INSTRUCTION MANUAL

TYPE 3A1

DUAL-TRACE AMPLIFIER

MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

INSTRUCTION MANUAL

Serial Number _____

TYPE 3A1

DUAL-TRACE AMPLIFIER

Tektronix, Inc.
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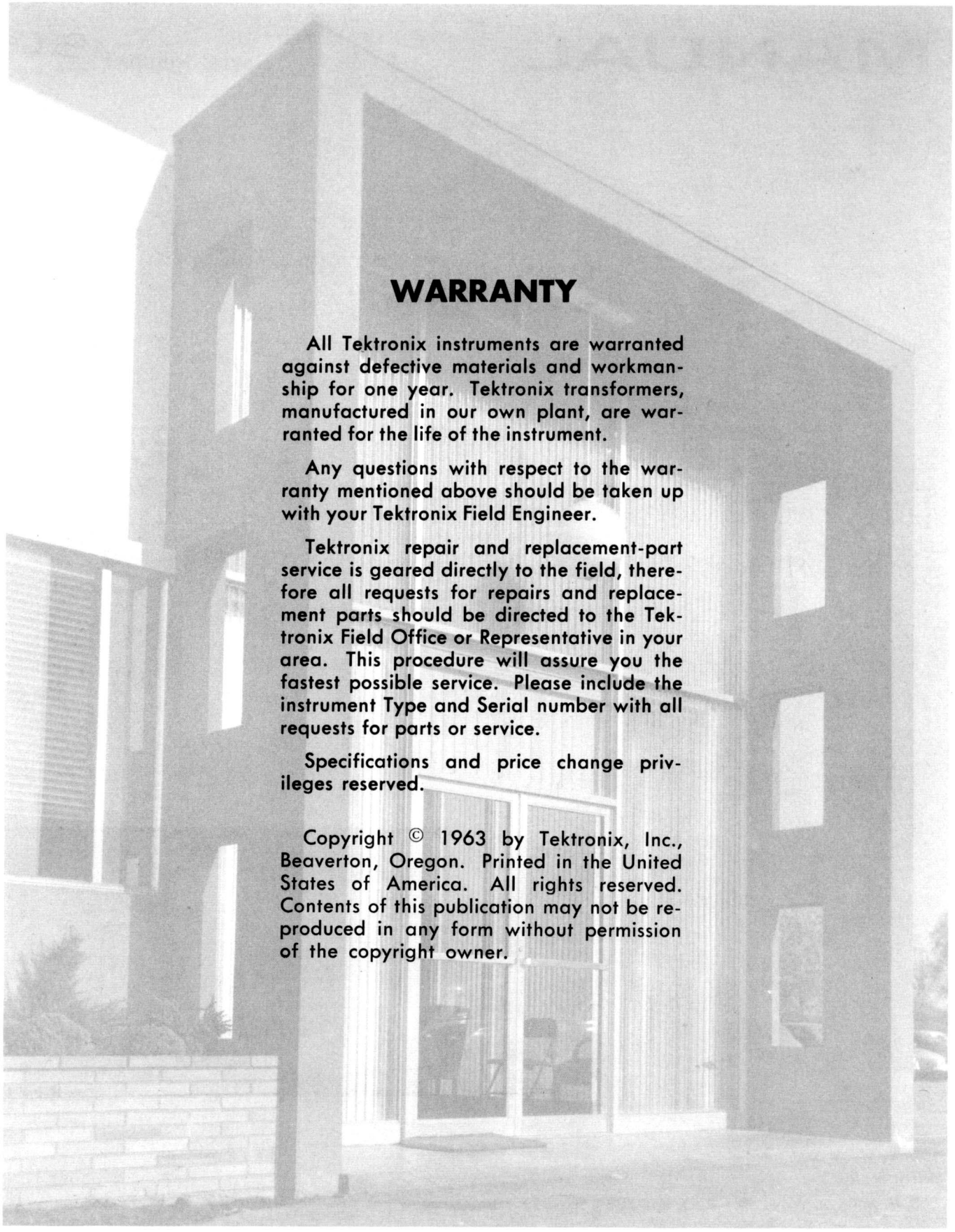

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All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

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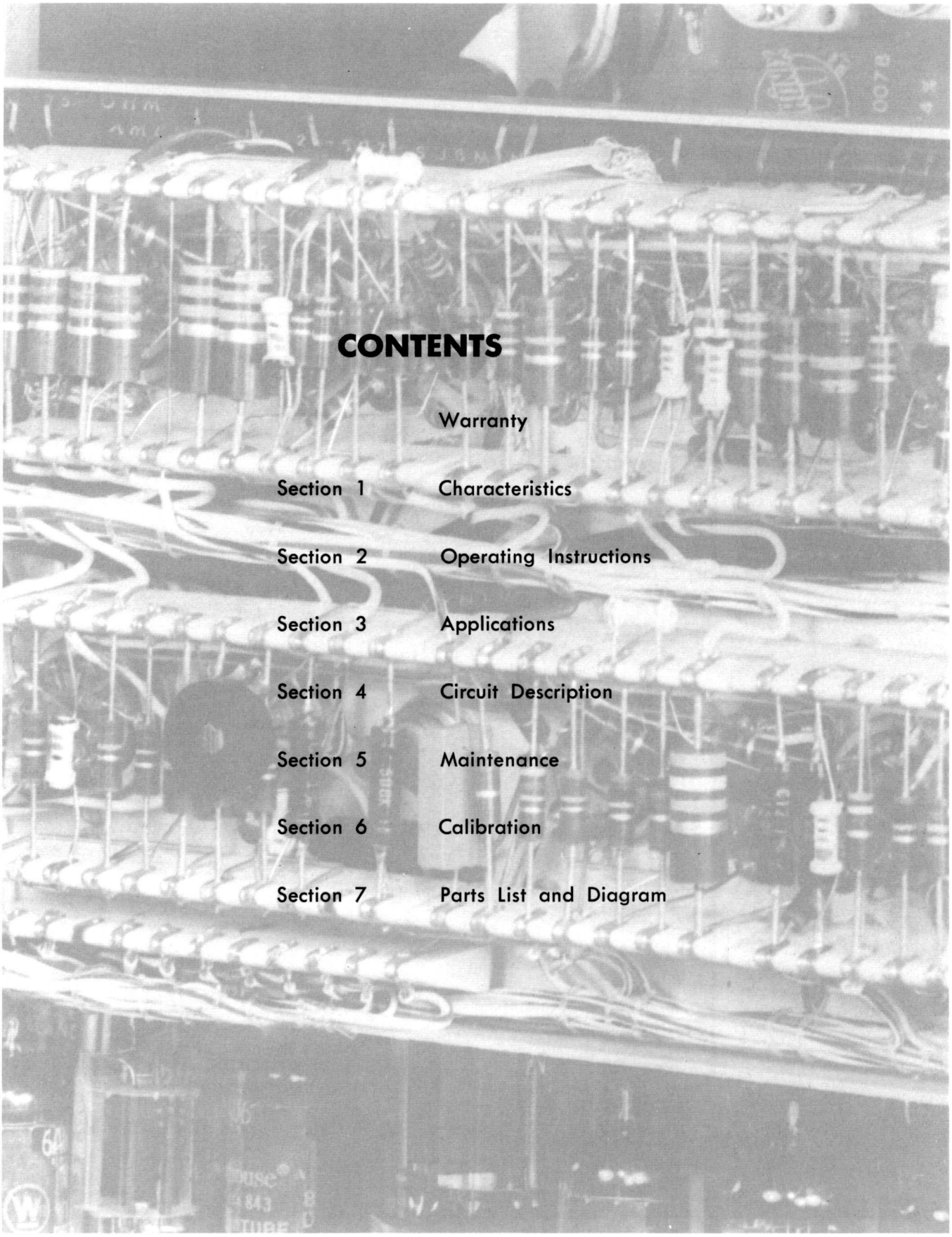

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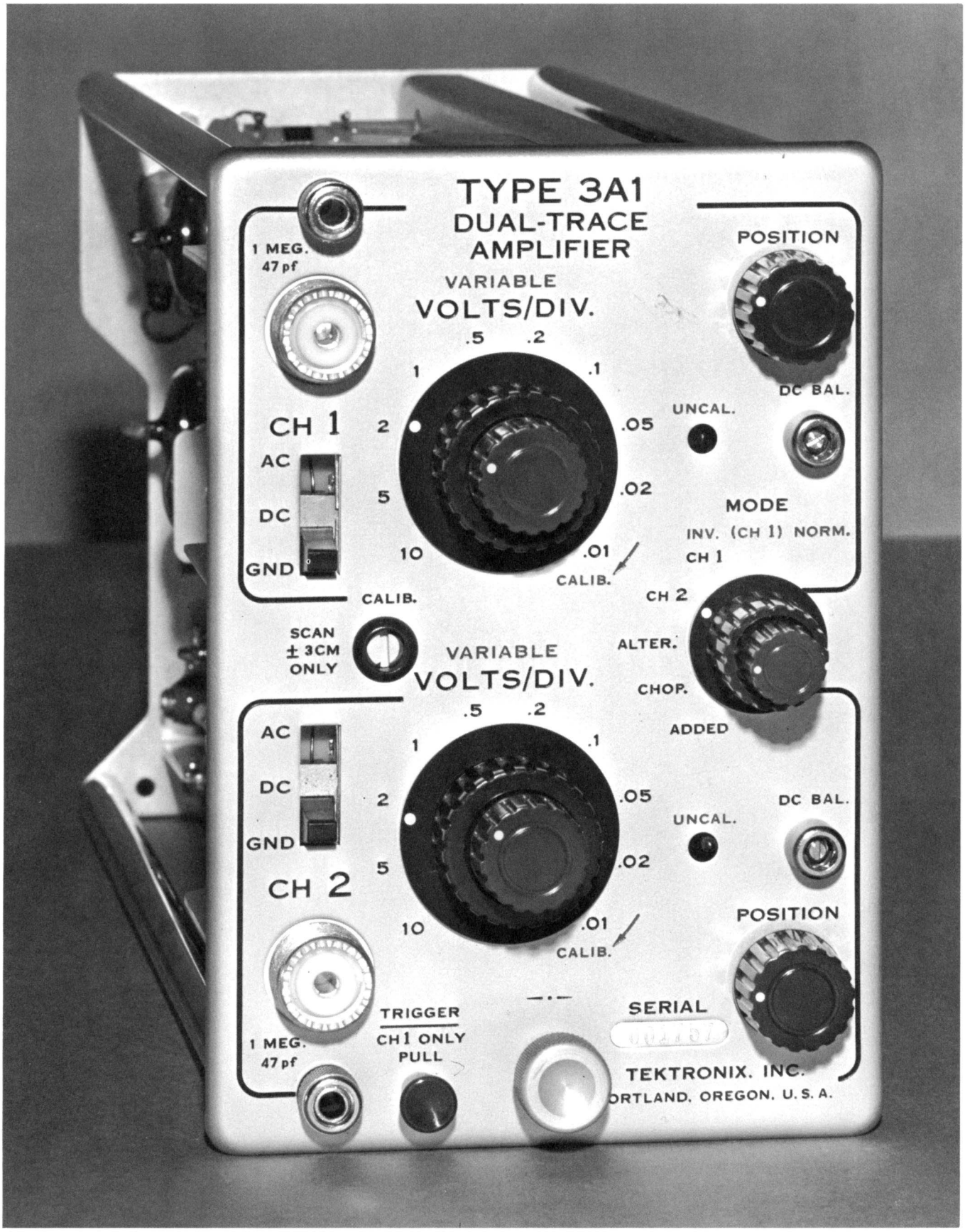

TYPE 3A1
DUAL-TRACE
AMPLIFIER
1 MEG.
47 pf
VARIABLE
VOLTS/DIV.
.5
.2
1
.1
2
.05
5
.02
10
.01
CALIB.
POSITION
DC BAL.
UNCAL.
CH 1
AC
DC
GND
MODE
INV. (CH 1) NORM.
CH 1
CH 2
ALTER.
CHOP.
ADDED
CALIB.
SCAN
± 3CM
ONLY
VARIABLE
VOLTS/DIV.
AC
DC
GND
CH 2
UNCAL.
DC BAL.
POSITION
1 MEG.
47 pf
TRIGGER
CH1 ONLY
PULL
SERIAL
TEKTRONIX, INC.
ORTLAND, OREGON, U.S.A.

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

Sensitivity

Each channel has ten sensitivities from 0.01 volts/div to 10 volts/div. in a 1, 2, 5 sequence. Accuracy is ±3% of indicated sensitivity. 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 sensitivity. A warning indicator lights when the variable attenuator is not in the calibrated position.

Frequency Response

Dc to 10 mc

Risetime

35 nanoseconds

Input Impedance

1 megohm, paralleled by 47 pf (10-12 farads)

Input Coupling

Ac or dc coupling of signals may be selected for either channel. A 0.1 μf capacitor limits low-frequency response to about 2 cps 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 200 kc, with a 5 μsec 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

Finish: Photo-etched anodized front panel

Weight: Approx. 5 pounds

NOTES

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 particiularly 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 affect the operation of the device under test or distort the signal.

