium	ED2007
D257	152-071	Germanium	ED2007
D258	152-071	Germanium	ED2007
D263	*152-061	Silicon	Tek Spec
			X8570-up
D278	*152-075	Germanium	Tek Spec
D288	*152-075	Germanium	Tek Spec
D337	152-071	Germanium	ED2007
D338	152-071	Germanium	ED2007
D345	*152-075	Germanium	Tek Spec
			101-6729X
			101-6729X
D355	*152-075	Germanium	Tek Spec
D365	152-071	Germanium	ED2007
D366	152-071	Germanium	ED2007
D378	152-024	Zener	15 v 1 w 5%
D397	152-057	Zener	56 v 1.5 w 5%
			101-4327X
			101-4327X

### Inductors

LR103	*108-283	.13 $\mu$ h		X6940-up
LR105	*108-286	.17 $\mu$ h		X6940-up
LR107	*108-283	.13 $\mu$ h		X6940-up
LR203	*108-283	.13 $\mu$ h		X6940-up
LR205	*108-286	.17 $\mu$ h		X6940-up
LR207	*108-283	.13 $\mu$ h		X6940-up
L315	*108-147	2.2 $\mu$ h		
L326	*108-253	7.8 $\mu$ h		
L336	*108-253	7.8 $\mu$ h		
L341	*108-147	2.2 $\mu$ h		
L344	*108-072	.75 $\mu$ h		101-4327X
L345	276-507	Core, Ferramic Suppressor		101-4327X
L351	*108-147	2.2 $\mu$ h		
L354	*108-072	.75 $\mu$ h		101-4327X
L355	276-507	Core, Ferramic Suppressor		101-4327X
L361	*114-151	35-50 $\mu$ h	Var. Core 276-511	
L363	*108-252	3.6 $\mu$ h		
L371	*114-151	35-50 $\mu$ h	Var. Core 276-511	
L373	*108-252	3.6 $\mu$ h		
L378	*108-200	40 $\mu$ h		
L396	*108-016	29 $\mu$ h		

### Resistors

Resistors are fixed, composition,  $\pm 10\%$  unless otherwise indicated.

R101	302-100	10 $\Omega$	$\frac{1}{2}$ w		
R103C	Use 322-643	600 k	$\frac{1}{4}$ w	Prec.	1%
R103E	Use 322-644	666.6 k	$\frac{1}{4}$ w	Prec.	1%
R105C	Use 322-620	800 k	$\frac{1}{4}$ w	Prec.	1%
R105E	Use 322-614	250 k	$\frac{1}{4}$ w	Prec.	1%

Resistors (Cont'd)

Ckt. No.	Tektronix Part No.		Description			S/N Range
R107C	Use 322-621	900 k	1/4 w	Prec.	1%	
R107E	Use 322-608	111 k	1/4 w	Prec.	1%	
R109A	315-101	100 Ω	1/4 w		5%	X6940-up
R109C	Use 322-624	990 k	1/4 w	Prec.	1%	
R109D	315-510	51 Ω	1/4 w		5%	X6940-up
R109E	Use 322-605	10.1 k	1/4 w	Prec.	1%	
R109F	316-150	15 Ω	1/4 w			
R110	315-100	10 Ω	1/4 w		5%	101-6939
R110	315-470	47 Ω	1/4 w		5%	6940-up
R111	Use 322-481	1 meg	1/4 w	Prec.	1%	
R113	315-105	1 meg	1/4 w		5%	
R114	316-101	100 Ω	1/4 w			
R115	302-221	220 Ω	1/2 w			
R116	301-392	3.9 k	1/2 w		5%	101-4327
R116	301-562	5.6 k	1/2 w		5%	4328-up
R119	311-321	2 x 500 k		Var.		DC BAL
R120	Use 316-335	3.3 meg	1/4 w			
R121	316-274	270 k	1/4 w			
R123	316-182	1.8 k	1/4 w			
R124	316-101	100 Ω	1/4 w			
R125	316-101	100 Ω	1/4 w			
R126	301-392	3.9 k	1/2 w		5%	101-4327
R126	301-562	5.6 k	1/2 w		5%	4328-up
R131	316-0103-00	10 k	1/4 w			X9300-up
R132	316-0472-00	4.7 k	1/4 w			X9300-up
R133	301-431	430 Ω	1/2 w		5%	
R134	315-391	390 Ω	1/4 w		5%	
R135	309-117	2.1 k	1/2 w	Prec.	1%	
R137	316-470	47 Ω	1/4 w			
R138	315-391	390 Ω	1/4 w		5%	
R139†	*311-319	375 Ω		Var.		VARIABLE
R142	309-028	1.48 k	1/2 w	Prec.	2%	
R143	301-431	430 Ω	1/2 w		5%	
R144	315-391	390 Ω	1/4 w		5%	
R145	309-117	2.1 k	1/2 w		1%	
R147	311-258	100 Ω		Var.		20 MV GAIN
R148	316-680	68 Ω	1/4 w			
R149	311-258	100 Ω		Var.		10 MV GAIN
R150	316-104	100 k	1/4 w			
R151	302-683	68 k	1/2 w			
R152	301-163	16 k	1/2 w		5%	
R153	311-114	2 x 250 k		Var.		POSITION
R154	302-683	68 k	1/2 w			
R164	315-622	6.2 k	1/4 w		5%	
R167	315-820	82 Ω	1/4 w		5%	
R170	316-221	220 Ω	1/4 w			
R171	311-159	20 k		Var.		TRIG. DC LEVEL

† R139 ganged with SW150. Furnished as a unit.

# Electrical Parts List—Type 3A1

## Resistors (Cont'd)

Ckt. No.	Tektronix Part No.		Description			S/N Range
R172	316-333	33 k	1/4 w			
R173	301-152	1.5 k	1/2 w		5%	
R174	315-622	6.2 k	1/4 w		5%	
R175	315-513	51 k	1/4 w		5%	
R176	316-332	3.3 k	1/4 w			
R184	301-332	3.3 k	1/2 w		5%	
R185	315-151	150 Ω	1/4 w		5%	
R187	316-473	47 k	1/4 w			
R188	316-105	1 meg	1/4 w			
R201	302-100	10 Ω	1/2 w			
R203C	Use 322-643	600 k	1/4 w	Prec.	1%	
R203E	Use 322-644	666.6 k	1/4 w	Prec.	1%	
R205C	Use 322-620	800 k	1/4 w	Prec.	1%	
R205E	Use 322-614	250 k	1/4 w	Prec.	1%	
R207C	Use 322-621	900 k	1/4 w	Prec.	1%	
R207E	Use 322-608	111 k	1/4 w	Prec.	1%	
R209A	315-101	100 Ω	1/4 w		5%	X6940-up
R209C	Use 322-624	990 k	1/4 w	Prec.	1%	
R209D	315-510	51 Ω	1/4 w		5%	X6940-up
R209E	Use 322-605	10.1 k	1/4 w	Prec.	1%	
R209F	316-150	15 Ω	1/4 w			
R210	315-100	10 Ω	1/4 w		5%	101-6939
R210	315-470	47 Ω	1/4 w		5%	6940-up
R211	Use 322-481	1 meg	1/4 w	Prec.	1%	
R213	315-105	1 meg	1/4 w		5%	
R214	316-101	100 Ω	1/4 w			
R215	302-221	220 Ω	1/2 w			
R216	301-392	3.9 k	1/2 w		5%	101-4327
	301-562	5.6 k	1/2 w		5%	4328-up
R219	311-321	2 x 500 k		Var.	DC BAL	
R220	Use 316-335	3.3 meg	1/4 w			
R221	316-274	270 k	1/4 w			
R223	316-182	1.8 k	1/4 w			
R224	316-101	100 Ω	1/4 w			
R225	316-101	100 Ω	1/4 w			
R226	301-392	3.9 k	1/2 w		5%	101-4327
R226	301-562	5.6 k	1/2 w		5%	4328-up
R231	316-0103-00	10 k	1/4 w			X9300-up
R232	316-0472-00	4.7 k	1/4 w			X9300-up
R233	301-431	430 Ω	1/2 w		5%	
R234	315-391	390 Ω	1/4 w		5%	
R235	309-117	2.1 k	1/2 w	Prec.	1%	
R237	316-470	47 Ω	1/4 w			
R238	315-391	390 Ω	1/4 w		5%	
R239†	*311-319	375 Ω		Var.	VARIABLE	
R242	309-028	1.48 k	1/2 w		2%	
R243	301-431	430 Ω	1/2 w		5%	

† R239 ganged with SW250. Furnished as a unit.

Resistors (Cont'd)

Ckt. No.	Tektronix Part No.		Description			S/N Range
R244	315-391	390 Ω	1/4 w			5%
R245	309-117	2.1 k	1/2 w		Prec.	1%
R247	311-258	100 Ω		Var.		20 MV GAIN
R248	316-680	68 Ω	1/4 w			
R249	311-258	100 Ω		Var.		10 MV GAIN
R250	316-104	100 k	1/4 w			
R251	302-683	68 k	1/2 w			
R252	301-163	16 k	1/2 w			5%
R253	311-114	2 x 250 k		Var.		POSITION
R254	302-683	68 k	1/2 w			
R260	316-222	2.2 k	1/4 w			101-7069
R260	316-102	1 k	1/4 w			7070-up
R262	302-153	15 k	1/2 w			101-8569
R262	Use 302-0123-00	12 k	1/2 w			8570-up
R263	302-470	47 Ω	1/2 w			
R265	301-223	22 k	1/2 w			5%
R266	301-183	18 k	1/2 w			5%
R268	316-101	100 Ω	1/4 w			
R271	302-103	10 k	1/2 w			
R273	301-202	2 k	1/2 w			5%
R275	301-202	2 k	1/2 w			5%
R276	309-121	9.5 k	1/2 w		Prec.	1%
R277	318-099	3 k	1/8 w		Prec.	1%
R278†	Use 309-407	400 Ω	1/2 w		Prec.	1/2%
R279	302-561	560 Ω	1/2 w			
R285	301-202	2 k	1/2 w			5%
R286	309-121	9.5 k	1/2 w		Prec.	1%
R287	318-099	3 k	1/8 w		Prec.	1%
R288†	Use 309-407	400 Ω	1/2 w		Prec.	1/2%
R289	302-561	560 Ω	1/2 w			
R291	302-100	10 Ω	1/2 w			
R292	315-152	1.5 k	1/4 w			5%
R293	309-274	1.4 k	1/2 w		Prec.	1%
R294	309-274	1.4 k	1/2 w		Prec.	1%
R304	309-097	600 Ω	1/2 w		Prec.	1%
R306	309-078	343 Ω	1/2 w		Prec.	1%
R307	309-273	866 Ω	1/2 w		Prec.	1%
R314	309-097	600 Ω	1/2 w		Prec.	1%
R315	301-120	12 Ω	1/2 w			5%
R322	301-511	510 Ω	1/2 w			5%
R323	315-751	750 Ω	1/4 w			5%
R325	316-470	47 Ω	1/4 w			
R326	309-158	1.19 k	1/2 w		Prec.	1%
R327	Use 302-681	680 Ω	1/2 w			
R328	311-323	1.5 k		Var.	WW	OUTPUT DC LEVEL
R329	303-203	20 k	1/2 w			5%
R333	315-751	750 Ω	1/4 w			5%

† S/N 101-1359, R278 and R288 have to be replaced at the same time.

