INSTRUCTION MANUAL

Serial Number ____________

TYPE 1A7A DIFFERENTIAL AMPLIFIER

Tektronix, Inc.

S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon 97005 ● Phone 644-0161 ● Cables: Tektronix

070-0782-00

368

WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our 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.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial or Model Number with all requests for parts or service.

Specifications and price change privileges reserved.

Copyright © 1968 by Tektronix, Inc., Beaverton, Oregon. Printed in the United States of America. All rights reserved. Contents of this publication may not be reproduced in any form without permission of the copyright owner.

CONTENTS

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

Fig. 1-1. Type 1A7A Plug-In Unit.

SECTION 1
CHARACTERISTICS

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

The Type 1A7A Vertical Plug-In is a DC coupled differential amplifier with excellent common-mode rejection and high gain characteristics for low level applications.

The DC Offset capability of the Type 1A7A allows the display of very small AC signals containing a large DC component. The vertical deflection factor of the Type 1A7A is from 10 μV through 10 volts. The high and low frequency —3 dB points, which control the bandwidth from DC to 1 MHz, are selectable from the front panel; thus, for low frequency applications the signal to noise ratio can be improved by restricting the bandwidth of the Type 1A7A.

The Type 1A7A is designed for use in Tektronix Type 530-540-550 series oscilloscopes.

The electrical characteristics which follow are divided into two categories, Performance Requirement and Operational Information. Items listed in the Operational Information column are provided for reference use and do not directly reflect the measurement capabilities of this instrument. The Performance Check procedure given in Section 5 of this manual provides a convenient method of checking most items listed in the Performance Requirement column. The following electrical characteristics apply over a calibration interval of 1000 hours at an ambient temperature range of 0° C to +50° C (except as otherwise indicated) when calibrated at +25° C ±5° C. Warm-up time for given accuracy is 5 minutes.

ELECTRICAL CHARACTERISTICS

Characteristics	Performance Requirement	Operational Information
Deflection Factor		
Calibrated range	10 μV/CM to 10 V/CM	19 steps in a 1-2-5 sequence
Accuracy	Within 2% of indicated deflection	
Uncalibrated (VARIABLE) range	Provides continuously variable deflection factors between the calibrated steps. Extends maximum uncalibrated deflection factor to at least 25 V/CM.	
Differential Dynamic Range (DC OFFSET at OFF)		
10 μV/CM to 10 mV/CM	±400 mV	
20 mV/CM to 0.1 V/CM	±4 V	
0.2 V/CM to 1 V/CM	±40 V	
2 V/CM to 10 V/CM	±400 V	
Frequency Response (Full Graticule Reference)		
Overall Frequency DC (Direct) Coupled Input	DC to 1 MHz —0%, +30%	
AC (Capacitive) Coupled Input Lower Bandwidth Frequency	1.6 Hz within 5%	
Bandwidth Limit Accuracy (—3 dB points)		
High		
1 MHz	—0% to +30%	9 steps in a 10-3-1 sequence.
300 kHz to 100 Hz	Within 12% of frequency indicated by HIGH FREQ —3 dB POINT switch setting.	
Low		
0.1 Hz to 10 kHz	Within 12% of frequency indicated by LOW FREQ —3 dB POINT switch setting.	6 steps in a 1-10-100 sequence.

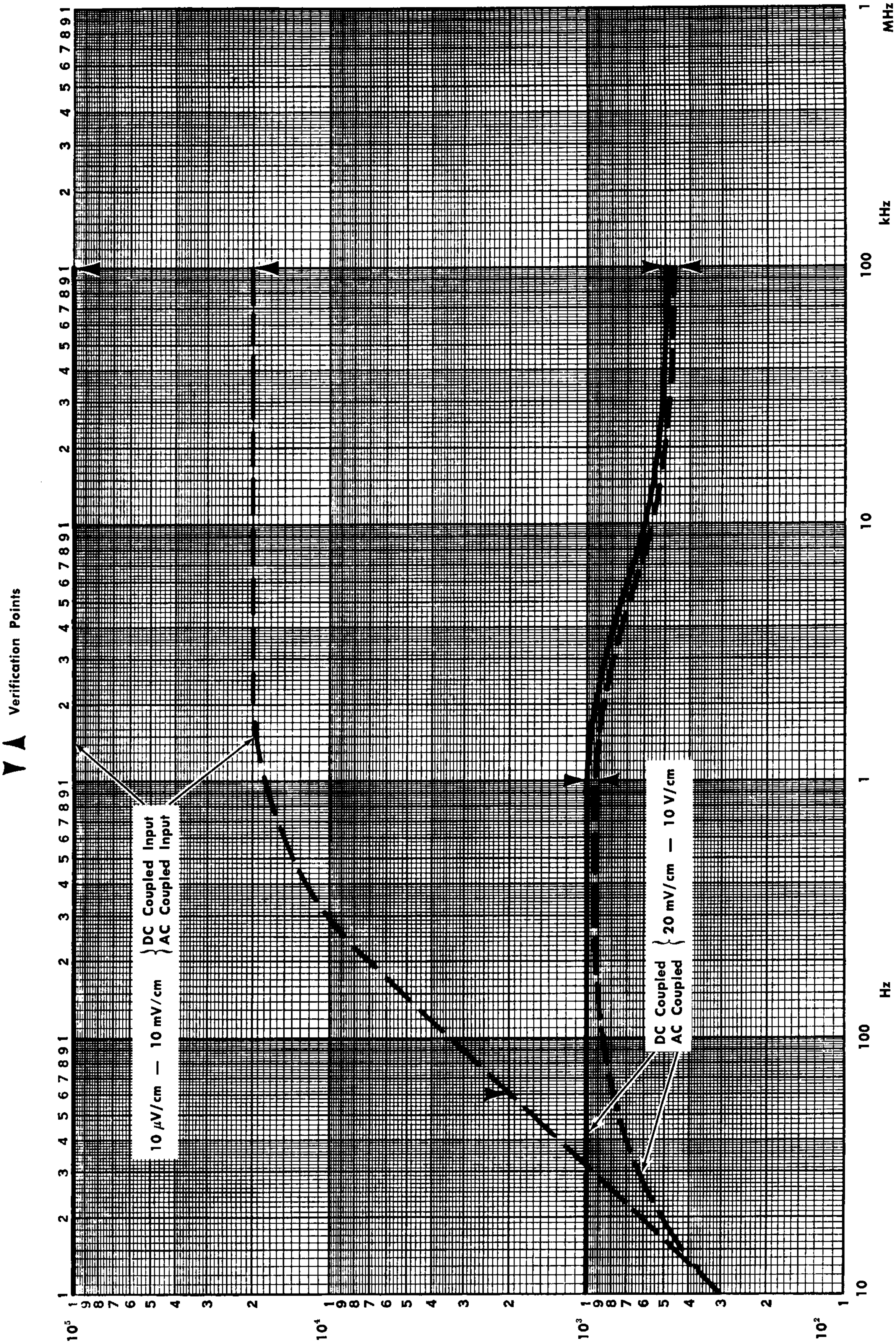


Fig. 1-2. CMRR vs Frequency For Signals Not Exceeding Common-Mode Dynamic Range.

Ⓐ

ELECTRICAL CHARACTERISTICS (cont)

Characteristics	Performance Requirement	Operational Information
Step Response (Full Graticule Reference)		
Risetime 1 MHz Bandwidth)	350 nanoseconds to 270 nanoseconds.	
Aberrations		+1%, −1% or less, 1 microsecond after the 50% amplitude point with 25 ohm source impedance.
Overdrive Recovery	Requires 10 microseconds or less to recover to within 0.5% of zero level after the removal of a + or − test input applied for 1 second. Test signal not to exceed Differential Dynamic Range. Aberrations not to exceed ±0.5% of test signal amplitude.	
Common Mode Dynamic Range		Overload occurs at approximately:
10 μV/CM to 10 mV/CM	±10 volts	±15 volts
20 mV/CM to 0.1 V/CM	±100 volts	±150 volts
0.2 V/CM to 10 V/CM	±500 volts	
Input Overload Light	Indicates that differential overload is being approached.	Light turns on when differential input plus DC offset exceeds at least 75% of Dif-Differential Dynamic Range, but before overload occurs.
Common Mode Rejection Ratio		
DC (Direct) Coupled	Refer to graph Fig. 1-2.	
AC (Capacitive) Coupled	Refer to graph Fig. 1-2.	
Maximum Input Voltage		
DC (Direct) Coupled, DC plus Peak AC		
10 μV/CM to 10 mV/CM	±20 volts	
20 mV/CM to 10 V/CM	±500 volts	
AC (Capacitive) Coupled Input, DC Voltage	±500 volts, each input.	
AC (Capacitive) Coupled, Input DC Rejection	At least 400,000:1	
Input R and C		
Resistance	1 megohm within 1%	
Capacitance	47 picofarads within 2.5 picofarad.	
Time Constant	47 microseconds within 4%	
Maximum Input Current	+25° C +50° C	
10 μV/CM to 10 mV/CM	±20 pA ±100 pA each input	
	±40 pA ±200 pA both inputs	
20 mV/CM to 10 V/CM	±10 pA ±10 pA	
Display shift at 10 mV/CM (AC Coupled)	±2 CM ±10 CM	
Variable Balance	Display shift is 0.2 CM or less as VARIABLE (VOLTS/CM) is turned from fully clockwise to fully counterclockwise.	Adjustable to zero using internal Var Bal control.
STEP ATTEN DC BAL	Adjustable for no position change of the display while switching the VOLTS/CM switch through its range.	
Position Range		At least +8 to −8 CM from graticule center.
Displayed Noise (Tangentially Measured)	16 microvolts or 0.1 cm (whichever is greater) at 1 MHz bandwidth and a source resistance of 25 ohms or less.	
DC Drift Drift with Time (Ambient Temperature and Line Voltage Constant)		

ELECTRICAL CHARACTERISTICS (cont)

Characteristics	Performance Requirement	Operational Information
Short Term	5 μV/minute (peak to peak) or 0.1 cm, whichever is greater, after 1 hour warmup.	
Long Term	10 μV/hour (peak to peak) or 0.1 cm whichever is greater, after 1 hour warmup.	
Drift with Ambient Temperature, Line Voltage Constant.	50 μV/degree centigrade	
Isolation between + and — Inputs (+ INPUT to an open — INPUT, — INPUT to an open + INPUT)		
10 μV/CM to 10 mV/CM	At least 100:1, DC to 1 MHz	Increase if probe or cable capacitance is added to the open input.
20 mV/CM to 10 V/CM	At least 200:1, DC to 1 MHz	
SIGNAL OUTPUT		
Dynamic Range		At least +4 volts to —4 volts
Amplitude	0.25 volts per displayed cm within 10%	
Output Resistance Minimum Load Resistor		750 ohm or less 10 kilohm
DC OFFSET		
COARSE Range from Electrical Zero		FINE Range
10 μV/CM to 10 mV/CM	+0.4 volts to —0.4 volts within 10%	2 mV
20 mV/CM to 0.1 V/CM	+4 volts to —4 volts within 10%	20 mV
0.2 V/CM to 1 V/CM	+40 volts to —40 volts within 10%	0.2 V
2 V/CM to 10 V/CM	+400 volts to —400 volts within 10%	2 V

ENVIRONMENTAL CHARACTERISTICS

The following environmental test limits apply when tested in accordance with the recommended test procedure. This instrument will meet the electrical performance requirements given in this section following environmental test. Complete details on environmental test procedures, including failure criteria, etc., may be obtained from Tektronix Inc. Contact your local Tektronix Field Office or representative.

Characteristics	Performance Requirement	Supplemental Information
Temperature		
Operating	0°C to 50°C	
Non-operating	—40°C to +65°C	
Altitude		
Non-operating	To 50,000 feet	
Operating	To 15,000 feet	
Vibration		
Operating		15 minutes along each axis at a total displacement of 0.015 inch, frequency varied from 10-50-10 cycles/second in 1 minute cycles with instrument secured to vibration platform. Three minutes along each axis at any resonant point or at 50 cycles/second.
Shock		
Non-operating		30 g's, one-half sine, 11 millisecond duration, 2 guillotine-type shocks per axis.
Transportation	Qualifies under NTSC Procedure 1A, Category II (24 inch drop)	

MECHANICAL CHARACTERISTICS

Characteristic	Information
Finish	Anodized aluminum front panel

STANDARD ACCESSORIES

Standard accessories supplied with the Type 1A7A are listed on the last pullout page of the Mechanical Parts List illustrations. For optional accessories available for use with this instrument, see current Tektronix, Inc. catalog.

NOTES

SECTION 2
OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

FRONT PANEL

Introduction

This section opens with a brief functional description of the front-panel controls, INPUT OVERLOAD light, input connectors, securing rod and SIGNAL OUTPUT connector. Following the front panel description is a familiarization procedure and finally a general discussion of the operation of the Type 1A7A.

INPUT OVERLOAD	Input overload indicator light. Turns on to indicate excessive differential drive to the input amplifier stage. Approximately 90% of the differential dynamic range between input connectors causes the light to turn on.
VOLTS/CM	Volts per centimeter (charcoal-colored knob). Nineteen-position switch used to select the calibrated deflection factors.
VARIABLE	Variable volts per centimeter (red knob). Provides continuously variable uncalibrated attenuation between the calibrated deflection factors and extends the attenuation range to at least 25 V/CM. This control has a switch detent position for CALIBRATED operation.
GAIN	Screwdriver-adjust control to set the gain of the amplifier so the CRT deflection will agree with VOLTS/CM switch indication. Adjusted for proper deflection when the VOLTS/CM switch is set to the 1 mV position.
POSITION	A control that varies the vertical position of the trace or display.
HIGH FREQ —3 dB POINT	Nine-position switch (red knob) to select the approximate high-frequency —3 dB down point. The switch positions are: 100 and 300 Hz; 1, 3, 10, 30, 100 and 300 kHz; and 1 MHz.
LOW FREQ —3 dB POINT	Seven position switch (charcoal knob) to select DC coupling, or the approximate low-frequency —3 dB down points. The switch positions are: DC; .1, 1, 10 and 100 Hz; 1 and 10 kHz.
+ INPUT	Signal input connector. Positive input produces deflection upward (see Fig. 2-1).
— INPUT	Signal input connector. Positive input produces deflection downward (see Fig. 2-1).
AC-GND-DC (+ INPUT coupling)	Three-position switch to select input coupling. AC and DC positions determine whether input signals applied to the + INPUT connector are AC or DC coupled to the Type 1A7A amplifier. The GND position disconnects the input signal and internally grounds the + input circuit. Also, the GND position permits the coupling capacitor to charge before switching to AC.
AC-GND-DC (— INPUT coupling)	Same function as + INPUT coupling switch but applies to the — INPUT.

IMPORTANT

The following controls are operative only when the LOW FREQ —3 dB POINT switch is set to DC.

STEP ATTEN DC BAL	Front-panel control for DC balancing the amplifier input stage. With no signals applied to the input connectors, the control is adjusted so there is no trace shift as the VOLTS/CM switch is moved from the 10 mVOLTS position to the 10 μVOLTS position.
DC OFFSET (ON-OFF switch) DC OFFSET COARSE and FINE control	Three controls that provide internal offset bias while maintaining the differential capability. Available range of the offset bias depends upon the setting of the VOLTS/CM switch, and is indicated on the front panel in green around the switch. DC OFFSET ON-OFF—Two-position toggle switch that turns the DC OFFSET COARSE and FINE controls on or off. DC OFFSET COARSE—A coarse control (center knob) for adjusting the DC offset voltage. DC OFFSET FINE—A vernier control (outer knob) for adjusting the DC offset voltage.
SIGNAL OUTPUT	Signal output connector. Provides a DC-coupled output signal at about .25 V per displayed cm.
Securing Rod	Gray knob, located near bottom center of the front panel; holds unit securely in the plug-in compartment.

OPERATING INSTRUCTIONS

First-Time Operation

Steps 1 through 5 in the following procedure are intended to help you get the trace on the screen quickly and prepare

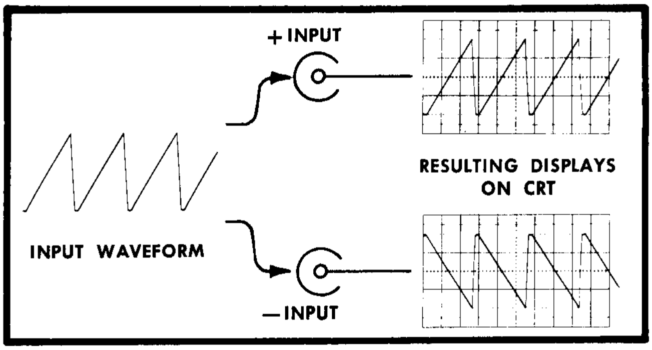


Fig. 2-1. Waveforms applied to the + INPUT connector produce an upright display, while waveforms applied to the — INPUT are inverted.

the unit for immediate use. Steps 6 through 8 are used to check the GAIN adjustment. These steps along with those remaining are intended to acquaint you with some of the basic functions of the Type 1A7A.

1. Insert the unit into the oscilloscope plug-in compartment. Tighten the securing rod.

2. Set the Type 1A7A front-panel controls as follows:

VOLTS/CM	1 mVOLTS
VARIABLE	CALIBRATED
POSITION	Midrange
HIGH FREQ —3 dB POINT	1 MHz
LOW FREQ —3 dB POINT	DC
AC-GND-DC (+ INPUT)	GND
AC-GND-DC (— INPUT)	GND
STEP ATTEN DC BAL	Midrange
DC OFFSET ON-OFF	OFF

3. Turn the oscilloscope Intensity control fully counterclockwise and turn on the oscilloscope power. Preset the time base and triggering controls for a 0.5-ms/cm sweep rate and automatic triggering.

4. Wait about five minutes for the Type 1A7A and oscilloscope to warm up.

NOTE

About five minutes is sufficient time for warmup when using the Type 1A7A for short-term DC measurements. For long-term DC measurements using the higher sensitivities, allow at least 1 hour warmup time.

5. Turn up the Intensity control for normal viewing of the trace. The trace should appear near the graticule center.

6. Using the POSITION control, position the trace 3 cm below graticule center. This procedure assumes the oscilloscope has a 6-cm high CRT viewing area. If the viewing area is less, adapt the procedure accordingly.

CAUTION

If the maximum input voltage rating in the 10 μV/CM - 10 mV/CM range of the VOLTS/CM switch is exceeded, the inputs are diode-clamped to either a fixed voltage of approximately +22 or —27 V. If the signal source can supply more than 1/16 A of current, the input protective fuse(s) will blow. An open input fuse is indicated by the lighting of the INPUT OVERLOAD light with the input coupling switches set to GND.

7. Apply a 5-mV peak-to-peak calibrator signal through a coaxial cable to the + INPUT connector on the Type 1A7A.

8. Set the + INPUT AC-GND-DC coupling switch to DC. The display should be square waves 5 cm in amplitude. This is an example of DC coupled single-ended operation. The calibrator waveform is positive-going 5 mV from the reference established in step 6.

NOTE

If the display is not exactly 5 cm in amplitude, refer to the Operational Adjustments topic for proper gain adjustment procedure.

9. Using the POSITION control, position the display so the lower flat portions of the square waves coincide with graticule center.

10. Set the + INPUT AC-GND-DC coupling switch to AC and note that the display shifts downward about 2.5 cm to its average level. This is an example of AC coupled single-ended input operation.

11. Disconnect the coaxial cable from the CAL OUT connector. Connect a BNC T connector to the CAL OUT connector and connect the coaxial cable from the + INPUT to the BNC T connector. Connect a coaxial cable, equal in length to the one used for the + INPUT, from the T connector to the — INPUT.

12. Set the — INPUT AC-GND-DC coupling switch to AC. Now the calibrator signal is applied to both inputs as a common-mode signal. A trace (but no waveform) will be displayed because the common-mode signal is rejected by the Type 1A7A. This is an example of AC coupled differential mode of operation.

This completes the basic operating procedure for the Type 1A7A. Operation of controls not used here, or operation which needs further explanation, will be discussed under General Operating Information.

Operational Adjustments

After the unit has warmed up for at least 1 hour and stabilized, check its operation to see if adjustment of one or more of the following controls is necessary. Be sure that the vertical amplifier of the oscilloscope used in conjunction with the Type 1A7A is correctly balanced and calibrated (refer to oscilloscope instruction manual), and that the calibrator output voltage is correct.

1. STEP ATTEN DC BAL Adjustment

With no signal input, if the STEP ATTEN DC BAL adjustment is not properly compensated the CRT trace will shift vertically as the VOLTS/CM switch is rotated through its range. The shift is more noticeable on the most sensitive positions.

a. Set the Type 1A7A front panel controls, except VOLTS/CM, as specified in step 2 of the First-Time Operation procedure. Set the VOLTS/CM control to 10 mV/CM.

b. Using the POSITION control, position the CRT trace to the center of the graticule.

c. Set the VOLTS/CM switch to 10 μV.

d. Return the trace to graticule center by using the STEP ATTEN DC BAL control.

NOTE

The adjustment of the STEP ATTEN DC BAL control should be checked periodically during the use of the instrument. If the Type 1A7A is used in the 10 μV/CM to 0.1 mV/CM ranges and DC coupled or the ambient temperature is varying significantly, the STEP ATTEN DC BAL control should be checked quite frequently. It is good practice to check this control before any critical measurement is made under the above conditions.

2. GAIN Adjustment

a. Perform steps 1 through 8 in the First-Time Operation Procedure.

b. Adjust the GAIN control so the display is exactly 5 cm in amplitude.

NOTE

Accuracy of this adjustment is dependent on the voltage accuracy of the calibration source.

3. AC ATTEN BAL Internal Adjustment—AC Stabilization

When the LOW FREQ-3 dB POINT switch is used to limit the low frequency response of the 1A7A, the unit automatically employs AC stabilization. This means that when the switch is set to any position except DC, the STEP ATTEN DC BAL and DC OFFSET controls become inoperative and the DC drift in the amplifier is greatly reduced.

VOLTS/CM balance is then controlled with AC ATTEN BAL, an internal adjustment (see Fig. 2-2). When transferring the Type 1A7A from one oscilloscope to another, it may be necessary to perform a minor readjustment of this control due to normal power supply variations between oscilloscopes. The adjustment of this control in no way affects the calibration of the unit and may be performed without interaction with any other controls as follows:

a. With the Type 1A7A inserted into the oscilloscope, remove the left side panel of the scope, and set the Type 1A7A controls to these positions:

VOLTS/CM	10 mVOLTS
AC-GND DC (+ INPUT and — INPUT)	GND
LOW FREQ —3 dB POINT	10 kHz
HIGH FREQ —3 dB POINT	100 Hz
DC OFFSET ON-OFF	OFF

b. Using the POSITION control, position the trace to graticule center.

c. Set the VOLTS/CM switch to 20 μV.

d. Adjust the AC ATTEN BAL control R505 to position the trace to within 1.5 cm of graticule center.

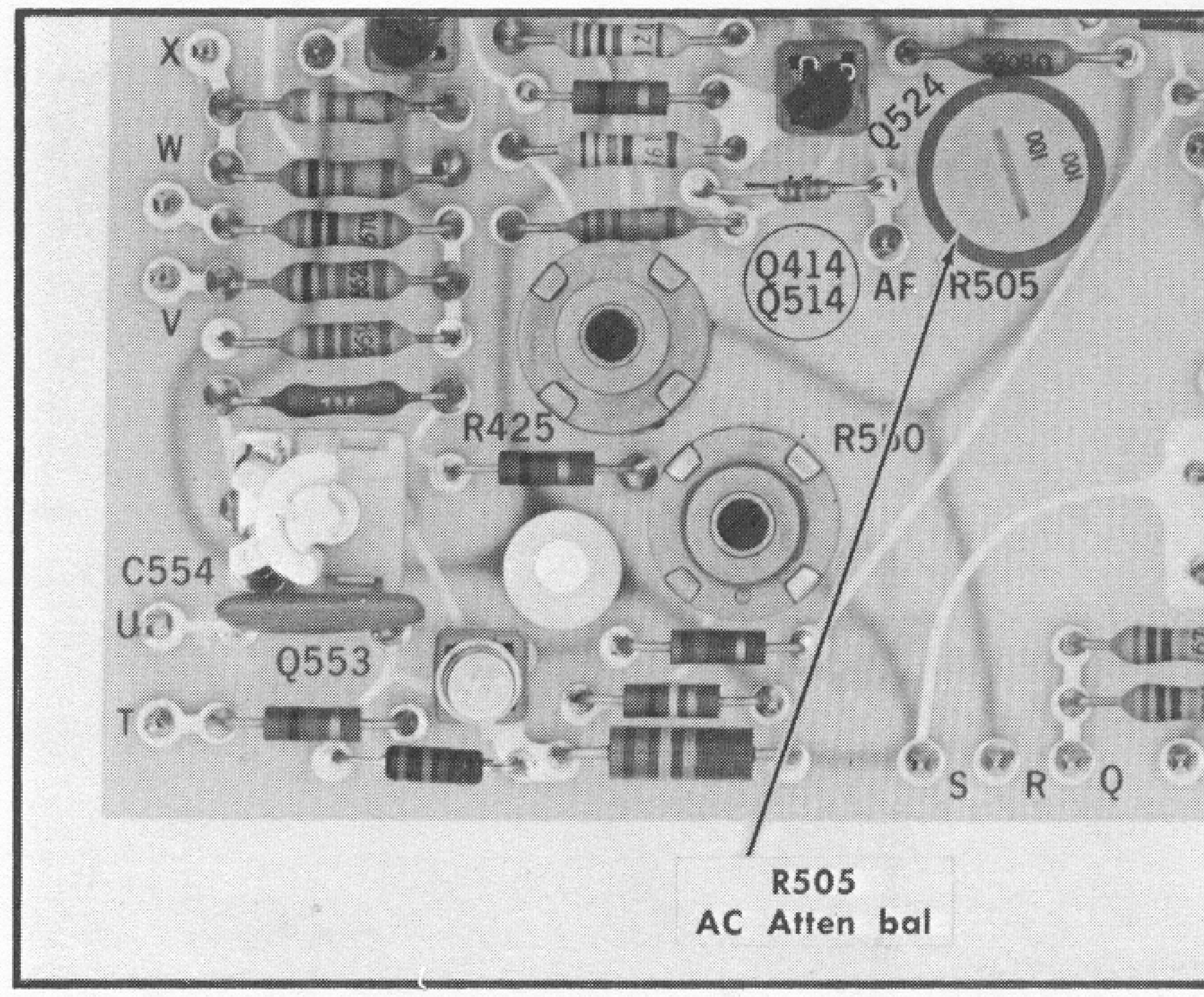


Fig. 2-2. Location of the AC Atten Bal adjustment.

4. SIGNAL OUTPUT DC Level Internal Adjustment

When first operating the Type 1A7A, or when changing main frames, the SIGNAL OUTPUT DC level should be checked. The DC level at the SIGNAL OUTPUT connector should be zero volts when the trace is centered on the CRT. This adjustment in no way affects the calibration of the unit and may be performed without interaction with any other controls as follows:

a. Set the Type 1A7A controls to these positions:

VOLTS/CM	10 mV
AC-GND-DC (+ INPUT and — INPUT)	GND
LOW FREQ —3 dB POINT	DC
HIGH FREQ —3 dB POINT	1 MHz
DC OFFSET ON-OFF	OFF

b. Using the POSITION control, position the trace to graticule center.

c. Connect a DC voltmeter or a test oscilloscope to the SIGNAL OUTPUT connector and measure the DC level.

d. With the left side panel of the oscilloscope removed, adjust for zero volts with the Sig Out DC Level adjustment, R550, (see Fig. 2-3).

GENERAL OPERATING INFORMATION

Trace Drift

The environment in which the Type 1A7A is operated, and the inherent characteristics of the Type 1A7A, influence trace drift. Therefore, to determine trace drift for a specific enviroment refer to the Characteristics section of this manual. In an environment where the ambient temperature does not vary much (such as an air-conditioned laboratory) the trace drift generally will not exceed 10 μV in one hour.

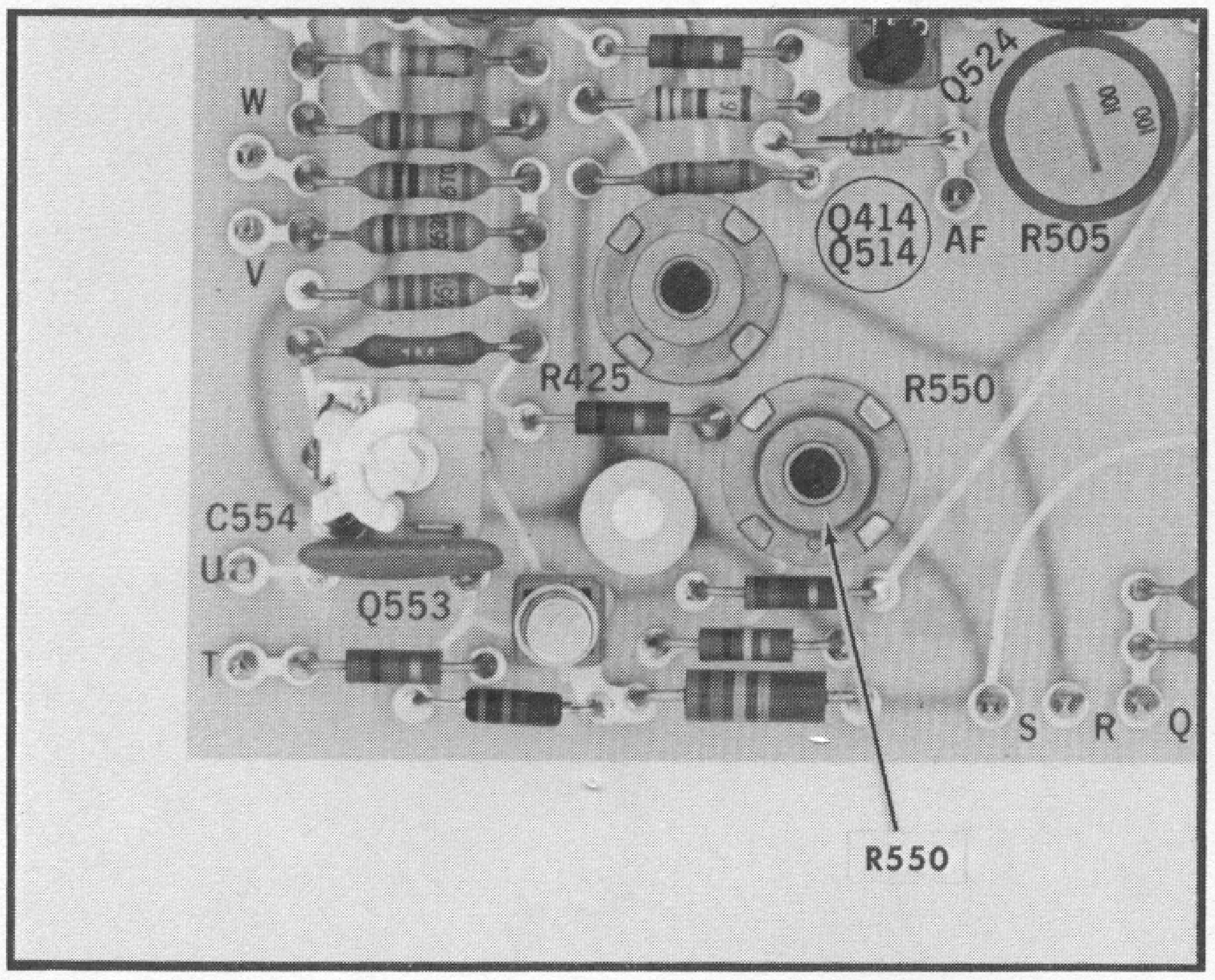


Fig. 2-3. Location of SIGNAL OUTPUT DC Level adjustment.

To obtain accurate DC measurements at maximum sensitivity, it is necessary to ground the input and DC-balance the amplifier just before making the measurement. This is accomplished by adjusting the STEP ATTEN DC BAL control as described above.

When using the 0.1 mV - 10 μV ranges for measurements with an AC coupled input, or for DC measurements where the DC source impedance is high (in excess of 1 MΩ), the input gate current should be checked and allowed for, or input gate current should be checked and allowed for. This is particularly desired at high ambient temperatures (above 40° C). Step 7 and 8 in the Performance Check/Calibration Procedure describes how to check and adjust the internal + Gate Current and — Gate Current controls to offset the trace shift due to gate current.

Applying Signals

When measuring DC voltages, use the largest deflection factor (10 V/CM) when first connecting the Type 1A7A to an unknown voltage source. Then, if the deflection is too small to make the measurement, switch to a lower deflection factor. If the input stage is overdriven, a large amount of current might flow into the Input. See CAUTION after item 6 of First Time Operation.

For signals having both AC and DC components where you intend to measure only the AC component, take advantage of the pre-charging circuit incorporated in the unit. This circuit permits the 0.1 μF coupling capacitor to charge to the DC source voltage when the AC-GND-DC input coupling switch is set to GND. The procedure for using this circuit is as follows:

a. Before connecting the Type 1A7A to a signal containing a DC component, set the AC-GND-DC input coupling switch to GND. Then connect the input to the circuit under test.

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

c. Set the input coupling switch to AC. The trace (display) will remain on the screen and the AC component can be measured in the usual manner.

d. Upon completion of the measurement set the AC-GND-DC switch to GND and short the Input connector to ground, thus discharging the input capacitor.

The above procedure should be followed whenever another signal with a different DC Level is connected.

NOTE

When a large DC voltage has been applied to the Type 1A7A with the input AC coupled, the input coupling capacitors acquire a charge and act as low voltage high impedance batteries with a very slowly decaying voltage. This can offset subsequent AC coupled measurements at other DC voltages and drive the trace off screen. A period of at least 10 minutes should be allowed to assure reasonable recovery from polarization, and a longer period may be necessary for critial measurements.

Signal Input Connectors

When connecting signals to the + INPUT and — INPUT connectors on the Type 1A7A, consider the method of coupling that will be used. Ordinary unshielded test leads can sometimes be used to connect the Type 1A7A to a signal source, particularly when a high level, low-frequency signal is monitored at a low impedance point. However, when any of these factors are missing, it becomes increasingly important to use shielded signal cables. In all cases, the signal-transporting leads should be kept as short as practical.

When making single-ended input measurements (conventional amplifier operation), be sure to establish a common-ground connection between the device under test and the Type 1A7A. The shield of a coaxial cable is normally used for this purpose.

In some cases differential measurements require no common-ground connection,[1] and therefore are less susceptible to interference by ground-loop currents. Some problems with stray magnetic coupling into the signal-transporting leads can also be minimized by using a differential rather than a single-ended measurement. These considerations are discussed later in this section under Differential Operation.

It is always important to consider the signal-source loading and resulting change in the source operating characteristics due to the signal-transporting leads and the input circuit of the Type 1A7A. The circuit at the input connectors can normally be represented by a 1 megohm resistance to ground paralleled by 47 pF. A few feet of shielded cable may increase the parallel capacitance to 100 pF or more. In many cases, the effects of these resistive and capacitive loads may be too great and it may be desirable to minimize them through the use of an attenuator probe.

Attenuator probes not only decrease the resistive and capacitive loading of a signal source, but also extend the

[1]The DC plus peak AC voltages on the test points with respect to the chassis potential of the Type 1A7A should be limited to the levels listed in Section 1 under Maximum Common-mode Input Voltage characteristics. Higher levels will degrade the common-mode rejection ratio and exceed the input voltage rating of the unit.

measurement range of the Type 1A7A to include substantially higher voltages. Passive attenuator probes having attenuation factors of 10×, 100× and 1000×, as well as other special-purpose types are available through your Tektronix Field Engineer or Field Office.

Some measurement situations require a high-resistance input to the Type 1A7A with very little source loading or signal attenuation. In such a situation a passive attenuator probe cannot be used. However, this problem may be solved by using a cathode-follower probe or the high impedance input provision of the Type 1A7A.