***To make it easier to connect test leads to the unit, adapters such as a single binding post fitted with a UHF plug (Tektronix Part No. 013-004) are available as optional accessories. These items can be ordered through your local Tektronix Field Office.**

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	.2
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/cm and the triggering controls for a stable 5-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

ALTER. position. Set the time-base plug-in for 5 μsec/div. The individual chopped portions of the waveform will be seen. Set both Type 3A1 VOLTS/DIV. controls to .5.

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 cps (about 0.2 cps 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 200 KC rate with 5 μsec 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 2 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.

NOTES

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 externally 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°.

NOTES

SECTION 4

CIRCUIT DESCRIPTION

General

Th Type 3A1 Dual-Trace Amplifier contains two identical input channels, a common output amplifier, a switching circuit, 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 paralled 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 preceeded by the X10 or

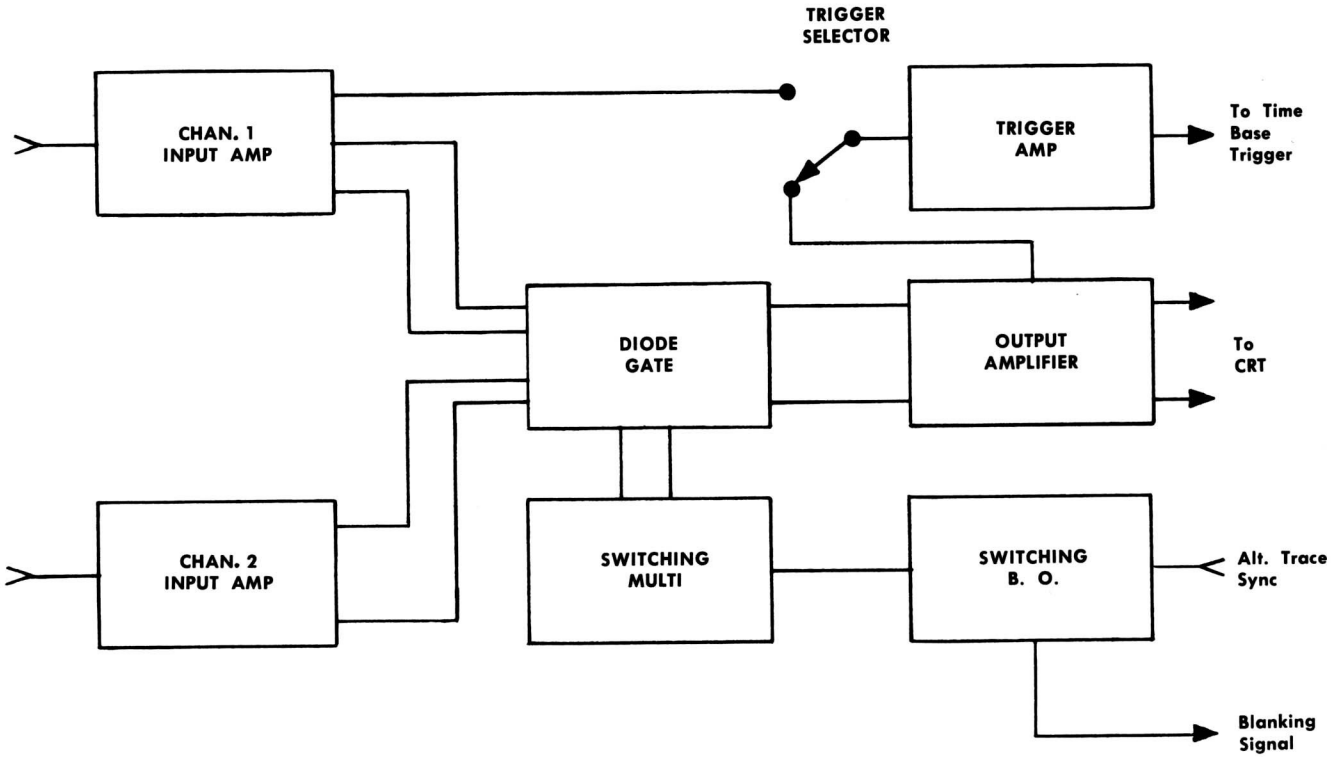


Fig. 4-1. Type 3A1 Block Diagram

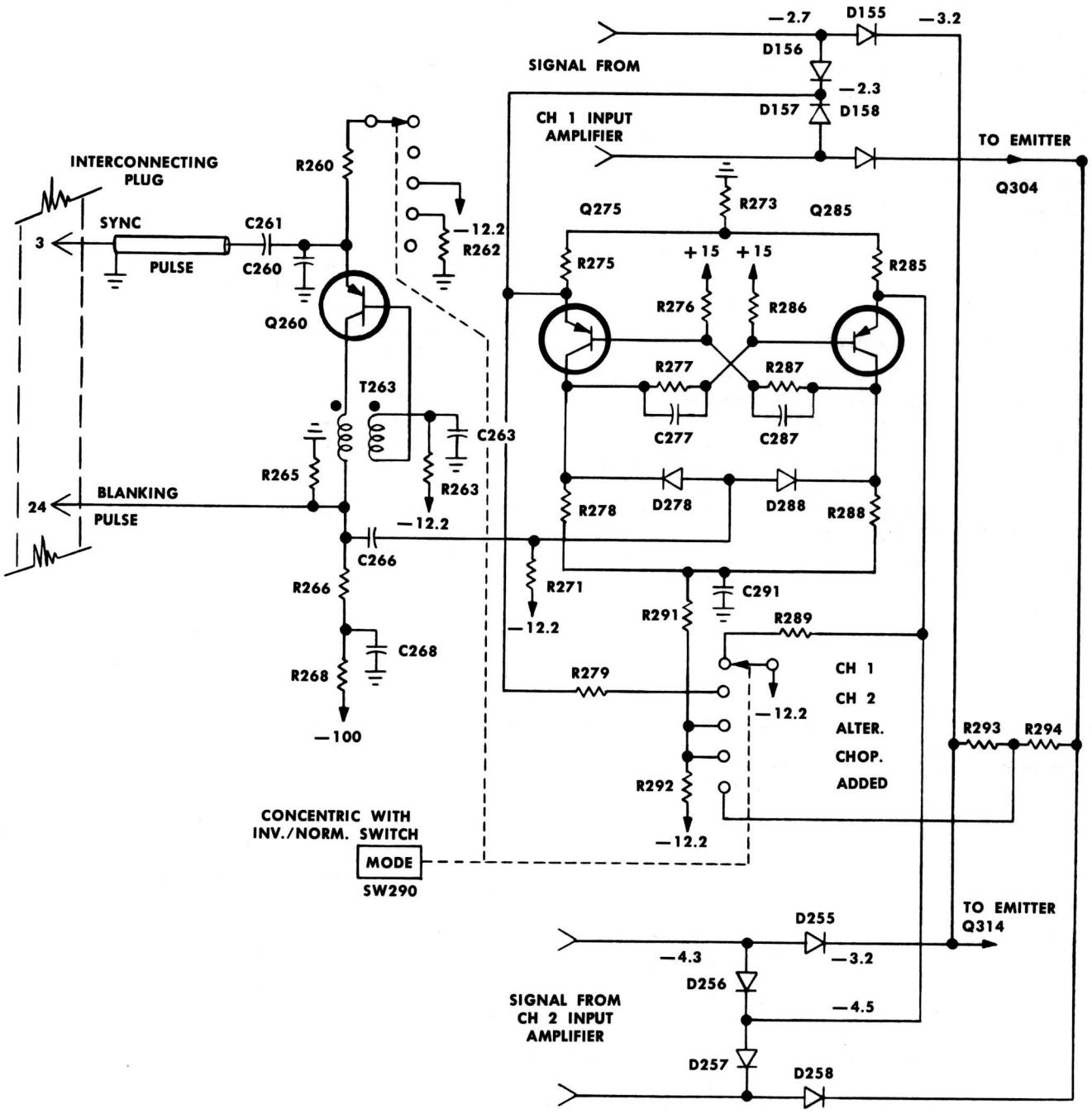


Fig. 4-2. Switching Circuit, Simplified Schematic

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, all of which drive the multivibrator. Fig. 4-2 is a simplified schematic of the switching circuit. 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 emitters 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. The shunt diodes D156 and D157 are back-biased and thus cut off by MODE switch (SW 290) holding Q285 in the "on" state. Q275 is held "off", and the junction of D156 and D157 is at 2.3 volts. The dc level in the signal output lines from the channel 1 input amplifier is —2.7, and thus the shunt diodes are back-biased.

In the channel 2 diode gate D256 and D257 are held at about —4.5 volts by Q285, which is "on". This holds the channel 2 output lines at about —4.3 volts. Since the outputs from the diode gates are about —3.2 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 the channel 2 input amplifier.

When the MODE switch is in the CH 2 position, the conditions of the switching circuit are reversed. Q275 is held "on", allowing D156 and D157 to conduct, and back-biasing D155 and D158. 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 switching 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 emitter 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 C287 or C277. The resistance dividers, R277 and R286; and R287 and R276 set the levels at the transistor emitters. The levels are adjusted so switching action can occur when pulses are received from the blocking oscillator.

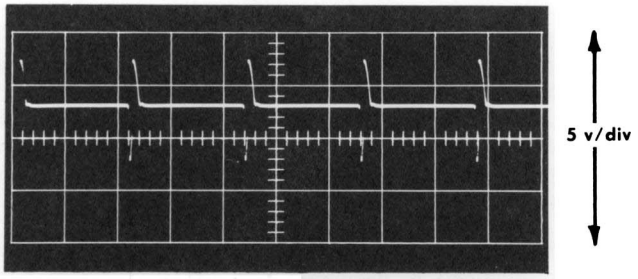
Operation of the diode gates in ALTER and CHOP. is the same as described in the CH 1 and CH 2 of the MODE switch positions. However, the multivibrator is free to switch states when it receives a trigger signal, and thus operate the diode gates so a signal is transmitted to the output amplifier from channel 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 must draw current through R292 and is not able to switch the diode gates by itself. 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 lines through R293 and R294, holding the series diodes in both diode gates in conduction. Since the multivibrator transistors are both near cut off, the diode-gate shunt diodes are back-biased and thus inoperative.

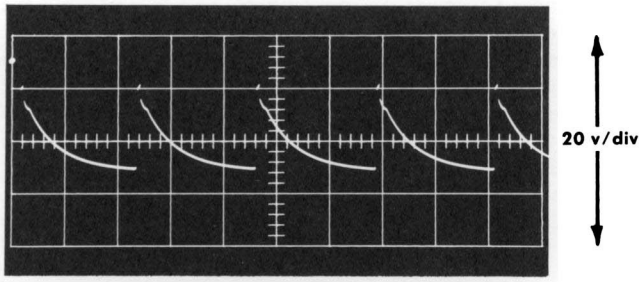
In the CHOP. and ALTER. positions of the MODE switch, Q260 (the switching blocking oscillator) is energized, supplying pulses to the switching multivibrator. Fig. 4-3 shows waveforms seen in the blocking oscillator with the MODE switch in the CHOP. position. In the ALTER. mode, the emitter of Q260 is connected to the —12.2 volt supply through R260. The collector is also connected to the —12.2 volt supply through the emitter winding of blocking oscillotor (BO) transformer T263. When a positive pulse is fed from the time-base plug-in 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. The collector current passing through the emitter circuit and R260 raises the voltage at the emitter, keeping Q260 in conduction. However, the current rise also induces a voltage in the emitter winding of the Blocking Oscillator transformer T263, driving Q260 further into conduction. A normal blocking oscillator cycle occurs, with the backswing cutting the transistor off. The emitter 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. Normal blocking oscillator action occurs; however, when a cycle is completed, the emitter is forward biased since it is 12.2 volts above the base. The blocking oscillator is thus automatically triggered and free-runs at a 200 kc rate.

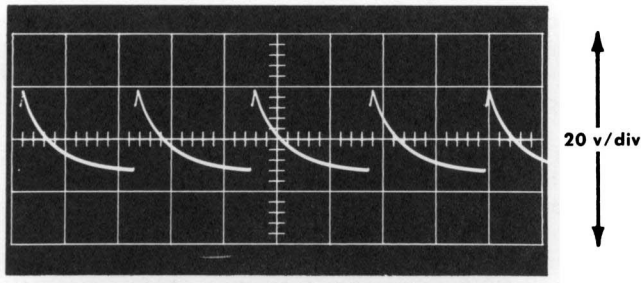
Pulses from the collector circuit of Q260 are fed to the switching multivibrator through C266. Only the positive pulses, which occur at the beginning of the blocking oscillator cycle, will switch the multivibrator. The collector pulse is also fed to pin 24 of the interconnecting plug for use as a blanking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



(a) Signal at base of Q260



(b) Signal at collector of Q260



(c) Output to pin 24 of Interconnecting Plug

Fig. 4-3. Signals in blocking oscillator circuit. Oscilloscope ac coupled, sweep rate 2 μsec/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. 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. 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.

Output tubes V364 and V374 operate as a conventional push-pull amplifier. R364 (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 improve linearity on large signals by shunting R374. 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 and TROUBLESHOOTING

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 caibration 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 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. Occassional 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 251-514.