**Electrical Parts List—Type 3A1**

**Resistors (Cont'd)**

Ckt. No.	Tektronix Part No.		Description			S/N Range
R335	316-470	47 Ω	1/4 w			
R336	309-158	1.19 k	1/2 w	Prec.	1%	
R337	316-101	100 Ω	1/4 w			
R339	303-203	20 k	1/2 w		5%	
R340	302-102	1 k	1/2 w			101-4327
R340	308-077	1 k	3 w	WW		4328-up
R341	316-470	47 Ω	1/4 w			
R346	316-470	47 Ω	1/4 w			X4328-up
R347	301-622	6.2 k	1/2 w		5%	
R351	316-470	47 Ω	1/4 w			
R356	316-470	47 Ω	1/4 w			X4328-up
R357	301-622	6.2 k	1/2 w		5%	
R360	308-089	1 k	10 w	WW	5%	101-4327
R360	308-289	820 Ω	10 w	WW	5%	4328-up
R361	*310-596	1.5 k	8 w	Prec.	1%	
R364	316-220	22 Ω	1/4 w			101-4327
R364	321-101	110 Ω	1/8 w	Prec.	1%	4328-up
R366	302-274	270 k	1/2 w			
R367	309-344	100 Ω	1/2 w	Prec.	1%	
R368	305-620	62 Ω	2 w		5%	X4328-up
R369	316-470	47 Ω	1/4 w			
R371	*310-596	1.5 k	8 w	Prec.	1%	
R374	311-308	50 Ω	2 w	Var.		101-4327
R374	311-383	150 Ω	2 w	Var.		4328-up
R376	302-274	270 k	1/2 w			
R377	309-344	100 Ω	1/2 w	Prec.	1%	
R378	308-232	320 Ω	5 w	WW	5%	101-4327
R378	308-251	256 Ω	5 w	WW	5%	4328-up
R381	309-055	370 k	1/2 w	Prec.	1%	101-4327
	323-441	383 k	1/2 w	Prec.	1%	4328-up
R382	309-243	193 k	1/2 w	Prec.	1%	101-4327
R382	323-412	191 k	1/2 w	Prec.	1%	4328-up
R384	316-101	100 Ω	1/4 w			
R385	316-471	470 Ω	1/4 w			
R387	302-473	47 k	1/2 w			
R389	306-123	12 k	2 w			
R390	316-101	100 Ω	1/4 w			
R391	316-471	470 Ω	1/4 w			
R392	302-473	47 k	1/2 w			
R393	306-102	1 k	2 w			X7930-up
R394	307-034	8.2 Ω	1/2 w			
R395	307-034	8.2 Ω	1/2 w			
R397	308-230	2.7 k	3 w	WW	5%	
R398	316-270	27 Ω	1/4 w			

**Switches**

	Unwired	Wired			
SW101	260-448		Slide		
SW110	260-441	Use *262-653	Rotary	VOLTS/DIV	101-6939
SW110	260-607	*262-653	Rotary		6940-up
SW150†	*311-319			CALIBRATED	
SW155††	260-442		Rotary	INV/NORM	

Switches (Cont'd)

Ckt. No.	Tektronix Part No.		Description	S/N Range
	Unwired	Wired		
SW201	260-448		Slide	
SW210	260-441	Use *262-653	Rotary	101-6939
SW210	260-607	*262-653	Rotary	6940-up
SW250†††	*311-319			CALIBRATED
SW290††	260-442		Rotary	MODE
SW390	260-212		Slide	TRIGGER
	260-447		Slide	TRIGGER
				101-5049
				5050-up

†SW150 ganged with R139. Furnished as a unit.

††SW155 and SW290 are concentric. Furnished as a unit.

†††SW250 ganged with R239. Furnished as a unit.

Transformers

T263	*120-281	Toroid 7T TD73
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Transistors

Q133	151-092	2N711A	
Q134	151-089	2N962	
Q143	151-092	2N711	
Q144	151-089	2N962	
Q164	151-076	2N2048	
Q173	151-089	2N962	
Q174	151-076	2N2048	
Q184	Use *151-103	Replaceable by 2N2219	
Q233	151-092	2N711A	
Q234	151-089	2N962	
Q243	151-092	2N711A	
Q244	151-089	2N962	
Q260	151-091	2N1226	101-7069
Q260	151-063	2N2207	7070-up
Q275	151-076	2N2048	
Q285	151-076	2N2048	
Q304	151-076	2N2048	
Q314	151-076	2N2048	
Q323	151-089	2N962	
Q333	151-089	2N962	
Q364	151-107	2N967	X4328-up
Q374	151-107	2N967	X4328-up

Electron Tubes

V113	Use *154-0306-02	7586, aged
V123	Use *154-0306-02	7586, aged
V213	Use *154-0306-02	7586, aged
V223	Use *154-0306-02	7586, aged
V334	154-187	6DJ8
V353	154-187	6DJ8
V364	154-361	8233/E55L
V374	154-361	8233/E55L
V383	154-187	6DJ8

## FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear on the pullout pages immediately following the Diagrams section of this instruction manual.

## 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.

*Assembly and/or Component*  
*Detail Part of Assembly and/or Component*  
*mounting hardware for Detail Part*  
*Parts of Detail Part*  
*mounting hardware for Parts of Detail Part*  
*mounting hardware for Assembly and/or Component*

Mounting hardware always appears 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.

**Mounting hardware must be purchased separately, unless otherwise specified.**

## 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 or model 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.

## ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.



**INDEX OF MECHANICAL PARTS LIST ILLUSTRATIONS**

FIG. 1      FRONT, SWITCHES & FRAME

FIG. 2      CHASSIS

# SECTION 9 MECHANICAL PARTS LIST

FIG. 1 FRONT, SWITCHES & FRAME

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q † y	1 2 3 4 5					Description
					1	2	3	4	5	
1-1	333-0704-00 333-0804-00	101 4328	4327	1						PANEL, front
				1						PANEL, front
-2	366-0148-00			2						KNOB, charcoal—POSITION (CH 1)
	- - - - -			-						knob includes:
	213-0004-00			1						SCREW, set, 6-32 x 3/16 inch, HSS
-3	- - - - -			1						RESISTOR, variable
	- - - - -			-						mounting hardware: (not included w/resistor)
-4	210-0012-00			1						LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-5	210-0840-00			1						WASHER, flat, 0.390 ID x 9/16 inch OD
-6	210-0413-00			1						NUT, hex., 3/8-32 x 1/2 inch
-7	- - - - -			2						RESISTOR, variable
	- - - - -			-						mounting hardware for each: (not included w/resistor)
	210-0011-00			1						LOCKWASHER, internal, 1/4 ID x 15/32 inch OD
	358-0075-00			1						BUSHING, 1/4-32 x 0.343 ID x 0.295 inch long
-8	366-0175-00 366-0250-00	101 3350	3349	1						KNOB, charcoal—MODE
	- - - - -			1						KNOB, charcoal—MODE
	- - - - -			-						knob includes:
	213-0004-00			1						SCREW, set, 6-32 x 3/16 inch, HSS
-9	366-0189-00	101	3349	1						KNOB, red—INV (CH 1) NORM
	- - - - -			-						knob includes:
	213-0020-00	101	3349	1						SCREW, set, 6-32 x 1/8 inch, HSS
	366-0140-00	3350		1						KNOB, red—INV (CH 1) NORM
	- - - - -			-						knob includes:
	213-0004-00	3350		1						SCREW, set, 6-32 x 3/16 inch, HSS
-10	260-0442-00			1						SWITCH, unwired—MODE
	- - - - -			-						mounting hardware: (not included w/switch)
-11	210-0012-00			1						LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-12	210-0840-00			1						WASHER, flat, 0.390 ID x 9/16 inch OD
-13	210-0413-00			1						NUT, hex., 3/8-32 x 1/2 inch
-14	366-0148-00			1						KNOB, charcoal—POSITION (CH 2)
	- - - - -			-						knob includes:
	213-0004-00			1						SCREW, set, 6-32 x 3/16 inch, HSS
-15	366-0109-00			1						KNOB, plug-in securing
	- - - - -			-						knob includes:
	213-0005-00			1						SCREW, set, 8-32 x 1/8 inch, HSS
-16	210-0894-00			1						WASHER, flat, 0.190 ID x 7/16 inch OD
-17	214-0052-00			1						FASTENER, pawl right, w/stop
	- - - - -			-						mounting hardware: (not included w/fastener)
-18	210-0004-00			2						LOCKWASHER, internal #4
-19	210-0406-00			2						NUT, hex., 4-40 x 3/16 inch