The high impedance input provision applies only to DC coupled signals which permit the use of 10 mV through 10 μV positions of the VOLTS/CM switch. Since no input attenuator is used at these switch positions, the internal gate return resistor alone establishes the 1-megohm input resistance. This resistor in each input can be disconnected by removing a wire strap from the attenuator circuit board (see Fig. 2-4). The signal source must then provide a DC path for the FET gate current.

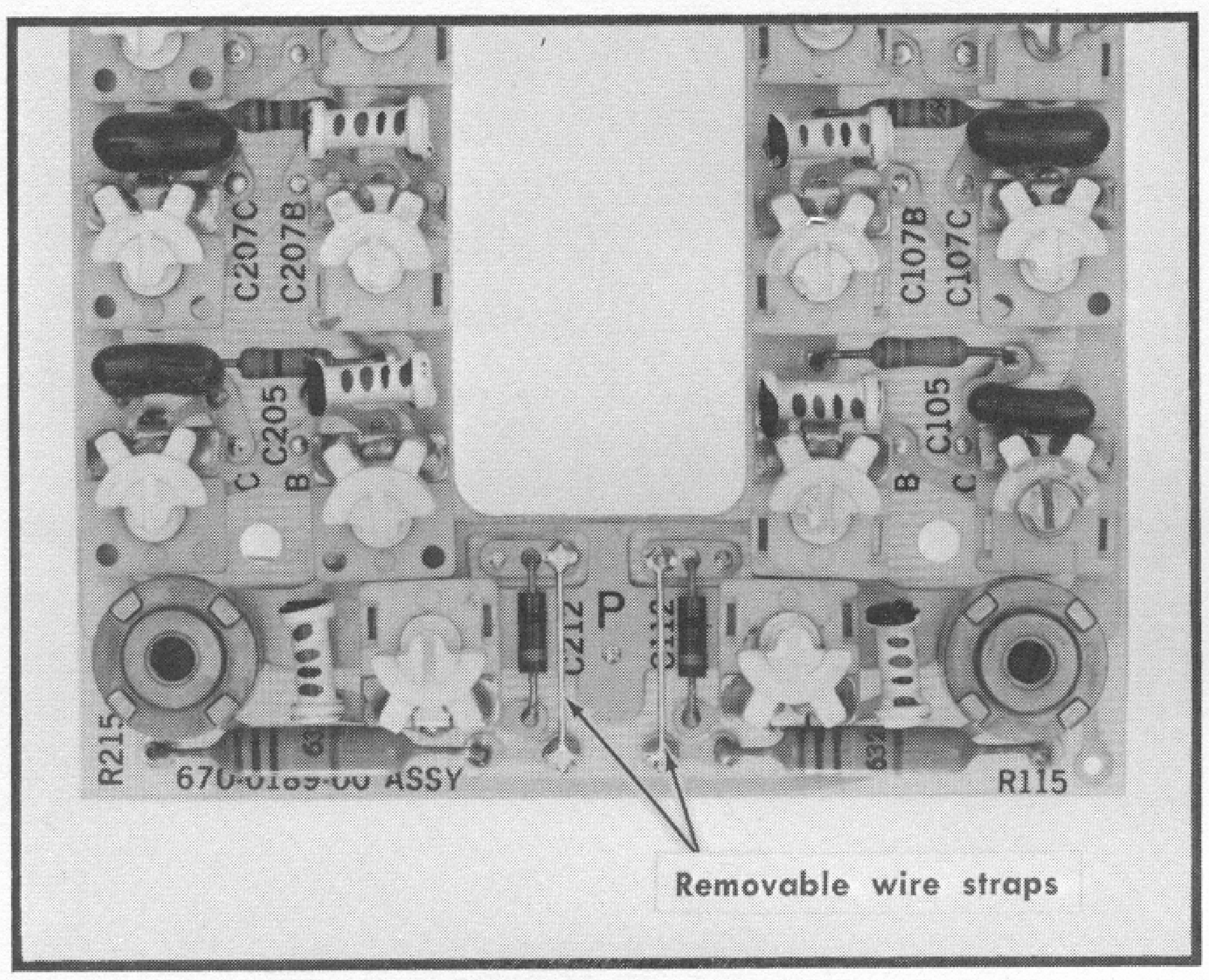


Fig. 2-4. Location of removable wire straps for high impedance input provision.

The compensated gate current is typically less than 10 picoamperes, but may be several times higher depending upon the operating temperature. The signal-source impedance is therefore an important factor since gate current will produce a DC offset. For example, a 10 picoampere gate current through 10 megohms produces a .1 mV offset; this may result in a significant error where small voltages are of concern. This effect can be minimized by insuring that the source impedance to both inputs is the same.

IMPORTANT

When the wire straps are removed from the attenuator circuit board, the + GATE CURRENT and — GATE CURRENT internal adjustments are disconnected. The deflection factor in the 20 mV - 10 V range will be incorrect.

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

Display Polarity

Single-ended signals can be applied to either the + INPUT or — INPUT connector. If the + INPUT is chosen, positive-going changes in the input signal will cause the trace to be deflected upward, and negative-going changes will cause it to be deflected downward. If the — INPUT is chosen, input-to-display polarity relationship will be reversed as shown previously in Fig. 2-1.

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

Deflection Factor

The amount of trace deflection produced by a signal is determined by the signal amplitude, the attenuation factor (if any) of a probe, the setting of the VOLTS/CM switch and the setting of the VARIABLE control. The calibrated deflection factors indicated by the VOLTS/CM switch apply only when the VARIABLE control is set fully clockwise into the switch detent CALIBRATED position.

The range of the VARIABLE control is at least 2.5:1. It provides uncalibrated deflection factors covering the full range between the fixed settings of the VOLTS/CM switch. The control can be set to extend the deflection factor to at least 25 volts/cm.

To reduce noise and obtain a more usable display when the VOLTS/CM switch is operated in the 10 μV, 20 μV, or 50 μV positions, it is suggested that the HIGH FREQ —3 dB POINT switch be set to 30 kHz or less for the 10 μV position and 100 kHz or less for the 20 μV and 50 μV positions. In general it is good practice to use the lowest bandwidth setting which does not appreciably distort the desired features of the signal under observation.

Voltage Comparison Measurements

Some applications require a set of deflection factors other than the fixed values provided by the VOLTS/CM switch. One such application is comparison of signal amplitudes by ratio rather than by absolute voltage. To accomplish this, apply a reference signal to either input of the Type 1A7A.

Set the VOLTS/CM switch and VARIABLE control so that the reference display covers the desired number of graticule divisions. Do not change this setting of the VARIABLE control throughout the subsequent comparisons. The settings of the VOLTS/CM switch can be changed, however, to accommodate large ratios. In doing so, regard the numbers which designate the switch position as ratio factors rather than voltages.

Differential Operation

Differential voltage measurements are made by applying the signals to the + INPUT and — INPUT connectors. Then, both AC-GND-DC switches should be set to the same position: AC or DC, depending on the method of signal coupling desired. When using the Type 1A7A for differential operation, only the voltage difference between the two signals is amplified and displayed on the CRT. Common-mode signals (signals that are common in amplitude, frequency and phase) are rejected and not displayed (see Fig. 2-5).

The Type 1A7A differential input provision may be used to eliminate interfering signals such as AC line-frequency hum. Single-ended measurements often yield unsatisifactory information because of interference resulting from ground-loop currents between the oscilloscope and the device under test. In other cases, it may be desirable to eliminate a DC voltage by means other than the use of a DC-blocking capacitor which would limit low-frequency response.

These limitations of single-ended measurements are virtually eliminated in differential measurements. A differential measurement is made by connecting each of the two inputs to selected points in the test circuit. Since the chassis of the Type 1A7A need not be connected in any way to the test circuit there are few limitations to the selection of these test points.

The ability of the Type 1A7A to reject common-mode signals is indicated by the common-mode rejection ratio (CMRR). This ratio is at least 100,000:1 at the input connectors for the lower deflection factor (10 μV - 10 mV/CM) when signals between DC and 100 kHz are DC-coupled to the inputs. To show the significance of this characteristic, assume that a single-ended input signal consists of an unwanted 60-Hz hum at 1 volt peak to peak plus a desired signal at 1 mV peak to peak. If an attempt is made to display the desired signal with the VOLTS/CM switch set to .2 mV, the 60-Hz hum would produce a deflection equivalent to 5000 cm and thus little useful information about the 1 mV signal could be obtained.

If the same 1 mV signal is monitored differentially so that the 60-Hz hum signal is common mode at the inputs, no greater than one part in 100,000 of the common-mode signal will appear in the display. Thus, the desired signal produces a display amplitude of 5 cm (1 mV $\div$ .2 mV/CM = 5 cm) with no more than .05 cm (1 V $\div$ 100,000 = 10 μV; 10 μV $\div$ .2 mV/CM = .05 cm) of interference due to the common-mode signal.

There are a number of factors which can degrade the common-mode rejection ratio of the Type 1A7A. The principal requirement for maximum rejection is for a common-mode signal to arrive at the gates of the two input FETs in precisely the same form. For example, a difference of only 0.01% in the attenuation factors of the two input attenuators may reduce the rejection ratio to 10,000:1. Likewise, any difference between the source impedance at the two points in the device under test will degrade the rejection ratio. Another factor is that ordinary attenuator probes may reduce the rejection ratio to 100:1 or less. However, P6023 Probes have adjustable R and C attenuation factors which permit them to be used with minimum reduction in the common-mode rejection ratio.

Outside influences such as magnetic fields can also degrade the performance, particularly when low level signals

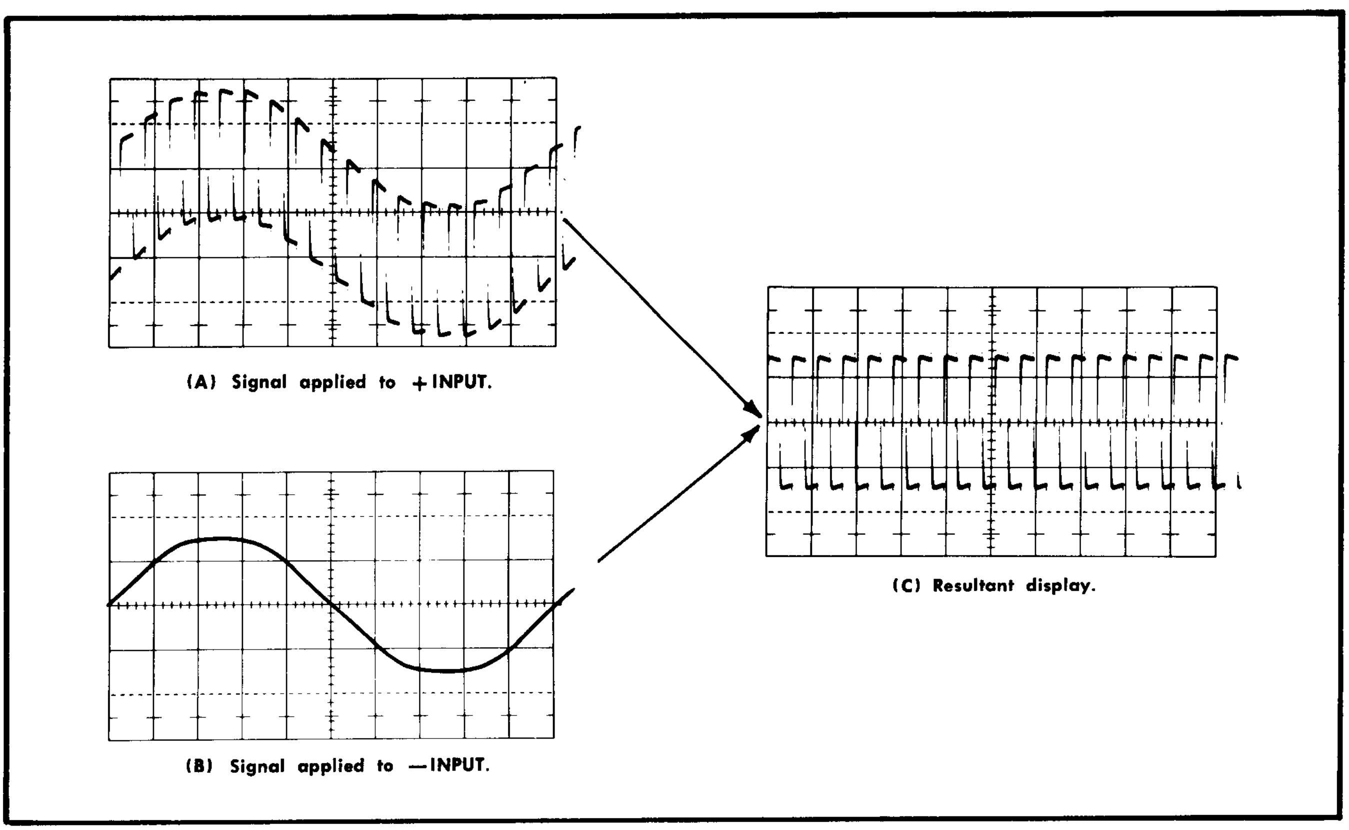


Fig. 2-5. Waveforms showing differential rejection of a common-mode signal. Resultant waveform (c) shows the difference between the two signals.

are involved. This type of interference can be minimized by using the same type of signal-transporting lead for each input.

Where an interfering magnetic field cannot be avoided, the pickup loop formed by the two leads should be minimized by taping or twisting them together throughout most of their length. Low-frequency measurements can be similarly protected by using a shielded cable which contains a twisted pair of conductors.

P6023 Probes

The following adjustment procedure is recommended when preparing to use P6023 Probes for differential measurements:

a. Connect one probe for DC-coupled single-ended input operation. Obtain a triggered display of an appropriate square-wave signal such as that from the oscilloscope amplitude calibrator. Adjust the probe DC Atten Calibration control for correct deflection sensitivity; then use the AC Coarse Comp and AC Comp Fine Adjust control to compensate the probe for proper square-wave response.

b. Connect a second probe for DC-coupled operation. Apply the square-wave signal to both probes at 100 volts peak to peak. Obtain a free-running sweep and adjust the DC Atten Calibration control of the second probe for maximum low-frequency cancellation. This is indicated by elimination of the two-trace appearance, resulting in one trace of minimum thickness.

c. Adjust the AC Coarse Comp and AC Comp Fine Adjust controls of the second probe to minimize the amplitude of the differentiated pulses on the trace.

d. This procedure matches the probes for use at any sensitivity which employs the particular input attenuator used in steps b and c. Whenever it is necessary to use a different input attenuator, steps b and c should be repeated for that attenuator. The input sensitivity group associated with each of the four attenuators is listed in Table 2-1.

TABLE 2-1

VOLTS/CM Switch Position	Input Attenuator
10 μV to 10 mV	1×
20 mV to .1 V	10×
.2 V to 1 V	100×
2 V to 10 V	1000×

e. When a small differential signal in the presence of relatively large common-mode components is being examined, a fine adjustment of the probe CMRR may be made by temporarily connecting both probes to either of the two signal sources. Movement of the probe cables should be minimized after the adjustment. The above adjustment is accomplished in the same manner as just described in steps a through d.

Bandwidth Selection

In addition to the differential rejection of unwanted signals, many times an undesired signal can be attenuated by varying the bandwidth of the unit. The concentric LOW FREQ —3 dB POINT and HIGH FREQ —3 dB POINT switches on the front panel of the Type 1A7A control the low-frequency and high frequency 3 dB down points of the amplifier. The LOW FREQ —3 dB POINT switch provides low-frequency cutoff flat to DC or approximately 3 dB down points at 0.1, 1, 10, 100 Hz, 1 kHz and 10 kHz. The HIGH FREQ —3 dB POINT switch controls the high frequency rolloff from 1 MHz to 100 Hz in a 1-3-10 sequence. Beyond the —3 dB point, frequency response falls off at a 6 dB/octave rate.

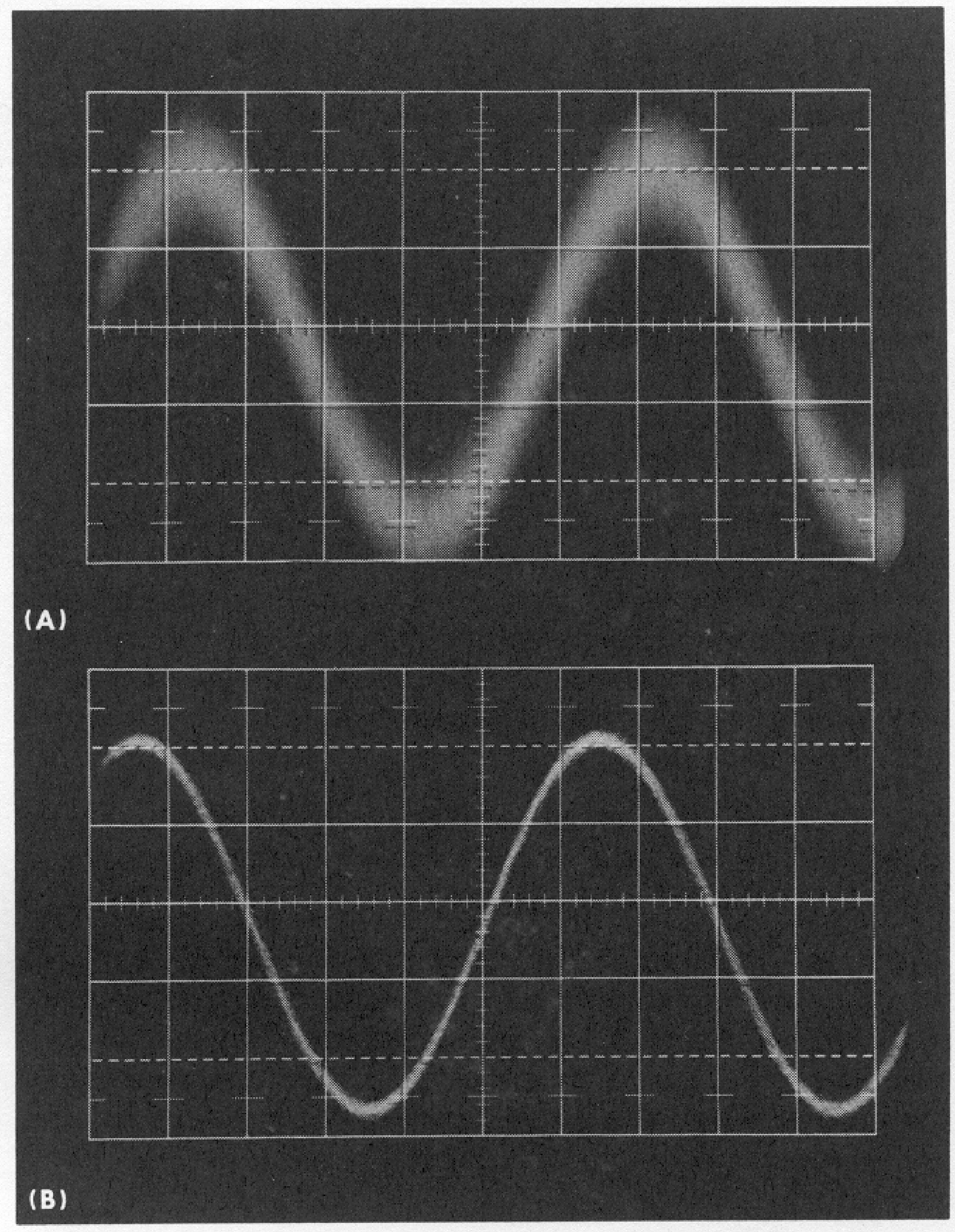


Fig. 2-6. Improving the signal to noise ratio by controlling the bandwidth of the Type 1A7A. (A) The LOW FREQ —3 dB POINT selector is set to DC and the HIGH FREQ —3 dB POINT selector is set to 1 MHz. (B) The LOW FREQ —3 dB POINT selector is set to DC and the HIGH FREQ —3 dB POINT selector is set to 10 kHz.

Varying the bandwidth of the Type 1A7A is useful for example when displaying a low-frequency signal. By reducing the high-frequency response the noise can, in many cases, be considerably reduced without distorting the desired signal (see Fig. 2-6). Likewise, undesired line-frequency hum can be filtered out by restricting the low-frequency response of the unit. When using the LOW FREQ —3 dB POINT and HIGH FREQ —3 dB POINT switches, be careful not to distort non-sinusoidal waveforms by overly restricting the amplifier bandwidth.

DC Offset Operation

By using the DC OFFSET controls, it is possible to use the Type 1A7A DC-coupled to observe small signals whose

DC potential difference may be considerable. The offset is continuously adjustable from +400 mV to −400 mV when using a DC deflection factor of 10 μV/cm to 10 mV/cm (see Table 2-2).

In the 20 mV, 50 mV, and .1 V positions of the VOLTS/CM switch, the ±400 mV offset is effectively multiplied by the input attenuator to a range of ±4 V. Table 2-2 summarizes the effective DC offset voltages internally available for all the VOLTS/CM switch positions. The table also lists the input attenuator that is switched into the amplifier circuit for the various VOLTS/CM switch positions.

TABLE 2-2

VOLTS/CM Switch Positions	Input Attenuator Switched In	Effective Offset Voltage Range
10 μV to 10 mV	1×	±400 mV
20 mV to .1 V	10×	±4 V
.2 V to 1 V	100×	±40 V
2 V to 10 V	1000×	±400 V

INPUT OVERLOAD Light

At the lower deflection factors the INPUT OVERLOAD light turns on whenever a DC differential signal greater than approximately 0.35 volt is applied to the input. The Type 1A7A should not be left connected to a circuit if this light is on, as this may mean that a damaging voltage is present. Table 2-3 lists the approximate DC voltage that will turn on the light.

TABLE 2-3

Approx. Turn-on DC Voltage for INPUT OVERLOAD Light	VOLTS/CM Switch Position
0.35 V	10 μV to 10 mV
3.5 V	20 mV to .1 V
35 V	.2 V to 1 V
350 V	2 to 10 V

The neon INPUT OVERLOAD light serves another important function. Since most sensitive differential amplifiers of the past have been AC coupled internally, they are incapable of indicating to the operator the presence of a DC differential signal.

Since these amplifiers were usually direct-coupled at the input, a DC differential signal could overload the input stage and cause a reduction in gain. The small voltages to be measured would not be distorted, but were reduced in amplitude. As a result, amplitude measurements made under such conditions were not accurate and the operator could not be aware of the inaccuracies. In contrast, the Type 1A7A INPUT OVERLOAD light provides an indication that such a signal is present by lighting before the gain calibration changes by 1%.

If the INPUT OVERLOAD light turns on, there are two options:

1. When the Type 1A7A is in AC stabilization (LOW FREQ −3 dB POINT switch is not set to DC). DC differential signals as great as 0.75 volt may be balanced out by using the front-panel DC OFFSET controls. Once the INPUT OVERLOAD light is extinguished, gain calibration is restored to within 1%. Direct-coupled operation (AC-GND-DC switch set to DC) is possible for signals with up to 0.4-volt offset at the higher sensitivities. See Table 2-2, which lists the effective offset voltage ranges.

2. DC differential signals up to 1000 volts (either input not to exceed 500 V) may be removed by using AC coupling at the input (AC-GND-DC switch set to AC). This necessarily limits the low-frequency response to 1.6 Hz (or 0.16 Hz with a 10× probe).

If there is any doubt as to the amount of input DC offset voltage present, set the VOLTS/CM switch to a larger deflection factor (lower sensitivity) and check that the DC OFFSET ON-OFF switch is set to OFF. Then, measure the DC offset voltage using normal DC-coupled differential operation.

The INPUT OVERLOAD light is insensitive to common-mode overloads, and it is possible to overload the Type 1A7A without lighting the input overload light.

In summary the overload light will turn on under the following conditions:

a. The input signal plus the DC offset exceeds the differential dynamic range of the amplifier (see Characteristics Section for table of dynamic ranges).

b. An input protective fuse is blown. In this case, the light will remain on even if the AC-GND-DC switches are set to GND.

c. There is a circuit malfunction.

SIGNAL OUTPUT Connector

A DC-coupled vertical signal output, referenced to zero volts DC, is provided on the front panel of the Type 1A7A. Output signal amplitude is about .25 V per displayed cm. Two suggested uses for this output are:

1. Differential measurements.

2. Minimum-noise low-level signal work.

Not all voltmeters have a signal output connector for applying a monitoring signal to the oscilloscope. To overcome these limitations of AC voltmeters, the following setup is suggested:

1. Instead of connecting the signal from the device under test to the voltmeter, connect the signal to the Type 1A7A. Use the oscilloscope to provide a visual display.

2. Connect the voltmeter to the SIGNAL OUTPUT connector.

3. Calibrate the system by feeding into the 1A7A a signal whose value is known (e.g. main frame CAL signal) and use the VARIABLE control. Set the voltmeter scale factor and Type 1A7A VOLTS/CM switch to suitable values. After calibration the Type 1A7A VOLTS/CM switch should be used to set the overall sensitivity. The voltmeter sensitivity should be between 0.1 V and 1 V full scale.

SECTION 3
CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

A block diagram description covering the general configuration of each circuit in the Type 1A7A is included in this section. Following the block diagram description is a detailed description of each circuit and the functions of specific components.

Simplified drawings are provided where necessary for easier circuit understanding. Complete schematic diagrams are included in the Diagrams section. These should be referred to throughout the detailed circuit description.

The value of resistors on the schematics is in ohms unless otherwise specified. Capacitor values are indicated in the following manner unless otherwise specified: whole numbers indicate the value in pF, decimal numbers indicate the value in μF. Example 0.1 is μF; 33 is pF.

BLOCK DIAGRAM DESCRIPTION

With one exception, the input attenuators for the + and — inputs are identical and are the conventional RC type attenuators. The difference between the two attenuators is that the resistive elements of the — input attenuator are adjustable so the — input side can be matched to the + input to obtain optimum DC common-mode signal rejection.

A signal applied to the + INPUT connector passes through the input coupling selector switch to the input attenuator circuit where it is attenuated by a factor of 1, 10, 100 or 1000. For deflection factors from 10 μV through 10 mV no input attenuation is used. The desired deflection factor is obtained by switching the gain setting resistor of the output amplifier.

From the input attenuators the signal is coupled to the ×24 Pre-amp. The ×24 Pre-amp consists of two identical feedback amplifiers connected in a differential configuration. The overall differential gain is approximately 24. The supply voltages for the two amplifiers are obtained from a common bootstrapped power supply which improves the CMRR of the Pre-amp. Each input is equipped with an overdrive protection circuit, consisting of fuses and clamping diodes. For deflection factors of 10 mV and below when the input voltage exceeds approximately 25 V at a current of 1/16 A or more, the fuse opens and prevents damage to the input circuitry.

An Input Overload Detector circuit has been provided to indicate that the ×24 Pre-amp is approaching the limits of its differential dynamic range. A front-panel indicating lamp lights when an overload occurs. When the LOW FREQ —3 dB POINT selector is in any position other than DC, and the input coupling switch is in DC, there is no on-secreen indication of the DC conditions in the ×24 Pre-amp. If the differential dynamic range of the amplifier is exceeded and the amplifier is driven into non-linearity or overload, an erroneous display is likely.

An Offset Generator is provided to balance out any resultant currents in the ×24 Pre-amp produced by a signal containing a DC differential component. This allows the varying component to be amplified, and the amplifier to maintain its differential capabilities.

The push-pull output of the ×24 Pre-amp is coupled through a LOW FREQ —3 dB POINT selector. The selector switches the components of the coupling network in each output of the amplifier and selects cutoff frequencies of .1 Hz, 1 Hz, 10 Hz, 100 Hz, 1 kHz, and 10 kHz. The DC position of the selector bypasses the low frequency —3 dB point circuit and direct-couples the amplifier.

The signal is then coupled into a Gain Switching Amplifier stage composed of a circuit similar to the ×24 Pre-amp. The VOLTS/CM switch, switches the common source resistor of the amplifier, thereby changing the gain of the amplifier. This method is used in conjunction with the input attenuators to provide the deflection factors as indicated on the VOLTS/CM switch.

The output stage of the amplifier is composed of two transistors connected in a common emitter configuration. The transistors have their current varied in a push-pull manner by the Vertical POSITION control to position the trace on the CRT. The gain of the amplifier is calibrated in this stage by adjusting the common emitter resistance of the two transistors.

The HIGH FREQ —3 dB POINT selector switches the capacitance across the output of the output stage, changing the high frequency —3 dB point.

A single ended output is coupled from the output stage through a source follower to the SIGNAL OUTPUT jack on the front panel of the Type 1A7A. The amplitude of the signal available at the output connector is approximately .25 V/cm.

Input Coupling

Input signals applied to the + INPUT connector can be AC coupled, DC coupled or internally disconnected. When the Input Coupling switch SW101 (see Input Amplifier diagram), is in the DC position, the input signal is coupled directly to the input attenuator. In the AC position, the AC signal is coupled through coupling capacitor C102, and the DC component is blocked from the input amplifier. The GND position internally disconnects the signal from the Type 1A7A and connects the gate of the input amplifier to ground. This provides a ground reference for the amplifier without removing the input leads or otherwise disconnecting the input signal. Resistor R101 allows C101 to be precharged in the GND position so that when SW101 is switched to the AC position with a high DC level applied, there is no charging current surge into the input of the amplifier. Excessive loading is also avoided for the circuit under test. The — input functions in the same manner as the + input.

Input Attenuator

To produce the vertical deflection indicated on the front panel by the VOLTS/CM switch, the gain of the feedback amplifier in the Output Amplifier circuit is changed by switching the source resistor (R408) of Q404A/B for switch positions below 10 mV. For switch positions above 10 mV/CM, Input Attenuators are switched into the input circuit of the Type 1A7A, in conjunction with the gain switching resistors, to produce the selected deflection sensitivity.

The input attenuators diagram 4 are frequency-compensated voltage dividers. For DC and low frequency signals, they are primarily resistance dividers and the voltage attenuation is determined by the resistance ratio in the circuit. The reactance of the capacitors in the circuit is so high at the lower frequencies that their effect is negligible. However, at higher frequencies, the reactance of the capacitors decrease and the attenuator becomes primarily a capacitor voltage divider.

In addition to providing constant attenuation at all frequencies within the bandwidth of the instrument, the input attenuators are designed to maintain the same input RC characteristics (one megohm in parallel with 47 pF) for each setting of the VOLTS/CM switch. Each attenuator contains an adjustable capacitor to provide correct attenuation at high frequencies, and an adjustable shunt capacitor to provide correct input capacitance.

INPUT AMPLIFIER

General

The input amplifier circuit in the Type 1A7A is made up of two identical feedback amplifiers connected in a differential configuration with a push pull output. The power supply voltages (except at the output) for each feedback amplifier are obtained from a power supply that is bootstrapped to the common-mode input signal, thus improving the common mode rejection ratio of the amplifier. Input overdrive protection is provided in the input circuit to prevent damage to the semiconductors if a large overdrive is inadvertently applied to the input.

Feedback Amplifiers

Since the Type 1A7A utilizes several multi-stage feedback amplifiers, a brief review of feedback systems in general is given.

A generalized feedback system is illustrated in Fig. 3-1 in which it is desired to produce an output signal accurately related to the input. The Modifier output is nearly equal to the input signal. Any difference between these two signals is detected by the Comparator, which produces an error signal and applies it to the Error Amplifier. The signal is then amplified and coupled back to the comparator, through the feedback modifier, as a correction to reduce the original error.

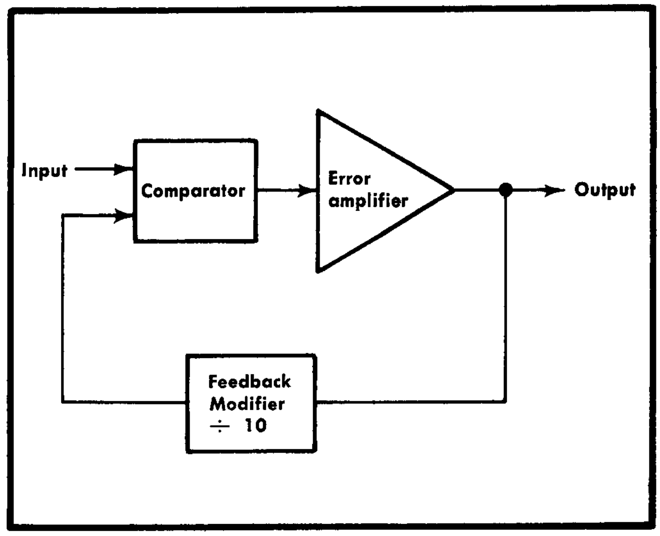


Fig. 3-1. Block diagram of generalized feedback system.

A single-ended version of the basic configuration used in the Type 1A7A is illustrated in Fig. 3-2 with the blocks of Fig. 3-1 identified. The comparator is FET Q1, and any change in gate-to-source bias voltage will produce a change in drain current. This change is applied as an error signal to the input of the error amplifier, Q2/Q3. The system output which appears at the emitter of Q3 is fed back to the comparator input through the feedback modifier, R1 and R2. For this amplifier the system output, V_{os}, can be determined by: $V_{os} = (1 + \frac{R2}{R1})V_{om}$. Since V_{om} is approximately equal to V_i (input voltage) then the system gain $\frac{V_{os}}{V_i}$ is approximately equal to $1 + \frac{R2}{R1}$.

The real output of the amplifier is the collector signal of Q3, which is determined by the signal current I through R3. This current is nearly equal to the emitter I' that flows through R1, plus the relatively small error current from Q1. Then $V_{om} = (I')(R1)$. Since V_{om} is approximately equal to V_i, and I' is approximately equal to I, I is approximately equal to $\frac{V_i}{R1}$. Thus, the ratio of output current to input voltage depends primarily on the gain setting resistor R1. The overall output voltage gain is $\frac{V_o}{V_i}$ or $\frac{R3}{R1}$.

If the lower end of R1 is connected to the same point in another identical circuit instead of being returned to ground, the result is a differential feedback amplifier with push pull output, which is the configuration in the Type 1A7A.

×24 Pre-Amp

The feedback amplifiers in the + and — inputs are identical except for circuit numbers; therefore, only the amplifier in the + input will be described in detail. The amplifier has a gain of approximately ×24. Fig. 3-3 is a partial diagram of the Input Amplifier illustrating the feedback

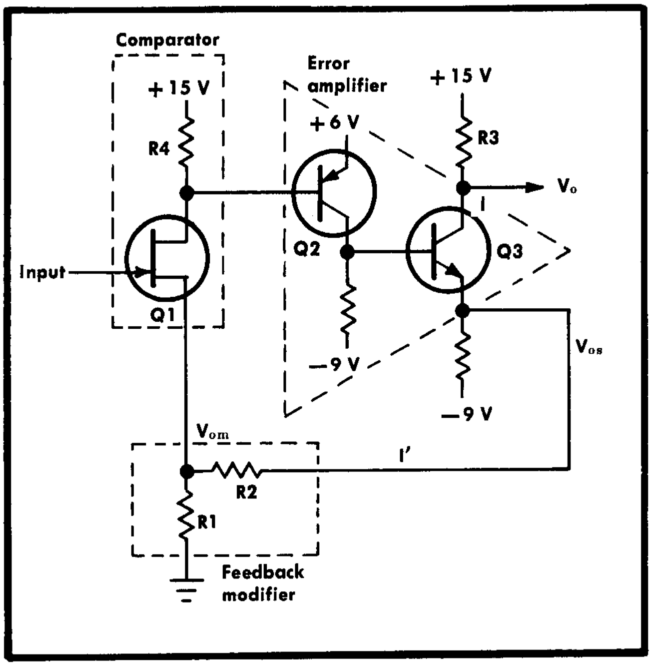


Fig. 3-2. Simplified single ended version of the basic feedback configuration used in the Type 1A7A.

amplifiers. The path of current flow from the power supply through the feedback amplifiers is illustrated by arrows.