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

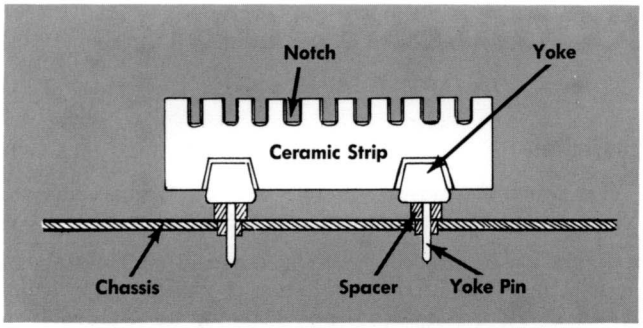


Fig. 5-1. Ceramic terminal strip installation.

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.

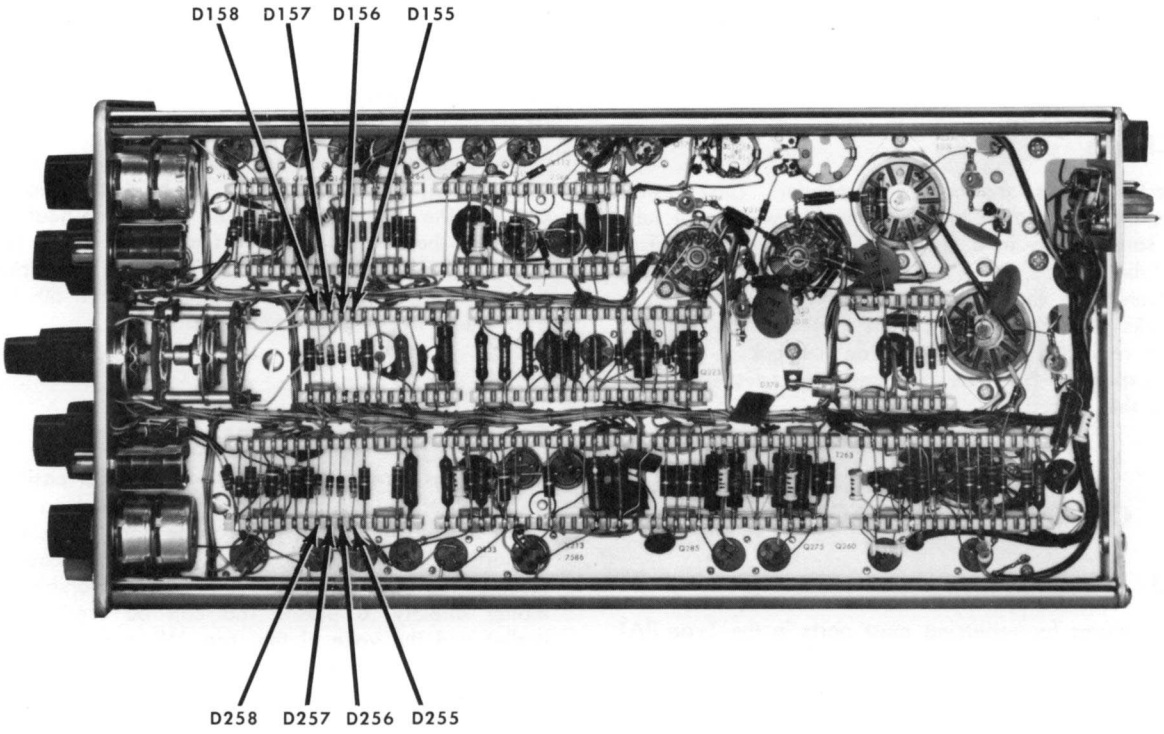


Fig. 5-2. Location of Type 3A1 major components.

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.

NOTES

SECTION 6

CALIBRATION PROCEDURE

Introduction

The Type 3A1 Dual-Trace Amplifier plug-in unit should be calibrated at least every six months or after every 500 hours of operation, whichever occurs first. When transistors, tubes, or other components are changed, the calibration of the repaired circuit should be checked.

Sometimes trouble in the instrument is caused by changes in component values. The cause can often be found by checking the calibration of the suspected circuit. Use this procedure together with the troubleshooting charts in section 5.

The following instructions are arranged in sequence to calibrate the instrument without unnecessary repetition of checks and adjustments.

Equipment Required

1. 560-Series Oscilloscope
2. Time-Base unit for 560-Series Oscilloscope
3. Dc voltmeter, 5000 ohms per volt, 2% accuracy.
4. Square-Wave Generator with a frequency range between 100 cycles and 300 kc. Risetime of 20 nanoseconds or less, and at least 0.25 volt output amplitude, such as Tektronix Type 105 Square-Wave Generator.
5. Input Capacitance Standardizer, such as Tektronix Type CS47.
6. 5XT Attenuator, such as Tektronix Part No. 011-032 (or Type B52-T5).
7. Non-metal alignment tool, such as Tektronix Part No. 003-301.

Preliminary

Install the Type 3A1 in the left-hand opening of the oscilloscope, and the time-base plug-in unit in the right-hand opening. Remove both side covers of the oscilloscope. Turn the oscilloscope power on and allow it to warm up for at

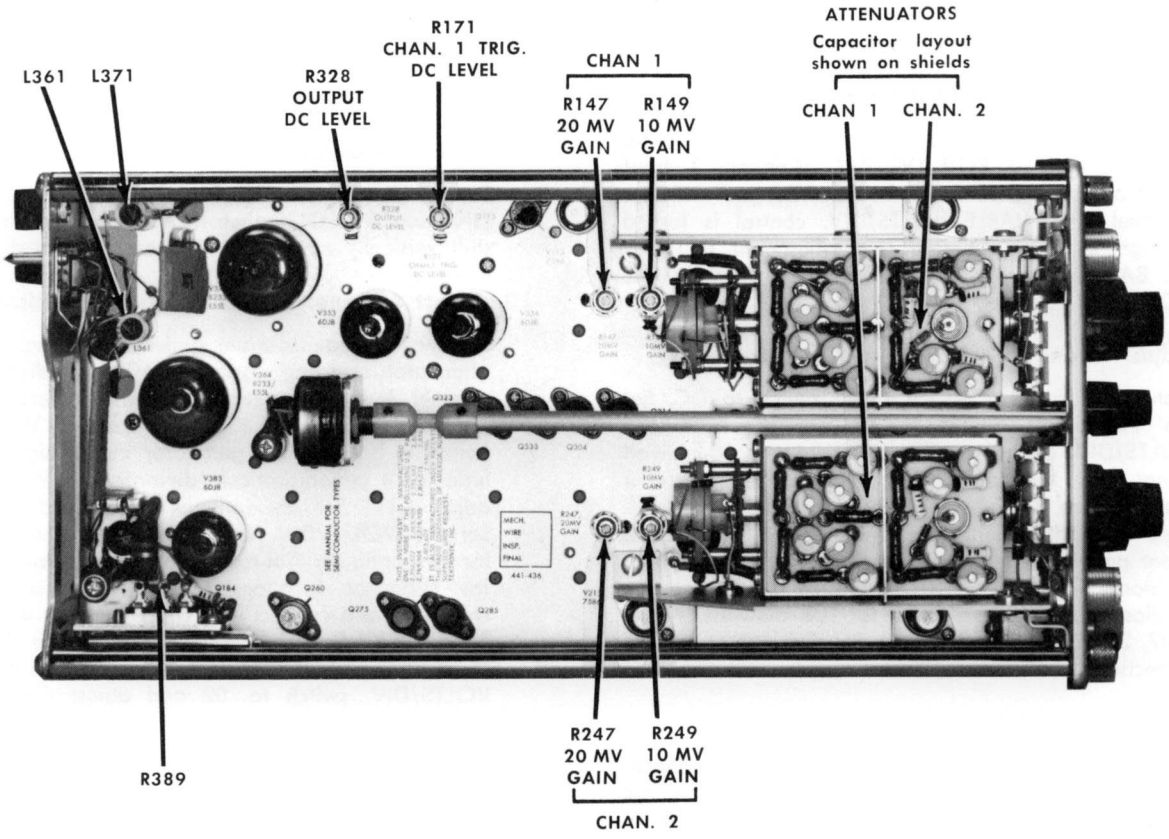


Fig. 6-1. Location of Type 3A1 calibration controls.

least fifteen minutes. Set the time-base plug-in for a 1 millisecond/div. free-running sweep. Set the controls for both channels of the Type 3A1 as follows:

POSITION	midrange
VOLTS/DIV	.01
VARIABLE VOLTS/DIV.	CALIB.
AC-DC-GND	GND.
MODE	ALTER.
INV. (CH 1) NORM.	NORM.
CALIB.	Fully clockwise
DC BAL.	midrange

Procedure

1. **Adjust Output Dc Level**

   Push in the TRIGGER CH 1 ONLY switch. Position the trace to the graticule horizontal centerlines. Measure the dc voltage from each of the crt vertical deflection plates to ground. Adjust R328 OUTPUT DC LEVEL so the average of the two voltages is +180 volts: For example, one plate at +170 and the other at +190 volts.

2. **Adjust Channel 1 Trigger Dc Level**

   Turn the MODE switch to CH 1 and pull out the TRIGGER CH I ONLY switch. Connect the dc voltmeter to R389 at switch SW390 (see Fig. 6-1). Adjust R171, CHAN. 1 TRIG. DC LEVEL for zero volts on the meter.

3. **Adjust Channel 1 and 2 Dc Balance.**

   Position the channel 1 trace to the graticule horizontal centerline. Adjust R119 DC BAL. (Channel 1 front panel adjustment) so the trace does not move as the Channel 1 VARIABLE VOLTS/DIV. control is turned through its range. Repeat this adjustment for R219 DC BAL. in channel 2 as the Channel 2 VARIABLE VOLTS/DIV. Control is turned.

4. **Adjust Channel 1 Gain and Calibration.**

   Push the channel 1 AC-DC-GND switch to DC. Set the VOLTS/DIV. switch to .01 and the VARIABLE VOLTS/DIV. control to CALIB. Connect a 50-millivolt signal from the calibrator output to the channel 1 input. Adjust R149 10 MV GAIN for six major divisions of vertical deflection. Then adjust R364 CALIB. (front panel) until the vertical deflection is five major divisions. Set the VOLTS/DIV. switch to .02 and the oscilloscope calibrator output for 100 millivolts. Adjust R147, 20 MV GAIN for five major divisions of vertical deflection.

5. **Adjust Channel 2**

   Connect another cable from the oscilloscope calibrator output to the channel 2 input connector. Set the channel 2 AC-DC-GND switch to DC. Set both channel VOLTS/DIV. switches to .01. Set the calibrator output for 50 millivolts. Set the MODE switch to ADDED and the INV. (CH 1) NORMAL switch to INV. Adjust R249, 10 MV GAIN, for cancellation of the display shown by a single line of trace. Set the calibrator output for 100 millivolts and both VOLTS/DIV. switches to .02. Adjust R247 20 MV GAIN for cancellation of the display.

6. **Check Both VARIABLE VOLTS/DIV. controls.**

   Set both VOLTS/DIV. switches to .01 and both VARIABLE VOLTS/DIV. controls to CALIB. Set the INV. (CH 1) NORM switch to NORM. Connect a 50-millivolt signal from the oscilloscope calibrator to the input of both channels. Set the MODE switch to CH 1; there should be 5 major divisions of vertical deflection. Turn the channel 1 VARIABLE VOLTS/DIV. control fully counterclockwise; there should be two (or less) major divisions of vertical deflection. Check to see that the UNCAL. neon is turned on. Return the Channel 1 VARIABLE VOLTS/DIV. control to CALIB.; the UNCAL. neon should turn off. Next, turn the MODE switch to CH 2 and repeat this check for the channel 2 VARIABLE VOLTS/DIV. control.

7. **Check Alternate Mode Operation.**

   Set the MODE switch to ALTER. and position the two traces about two major divisions apart. Set the time-base plug-in for a sweep rate of 0.1 second/division and check to see that the trace alternates between channels 1 and 2.

8. **Check Chopped Mode Operation.**

   Set the time-base plug-in for a sweep rate of 5 μsec/division and the Type 3A1 MODE switch to CHOP. The chopped trace on the crt should show about 1 sample for each major horizontal graticule division.

9. **Check For Gassy Input Amplifier.**

   Set the VOLTS/DIV. switch to .02 and set the AC-DC-GND switch to GND then to AC. The trace should not shift vertically more than 1 minor graticule division.

10. **Adjust Channel 1 and 2 Input Capacitance.**

    Connect the square-wave generator through the 5XT attenuator and the capacitance standardizer to the channel 1 input connector. Set the generator for a 1-kc ouput signal. Set the Channel 1 VOLTS/DIV. switch to .01. Set the generator output signal amplitude for 4 major graticule divisions of deflection and adjust C111 for an optimum flat-topped waveform. Set the VOLTS/DIV. switch to .02 and adjust C112 for an optimum flat-topped waveform (see Fig. 6-2 for capacitor locations). Remove the signal from channel 1 and connect it to channel 2. Set the channel 2 VOLTS/DIV. switch to .01 and adjust C211 for an optimum flat-topped waveform. Set the channel 2 VOLTS/DIV. switch to .02 and adjust C212 for an optimum flat-topped waveform.

11. **Adjust Channel 1 and 2 VOLTS/DIV.**

    Switch Compensation Capacitors. Use the same test setup as in step 10. Adjust the square-wave generator for a 1-kc output signal with four major graticule divisions of amplitude. Perform the adjustments indicated in Table 6-1 for channel 1 and then connect

the square-wave generator to the channel 2 input connector and perform the adjustments for channel 2.