Mechanical Parts List—Type 3A1

FIG. 1 FRONT, SWITCHES & FRAME (Cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q † y	Description
1-20	129-0053-00			2	ASSEMBLY, binding post
	- - - - -			-	each assembly includes:
	355-0507-00			1	STEM, binding post adapter
	200-0103-00			1	CAP, binding post
	210-0011-00			1	LOCKWASHER, internal, 1/4 ID x 15/32 inch OD
	210-0455-00			1	NUT, hex., 1/4-28 x 3/8 inch
-21	260-0448-00			2	SWITCH, slide—AC DC GND (CH 1 & 2)
	- - - - -			-	mounting hardware for each: (not included w/switch)
	210-0004-00			2	LOCKWASHER, internal #4
	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
-22	352-0008-00	101	609	2	HOLDER, neon, single, black
	352-0053-00	610	10649	2	HOLDER, neon, single, black
	352-0067-00	10650		2	HOLDER, neon, single, gray
	- - - - -			-	mounting hardware for each: (not included w/holder)
-23	211-0031-00	101	10649	1	SCREW, 4-40 x 1 inch, 100° csk, FHS
	211-0109-00	10650		1	SCREW, 4-40 x 7/8 inch, 100° csk, FHS
	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
-24	131-0081-00	101	2019	2	CONNECTOR, 1 contact, UHF
	131-0126-00	2020		2	CONNECTOR, coaxial, 1 contact, BNC
-25	358-0178-00	101	10569	1	BUSHING, charcoal
	358-0216-00	10570		1	BUSHING, gray
-26	384-0246-00			1	ROD, extension, 1/4 inch diameter x 7 3/8 inches long
-27	376-0011-00			1	COUPLING, plastic
	- - - - -			-	coupling includes:
	213-0048-00			2	SCREW, set, 4-40 x 1/8 inch, HSS
-28	406-0814-00			1	BRACKET, resistor mounting
	- - - - -			-	mounting hardware: (not included w/bracket)
	211-0504-00			2	SCREW, 6-32 x 1/4 inch, PHS
-29	- - - - -			1	RESISTOR, variable
	- - - - -			-	mounting hardware: (not included w/resistor)
-30	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-31	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-32	384-0245-00	101	5049	1	ROD, extension, w/knob
	- - - - -			-	mounting hardware: (not included w/rod)
	210-0006-00	101	5049X	1	LOCKWASHER, internal #6
	210-0449-00	101	5049X	2	NUT, hex., 5-40 x 1/4 inch
	384-0304-00	5050		1	ROD, extension, w/knob
-33	406-0802-00	101	5049	1	BRACKET, slide switch actuator
	406-0918-00	5050		1	BRACKET, slide switch actuator
	214-0237-00	101	5049X	1	SPRING, slide switch
-34	406-0949-00	X5050		1	BRACKET, slide switch
-35	260-0212-00	101	5049	1	SWITCH, unwired—TRIGGER CH 1 ONLY
	- - - - -			-	mounting hardware: (not included w/switch)
	213-0105-00	101	5049	2	SCREW, shouldered, 6-32 x 2 1/4 inch

FIG. 1 FRONT, SWITCHES & FRAME (Cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q † y	Description				
					1	2	3	4	5
1-36	260-0447-00	5050		1	SWITCH, unwired—TRIGGER CH 1 ONLY				
	- - - - -			-	mounting hardware: (not included w/switch)				
	210-0406-00	5050		2	NUT, hex., 4-40 x 1/4 inch				
	210-0004-00	5050		2	LOCKWASHER, internal, #4				
-37	406-0800-00			1	BRACKET, slide switch				
	- - - - -			-	mounting hardware: (not included w/bracket)				
-38	211-0504-00			2	SCREW, 6-32 x 1/4 inch, PHS				
-39	210-0201-00			1	LUG, solder, SE #4				
	- - - - -			-	mounting hardware: (not included w/lug)				
	211-0029-00			1	SCREW, 5-40 x 3/16 inch, PHS				
-40	387-0660-00			1	PLATE, sub-panel front				
-41	366-0160-00			1	KNOB, charcoal—VOLTS/DIV (CH 1)				
	- - - - -			-	knob includes:				
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS				
-42	366-0031-00			1	KNOB, red—VARIABLE (CH 1)				
	- - - - -			-	knob includes:				
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS				
-43	262-0487-00	101	6939	1	SWITCH, wired—VOLTS/DIV (CH 1)				
	262-0653-00	6940		1	SWITCH, wired—VOLTS/DIV (CH 1)				
	- - - - -			-	switch includes:				
	260-0441-00	101	6939	1	SWITCH, unwired—VOLTS/DIV (CH 1)				
	260-0607-00	6940		1	SWITCH, unwired—VOLTS/DIV (CH 1)				
-44	406-0813-00	101	6939	1	ASSEMBLY				
	441-0564-00	6940		1	CHASSIS, attenuator				
	- - - - -			-	mounting hardware: (not included w/chassis)				
-45	210-0004-00			3	LOCKWASHER, internal, #4				
-46	210-0227-00	101	9898	1	LUG, solder, SE #6				
	210-0201-00	9899	10279X	1	LUG, solder, SE #4				
-47	210-0406-00			4	NUT, hex., 4-40 x 3/16 inch				
-48	211-0007-00			4	SCREW, 4-40 x 3/16 inch, PHS				
-49	337-0505-00	101	6939	1	SHIELD				
	337-0680-00	6940		1	SHIELD				
	- - - - -			-	mounting hardware: (not included w/shield)				
	211-0503-00	6940	8739X	2	SCREW, 6-32 x 3/16 inch, PHS				
-50	211-0008-00	X8740		1	SCREW, 4-40 x 1/4 inch, PHS				
-51	210-0004-00	X8740		2	LOCKWASHER, internal, #4				
-52	210-0586-00	X8740		2	NUT, keps, 4-40 x 1/4 inch				
-53	211-0007-00	X8740		1	SCREW, 4-40 x 3/16 inch, PHS				
-54	131-0182-00			1	CONNECTOR, terminal feed thru				
	- - - - -			-	mounting hardware: (not included w/connector)				
-55	358-0135-00			1	BUSHING, plastic				
-56	131-0344-00	X6940		8	CONNECTOR, bifurcated feed thru				
	- - - - -			-	mounting hardware for each: (not included w/connector)				
-57	358-0241-00	X6940		1	BUSHING, plastic				

Mechanical Parts List—Type 3A1

FIG. 1 FRONT, SWITCHES & FRAME (Cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q † y	Description
		Eff	Disc		
1-58	- - - - -			10	CAPACITOR, variable, air
-59	214-0456-00	X6940		-	mounting hardware for each: (not included w/capacitor)
				1	FASTENER, plastic press type
-60	- - - - -			1	RESISTOR, variable
				-	resistor includes:
-61	384-0296-00			1	ROD, extension
	213-0022-00			1	SCREW, set, 4-40 x 3/16 inch, HSS
				-	mounting hardware: (not included w/resistor)
-62	210-0004-00			2	LOCKWASHER, internal, #4
-63	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
				-	mounting hardware: (not included w/switch)
	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-64	366-0160-00			1	KNOB, charcoal—VOLTS/DIV (CH 2)
				-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-65	366-0031-00			1	KNOB, red—VARIABLE (CH 2)
				-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-66	262-0487-00	101	6939	1	SWITCH, wired—VOLTS/DIV (CH 2)
	262-0653-00	6940		1	SWITCH, wired—VOLTS/DIV (CH 2)
				-	switch includes:
	260-0441-00	101	6939	1	SWITCH, unwired—VOLTS/DIV (CH 2)
	260-0607-00	6940		1	SWITCH, unwired—VOLTS/DIV (CH 2)
-67	406-0813-00	101	6939	1	ASSEMBLY
	441-0564-00	6940		1	CHASSIS, attenuator
				-	mounting hardware: (not included w/chassis)
-68	210-0004-00			3	LOCKWASHER, internal, #4
-69	210-0227-00	101	9898	1	LUG, solder, SE #6
	210-0201-00	9899	10279X	1	LUG, solder, SE #4
-70	210-0406-00			4	NUT, hex., 4-40 x 3/16 inch
-71	211-0007-00			4	SCREW, 4-40 x 3/16 inch, PHS
-72	337-0505-00	101	6939	1	SHIELD
	337-0680-00	6940		1	SHIELD
				-	mounting hardware: (not included w/shield)
	211-0503-00	6940	8739X	2	SCREW, 6-32 x 3/16 inch
-73	211-0008-00	X8740		1	SCREW, 4-40 x 1/4 inch, PHS
-74	210-0004-00	X8740		2	LOCKWASHER, internal, #4
-75	210-0586-00	X8740		2	NUT, keps, 4-40 x 1/4 inch
-76	211-0007-00	X8740		1	SCREW, 4-40 x 3/16 inch, PHS
-77	131-0182-00			1	CONNECTOR, terminal feed thru
				-	mounting hardware: (not included w/connector)
-78	358-0135-00			1	BUSHING, plastic
-79	131-0344-00	X6940		8	CONNECTOR, bifurcated feed thru
				-	mounting hardware for each: (not included w/connector)
-80	358-0241-00	X6940		1	BUSHING, plastic

FIG. 1 FRONT, SWITCHES &amp; FRAME (Cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q					Description	
				t	y	1	2	3		4
1-81	- - - - -			10						CAPACITOR, variable, air
	- - - - -			-						mounting hardware for each: (not included w/capacitor)
-82	214-0456-00	X6940		1						FASTENER, plastic press type
-83	- - - - -			1						RESISTOR, variable
	- - - - -			-						resistor includes:
-84	384-0296-00			1						ROD, extension
	213-0022-00			1						SCREW, set 4-40 x 3/16 inch, HSS
	- - - - -			-						mounting hardware: (not included w/resistor)
-85	210-0004-00			2						LOCKWASHER, internal #4
-86	210-0406-00			2						NUT, hex., 4-40 x 3/16 inch
	- - - - -			-						mounting hardware: (not included w/switch)
	210-0012-00			1						LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	210-0413-00			1						NUT, hex., 3/8-32 x 1/2 inch
-87	337-0506-00			1						SHIELD, bottom box, 7/16 x 3/4 x 2 1/2 inches
	- - - - -			-						mounting hardware: (not included w/shield)
-88	211-0503-00			2						SCREW, 6-32 x 3/16 inch, PHS
-89	337-0507-00			1						SHIELD, top box, 7/16 x 23/32 x 3 5/8 inches
	- - - - -			-						mounting hardware: (not included w/shield)
-90	211-0503-00			2						SCREW, 6-32 x 3/16 inch, PHS
-91	337-0508-00	101	6939	1						SHIELD, top, attenuator switch
	337-0675-00	6940		1						SHIELD, top, attenuator switch
	- - - - -			-						mounting hardware: (not included w/shield)
-92	211-0504-00			2						SCREW, 6-32 x 1/4 inch, PHS
-93	406-0845-00			1						BRACKET, shield mounting
-94	337-0510-00			1						SHIELD, double, middle, attenuator switch
	- - - - -			-						mounting hardware: (not included w/shield)
	211-0504-00			2						SCREW, 6-32 x 1/4 inch, PHS
-95	337-0509-00	101	6939	1						SHIELD, bottom, attenuator switch
	337-0676-00	6940		1						SHIELD, bottom, attenuator switch
	- - - - -			-						mounting hardware: (not included w/shield)
-96	211-0504-00			2						SCREW, 6-32 x 1/4 inch, PHS
-97	406-0845-00			1						BRACKET, shield mounting