The feedback amplifier in the + input is composed of Q133A, Q144A and Q154. The feedback path is from the source of Q154, through the divider consisting of R153/R151 to the source of Q133A; with the internal voltage gain determined by $(1 + \frac{R153}{R151})$. R151 is the gain setting resistor for the amplifier, and the approximate gain of the amplifier can be determined by dividing R157 by R151 (R_o/R_i).

Assume the —INPUT switch is in the GND position and a positive-going signal is applied to the gate of Q133A. The signal is amplified by Q133A/Q144A and coupled to the gate of Q154. A positive-going signal on the gate of Q154 causes the source of Q154 to become positive with respect to the source of Q254. The current increases through Q154 and decreases an equal amount through Q254, developing a push-pull signal on the drains of Q154/Q254. The output of the input amplifier is a push pull output. The input common mode signal developed across R252 is coupled to the base of Q283. Q283 drives the bootstrapped power supply, causing the power supply voltages to follow one half of the input signal.

When common-mode signals arrive at the gates of Q154 and Q254, there is no difference of potential developed across R151/R251; therefore, the current through Q154 and Q254 does not change and no output signal should result. Also the signal developed at the junction of R151 and R251 will be coupled through Q283 to the floating power supply, and the supply voltages will follow the common mode signal. This reduces the possibility of a differential signal being developed due to a mismatch of components in the two feedback amplifiers.

The DC level at the output of Q154 and Q254 is balanced by R259, STEP ATTEN DC BAL. The STEP ATTEN DC BAL control changes the current through R256 and R257, thereby changing the DC balance. The STEP ATTEN DC BAL control is used to make a fine adjustment of the difference in potential across the output of the ×24 Pre-amp (pins BA and BD) to zero with the input coupling switch in GND and the LOW FREQ —3 dB POINT switch set to DC.

Diode D142 connected between the base and emitter of Q144A is a protection diode. If the current through Q133A were to reduce sufficiently, there would be approximately 9 V difference of potential across the base-emitter junction of Q144A, resulting in reverse base-emitter breakdown and possible damage. With D142 connected across the base-emitter junction, if the current through Q133A decreases sufficiently the diode will become forward biased and the difference of potential will be approximately 0.6 V. D272 is for temperature compensation of the base-emitter junctions of Q144A/B. This keeps the total voltage across the input stage current setting resistors R134/R234 constant with temperature.

With high frequency common-mode signals, the wiring stray capacitance of the ×24 amplifier can inject undesirable currents into the two output lines at high frequencies. C162 is adjusted to equalize these currents, thus extending the frequency range over which useful CMRR can be obtained.

The use of a common boot strapped power supply results in an undesirable capacitance coupling between the two inputs. If the signal is applied to the + INPUT while the — INPUT is open or has a high impedance to ground, a signal is coupled to the drain of Q133B. The signal is coupled through the drain-to-gate capacitance of Q133B and produces a voltage on the — input which subtracts from the original input signal. This effect is neutralized by supplying a signal, via C231, from the source of Q254 which is opposite in polarity to the drain to gate signal of Q133B. C231 is adjusted for exact cancellation of the signal.

Bootstrapped Power Supply

The source voltages (+17.2 V, +8.2 V, and —7 V) for the feedback amplifiers are obtained from zener diode shunt regulators D275, D285, and D295 connected in series. C275, C285, and C295 connected across the zener diodes are filter capacitors. Current for the feedback amplifiers and the zener diodes is supplied by two current sources Q284 and Q294. The current through Q284 is determined by the voltage drop across R273. The current through Q294 is set by the voltage drop across R349 (Offset Generator diagram). The base voltage of Q294 is set at —27 V by zener diode D292.

Any common mode changes that occur in the input amplifier, except at the output, are coupled to the power supply through Q283. Q283 is an emitter follower and the gain is maintained very close to unity by the minimum loading presented to the output of Q283 by the high collector impedance of Q284 and Q294, thus achieving good bootstrap efficiency.

Input Overdrive Protection

To prevent damage to the semiconductors used in the input amplifier when overdrive voltages are applied to

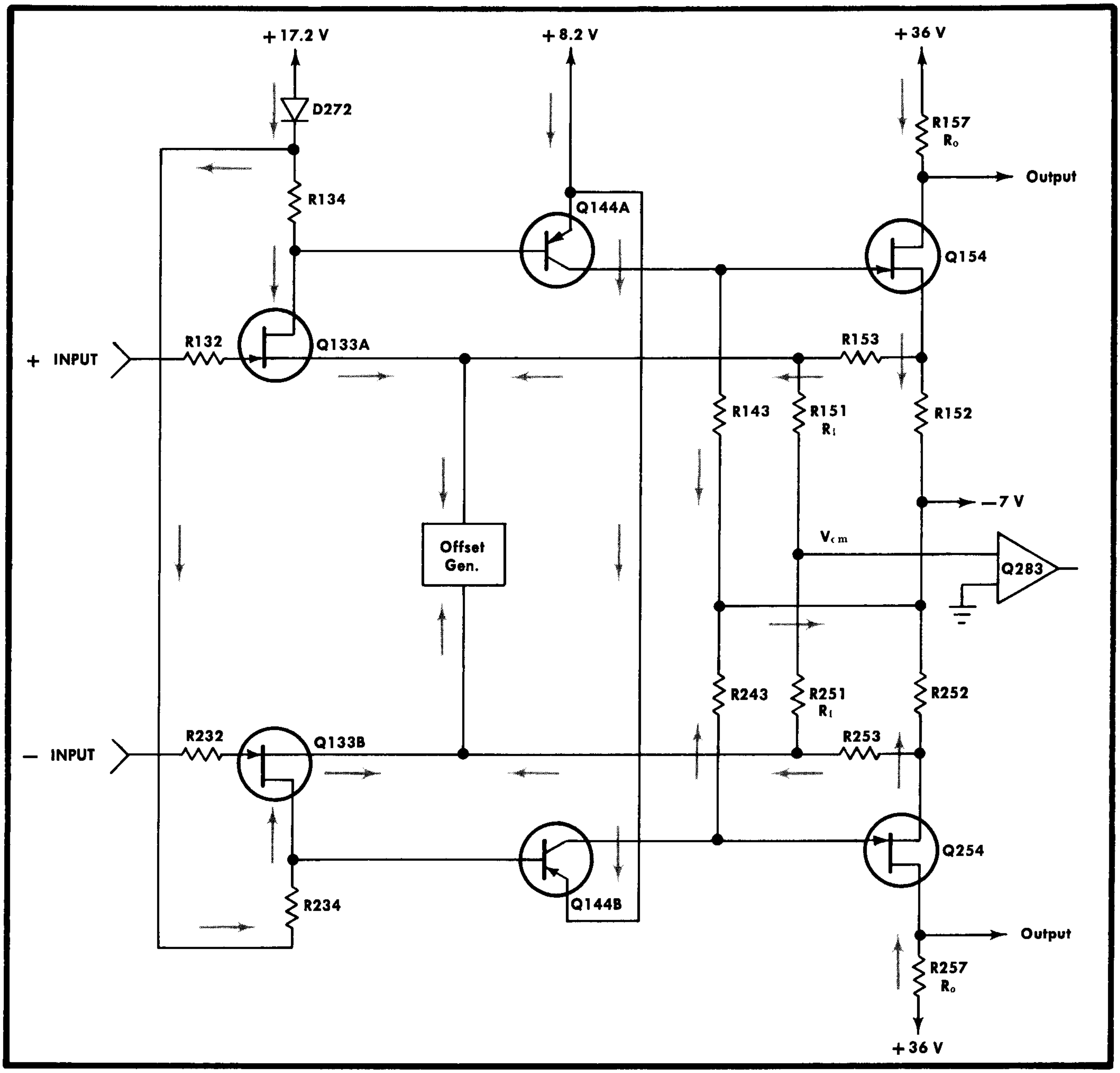


Fig. 3-3. Partial diagram of Input Amplifier illustrating the feedback amplifiers.

them, an overdrive circuit has been incorporated into the Type 1A7A. Fig. 3-4 is a diagram showing the path of current flow for a positive or negative voltage overdrive at the + INPUT.

First, assume a steadily increasing positive voltage at the input. The floating power supply voltages continue to rise with the input. When the gate voltage of Q133A approaches approximately 23 V, D133 turns on and clamps the gate, drawing current through F131. When the current through F131 exceeds 1/16A the fuse opens, removing the overdrive from the circuit.

With a negative voltage whose magnitude is steadily increasing at the input, D132 turns on when the signal approaches approximately —7.6 V and draws current through the —7 V supply. The —7 V supply becomes more negative (follows the input), causing the remaining supply voltages to go in the negative direction and Q283 cuts off. When the overdrive voltage becomes approximately —27 V, the collector to base junction of Q294 becomes forward-biased and conducts the overdrive current through D292. F131 opens when the current exceeds 1/16A.

Gate Current Compensation

The leakage current associated with the gates of the input amplifiers and the overload diodes increases with temperature. To compensate for this increase, a temperature sensitive input current balancing network, using thermistors as

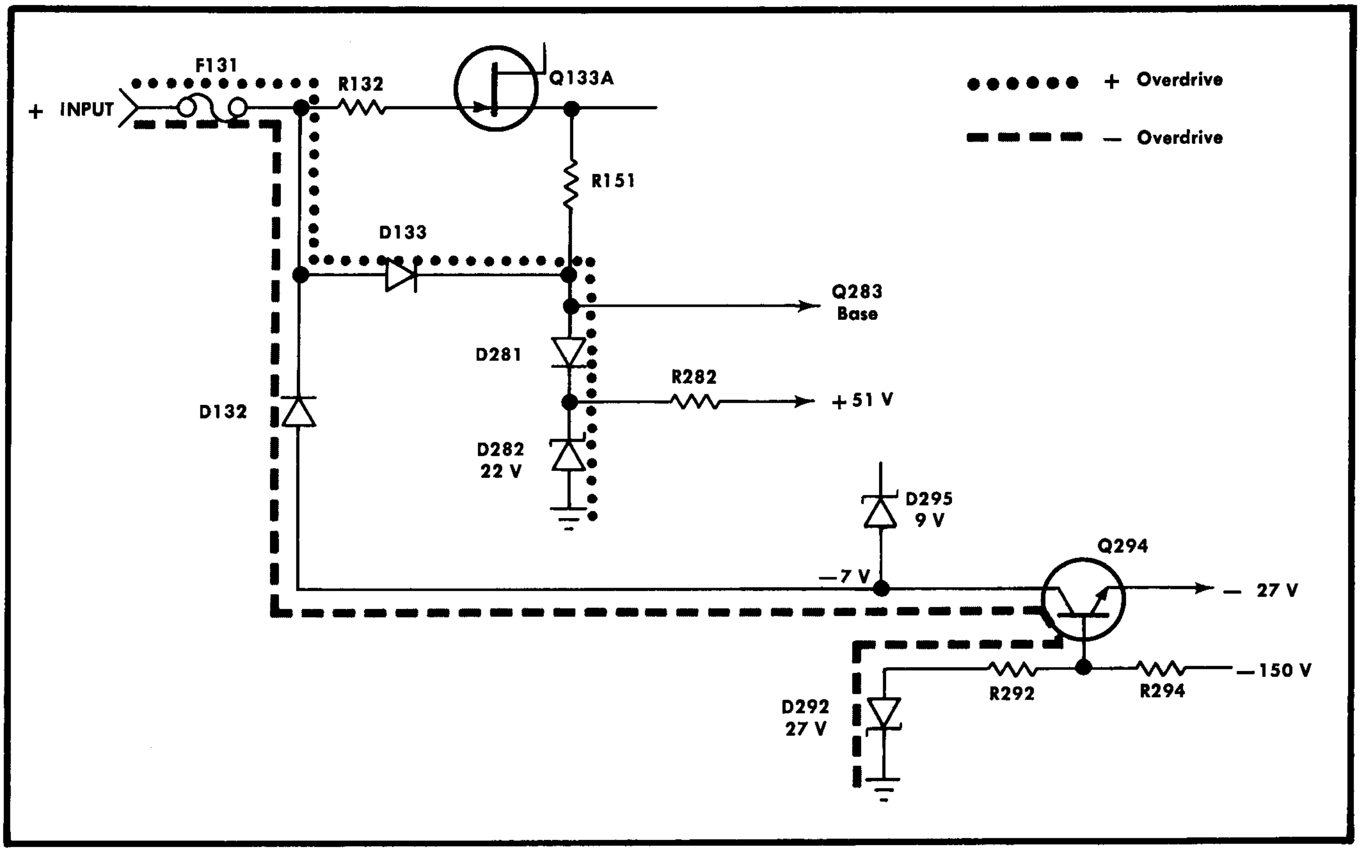


Fig. 3-4. Diagram showing the path of current flow for a positive or negative voltage overload at the + INPUT.

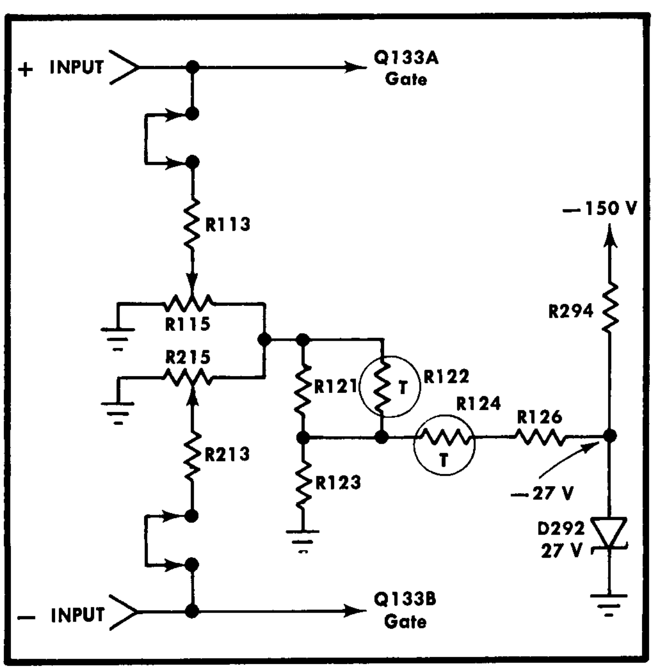


Fig. 3-5. Diagram illustrating the temperature compensating network in the Input Amplifier.

the sensing elements, is provided in the Input Amplifier circuit. Fig. 3-5 is a partial diagram illustrating the temperature-compensating network. R115 and R215 are adjusted for zero net output current from the + and — inputs.

NOTE

When the straps are removed for high input impedance operation, the compensating network becomes inoperative.

Input Overload Indicator

When the LOW FREQ —3 dB POINT selector is in any position other than DC and the input coupling switch is in DC, there is no on-screen indication of the DC conditions in the ×24 pre-amp. The amplifier may be driven into non-linearity or overload by a DC component which would result in an erroneous display. The input overload detector indicates by means a light that the ×24 pre-amp is approaching the limits of its differential dynamic range.

The indicator circuit is composed of Q163, Q164 and B174. Q163 is normally off and Q164 is saturated. With Q164 saturated, the voltage across B174 is below the striking potential and the light is off. D162 and D262 are reverse biased. When the voltage on either output line (anodes of D162/D262) exceeds the voltage on the emitter of Q164 by approximately 0.7 V, D162 or D262 and Q163 turns on, turning off Q164. This allows the current through R172 to ignite the INPUT OVERLOAD light. C164 and R164 allow the light to indicate on short duty cycle pulses. C164 charges through Q163, R171/R172, and when the transistor is turned off the capacitor slowly discharges through R164. R171 and R174 equalize the firing transients on the two leads of the neon, thus reducing radiation into the input circuitry.

LOW FREQ —3 dB POINT

The low frequency —3 dB point of the amplifier is selected with the LOW FREQ —3 dB POINT switch SW175, in decade steps of .1 Hz, 1 Hz, 10 Hz, 100 Hz, 1 kHz, and 10 kHz. The selection is accomplished by switching the input and output resistors and the capacitor of the RC coupling network in each output of the Input Amplifier.

Fig. 3-6 is a simplified illustration showing the component configuration for one half of the switch in each position. When either R176 or R177 is not across the output it is switched across the input to keep the high frequency load resistance constant. In the DC position of the switch the coupling capacitor is shorted out of the circuit.

Resistors R156 and R256 are connected in series with the ×24 pre-amp output resistors (R157-R257) in the 100 Hz through 10 kHz positions of the LOW FREQ —3 dB POINT switch. These resistors increase the gain of the amplifier a slight amount to compensate for any gain loss through the capacitive divider (consisting of C158/C258 and the stray capacitance) across the output of the selector.

OFFSET GENERATOR

The purpose of the DC offset system is to balance out any resultant currents in the ×24 amplifier produced by an input signal containing a DC component. This allows the varying component to be amplified and the amplifier to maintain its differential capability.

The offset generator produces an adjustable offset current for use in the ×24 amplifier. Since the range of the offset generator is so wide (80,000 cm at 10 μV/CM), stable components and circuit techniques which minimize noise and drift are employed in the offset generator. A 10 turn COARSE OFFSET control is used to obtain adequate resolution and insure obtaining a display on screen at minimum deflection factors.

The offset generator is composed of two feedback amplifiers, Q314A/Q334 and Q314B/Q324, and a current source Q326. Zener diode D352 establishes the reference voltage across R355A and R355B, the FINE and COARSE DC OFFSET controls respectively.

When the DC OFFSET switch SW355 is in the OFF position, the emitter of Q314A is connected to a fixed voltage divider, R342/R343, which is connected across D352. The emitter of Q314B is connected to the arm of the Coarse DC Bal adjustment, R345. The output of the Offset Generator under these conditions is a balanced output current through the drains of Q324 and Q334 to the two feedback amplifiers in the input amplifier. The Coarse DC Bal adjustment is to adjust out any initial DC unbalance in the ×24 amplifier and to bring its output to zero with zero signal input.

When the DC OFFSET switch is in the ON position the emitter of Q314A is connected to the arm of the COARSE DC OFFSET control. If the arm of the control is moved toward a more negative potential, the current through Q314A decreases. This causes the collector of Q314A to go more negative, decreasing the current through Q334. As the current through Q334 decreases, the current through Q314B increases, causing its collector to move in the positive direction. This causes the current through Q324 to increase. The resultant current change flows through the drains of Q324/Q334 to the ×24 amplifier as an offset current.

Since Q334/Q314A and Q324/Q314B form two feedback amplifiers another way of analyzing the circuit is as follows: because of the feedback action, Q334 source follows Q314A emitter and Q324 source follows Q314B emitter. Therefore, the differential input (V_Q314B — V_Q314A) is reproduced across R321/R331 as (V_Q324 — V_Q334), and the resultant current, $1\ \text{offset} = \frac{V_Q324 - V_Q334}{R321 + R331}$, flows through the drains of Q324/Q334 to the ×24 pre-amp. This offset current develops an offset voltage across R151 and R251 in the ×24 pre-amp, which balances out any offset voltage applied to the pre-amp input. A FINE DC OFFSET control is connected across the reference zener D352, and the arm of the fine control is connected to the center of the divider which is connected across the coarse control. By moving the arm of the fine control, the voltage at the arm of the coarse control is shifted a slight amount. This allows a finer adjustment of the DC offset in the lower deflection factor positions of the VOLTS/CM switch.

The range of the adjustable reference voltage to the emitter of Q314A is ±4 V. Capacitor C336 filters out zener noise and C335 is a high frequency bypass.

OUTPUT AMPLIFIER

Introduction

The gain switching amplifier, in conjunction with the input attenuators, provides the various deflection factors indicated by the VOLTS/CM switch. The output of the gain switching amplifier is coupled to the output stage where vertical positioning is accomplished.

Gain Switching Amplifier

The gain switching amplifier consists of two feedback amplifiers connected in a differential configuration similar to the feedback amplifiers in the Input Amplifier circuit. Q404A, Q414 and Q424 form the feedback amplifier for the + INPUT; the — INPUT is composed of Q404B, Q514 and Q524. R408 is the gain setting resistor. The input to the gain-switching amplifier is two signals equal in amplitude and opposite in polarity from the output of the Input Amplifier.

The path of DC current or quiescent current for the two amplifiers is through R423 and R523. The voltage level at each end of the parallel combination R408/R407 is the same, under no-signal conditions or for common mode signals, and there is no current flow through R407 or R408. R505 AC Atten Bal is an adjustment to balance out any initial DC unbalance of the gate-to-source voltages of Q404. Assume that there

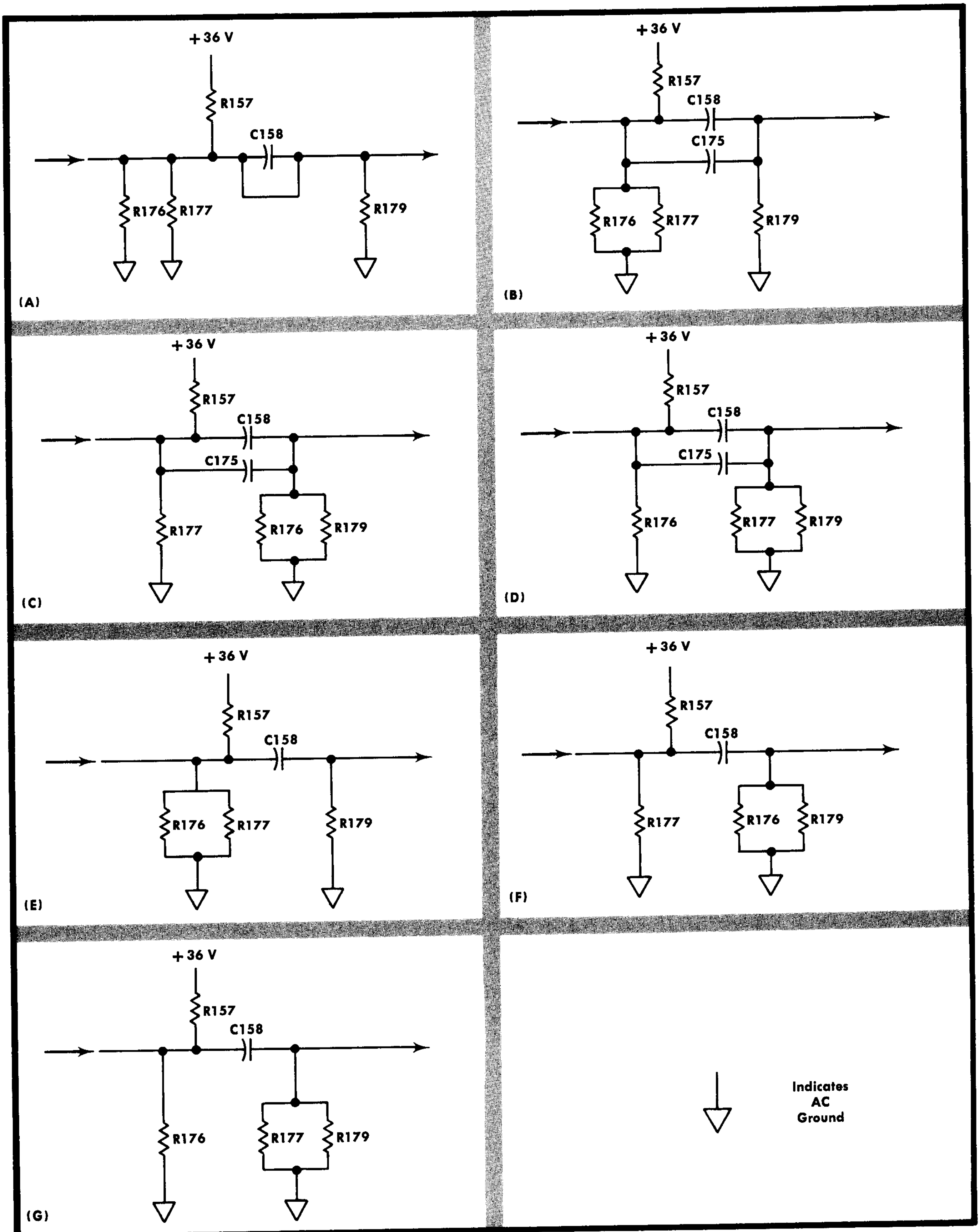


Fig. 3-6. Component configuration for one side of the LOW FREQ —3 dB POINT SWITCH, (A) DC (B) .1 Hz (C) 1 Hz (D) 10 Hz (E) 100 Hz (F) 1 kHz (G) 10 kHz.

is a positive-going signal on the gate of Q404A, and a negative-going signal on the gate of Q404B. These signals cause an increase of current flow through Q404A and a decrease of current flow through Q404B. The increase of current flow through Q404A causes Q414 to increase conduction; the decrease of current flow through Q404B causes Q514 to decrease conduction. These signals will produce a difference of potential across R407/R408 equal to the input signal, causing current to flow. Q414 and Q514 are connected in a common emitter configuration. A positive-going signal is developed on the collector of Q414 and a negative-going signal on the collector of Q514. These signals are coupled to the bases of Q424 and Q524 respectively. The output signal for Q424 and Q524 is then developed across R424, R425 and R524. The signals on the collectors of Q424/Q524 will be two signals equal in amplitude, but opposite in polarity. The gain of the stage can be determined by R_{out}/R_{in}. R_o is the total resistance of R423, R425 and R523. R_i is to total resistance of R423/R523 in parallel with the parallel combination of R407/R408. Refer to the VOLTS/CM switch diagram for the value of R408 in the various positions of the VOLTS/CM switch.

Diodes D422 and D522 prevent base-emitter breakdown of Q424/Q524 and assure a clean overload recovery of the gain switching amplifier. R425 Variable Balance is adjusted for zero volts difference of potential between the collectors of Q424/Q524 with zero signal input.

Output Stage

The output stage is composed of Q434/Q534 connected in a common-emitter configuration and operated push-pull. The gain of the stage is determined by the total emitter-to-emitter resistance of Q434 and Q534, similar to the previous description for the gain-switching amplifier. The overall gain of the amplifier is adjusted by R435, which changes the total emitter-to-emitter resistance of Q434/Q534. This resistance can be changed over a 2.5:1 range by the VARIABLE control of the VOLTS/CM switch which is useful for interpolating between the positions of the VOLTS/CM switch. When the VARIABLE control is out of the CAL position the overall gain of the amplifier is uncalibrated.

Vertical positioning is accomplished by changing the amount of current through Q434/Q534. When the current is increased through one transistor it is decreased through the other. This produces an unbalance at the output and positions the trace vertically on the CRT.

The output impedance of the amplifier can be changed with the HIGH FREQ —3 dB POINT switch SW445, which connects a capacitor across the output of the amplifier. The impedance of the selected capacitor causes the gain of the amplifier to correspond to the — 3 dB point of the frequency to which the switch is positioned. Refer to the Bandwidth Switch diagram for the value of the capacitor for the selected position.

Signal Output Connector

The signal from one side of the output stage is coupled to a source-follower, Q553, and is available at the front panel of the Type 1A7A. The DC level of the output signal can be adjusted by R550, which sets the gate voltage of Q553. C554 is adjusted for high frequency compensation. D558 is a protection diode in case the signal output connector is connected to a positive voltage that exceeds the drain voltage of Q553.

SECTION 4
MAINTENANCE

Change information, if any, affecting this section will be found at the rear of the manual.

PREVENTIVE MAINTENANCE

General

Preventive maintenance consists of cleaning, visual inspection, lubrication and recalibration. Preventive maintenance performed on a regular basis will help prevent failure of the unit and will improve its reliability.

Cleaning the Front Panel

Loose dust may be removed with cloth and a dry paint brush. Water and mild detergents such as Kelite or Spray-White may be used.

CAUTION

Avoid the use of chemical agents which might damage the plastics used in this unit. Avoid chemicals such as benzene, toluene, Xylene, acetone or similar solvents.

Cleaning the Interior

Cleaning of the interior of the unit should precede calibration, since the cleaning process could alter the setting of the calibration adjustments.

To clean the interior, use low-velocity compressed air to blow off the accumulated dust. Very high velocity air streams should be avoided to prevent damage to some of the components. Hardened dirt can be removed with a soft, dry paint brush, cotton-tipped swab or cloth dampened with a water and mild detergent solution. Avoid the use of chemical cleaning agents that might damage the plastic parts.

Lubrication

The reliability of potentiometers, rotary switches and other moving parts can be increased if they are kept properly lubricated. Use a cleaning-type lubricant on shaft bushings interconnecting plug contacts and switch contacts. Lubricate switch detents with a heavier grease. A lubrication kit containing the necessary lubricating materials and instructions is available through any Tektronix Field Office. Order by Tektronix Part No. 003-0342-00.

Visual Inspection

The unit should be inspected occasionally for such defects as poor connections, broken or damaged etched-wiring boards, improperly seated transistors and heat-damaged parts. The remedy for most visible defects is obvious. But, damage from overheating is usually a symptom of less obvious trouble; and unless the cause is determined before parts are replaced, the damage may be repeated.

Transistor Checks

Periodic preventive maintenance checks on the transistors used in the unit are not recommended. The circuits within the unit generally provide the most satisfactory means of checking transistor usability. Performance of the circuits is thoroughly checked during recalibration, and substandard transistors will usually be detected at that time.

Recalibration

To insure accurate measurements, the Type 1A7A calibration should be checked after each 1000 hours of operation or every six months if used intermittently. Complete calibration instructions are contained in Section 5.

The calibration procedure can be helpful in isolating major troubles in the unit. Moreover, minor troubles not apparent during regular operation may be revealed and corrected during calibration.

CORRECTIVE MAINTENANCE

General

Replacement of some parts in the unit should be done by following a definite procedure. Some procedures, such as soldering and replacing components on the etched-wiring boards, are outlined in this portion of the manual.

Many electrical components are mounted in a particular way to reduce or control stray capacitance and inductance. When selecting replacement parts, it is important to remember that the physical size and shape of a component may affect its performance at high frequencies. When a repair is made, calibration of that portion of the circuit should be checked. Refer to the Performance Check Calibration procedure in Section 5 and perform the applicable calibration steps.

Obtaining Replacement Parts

Standard Parts. All electrical and mechanical part replacements for the Type 1A7A can be obtained through your local Tektronix Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, check the parts lists for value, tolerance, rating and description.

NOTE

When selecting replacement parts, it is important to remember that the physical size and shape of the component may affect its performance in the instrument, particularly at high frequencies. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect instrument performance.

Special Parts

Some parts are manufactured or selected by Tektronix to satisfy particular requirements, or are manufactured for Tektronix to our specifications. These and most mechanical parts should be ordered through your Tektronix Field Engineer or Field Office. See Parts Ordering Information and Special Notes and Symbols on the page immediately preceding Section 6.

Soldering Techniques

Etched-Wiring Boards. Use ordinary 60/40 solder and a 35- to 40-watt pencil-type soldering iron on the etched-wiring boards. The tip of the iron should be clean and properly tinned for best heat transfer to the solder joint. A higher wattage soldering iron may separate the etched wiring from the base material.

The following technique should be used to replace a component on an etched-wiring board. Most components can be replaced without removing the board from the unit.

1. Grip the component lead with long-nose pliers. Touch the soldering iron to the lead at the solder connection. Do not touch the soldering iron tip directly on the board as it may damage the board.

2. When the solder begins to melt, pull the lead out gently. This should leave a clean hole in the board. If not, the hole can be cleaned by reheating the solder and placing a sharp object such as a toothpick or pointed tool into the hole to clean it out.

3. Bend the leads of the new component to fit the holes in the board. Cut the leads of the new component to the same length as those of the old component. Insert the leads into the board until the component is firmly seated against the board. If it does not seat properly, heat the joint, and gently press the component into place.

4. Apply the iron and a small amount of solder to the connection to make a firm solder joint. To protect heat-sensitive components, hold the lead between the component body and the solder joint with a pair of long-nose pliers or other heat sink.

5. Clip the excess lead that protrudes through the board.

6. Clean the area around the soldered connection with flux-remover solvent to maintain good environmental characteristics and appearance. Be careful not to remove information printed on the board.

Metal Terminals

When soldering metal terminals (e.g., interconnecting plug pins, switch terminals, potentiometers, etc.), ordinary 60/40 solder can be used. The soldering iron should have a 40- to 75-watt rating with a $\frac{1}{8}$-inch wide chisel-shaped tip.

Observe the following precautions when soldering to metal terminals:

1. Apply only enough heat to make the solder flow freely.

2. Apply only enough solder to form a solid connection; excess solder may impair the function of the part.

3. If a wire extends beyond the solder joint, clip the excess close to the joint.

4. Clean the flux from the solder joint with a flux-remover solvent to maintain good environmental characteristics and appearance.

Removing or Replacing Circuit Boards

In general, the etched-wiring boards used in the Type 1A7A are never removed unless they need to be replaced or the Attenuator board, for example, needs to be removed so the VOLTS/CM switch can be replaced. Electrical connections to the boards are made by three methods: soldered lead connections, soldered pin connectors and unsoldered pin connectors. Each of the boards uses one or more of these methods.

To remove or replace a board, proceed as follows:

1. Disconnect all leads connected to the board. Observe the soldering precautions given earlier in this section.

2. Remove all the screws holding the board to the chassis or other mounting surface.

3. Lift the etched-wiring board out of the unit. Do not force or bend the board.

4. To replace the board, reverse the order of removal. As a guide, correct connections of the wires are shown in Figs. 4-3, 4-4 and 4-5. When reconnecting the pin connectors, use care in mating the pins so the connectors are not damaged or enlarged.

Removing and Replacing Switches

If either of the AC-GND-DC switches or the DC OFFSET ON-OFF switch is defective, remove and replace the switch. Use normal care in disconnecting and reconnecting the leads. (To gain access to the AC-GND-DC switches, remove the shield). The switches can be replaced without removing the front panel overlay. First, remove the nuts and lockwashers from the switch, then remove the switch.

Single wafers on the VOLTS/CM and BANDWIDTH switches are not normally replaced. If any of these switches are defective, the entire switch should be replaced. The switches can be ordered through your Tektronix Field Engineer either unwired or wired, as desired. Refer to the Electrical Parts List to find the unwired and wired switch part numbers.

CAUTION

When disconnecting or connecting leads to a wafer-type switch, do not let solder flow around and beyond the rivet on the switch terminal. Excessive solder can destroy the spring tension of the contact.

Fuse Replacement

The fuses in the + and − inputs are located on the amplifier circuit board and are 1/16 amp each. Spare fuses are located on the shield of the input connectors.

TROUBLESHOOTING

Introduction

The following information is provided to facilitate troubleshooting of the Type 1A7A, if trouble develops. Information contained in other sections of this manual should be used along with the following information to aid in locating the defective component. An understanding of the circuit operation is very helpful in locating troubles. See the Circuit Description section for complete information.

Troubleshooting Aids

Diagrams. Circuit diagrams are given on foldout pages in Section 8. The component number and electrical value of each component in this instrument are shown on the diagrams. Each main circuit is assigned a series of component numbers. Important voltages and waveforms are also shown on the diagrams. The portions of the circuit mounted on circuit boards are enclosed with a blue line.

Switch Wafer Identification. Switch wafers shown on the circuit diagrams are coded to indicate the physical location of the wafer on the actual switch. The number portion of the code refers to the wafer number of the switch assembly. Wafers are numbered from the first wafer behind the driven end of the shaft to the last wafer.

The letters F and R indicate whether the front or rear of the wafer is used to perform the particular switching function. For example, 2R of the HIGH FREQ −3 dB POINT switch is the second wafer when counting back from the driven end; the letter R refers to the rear side of the wafer.

Wiring Color Code. All insulated wires used in the Type 1A7A are color-coded according to the EIA standard color code (as used for resistors) to facilitate circuit tracing. The widest color stripe identifies the first color of the code.

Power-supply voltages can be identified by three color stripes and the following background color-code; white, positive voltage; tan, negative voltage; gray, unregulated voltage.

Table 4-1 shows the wiring color code for the power-supply voltages using insulated wires for interconnection in the Type 1A7A.

TABLE 4-1

Supply	Back-ground Color	1st Stripe	2nd Stripe	3rd Stripe
+100 V	White	Brown	Black	Brown
−150 V	Tan	Brown	Green	Brown

The remainder of the wiring in the Type 1A7A is color coded with two or less stripes, or has a solid background with no stripes. The color coding helps to trace a wire from one point in the unit to another.