12. Adjust High-Frequency Compensation.

Connect the square-wave generator to channel 1. Set the generator output frequency for about 300 kc and adjust the amplitude for four major graticule divisions of vertical deflection. Set the time-base plug-in to display a single waveform. Adjust L361 and L371 (see Fig. 6-1) for optimum square corners without appreciable overshoot on the waveform.

TABLE 6-1

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

SECTION 7
PARTS LIST AND SCHEMATICS

PARTS ORDERING INFORMATION

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

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 including any suffix, instrument type, serial number, and modification number if applicable.

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

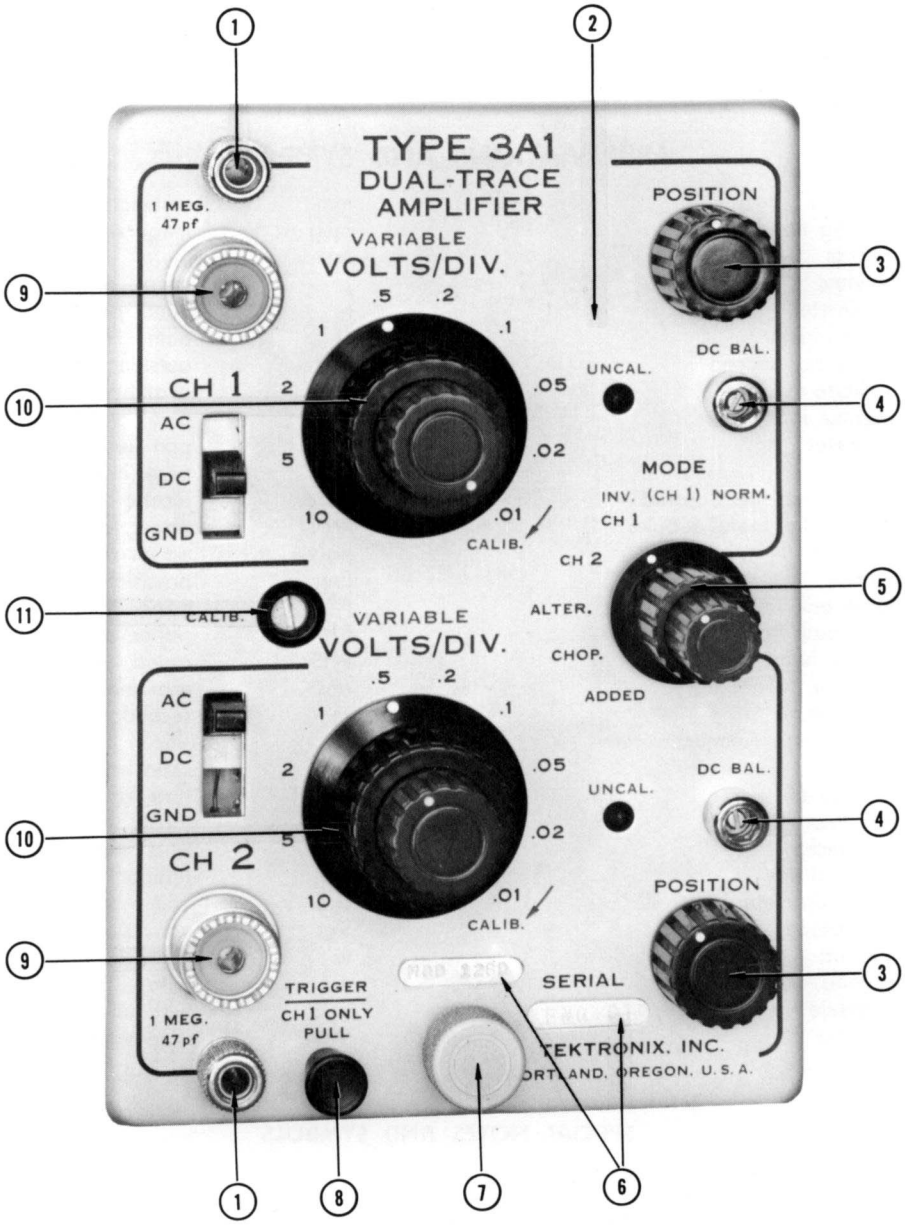
ABBREVIATIONS AND SYMBOLS

a or amp	amperes
BHS	binding head steel
C	carbon
cer	ceramic
cm	centimeter
comp	composition
cps	cycles per second
crt	cathode-ray tube
CSK	counter sunk
dia	diameter
div	division
EMC	electrolytic, metal cased
EMT	electroyltic, metal tubular
ext	external
f	farad
F & I	focus and intensity
FHS	flat head steel
Fil HS	fillister head steel
g or G	giga, or 10^9
Ge	germanium
GMV	guaranteed minimum value
h	henry
hex	hexagonal
HHS	hex head steel
HSS	hex socket steel
HV	high voltage
ID	inside diameter
incd	incandescent
int	internal
k or K	kilohms or kilo (10^3)
kc	kilocycle
m	milli, or 10^{-3}
mc	megacycle
mm	millimeter
meg or M	megohms or mega (10^6)
met.	metal
μ	micro, or 10^{-6}
n	nano, or 10^{-9}
Ω	ohm
OD	outside diameter
OHS	oval head steel
p	pico, or 10^{-12}
PHS	pan head steel
piv	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
Prec	precision
PT	paper tubular
PTM	paper or plastic, tubular, molded
RHS	round head steel
rms	root mean square
sec	second
Si	silicon
S/N	serial number
t or T	tera, or 10^{12}
TD	toroid
THS	truss head steel
tub.	tubular
v or V	volt
Var	variable
w	watt
w/	with
w/o	without
WW	wire-wound

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number.
000X	Part removed after this serial number.
*000-000	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, or reworked or checked components.
Use 000-000	Part number indicated is direct replacement.
	Internal screwdriver adjustment.
	Front-panel adjustment or connector.

FRONT


TYPE 3A1
DUAL-TRACE
AMPLIFIER
1 MEG.
47 pf
VARIABLE
VOLTS/DIV.
.5
.2
.1
.05
.02
.01
1
2
5
10
CALIB.
CH 1
AC
DC
GND
UNCAL.
POSITION
DC BAL.
MODE
INV. (CH 1) NORM.
CH 1
CH 2
ALTER.
CHOP.
ADDED
CALIB.
VARIABLE
VOLTS/DIV.
CH 2
TRIGGER
CH 1 ONLY
PULL
SERIAL
TEKTRONIX, INC.
PORTLAND, OREGON, U.S.A.
1
2
3
4
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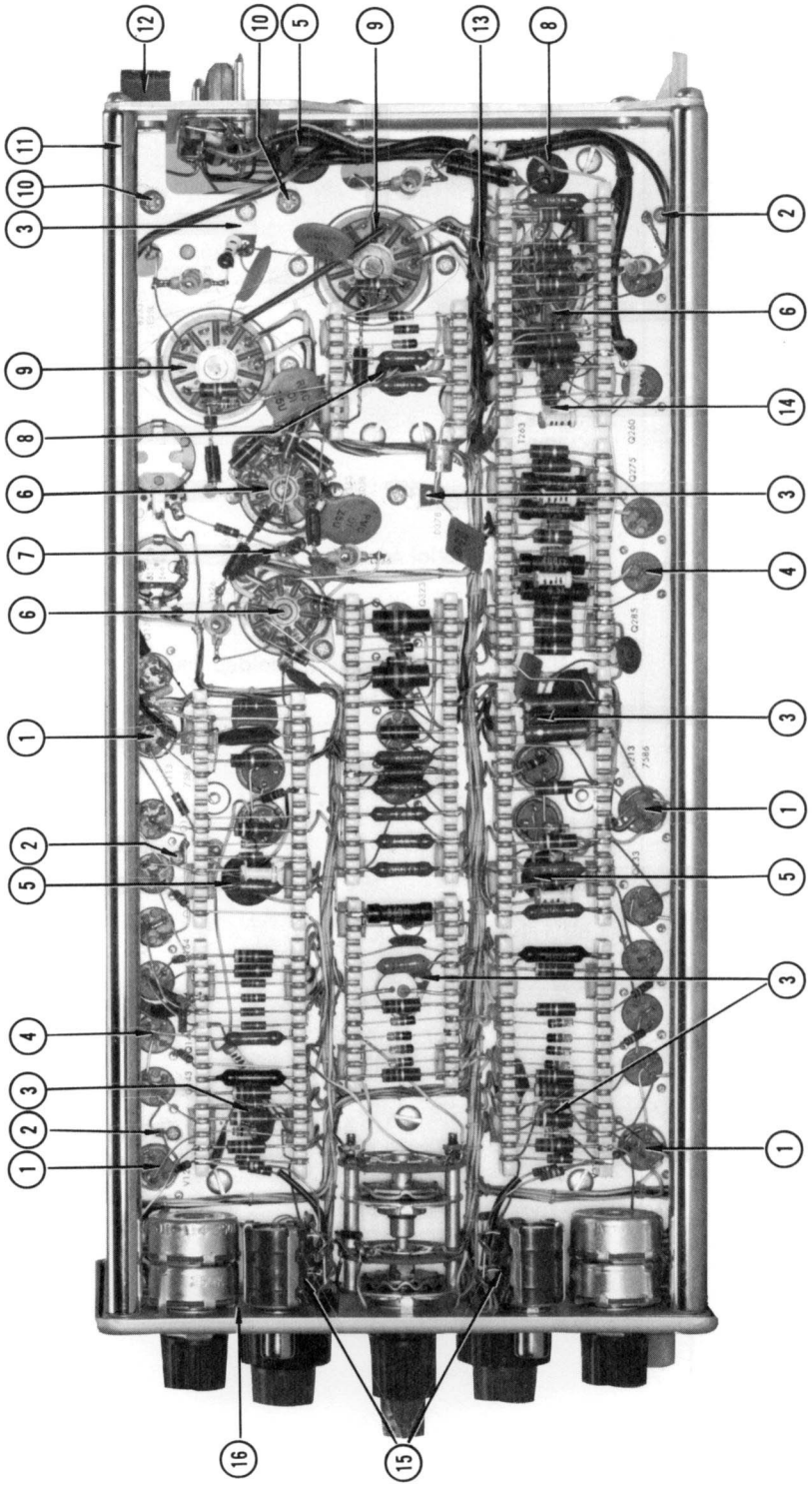
6
7
8
9
10
11

FRONT

REF. NO.	PART NO.	SERIAL NO. EFF.	SERIAL NO. DISC.	QTY.	DESCRIPTION
1.	129-035			2	POST, ground, assembly
					Each Consisting Of:
	355-507			1	STEM, adapter
	200-103			1	CAP
	210-011			1	LOCKWASHER
	210-455			1	NUT
2.	333-704			1	PANEL, front
	004-146			1	COVER, panel
3.	366-148			2	KNOB
	210-413			2	NUT
	210-840			2	WASHER
	210-012			2	LOCKWASHER
4.	358-075			2	BUSHING, pot mounting
5.	366-175			1	KNOB, large
	366-189			1	KNOB, small
	210-413			1	NUT
	210-012			1	LOCKWASHER
6.	334-679			2	TAG, metal serial no. insert
7.	366-109			1	KNOB, plug-in securing
8.	384-245			1	ROD, extension, assembly w/molded knob
9.	131-081			2	CONNECTOR, chassis mt., coaxial
	210-241			2	LUG, ground
10.	366-160			2	KNOB, large
	366-031			2	KNOB, small
	210-413			2	NUT
	210-012			2	LOCKWASHER
11.	358-178			1	BUSHING, front panel