Mechanical Parts List—Type 3A1

FIG. 1 FRONT, SWITCHES & FRAME (Cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description	
				t	y	1	2	3		4
1-98	384-0566-00	101	4309	4						ROD, frame spacing
	384-0615-00	4310		4						ROD, frame spacing
	- - - - -			-						mounting hardware for each: (not included w/rod)
-99	212-0044-00			1						SCREW, 8-32 x 1/2 inch, RHS
-100	387-0647-00			1						PLATE, rear
-100	351-0037-00			1						GUIDE, plug-in, 5/8 x 1 3/16 inch
	- - - - -			-						mounting hardware: (not included w/guide)
-102	211-0013-00			1						SCREW, 4-40 x 3/8 inch, RHS
	210-0004-00			1						LOCKWASHER, internal #4
	210-0406-00			1						NUT, hex., 4-40 x 3/16 inch
-103	214-0276-00			2						SPRING, ground, 29/64 x 1/2 x 1 1/6 inches
	- - - - -			-						mounting hardware for each: (not included w/spring)
-104	211-0504-00			1						SCREW, 6-32 x 1/4 inch, PHS
-105	210-0006-00			1						LOCKWASHER, internal #6
-106	210-0407-00			1						NUT, hex., 6-32 x 1/4 inch
-107	131-0149-00			1						CONNECTOR, 24 contact, male
	- - - - -			-						mounting hardware: (not included w/connector)
-108	211-0008-00			2						SCREW, 4-40 x 1/4 inch, PHS
-109	210-0201-00			2						LUG, solder, SE #4
-110	210-0406-00			2						NUT, hex., 4-40 x 3/16 inch
-111	378-0541-00	X10650		2						FILTER, lens, neon

Mechanical Parts List—Type 3A1

FIG. 2 CHASSIS

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q † y	1 2 3 4 5					Description
					1	2	3	4	5	
2-1	441-0436-00	101	4327	1						CHASSIS
	441-0537-00	4328		1						CHASSIS
	- - - - -			-						mounting hardware: (not included w/chassis)
	211-0504-00			2						SCREW, 6-32 x 1/4 inch, PHS
	211-0538-00			3						SCREW, 6-32 x 5/16 inch, 100° csk, FHS
-2	136-0101-00			4						SOCKET, nuvistor, 5 pin
	- - - - -			-						mounting hardware for each: (not included w/socket)
	213-0055-00			2						SCREW, thread forming, 2-32 x 3/16 inch, PHS
-3	136-0095-00	X4328	6519	2						SOCKET, transistor, 4 pin
	- - - - -			-						mounting hardware for each: (not included w/socket)
	213-0113-00	X4328	6519	2						SCREW, thread forming, 2-32 x 5/16 inch, RHS
	136-0181-00	6520		2						SOCKET, transistor, 3 pin
	- - - - -			-						mounting hardware for each: (not included w/socket)
	354-0234-00	6520		1						RING, transistor mounting
-4	136-0095-00	101	6519	18						SOCKET, transistor, 4 pin
	- - - - -			-						mounting hardware for each: (not included w/socket)
	213-0113-00	101	6519	2						SCREW, thread forming, 2-32 x 5/16 inch, RHS
	136-0181-00	6520		18						SOCKET, transistor, 3 pin
	- - - - -			-						mounting hardware for each: (not included w/socket)
-5	354-0234-00	6520		1						RING, transistor mounting
-6	136-0095-00	101	6519	1						SOCKET, transistor, 4 pin
	- - - - -			-						mounting hardware: (not included w/socket)
	213-0113-00	101	6519	2						SCREW, thread forming, 2-32 x 5/16 inch, RHS
	136-0181-00	6520	7279	1						SOCKET, transistor, 3 pin
	136-0182-00	7280		1						SOCKET, transistor, 4 pin
	- - - - -			-						mounting hardware: (not included w/socket)
	354-0234-00			1						RING, transistor mounting
-7	210-0201-00			6						LUG, solder SE #4
	- - - - -			-						mounting hardware for each: (not included w/lug)
-8	213-0044-00			1						SCREW, thread forming, 5-32 x 3/16 inch, PHS
-9	131-0183-00			2						CONNECTOR, terminal feed thru
-10	348-0004-00			3						GROMMET, rubber, 3/8 inch
-11	- - - - -			4						RESISTOR, variable
	- - - - -			-						mounting hardware for each: (not included w/resistor)
-12	210-0011-00			1						LOCKWASHER, internal, 1/4 ID x 15/32 inch OD
-13	210-0583-00			1						NUT, hex., 1/4-32 x 5/16 inch
-14	- - - - -			2						RESISTOR, variable

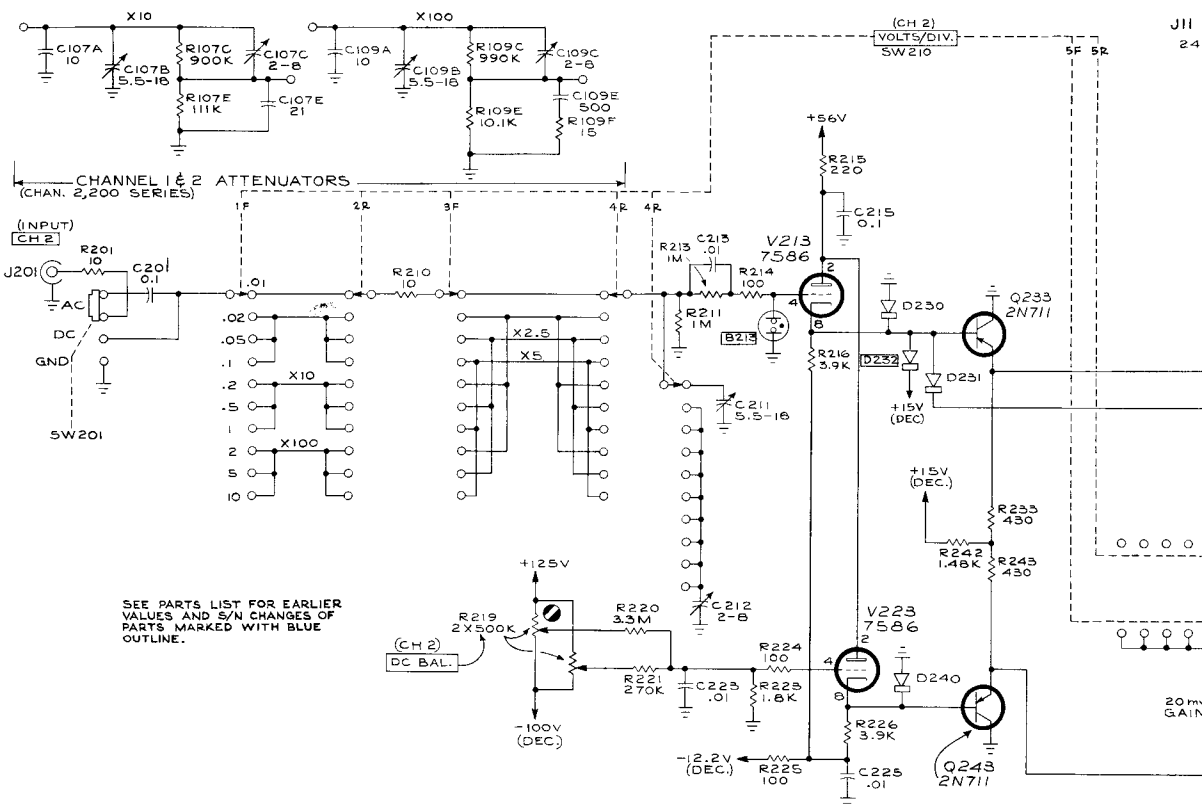
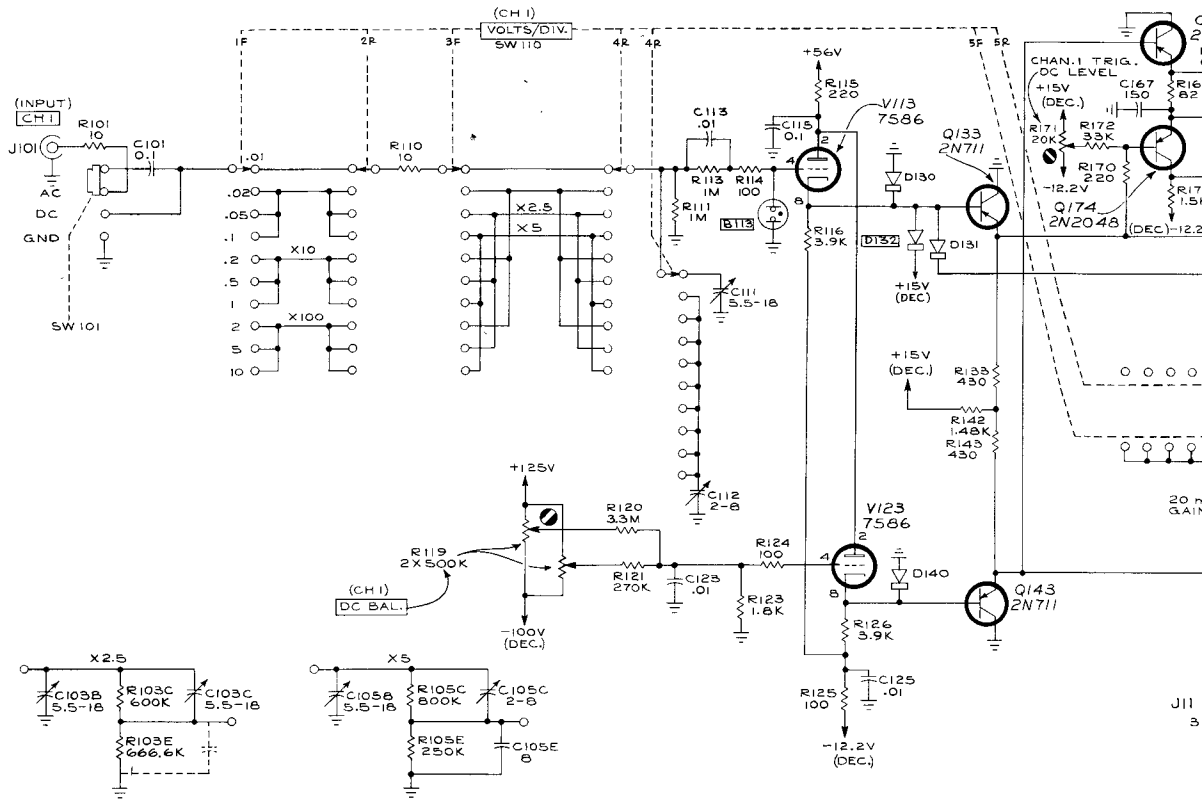