Resistor Color Code. Stable metal-film resistors are used in this unit. These resistors can be identified by their light blue or gray body color. If a metal-film resistor has a value indicated by three significant figures and a multiplier, it will be color coded according to the EIA standard resistor color code. If it has a value indicated by four significant figures and a multiplier, the value will be printed on the body of the resistor. For example, a 333-kΩ resistor will be color-coded, but a 333.5 kΩ resistor will have its value printed on the resistor body. The color-code sequence is shown in Fig. 4-1.

Composition resistors are color coded according to the EIA standard resistor color code.

Capacitor Marking. The capacitance values of common disc capacitors and small electrolytics are marked in microfarads on the side of the component body. The white ceramic capacitors used in the Type 1A7A are color coded in picofarads using a modified EIA code (see Fig. 4-1).

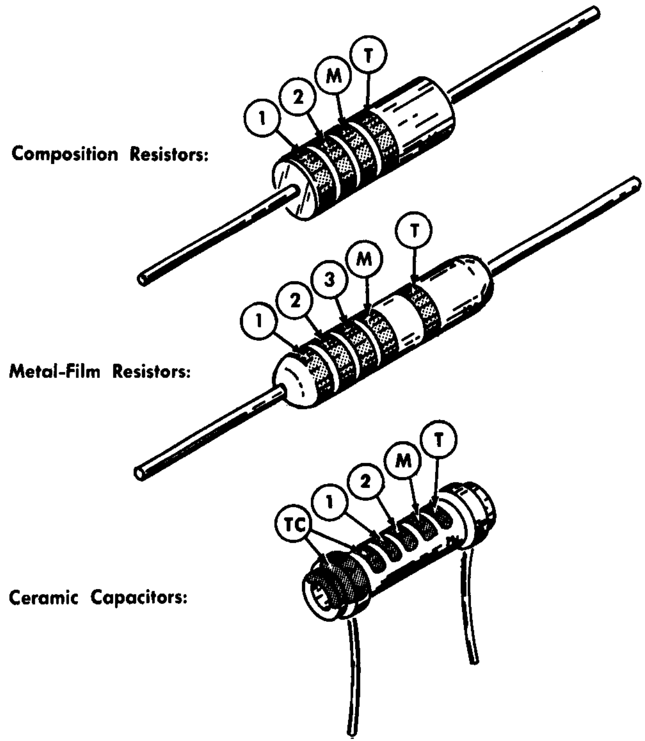
Diode Color Code. The cathode end of each glass-encased diode is indicated by a stripe, a series of stripes or a dot. For most silicon or germanium diodes with a series of stripes, (the first stripe either blue or pink) the color code indicates the three significant figures of the Tektronix Part Number using the resistor color code system. Example: a diode color-coded blue-brown-gray-green indicates a diode with Tektronix Part No. 152-0185-00. The cathode and anode end of a metal-encased diode can be identified by the diode symbol marked on the body.

Transistor Lead Configuration. Fig. 4-2 shows the lead configuration of the transistors used in this instrument. The top of the socket and the bottom view of the transistors are illustrated.

Circuit Boards. Fig. 4-3, 4-4 and 4-5 show the circuit boards used in the Type 1A7A. Each electrical component on the boards is identified by its circuit number. The circuit boards are outlined with a blue line on the diagrams. The photographs of the boards used along with the diagrams will aid in locating the components mounted on the circuit boards and checking inter-connecting wiring to the boards.

Test Equipment

When preparing to troubleshoot the Type 1A7A, you may find some of the equipment described here useful.



Resistor and Capacitor Color Code

Color	Significant Figures	Multiplier		Tolerance	
		Resistors	Capacitors	Resistors	Capacitors
Silver	---	10^{-2}	---	±10%	---
Gold	---	10^{-1}	---	±5%	---
Black	0	1	1	---	±20% or 2 pF*
Brown	1	10	10	±1%	±1% or 0.1 pF*
Red	2	10^{2}	10^{2}	±2%	±2%
Orange	3	10^{3}	10^{3}	±3%	±3%
Yellow	4	10^{4}	10^{4}	±4%	+100% −0%
Green	5	10^{5}	10^{5}	±0.5%	±5% or 0.5 pF*
Blue	6	10^{6}	10^{6}	---	---
Violet	7	---	---	---	---
Gray	8	---	10^{-2}	---	+80% −20% or 0.25 pF*
White	9	---	10^{-1}	---	±10% or 1 pF*
(none)	---	---	---	±20%	±10% or 1 pF*

*For capacitance of 10 pF or less.

NOTE: (T) and/or (TC) color code for capacitors depends upon manufacturer and capacitor type. May not be present in some cases.

Fig. 4-1. Color-code for resistors and ceramic capacitors.

1. Transistor Tester

Description: Tektronix Type 575 Transistor-Curve Tracer.

Purpose: Test semiconductors used in the Type 1A7A.

2. VOM

Description. 20,000/V DC. Be sure the test prods are suitable for use in tight places to prevent accidental shorting.

Purpose: General troubleshooting.

3. Test Oscilloscope

Description: Bandwidth, DC to 1 MHz or better. Calibrated vertical deflection factors down to 5 mV/div with a 1× probe. The vertical amplifier should have a differential input. A second 1× probe is also needed.

Purpose: For low-frequency signal tracing in the amplifier stages.

4. Flexible Cable Plug-In Extension

Description: 30 inches long, Tektronix Part No. 012-0038-00.

Purpose: Permits operating the Type 1A7A out of the oscilloscope plug-in compartment for better accessibility.

5. BNC Coaxial Cables (two required)

Description: Equipped with BNC plug connectors on each end. Tektronix Part No. 012-0057-00.

Purpose: Use in low-frequency signal-tracing setup.

6. BNC T Connector

Description: Fits one BNC jack and two BNC plugs. Tektronix Part No. 103-0030-00.

Purpose: Use in a low-frequency signal-tracing setup.

7. Miscellaneous: Replacement transistors and diodes.

Troubleshooting Techniques

This troubleshooting procedure is arranged in an order which checks the simple trouble possibilities before proceeding with extensive troubleshooting. The first few checks assure proper connections, operation and calibration. If the trouble is not located by these checks, the remaining steps aid in locating the defective component. When the defective component is located, it should be replaced following the replacement procedures given under Corrective Maintenance.

1. Check Control Settings. Incorrect control settings can indicate a trouble that does not exist. If there is any question

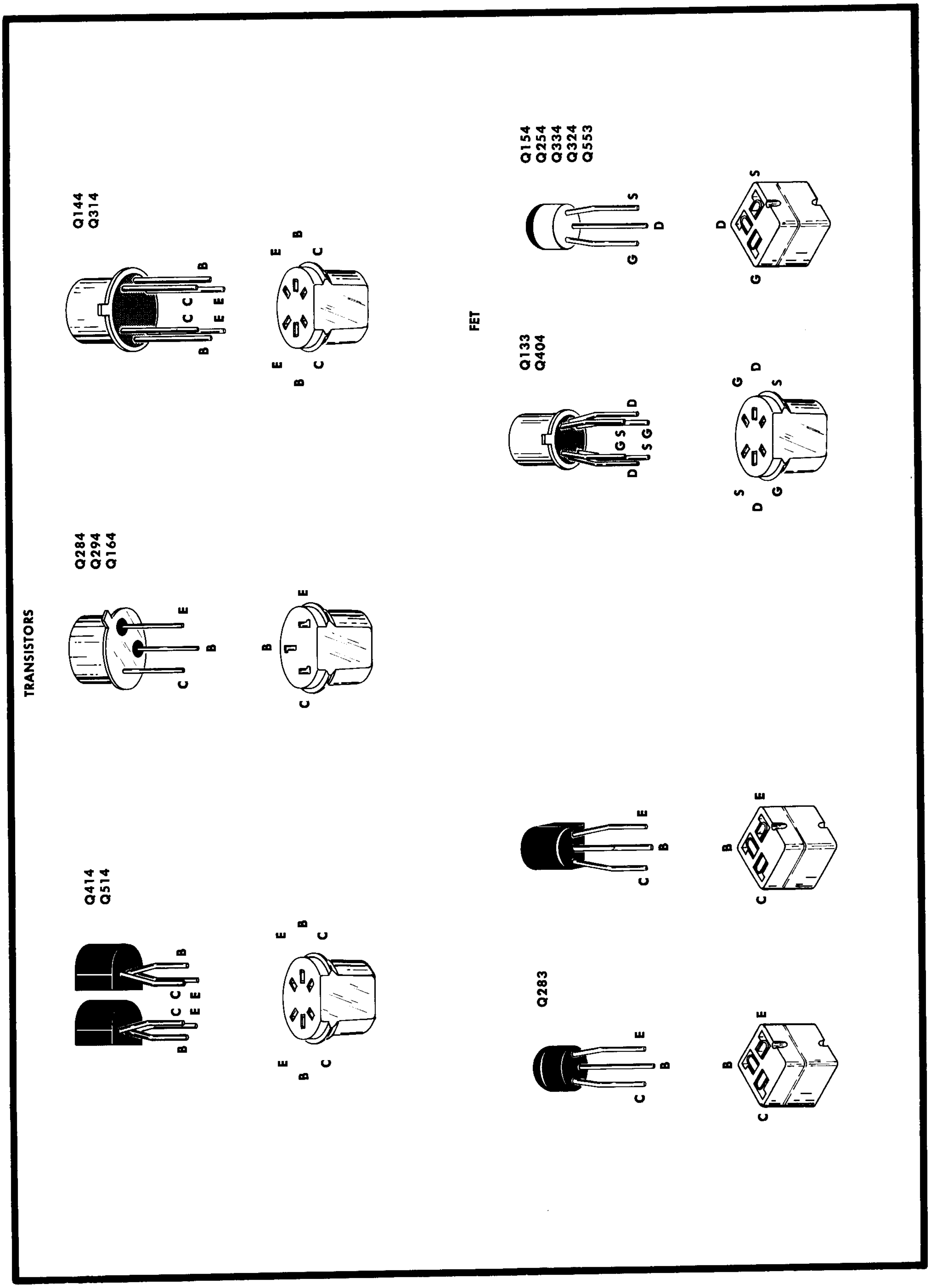


Fig. 4-2. Electrode configuration of transistors used in this instrument.

about the correct function or operation of any control, see the Operating Instructions section.

2. Check Associated Equipment. Before proceeding with troubleshooting of the Type 1A7A, check that the equipment used with it is operating correctly. Check that the signal is properly connected and that the interconnecting cables are not defective. Also, check the power source.

3. Visual Check. Visually check the portion of the instrument in which the trouble is located. Many troubles can be located by visual indications such as unsoldered connections, broken wires, damaged circuit boards, damaged components, etc.

4. Check Instrument Calibration. Check the calibration of the instrument, or the affected circuit if the trouble exists in one circuit. The apparent trouble may only be a result of misadjustment or may be corrected by calibration. Complete calibration instructions are given in the Performance Check/Calibration section of this manual.

5. Isolate Trouble to a Circuit. To isolate trouble to a circuit, note the trouble symptom. The symptom often identifies the circuit in which the trouble is located.

6. Check Circuit Board Interconnections. After the trouble has been isolated to a particular circuit, check the pin connectors on the circuit board for correct connection. Fig. 4-3, 4-4 and 4-5 show the correct connections for each board.

7. Check Voltages and Waveforms. Often the defective component can be located by checking for the correct voltage or waveform in the circuit. Typical voltages and waveforms are given on the diagrams.

NOTE

Voltages and waveforms given on the diagrams are not absolute and may vary slightly between instruments. To obtain operating conditions similar to those used to take these readings, see the first diagram page.

8. Check Individual Components. The following procedures describe methods of checking individual components in the Type 1A7A. Components which are soldered in place are best checked by disconnecting one end. This isolates the measurement from the effects of surrounding circuitry.

A. TRANSISTORS. The best check of transistor operation is actual performance under operating conditions. If a transistor is suspected of being defective, it can best be checked by substituting a new component or one which has been checked previously. However, be sure that circuit conditions are not such that a replacement transistor might also be damaged. If substitute transistors are not available, use a dynamic tester (such as Tektronix Type 575). Static-type testers are not recommended, since they do not check operation under simulated operating conditions.

CAUTION

POWER switch must be turned off before removing or replacing transistors.

B. DIODES. A diode can be checked for an open or shorted condition by measuring the resistance between terminals. With an ohmmeter scale having an internal source of between 800 millivolts and 3 volts, the resistance should be very high in one direction and very low when the meter leads are reversed.

CAUTION

Do not use an ohmmeter scale that has a high internal current. High currents may damage the diode.

C. RESISTORS. Check the resistors with an ohmmeter. See the Electrical Parts List for the tolerance of the resistors used in this instrument. Resistors normally do not need to be replaced unless the measured value varies widely from the specified value.

D. CAPACITORS. A leaky or shorted capacitor can best be detected by checking resistance with an ohmmeter on the highest scale. Do not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open capacitor can best be detected with a capacitance meter or by checking if the capacitor passes AC signals.

9. Repair and Readjust the Circuit. If any defective parts are located, follow the replacement procedure given in this section. Be sure to check the performance of any circuit that has been repaired or that has had any electrical components replaced.

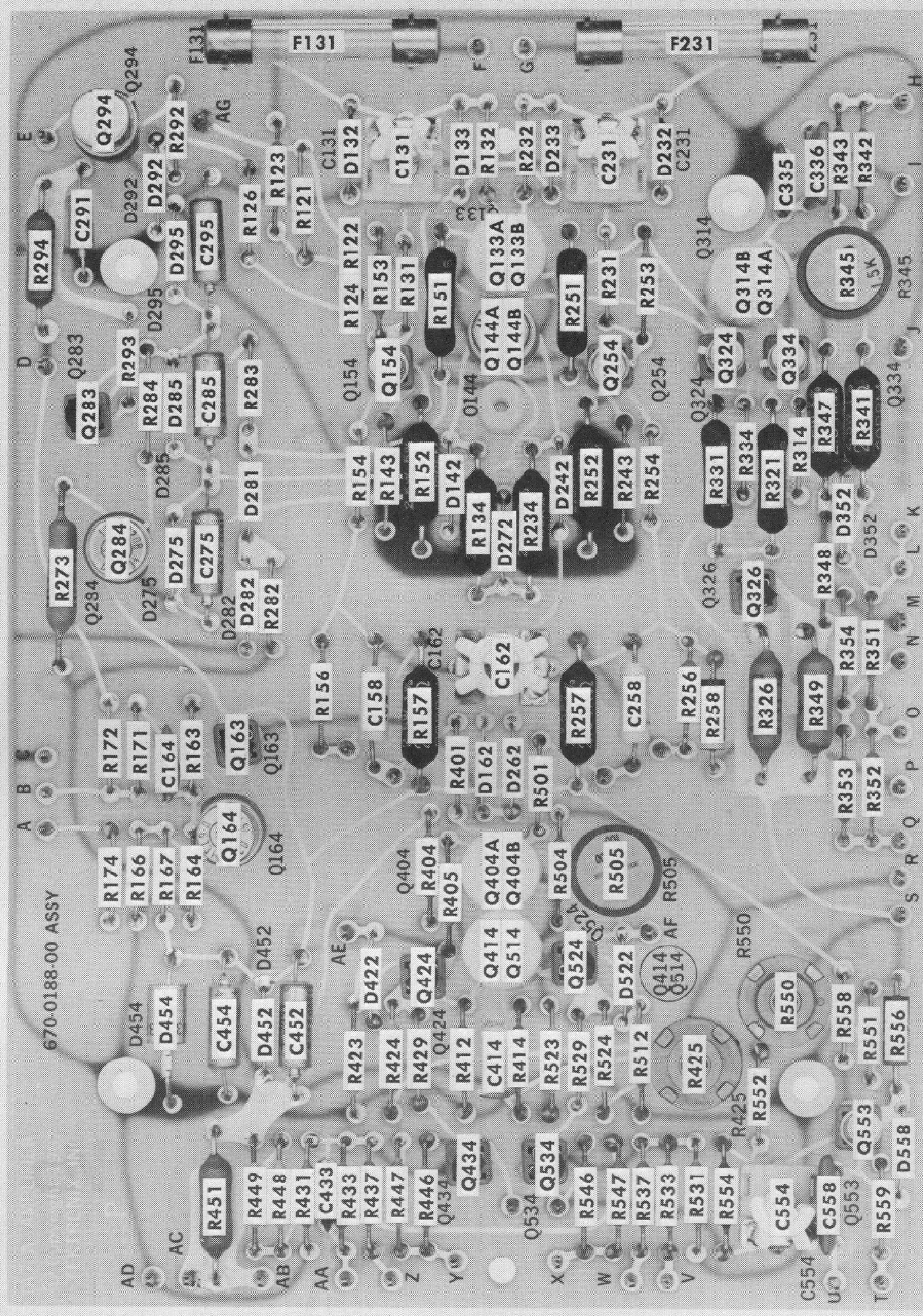


Fig. 4-3. Amplifier circuit board used in Type 1A7A.

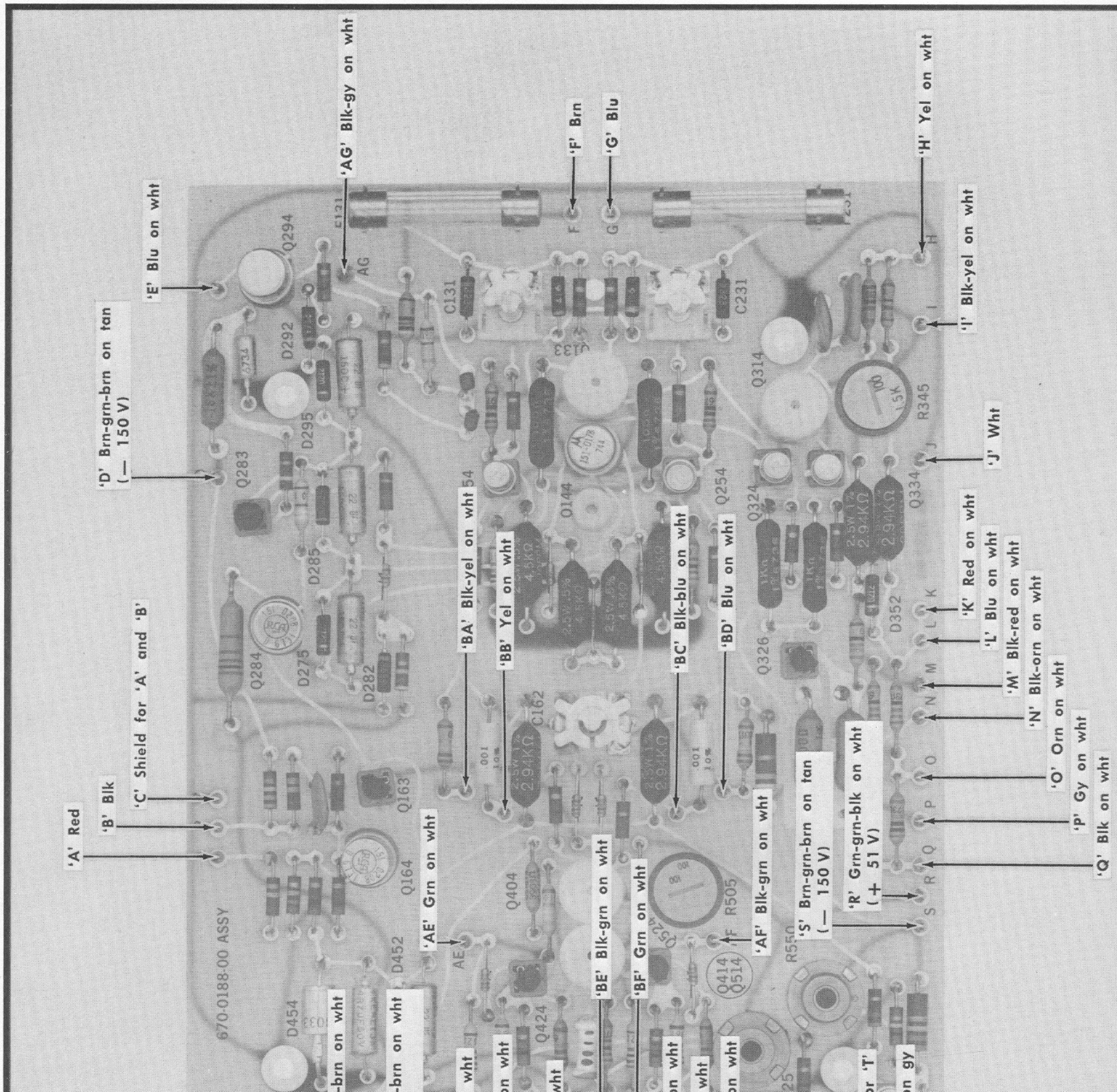


Fig. 4-4. Pin connections.

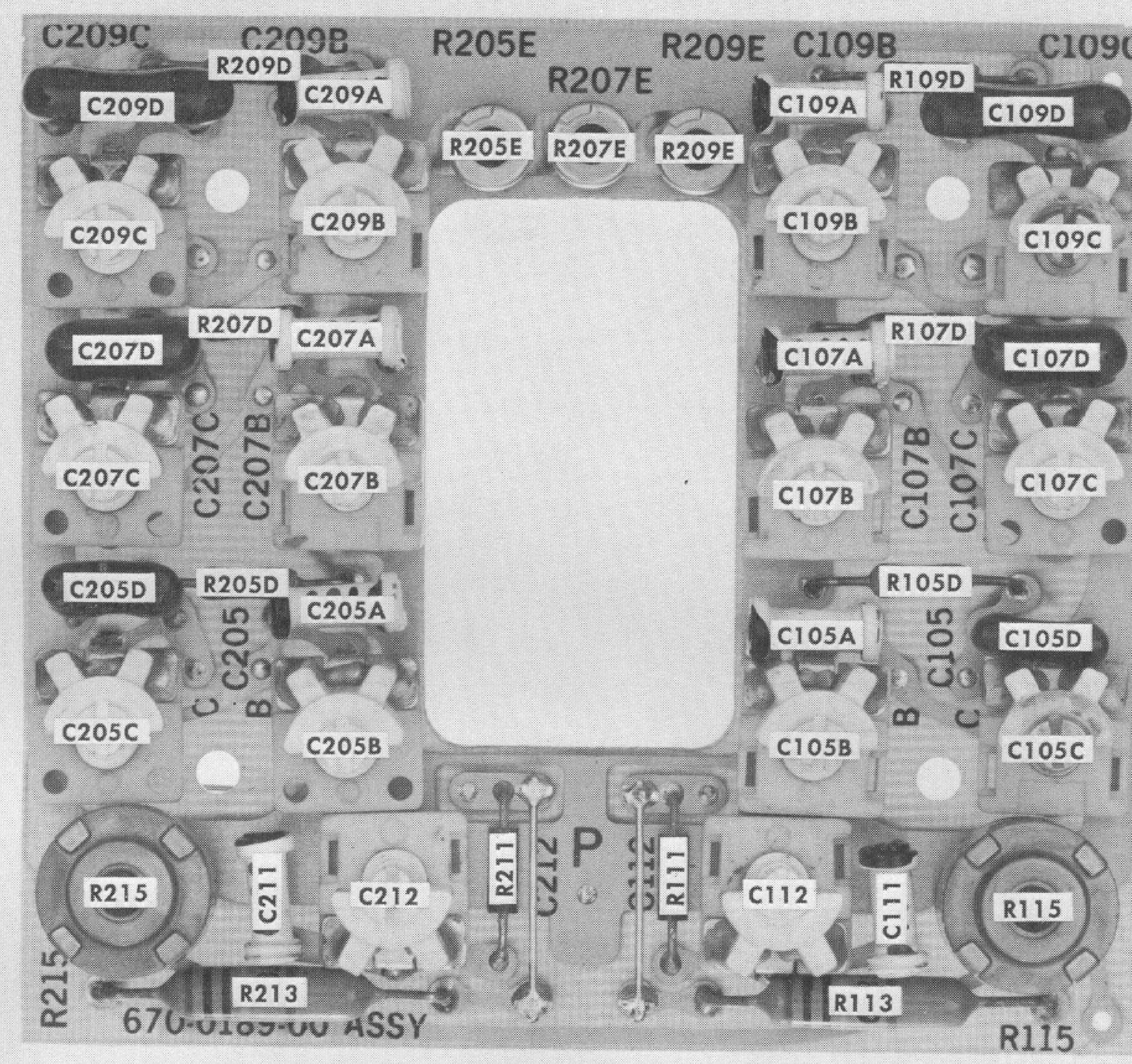


Fig. 4-5. Attenuator circuit board used in Type 1A7A.

NOTES

SECTION 5
PERFORMANCE CHECK/CALIBRATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

Complete information for performing a Performance Check or Calibration of the Type 1A7A is contained in this section of the manual. The Equipment Required list is needed for either a Performance Check or for calibrating the Type 1A7A. All waveform photographs, equipment setup pictures, and control settings apply whether the instrument is being calibrated or checked for performance.

To conduct a Performance Check complete all the parts of each step in the following procedure, except the part subtitled ADJUST. To check the performance of the Type 1A7A, it is not necessary to remove the oscilloscope side panel or make any internal adjustments. Adjustments located on the front panel of the Type 1A7A can be performed when checking the performance of the instrument. If the instrument does not meet the performance requirements given in this procedure, the complete procedure including adjustments should be done. All performance requirements given in this section correspond to the characteristics given in Section 1 of this manual. For convenience in calibrating the Type 1A7A, steps containing internal adjustments are marked with the symbol ⓘ.

Calibration of the Type 1A7A requires completion of all parts of each step in the following procedure. The oscilloscope left side cover must be removed and internal adjustments performed. Completion of every step in this procedure returns the Type 1A7A to its original performance standards. To assure accurate measurements and correct operation, the calibration of the Type 1A7A should be checked after each 1000 hours of operation, or every six months if used infrequently. Before performing a complete calibration, thoroughly clean and inspect this instrument as outlined in the Maintenance section.

TEST EQUIPMENT REQUIRED

General

The following test equipment and accessories or equivalent, is required for a complete performance check or calibration of the Type 1A7A (see Fig. 5-1 and Fig. 5-2). Specifications given are the minimum necessary for accurate performance of this instrument. All test equipment is assumed to be correctly calibrated and operating within the given specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

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

1. 530 or 540 series oscilloscope, referred to as "oscilloscope" in this procedure. For this procedure a Type 547 was used.

2. Test Oscilloscope. Bandwidth, DC to 30 MHz or better; minimum deflection factor, 50 mV/division. Tektronix Type 545B with Type 1A2 Plug-In recommended.

3. Sine-Wave Generator. Output frequincies of 10 Hz through 1.5 MHz; output amplitude range from 2 V to 20 V peak to peak.

4. Square Wave Generator. Frequency 100 kHz; risetime 27 ns or less into 50 ohms; output amplitude 0.5 V to 10 volts into 50 ohms. Tektronix Type 106 recommended.

5. Standard Amplitude Calibrator. Amplitude accuracy, within 0.25%; signal amplitude 0.5 mV to 100 V; output signal 1 kHz square wave. Tektronix calibration fixture 067-0502-00 recommended.

6. Coaxial Cable, Impedance 50 ohms; length 42 inches; BNC connectors; two each. Tektronix Part Number 012-0057-01.

7. Patch Cord, length 18 inches; connectors; BNC on one end, Banana Plug on the other end. Tektronix Part Number 012-0091-00.

8. Dual Input BNC connector. Provides matched signal paths to both Type 1A7A input connectors. Tektronix Part Number 067-0525-00.

9. Variable Attenuator. A variable attenuator which has the end terminals of a 100 ohm potentiometer connected from input to ground and the potentiometer divider arm connected to the attenuator output. Tektronix Calibration Fixture 067-0511-00 recommended.

10. 1000:1 divider. Tektronix Part Number 067-0529-00.

11. Input RC Normalizer, RC time constant 1 MΩ × 47 pF; connectors BNC. Tektronix Part Number 067-0541-00.

12. 10:1 Attenuator, impedance 50 ohms, BNC connectors; two each. Tektronix Part Number 011-0059-00.

13. BNC 50 ohm termination. Tektronix Part Number 011-0049-00.

14. BNC to Binding Post adapter. Tektronix Part Number 103-0033-00.

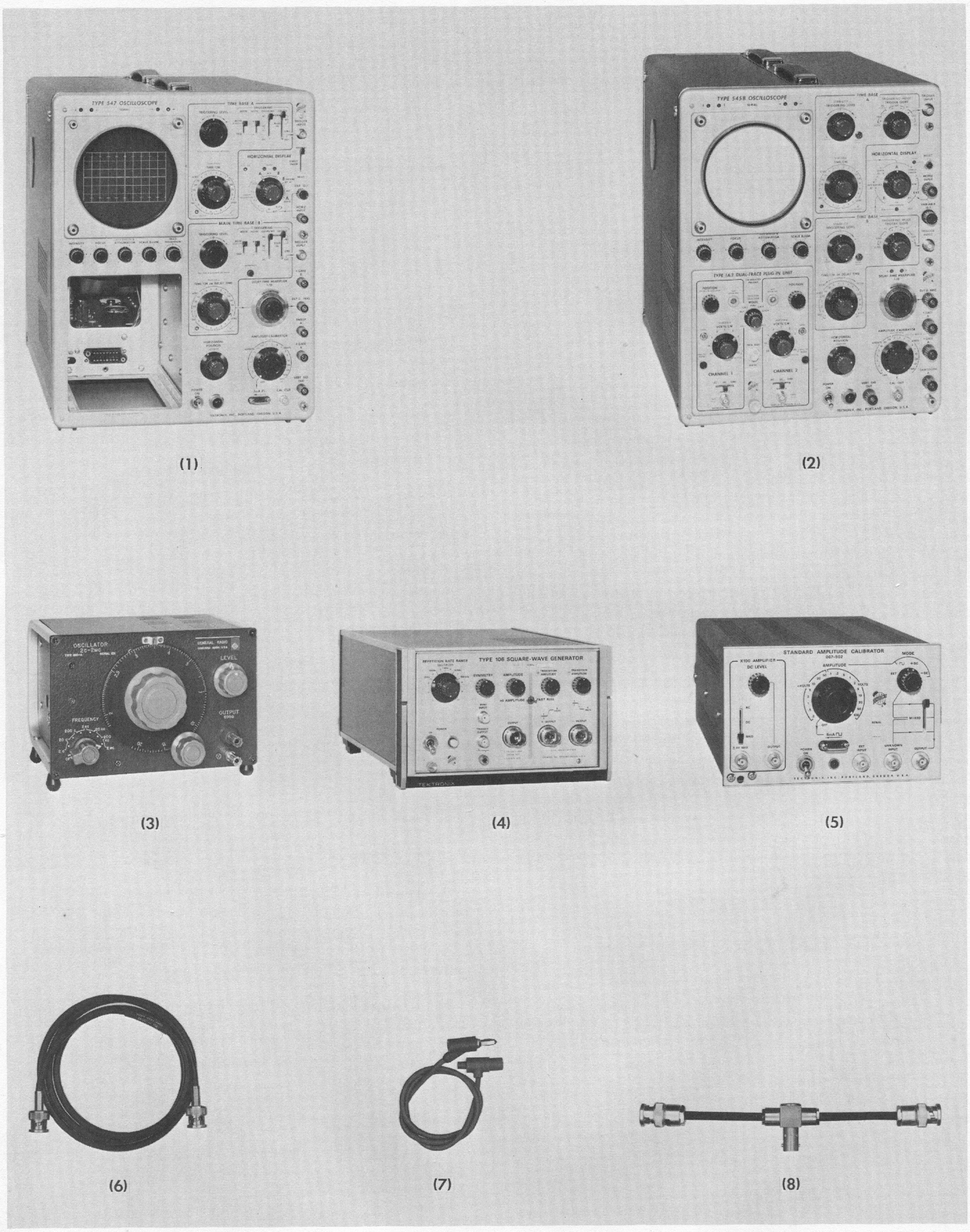


Fig. 5-1. Test equipment required, item 1 through item 8.

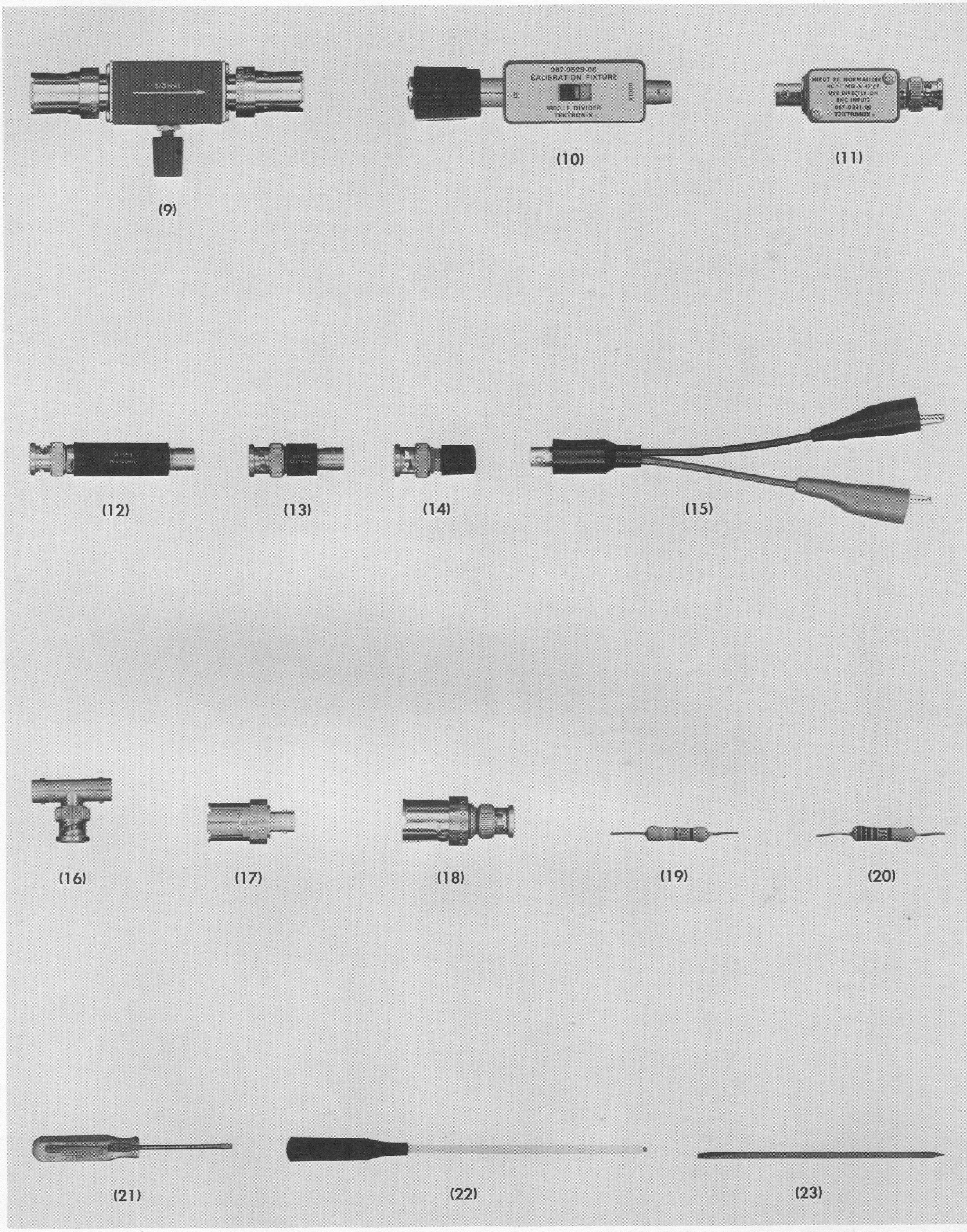


Fig. 5-2. Test equipment required, item 9 through item 23.