RIGHT SIDE



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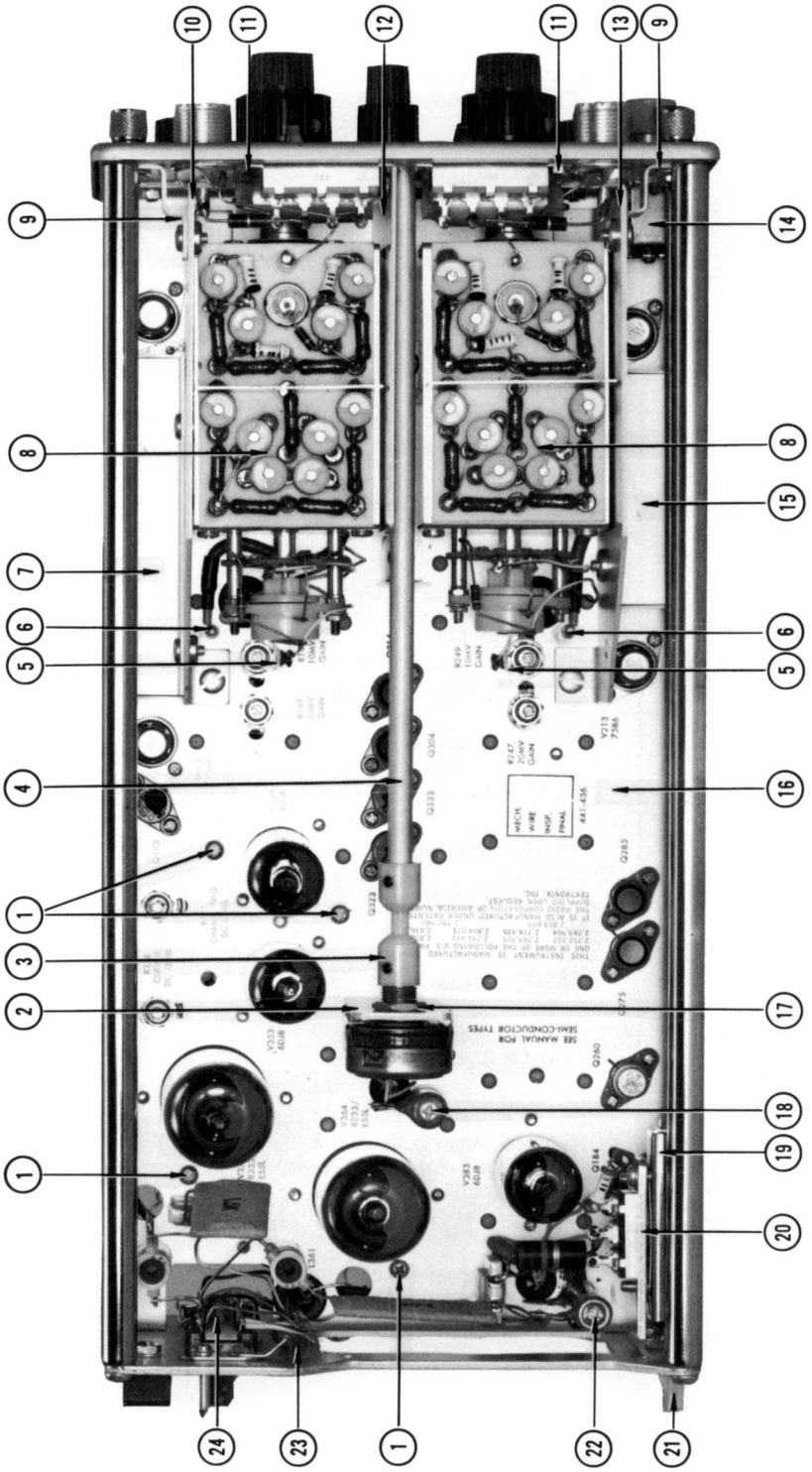
RIGHT SIDE

REF. NO.	PART NO.	SERIAL NO. EFF.	SERIAL NO. DISC.	QTY.	DESCRIPTION
1.	136-101			4	SOCKET, 5 pin
					Mounting Hardware For Each: (not included)
	213-055			2	SCREW, thread cutting
2.	210-215			3	LUG, banana, peewee
	213-055			3	SCREW, thread cutting
3.	210-201			6	LUG, solder
	213-044			6	SCREW, thread cutting
4	136-095			19	SOCKET, 4 pin transistor
					Mounting Hardware For Each: (not included)
	213-113			2	SCREW
5.	348-004			3	GROMMET
6.	136-015			3	SOCKET
					Mounting Hardware For Each: (not included)
	213-044			2	SCREW, thread cutting
7.	131-235			1	CONNECTOR, terminal bifurcated
	358-136			1	BUSHING
8.	348-003			2	GROMMET
9.	136-126			2	SOCKET, 9 pin
					Mounting Hardware For Each: (not included)
	213-044			2	SCREW, thread cutting
10.	213-054			2	SCREW, thread cutting
11.	384-566			4	ROD, frame, spacing
12.	214-276			2	SPRING, ground
	211-504			1	SCREW
	210-006			1	LOCKWASHER, int.
	210-407			1	NUT
13.	179-643			1	CABLE, harness
14.	426-121			1	MOUNT, toroid
	361-007			1	SPACER
15.	352-008	101	609	2	HOLDER, neon bulb, single
	352-053	610		2	HOLDER, neon bulb, single
					Mounting Hardware: (not included)
	211-031			1	SCREW
	210-406			2	NUT
16.	387-660			1	PLATE, front subpanel

LEFT SIDE



LEFT SIDE

REF. NO.	PART NO.	SERIAL NO. EFF.	SERIAL NO. DISC.	QTY.	DESCRIPTION
1.	213-035			4	SCREW, thread cutting
	210-201			1	LUG, solder
2.	406-814			1	BRACKET, pot
					Mounting Hardware: (not included)
	211-504			2	SCREW
3.	376-011			1	COUPLING, insulating
4.	384-246			1	ROD, extension
5.	210-223			2	LUG, solder
6.	131-183			2	CONNECTOR, terminal feed-thru
	358-136			2	BUSHING
7.	337-507			1	SHIELD
					Mounting Hardware: (not included)
	211-503			3	SCREW
8.	262-487			2	SWITCH, wired, attenuator
					Each Includes:
	406-813			1	BRACKET, attenuator switch assembly
					Mounting Hardware:
	211-008			4	SCREW
	210-004			3	LOCKWASHER
	210-201			1	LUG, solder
	210-406			4	NUT
	337-505			1	SHIELD
					Mounting Hardware:
	210-406			2	NUT
	210-004			2	LOCKWASHER, int.
	131-182			1	CONNECTOR, terminal feed-thru
	358-135			1	BUSHING
9.	406-845			2	BRACKET, ground
					Mounting Hardware For Each: (not included)
	211-504			1	SCREW
	210-006			1	LOCKWASHER, int.
	210-407			1	NUT
10.	337-508			1	SHIELD, top
					Mounting Hardware: (not included)
	211-504			2	SCREW
11	210-406			4	NUT
12	337-510			1	SHIELD, middle
					Mounting Hardware: (not included)
	211-504			2	SCREW
13	337-509			1	SHIELD, bottom
					Mounting Hardware: (not included)
	211-504			2	SCREW
14.	214-052			1	FASTENER, pawl right w/stop
					Mounting Hardware. (not included)
	210-406			2	NUT
	210-004			2	LOCKWASHER, int.

LEFT SIDE *(Cont.)*

REF. NO.	PART NO.	SERIAL NO. EFF.	SERIAL NO. DISC.	QTY.	DESCRIPTION
15	337-506			1	SHIELD, bottom box
					Mounting Hardware: (not included)
	211-503			2	SCREW
16.	441-436			1	CHASSIS
					Mounting Hardware: (not included)
	211-504			3	SCREW
	211-538			3	SCREW phillips
	210-006			3	LOCKWASHER
	210-407			3	NUT
17.	210-413			1	NUT
	210-840			1	WASHER
18.	211-544			1	SCREW, phillips
	210-478			1	NUT, resistor mounting
	211-507			1	SCREW
19.	406-802			1	BRACKET, switch actuating
					Mounting Hardware: (not included)
	210-449			2	NUT
	210-006			1	LOCKWASHER
	210-202			1	LUG, solder
	213-105			2	SCREW, shoulder
	214-237			1	SPRING, switch slide
20.	406-800			1	BRACKET, switch slide
					Mounting Hardware: (not included)
	211-504			2	SCREW
21.	351-037			1	GUIDE, plug-in
					Mounting Hardware: (not included)
	211-013			1	SCREW
	210-004			1	LOCKWASHER
	210-406			1	NUT
22.	211-553			1	SCREW, phillips
	210-601			1	EYELET
	210-478			1	NUT, resistor mounting
	211-507			1	SCREW
23.	387-647			1	PLATE, rear
					Mounting Hardware: (not included)
	212-044			4	SCREW
24.	131-149			1	CONNECTOR, chassis mount, 24 contact, male
					Mounting Hardware: (not included)
	211-008			2	SCREW
	210-201			2	LUG, solder
	210-406			2	NUT

ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Description			S/N Range
		BULBS			
B113	150-027	Neon, NE-23			X1710-up
B150	Use 150-027	Neon, NE-23		UNCALIBRATED	
B213	150-027	Neon, NE-23			X1710-up
B250	Use 150-027	Neon, NE-23		UNCALIBRATED	
		CAPACITORS			
		Tolerance ±20% unless otherwise indicated.			
		Tolerance of all electrolytic capacitors are 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 μf MT	600 v	10%	
C103B	281-061	5.5-18 pf Cer. Var.			
C103C	281-061	5.5-18 pf Cer. Var.			
C105B	281-061	5.5-18 pf Cer. Var.			
C105C	281-060	2-8 pf Cer. Var.			
C105E	281-503	8 pf Cer.	500 v	±0.5 pf	
C107A	281-504	10 pf Cer.	500 v	10%	
C107B	281-061	5.5-18 pf Cer. Var.			
C107C	281-060	2-8 pf Cer. Var.			
C107E	281-579	21 pf Cer.	500 v	5%	
C109A	281-504	10 pf Cer.	500 v	10%	
C109B	281-061	5.5-18 pf Cer. Var.			
C109C	281-060	2-8 pf Cer. Var.			
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.			
C112	281-060	2-8 pf Cer. Var.			
C113	283-068	.01 μf Disc Type	500 v		
C114	281-500	2.2 pf Cer.	500 v	±0.5 pf	X3075-up
C115	283-012	.1 μf Disc Type	100 v		
C123	283-003	.01 μf Disc Type	150 v		
C125	283-003	.01 μf Disc Type	150 v		
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 μf MT	600 v	10%	
C203B	281-061	5.5-18 pf Cer. Var.			
C203C	281-061	5.5-18 pf Cer. Var.			
C205B	281-061	5.5-18 pf Cer. Var.			
C205C	281-060	2-8 pf Cer. Var.			
C205E	281-503	8 pf Cer.	500 v	±0.5 pf	

CAPACITORS *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
C207A	281-504	10 pf	Cer.		500 v	10%	
C207B	281-061	5.5-18 pf	Cer.	Var.			
C207C	281-060	2-8 pf	Cer.	Var.			
C207E	281-579	21 pf	Cer.		500 v	5%	
C209A	281-504	10 pf	Cer.		500 v	10%	
C209B	281-061	5.5-18 pf	Cer.	Var.			
C209C	281-060	2-8 pf	Cer.	Var.			
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.			
C212	281-060	2-8 pf	Cer.	Var.			
C213	283-068	.01 μf	Disc Type		500 v		
C214	281-500	2.2 pf	Cer.		500 v	±0.5 pf	X3075-up
C215	283-012	.1 μf	Disc Type		100 v		
C223	283-003	.01 μf	Disc Type		150 v		
C225	283-003	.01 μf	Disc Type		150 v		
C237	281-549	68 pf	Cer.		500 v	10%	
C260	283-067	.001 μf	Disc Type		200 v	10%	
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		
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	283-059	1 μf	Disc Type		25 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	X1710-up
D140	152-008	Germanium	T12G	
D155	152-071	Germanium	ED2007	
D156	152-071	Germanium	ED2007	

Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description		S/N Range
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	X1710-up
D240	152-008	Germanium	T12G	
D255	152-071	Germanium	ED2007	
D256	152-071	Germanium	ED2007	
D257	152-071	Germanium	ED2007	
D258	152-071	Germanium	ED2007	
D278	152-075	Germanium	6075	
D288	152-075	Germanium	6075	
D337	152-071	Germanium	ED2007	
D338	152-071	Germanium	ED2007	
D345	152-075	Germanium	6075	
D355	152-075	Germanium	6075	
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%	

Inductors

L315	*108-147	2.2 μh	
L326	*108-253	7.8 μh	
L336	*108-253	7.8 μh	
L341	*108-147	2.2 μh	
L344	*108-072	.75 μh	
L345	276-507	Ferramic Suppressor	
L351	*108-147	2.2 μh	
L354	*108-072	.75 μh	
L355	276-507	Ferramic Suppressor	
L361	*114-151	35-50 μh	Var.
L363	*108-252	3.6 μh	
L371	*114-151	35-50 μh	Var.
L373	*108-252	3.6 μh	
L378	*108-200	40 μh	
L396	*108-016	29 μh	

RESISTORS

Resistors are fixed, composition, ±10% unless otherwise indicated.