FIG. 2 CHASSIS (Cont)

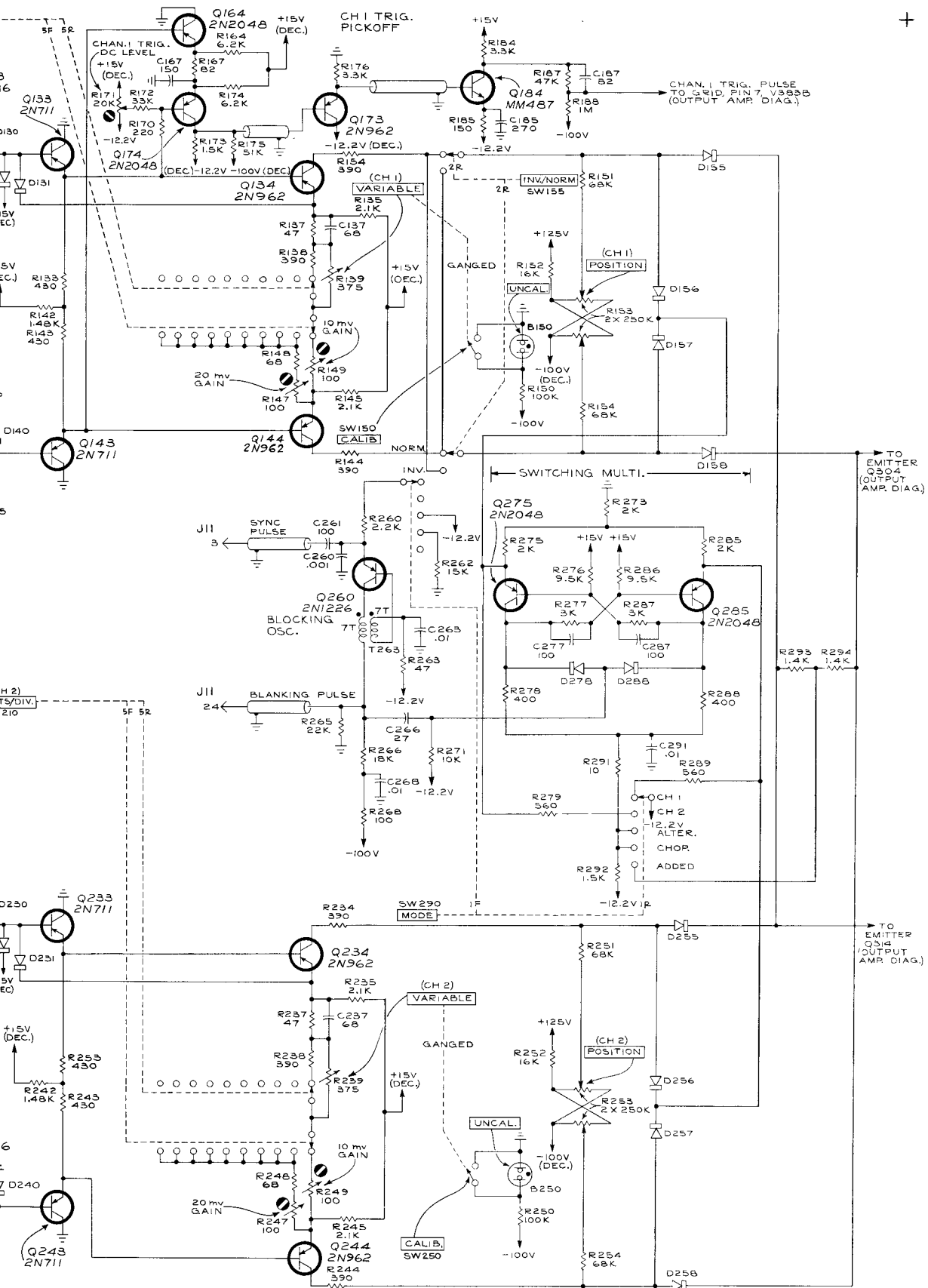
Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q t y	Description				
					1	2	3	4	5
2-17	131-0235-00			1	CONNECTOR, terminal				
-18	210-0259-00			3	LUG, solder, #2				
	- - - - -			-	mounting hardware for each: (not included w/lug)				
-19	213-0055-00			1	SCREW, thread forming, 2-32 x 3/16 inch, PHS				
-20	348-0003-00			1	GROMMET, rubber, 5/16 inch diameter				
-21	348-0003-00	101	4327	1	GROMMET, rubber, 5/16 inch diameter				
	348-0031-00	4328		2	GROMMET, plastic, 5/32 inch diameter				
-22	426-0121-00			1	MOUNT, plastic, toroid holder				
	- - - - -			-	mounting hardware: (not included w/mount)				
-23	361-0007-00			1	SPACER, plastic, 0.188 inch long				
-24	136-0015-00			4	SOCKET, tube, 9 pin, w/ground lugs				
	- - - - -			-	mounting hardware for each: (not included w/socket)				
-25	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS				
-26	136-0126-00	101	2749	2	SOCKET, tube, 9 pin, oversize contacts				
	136-0174-00	2750		2	SOCKET, tube, 9 pin				
	- - - - -			-	mounting hardware for each: (not included w/socket)				
-27	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS				
-28	- - - - -			1	RESISTOR				
	- - - - -			-	mounting hardware: (not included w/resistor)				
	211-0553-00			1	SCREW, 6-32 x 1 1/2 inches, RHS				
	210-0601-00			1	EYELET, 0.190 ID x 0.323 inch OD				
-29	210-0478-00			1	NUT, hex., 5/16 x 2 1/32 inch long				
-30	210-0204-00			1	LUG, solder, DE #6				
-31	211-0507-00			1	SCREW, 6-32 x 5/16 inch, PHS				
-32	- - - - -			1	RESISTOR				
	- - - - -			-	mounting hardware: (not included w/resistor)				
-33	211-0544-00			1	SCREW, 6-32 x 3/4 inch, THS				
-34	210-0478-00			1	NUT, hex., 5/16 x 2 1/32 inch long				
-35	211-0507-00			1	SCREW, 6-32 x 5/16 inch, PHS				

FIG. 2 CHASSIS (Cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q † y	Description
		Eff	Disc		
2-36	- - - - -			4	COIL
-37	213-0088-00			1	SCREW, thread forming, 4-40 x 1/4 inch, PHS
-38	- - - - -			2	COIL
-39	213-0054-00			1	SCREW, thread forming, 6-32 x 5/16 inch, PHS
-40	179-0643-00			1	CABLE HARNESS, chassis
-41	124-0146-00			12	STRIP, ceramic 7/16 inch h, w/16 notches
	- - - - -				each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - -				mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 0.406 inch long
-42	124-0147-00			2	STRIP, ceramic 7/16 inch h, w/13 notches
	- - - - -				each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - -				mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 0.406 inch long
-43	124-0145-00			2	STRIP, ceramic 7/16 inch h, w/20 notches
	- - - - -				each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - -				mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 0.406 inch long
-44	124-0148-00			2	STRIP, ceramic 7/16 inch h, w/9 notches
	- - - - -				each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - -				mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 0.406 inch long
-45	124-0086-00			1	STRIP, ceramic 3/4 inch h, w/2 notches
	- - - - -				strip includes:
	355-0046-00			1	STUD, plastic
	- - - - -				mounting hardware: (not included w/strip)
	361-0009-00			1	SPACER, plastic, 0.406 inch long
-46	124-0118-00			1	STRIP, ceramic 7/16 inch h, w/1 notch
	- - - - -				strip includes:
	355-0046-00			1	STUD, plastic
	- - - - -				mounting hardware: (not included w/strip)
	361-0007-00			1	SPACER, plastic, 0.188 inch long
<b>STANDARD ACCESSORIES</b>					
	070-0343-01			2	MANUAL, instruction (not shown)