15. Adapter. Connectors, BNC female and two alligator clips. Tektronix Part Number 013-0076-00.

16. BNC T connector. Tektronix Part Number 103-0030-00.

17. Adapter, GR to BNC Female. Tektronix Part Number 017-0063-00.

18. Adapter, GR to BNC male. Tektronix Part Number 017-0064-00.

19. Resistor, 499 kΩ; ½ watt; 1% tolerance. Tektronix Part Number 323-0452-00.

20. Resistor, 2 kΩ; ½ watt; 1% tolerance. Tektronix Part Number 323-0222-00.

21. Screwdriver. Three inch shaft, 3/32 inch bit for slotted screws. Tektronix Part Number 003-0192-00.

22. Low Capacitance screwdriver, 7 inch shaft. Tektronix Part Number 003-0001-00 (for calibration only).

23. Fiber rod, length 8 inches; ¼ inch diameter; screwdriver shaped ends. Tektronix Part Number 003-0209-00 (for calibration only).

SHORT-FORM PERFORMANCE CHECK/ CALIBRATION PROCEDURE

This short-form procedure is provided to aid in checking the performance or calibration of the Type 1A7A. It may be used as a guide by the experienced operator or calibrator, or it may be reproduced and used as a permanent record of calibration. Since the step numbers and titles used here correspond to those used in the complete procedure, this procedure also serves as an index to locate a step in the complete procedure. Performance requirements listed here correspond to those given in Section 1.

Type 1A7A, Serial No. ______________________

Calibration Date ______________________

Calibrated by ______________________

☐ 1. Check or Adjust AC Atten Bal (R505) — Page 5-7

Trace within 1.5 CM of graticule center as VOLTS/CM is changed from 10 mV to 20 μV.

☐ 2. Check or Adjust Variable Bal (R425) — Page 5-7

Maximum trace shift ± 0.2 CM as the VARIABLES (VOLTS/CM) is rotated counterclockwise.

☐ 3. Check or Adjust Coarse DC Bal (R345) — Page 5-7

Trace centered when LOW FREQ —3 dB POINT selector is changed from 10 kHz to DC.

☐ 4. Check or Adjust Gain (R435) — Page 5-9

Correct vertical deflection in the 1 mV position of the VOLTS/CM switch (front panel adjustment).

☐ 5. Check VARIABLE control Ratio — Page 5-9

Display amplitude decreases by a ratio of 2.5:1 when VARIABLE control is rotated fully counterclockwise.

☐ 6. Check VOLTS/CM Gain Switching — Page 5-9

Correct vertical deflection from 10 μV through 10 mV.

☐ 7. Check or Adjust + Input Zero (R115) — Page 5-11

Maximum trace shift ± 2 CM as the + Input AC-GND-DC switch is switched from GND to AC.

☐ 8. Check or Adjust — Input Zero (R215) — Page 5-12

Maximum trace shift ± 2 CM as the — Input AC-GND-DC switch is switched from GND to AC.

☐ 9. Check Total DC Offset Range — Page 5-13

Trace returns within + 4 cm or — 4 cm of graticule center as the + Input AC-GND-DC switch and the DC OFFSET switch are switched simultaneously.

☐ 10. Check or Adjust C231—Cross Neutralization — Page 5-15

With signal connected to + INPUT and — INPUT AC-GND-DC switch switched from GND to DC, aberration should not exceed ±1%.

☐ 11. Check or Adjust C131—Cross Neutralization — Page 5-16

With signal connected to — INPUT and the + Input AC-GND-DC switch switched from GND to DC, aberration should not exceed ± 1%.

☐ 12. Check or Adjust C112—X1 + Input Attenuator Time Constant Standardization — Page 5-17

Optimum square wave response.

☐ 13. Check or Adjust C212—X1 — Input Attenuator Time Constant Standardization — Page 5-18

Optimum square wave response.

☐ 14. Check Input Attenuator Accuracy — Page 5-19

Correct vertical deflection from 10 mV through 10 volts.

☐ 15. Check or Adjust Attenuator Differential Balance (R205E, R207E, R209E) — Page 5-20

Optimum differential balance.

☐ 16. Check or Adjust + Input Attenuator Compensation (C105C/B, C107C/B, C109C/B) — Page 5-22

Optimum square wave response.

- [ ] 17. Check or Adjust — Input Attenuator Series Compensation to Match + Input (C205C, C207C, C209C). Page 5-24

  Best common-mode signal rejection (minimum spike amplitude).

- [ ] 18. Check or Adjust — Input Attenuator Shunt Compensation (205B, C207B, C209B) Page 5-26

  Optimum flat bottom display.

- [ ] 19. Check 100 Hz CMRR Page 5-28

  Vertical deflection does not exceed 2 cm as the + Input and — Input AC-GND-DC switches are simultaneously switched from GND to DC.

- [ ] 20. Check AC Coupled CMRR at 60 Hz Page 5-29

  Vertical deflection should not exceed 1 cm as the + Input and — Input AC-GND-DC switches are simultaneously switched from GND to AC.

- [ ] 21. Check or Adjust 100 kHz, Check 1 kHz CMRR Page 5-29

  Display Tilt and vertical deflection should not exceed limit specified in Characteristics Section when the + Input and — Input AC-GND-DC switches are simultaneously switched from GND to DC.

- [ ] 22. Check Risetime Page 5-30

  Risetime between 0.27 μs and 0.35 μs, measured between the 10% and 90% amplitude levels.

- [ ] 23. Check INPUT OVERLOAD Neon Page 5-31

  The overload light turns on when an excessive voltage is applied and extinguishes when the voltage is decreased.

- [ ] 24. Check or Adjust Signal Output DC Level (R550) Page 5-32

  Zero volts DC at the SIGNAL OUTPUT connector.

- [ ] 25. Check Signal Output Gain Page 5-32

  Correct signal amplitude at the SIGNAL OUTPUT connector (0.25 V per displayed cm).

- [ ] 26. Check or Adjust Signal Output Divider Compensation (C554) Page 5-33

  Optimum square wave response.

- [ ] 27. Check High and Low Freq —3 dB Point Page 5-34

  Bandwidth limit of HIGH FREQ —3 dB POINT and LOW FREQ —3 dB POINT selectors.

- [ ] 28. Check Overall Noise Level Tangentially Page 5-36

  Less than 16 μV of displayed noise measured tangentially.

PERFORMANCE CHECK/CALIBRATION PROCEDURE

General

The following procedure is arranged in a sequence which allows the Type 1A7A to be calibrated with the least interaction of adjustments and reconnection of equipment. The steps in which adjustments are made are identified by the symbol ◑ following the title. Instrument performance is checked in the "CHECK" part of the step before an adjustment is made. The "ADJUST" part of the step identifies the point where the actual adjustment is made. Steps listed in the "INTERACTION" part of the step may be affected by the adjustment just performed. This is particularly helpful when only a partial calibration procedure is performed.

NOTE

To prevent recalibration of other parts of the instrument when performing a partial calibration, readjust only if the tolerances given in the "CHECK" part of the step are not met. However, when performing a complete calibration, best overall performance is obtained if each adjustment is made to the exact setting even if the "CHECK" is within the allowable tolerance.

In the following procedure, a test-equipment setup picture is shown for each major group of checks and adjustments. Each step continues from the equipment setup and control settings used in the preceding step(s) unless noted otherwise, if only a partial calibration or performance check is performed, start with the test equipment setup preceding the desired portion. External controls or adjustments of the Type 1A7A referred to in this procedure are capitalized (e.g., POSITION). Internal adjustment names are initial capitalized only (e. g., Variable Bal).

All waveforms shown in this procedure are actual waveform photographs taken with a Tektronix Oscilloscope Camera System and Projected Graticule. The following procedure uses the equipment listed under Test Equipment Required. If equipment is substituted, control settings or test equipment setup may need to be altered to meet the requirements of the equipment used. Detailed operating instructions for the test equipment are not given in this procedure. If in doubt as to the correct operation of any of the test equipment, refer to the instruction manual for that unit.

NOTE

It is assumed that performance is checked within a temperature range of 0° C to +50° C and calibration +25° C, ±5° C; the tolerances given in this procedue are for this temperature range. However, if the procedure is performed at some other temperature, check to the applicable tolerances for that temperature range.

Preliminary Procedure

1. If the Type 1A7A is to be calibrated remove the left side panel from the oscilloscope; otherwise leave the panel in place and proceed to Step 2.

2. Insert the Type 1A7A into the oscilloscope plug-in compartment.

3. Connect the oscilloscope power cord to the design center operating voltage for which the oscilloscope is wired.

4. Turn on the oscilloscope POWER switch. Allow at least 20 minutes warmup for checking the instrument to the given accuracy.

5. Preset the Type 1A7A front panel controls as follows:

VOLTS/CM	10 mV
VARIABLE	Fully clockwise
POSITION	Midrange
HIGH FREQ —3 dB POINT	100 Hz
LOW FREQ —3 dB POINT	10 kHz
AC-GND-DC (+ INPUT)	GND
AC-GND-DC (— INPUT)	GND
STEP ATTEN DC BAL	Midrange
DC OFFSET ON-OFF	OFF
DC OFFSET COARSE	MIDRANGE (five turns from either extreme)
DC OFFSET FINE	MIDRANGE

6. Preset the oscilloscope front panel controls to these settings:

TIME/CM	.5 ms
VARIABLE (TIME/CM)	Calibrated
TRIGGERING	AUTO, + SLOPE, AC, INT

NOTES

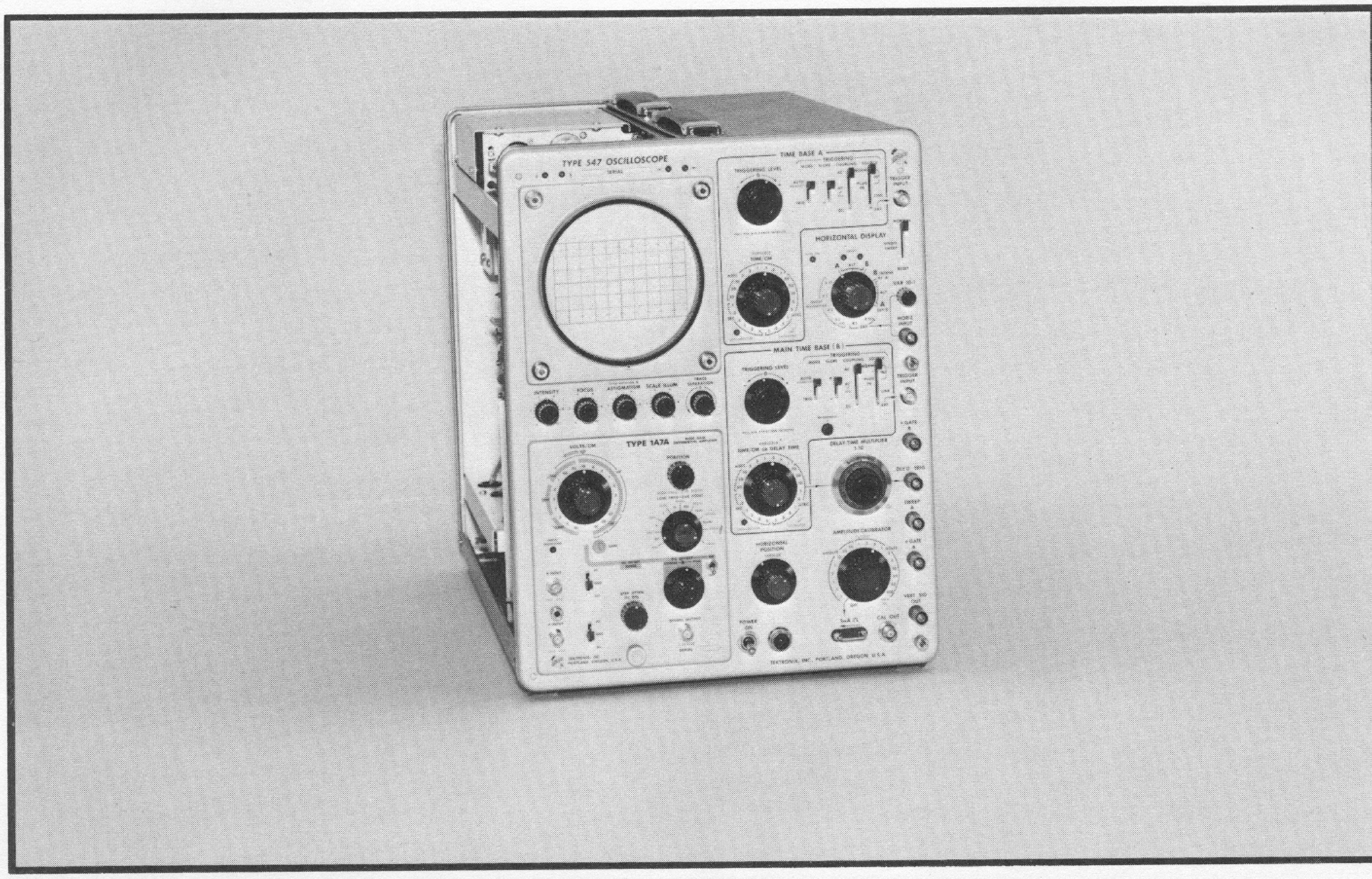


Fig. 5-3. Test equipment setup for steps 1 through 3.

1. Check or Adjust AC Atten Bal

a. Test equipment setup is shown in Fig. 5-3.

b. Center the trace on the CRT with the POSITION control.

c. Rotate the VOLTS/CM switch from the 10 mV position to the 20 μV position.

d. CHECK—The trace should remain within 1.5 cm of graticule center.

e. ADJUST—AC Atten Bal control, R505 (see Fig. 5-4) so the trace is positioned within 1.5 cm of graticule center.

2. Check or Adjust Variable Bal

a. Set the Type 1A7A VOLTS/CM switch to 10 mV.

b. Position the trace to graticule center with the POSITION control.

c. Rotate the VARIABLE (VOLTS/CM) counterclockwise.

d. CHECK—For maximum trace shift not to exceed $\pm$0.2 cm while rotating the VARIABLE control throughout its range.

e. ADJUST—Variable Bal control, R425 (see Fig. 5-4) for no trace shift while rotating the VARIABLE control.

3. Check or Adjust Coarse DC Bal

a. Set the VARIABLE (VOLTS/CM) to the CAL position.

b. Position the LOW FREQ —3 dB POINT switch to the DC position.

c. CHECK—The trace should be within 0.1 cm of graticule center.

d. ADJUST—Coarse DC Bal, R345 (see Fig. 5-4) to position the trace to graticule center.

e. Set the VOLTS/CM switch to 50 μV.

f. CHECK—The trace should be on screen.

g. ADJUST—If the trace is not on screen, start at the position of the VOLTS/CM switch where an on screen display is obtained and readjust the Coarse DC Bal, working down to the 50 μV position so the end result is an on-screen trace at 50 μV.

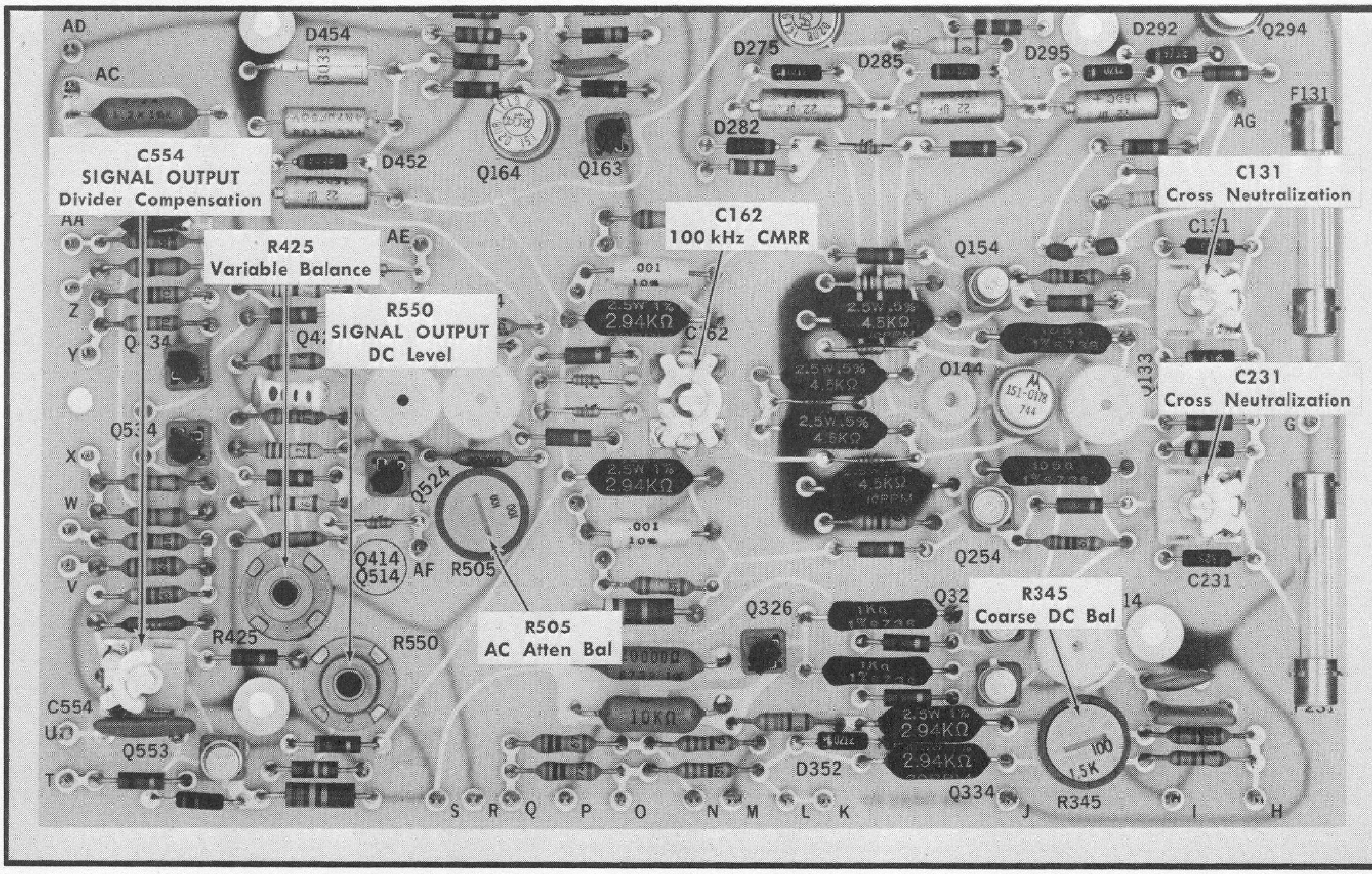


Fig. 5-4. Adjustments located on the Amplifier board.

NOTES

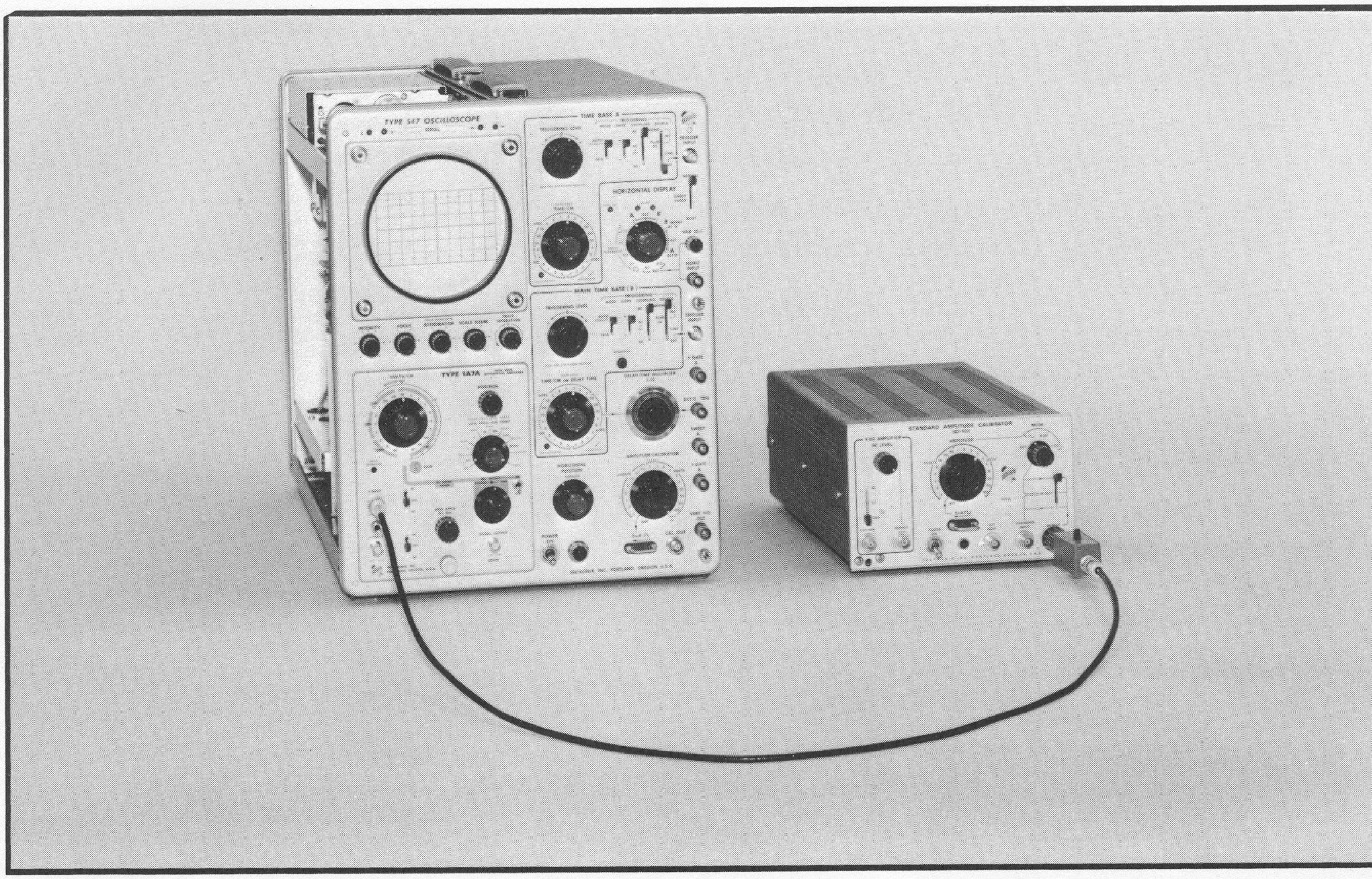


Fig. 5-5. Test equipment setup for steps 4 through 6.

Type 1A7A controls

VOLTS/CM	1 mV
VARIABLE	CAL
POSITION	Midrange
HIGH FREQ —3 dB POINT	1 MHz
LOW FREQ —3 dB POINT	DC
AC-GND-DC (+ INPUT)	DC
AC-GND-DC (— INPUT)	GND
STEP ATTEN DC BAL	Adjust for proper DC balance. (See Operating Section)
DC OFFSET	OFF

Oscilloscope controls

TIME/CM	.5 ms
VARIABLE (TIME/CM)	CAL
TRIGGERING	AUTO, + SLOPE, AC, INT

4. Check or Adjust Gain

a. Test equipment setup is shown in Fig. 5-5.

b. Connect a 5 mV peak to peak square wave signal from a standard amplitude calibrator through a 1000:1 divider and a coaxial cable to the + Input connector.

c. Set the 1000:1 divider to ×1.

d. Align the display with the graticule lines, using the POSITION control.

e. CHECK—The display for a vertical amplitude of exactly 5 CM.

f. ADJUST—The GAIN control, which is a front panel adjustment R435, (see Fig. 5-6) for exactly 5 cm of display amplitude.

5. Check VARIABLE Control Ratio

a. Rotate the VARIABLE control fully counterclockwise.

b. CHECK—The display amplitude should be 2 cm or less to meet the 2.5:1 ratio requirement.

c. Reset the VARIABLE control to the CAL position.

6. Check VOLTS/CM Gain Switch

a. Set the HIGH FREQ —3 dB POINT switch to 3 kHz.

b. Set the LOW FREQ —3 dB POINT switch to 1 Hz.

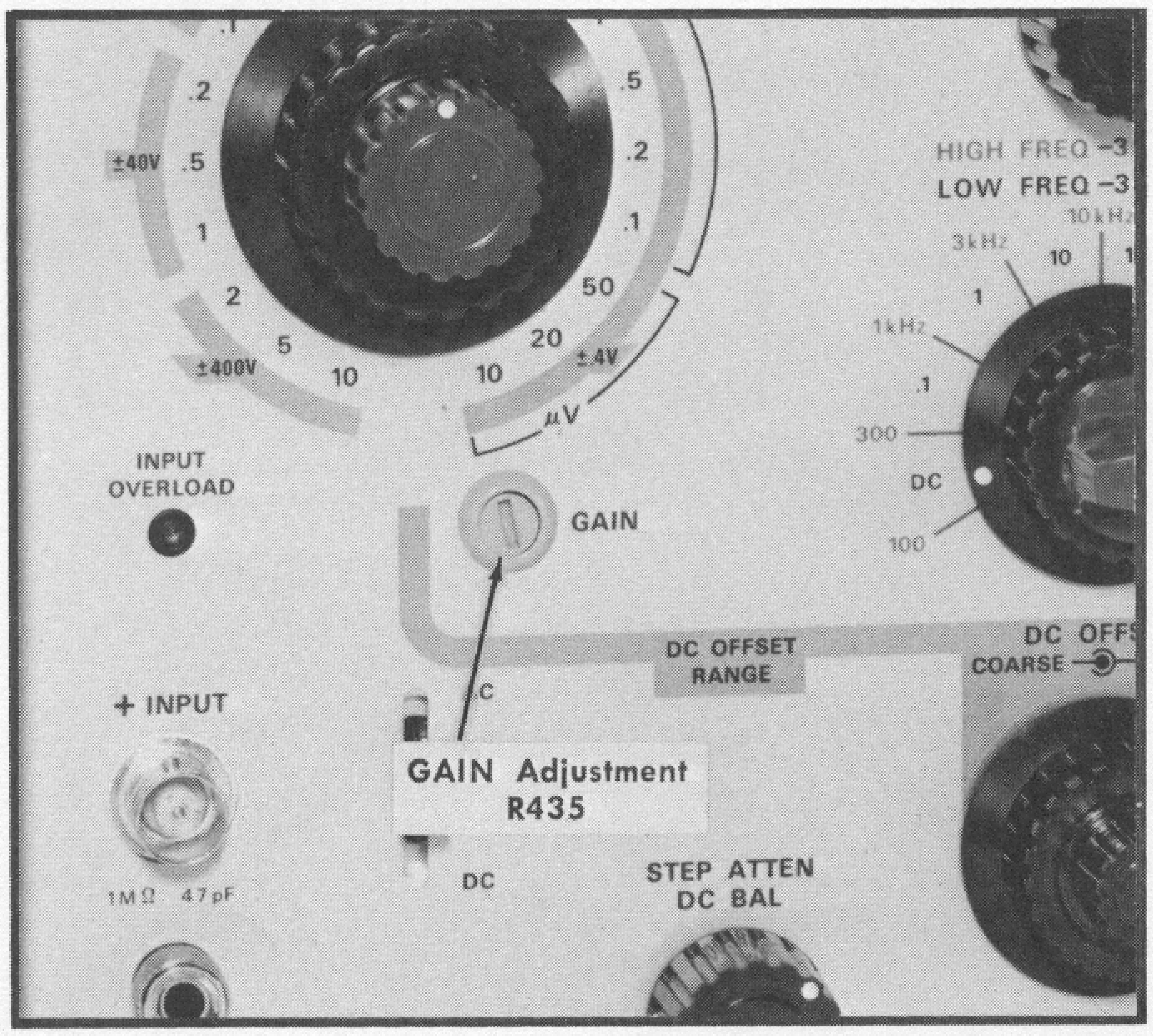


Fig. 5-6. Location of GAIN Adjustment, R435.

c. Set the standard amplitude calibrator output to 10 mV.

d. Using the VARIABLE (VOLTS/CM) control, adjust the display amplitude to 5 cm.

e. Set the oscilloscope TRIGGERING SOURCE to LINE and trigger the oscilloscope at the line frequency.

f. Position the oscilloscope TIME/CM switch to .1 ms.

g. Switch the 1000:1 divider to ×1000.

h. CHECK—The vertical deflection factor from 10 μV through 50 μV. Table 5-1 is provided as a guide.

TABLE 5-1

VOLTS/CM Switch Position	Standard Amplitude Calibrator Output Amplitude	Divisions of Deflection	Accuracy
10 μV	.1 V	5	± 2% or .1 cm
20 μV	.2 V	5	± 2% or .1 cm
50 μV	.5 V	5	± 2% or .1 cm

i. Return the VARIABLE to the CAL position.

j. Switch the 1000:1 divider to the ×1 position.

k. CHECK—The vertical deflection factor from .1 mV through 10 mV using Table 5-2 as a guide.

l. Disconnect the calibrator signal.

TABLE 5-2

VOLTS/CM Switch Position	Standard Amplitude Calibrator Output Amplitude	Divisions of Deflection	Accuracy
.1 mV	.5 mV	5	± 2% or .1 cm
.2 mV	1 mV	5	
.5 mV	2 mV	4	
1 mV	5 mV	5	
2 mV	10 mV	5	
5 mV	20 mV	4	
10 mV	50 mV	5	

NOTES

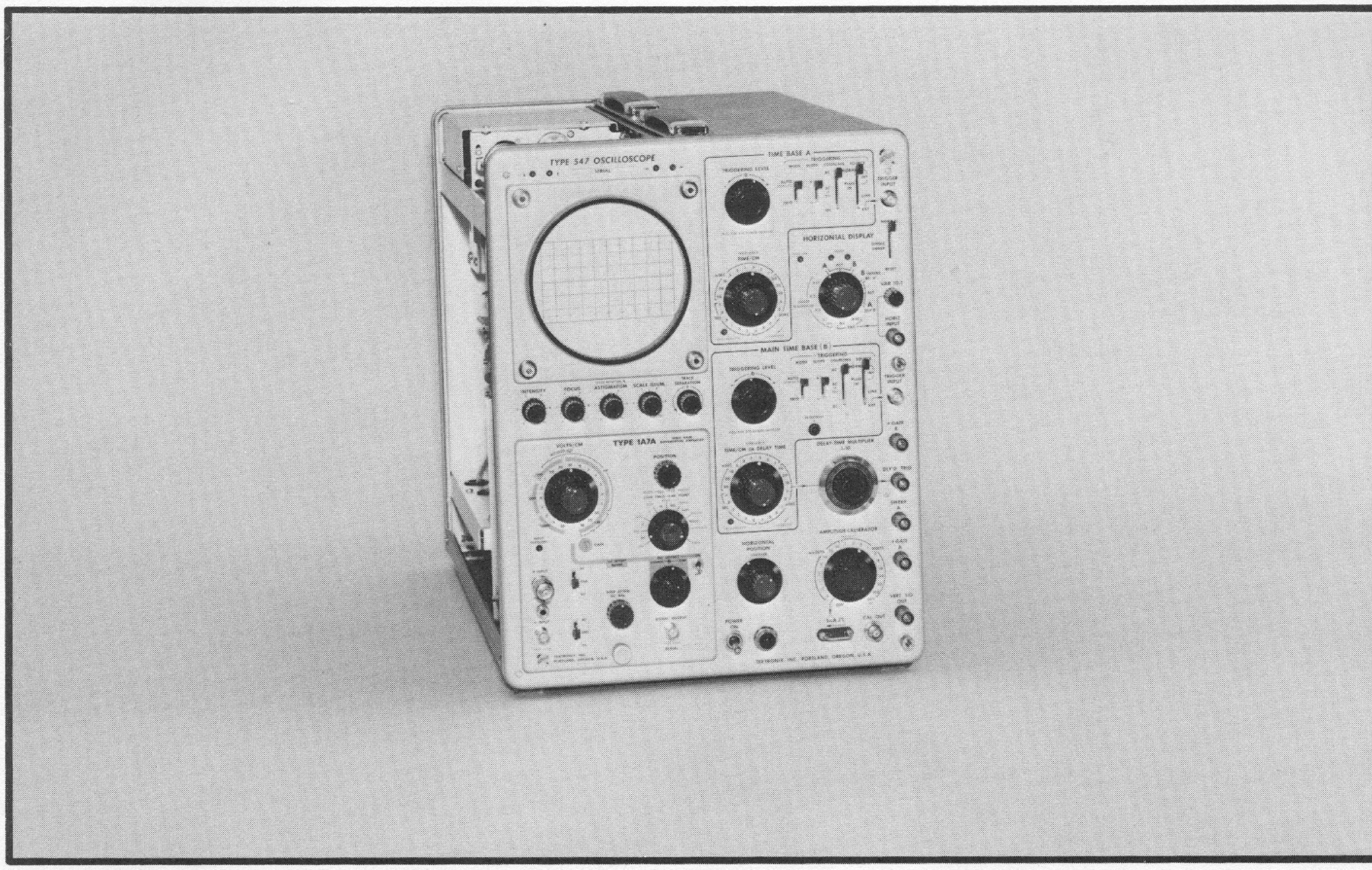


Fig. 5-7. Test equipment setup for steps 7 and 8.

Type 1A7A Controls

VOLTS/CM	10 μV
VARIABLE	CAL
POSITION	Midrange
HIGH FREQ —3 dB POINT	100 Hz
LOW FREQ —3 dB POINT	DC
AC-GND-DC (+ INPUT)	GND
AC-GND-DC (— INPUT)	GND
STEP ATTEN DC BAL	Adjust for proper DC balance
DC OFFSET	OFF

Oscilloscope Controls

TIME/CM	.5 ms
VARIABLE (TIME/CM)	CAL
TRIGGERING	AUTO, + SLOPE, AC INT

7. Check or Adjust + Input Zero

a. Test equipment setup is shown in Fig. 5-7.

b. Connect a 50 ohm termination to the + INPUT connector.

c. Using the STEP ATTEN DC BAL control, position the trace to coincide with graticule center.

d. Set the + INPUT AC-GND-DC switch to AC.

e. CHECK—For maximum trace shift within ±2 cm.

f. ADJUST—The + Input Zero control, R115 (see Fig. 5-8) to return the trace to graticule center.

g. CHECK—(only if adjustment has been performed). Return the + Input AC-GND-DC switch to GND and back to AC. There should be no trace shift.

h. Set the + Input AC-GND-DC switch to GND.