R101	302-100	10 Ω	½ w		
R103C	309-381	600 k	½ w	Prec.	1%
R103E	309-382	666.6 k	½ w	Prec.	1%
R105C	309-383	800 k	½ w	Prec.	1%
R105E	309-380	250 k	½ w	Prec.	1%

RESISTORS *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R107C	309-396	900 k	½ w		Prec. 1%	
R107E	309-379	111 k	½ w		Prec. 1%	
R109C	309-385	990 k	½ w		Prec. 1%	
R109E	309-378	10.1 k	½ w		Prec. 1%	
R109F	316-150	15 Ω	¼ w			
R110	315-100	10 Ω	¼ w		5%	
R111	309-386	1 meg	½ w		Prec. 1%	
R113	315-105	1 meg	¼ w		5%	
R114	316-101	100 Ω	¼ w			
R115	302-221	220 Ω	½ w			
R116	301-392	3.9 k	½ w		5%	
R119	311-321	2 x 500 k		Var.	DC BAL	
R120	Use 316-335	3.3 meg	¼ w			
R121	316-274	270 k	¼ w			
R123	316-182	1.8 k	¼ w			
R124	316-101	100 Ω	¼ w			
R125	316-101	100 Ω	¼ w			
R126	301-392	3.9 k	½ w		5%	
R133	301-431	430 Ω	½ w		5%	
R134	315-391	390 Ω	¼ w		5%	
R135	309-117	2.1 k	½ w		Prec. 1%	
R137	316-470	47 Ω	¼ w			
R138	315-391	390 Ω	¼ w		5%	
R139†	*311-319	375 Ω		Var.	VARIABLE	
R142	309-028	1.48 k	½ w		Prec. 2%	
R143	301-431	430 Ω	½ w		5%	
R144	315-391	390 Ω	¼ w		5%	
R145	309-117	2.1 k	½ w		Prec. 1%	
R147	311-258	100 Ω		Var.	20 MV GAIN	
R148	316-680	68 Ω	¼ w			
R149	311-258	100 Ω		Var.	10 MV GAIN	
R150	316-104	100 k	¼ w			
R151	302-683	68 k	½ w			
R152	301-163	16 k	½ w		5%	
R153	311-114	2 x 250 k		Var.	POSITION	
R154	302-683	68 k	½ w			
R164	315-622	6.2 k	¼ w		5%	
R167	315-820	82 Ω	¼ w		5%	
R170	316-221	220 Ω	¼ w			
R171	311-159	20 k		Var.	TRIG. DC LEVEL	
R172	316-333	33 k	¼ w			
R173	301-152	1.5 k	½ w		5%	
R174	315-622	6.2 k	¼ w		5%	
R175	315-513	51 k	¼ w		5%	
R176	316-332	3.3 k	¼ w			

† R139 ganged with SW150. Furnished as a unit.

RESISTORS *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R184	301-332	3.3 k	½ w		5%	
R185	315-151	150 Ω	¼ w		5%	
R187	316-473	47 k	¼ w			
R188	316-105	1 meg	¼ w			
R201	302-100	10 Ω	½ w			
R203C	309-381	600 k	½ w	Prec.	1%	
R203E	309-382	666.6 k	½ w	Prec.	1%	
R205C	309-383	800 k	½ w	Prec.	1%	
R205E	309-380	250 k	½ w	Prec.	1%	
R207C	309-396	900 k	½ w	Prec.	1%	
R207E	309-379	111 k	½ w	Prec.	1%	
R209C	309-385	990 k	½ w	Prec.	1%	
R209E	309-378	10.1 k	½ w	Prec.	1%	
R209F	316-150	15 Ω	¼ w			
R210	315-100	10 Ω	¼ w		5%	
R211	309-386	1 meg	½ w	Prec.	1%	
R213	315-105	1 meg	¼ w		5%	
R214	316-101	100 Ω	¼ w			
R215	302-221	220 Ω	½ w			
R216	301-392	3.9 k	½ w		5%	
R219	311-321	2 x 500 k		Var.	DC BAL	
R220	Use 316-335	3.3 meg	¼ w			
R221	316-274	270 k	¼ w			
R223	316-182	1.8 k	¼ w			
R224	316-101	100 Ω	¼ w			
R225	316-101	100 Ω	¼ w			
R226	301-392	3.9 k	½ w		5%	
R233	301-431	430 Ω	½ w		5%	
R234	315-391	390 Ω	¼ w		5%	
R235	309-117	2.1 k	½ w	Prec.	1%	
R237	316-470	47 Ω	¼ w			
R238	315-391	390 Ω	¼ w		5%	
R239†	*311-319	375 Ω		Var.	VARIABLE	
R242	309-028	1.48 k	½ w		2%	
R243	301-431	430 Ω	½ w		5%	
R244	315-391	390 Ω	¼ w		5%	
R245	309-117	2.1 k	½ w	Prec.	1%	
R247	311-258	100 Ω		Var.	20 MV GAIN	
R248	316-680	68 Ω	¼ w			
R249	311-258	100 Ω		Var.	10 MV GAIN	
R250	316-104	100 k	¼ w			
R251	302-683	68 k	½ w			
R252	301-163	16 k	½ w		5%	
R253	311-114	2 x 250 k		Var.	POSITION	
R254	302-683	68 k	½ w			
R260	316-222	2.2 k	¼ w			
R262	302-153	15 k	½ w			
R263	302-470	47 Ω	½ w			

† R239 ganged with SW250. Furnished as a unit.

RESISTORS *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R265	301-223	22 k	½ w			5%	
R266	301-183	18 k	½ w			5%	
R268	316-101	100 Ω	¼ w				
R271	302-103	10 k	½ w				
R273	301-202	2 k	½ w			5%	
R275	301-202	2 k	½ w			5%	
R276	309-121	9.5 k	½ w		Prec.	1%	
R277	318-099	3 k	⅛ w		Prec.	1%	
R278†	Use 309-407	400 Ω	½ w		Prec.	½%	
R279	302-561	560 Ω	½ w				
R285	301-202	2 k	½ w			5%	
R286	309-121	9.5 k	½ w		Prec.	1%	
R287	318-099	3 k	⅛ w		Prec.	1%	
R288†	Use 309-407	400 Ω	½ w		Prec.	½%	
R289	302-561	560 Ω	½ w				
R291	302-100	10 Ω	½ w				
R292	315-152	1.5 k	¼ w			5%	
R293	309-274	1.4 k	½ w		Prec.	1%	
R294	309-274	1.4 k	½ w		Prec.	1%	
R304	309-097	600 Ω	½ w		Prec.	1%	
R306	309-078	343 Ω	½ w		Prec.	1%	
R307	309-273	866 Ω	½ w		Prec.	1%	
R314	309-097	600 Ω	½ w		Prec.	1%	
R315	301-120	12 Ω	½ w			5%	
R322	301-511	510 Ω	½ w			5%	
R323	315-751	750 Ω	¼ w			5%	
R325	316-470	47 Ω	¼ w				
R326	309-158	1.19 k	½ w		Prec.	1%	
R327	Use 302-681	680 Ω	½ w				
R328	311-323	1.5 k		Var.	WW	OUTPUT DC LEVEL	
R329	303-203	20 k	½ w			5%	
R333	315-751	750 Ω	¼ w			5%	
R335	316-470	47 Ω	¼ w				
R336	309-158	1.19 k	½ w		Prec.	1%	
R337	316-101	100 Ω	¼ w				
R339	303-203	20 k	½ w			5%	
R340	302-102	1 k	½ w				
R341	316-470	47 Ω	¼ w				
R347	301-622	6.2 k	½ w			5%	
R351	316-470	47 Ω	¼ w				
R357	301-622	6.2 k	½ w			5%	
R360	308-089	1 k	10 w		WW	5%	
R361	*310-596	1.5 k	8 w		Prec.	1%	
R364	316-220	22 Ω	¼ w				
R366	302-274	270 k	½ w				
R367	309-344	100 Ω	½ w		Prec.	1%	
R369	316-470	47 Ω	¼ w				
R371	*310-596	1.5 k	8 w		Prec.	1%	

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

RESISTORS *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R374	311-308	50 Ω	2 w	Var.	CALIB.	
R376	302-274	270 k	½ w			
R377	309-344	100 Ω	½ w	Prec.	1%	
R378	308-232	320 Ω	5 w	WW	5%	
R381	309-055	370 k	½ w	Prec.	1%	
R382	309-243	193 k	½ w	Prec.	1%	
R384	316-101	100 Ω	¼ w			
R385	316-471	470 Ω	¼ w			
R387	302-473	47 k	½ w			
R389	306-123	12 k	2 w			
R390	316-101	100 Ω	¼ w			
R391	316-471	470 Ω	¼ w			
R392	302-473	47 k	½ k			
R397	308-230	2.7 k	3 w	WW	5%	
R398	316-270	27 Ω	¼ w			

SWITCHES

	Unwired	Wired		
SW101	260-448		Slide	
SW110	260-441	*262-487	Rotary	VOLTS/DIV
SW150†	*311-319			CALIBRATED
SW155††	260-442		Rotary	INV/NORM
SW201	260-448		Slide	
SW210	260-441	*262-487	Rotary	VOLTS/DIV
SW250†††	*311-319			CALIBRATED
SW290††	260-442		Rotary	MODE
SW390	260-212		Slide	TRIGGER

†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

TRANSISTORS

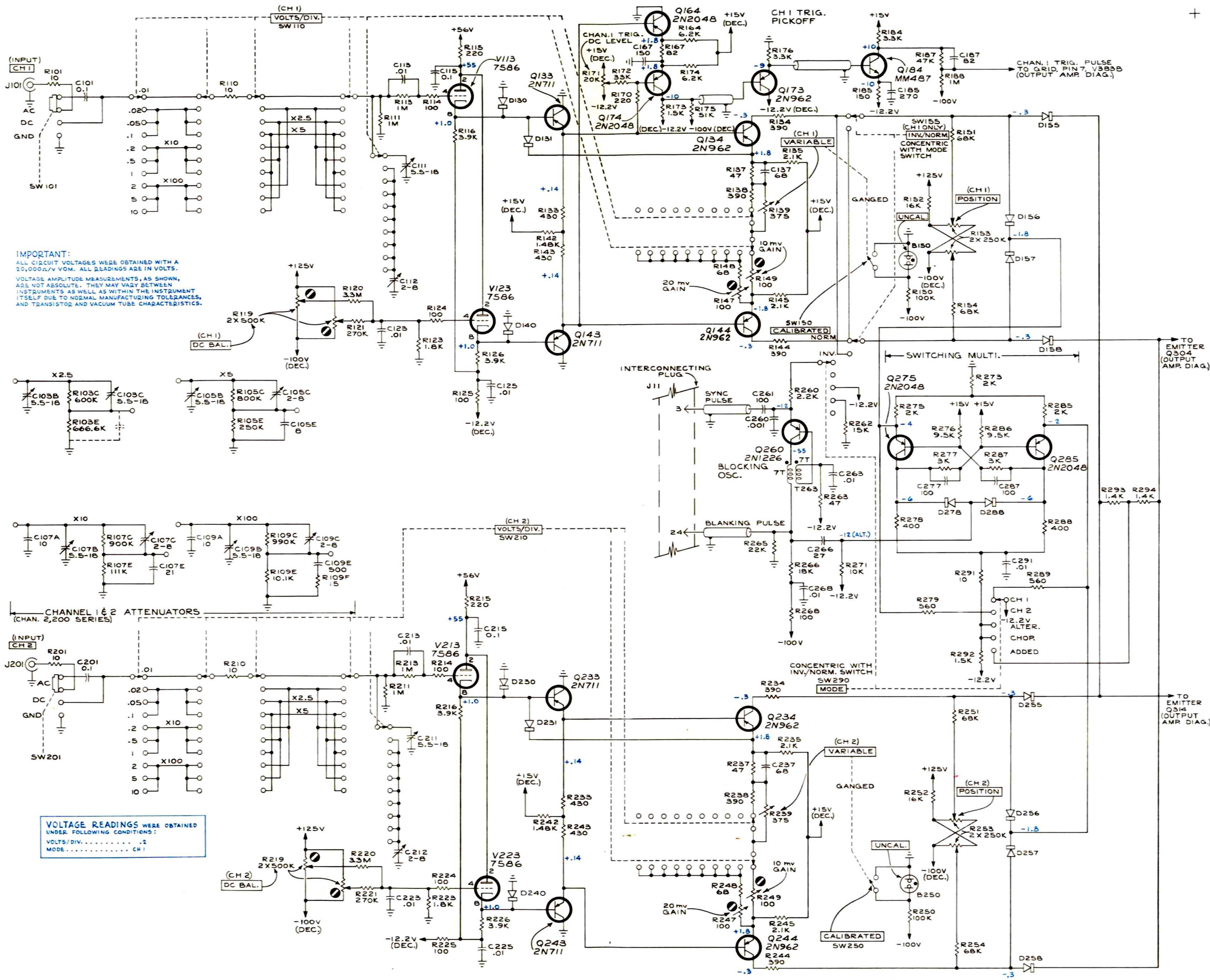
Q133	151-092	2N711
Q134	151-089	2N962
Q143	151-092	2N711
Q144	151-089	2N962
Q164	151-076	2N2048

Transistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
Q173	151-089	2N962	
Q174	151-076	2N2048	
Q184	Use 151-103	Planar Silicon	
Q233	151-092	2N711	
Q234	151-089	2N962	
Q243	151-092	2N711	
Q244	151-089	2N962	
Q260	151-091	2N1226	
Q275	151-076	2N2048	
Q285	151-076	2N2048	
Q304	151-076	2N2048	
Q314	151-076	2N2048	
Q323	151-089	2N962	
Q333	151-089	2N962	