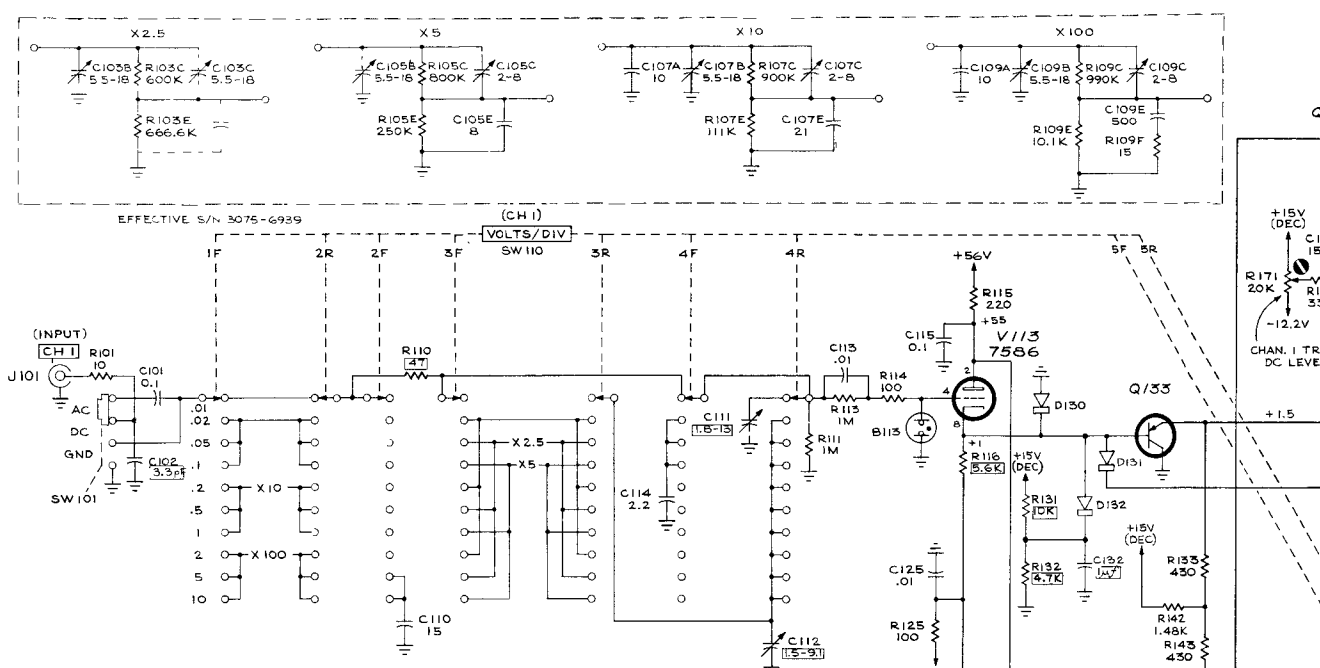


TYPE 3A1 PLUG-IN

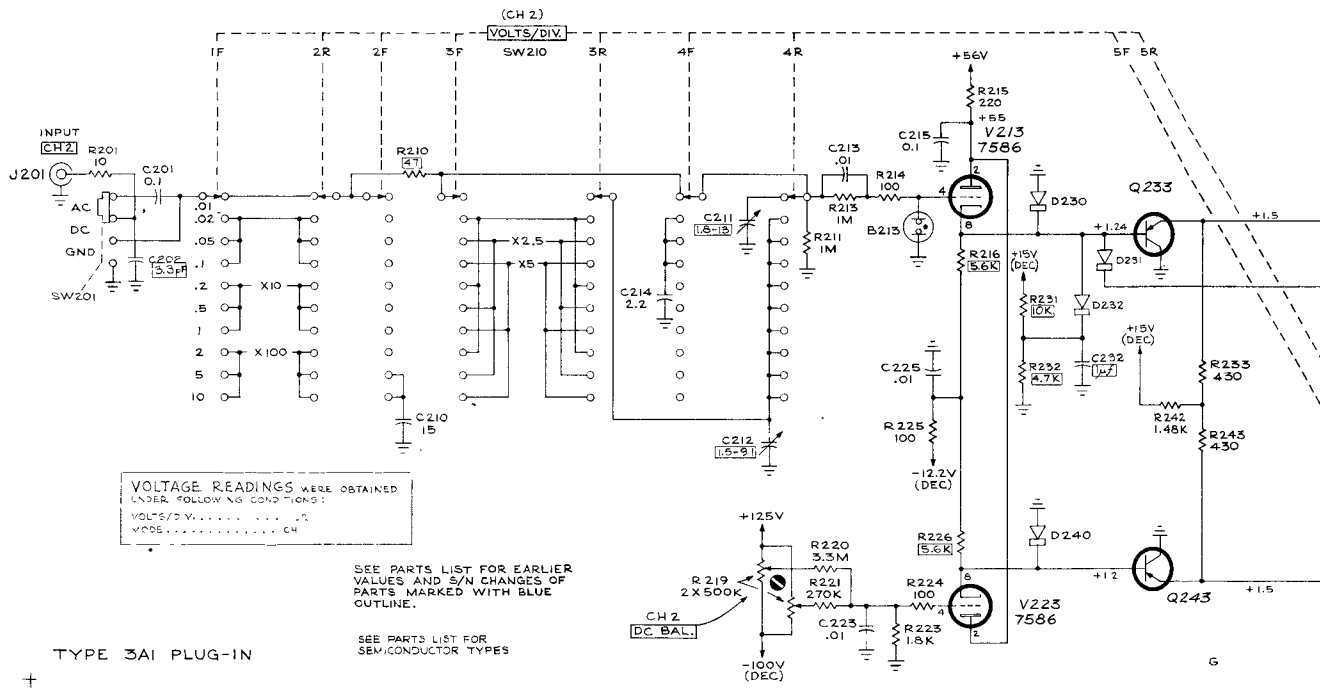
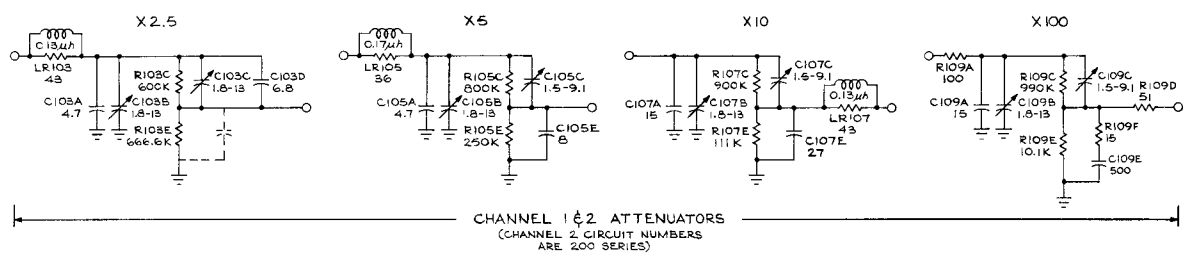


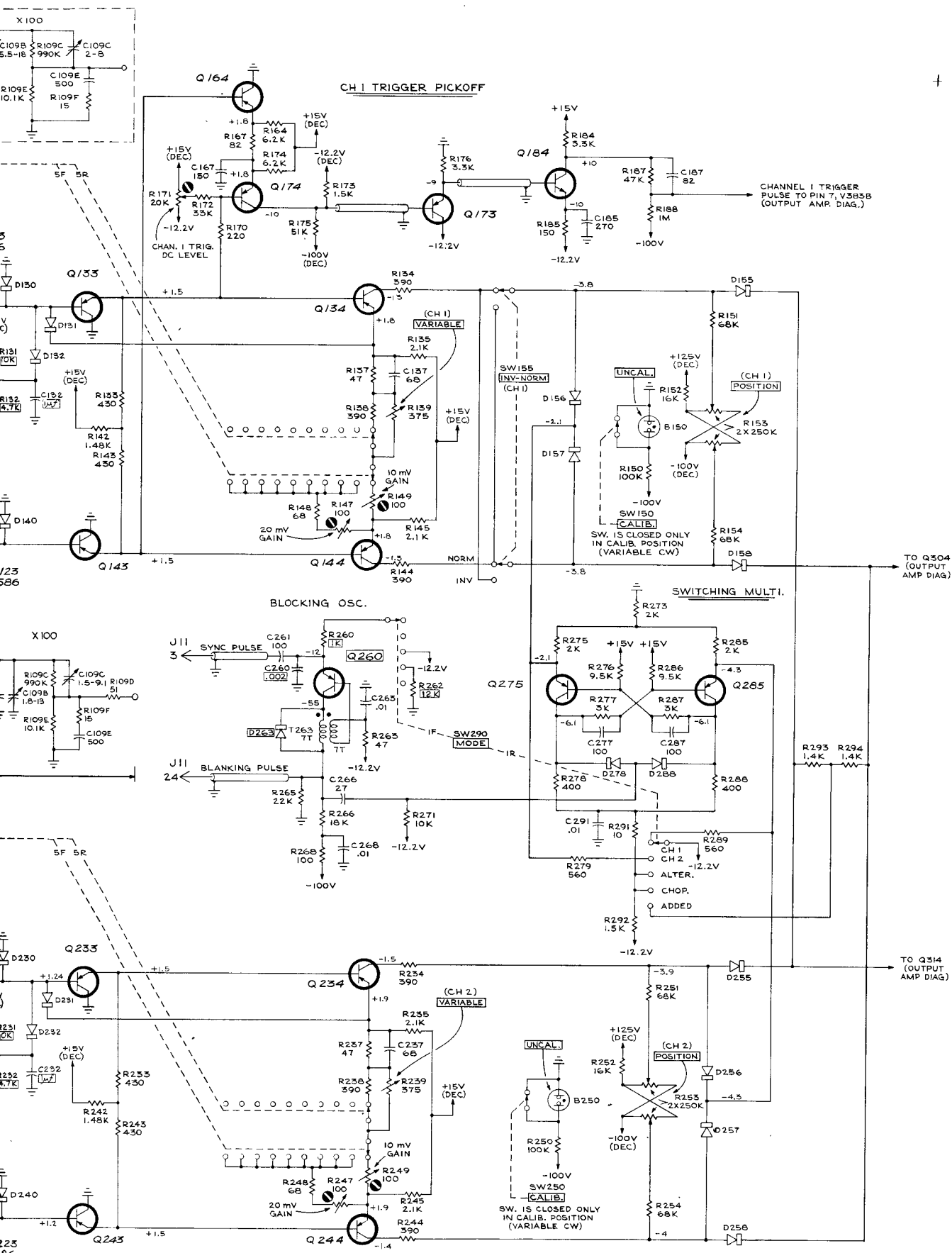
S/N 101 - 3074  
 INPUT AMPLIFIER & SWITCHING CIRCUIT PLV  
 1163