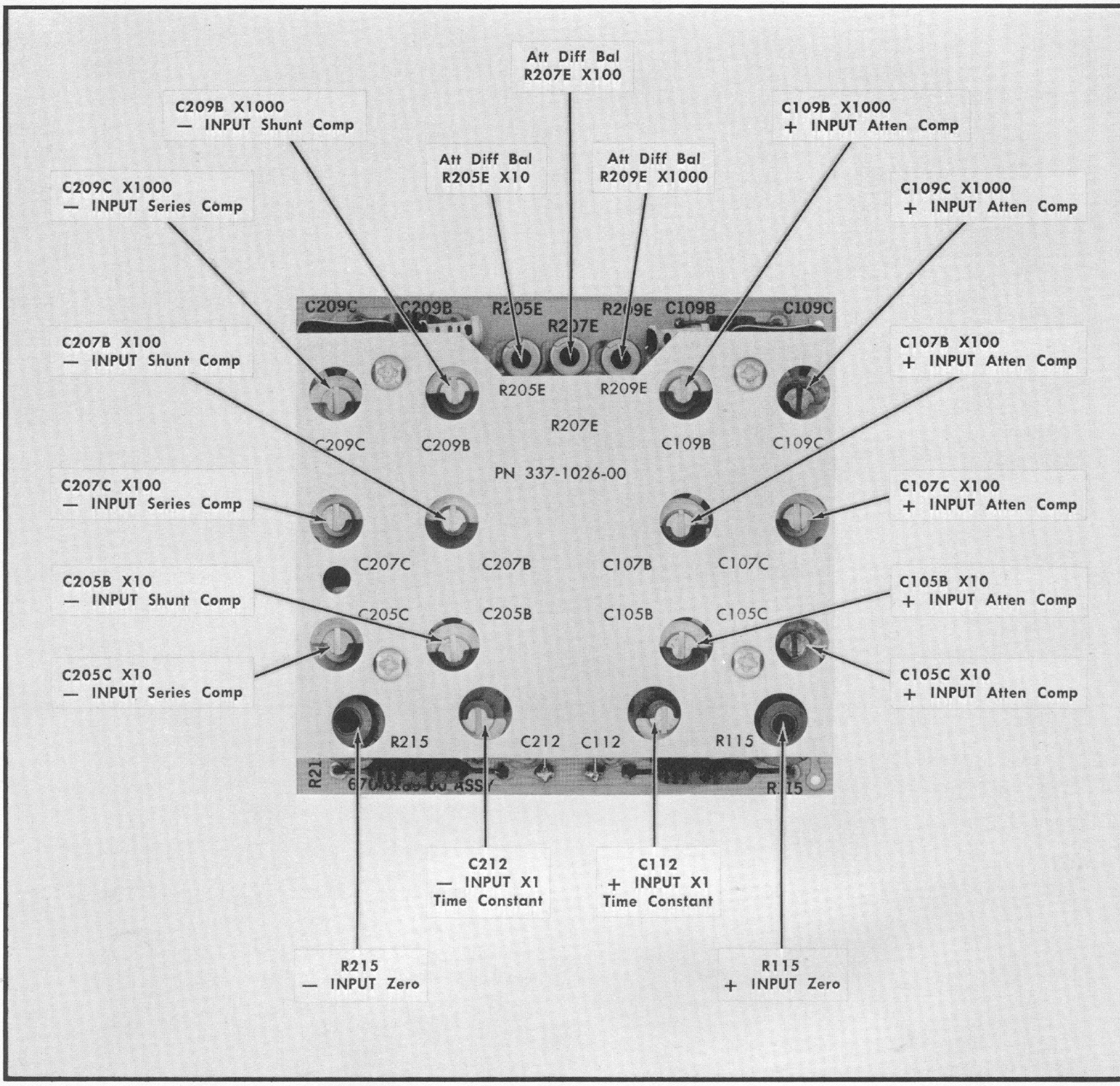


Fig. 5-8. Adjustments located on the Attenuator board.

8. Check or Adjust — Input Zero ⓘ

a. Remove the 50 ohm termination from the + INPUT and connect it to the — INPUT connector.

b. Position the trace to graticule center with the STEP ATTEN DC BAL control.

c. Set the — Input AC-GND-DC switch to AC.

d. CHECK—For maximum trace shift within ± 2 cm.

e. ADJUST—The — Input Zero control, R215 (see Fig. 5-8) to position the trace to graticule center.

f. CHECK—(only if adjustment has been performed) Return the — Input AC-GND-DC switch to GND and back to AC. There should be no trace shift.

g. Disconnect the 50 ohm termination.

h. Set the — Input AC-GND-DC switch to GND.

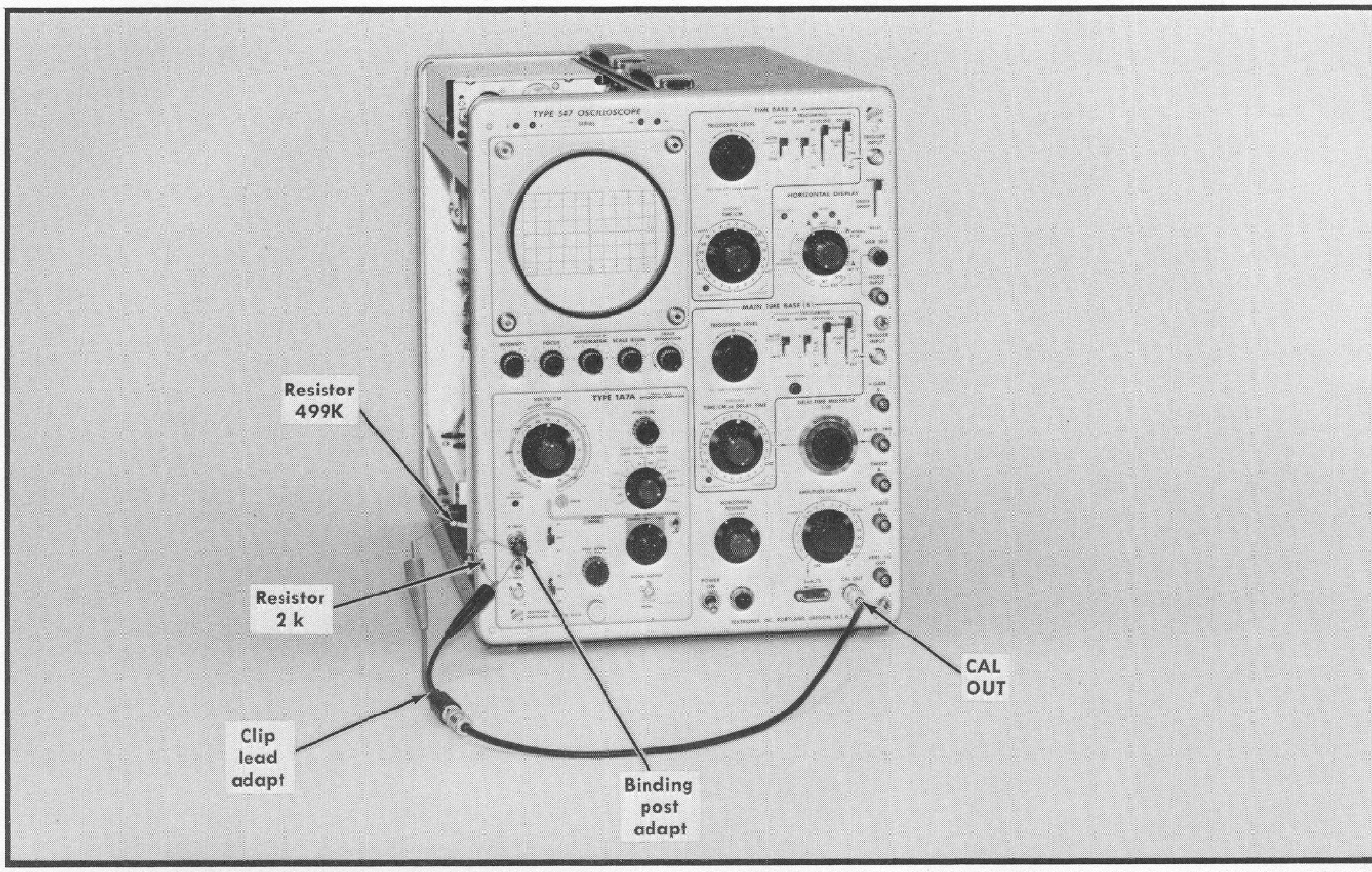


Fig. 5-9. Test equipment setup for step 9.

9. Check Total DC Offset Range

a. Test equipment setup is shown in Fig. 5-9.

b. Set the Type 1A7A controls as follows:

VOLTS/CM	10 mV
HIGH FREQ —3 dB POINT	1 MHz
DC OFFSET (COARSE)	Fully counterclockwise
DC OFFSET (FINE)	Fully counterclockwise

c. Connect a binding post adapter (item 14) to the + INPUT connector.

d. Connect the resistors (items 19 and 20) to the + INPUT connector using Fig. 5-9 and Fig. 5-10 as a guide.

e. Apply + 100 VDC from the oscilloscope calibrator to the divider (see Fig. 5-9).

f. Position the trace to graticule center using the POSITION control.

g. Set these controls simultaneously:

AC-GND-DC (+ Input)	DC
DC OFFSET ON-OFF	ON

h. CHECK—That the trace returns within + 4 cm (+ 40 mV) or — 4 cm (— 40 mV) of graticule center.

i. Turn off the calibrator. Disconnect the divider resistors and connector adapter from the + INPUT and connect them to the — INPUT connector.

j. Set the 1A7A controls as follows:

AC-GND-DC (+ Input)	GND
DC OFFSET ON-OFF	OFF
DC OFFSET (COARSE)	Fully clockwise
DC OFFSET (FINE)	Fully clockwise
POSITION	Trace Centered

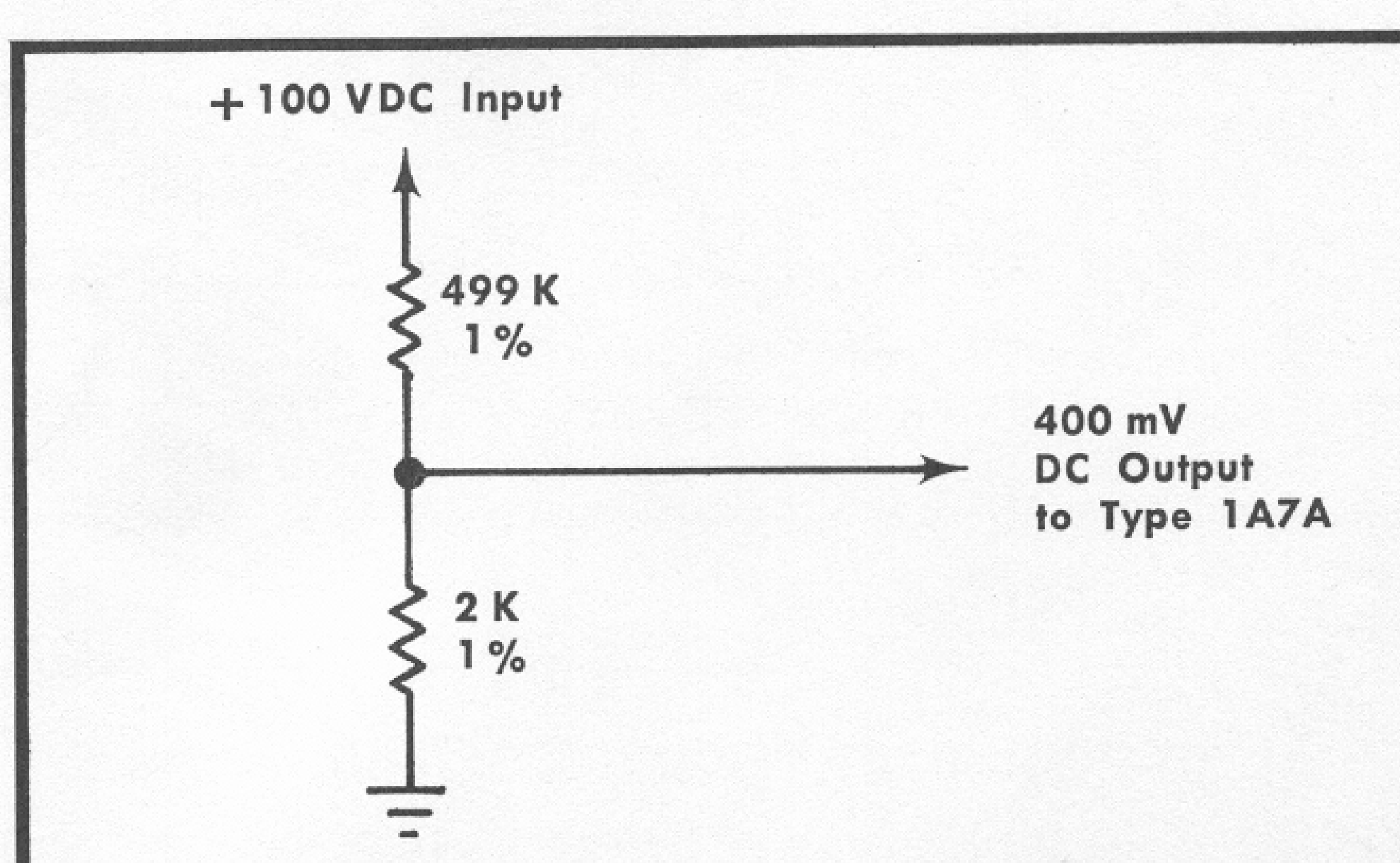


Fig. 5-10. Schematic of DC Offset Divider.

k. Reset the calibrator for + 100 VDC.

l. Set these controls simultaneously:

AC-GND-DC (— Input)	DC
DC OFFSET ON-OFF	ON

m. CHECK—That the trace returns within — 4 cm or + 4 cm of graticule center.

n. Decrease the output of the oscilloscope calibrator and disconnect the clip lead adapter, resistors, and binding post adapter. Set the DC OFFSET ON-OFF to OFF.

NOTES

®

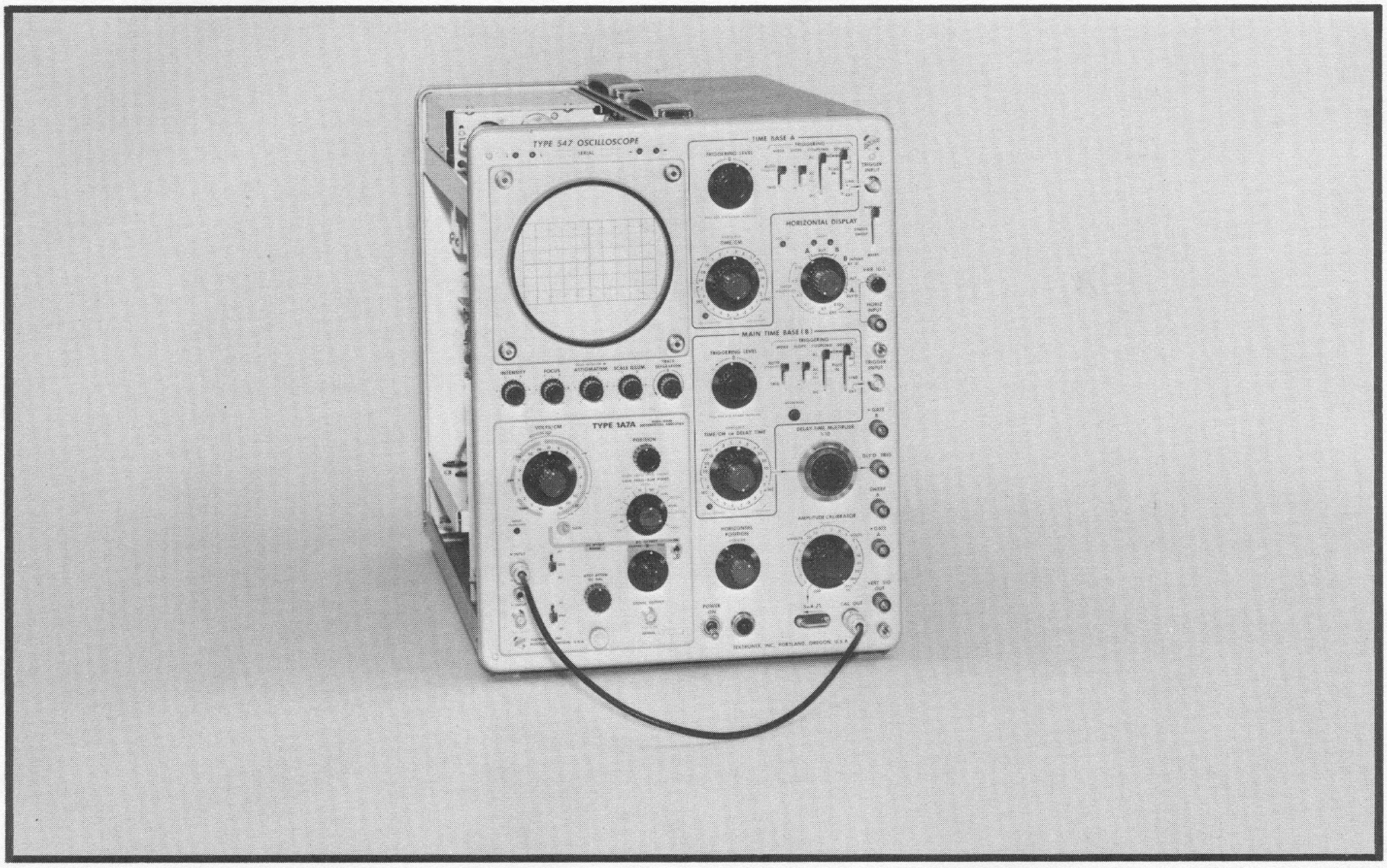


Fig. 5-11. Test equipment setup for steps 10 and 11.

Type 1A7A controls

VOLTS/CM	10 mV
VARIABLE	CAL
POSITION	Midrange
HIGH FREQ —3 dB POINT	1 MHz
LOW FREQ —3 dB POINT	DC
AC-GND-DC (+ INPUT)	DC
AC-GND-DC (—INPUT)	GND
STEP ATTEN DC BAL	Adjusted for proper DC balance.
DC OFFSET	OFF

Oscilloscope controls

TIME/CM	.5 ms
VARIABLE (TIME/CM)	CAL
TRIGGERING	AUTO, + SLOPE, AC, INT

10. Check or Adjust C231—Cross Neutralization

a. Test equipment setup is shown in Fig. 5-11.

b. Set the oscilloscope calibrator output to 50 mV.

c. Connect the coaxial cable from the oscilloscope calibrator to the + INPUT connector.

NOTE

From this point on in the procedure, the Type 1A7A POSITION control and the oscilloscope horizontal positioning control may not always be mentioned. Use these controls whenever it is necessary to position the display for best viewing.

d. CHECK—The upper leading corner of the waveform, and note any aberration that occurs while switching the — Input AC-GND-DC switch from GND to DC. The waveform should appear similar to the one in Fig. 5-12A. The percentage of aberration should not exceed ±1% (±0.05 cm).

e. Set the — Input AC-GND-DC switch to DC.

f. Adjust—C231 (see Fig. 5-4) for best square corner.

g. INTERACTION: C231 affects the ×1 input capacitance and all other input attenuator adjustments. If C231 is adjusted out of sequence, steps 12, 13, and 15 through 17 must also be performed.

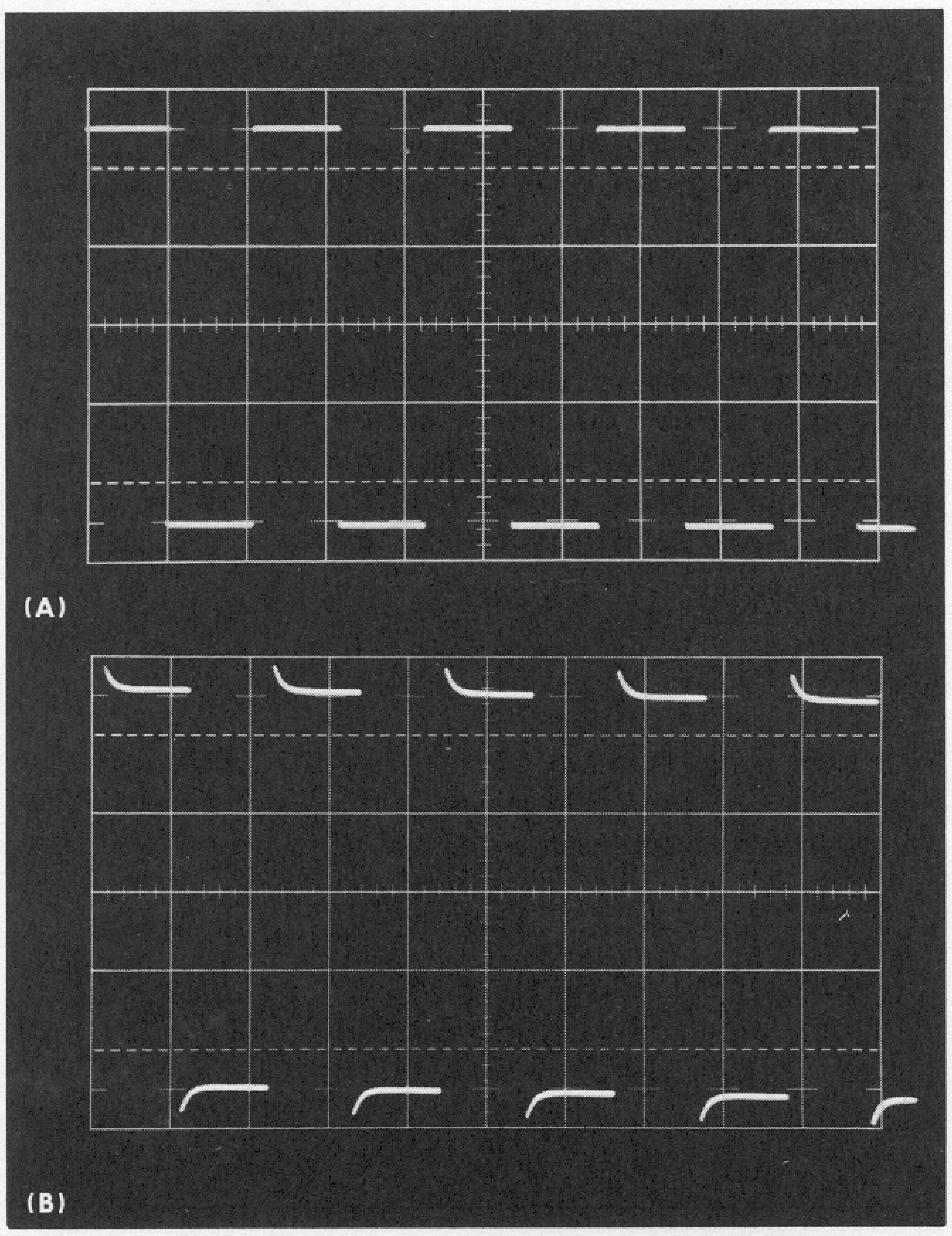


Fig. 5-12. Waveforms showing, (A) Cross neutralization properly adjusted (B) Excessive aberration.

11. Check or Adjust C131—Cross Neutralization

a. Disconnect the signal from the + INPUT connector and connect it to the — INPUT connector.

b. Set the + Input AC-GND-DC switch to GND.

c. CHECK—The lower leading corner of the second cycle of the display and note any aberration that occurs while switching the + Input AC-GND-DC switch from GND to DC. The bottom leading corner of the waveform should appear similar to the one shown in Fig. 5-12A. The aberrations should not exceed ± 1% (± 0.05 cm).

d. Set the + Input AC-GND-DC switch to DC.

e. ADJUST—C131 (see Fig. 5-4) for best square corner.

f. INTERACTION: C131 affects the ×1 input capacitance and all other input attenuator adjustments. If C131 is adjusted out of sequence, steps 12, 13 and 15 through 17 must be performed.

NOTES

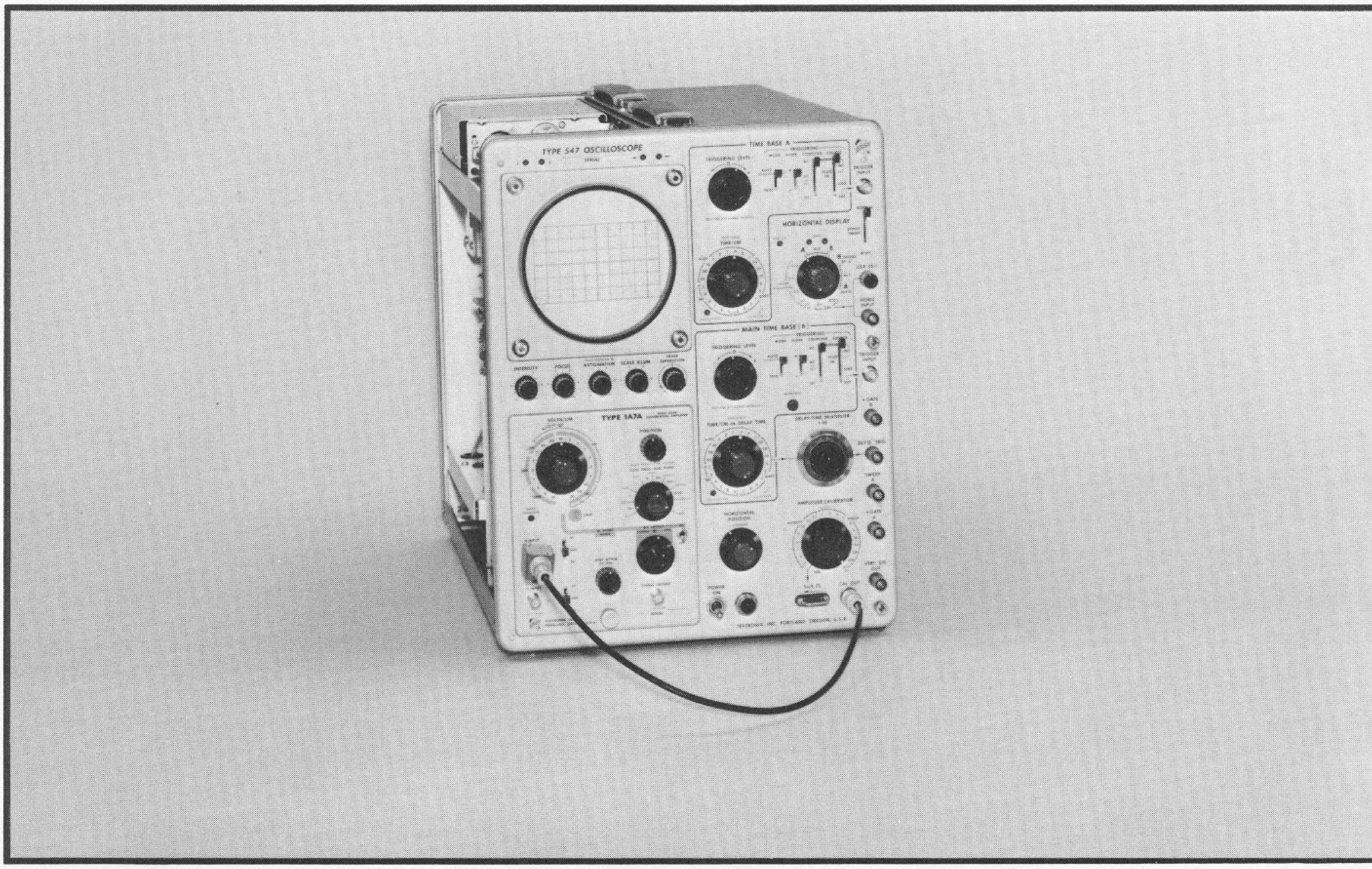


Fig. 5-13. Test equipment setup for steps 12 and 13.

12. Check or Adjust C112—×1 + Input Attenuator Time Constant Standardization

NOTE

It is important that C131 and C231 be properly adjusted before performing this adjustment. If you have not performed steps 10 and 11, do so at this point.

a. Test equipment setup is shown in Fig. 5-13.

b. Connect a 47 pF input RC standardizer to the + INPUT connector.

c. Disconnect the coaxial cable from the — INPUT connector and connect it to the RC standardizer.

d. Set the — Input AC-GND-DC switch to GND.

e. Set the + Input AC-GND-DC switch to DC.

f. Set the oscilloscope calibrator output to 0.1 V.

NOTES

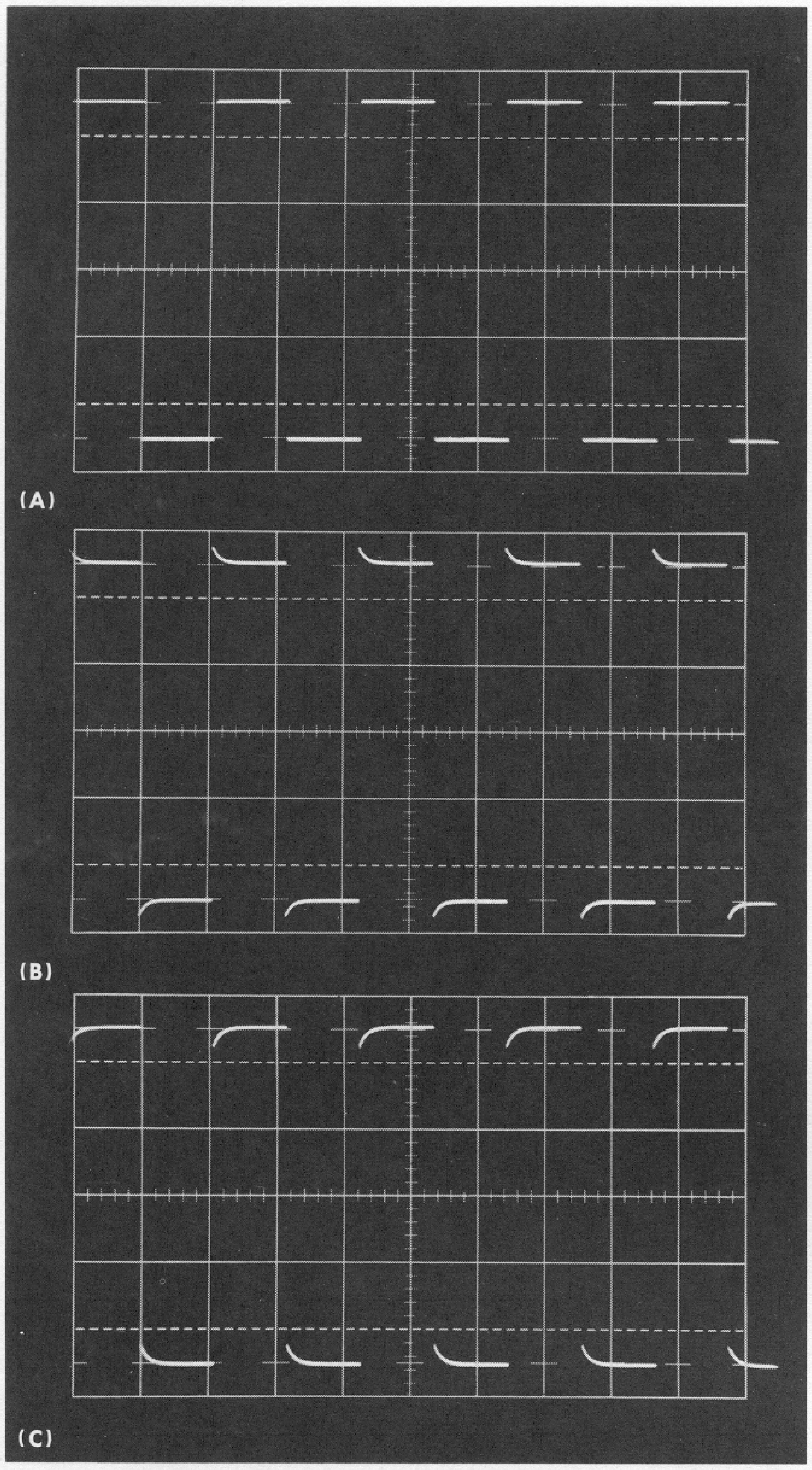


Fig. 5-14. Waveform showing (A) correct adjustment of Input Attenuator Time Constant. (B) and (C) Incorrect adjustment.

g. CHECK—The square wave display for flat tops (see Fig. 5-14A).

h. ADJUST—C112 (see Fig. 5-8) to obtain best square wave response.

i. INTERACTION: If C112 is adjusted out of sequence, steps 13 and 15 through 18 must also be performed.

13. Check or Adjust C212—×1 — Input Attenuator Time Constant Standardization ⓘ

a. Disconnect the RC standardizer from the + INPUT and connect it to the — INPUT.

b. Set the Type 1A7A controls as follows:

AC-GND-DC (+ INPUT)	GND
AC-GND-DC (— INPUT)	DC

c. CHECK—Each square wave for a flat bottom, using Fig. 5-14 as a guide.

d. ADJUST—C212 (see Fig. 5-8) for best flat bottom square wave display.

e. INTERACTION: If C212 is adjusted out of sequence, steps 12 and 15 through 18 must also be performed.

f. Disconnect the signal and the standardizer.

NOTES

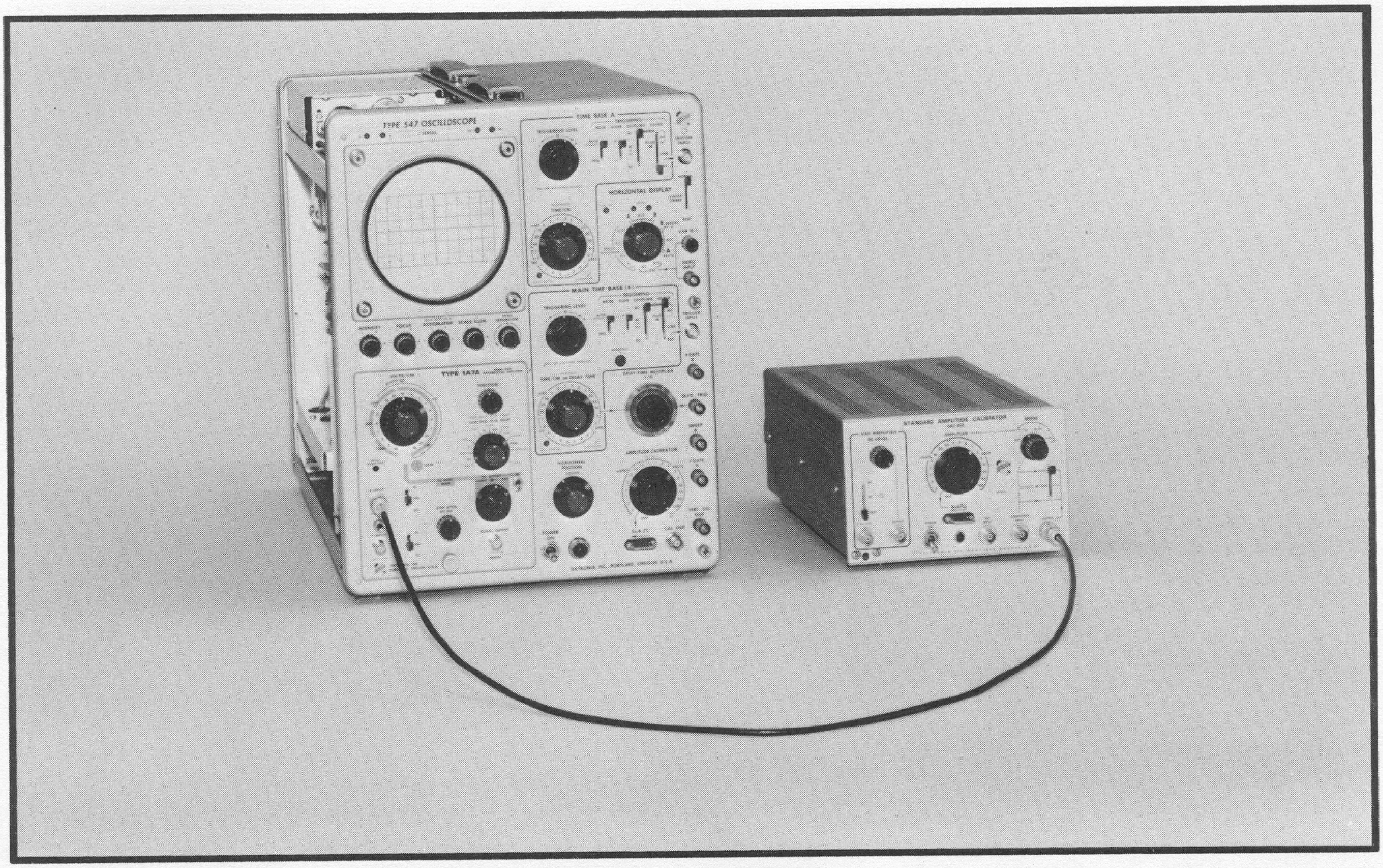


Fig. 5-15. Test equipment setup for step 14.

Type 1A7A controls

VOLTS/CM	10 mV
VARIABLE	CAL
HIGH FREQ —3 dB POINT	1 MHz
LOW FREQ —3 dB POINT	DC
AC-GND-DC (+ INPUT)	GND
AC-GND-DC (— INPUT)	GND
STEP ATTEN DC BAL	Adjusted for proper DC balance.
DC OFFSET	OFF

Oscilloscope controls

TIME/CM	.5 ms
VARIABLE (TIME/CM)	CAL
TRIGGERING	AUTO, + SLOPE, AC, INT

14. Check Input Attenuator Accuracy

a. Test equipment setup is shown in Fig. 5-15.

b. Connect a 50 mV peak-to-peak square wave signal from the standard amplitude calibrator through a coaxial cable to the + INPUT.

c. Set the + Input AC-GND-DC switch to DC.

d. CHECK—The input attenuators using Table 5-3 as a guide.