ELECTRON TUBES

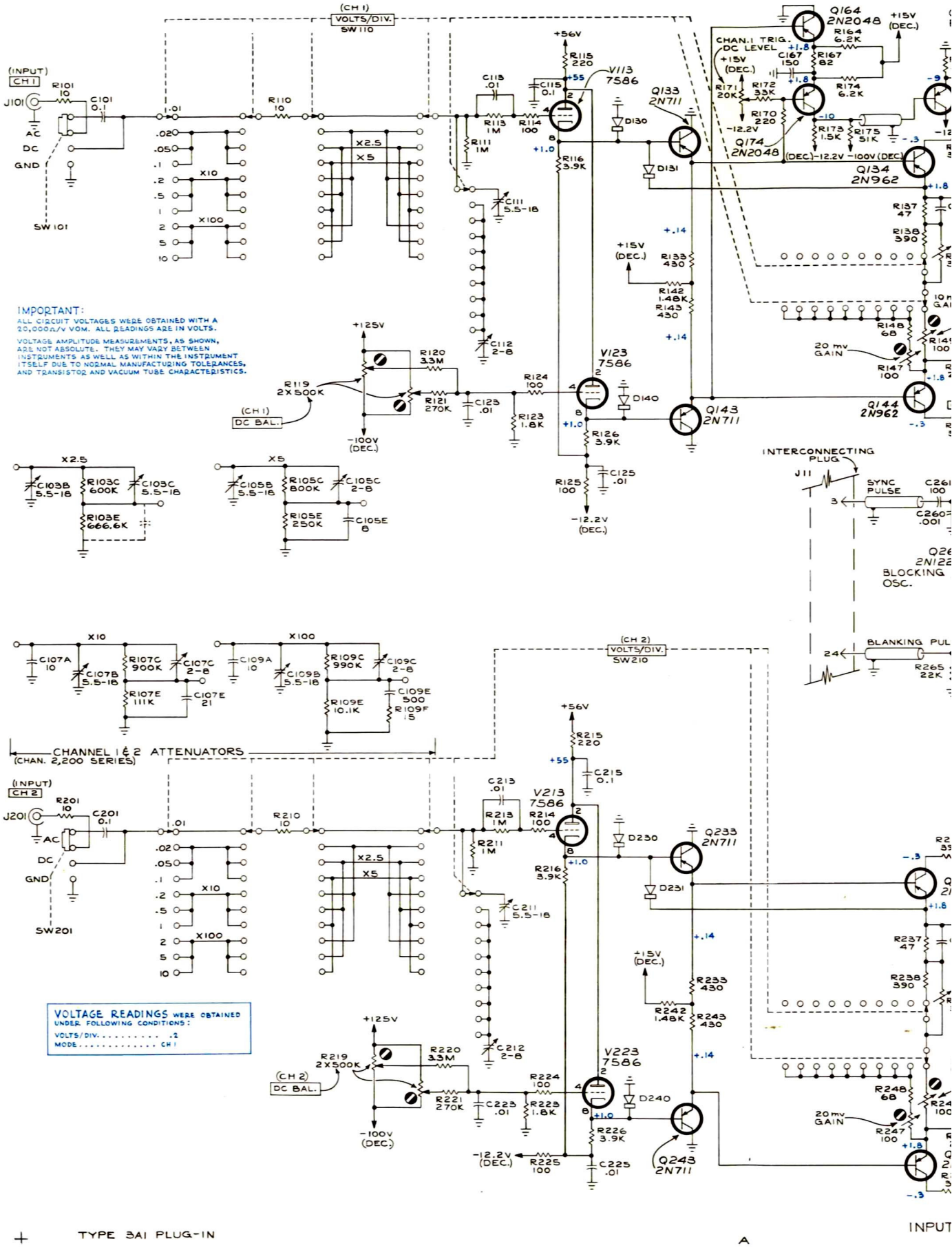
V113	154-306	7586	
V123	154-306	7586	
V213	154-306	7586	
V223	154-306	7586	
V334	154-187	6DJ8	
V353	154-187	6DJ8	
V364	154-361	8233/E55L	
V374	154-361	8233/E55L	
V383	154-187	6DJ8	



PLM 563

INPUT AMPLIFIER & SWITCHING CIRCUIT

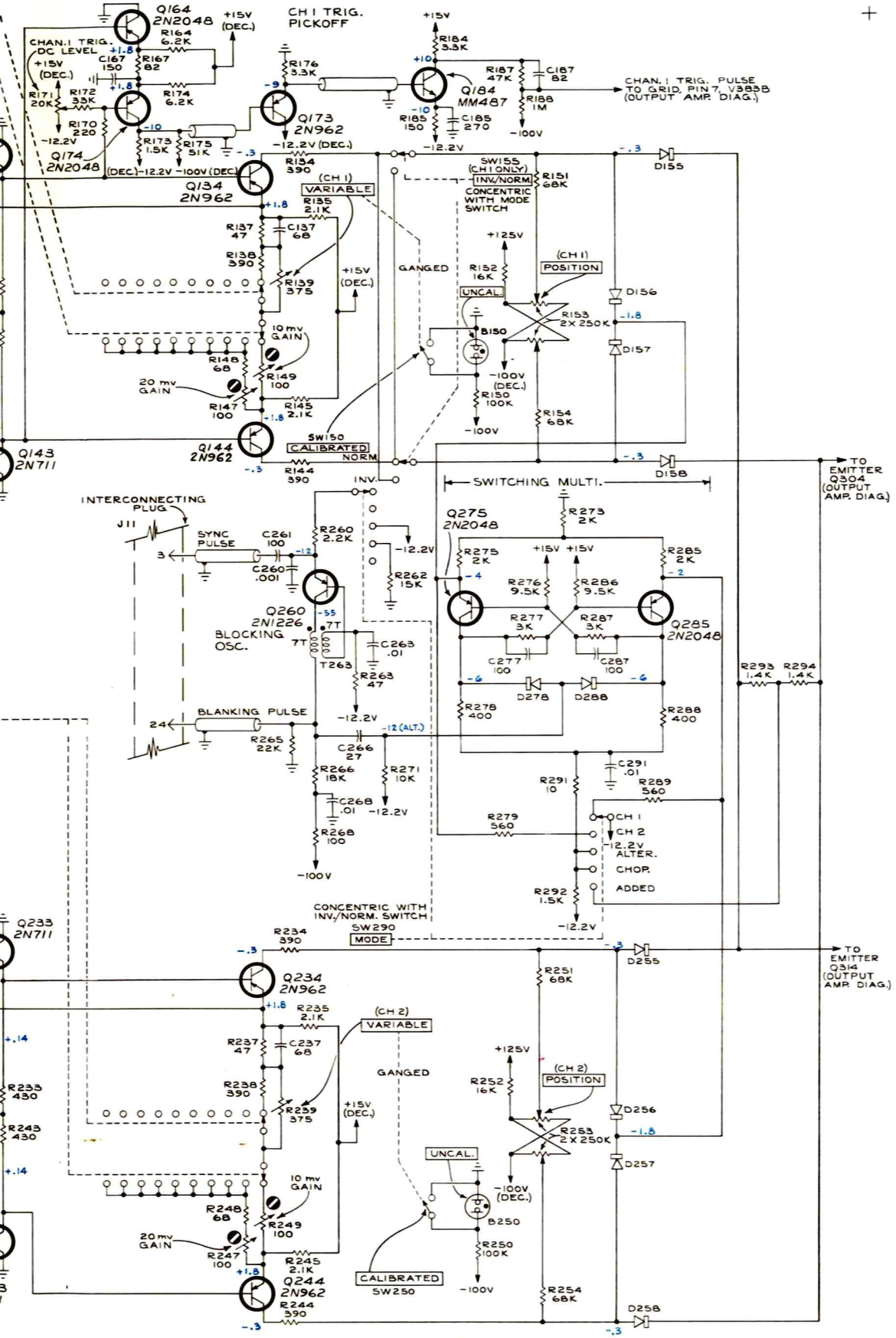
CIRCUIT NUMBERS 100 THRU 299



+ TYPE 3A1 PLUG-IN

A

INPUT

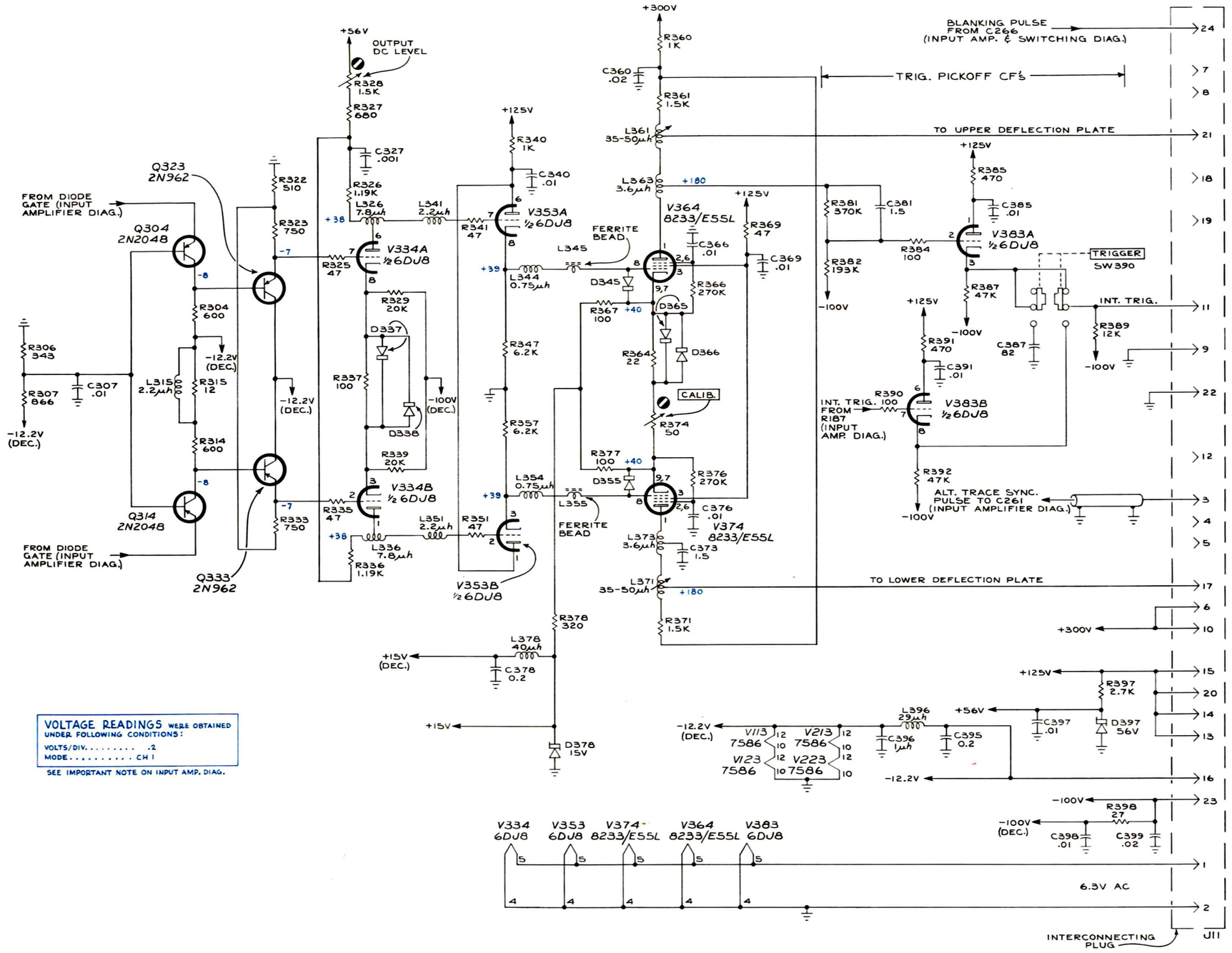


PLM 563

INPUT AMPLIFIER & SWITCHING CIRCUIT

CIRCUIT NUMBERS 100 THRU 299

A



VOLTAGE READINGS WERE OBTAINED UNDER FOLLOWING CONDITIONS:
VOLTS/DIV. 2
MODE . . . . . CH 1
SEE IMPORTANT NOTE ON INPUT AMP. DIAG.

