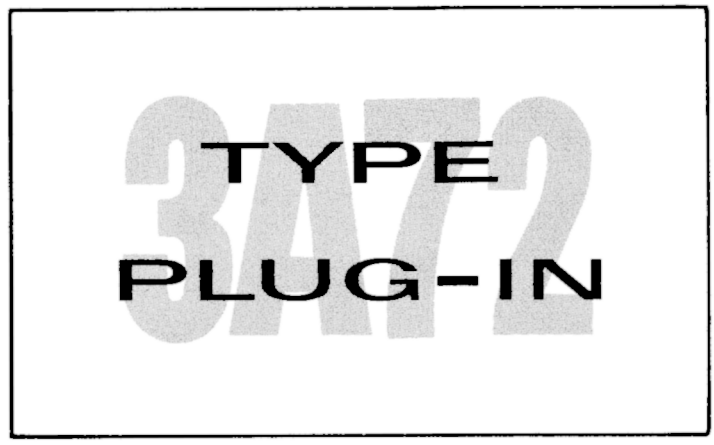
INSTRUCTION MANUAL

PRIOR TO SERIAL NUMBER 1420 THE TYPE 3A72 WAS REFERRED TO AS TYPE 72. The 3A72 Plug-in is interchangeable with the 72 and this manual also applies to the type 72 as far as operation and calibration are concerned.



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070-274

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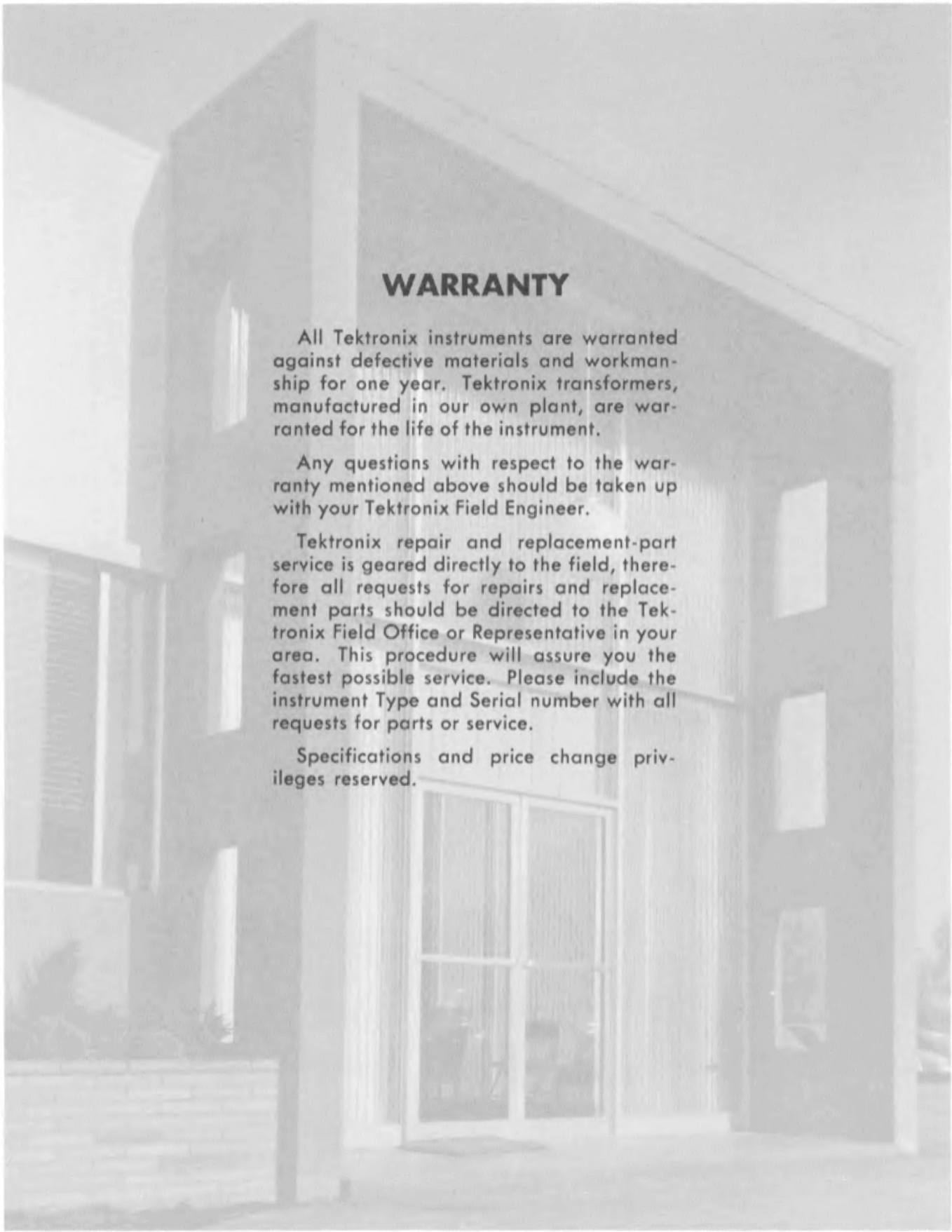

WARRANTY

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.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

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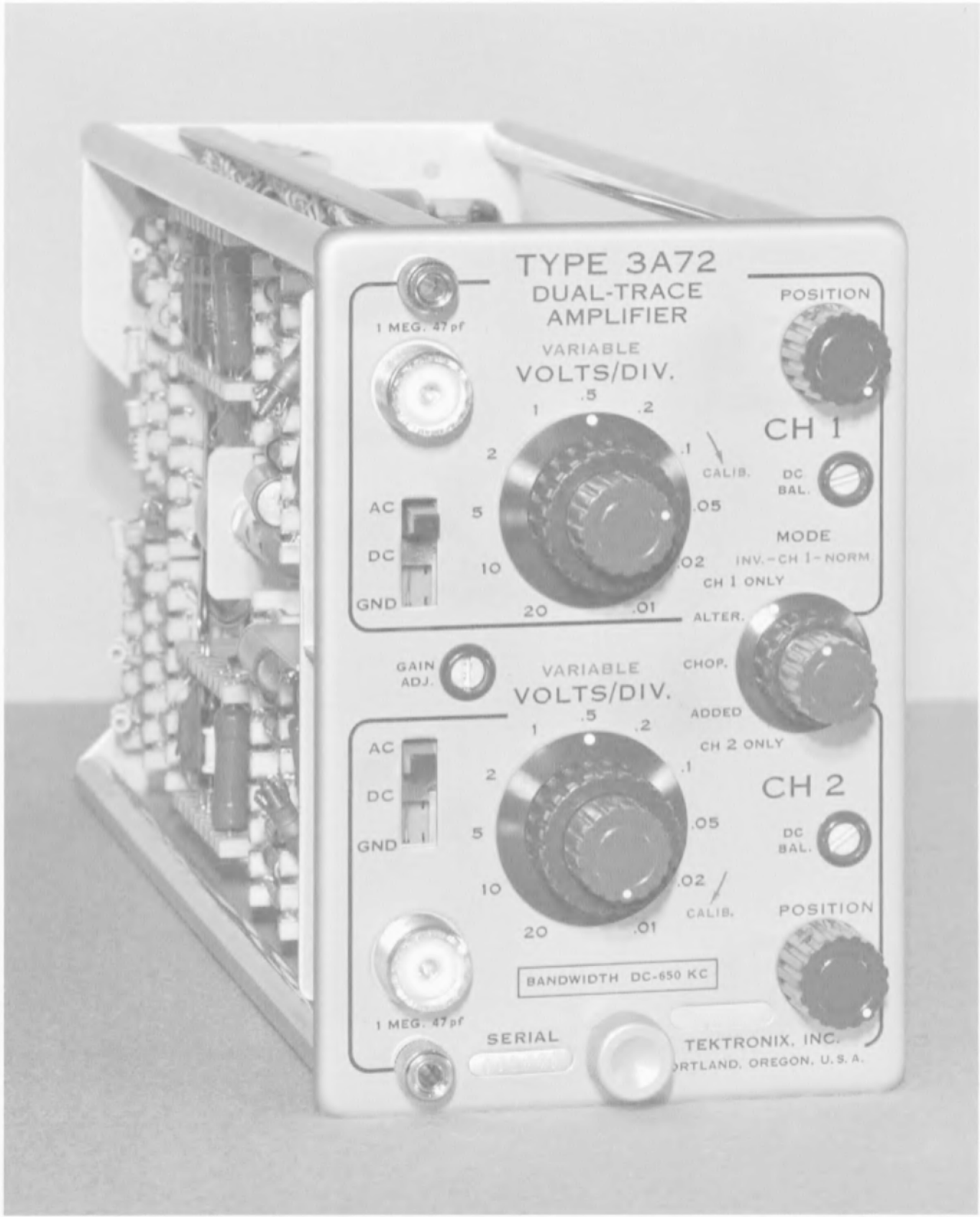

Fig. 1. The Type 3A72 Dual-Trace Amplifier.

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TYPE 3A72 DUAL-TRACE AMPLIFIER

INTRODUCTION

The Type 3A72 Dual-Trace Amplifier, Fig. 1, is a two-channel amplifier designed for use with the Type 561 or Type 565 Oscilloscope. It has a bandpass of dc to 650 kilocycles in both channels. Sensitivity of each channel is variable in eleven calibrated (within 3%) steps from 10 millivolts per division to 20 volts per division and is continuously variable (uncalibrated) from 10 millivolts to about 50 volts per division. Each channel has an input resistance of 1 megohm paralleled by 47 picofarads at all sensitivity settings. Five modes of operation are available: 1 Channel only, 2 Channel only, algebraic addition or subtraction, and chopped and alternate dual-trace operation.

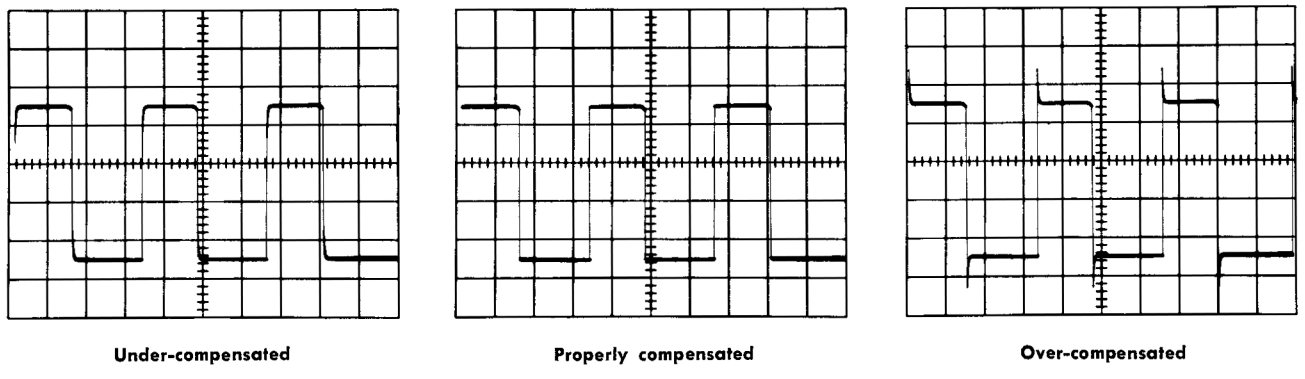
Throughout the following discussion it is assumed, unless otherwise noted, that the Type 3A72 is inserted into the Y-axis opening of a Type 561 or Type 565 Oscilloscope, thereby providing vertical deflection of the electron beam. If the Type 3A72 is inserted into the X-axis opening of a Type 561 Oscilloscope it will provide horizontal deflection and the instructions must be interpreted accordingly. If you are using a Type 561 Oscilloscope, it is further assumed that there is a time-base unit in its X-axis opening.

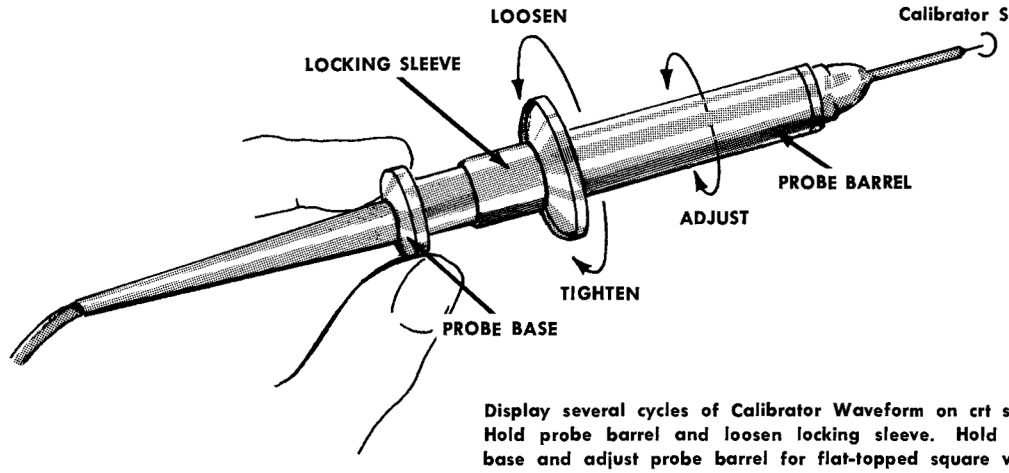
Operating Instructions

Signal Connections

The signal (or signals) to be displayed is applied to either (or both) input connector on the front panel of the Type 3A72. For best results the signals should be applied through a shielded cable with the shield connected to the chassis of both the oscilloscope and the signal source. Leads should be as short as possible.

High impedance attenuator probes are available for use with the Type 3A72. These probes reduce the capacitive and resistive loading effect of the unit and, at the same time, attenuate the signal to allow display of larger signals than would otherwise be possible. If a probe is used it should first be compensated as shown in Fig. 2. Probes and other accessories are described in the Accessories Section of the Type 561 and Type 565 Oscilloscope manuals.