TABLE 5-3

VOLTS/CM Switch Position	Calibrator Output Peak to Peak	Vertical Deflection (Accuracy: ± 2%)
10 mV	50 mV	5 cm, ± .1 cm
20 mV	.1 V	5 cm, ± .1 cm
50 mV	.2 V	4 cm, ± .08 cm
.1 V	.5 V	5 cm, ± .1 cm
.2 V	1 V	5 cm, ± .1 cm
.5 V	2 V	4 cm, ± .08 cm
1 V	5 V	5 cm, ± .1 cm
2 V	10 V	5 cm, ± .1 cm
5 V	20 V	4 cm, ± .08 cm
10 V	50 V	5 cm, ± .1 cm

e. Disconnect the signal from the Type 1A7A.

NOTE

(Applies to calibration only)

If there is a spike or fast rolloff of the leading corner of the square wave when checking from 20 mV/CM to 10 V/CM, ignore these, as they will be adjusted out in step 16.

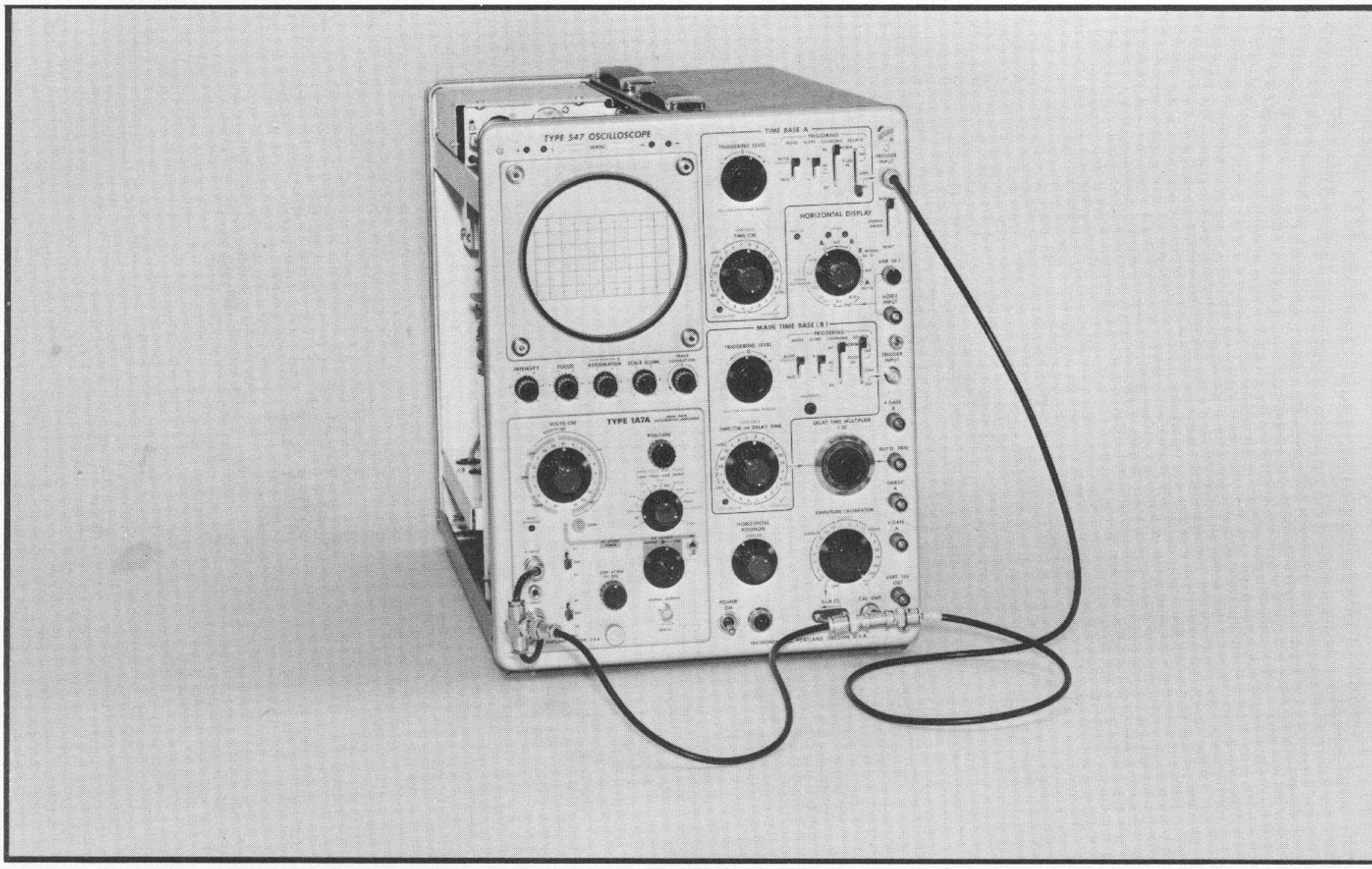


Fig. 5-16. Test equipment setup for step 15.

15. Check or Adjust Input Attenuator Differential Balance

a. Test equipment setup is shown in Fig. 5-16.

b. Connect a T connector to the CAL OUT connector on the oscilloscope and a dual input connector to the + INPUT and — INPUT connectors on the Type 1A7A.

c. Connect a coaxial cable from the T connector to the dual input connector. Connect a coaxial cable from the T connector to the TRIGGER INPUT connector on the oscilloscope.

d. Set the Type 1A7A controls as follows:

VOLTS/CM	50 mV
AC-GND-DC (— INPUT)	DC

e. Set the oscilloscope TRIGGERING SOURCE switch to EXT.

f. Set the oscilloscope calibrator output to 50 V peak to peak.

g. CHECK—For optimum differential balance according to the information given in Table 5-4. The trailing portions of the cycles must match each other (see Fig. 5-17). When performing calibration, disregard any spikes on the waveform.

h. ADJUST—R205E, R207E, R209E (see Fig. 5-8) to match the trailing portion of each waveform according to the information given in Table 5-4.

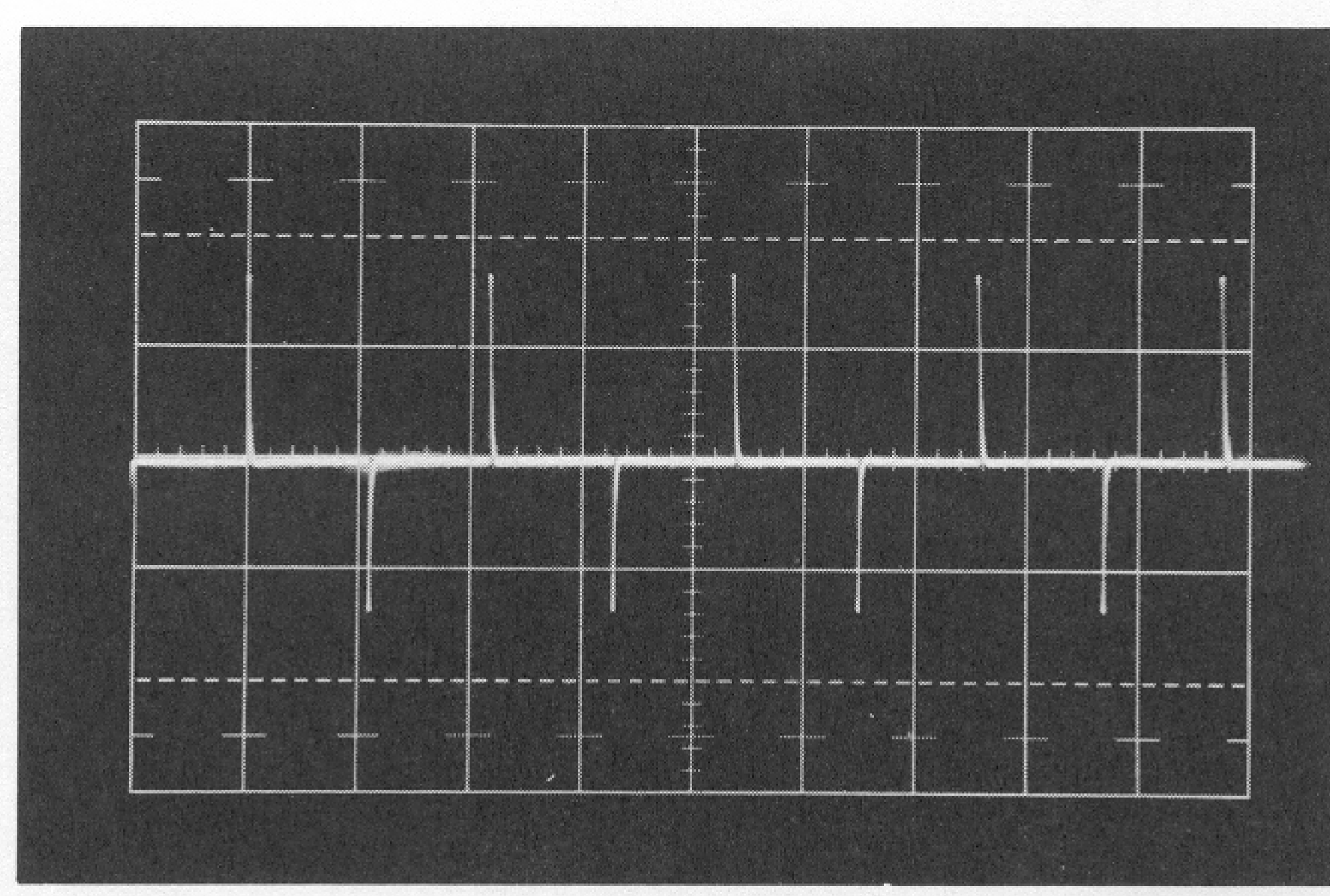


Fig. 5-17. Typical display obtained when Input Attenuators are adjusted for optimum differential balance.

TABLE 5-4

VOLTS/CM Switch Position	Calibrator Output (Peak to Peak)	Check and Adjust for Null	Input Attenu-ator
50 mVOLTS	50 Volts	Check/Adjust R205E	
20 mVOLTS	50 Volts	Check	×10
.1 VOLTS	50 Volts	Check	
.5 VOLTS	100 Volts	Check/Adjust R207E	
.2 VOLTS	100 Volts	Check	×100
1 VOLTS	100 Volts	Check	
5 VOLTS	100 Volts	Check/Adjust R209E	
2 VOLTS	100 Volts	Check	×1000
10 VOLTS	100 Volts	Check	

i. Set the oscilloscope calibrator for 0.2 V peak to peak output.

j. Disconnect all signal connections from the Type 1A7A and the oscilloscope.

NOTES

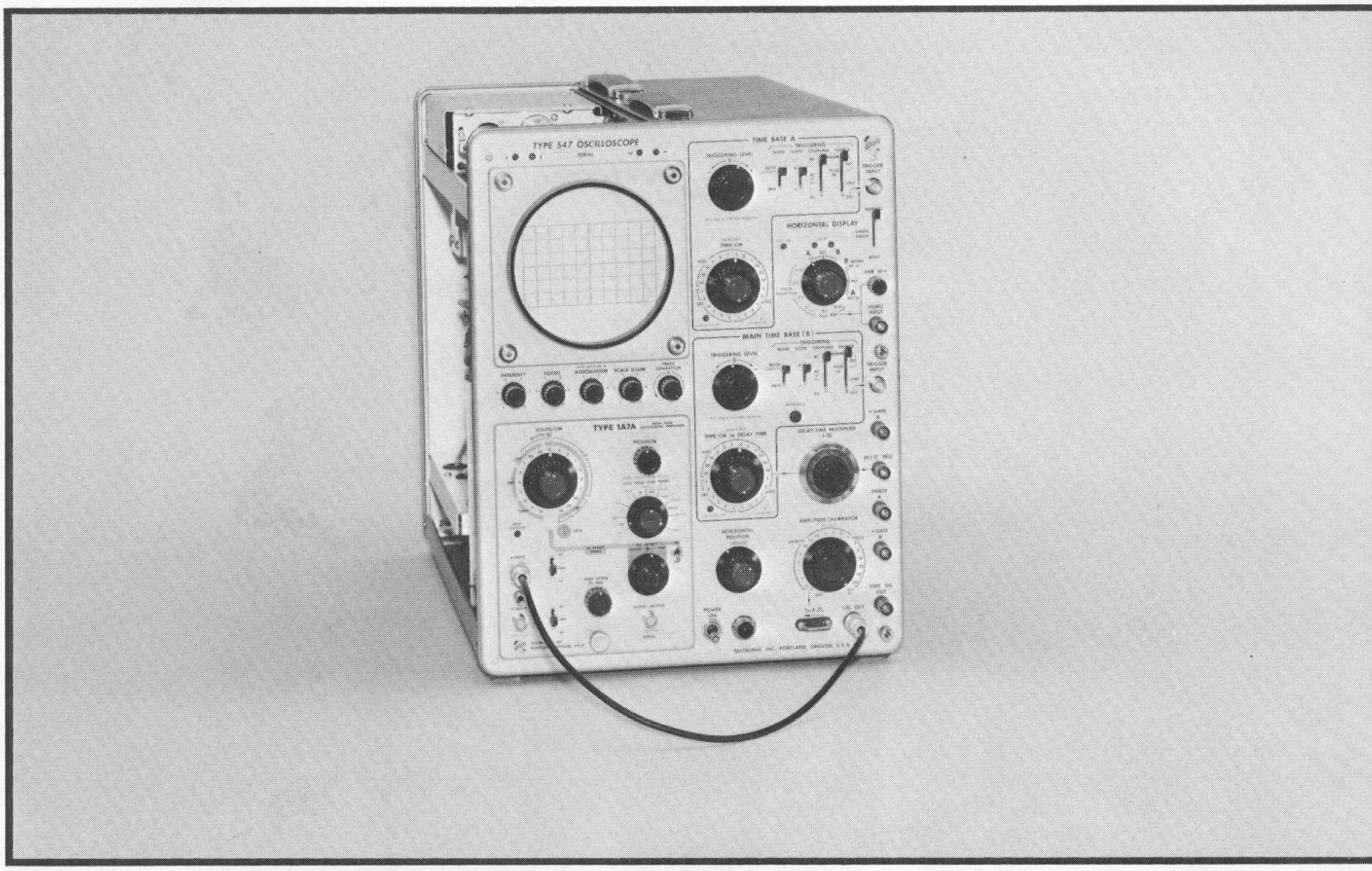


Fig. 5-18. Test equipment setup for step 16.

Type 1A7A controls

VOLTS/CM	50 mV
VARIABLE	CAL
HIGH FREQ —3 dB POINT	1 MHz
LOW FREQ —3 dB POINT	DC
AC-GND-DC (+ INPUT)	DC
AC-GND-DC (— INPUT)	GND
STEP ATTEN DC BAL	Adjusted for proper DC balance.
DC OFFSET	OFF

Oscilloscope controls

TIME/CM	.5 ms
VARIABLE (TIME/CM)	CAL
TRIGGERING	AUTO, + SLOPE, AC, INT

16. Check or Adjust + Input Attenuator Compensation

a. Test equipment setup is shown in Fig. 5-18.

TABLE 5-5

Calibrator Output (Peak to Peak)	VOLTS/CM Switch Position	Check or Adjust for Optimum		+ Input Attenuator
		Upper Leading Corner	Flat Top	
.2 V	50 mV	C105C		
.1 V	20 mV	Check		×10
.5 V	.1 V	Check		
2 V	.5 V	C107C		
1 V	.2 V	Check		×100
5 V	1 V	Check		
20 V	5 V	C109C		
10 V	2 V	Check		×1000
50 V	10 V	Check		
Connect the 47 pF input RC standardizer between the + Input and the coaxial cable.				
50 V	5 V		C109B	
20 V	2 V		Check	×1000
100 V	10 V		Check	
5 V	.5 V		C107B	
2 V	.2 V		Check	×100
10 V	1 V		Check	
.5 V	50 mV		C105B	
.2 V	20 mV		Check	×10
1 V	.1 V		Check	

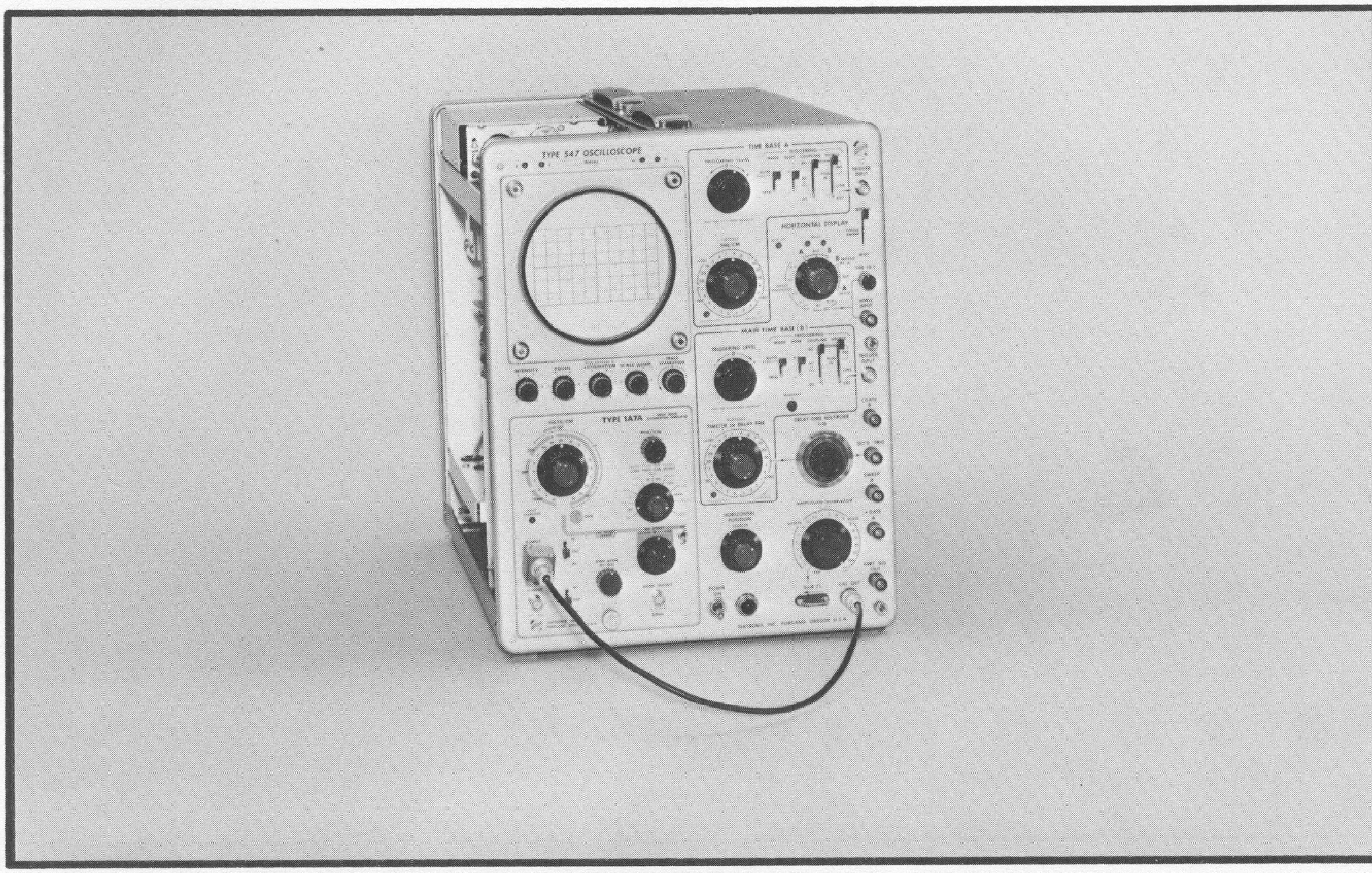


Fig. 5-19. Test equipment setup when performing the second half of Table 5-5.

b. Connect the 0.2 V peak to peak signal from the oscilloscope calibrator through a coaxial cable to the + INPUT of the Type 1A7A.

c. CHECK or ADJUST—The + Input attenuator compensation for best square wave response according to the information given in Table 5-5. Fig. 5-8 shows the locations of the adjustments.

For the check steps in the table, observe the square wave display for rolloff, overshoot, or level.

d. INTERACTION: If this step is performed out of sequence, steps 17 and 18 must be performed.

e. Disconnect the RC standardizer and coaxial cable from the Type 1A7A and oscilloscope.

NOTES

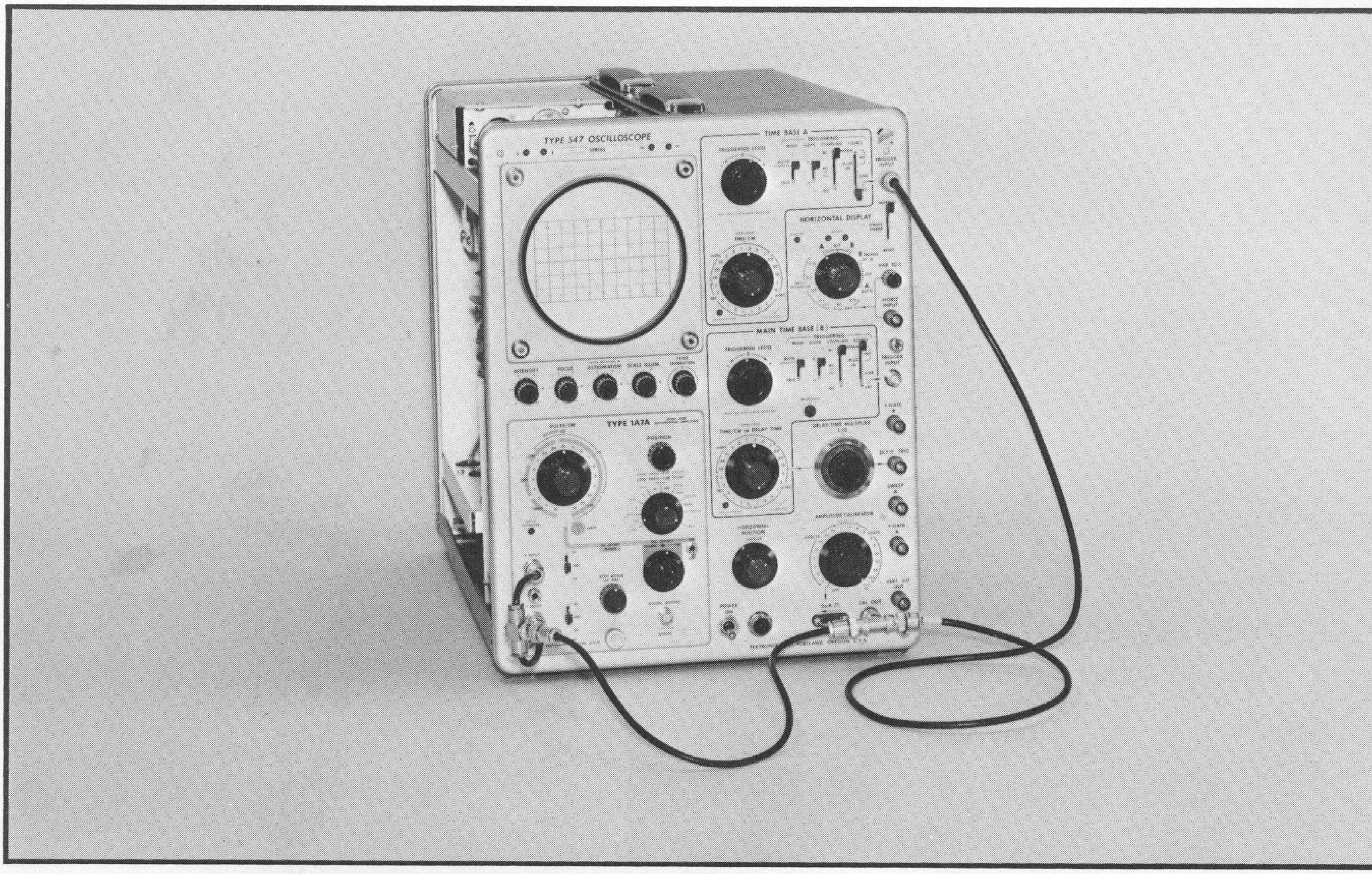


Fig. 5-20. Test equipment setup for step 17.

17. Check or Adjust — Input Attenuator Series Compensation to Match + Input

a. Test equipment setup is shown in Fig. 5-20.

b. Connect a T connector to the oscilloscope CAL OUT connector and a dual input connector to the Type 1A7A + INPUT and — INPUT connectors. Connect a coaxial cable from the T connector to the dual input connector; connect a coaxial cable from the T connector to the oscilloscpe TRIGGER INPUT connector.

c. Set the oscilloscope TRIGGERING SOURCE switch to EXT.

d. Set the oscilloscope calibrator output to 50 volts.

e. Set the Type 1A7A controls as follows:

VOLTS/CM	50 mV
AC-GND-DC (— INPUT)	DC

NOTES

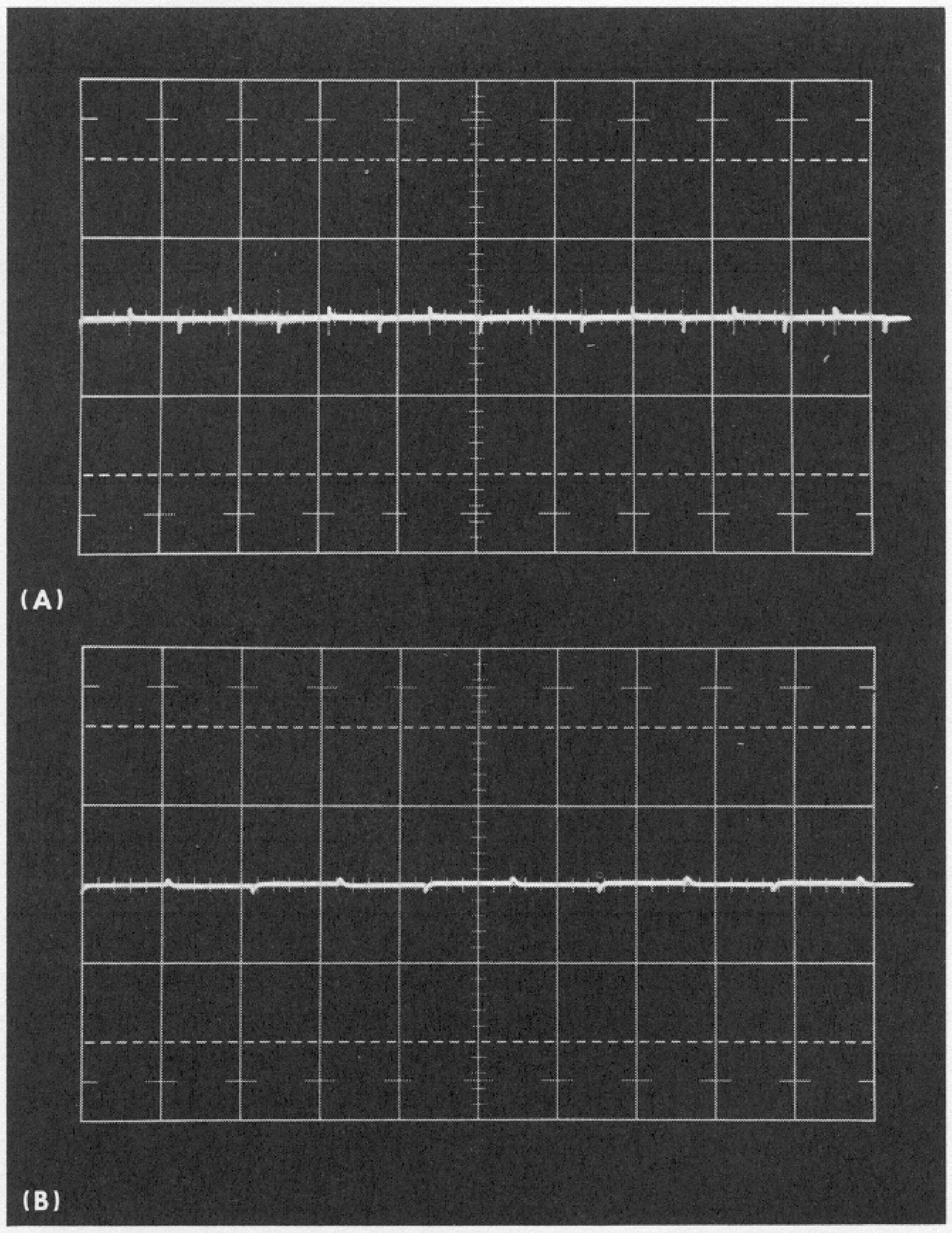


Fig. 5-21. Typical display obtained when — Input attenuator is adjusted for optimum common-mode signal rejection. (A) C205C adjusted properly (B) C207C adjusted properly.

TABLE 5-6

Calibrator Output (Peak to Peak)	VOLTS/CM Switch Position	Check or Adjust for Spike Amplitude	— Input Attenuator
50 Volts	50 mV	C205C	×10
50 Volts	20 mV	Check	×10
50 Volts	.1 V	Check	×10
100 Volts	.5 V	C207C	×100
100 Volts	.2 V	Check	×100
100 Volts	1 V	Check	×100
100 Volts	5 V	C209C	×1000
100 Volts	2 V	Check	×1000
100 Volts	10 V	Check	×1000

f. CHECK or ADJUST—The — Input attenuator series compensation for best common-mode signal rejection (minimum spike amplitude) according to the information given in Table 5-6. Fig. 5-21 illustrates the typical displays obtained and Fig. 5-8 shows the adjustment location.

g. Disconnect all signal leads from the Type 1A7A and the oscilloscope.

h. Return the oscilloscope TRIGGERING SOURCE switch to INT.

NOTES

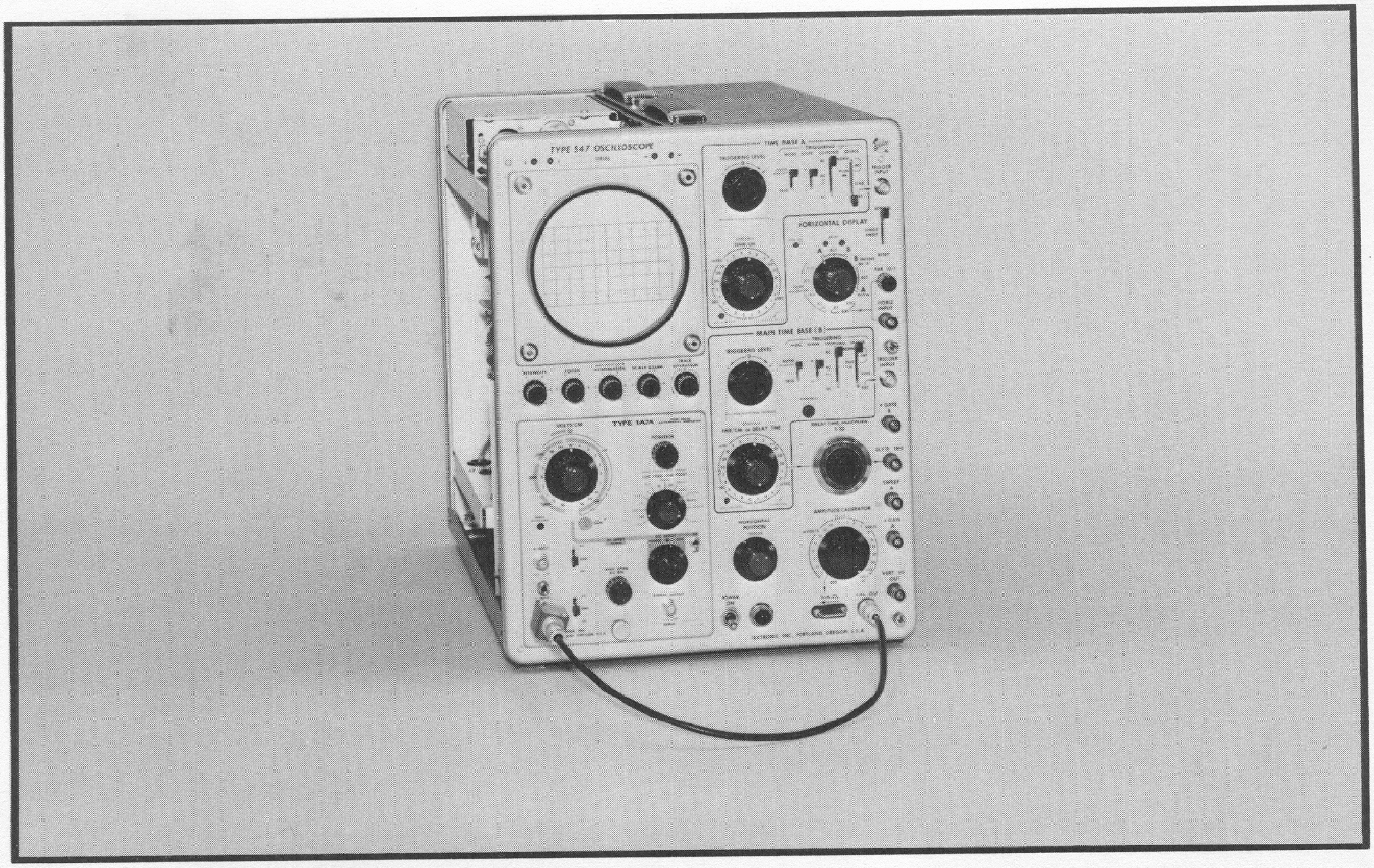


Fig. 5-22. Test equipment setup for step 18.

18. Check or Adjust — Input Attenuator Shunt Compensation

a. Test equipment setup is shown in Fig. 5-22.

b. Connect a 47 pF RC normalizer to the — Input of the Type 1A7A. Connect a coaxial cable from the oscilloscope CAL OUT connector to the RC normalizer.

c. Set the oscilloscope calibrator output to .5 volts.

d. Set the Type 1A7A controls as follows:

VOLTS/CM	50 mV
AG-GND-DC (+ INPUT)	GND

e. CHECK—Using Table 5-7 as a guide, check the display for a square wave response similar to the display illustrated in Fig. 5-14.

f. ADJUST—C205B, C207B, and C209B (see Fig. 5-8) for best flat bottom on the display, according to the information given in Table 5-7.

TABLE 5-7

Calibrator Output (Peak to Peak)	VOLTS/CM Switch Position	Check or Adjust for Optimum Flat Bottom	—Input Attenu-ator
.5 Volt	50 mV	C205B	×10
.2 Volt	20 mV	Check	
1 Volt	.1 V	Check	
5 Volts	.5 V	C207B	×100
2 Volts	.2 V	Check	
10 Volts	1 V	Check	
50 Volts	5 V	C209B	×1000
20 Volts	2 V	Check	
100 Volts	10 V	Check	

g. Turn off the oscilloscope calibrator and disconnect the coaxial cable and normalizer.