+ TYPE 3A1 PLUG-IN UNIT

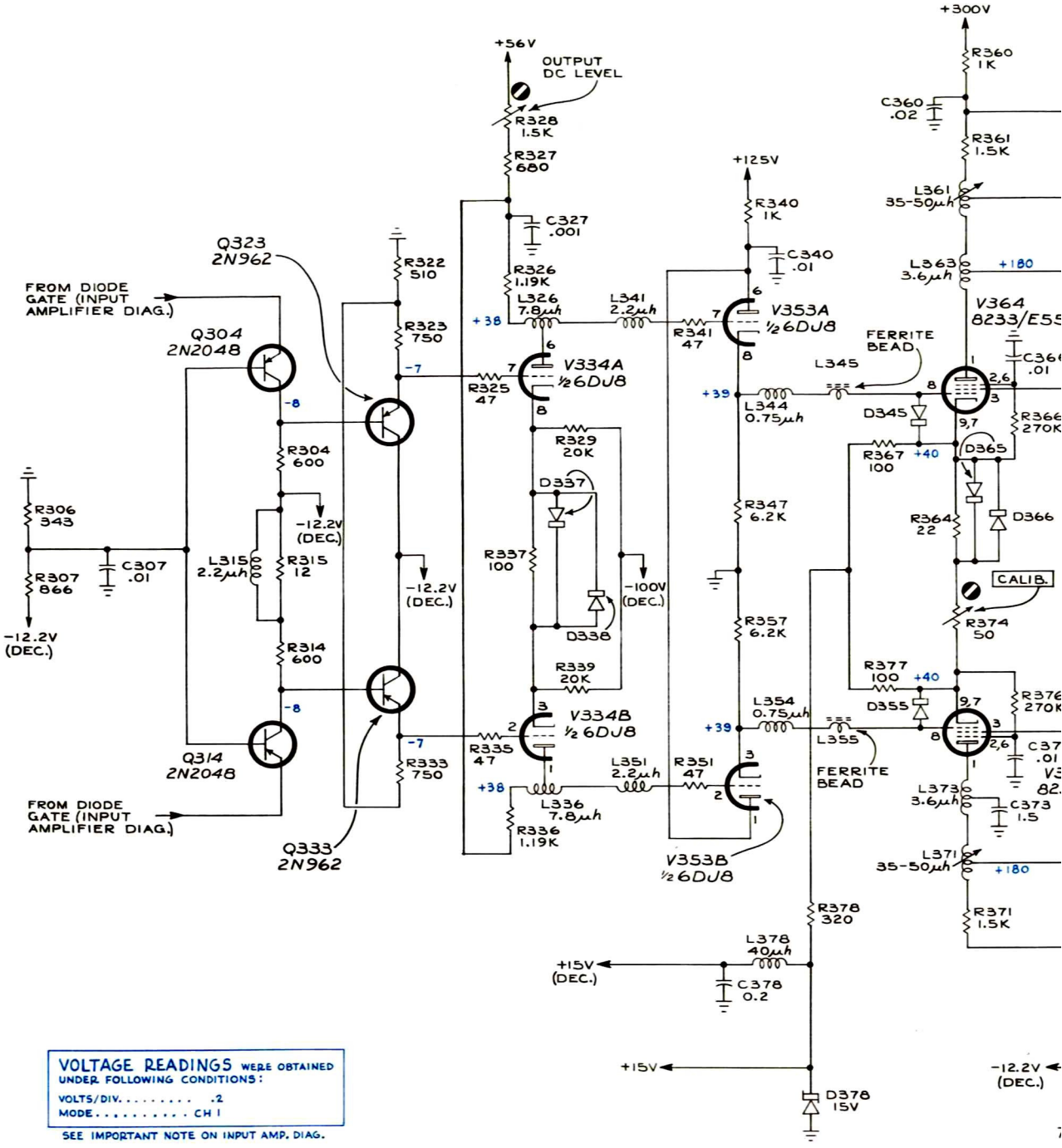
A

563 PLM

OUTPUT AMPLIFIER

CIRCUIT NUMBERS 300 THRU 399

OUTPUT AMPLIFIER

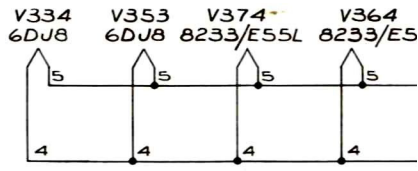


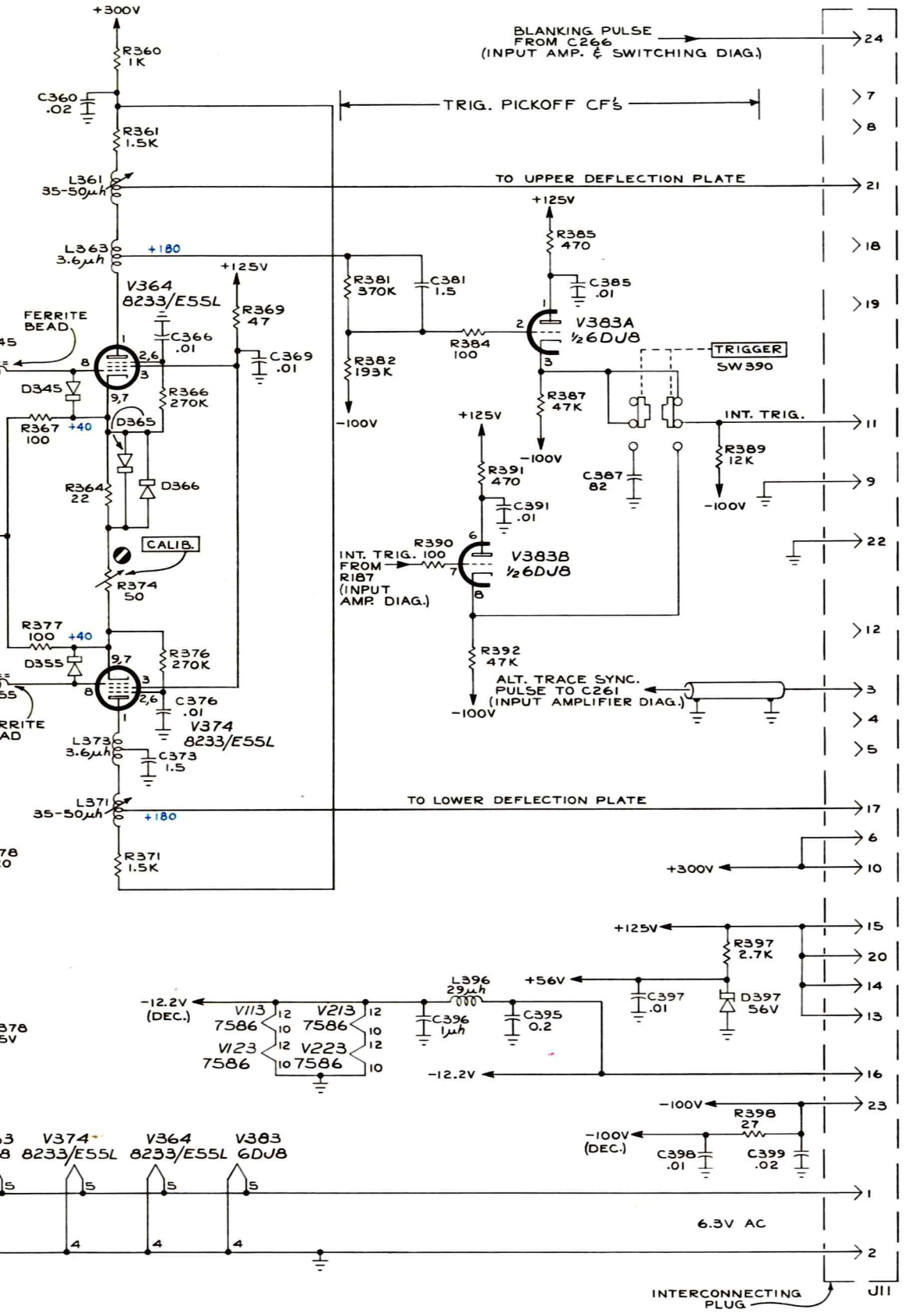
VOLTAGE READINGS WERE OBTAINED UNDER FOLLOWING CONDITIONS:

VOLTS/DIV. 2

MODE . . . . . CH 1

SEE IMPORTANT NOTE ON INPUT AMP. DIAG.





563 PLM

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OUTPUT AMPLIFIER

CIRCUIT NUMBERS 300 THRU 399

MANUAL CHANGE INFORMATION

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

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

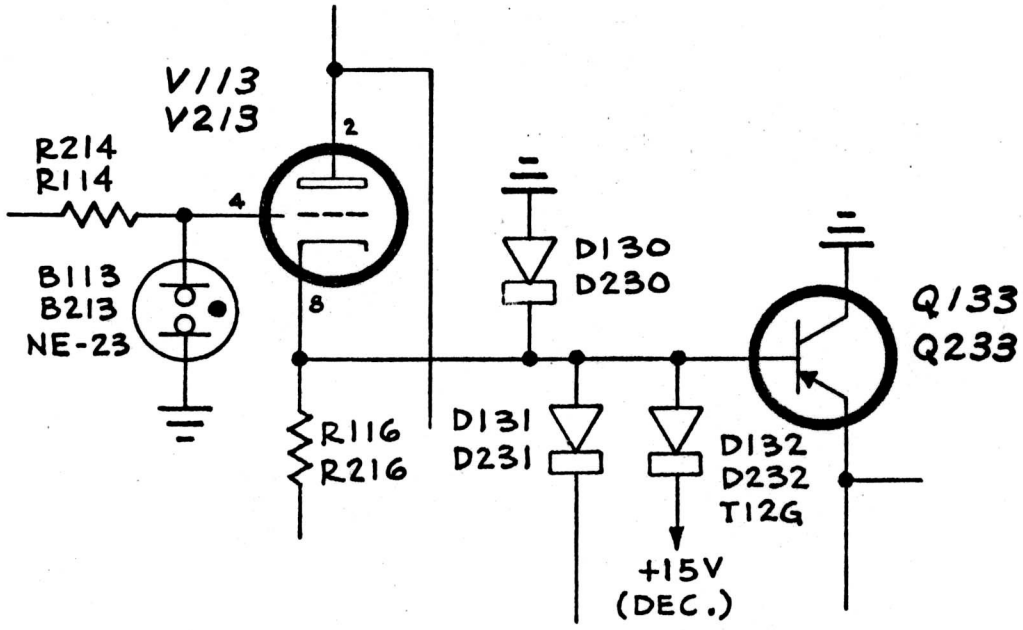
TYPE 3A1 Plug-In
MOD 6860 - Tent S/N 2020

Connector	Change to	BNC	1/2 D hole	131-126

TYPE 3A1
MOD 7115 - Tent S/N 1710

B113	Add	NE23 Neon	150-027
B213	Add	NE23 Neon	150-027
D132	Add	T12G Diode	152-008
D232	Add	T12G Diode	152-008

As Per Schematic Attached

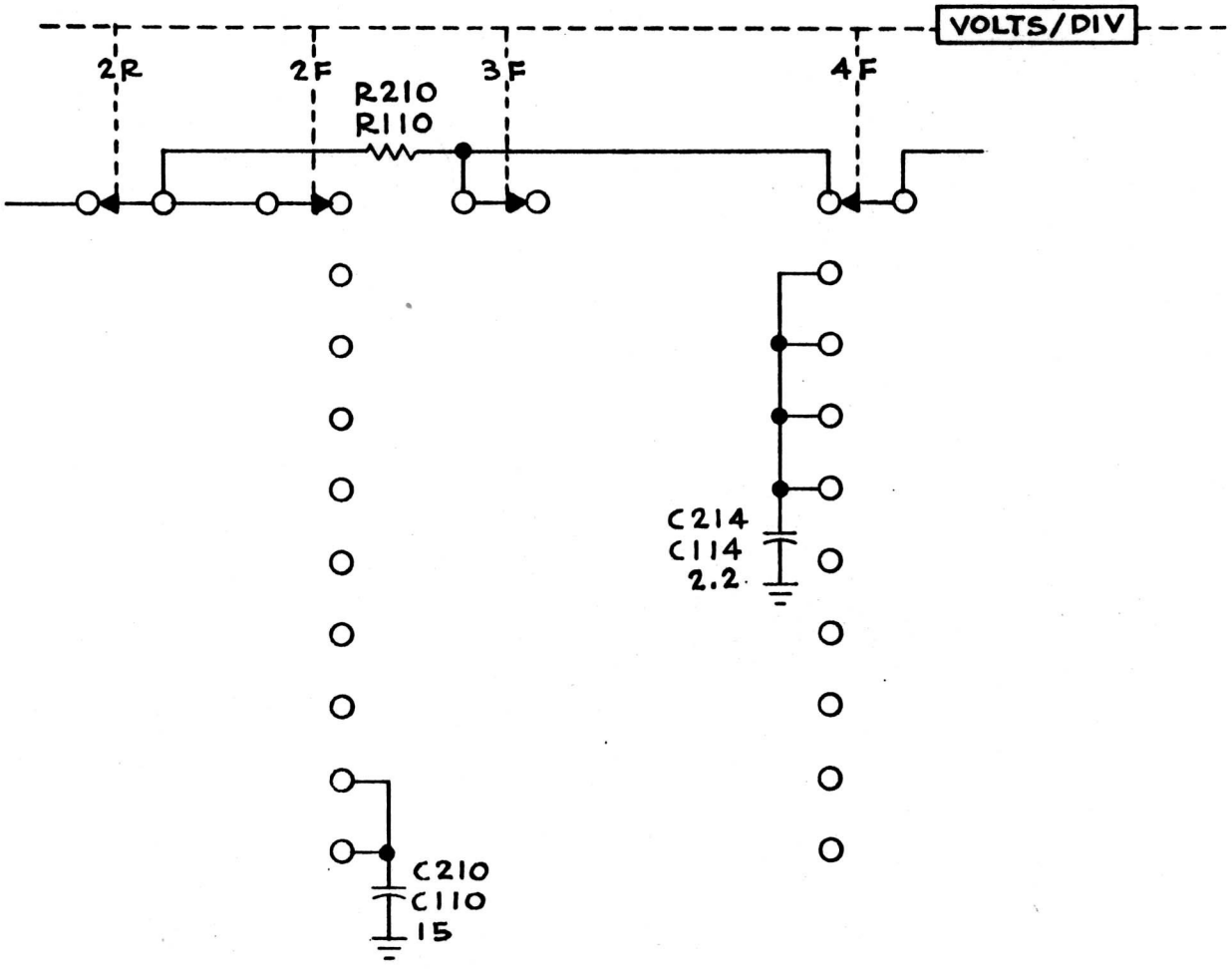


PART. INPUT AMPS. DIAG. 663

TYPE 3A1
MOD 6981 - Tent S/N 3050

C110	Add	15pf	cer	500v	281-509
C114	Add	2.2pf	cer	500v	281-500
C210	Add	15pf	cer	500v	281-509
C214	Add	2.2pf	cer	500v	281-500

As per Schematic attached.



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PART. CHAN. 1 & 2 ATTEN. SW.