Display several cycles of Calibrator Waveform on crt screen. Hold probe barrel and loosen locking sleeve. Hold probe base and adjust probe barrel for flat-topped square waves. Hold probe barrel and carefully tighten locking sleeve.

Fig. 2. Probe compensation adjustment.

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AC-DC-GND Switch

To display both the ac and dc components of an applied signal, set the appropriate AC-DC-GND switch to DC; to display only the ac component of a signal, set the appropriate AC-DC-GND switch to AC. In the AC position of the switch, the dc component of the signal is blocked by a capacitor in the input circuit. The lower frequency limit (3-db point) of the module is about 2 cps when the AC-DC-GND switch is in the AC position. Therefore, some low-frequency distortion of signals with components below this frequency will result if they are displayed with the AC-DC-GND switch in the AC position.

Placing the AC-DC-GND switch in the GND position grounds the input circuit of the Type 3A72; it does not ground the applied signal.

MODE Switch

When you wish to display a single signal with the Type 3A72, apply it to either input connector and set the MODE switch to the corresponding position (1 ONLY or 2 ONLY).

To display two signals simultaneously (dual-trace operation), connect a signal to each input connector and set the MODE switch to the CHOP. or ALTER. position. In general, you should use the CHOP. position with lower sweep rates and the ALTER. position with higher sweep rates.

To display the algebraic sum or difference of two signals as a single trace on the screen, connect one signal to each input connector and set the MODE switch to the ADDED position. If you wish to display the sum of the two signals, set the Channel 1 Polarity switch (red knob concentric with the MODE switch) to NORM. (1); if you wish to display the difference between the two signals, set the Channel 1 Polarity switch to INV. (1).

Dual-Trace Triggering

For dual-trace operation, it is usually best to trigger the time base with an external triggering signal which bears a fixed time relationship to the applied signals. (One of the applied signals may normally be used as the external triggering signal.) In this way, a stable display is more easily obtained, and the true time or phase relationship of the two signals is displayed. If the time or phase relationship between the two signals is not critical, you can use internal triggering of the time base in either the CHOP. or ALTER. mode of operation. Also, when using internal triggering in the ALTER. mode you should set the Coupling switch of the time base to AC FAST. Refer to the time-base manual for further information on triggering.

Gain and DC Balance Adjustments

Any time you move the Type 3A72 from one oscilloscope opening to another you must adjust the gain to compensate for differences in crt deflection sensitivities. In addition, the dc balance of both channels should be checked, and adjusted as necessary, from time to time.

To properly set the gain of the Type 3A72, proceed as follows:

1. Set the Channel 1 AC-DC-GND switch to DC and the MODE switch to 1 ONLY.

2. Set the Channel 1 VOLTS/DIV switch to .05 and the VARIABLE control fully clockwise.

3. Set the triggering controls of the time base for a free-running sweep.

4. Apply a 100-millivolt signal from the oscilloscope Calibrator to the Channel 1 input connector. (Do not use an attenuator probe.)

5. Set the GAIN ADJ. for a deflection of exactly two major graticule divisions.

6. Set the MODE switch to 2 ONLY and apply the 100-millivolt Calibrator signal to the Channel 2 input connector. You should obtain 2 divisions (±3%) of deflection. If you do not, refer to the CH. 2 GAIN procedure in the Calibration instructions of this manual.

If the dc balance of a channel is not properly adjusted, the position of a no-signal trace will shift on the screen as the VARIABLE control of that channel is moved. To properly set the dc balance, proceed as follows:

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

2. Set the MODE switch to 1 ONLY (or 2 ONLY) and position a free-running trace to the approximate center of the graticule.

3. Set the appropriate DC BAL. adjustment to the point where there is no trace shift on the screen as the VARIABLE control for that channel is rotated.

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 control is set fully clockwise.

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

1. Set the corresponding VOLTS/DIV switch such that the expected voltage (at the input connector) is not more than six times the setting. Make sure the VARIABLE control is set fully clockwise (to the CALIB. position).

2. Set the time-base controls so that the sweep free runs.

3. Set the appropriate AC-DC-GND switch to GND and, with the corresponding POSITION control, position the trace so that it lies along one of the horizontal graticule lines. This line will be used as a ground (or zero) reference line. The position of the reference line in any given case will depend upon the polarity and amplitude of the signal to be measured. Do not move the POSITION control of the Type 3A72 after the reference line has been established.

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4. Set the appropriate AC-DC-GND switch to DC. (If the position of the free-running trace shifts more than one minor graticule division when you switch the AC-DC-GND switch from GND to DC, see Troubleshooting, "DC Reference Level Shift".)

5. Apply the signal, preferably through a coaxial cable, to the appropriate input connector.

6. Set the triggering controls of the time base for a stable display.

7. Measure the vertical distance, in graticule divisions, from the ground (zero) reference line established in step 3 to the point on the waveform that you wish to measure.

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

You can re-establish your zero reference line at any time simply by setting the AC-DC-GND switch to GND; you do not need to disconnect the signal probe from the signal source. If you wish to establish a reference other than zero, set the AC-DC-GND switch to DC, touch the signal probe to the desired reference voltage, and position a free-running trace along one of the horizontal graticule lines.

Voltage Comparison Measurements

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

1. Apply the reference signal to either input connector and, with the corresponding VOLTS/DIV switch and its VARIABLE control, adjust the amplitude of the display for an exact number of graticule divisions. Do not move the VARIABLE control after you have obtained the desired deflection.

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.

$$\text{Conversion Factor} = \frac{\text{Amplitude of reference signal (in volts)}}{\text{Amount of Deflection} \times \text{VOLTS/DIV setting}}$$

3. To calculate the true sensitivity at any setting of the VOLTS/DIV switch, multiply the switch setting by the sensitivity conversion factor obtained in step 2.

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

This new set of sensitivity values applies to this channel only, and only as long as the VARIABLE control is not moved from the position to which it was set in step 1.

Phase-Difference Measurements

A phase comparison between two sine waves of the same frequency can be made by making use of the dual-trace feature of the Type 3A72. To make this comparison, proceed as follows:

1. Apply each signal to one of the input connectors, and set the MODE switch to CHOP. or ALTER., as appropriate. Externally trigger the time base.

2. With the POSITION controls of the Type 3A72, center both signals vertically on the graticule.

3. On the time base, set the TIME/DIV switch and the VARIABLE control so that one cycle of one waveform occupies 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 centerline. Multiply this distance by 40° per division to obtain the phase difference between the two signals.

For more precise measurements, you may increase both the vertical sensitivity and the sweep rate between steps 3 and 4 of the procedure if you desire. However, if you increase the sweep rate, you must take this into consideration in your calculations. That is, if you increase the sweep rate by a factor of 5, and then measure the distance between the waveforms, each division will represent 8° (40° ÷ 5) of a cycle.

Dual X-Y Displays

1. Insert a Type 3A72 into each opening of the Type 561A Oscilloscope.

2. Set both MODE switches to CH. 1 ONLY.

3. Connect one pair of signals to the CH. 1 input connectors and set the proper VOLTS/DIV. and POSITION controls for the desired display.

4. Set both MODE switches to ALTER.

NOTE

It is important at this point that the display does not change between steps 3 and 4. If the display does change, return both MODE switches momentarily to CH. 1 ONLY and then return them to ALTER. A change in the display indicates improper pairing; i.e. CHANNEL 1 of one unit is paired with CHANNEL 2 of the other unit and vice versa. If the problem persists, it might be corrected by reversing the two plug-in units and repeating the above procedure.

5. Set the MODE switch of the left hand plug-in unit to CHOP and apply the remaining pair of signals to the CH. 2 input connectors.

6. Set the CH. 2 VOLTS/DIV. and POSITION controls for the desired display. As a final check to insure that the individual channels are paired properly, move both CH. 1 POSITION controls simultaneously; these controls should change the vertical and horizontal position of one display only and not affect the other display.

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Circuit Description

The Type 3A72 Dual-Trace Amplifier contains two virtually identical input channels (Channel 1 and Channel 2), a common Output Amplifier, and a Switching Circuit (see Fig. 3). The output of either or both input channels may be applied to the Output Amplifier depending upon the condition of the Switching Circuit. Thus, the Switching Circuit makes it possible to display one signal as a single trace on the screen, two signals simultaneously in a dual-trace display, or the algebraic sum or difference of two signals as a single trace in a differential display.

A schematic diagram of the Type 3A72 Amplifier appears at the rear of this manual.

Input Channels

Each input channel consists of an attenuation network, an Input Amplifier, and a Switched Amplifier. The Input Amplifier (V434-V444 in Channel 1; V534-V544 in Channel 2) is a cathode-coupled paraphase amplifier which converts the single-ended input from the attenuation network to a push-pull output. The Switched Amplifier (V454-V464 in Channel 1; V554-V564 in Channel 2) is a push-pull amplifier which derives its name from the fact that it is turned off and on by the Switching Circuit to allow selection of the signal to be applied to the Output Amplifier and displayed on the crt.

Since the two input channels are virtually identical, the remainder of this discussion will refer to circuit components in Channel 1 only. Operation of Channel 2 is the same except for the Channel 1 Polarity switch.

The signal to be displayed is applied to the grid circuit of Input Amplifier tube V444 via the AC-DC-GND switch and the Attenuator. The AC-DC-GND switch is a three-position slide switch that either bypasses C400 (DC position) or places it in the circuit (AC position), or grounds the input of the attenuator circuit (GND position). When C400 is in the circuit, the dc component of the applied signal is blocked and only the ac component of the signal reaches the grid of V444. When C400 is bypassed, both the ac and dc components of the applied signal appear at the grid of V444.

The attenuation network is made up of resistive and capacitive voltage dividers. At low frequencies they act primarily as resistance dividers; at higher frequencies they act primarily as capacitance dividers. The variable capacitors at the input to each attenuator, together with C413 and C418, provide a means for setting the input capacity of the circuit to a standard value (47 picofarads in this case). The variable series capacitors (C410C, C411C, C414C, and C415C) in the attenuation networks are adjusted to maintain constant voltage division throughout the frequency range of the instrument. The design of the attenua-

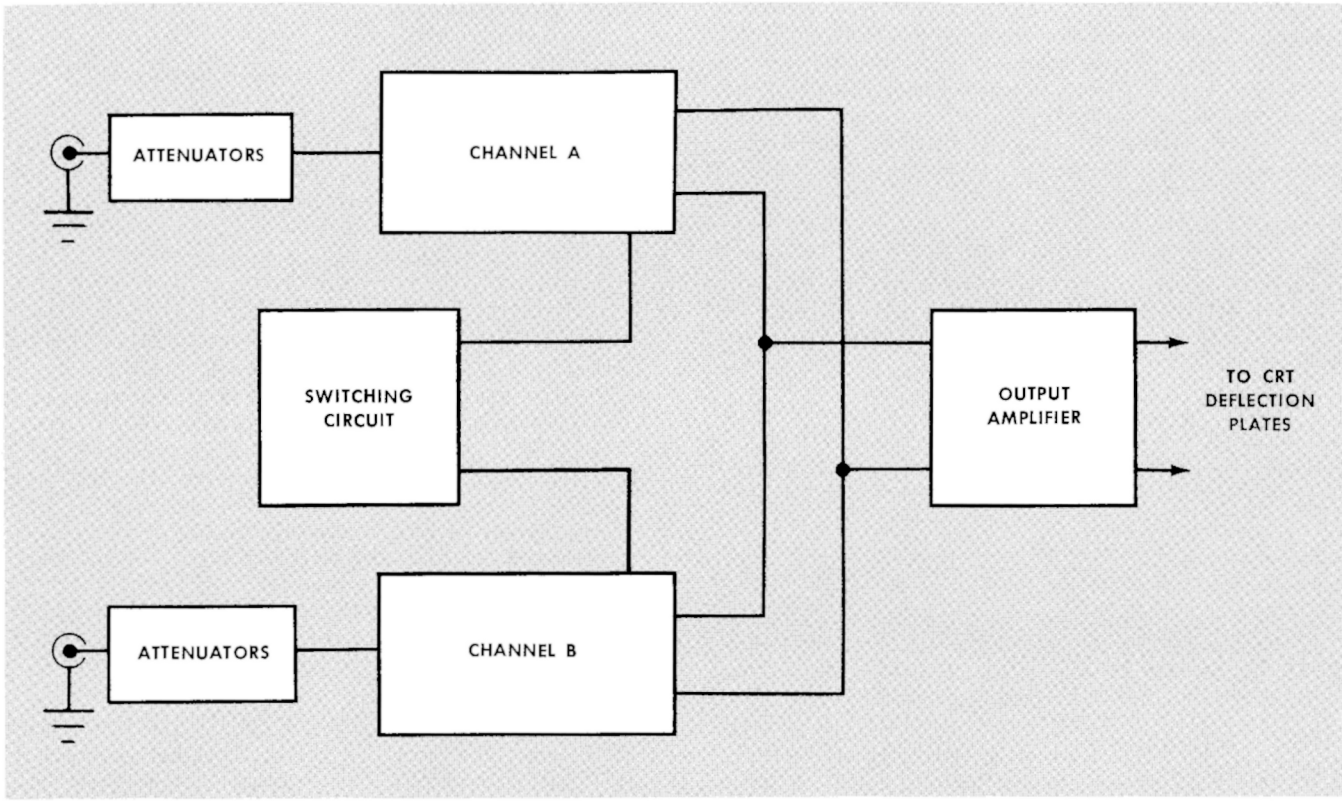

Fig. 3. Block diagram of the Type 3A72 Dual-Trace Amplifier.

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tion networks provides a constant input resistance of one megohm and a constant input capacitance of 47 picofarads at all settings of the VOLTS/DIV switch.