CIRCUIT NUMBERS  
 100 THRU 299



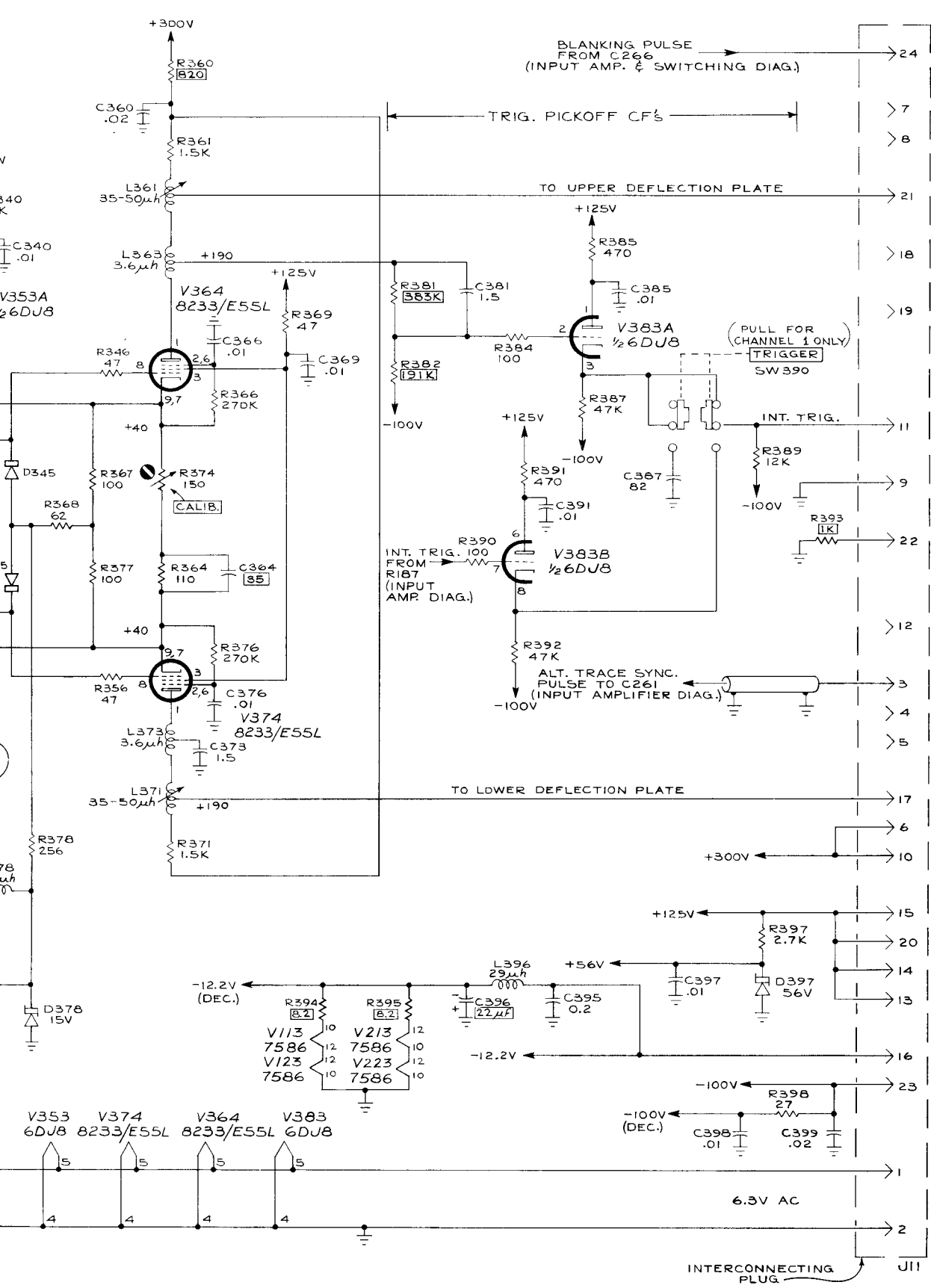
**IMPORTANT:**  
 ALL CIRCUIT VOLTAGES WERE OBTAINED WITH A 20,000Ω/V VOM. ALL READINGS ARE IN VOLTS.  
 VOLTAGE AMPLITUDE MEASUREMENTS, AS SHOWN, ARE NOT ABSOLUTE. THEY MAY VARY BETWEEN INSTRUMENTS AS WELL AS WITHIN THE INSTRUMENT ITSELF DUE TO NORMAL MANUFACTURING TOLERANCES, AND TRANSISTOR AND VACUUM TUBE CHARACTERISTICS.