The gain of the Input Amplifier varies with the value of R448 selected by the VOLTS/DIV switch. When the VOLTS/DIV switch is set at .01, the nominal gain of the stage is about 8; when the VOLTS/DIV switch is set at .02, the nominal gain of the stage is about 4; when the VOLTS/DIV switch is set at any of its other positions, the nominal gain of the stage is about 1.6. R435 and R445 also provide means for varying the gain by varying the cathode degeneration. R445 is set at zero resistance when the VARIABLE control is set fully clockwise. R435 is used to set the gain of Channel 1 equal to that of Channel 2.

C441 neutralizes the apparent changes in the grid-to-cathode capacity of the Input Amplifier as the cathode degeneration (gain) is varied.

The DC BAL. adjustment in the grid circuit of V434 is set to place both cathodes of the Input Amplifier at the same potential so that under no-signal conditions there is no current through R435 and R445. Otherwise, the position of a no-signal trace would shift on the screen as the value of R435 or R445 is changed.

The CH. 1 ATTEN. BAL. potentiometer, R439, provides the means of eliminating dc shift of the trace as the value of R448 is changed.

The Channel 1 Polarity switch (red knob concentric with the MODE switch) makes it possible to invert the displayed waveform with respect to the applied signal in Channel 1. Thus, it is possible to obtain either addition or subtraction of two signals when the MODE switch is in the ADDED position.

The Switched Amplifier V454-V464 is a push-pull circuit having a nominal gain of about 6. Rotation of either R453 or R455 forces the cathodes of the Switched Amplifier in opposite directions (one negative and one positive). The resulting changes in average plate voltages of the tubes causes the position of the trace on the oscilloscope screen to change. R453 is the front-panel POSITION control, and R455 is the internal CH. 1 POS. RANGE adjustment which is used to center the range of the POSITION control.

Output Amplifier

The push-pull output of the Switched Amplifier is applied to the common Output Amplifier which, in turn, drives the crt deflection plates via pins 17 and 21 of the interconnecting plug.

R484, the front-panel GAIN ADJ. adjustment, controls the gain of the Output Amplifier and is used to adjust the overall gain of the Type 3A72 to the proper value. The gain of the Output Amplifier can be varied over a wide enough range to allow for differences in crt deflection plate sensitivities from oscilloscope to oscilloscope and between oscilloscope openings. R484 is set to provide a gain in the Output Amplifier of about 48 when the Type 3A72 is in the Y-axis opening of an oscilloscope. Thus, in the most sensitive position of the VOLTS/DIV switch (.01 position), the overall gain of the Type 3A72 is about 2300, which produces about 23 volts of signal at the crt deflection plates for each 0.01 volt of signal at the grid of either Input Amplifier. (Nominal vertical sensitivity of the cathode-ray tubes used in the Type 561 and Type 565 Oscilloscopes is about 23 volts per centimeter of deflection.)

D494 and D495 improve the linearity of the Output Amplifier near the limits of its dynamic range by shunting R494 on large signals.

Trigger Pickoff

The Trigger Pickoff cathode follower, V484B, couples a sample of the signal at the plate of V484A to the time base (via pin 11 of the interconnecting plug) for internal triggering.

The INT. TRIG. DC LEVEL adjustment, R489, is used to set the dc level at the cathode of V484B to zero volts when the trace is centered on the screen and there is no signal applied to the instrument.

Output of the Trigger Pickoff cathode follower is about 3 volts for each division of deflection on the crt.

Switching Circuit

Selection of the input channel whose output is to be applied to the Output Amplifier is accomplished by means of the Switching Circuit. A block diagram of the Switching Circuit is shown in Fig. 4.

The Switching Circuit may be operated in any of five modes, selected by the MODE switch, SW585A. When the MODE switch is in the 1 ONLY position, V585A conducts heavily and V585B is cut off. With V585B cut off, its plate is at about +58 volts, and the cathode of V593B is at about +60 volts. D595 conducts and places the cathodes of the Channel 2 Switch Amplifier (V554-564) at +60 volts. Since the grids of the Switched Amplifiers are at about +35 volts, this cuts off the Channel 2 Switched Amplifier.

With V585A conducting, its plate is at about +10 volts, and the cathode of V593A is at about +15 volts. D594 is back-biased which returns the cathodes of the Channel 1 Switched Amplifier (V454-V464) to ground through R456. The Channel 1 Switched Amplifier conducts, applying its signal to the Output Amplifier.

When the MODE switch is set to 2 ONLY, just the opposite exists; the Channel 2 Switched Amplifier conducts and the Channel 1 Switched Amplifier is cut off. The Channel 2 signal is therefore displayed on the crt.

When the MODE switch is in the ALTER. position, the crt displays the signal in one channel for one sweep of the beam, and the signal in the other channel for the next sweep of the beam. In this mode of operation, V585 becomes a bistable switching multivibrator which is switched from one state to the other at the end of each sweep. Switching is accomplished as follows:

At the end of each sweep of the time base, a positive spike is applied from the Time-Base Generator through C570 to the grid of V494B. V494B is normally cut off; the spike turns it on momentarily. Current flows through the

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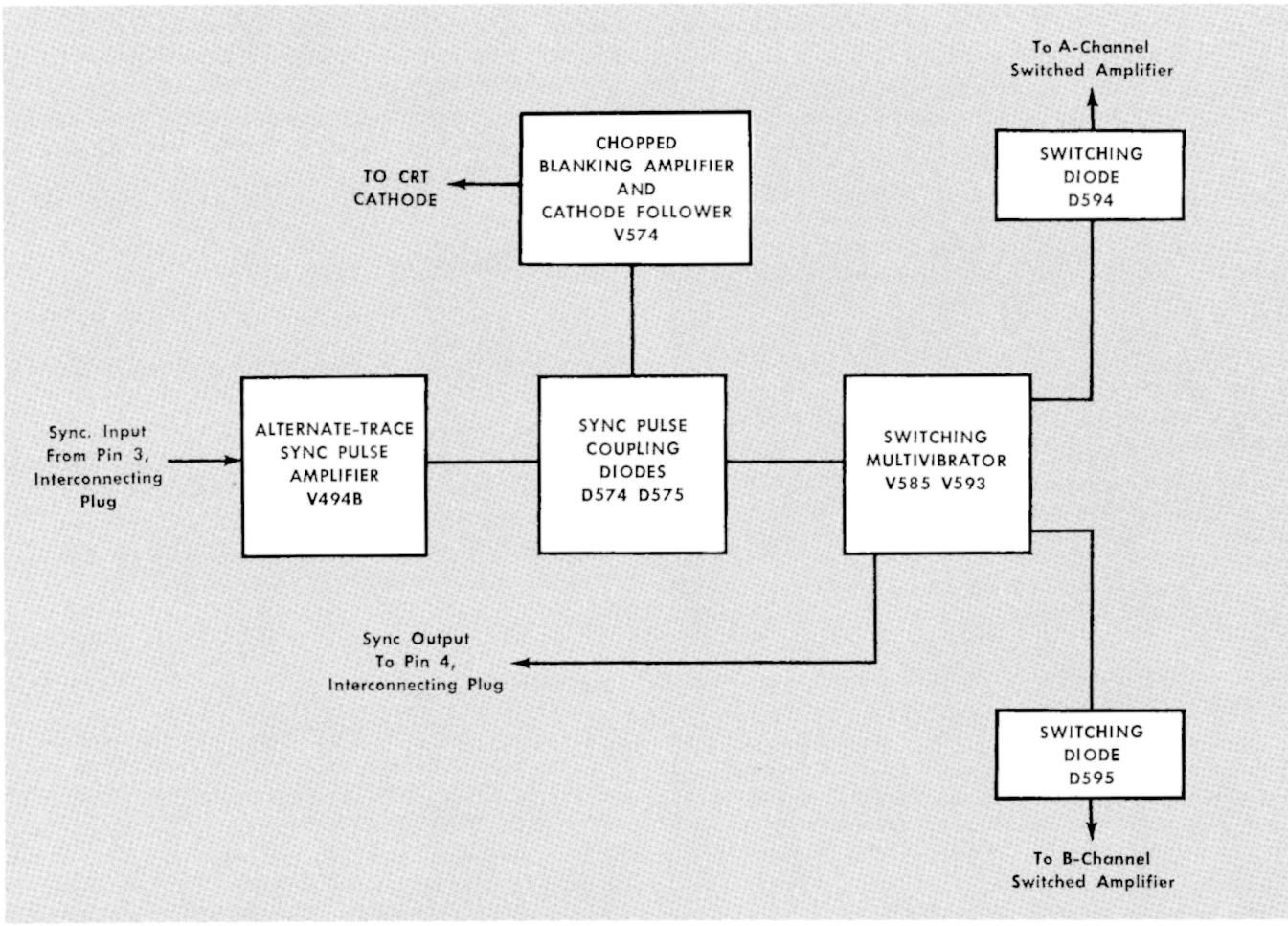

Fig. 4. Block diagram of the Switching Circuit.

tube and through D574 and D575, producing negative spikes which are coupled through V593A and V593B to both grids of V585. Since one side of V585 is already cut off, the negative spike on that grid will have no effect. However, the negative spike at the other grid will cut off that side (which is conducting) and cause the multivibrator to change states.

In the CHOP. position of the MODE switch, the Switching Circuit becomes an astable multivibrator and free-runs at about 30 kc. Thus, the outputs of the 1 and 2 channels are alternately turned off and on at a 30-kc rate, independent of the sweep rate.

Since the POSITION controls of the two channels are normally set at different levels, it is necessary, in the CHOP. mode, to turn the crt beam off as the switching between channels occurs. This is accomplished by V574. The negative-going pulses formed as the two sides of the multivibrator (V585) alternately come into conduction are differentiated and applied as negative spikes to the grid of V574A. V574A amplifies and inverts the spikes and applies them through cathode follower V574B and pin 24 of the interconnecting plug to the cathode of the crt. These pulses cut off the crt and blank the beam during switching.

In the ADDED position of the MODE switch, plate voltage is removed from the plates of V585. This allows both amplifier channels to operate simultaneously. With both channels working into the Output Amplifer, the Type 3A72 operates as a differential amplifier—that is, in-phase signals subtract and out-of-phase signals add, and the result is displayed on the crt. Also, plate current demands for the Switched Amplifiers is doubled. To compensate for this, R465 is placed in parallel with R466 to maintain the same average plate voltage.

The connection from the common cathodes of V585 to pin 4 of the interconnecting plug provides the means for synchronized dual-channel X-Y operation of two Type 3A72 Amplifiers in the same Type 561 Oscilloscope. A positive spike is generated at the cathodes each time the multivibrator changes states. Pin 4 of the interconnecting plug in one opening of the Type 561 Oscilloscope is connected to pin 3 of the other interconnecting plug. Thus, the positive switching spikes from a Type 3A72 set to the CHOP. mode in one oscilloscope opening will cause switching of a Type 3A72 set to the ALTER. mode in the other oscilloscope opening. Both will therefore switch at the 30-kc rate in synchronization.

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Troubleshooting

General

General maintenance and troubleshooting information is contained in the Type 561 and Type 565 Oscilloscope manuals. In the following discussion it is assumed that you have read that information and have isolated trouble to the Type 3A72.

Apparent troubles in the instrument may be due to improper calibration. Consequently, one of the first steps in troubleshooting should be to check the calibration of the instrument.

The Type 3A72 is composed of four general circuits. Channel 1, Channel 2, the Switching Circuit and the Output Amplifier. By comparing the various settings of the MODE switch with the trouble at hand the faulty circuit can generally be identified. Once the trouble has been isolated to one of the four general circuits, refer to the following instructions.

Circuit Troubleshooting

This portion of the Troubleshooting Section describes the method for isolating trouble to a particular stage in the instrument. Once the faulty stage is determined, the component or components causing the trouble can be located by tube and/or component substitution and/or by voltage and resistance measurements.

Abnormal or No Gain. If abnormal or no gain is noted in all modes of operation, the trouble is in the Output Amplifier or one of the following resistors: R465, R466, R467, or R468. If gain trouble is noted in a single channel and in certain positions of its VOLTS/DIV switch, the trouble is in the corresponding attenuator circuit. If trouble is noted in all positions of the applicable VOLTS/DIV switch, the trouble is in one of the amplifier stages, probably a component that is common to both sides of the push-pull circuit. To troubleshoot for this condition, check the voltages in the circuit and compare them with those indicated on the schematic diagram.

No Spot or Trace. This indicates an imbalance condition in the instrument. That is, there is a significant dc voltage difference between the two sides of the push-pull circuit. If this condition is noted in all modes of operation, the trouble is in the common Output Amplifier. If not, the trouble is in one of the amplifier channels. To troubleshoot for this condition, proceed as follows. With a shorting strap, short between the plates of the first stage (with the Type 3A72 plugged into the oscilloscope and power applied). If a spot or trace does not appear, short between the plates of the second stage. When the defective stage is shorted, a spot or trace will appear on the crt.

No Dual Trace. If a dual trace is not obtainable in either dual-trace mode (ALTER. or CHOP.), the trouble is in the Switching Multivibrator. If a dual trace can be obtained in the CHOP. mode but not in ALTER., the trouble is in V494B or its associated circuitry, or the MODE switch.

Switching Transients Visible in CHOP. Mode. If the switching transients are apparent in the CHOP. mode, the trouble is in V574 or its associated circuitry.

DC Reference Level Shift. If a free-running trace changes position by more than 1 minor graticule division as you move the AC-DC-GND switch from GND to DC, the input tube (V444 or V544) is defective and should be replaced. If a replacement tube is not readily available a satisfactory ground reference may be established by grounding the probe tip instead of placing the AC-DC-GND switch in the GND position. You must do this with the VOLTS/DIV switch in the setting that will be used for making the voltage measurement. Each time you change the setting of the VOLTS/DIV you should ground the probe tip to re-establish the ground reference line.

Calibration

Introduction

To maintain its high level of performance, we recommend that the Type 3A72 be calibrated after each 500 hours of operation or about every six months, whichever is sooner. However, if tubes or other circuit components are replaced, calibration of the circuit involved should be checked and adjusted as necessary.

In the instructions that follow, the steps are arranged in the proper sequence for a complete calibration. However, any single step may be performed individually or out of sequence as long as the entire step is completed.

Equipment Required

The following equipment is required for a complete calibration of the Type 3A72 Dual-Trace Amplifier:

1. A Type 561 Oscilloscope and a Type 2B67 Time-Base unit, or a Type 565 Oscilloscope.

2. Square-wave generator with a frequency output of about 1 kc, risetime of 0.5 μsec or less, and a variable output amplitude of about 1 to 80 volts. (Tektronix Type 105 Square-Wave Generator recommended.)

3. 47-pf capacitance standardizer (Tektronix Type CS-47 recommended) or a capacitance meter capable of measuring 47 picofarads (Tektronix Type 130 L-C meter and attenuator probe with variable capacitance recommended).

4. DC voltmeter, sensitivity at least 5000 ohms per volt.

5. Low-capacitance calibration tool: Tektronix part number 003-000 or equivalent.

6. 10:1 attenuator "T" pad: Tektronix Type B52-T10 or equivalent.

7. Coaxial cable: Tektronix Type P52 or equivalent.

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Calibration Procedure

Preliminary. With the exception of the INT. TRIG. DC LEVEL adjustment, all internal calibration adjustments are located in channels 1 and 2. The calibration method for each channel is identical. Consequently, the following instructions apply equally to both channels. Any control setting not mentioned in a given step is assumed to be in the position that it was in at the end of the previous step.

Figs. 5 and 6 show the location of the internal adjustments referred to in this procedure.

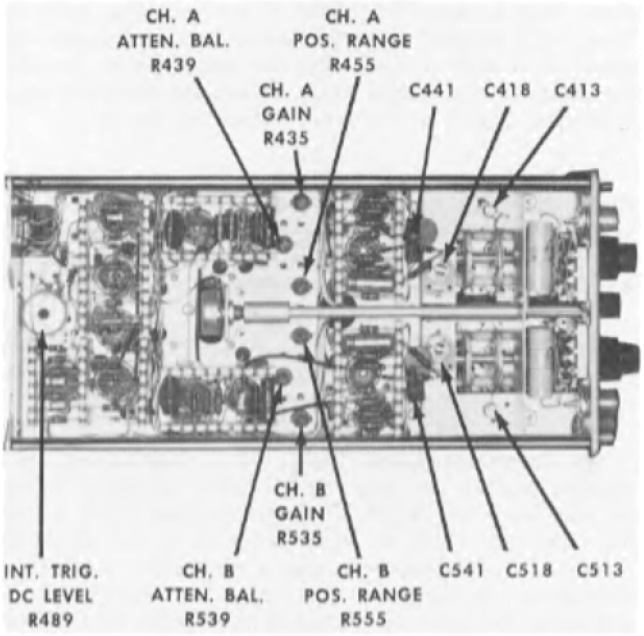

Fig. 5. Internal adjustments of the Type 3A72 Amplifier—left side.

Insert the Type 3A72 in the left-hand opening of the Type 561 or Type 565 Oscilloscope and allow it to warm up for at least 2 minutes. If you are using a Type 561 Oscilloscope, insert a Type 2B67 Time-Base unit into the right-hand (X-aaxis) opening. Set the time-base controls for automatic triggering.

After sufficient warm up, set the DC BAL. of both channels as described in the Operating Instructions.

CH. 1 and CH. 2 ATTEN. BAL. Set the time-base controls for a 1 millisecond-per-division free-running sweep. Set the MODE switch of the Type 3A72 to ALTER. With the POSITION controls of the Type 3A72, position both traces into the viewing area of the graticule. Switch the 1 Channel VOLTS/DIV switch back and forth between the .01 and .05 positions and adjust the CH. 1 ATTEN. BAL. for no trace shift. Switch the 2 Channel VOLTS/DIV switch back and forth between the .01 and .05 positions and adjust the CH. 2 ATTEN. BAL. for no trace shift.

CH. 1 and CH. 2 POS. RANGE. Set both POSITION controls of the Type 3A72 to midrange. With the CH. 1 and CH. 2 POS. RANGE adjustments, position both traces to the center of the graticule.

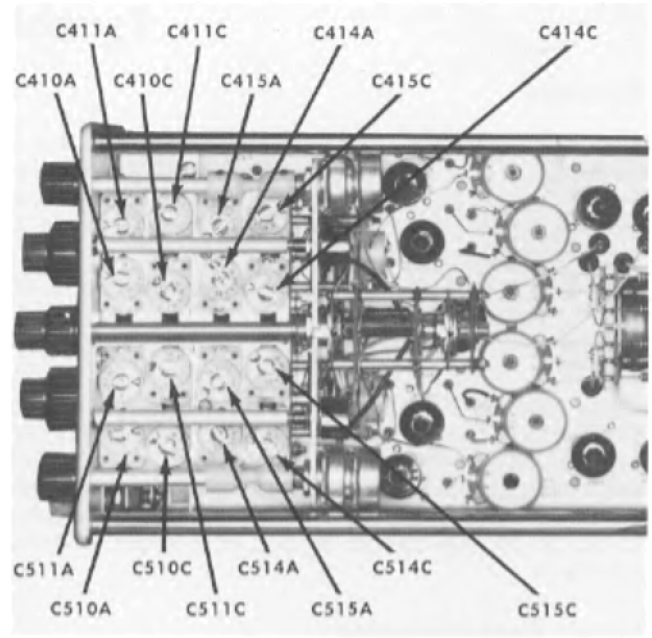

Fig. 6. Internal adjustments of the Type 3A72 Amplifier—right side.

CH. 1 GAIN. Apply a 0.1-volt signal from the Oscilloscope Calibrator to the 1 Channel input connector. Set the MODE switch to the 1 ONLY position and the CH. 1 GAIN adjustment to midrange. Place the 1-Channel VOLTS/DIV switch in the .05 position, the AC-DC-GND switch in the DC position, and the 1 Channel VARIABLE control fully clockwise. Set the GAIN ADJ. (a front-panel screwdriver adjustment) for exactly two major divisions of deflection.

CH. 2 GAIN. Apply a 0.1-volt signal from the Oscilloscope Calibrator to both input connectors of the Type 3A72. Place the 2 Channel VOLTS/DIV in the .05 position and turn the VARIABLE control fully clockwise. Set the black knob of the MODE switch to ADDED and the red knob to INV. (1). Set the POSITION controls of both channels to midrange. Adjust the CH. 2 GAIN for a null (most complete cancellation of signal) indication on the screen of the oscilloscope. If a null cannot be obtained, set the CH. 2 GAIN adjustment near the end of its range at which the null is most nearly obtained, and readjust the CH. 1 GAIN adjustment for a null. Then set the GAIN ADJ. (front-panel) for the proper deflection.

To check the 2 Channel, set the 1 Channel AC-DC-GND switch to GND and apply a 0.1-volt signal to the 2 Channel input. With the 2 Channel VOLTS/DIV switch at .05, the proper deflection on the screen is 2 graticule divisions.

Amplifier Input Capacity Standardization. The input capacitance standardization, attenuator frequency compensation, and the adjustment of the neutralizing capacitors interact with each other. Consequently, they cannot be performed individually or out of the sequence given in this procedure. The need for any or all of these adjustments will normally be indicated by distortion of fast-rising waveforms in one or more settings of the VOLTS/DIV switch.

Standardization of the input capacitance of the Type 3A72 requires the use of a 47-picofarad capacitance standardizer.

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If you do not have such a standardizer, you can make an attenuator probe into one by performing the following five steps (if you have a 47-picofarad capacitance standardizer, you may skip these five steps and go directly to the procedure following them):

1. Set the 1 Channel VOLTS/DIV switch to .05, the VARIABLE control fully clockwise, and the AC-DC-GND switch to DC.

2. Measure the input capacitance at the 1 Channel input connector. With a low-capacitance screwdriver, adjust C418 for a reading of 47 picofarads on the capacitance meter.

3. Disconnect the capacitance meter and connect the attenuator probe to the 1 Channel input connector.

4. Touch the probe tip to the 1-kc output of a square-wave generator, and adjust the controls on the generator and the time base for a display of several cycles of about four divisions of deflection.

5. Adjust the variable capacitor in the probe body for the best square-wave response.

Your probe is now standardized to perform as a 47-picofarad capacitance standardizer. You may use it as such in the following procedure to set the input capacitance of any Type 3A72 to 47 picofarads. (Do not adjust the probe further during the procedure.)

To set the input capacitances of a Type 3A72 to 47 picofarads, proceed as follows:

1. Set the 1 Channel AC-DC-GND switch to DC, the VOLTS/DIV switch to .05, and the VARIABLE control fully clockwise.

to the 1 Channel input connector through the coaxial cable and the 47-pf capacitance standardizer (or the standardized probe). See Fig. 7.

3. Set the grey knob of the MODE switch to 1 ONLY and the red knob to NORM. (1).

4. Adjust the output amplitude of the square-wave generator for a deflection of about four major graticule divisions.

5. Adjust the time-base controls for a stable display of several cycles of the square wave.

6. Adjust C418 for the best square-wave response (optimum flat top and square leading corner).

7. Set the 1 Channel VOLTS/DIV switch to .02.

8. Adjust the output amplitude of the square-wave generator for a deflection of about four or five graticule divisions (you may have to attenuate the output of the square-wave generator with an external attenuator to obtain the desired deflection).

9. Adjust C413 for the best square-wave response (optimum flat top and square leading corner).

10. Disconnect the signal from the 1 Channel input connector and apply it to the 2 Channel input connector.

11. Repeat steps 2 through 9 substituting the 2 Channel control settings for the corresponding 1 Channel controls (i.e., in step 3, set the MODE switch to 2 ONLY; in step 6, adjust C518; in step 9, adjust C513, etc.)

12. Leave the signal lead connected for the next adjustment.

Adjustment of Neutralizing Capacitors. To properly set the neutralizing capacitors (C541 and C441), proceed as follows:

1. Set both VOLTS/DIV switches to .05.

2. Turn the 2 Channel VARIABLE control fully counterclockwise and adjust the output amplitude of the square-wave generator for a vertical deflection of about eight major divisions.

3. Set the triggering controls of the time base for a stable display of several cycles.

4. With the 2 Channel POSITION control, position the display so that its most positive portions are in the viewing area of the graticule.

5. Adjust C541 for the best square-wave appearance (optimum flat top and square leading corners).

6. Disconnect the signal lead from the 2 Channel input connector and connect it to the 1 Channel input connector.

7. Turn the 1 Channel VARIABLE control fully counterclockwise and adjust the output amplitude of the square-wave generator for a vertical deflection of eight divisions.

8. With the 1 Channel POSITION control, position the display so that its most positive portions are in the viewing area of the graticule.

9. Adjust C441 for the best square-wave response (optimum flat top and square leading corner).

10. Repeat steps 2 through 9 in the adjustment of the Amplifier Input Capacity Standardization for both channels. This is necessary due to the relation between the neutralizing capacitors and the input capacity of the instrument. After you complete steps 2 through 9 of the Amplifier Input Capacity Standardization you may proceed with the following adjustment.

Frequency Compensation and Capacitance Standardization. To properly frequency compensate and standardize the attenuator circuit of the Type 3A72, proceed as follows:

1. Remove the Type 3A72 from the left-hand oscilloscope opening and place it in the right-hand opening. (If you are using a Type 561 Oscilloscope, remove the Type 2B67 Time-Base from the X-axis opening and place it in the Y-axis opening.)

2. Set the 2 Channel VOLTS/DIV switch to the positions indicated in Table 1 and adjust the corresponding capacitors for the best square-wave response as observed on the positive portions of the displays. (If you are using a Type 561 Oscilloscope, the positive portion of the display will be toward the right as observed from the front of the oscilloscope.) In each case, adjust the output of the square-

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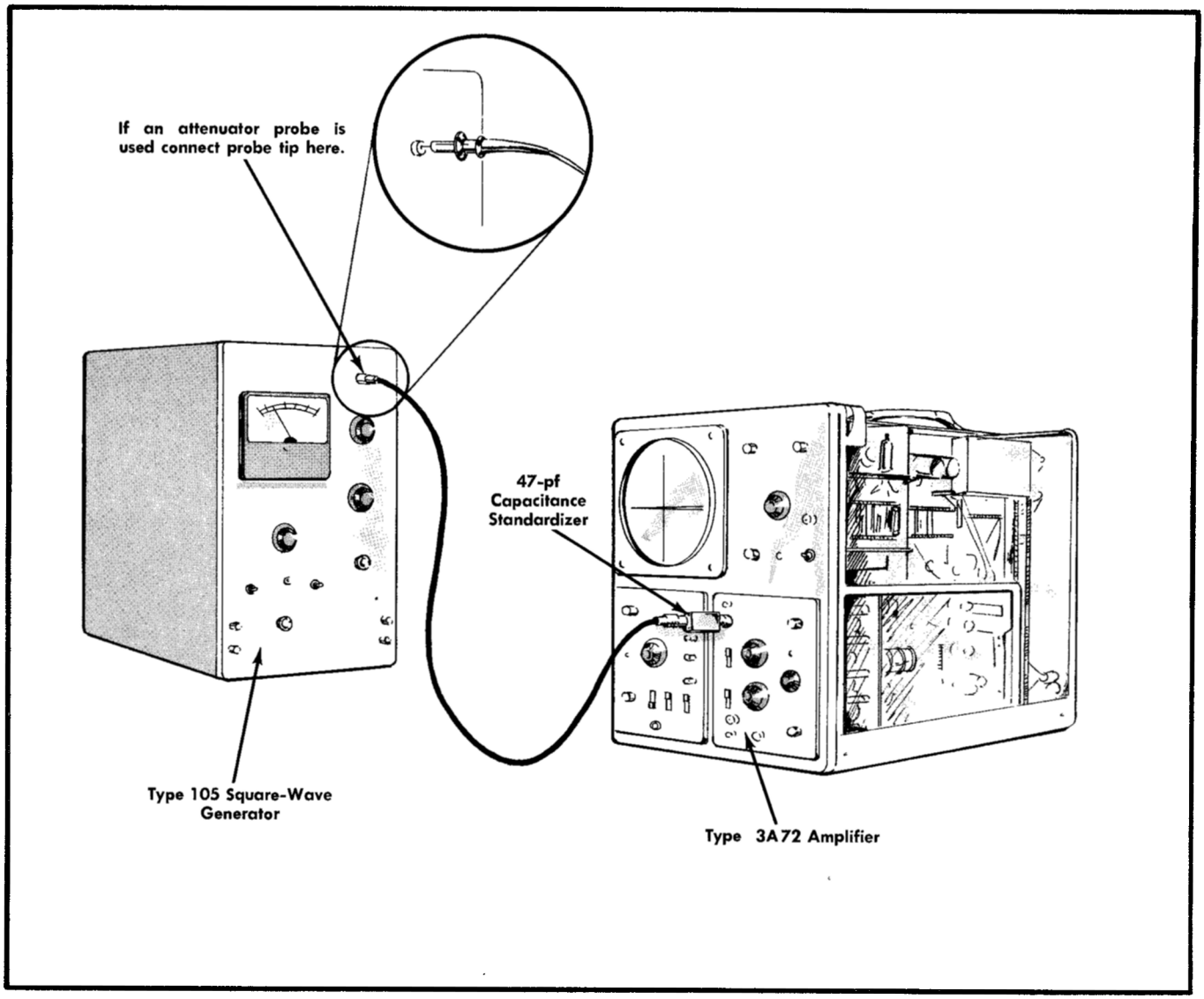

Fig. 7. The Tektronix Type 105 Square-Wave Generator connected to the Type 3A72 Amplifier for input capacity standardization.

wave generator for 4 to 5 divisions of deflection. Also, adjust the time-base triggering controls as necessary to maintain a stable display of several cycles in each case.