S/N 3075-UP  
 INPUT AMPLIFIER & SWITCHING CIRCUIT  
 DON 266  
 CIRCUIT NUMBERS 100 THRU 299



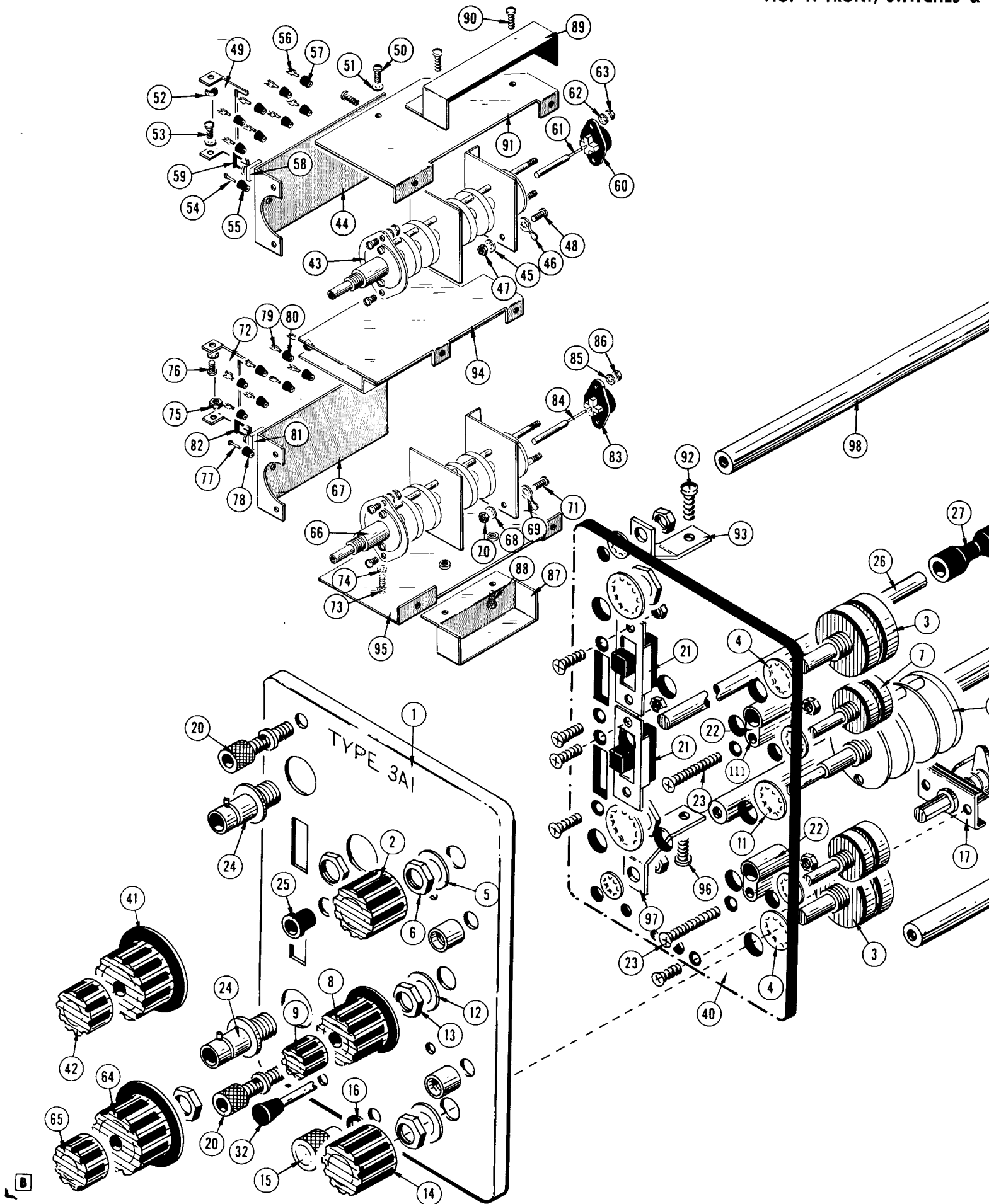


766  
PLM  
OUTPUT AMPLIFIER

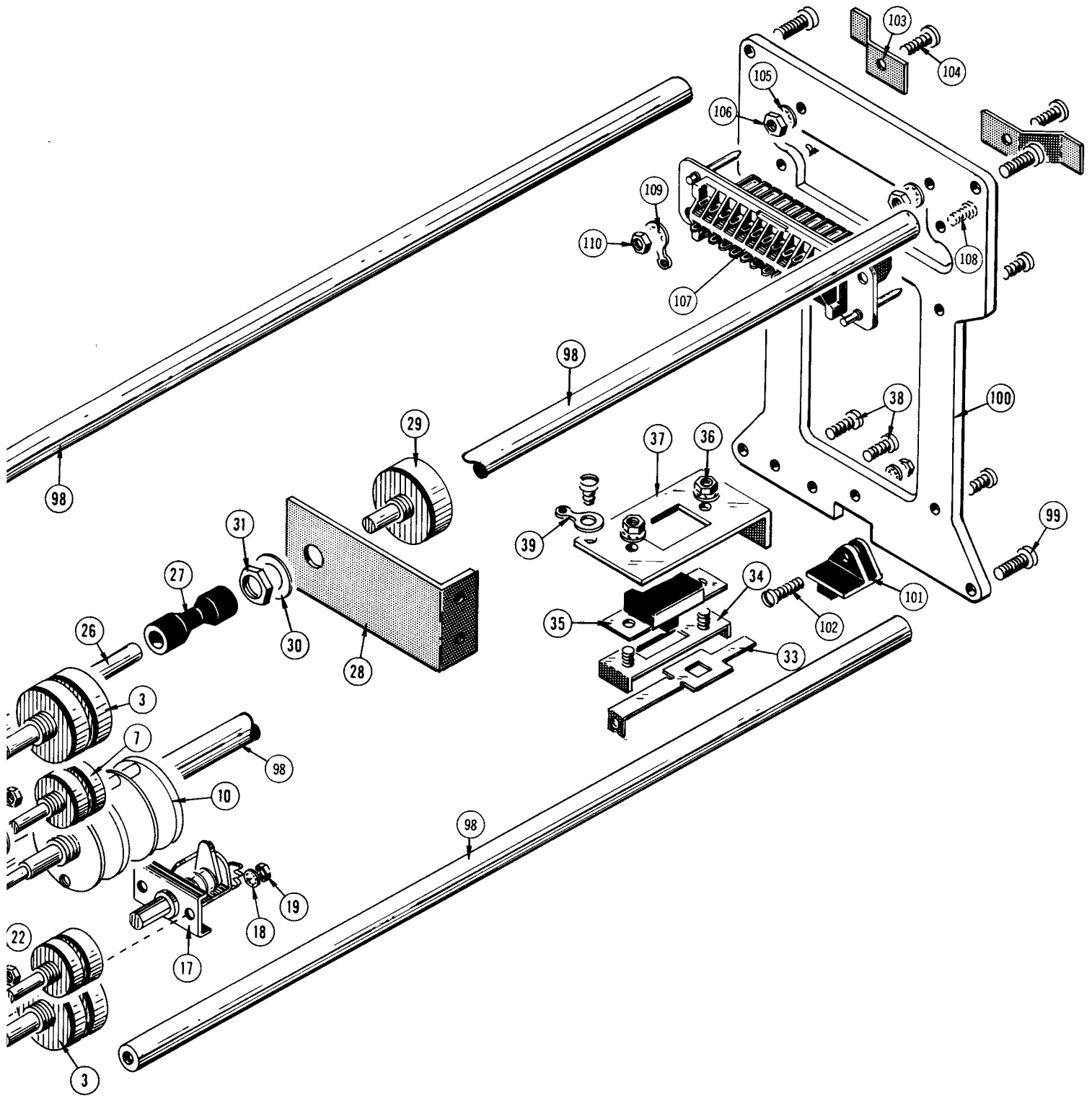
CIRCUIT NUMBERS  
300 THRU 399



FIG. 1. FRONT, SWITCHES &



. FRONT, SWITCHES & FRAME



TYPE 3A1 DUAL-TRACE AMPLIFIER PLUG-IN UNIT

FIG. 2. CHASSIS

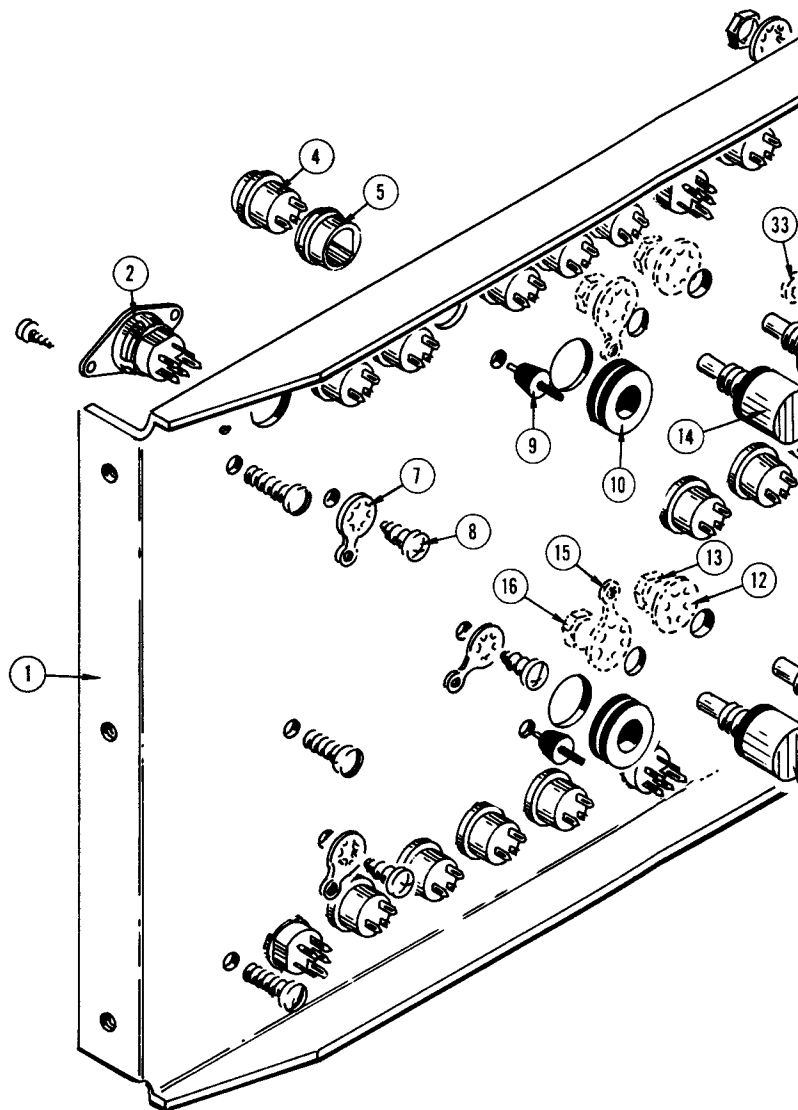
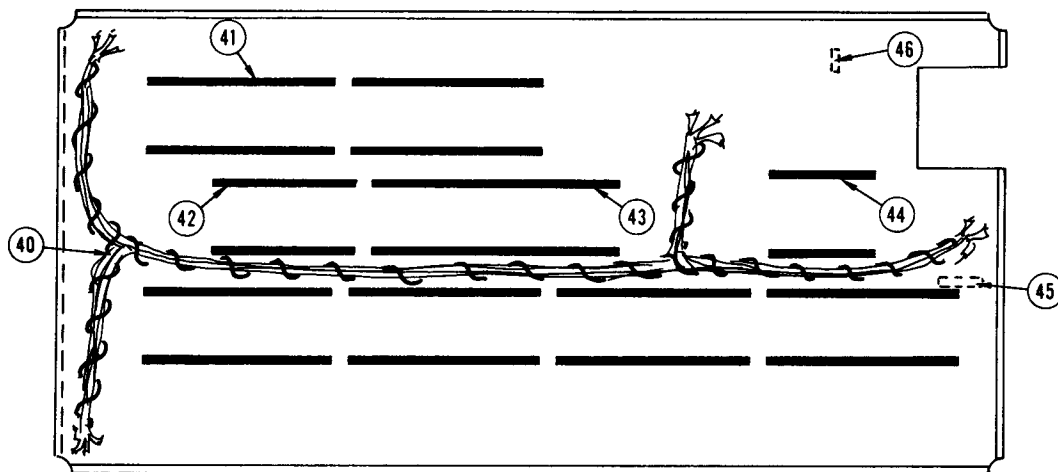
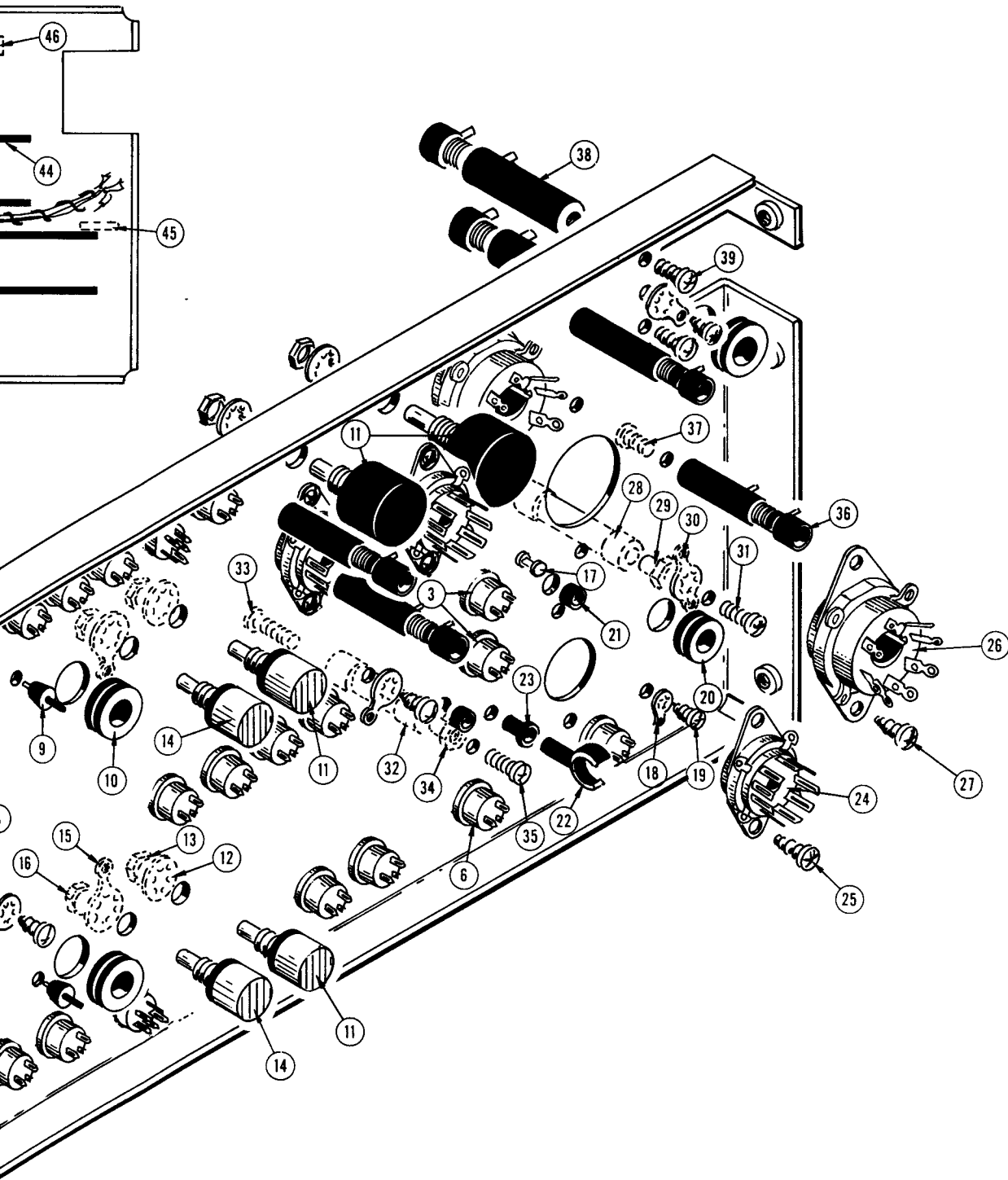


FIG. 2. CHASSIS



TYPE 3A1 DUAL-TRACE AMPLIFIER PLUG-IN UNIT