TABLE 1

VOLTS/DIV Setting	Adjust
.1	C514A, C514C
.2	C515A, C515C
.5	C510A, C510C
5	C511A, C511C

3. Disconnect the signal lead from the 2 Channel input connector and connect it to the 1 Channel input connector.

4. Set the MODE switch to 1 ONLY.

5. Set the 1 Channel VOLTS/DIV switch to the positions indicated in Table 2 and adjust the corresponding capacitors for the best square-wave response as observed on the positive portions of the display.

6. Disconnect the signal lead from the 1 Channel input connector.

INT. TRIG. DC LEVEL. Place the Type 3A72 into the left-hand oscilloscope opening. (If you are using a Type 561 Oscilloscope, remove the Type 3B67 Time-Base from the oscilloscope.) Set the 2 Channel AC-DC-GND switch to GND. With the 2 Channel POSITION control, position the spot or trace to the horizontal centerline of the graticule. Connect a voltmeter between pin 1 of V484 and ground. Adjust the INT. TRIG. DC LEVEL adjustment for zero volts. Remove the voltmeter connections.

TABLE 2

VOLTS/DIV Setting	Adjust
.1	C414A, C414C
.2	C415A, C415C
.5	C410A, C410C
5	C411A, C411C

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SECTION 6
PARTS LIST AND DIAGRAMS

PARTS ORDERING INFORMATION

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

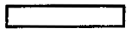
Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information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

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.

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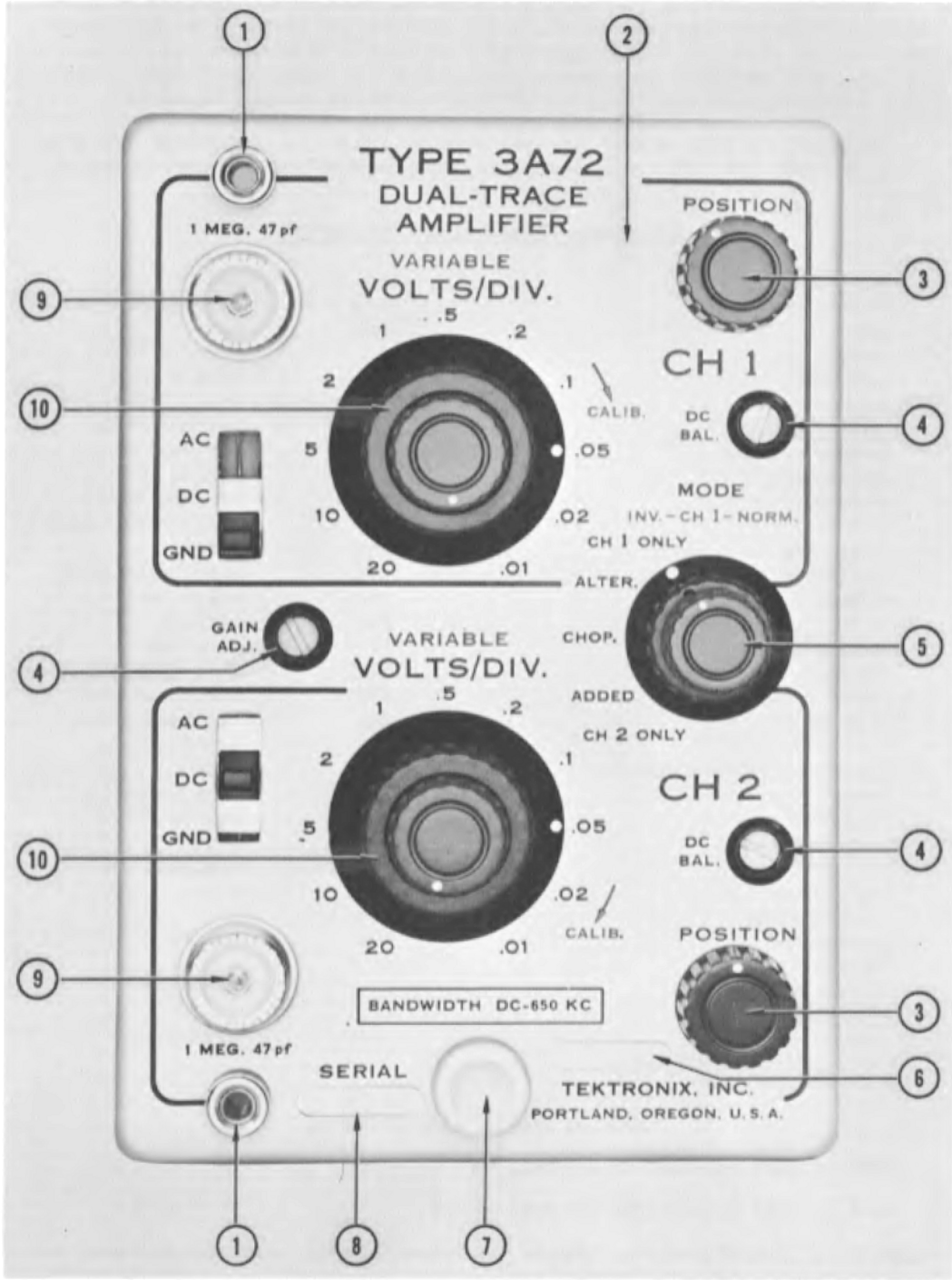
FRONT



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FRONT

REF. NO.	PART NO.	SERIAL NO. EFF.	SERIAL NO. DISC.	QTY.	DESCRIPTION
1	129-035			2	POST, binding, assembly
					Each Consisting Of:
	355-507			1	STEM, adapter
	200-103			1	CAP
	210-455			1	NUT, hex, 1/4-28 x 3/8
	210-011			1	LOCKWASHER, int, 1/4
2	333-633	101	1419	1	PANEL, front (type 72)
	333-728	1420		1	PANEL, front (type 3A72)
	387-582	101	495	1	PLATE, front subpanel
	387-462	496		1	PLATE, front subpanel
3	366-033	101	1419	2	KNOB, small black
	366-148	1420		2	KNOB, small charcoal
	358-029	496		2	BUSHING, hex, 3/8-32 x 13/32
	210-840	496		2	WASHER, .390 ID x 9/16 OD
	210-413	496		2	NUT, hex, 3/8-32 x 1/2
4	358-123	101	1419	3	BUSHING, front panel, black
	358-178	1420		3	BUSHING, front panel, charcoal
5	366-126	101	1419	1	KNOB, black
	366-156	1420		1	KNOB, charcoal
	366-081			1	KNOB, small red
6	334-829	1420		1	TAG, metal blank mod. insert
7	366-109			1	KNOB, plug-in securing
8	334-679			1	TAG, metal serial no. insert
9	131-081	101	2269	2	CONNECTOR, coaxial, 1 contact, female
	131-126	2270		2	CONNECTOR, BNC
	210-241			2	LUG, ground, 15/16 long
10	366-040	101	1419	2	KNOB, large black
	366-160	1420		2	KNOB, large charcoal
	366-031			2	KNOB, small red

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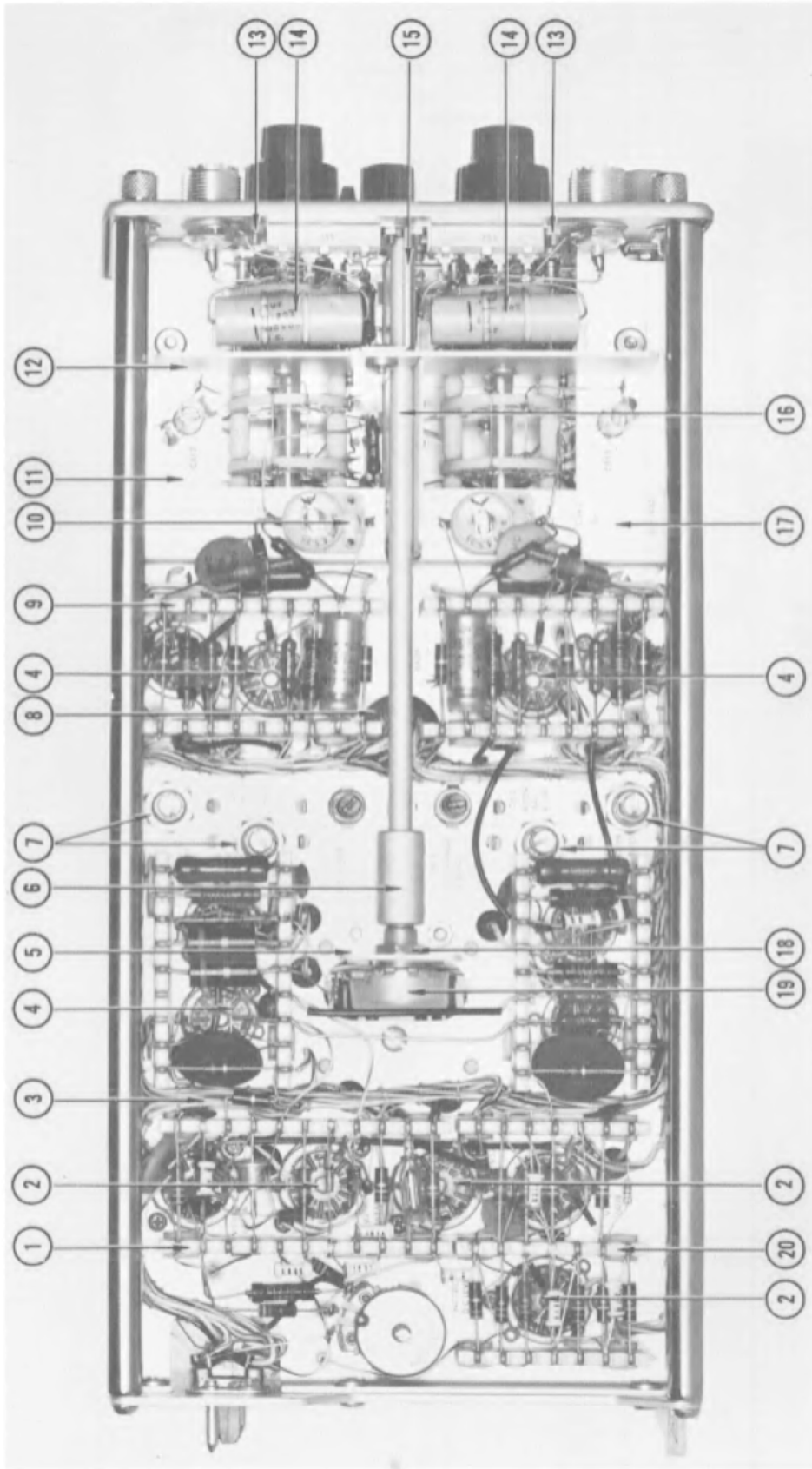
LEFT SIDE



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LEFT SIDE

REF. NO.	PART NO.	SERIAL NO. EFF.	SERIAL NO. DISC.	QTY.	DESCRIPTION
1	124-091			2	STRIP, ceramic, 3/4 x 11 notches
	361-007			4	SPACER, nylon, molded
2	136-015			5	SOCKET, STM9G
					Mounting Hardware For Each: (not included)
	213-044			2	SCREW, thread cutting, 5-32 x 3/16 Pan HS, phillips slot
3	179-476	101	1779	1	CABLE, harness
	179-738	1780		1	CABLE, harness
4	136-008			8	SOCKET, STM7G
					Mounting Hardware For Each: (not included)
	213-044			2	SCREW, thread cutting, 5-32 x 3/16 Pan HS, phillips slot
5	406-633			1	BRACKET, pot
					Mounting Hardware: (not included)
	211-507			2	SCREW, 6-32 x 5/16 BHS
	210-006			2	LOCKWASHER, int. #6
	210-407			2	NUT, hex, 6-32 x 1/4
6	376-007			1	COUPLING
7	210-413			4	NUT, hex, 3/8-32 x 1/2
	210-840			4	WASHER, .390 ID x 9/16 OD
8	348-006			1	GROMMET, rubber, 3/4
9	124-090			8	STRIP, ceramic, 3/4 x 9 notches
	361-007			16	SPACER, nylon, molded
10	214-153			2	FASTENER, snap, double pronged
11	441-339			1	CHASSIS
					Mounting Hardware: (not included)
	211-538			2	SCREW, 6-32 x 5/16 FHS 100° phillips slot
	211-504			3	SCREW, 6-32 x 1/4 BHS
12	337-392			1	SHIELD, input
					Mounting Hardware: (not included)
	211-504			2	SCREW, 6-32 x 1/4 BHS
13	210-406			4	NUT, hex, 4-40 x 3/16 (slide switch mounting)
14	343-006			2	CLAMP, cable, 1/2"
					Mounting Hardware For Each: (not included)
	211-511			1	SCREW, 6-32 x 1/2 BHS
	166-211			1	TUBE, spacer, capacitor
	210-803			1	WASHER, 6L
	210-006			1	LOCKWASHER, int. #6
	210-407			1	NUT, hex, 6-32 x 1/4
15	337-394			1	SHIELD, input
					Mounting Hardware: (not included)
	211-504			1	SCREW, 6-32 x 1/4 BHS
16	384-234			1	ROD, gain pot
17	337-435			1	SHIELD, Output
					Mounting Hardware: (not included)
	211-504			3	SCREW, 6-32 x 1/4 BHS
18	210-413			1	NUT, hex, 3/8-32 x 1/2
	210-840			1	WASHER, .390 ID x 9/16 OD
	210-012			1	LOCKWASHER, pot, int, 3/8 x 1/2
19	200-247			1	CAP, pot, poly.
20	124-089			3	STRIP, ceramic, 3/4 x 7 notches
	361-007			6	SPACER, nylon, molded

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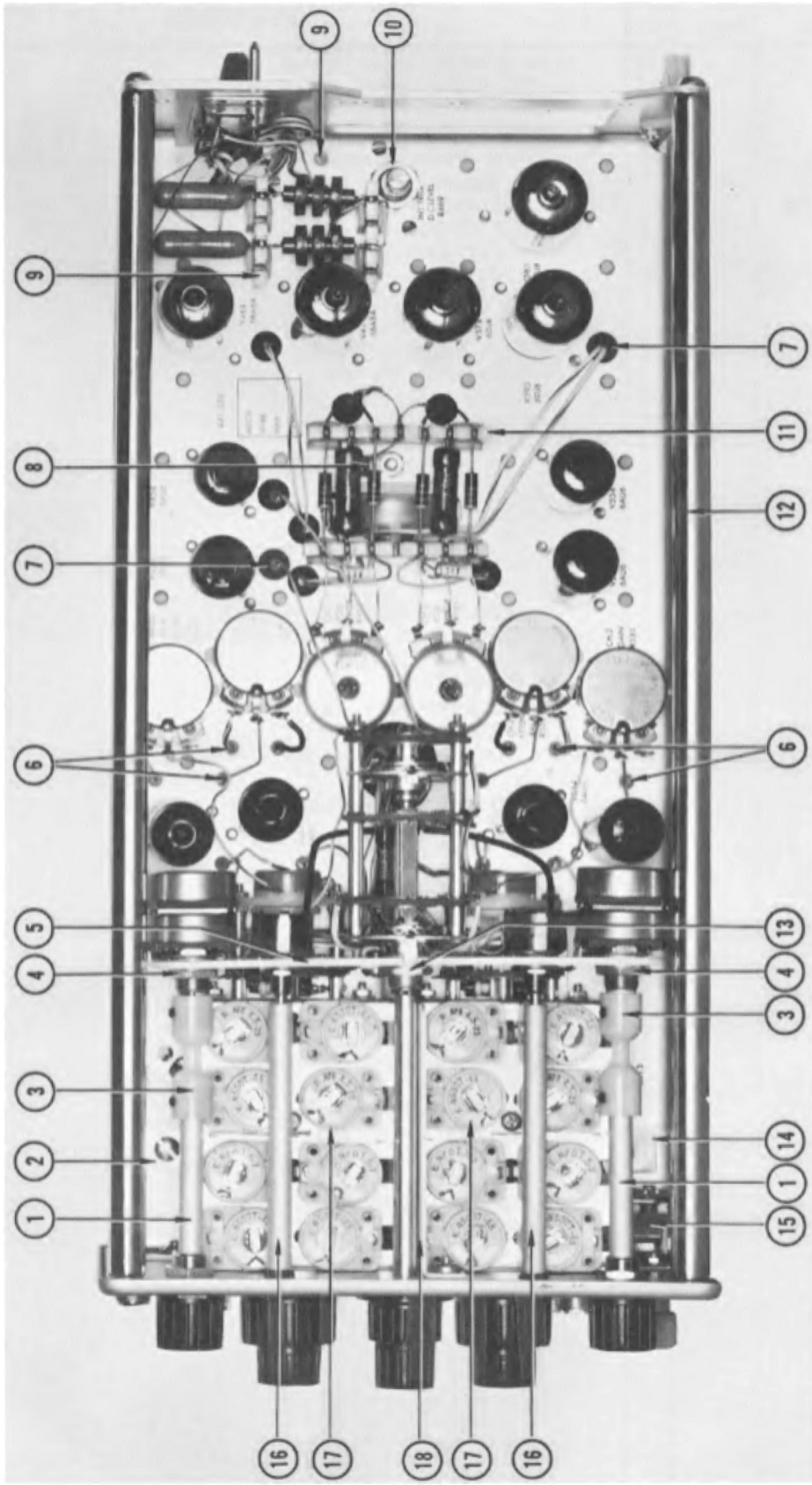
RIGHT SIDE



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RIGHT SIDE

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	384-233			2	ROD, shaft, position pot
2	337-438			1	SHIELD, capacitor bracket, top
					Mounting Hardware: (not included)
	211-507			1	SCREW, 6-32 x 5/16 BHS
	213-035			1	SCREW, thread cutting, 4-40 x 1/4 PHS, phillips slot
3	376-011			2	COUPLING, insulating
					Each Includes:
	213-048			2	SCREW, set, 4-40 x 1/8 HSS allen head
4	210-413			2	NUT, hex, 3/8-32 x 1/2
	210-840			2	WASHER, .390 ID x 9/16 OD
	210-012			2	LOCKWASHER, pot, int. 3/8 x 1/2
	210-207			2	LUG, solder, pot, plain, 3/8
5	406-618			1	BRACKET, mode switch
					Mounting Hardware: (not included)
	211-507			3	SCREW, 6-32 x 5/16 BHS
6	348-031			16	GROMMET, poly. snap-in
7	348-002			11	GROMMET, rubber, 1/4
8	210-202			1	LUG, solder, SE 6
	211-504			1	SCREW, 6-32 x 1/4 BHS
	210-407			1	NUT, hex, 6-32 x 1/4
9	124-120			3	STRIP, ceramic, 7/16 x 4 notches
	361-007	101	1959	6	SPACER, nylon, molded
	361-008	1960		6	SPACER, nylon, molded
10	210-413			1	NUT, hex, 3/8-32 x 1/2
	210-840			1	WASHER, .390 ID x 9/16 OD
11	124-094			2	STRIP, ceramic, 7/16 x 7 notches
	361-007	101	1959	4	SPACER, nylon, molded
	361-008	1960		4	SPACER, nylon, molded
12	384-566	101	2869	4	ROD, frame, spacing
	384-615	2870		4	ROD, frame, spacing
13	210-413			1	NUT, hex, 3/8-32 x 1/2
	210-840			1	WASHER, .390 ID x 9/16 OD
	210-012			1	LOCKWASHER, pot, int, 3/8 x 1/2
14	337-436			1	SHIELD, capacitor bracket, bottom
					Mounting Hardware: (not included)
	211-507			1	SCREW, 6-32 x 5/16 BHS
	213-035			1	SCREW, thread cutting, 4-40 x 1/4 PHS, phillips
15	214-052			1	FASTENER, pawl right, w/stop
					Mounting Hardware: (not included)
	210-406			2	NUT, hex, 4-40 x 3/16
	210-004			2	LOCKWASHER, int. #4
16	384-232			2	ROD, shaft, DC balance pot
					Each Includes:
	213-048			1	SCREW, set, 4-40 x 1/8 HSS allen head
17	262-409			2	SWITCH, wired, Volts/Div.
					Each Includes:
	406-694			1	BRACKET, switch, attenuator, capacitor mounting
					Mounting Hardware:
	211-008			2	SCREW, 4-40 x 1/4 BHS
	210-004			2	LOCKWASHER, int. #4
	210-406			2	NUT, hex, 4-40 x 3/16
	214-153			8	FASTENER, snap, double pronged
	210-406			2	NUT, hex, 4-40 x 3/16 (pot mounting)
	210-004			2	LOCKWASHER, int. #4
					Mounting Hardware For Each Switch: (not included)
	210-413			1	NUT, hex, 3/8-32 x 1/2
	210-840			1	WASHER, .390 ID x 9/16 OD
18	337-391			1	SHIELD, channel support
					Mounting Hardware: (not included)
	211-011			1	SCREW, 4-40 x 5/16 BHS
	211-038			2	SCREW, 4-40 x 5/16 FHS, phillips slot

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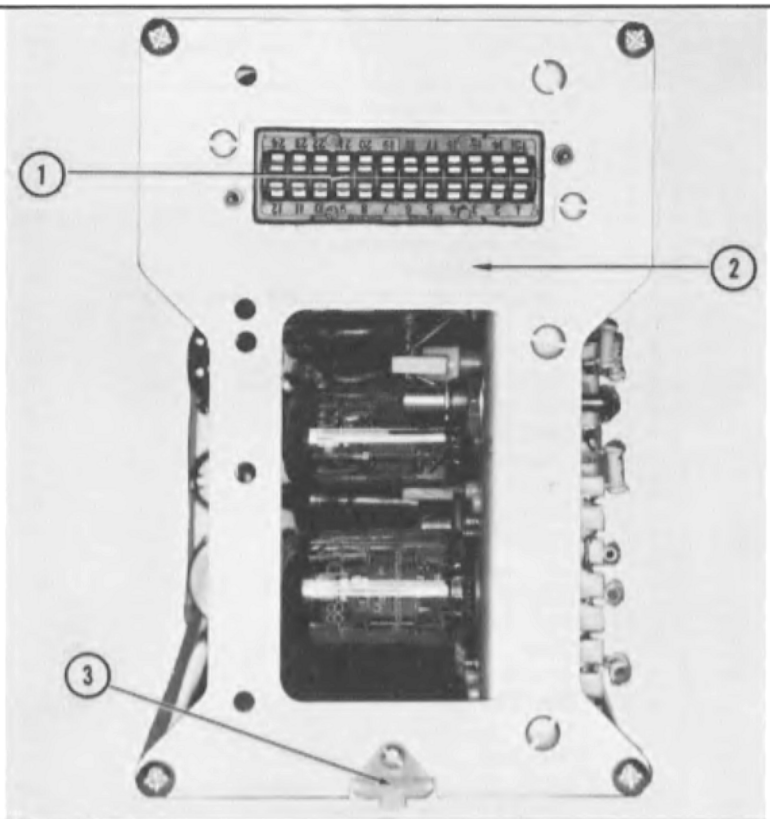
REAR



REF. NO.	PART NO.	SERIAL NO. EFF.	SERIAL NO. DISC.	QTY.	DESCRIPTION
1	131-149			1	CONNECTOR, chassis mt., 24 contact, male
					Mounting Hardware: (not included)
	211-008			2	SCREW, 4-40 x 1/4 BHS
	210-004			2	LOCKWASHER, int. #4
	210-406			2	NUT, hex, 4-40 x 3/16
2	387-581			1	PLATE, rear
					Mounting Hardware: (not included)
	212-044			4	SCREW, 8-32 x 1/2 RHS, phillips slot
3	351-037			1	GUIDE, plug-in
					Mounting Hardware: (not included)
	211-013			1	SCREW, 4-40 x 3/8 RHS
	210-004			1	LOCKWASHER, int. #4
	210-406			1	NUT, hex, 4-40 x 3/16

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PARTS LIST

Type 3A72

Values are fixed unless marked Variable.

Bulb

Ckt. No.	S/N Range	Description	Tektronix Part Number
B574		Neon, Type NE-23	Use 150-027

Capacitors

Tolerance ±20% unless otherwise indicated.

C400		.1 μf	PTM		600 v		285-587
C410A		7-45 μμf	Cer.	Var.			281-012
C410C		1.5-7 μμf	Cer.	Var.			281-005
C410E		22 μμf	Cer.		500 v	10%	281-511
C411A		7-45 μμf	Cer.	Var.			281-012
C411C		1.5-7 μμf	Cer.	Var.			281-005
C411E		270 μμf	Mica			5%	283-551
C413		.5-5 μμf	Tub.	Var.			281-001
C414A		4.5-25 μμf	Cer.	Var.			281-010
C414C		7-45 μμf	Cer.	Var.			281-012
C415A		7-45 μμf	Cer.	Var.			281-012
C415C		4.5-25 μμf	Cer.	Var.			281-010
C418		4.5-25 μμf	Cer.	Var.			281-010
C419		.01 μf	Discap		500 v		283-002
C431		.01 μf	PTM		400 v		285-510
C441		.7-3 μμf	Tub.	Var.			281-027
C444		.01 μf	Discap		150 v		283-003
C448B		11 μμf	Cer.		500 v	5%	281-576
C448C		47 μμf	Cer.		500 v	10%	281-519
C455		330 μμf	Cer.		500 v	10%	281-546
C466		.01 μf	Discap		500 v		283-002
C487	101-1319	1.5 μμf	Cer.		500 v	±0.25 μμf	281-529
C487	1320-up	2.2 μμf	Cer.		500 v	±0.5 μμf	281-500
C497A		.1 μf	Discap		500 v		283-008
C497B		5 μf	EMT		150 v		290-149
C497C		5 μf	EMT		150 v		290-149
C497D		.1 μf	Discap		500 v		283-008
C498		.02 μf	Discap		600 v		283-006
C500		.1 μf	PTM		600 v		285-587
C510A		7-45 μμf	Cer.	Var.			281-012
C510C		1.5-7 μμf	Cer.	Var.			281-005
C510E		22 μμf	Cer.		500 v	10%	281-511
C511A		7-45 μμf	Cer.	Var.			281-012
C511C		1.5-7 μμf	Cer.	Var.			281-005
C511E		270 μμf	Mica			5%	283-551
C513		5-5 μμf	Tub.	Var.			281-001

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Capacitors *(continued)*

							Tektronix Part Number
C514A		4.5-25 μμf	Cer.	Var.			281-010
C514C		7-45 μμf	Cer.	Var.			281-012
C515A		7-45 μμf	Cer.	Var.			281-012
C515C		4.5-25 μμf	Cer.	Var.			281-010
C518		4.5-25 μμf	Cer.	Var.			281-010
C519		.01 μf	Discap		500 v		283-002
C531		.01 μf	PTM		400 v		285-510
C534		.01 μf	Discap		150 v		283-003
C541		.7-3 μμf	Tub.	Var.			281-027
C548B		11 μμf	Cer.		500 v	5%	281-576
C548C		47 μμf	Cer.		500 v	10%	281-519
C549		1.5 μμf	Cer.		500 v	0.25 μμf	281-529
C555		330 μμf	Cer.		500 v	10%	281-546
C570		100 μμf	Cer.		350 v		281-523
C574		22 μμf	Cer.		500 v		281-510
C575		22 μμf	Cer.		500 v		281-510
C578		.005 μf	Discap		500 v		283-001
C579		39 μμf	Cer.		500 v	10%	281-516
C592		68 μμf	Cer.		500 v	10%	281-549
C596		68 μμf	Cer.		500 v	10%	281-549
C594	X1780-up	150 μμf	Cer.		500 v		281-524

Diodes

				Tektronix Part Number
D486	1N3042A	Zener		Use 152-0135-00
D494	T12G			152-008
D495	T12G			152-008
D574	T12G			152-008
D575	T12G			152-008
D594	T12G			152-008
D595	T12G			152-008

Inductors

		Tektronix Part Number
L482	750 μh	108-225
L483	Ferrite Core	*276-507
L492	750 μh	108-225
L493	Ferrite Core	*276-507

Resistors

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

					Tektronix Part Number
R410C	900 k	½ w	Prec.	1%	309-142
R410E	111 k	½ w	Prec.	1%	309-138
R411C	990 k	½ w	Prec.	1%	309-145
R411E	10.1 k	½ w	Prec.	1%	309-135
R412	47 Ω	¼ w			316-470
R414C	500 k	½ w	Prec.	1%	309-140
R414E	1 meg	½ w	Prec.	1%	309-148
R415C	750 k	½ w	Prec.	1%	309-141
R415E	333 k	½ w	Prec.	1%	309-139
R418	1 meg	½ w	Prec.	1%	309-148

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Resistors *(continued)*

							Tektronix Part Number
R419		100 k	½ w				302-104
R421		1 meg		Var.		DC Bal.	311-162
R423		1 meg	½ w				302-105
R424		4.7 k	½ w				302-472
R431		100 Ω	¼ w				316-101
R432		1.8 k	½ w				302-182
R433		5.1 k	½ w		Prec.	1%	309-337
R434		9 k	1 w		Prec.	1%	310-125
R435		250 Ω	½ w	Var.		CH. 1 Gain	Use 311-367
R436		30 k	½ w		Prec.	1%	309-154
R441		100 Ω	¼ w				316-101
R438		1 meg	½ w				302-105
R439		1 meg	½ w	Var.		CH. 1 Atten. Bal.	Use 311-370
R443		5.1 k	½ w		Prec.	1%	309-337
R444		11.48 k	½ w		Prec.	1%	309-192
R445		1.5 k		Var.	WW	VARIABLE	*311-234
R446		30 k	½ w		Prec.	1%	309-154
R448B		10 k	½ w		Prec.	1%	309-100
R448C		2.5 k	½ w		Prec.	1%	309-181
R451		100 Ω	½ w				302-101
R452		43 k	½ w			5%	301-433
R453		2 x 50 k		Var.		POSITION	311-111
R455 †		500 Ω		Var.		CH. 1 Pos. Range	*312-017
R456		5.55 k	1 w		Prec.	1%	310-126
R461		100 Ω	½ w				302-101
R462		43 k	½ w			5%	301-433
R465		5.25 k	½ w		Prec.	1%	309-032
R466		10 k	½ w		Prec.	1%	309-100
R467		5 k	½ w		Prec.	1%	309-159
R468		5 k	½ w		Prec.	1%	309-159
R481		100 Ω	¼ w				316-101
R482		10 k	5 w		WW	5%	308-054
R484		500 Ω		Var.		GAIN ADJ.	311-246
R485		5.6 k	2 w			5%	Use 305-562
R486		33 k	½ w				302-333
R487	101-1319	1 meg	½ w			5%	301-105
R487	1320-up	1 meg	½ w		Prec.	1%	309-014
R488	101-1319	360 k	½ w			5%	301-364
R488	1320-up	500 k	½ w		Prec.	1%	309-003
R489	101-1319	100 k		Var.		Int. Trig. DC Level	311-207
R489	1320-up	250 k	½ w	Var.			Use 311-373
R490	X1320-up	4.7 meg	½ w			5%	301-475
R491		100 Ω	¼ w				316-101
R492		10 k	5 w		WW	5%	308-054
R494	101-559	62 Ω	½ w			5%	301-620
R494	560-up	Selected nominal value 51 Ω				5%	301-510
R495		5.6 k	2 w			5%	Use 305-562
R496		100 Ω	¼ w				316-101
R497A,B,C,D		27 Ω	½ w				302-270
R498		2.2 k	½ w				302-222
R499		33 k	½ w				302-333
R510C		900 k	½ w		Prec.	1%	309-142
R510E		111 k	½ w		Prec.	1%	309-138
R511C		990 k	½ w		Prec.	1%	309-145
R511E		10.1 k	½ w		Prec.	1%	309-135

† Furnished as a matched pair with R555.

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Resistors *(continued)*

							Tektronix Part Number
R512		47 Ω	¼ w				316-470
R514C		500 k	½ w		Prec.	1%	309-140
R514E		1 meg	½ w		Prec.	1%	309-148
R515C		750 k	½ w		Prec.	1%	309-141
R515E		333 k	½ w		Prec.	1%	309-139
R518		1 meg	½ w		Prec.	1%	309-148
R519		100 k	½ w				302-104
R521		1 meg		Var.		DC Bal.	311-162
R523		1 meg	½ w				302-105
R524		4.7 k	½ w				302-472
R531		100 Ω	¼ w				316-101
R532		1.8 k	½ w				302-182
R533		5.1 k	½ w		Prec.	1%	309-337
R534		11.48 k	½ w		Prec.	1%	309-192
R535		250 Ω	½ w	Var.		CH. 2 Gain	Use 311-367
R536		30 k	½ w		Prec.	1%	309-154
R538		1 meg	½ w				302-105
R539		1 meg	½ w	Var.		CH. 2 Atten. Bal.	Use 311-370
R541		100 Ω	¼ w				316-101
R543		5.1 k	½ w		Prec.	1%	309-337
R544		9 k	1 w		Prec.	1%	310-125
R545		1.5 k		Var.	WW	VARIABLE	*311-234
R546		30 k	½ w		Prec.	1%	309-154
R548B		10 k	½ w		Prec.	1%	309-100
R548C		2.5 k	½ w		Prec.	1%	309-181
R551		100 Ω	¼ w				316-101
R552		43 k	½ w			5%	301-433
R553		2 x 50 k		Var.		POSITION	311-111
R555 †		500 Ω		Var.		CH. 2 Pos. Range	*312-017
R556		5.55 k	1 w		Prec.	1%	310-126
R561		100 Ω	¼ w				316-101
R562		43 k	½ w			5%	301-433
R570		22 k	½ w			5%	301-223
R571		330 k	½ w			5%	301-334
R572		100 Ω	¼ w				316-101
R574		470 k	½ w				302-474
R576		33 k	½ w				302-333
R577		100 Ω	¼ w				316-101
R578		470 Ω	½ w				302-471
R579		220 k	½ w				302-224
R581		62 k	½ w			5%	301-623
R582		56 k	½ w			5%	301-563
R584		3.3 k	½ w				302-332
R587		62 k	½ w			5%	301-623
R588		56 k	½ w			5%	301-563
R590		100 Ω	¼ w				316-101
R591		120 k	½ w				302-124
R592		150 k	½ w			5%	301-154
R593		680 k	½ w			5%	301-684
R594	X1780-up	15 k	½ w				302-153
R595		680 k	½ w			5%	301-684

† Furnished as a matched pair with R455.

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Resistors *(continued)*

				Tektronix Part Number
R596	150 k	½ w	5%	301-154
R597	120 k	½ w		302-124
R598	100 Ω	¼ w		316-101

Switches

				Unwired	Wired
SW400	101-1419	Slide	AC/DC	260-316	
SW400	1420-up	Slide	AC/DC	260-448	
SW410		Rotary	VOLTS/DIV	*260-349	*262-409
SW500	101-1419	Slide	AC/DC	260-316	
SW500	1420-up	Slide	AC/DC	260-448	
SW510		Rotary	VOLTS/DIV	*260-349	*262-409
SW585A		Rotary	MODE	*260-348	
SW585B †					

Electron Tubes

V434	6AU6	154-022
V444	6AU6	154-022
V454	6AU6	154-022
V464	6AU6	154-022
V484	6BA8A	154-163
V494	6BA8A	154-163
V534	6AU6	154-022
V544	6AU6	154-022
V554	6AU6	154-022
V564	6AU6	154-022
V574	6DJ8	154-187
V585	6DJ8	154-187
V593	6DJ8	154-187

† Concentric with SW585A.

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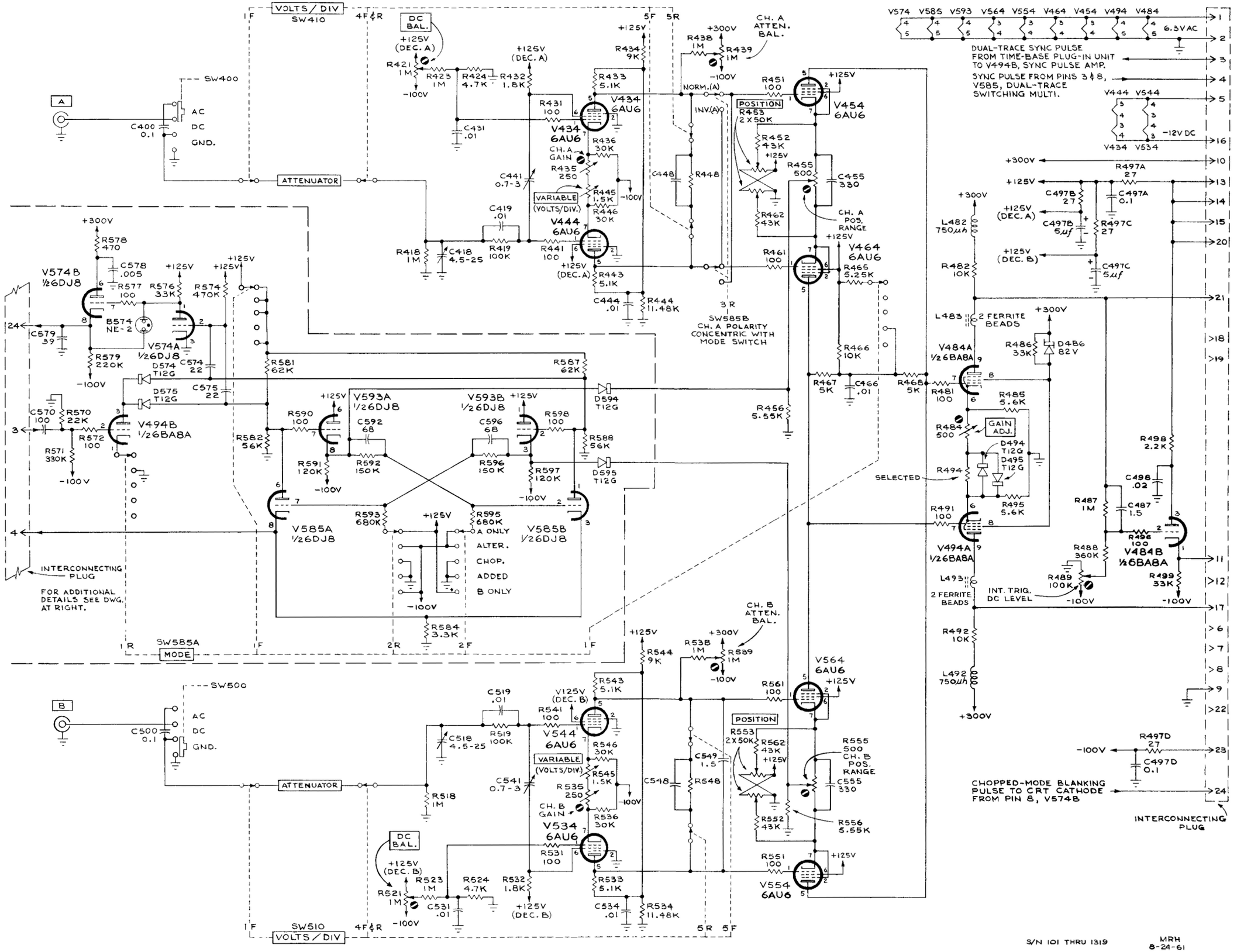

S/N 101 THRU 1319

MRH 8-24-61

DUAL TRACE AMPLIFIER

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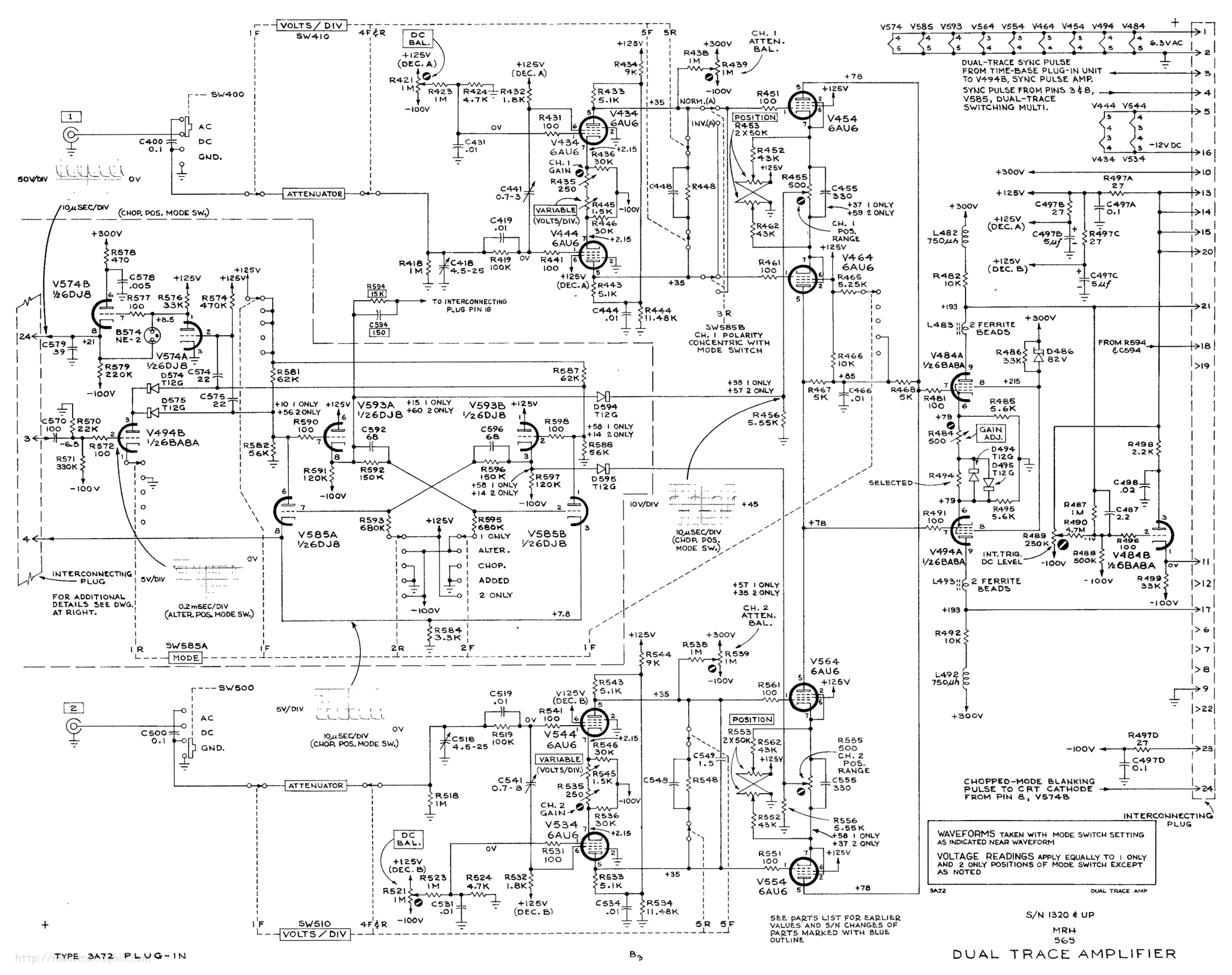
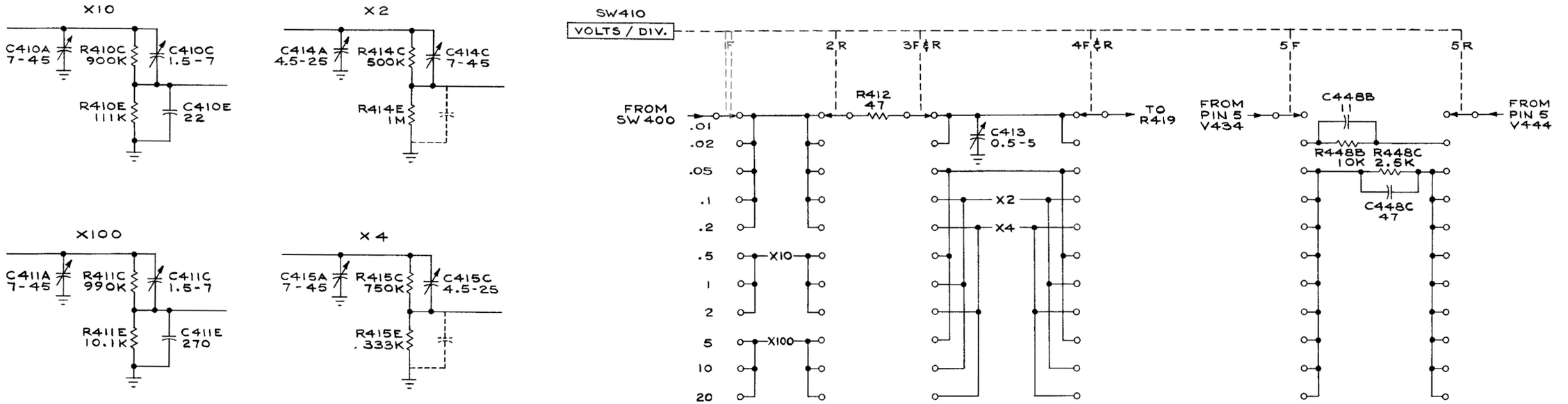
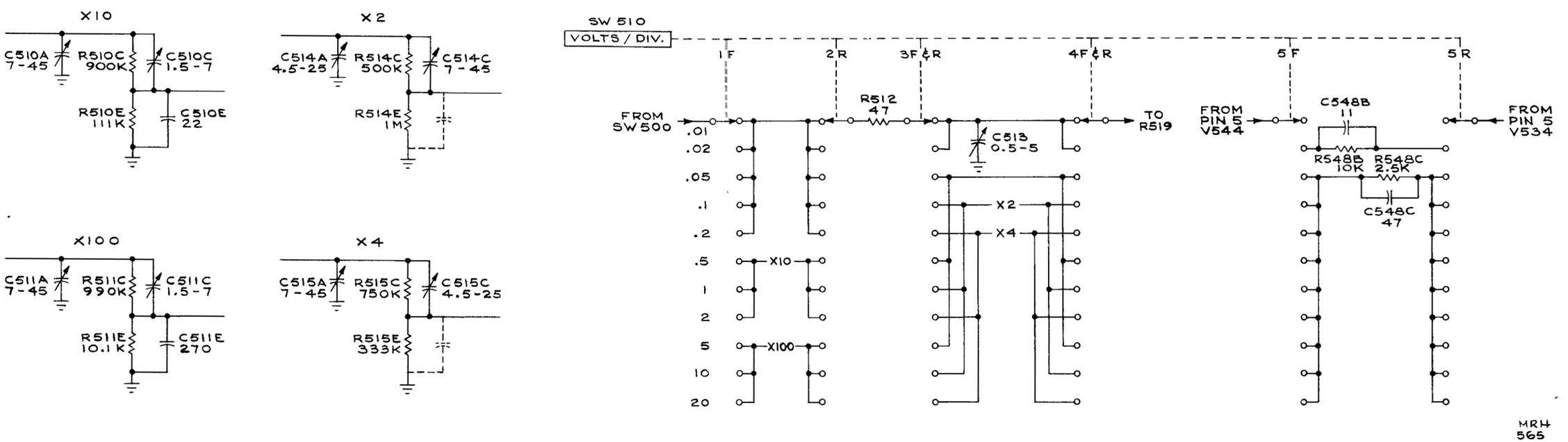

VOLTS / DIV
SW410
DC BAL.
+125V (DEC. A)
R421 1M
R423 1M
R424 4.7K
R432 1.8K
-100V
0V
C431 .01
R431 100
V434 6AU6
R433 5.1K
R434 9K
+125V
+35
NORM.(A)
INV.(A)
R436 30K
CH. 1 GAIN
R435 250
C441 0.7-3
VARIABLE (VOLTS/DIV.)
R445 1.5K
R446 30K
V444 6AU6
C419 .01
R418 1M
C418 4.5-25
R419 100K
R441 100
+125V (DEC. A)
R443 5.1K
C444 .01
R444 11.48K
R438 1M
R439 1M
CH. 1 ATTEN. BAL.
+300V
-100V
POSITION
R453 2X50K
R452 43K
R448
C448
R462 43K
R455 500
C455 330
+37 1 ONLY
+59 2 ONLY
CH. 1 POS. RANGE
V454 6AU6
R451 100
+78
R461 100
V464 6AU6
R465 5.25K
R466 10K
+85
R467 5K
C466 .01
R468 5K
R456 5.55K
+35 1 ONLY
+57 2 ONLY
3R
SW585B
CH. 1 POLARITY
CONCENTRIC WITH
MODE SWITCH
R594 15K
C594 150
TO INTERCONNECTING PLUG PIN 18
SW400
AC
DC
GND.
C400 0.1
ATTENUATOR
50V/DIV
10μSEC/DIV
(CHOP. POS. MODE SW.)
V574B 1/26DJ8
R578 470
C578 .005
R577 100
R576 33K
R574 470K
+8.5
B574 NE-2
V574A 1/26DJ8
C579 39
R579 220K
C574 22
D574 T12G
D575 T12G
C575 22
R581 62K
R587 62K
D594 T12G
D595 T12G
C570 100
R570 22K
R572 100
R571 330K
-6.5
-100V
V494B 1/26BA8A
V593A 1/26DJ8
+10 1 ONLY
+56 2 ONLY
+15 1 ONLY
+60 2 ONLY
V593B 1/26DJ8
R590 100
C592 68
R592 150K
R591 120K
R582 56K
C596 68
R596 150K
+58 1 ONLY
+14 2 ONLY
R597 120K
R598 100
R588 56K
+58 1 ONLY
+14 2 ONLY
V585A 1/26DJ8
V585B 1/26DJ8
R593 680K
R595 680K
1 ONLY
ALTER. CHOP. ADDED 2 ONLY
+7.8
R584 3.3K
10V/DIV
10μSEC/DIV (CHOP. POS. MODE SW.)
+45
5V/DIV
0.2mSEC/DIV (ALTER. POS. MODE SW.)
INTERCONNECTING PLUG
FOR ADDITIONAL DETAILS SEE DWG. AT RIGHT.
SW585A
MODE
SW500
AC
DC
GND.
C500 0.1
ATTENUATOR
R518 1M
C518 4.5-25
C519 .01
R519 100K
R541 100
V544 6AU6
R543 5.1K
R544 9K
+125V (DEC. B)
R546 30K
VARIABLE (VOLTS/DIV.)
R545 1.5K
C541 0.7-8
R535 250
CH. 2 GAIN
R536 30K
V534 6AU6
R531 100
R533 5.1K
R534 11.48K
C534 .01
R532 1.8K
R523 1M
R524 4.7K
C531 .01
R521 1M
DC BAL.
+125V (DEC. B)
-100V
SW510
VOLTS / DIV
R538 1M
R539 1M
CH. 2 ATTEN. BAL.
V564 6AU6
R561 100
POSITION
R553 2X50K
R562 43K
R548
C548
C549 1.5
R552 43K
R555 500
CH. 2 POS. RANGE
C555 330
R556 5.55K
+58 1 ONLY
+37 2 ONLY
V554 6AU6
R551 100
+78
+57 1 ONLY
+35 2 ONLY
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE
V574 V585 V593 V564 V554 V464 V454 V494 V484
6.3VAC
DUAL-TRACE SYNC PULSE FROM TIME-BASE PLUG-IN UNIT TO V494B, SYNC PULSE AMP.
SYNC PULSE FROM PINS 3 & 8, V585, DUAL-TRACE SWITCHING MULTI.
V444 V544
V434 V534
-12V DC
+300V
R497A 27
+125V
C497B 27
C497A 0.1
+125V (DEC. A)
C497B 5μf
R497C 27
+125V (DEC. B)
C497C 5μf
L482 750μh
R482 10K
+193
L483 2 FERRITE BEADS
FROM R594 & C594
V484A 1/26BA8A
R486 33K
D486 82V
+215
R481 100
R485 5.6K
+79
R484 500
GAIN ADJ.
D494 T12G
D495 T12G
R494
SELECTED
R495 5.6K
R491 100
R489 250K
INT. TRIG. DC LEVEL
R490 4.7M
R487 1M
C487 2.2
C498 .02
R498 2.2K
R488 500K
R496 100
V494A 1/26BA8A
V484B 1/26BA8A
L493 2 FERRITE BEADS
R499 33K
-100V
R492 10K
L492 750μh
R497D 27
C497D 0.1
CHOPPED-MODE BLANKING PULSE TO CRT CATHODE FROM PIN 8, V574B
INTERCONNECTING PLUG
WAVEFORMS TAKEN WITH MODE SWITCH SETTING AS INDICATED NEAR WAVEFORM
VOLTAGE READINGS APPLY EQUALLY TO 1 ONLY AND 2 ONLY POSITIONS OF MODE SWITCH EXCEPT AS NOTED
3A72
DUAL TRACE AMP
S/N 1320 & UP
MRH
565
DUAL TRACE AMPLIFIER
TYPE 3A72 PLUG-IN
B3



CHANNEL 1 ATTENUATOR DETAILS



CHANNEL 2 ATTENUATOR DETAILS

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