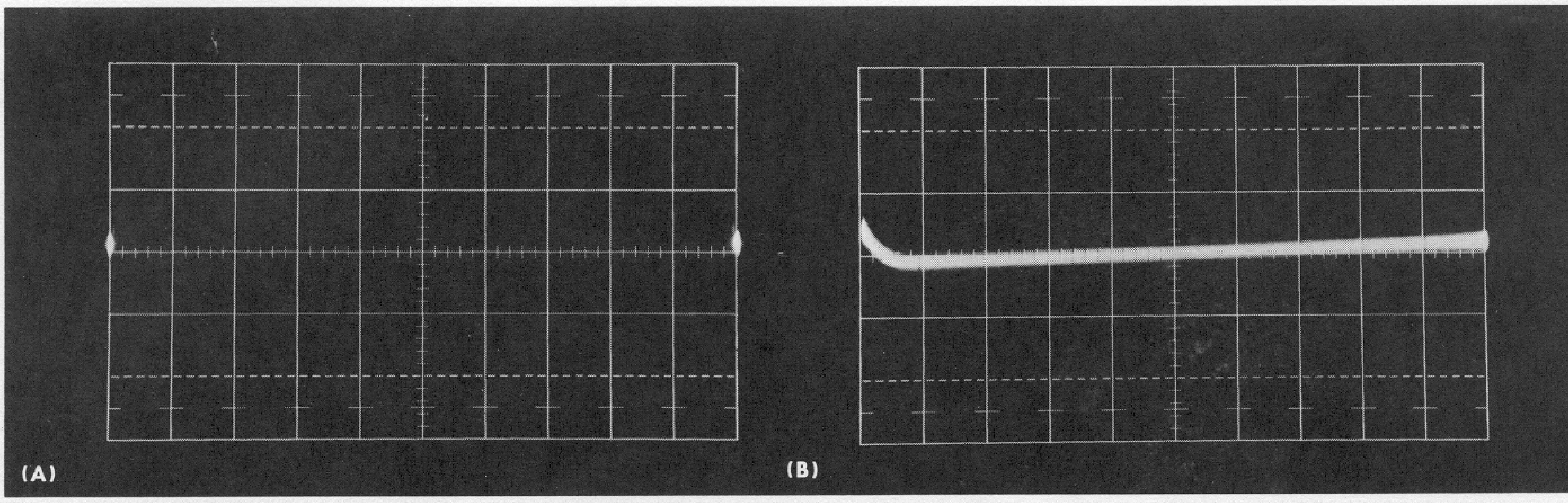


Fig. 5-23. Displays showing, (A) Horizontal deflection set at 2V/CM (B) Typical display obtained when checking 100 Hz CMRR.

NOTES

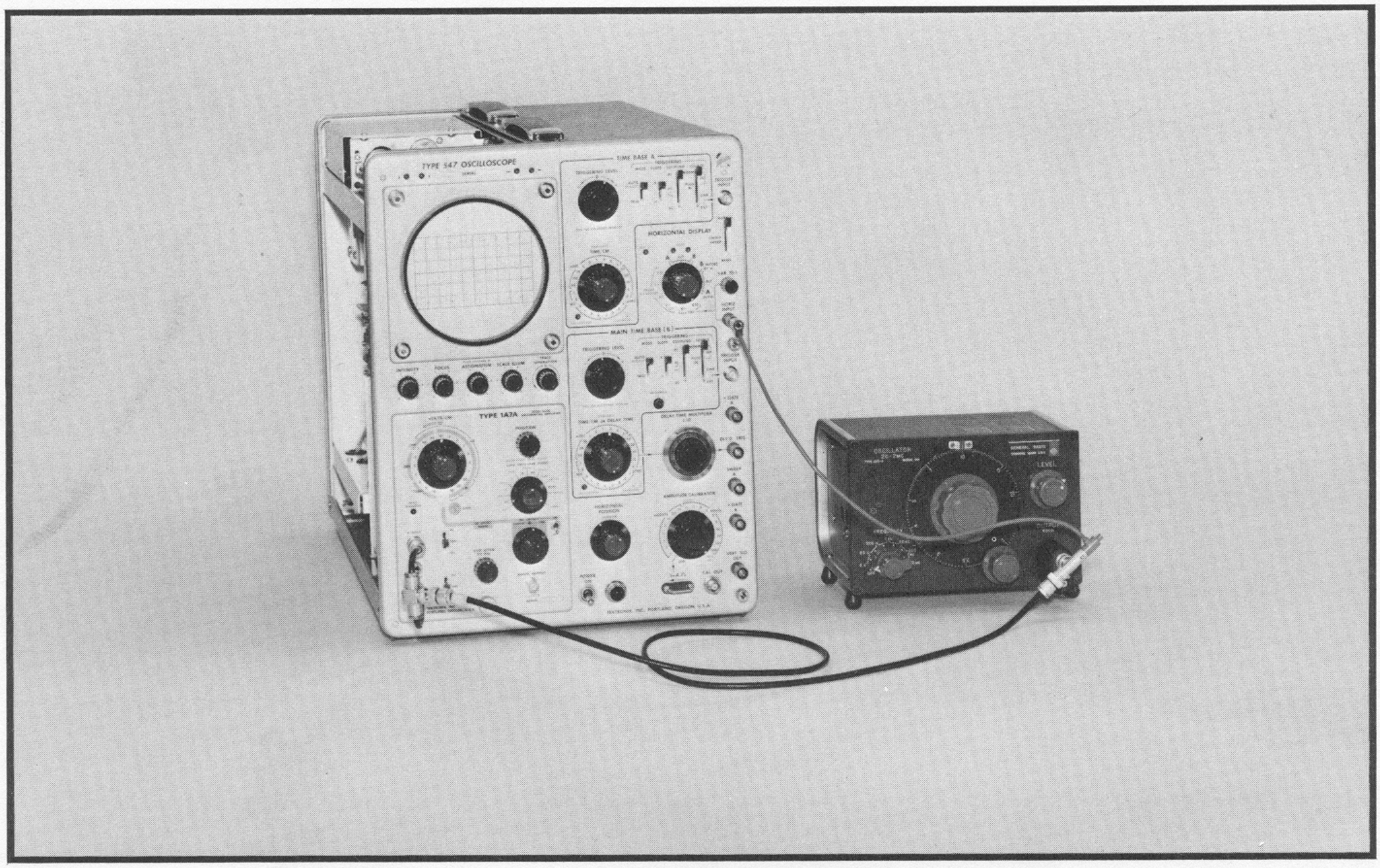


Fig. 5-24. Test equipment setup for steps 19 through 21.

Type 1A7A controls

VOLTS/CM	.1 mV
VARIABLE	CAL
HIGH FREQ —3 dB POINT	1 MHz
LOW FREQ —3 dB POINT	DC
AC-GND-DC (+ INPUT)	GND
AC-GND-DC (— INPUT)	GND
STEP ATTEN DC BAL	Adjusted for proper DC balance.
DC OFFSET	OFF

Oscilloscope controls

TIME/CM	.5 ms
VARIABLE (TIME/CM)	CAL
TRIGGERING	AUTO, + SLOPE, AC, INT
HORIZONTAL DISPLAY	EXT ×10

19. Check 100 Hz CMRR

a. Connect a 20 V peak to peak signal from the oscilloscope calibrator through a BNC to BANANA connector adapter cable (item 14) to the oscilloscope EXT HORIZ INPUT.

b. Adjust the oscilloscope Ext VAR 10-1 control so the horizontal display is two dots that are exactly 10 cm apart (see Fig. 5-23A). The horizontal deflection factor is now adjusted for 2 V/CM. Leave the VAR 10-1 control at this setting until step 21 has been completed.

c. Disconnect the calibrator signal.

d. Test equipment setup is shown in Fig. 5-24.

e. Connect a 100 Hz, 20 V peak to peak signal from a sine wave generator through a T connector, coaxial cable, and a dual input connector to the + and — Inputs of the Type 1A7A. Maintain the 20 V peak to peak output from the sine wave generator through step 21.

f. Connect the BNC to BANANA connector adapter cable from the T connector to the oscilloscope HORIZ INPUT.

g. The horizontal deflection should be 10 cm.

h. Set the + Input and — Input AC-GND-DC switches to DC.

i. CHECK—The horizontal display for vertical tilt. Vertical deflection of the tilt should not exceed 2 cm (see Fig. 5-23B). The 2 cm requirement at 0.1 mV/CM is equivalent to a CMRR of 100,000:1 (2 x .1 mV = .2 mV; 20 V ÷ .2 mV = 100,000).

20. Check AC Coupled CMRR at 60 Hz

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

b. Set the sine wave generator for an output frequency of 60 Hz.

c. Adjust the generator output so the horizontal deflection is exactly 10 cm (20 V).

d. Set the Type 1A7A VOLTS/CM switch to 10 mV.

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

f. CHECK—The vertical deflection of the display should not exceed 1 cm (CMRR = 2,000:1 or higher).

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

21. Check or Adjust 100 kHz, Check 1 kHz CMRR

a. Set the sine wave generator for an output frequency of 100 kHz.

b. Set the VOLTS/CM switch to .1 mV.

c. Adjust the sine wave generator output so the horizontal deflection is exactly 10 cm (20 V).

d. Simultaneously set the + Input and — Input AC-GND-DC switches to DC.

e. CHECK—The display tilt and vertical deflection should not exceed 2 cm.

f. ADJUST—C162 (see Fig. 5-4) for minimum vertical deflection.

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

h. Set the Type 1A7A VOLTS/CM switch to 0.5 mV.

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

j. CHECK—The vertical deflection of the display should not exceed 2 cm.

k. Set the + and — Input AC-GND-DC switches to GND.

l. Set the VOLTS/CM switch to 20 mV.

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

n. CHECK—The vertical deflection of the display should not exceed 2.2 cm.

o. Set both AC-GND-DC switches to GND and then simultaneously set them to DC.

p. CHECK—The vertical deflection should not exceed 2 cm.

q. Set the + and — Input AC-GND-DC switches to GND.

r. Set the sine wave generator output frequency to 1 kHz.

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

t. CHECK—The vertical deflection of the display should not exceed 1.1 cm.

u. Set both AC-GND-DC switches to GND and then to DC.

v. CHECK—The vertical deflection of the display should not exceed 1 cm[1].

w. Reduce the output level of the sine wave generator and disconnect all signal leads from the Type 1A7A and the oscilloscope. Return the HORIZONTAL DISPLAY switch to A.

[1]If CMRR is not within tolerance at 100 kHz and 1 kHz, C205 may be adjusted at 100 kHz and R205E at 1 kHz for minimum vertical deflection.

NOTES

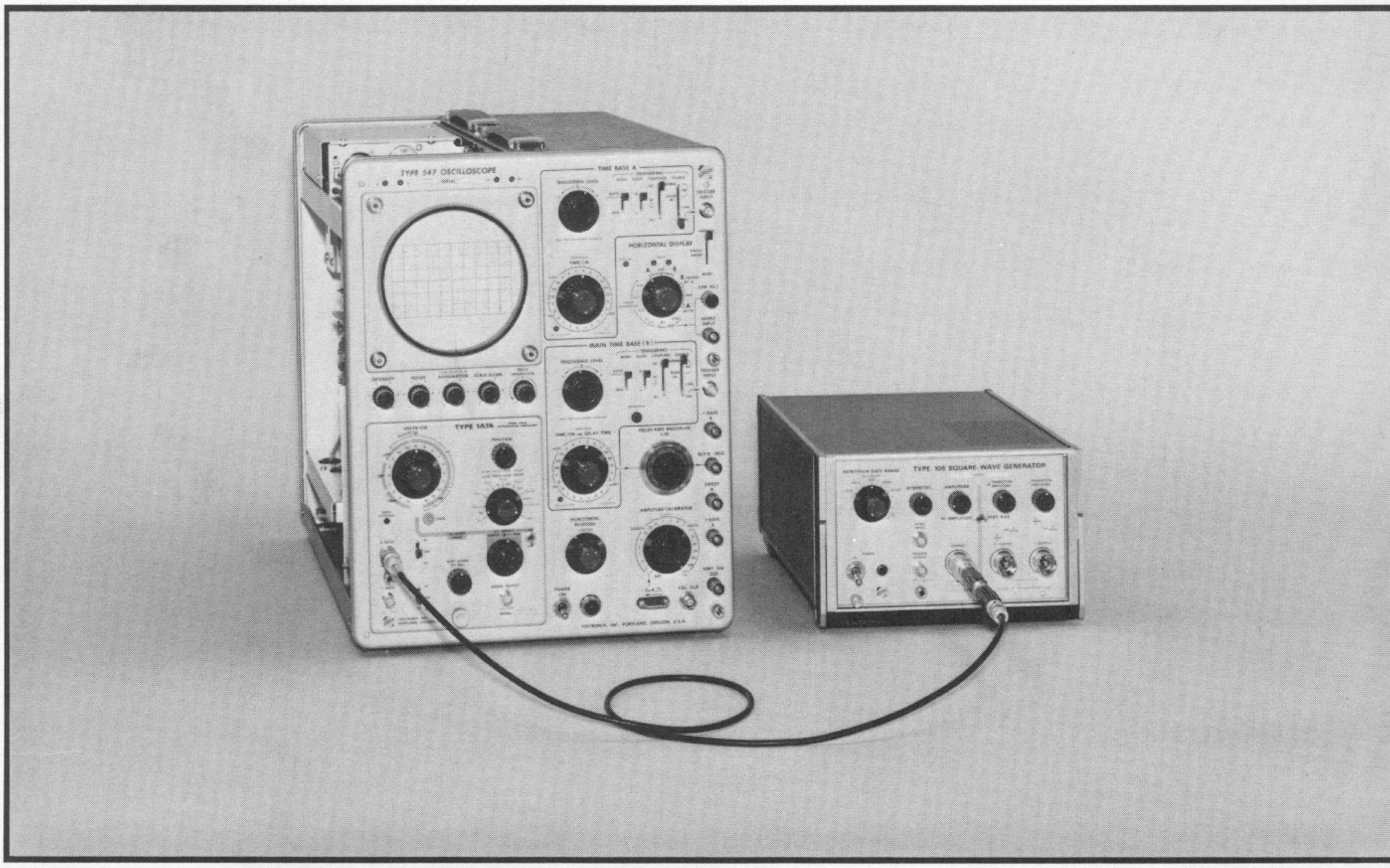


Fig. 5-25. Test equipment setup for steps 22 and 23.

Type 1A7A controls

VOLTS/CM	10 mV
VARIABLE	CAL
HIGH FREQ —3 dB POINT	1 MHz
LOW FREQ —3 dB POINT	DC
AC-GND-DC (+ INPUT)	DC
AC-GND-DC (— INPUT)	GND
STEP ATTEN DC BAL	Adjusted for proper DC balance
DC OFFSET	OFF

Oscilloscope controls

TIME/CM	5 μs
VARIABLE TIME/CM)	CAL
TRIGGERING	AUTO, + SLOPE, AC, INT

22. Check Risetime

a. Test equipment setup is shown in Fig. 5-25.

b. Connect a GR to BNC adapter to the HI AMPLITUDE output of the Type 106 Square Wave Generator; connect two 10× attenuators to the adapter; connect a 50 ohm termination to the Type 1A7A + Input; connect a coaxial cable from the 10× attenuators to the 50 ohm termination.

c. Set the Type 106 for an output frequency of 100 kHz and adjust the output Amplitude control so the display is 5 cm in amplitude. Adjust the Symmetry control for a symmetrical display.

d. Set the oscilloscope TIME/CM switch to .1 μs and adjust the TRIGGERING LEVEL control for a stable display, similar to the one illustrated in Fig. 5-26.

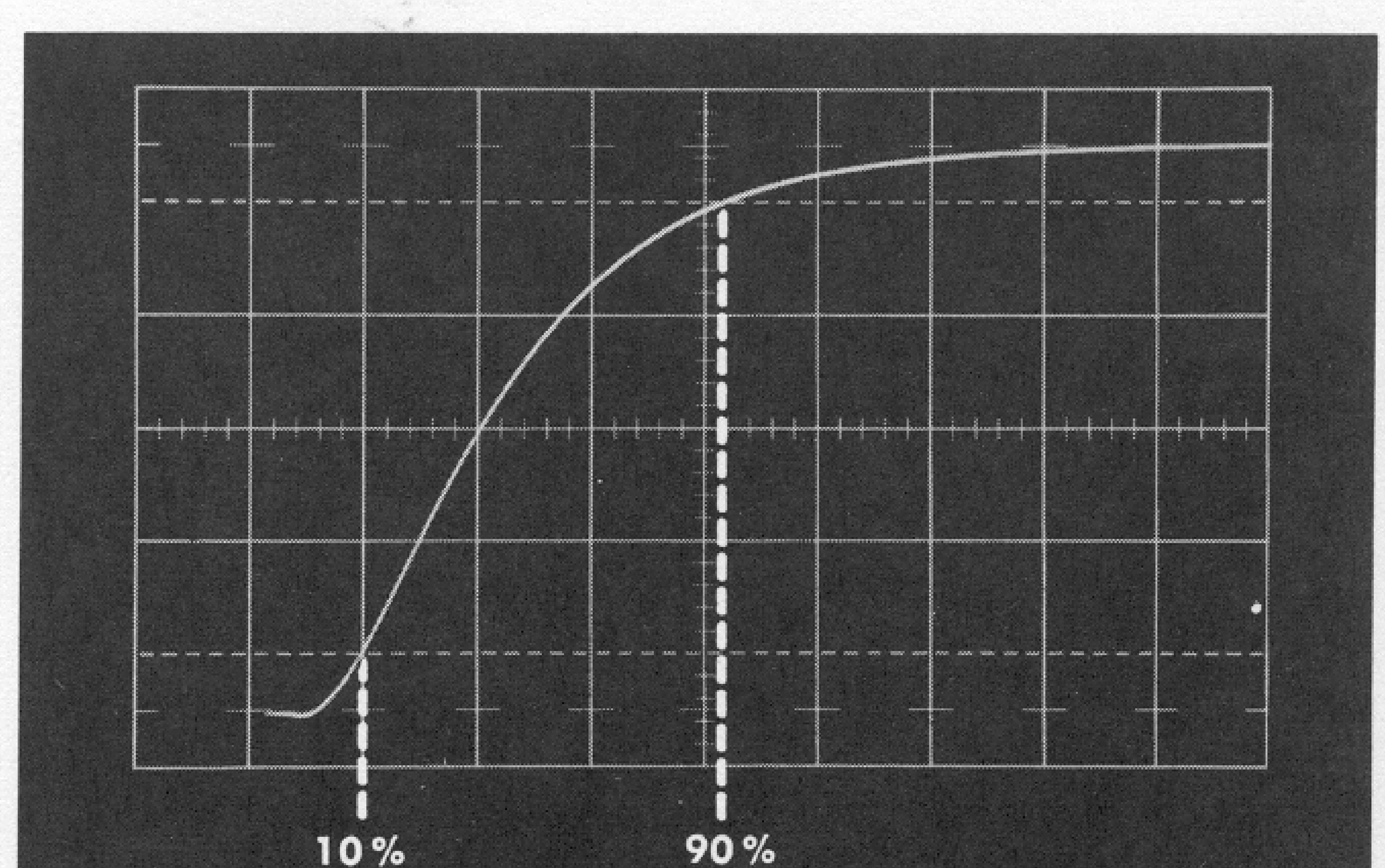


Fig. 5-26. Typical display when checking the risetime.

e. CHECK—The risetime of the display as shown in Fig. 5-26. Risetime should be between 0.27 μs and 0.35 μs as measured between the 10% and 90% amplitude levels of the rising portion of the waveform.

f. Set the oscilloscope TIME/CM switch to 20 μs.

g. Set the Type 1A7A VOLTS/CM switch to 50 mV.

23. Check INPUT OVERLOAD Neon

a. Disconnect the two 10X attenuators from the Type 106 and the coaxial cable. Connect the coaxial cable to the HI AMPLITUDE output of the Type 106.

b. Set the Type 106 output frequency to 1 kHz and reduce the output amplitude to minimum.

c. Observe the INPUT OVERLOAD indicator and increase the Type 106 output amplitude until the indicator light just turns on.

d. CHECK—The leading corner of the display for distortion (overshoot or undershoot). Minimum distortion, 1 cm or less.

e. Disconnect all test equipment.

f. Set the oscilloscope TIME/CM switch to .5 ms.

NOTES

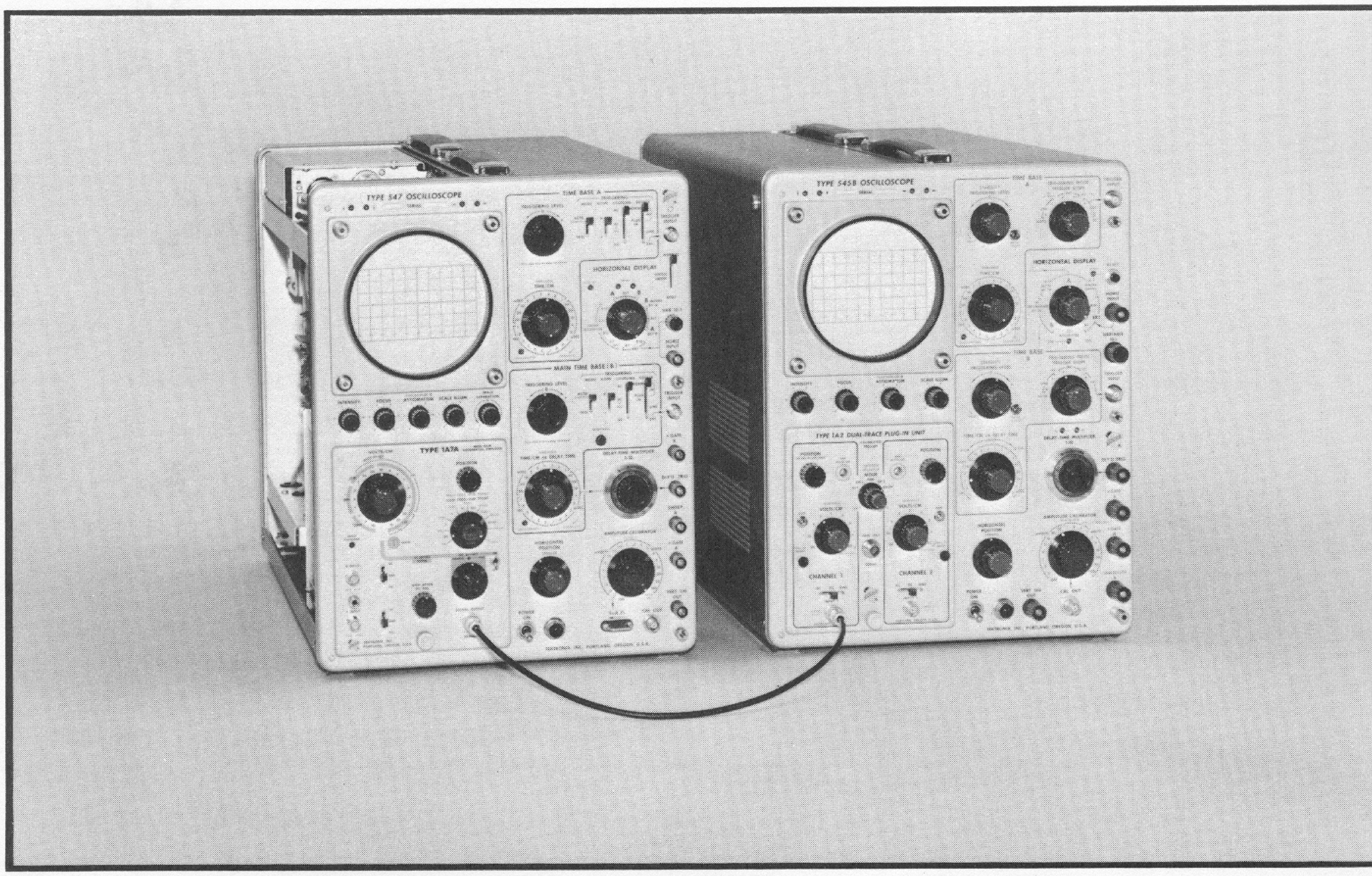


Fig. 5-27. Test equipment setup for steps 24 through 26.

24. Check or Adjust Signal Output DC Level Ⓘ

a. Test equipment setup is shown in Fig. 5-27.

b. Set the Test Oscilloscope controls as follows:

INPUT COUPLING	DC
TIME/CM	.5 ms
VOLTS/CM	.2 V

c. Free run the sweep on the Test Oscilloscope and position the trace on the oscilloscope and the Test Oscilloscope to graticule center.

d. Connect a coaxial cable from the SIGNAL OUTPUT connector on the Type 1A7A to the vertical input connector on the test oscilloscope.

e. CHECK—The trace on the Test Oscilloscope should remain centered.

f. ADJUST—The signal Output DC Level control, R550, (see Fig. 5-4) to return the trace to graticule center; (zero volts indication on the test oscilloscope).

25. Check Signal Output Gain

a. Set the oscilloscope calibrator output to 0.2 volts peak to peak.

b. Connect a coaxial cable from the oscilloscope CAL OUT connector to the Type 1A7A + INPUT connector.

c. Adjust the test oscilloscope Triggering Level control for a stable display.

d. CHECK—The test oscilloscope display for an amplitude of 1 volt peak to peak within a tolerance of ±10% (0.5 cm); see Fig. 5-28.

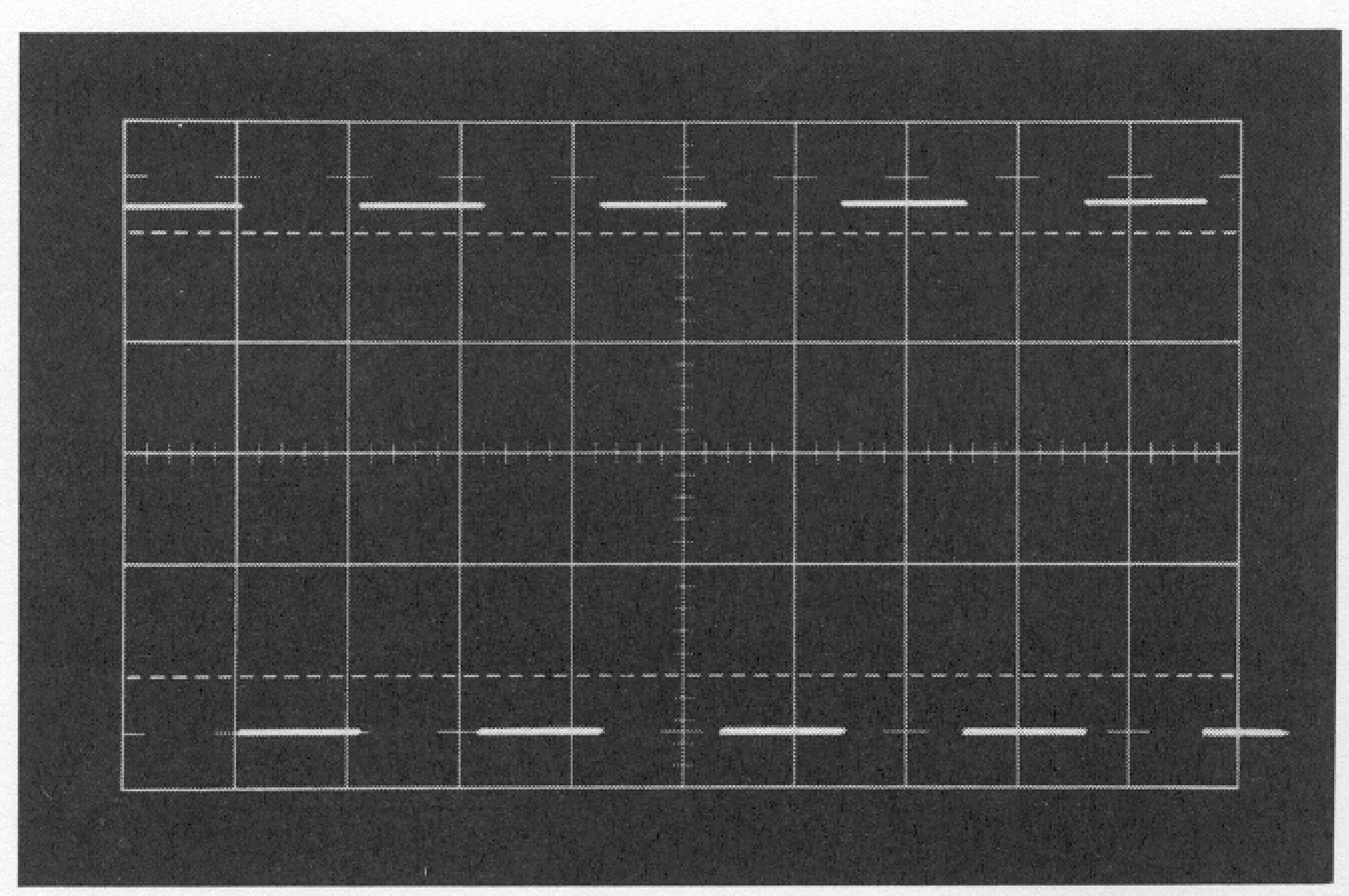


Fig. 5-28. Typical display obtained at the SIGNAL OUTPUT connector.

26. Check or Adjust Signal Output Divider Compensation

a. CHECK—The upper front corner of the Test Oscilloscope display. The waveform should appear similar to the one illustrated in Fig. 5-28; the top of the square wave should be flat, with no overshoot or rounding at the corner.

b. ADJUST—C554 (see Fig. 5-4) for optimum square wave response.

c. Disconnect the coaxial cables.

NOTES

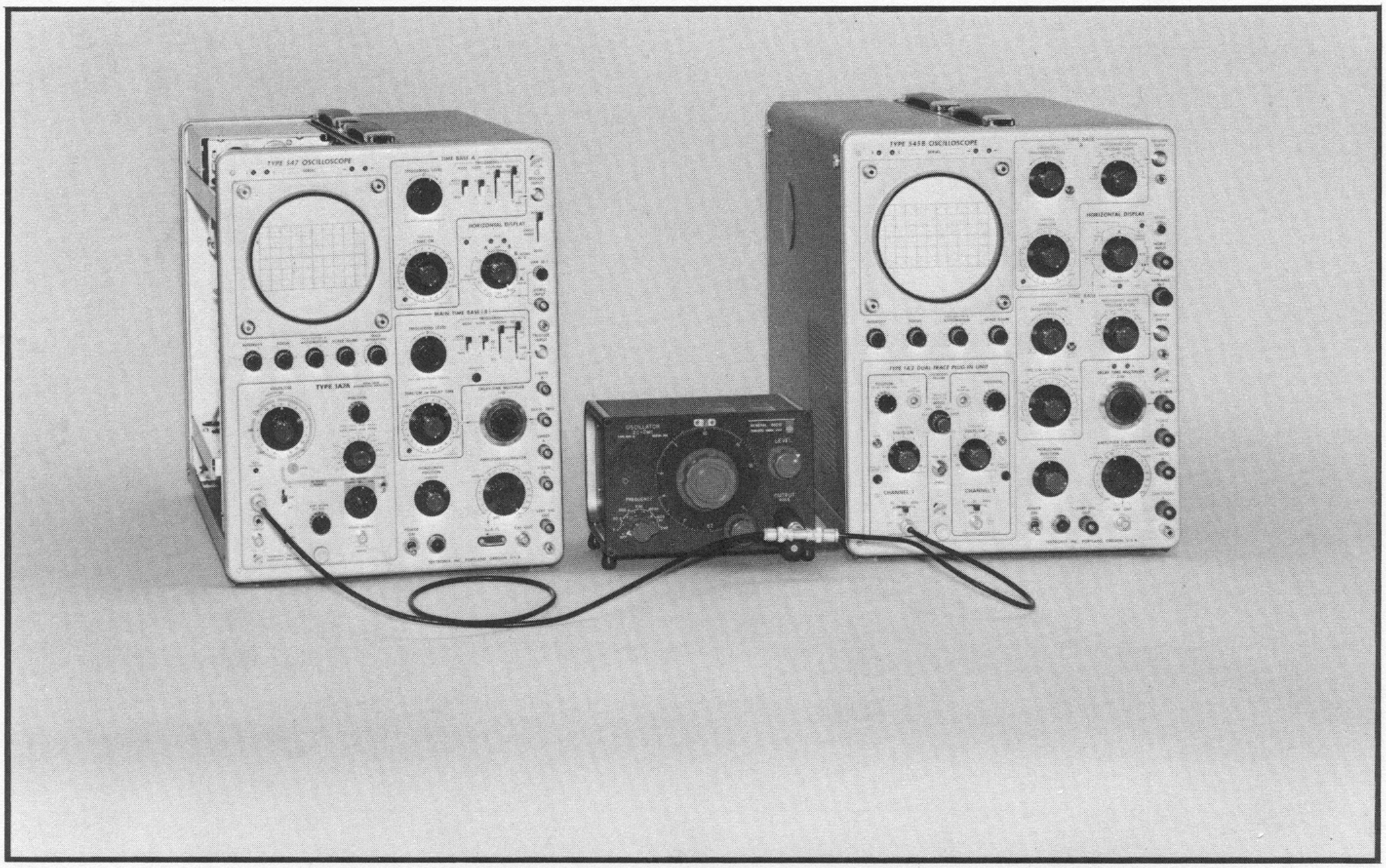


Fig. 5-29. Test equipment setup for step 27.

Type 1A7A controls

VOLTS/CM	10 mV
VARIABLE	CAL
HIGH FREQ —3 dB POINT	1 MHz
LOW FREQ —3 dB POINT	DC
AC-GND-DC (+ INPUT))	DC
AC-GND-DC (— INPUT)	GND
STEP ATTEN DC BAL	Adjust for proper DC balance.
DC OFFSET	OFF

Oscilloscope controls

TIME/CM	5 μs
VARIABLE (TIME/CM)	CAL
TRIGGERING	AUTO, + SLOPE, AC, INT

27. Check High and Low —3 dB Point

a. Test equipment setup is shown in Fig. 5-29.

b. Connect a T connector to the sine wave generator output connector. Connect a coaxial cable from the T connector to the Type 1A7A + INPUT and a coaxial cable from the T connector to the Test Oscilloscope vertical input connector.

c. Set the test oscilloscope TIME/CM switch to 5 μs and the VOLTS/CM switch to 10 mV. Free run the sweep. The purpose of the test oscilloscope is to monitor the output amplitude of the sine wave generator; therefore, the VOLTS/CM switch and the TIME/CM switch can be set to any convenient position.

d. Set the output frequency of the sine wave generator to 1 kHz and free run the oscilloscope.

e. Adjust the output level of the sine wave generator for a full graticule display (6 cm) on the oscilloscope.

f. Check the amplitude of the display on the test oscilloscope and maintain the output of the sine wave generator at this level, (by adjusting the output level of the sine wave generator throughout the remaining steps of this procedure.

g. Set the sine wave generator output frequency to 1 MHz.

h. CHECK—The amplitude of the oscilloscope display should be 4.2 cm (this is the —3 dB point at 1 MHz). If the amplitude is not 4.2 cm, increase the frequency of the sine wave generator until the display is 4.2 cm in amplitude. The generator frequency should be within 1 MHz, — 0 MHz to + .3 MHz (bandwidth tolerance).

i. Check the remaining positions of the HIGH FREQ —3 dB POINT selector in the same manner as in step h using Table 5-8 as a guide.

TABLE 5-8

HIGH FREQ —3 dB POINT Selector Position	Sine wave Generator Output Freq	Oscilloscope Display Amplitude	Bandwidth Tolerance
300 kHz	300 kHz	4.2 cm	± 36 kHz
100 kHz	100 kHz	4.2 cm	± 12 kHz
30 kHz	30 kHz	4.2 cm	± 3.6 kHz
10 kHz	10 kHz	4.2 cm	± 1.2 kHz
3 kHz	3 kHz	4.2 cm	± 0.36 kHz
1 kHz	1 kHz	4.2 cm	± 0.12 kHz
300 Hz	300 Hz	4.2 cm	± 36 Hz
100 Hz	100 Hz	4.2 cm	± 12 Hz

j. Set the HIGH FREQ —3 dB POINT selector to 1 MHz.

k. Using Table 5-9 as a guide check the Low Freq —3 dB Point in the same manner that was used to check the High Freq —3 dB Point.

TABLE 5-9

LOW FREQ —3 dB POINT Selector Position	Sine Wave Generator Output Freq	Oscilloscope Display Amplitude	Bandwidth Tolerance
10 Hz	10 Hz	4.2 cm	±1.2 Hz
100 Hz	100 Hz	4.2 cm	±12 Hz
1 kHz	1 kHz	4.2 cm	±120 Hz
10 kHz	10 kHz	4.2 cm	±1.2 kHz

NOTE

The components that are used in the 0.1 Hz and 1 Hz positions of the LOW FREQ —3 dB POINT selector are also used in the other positions of the selector; therefore, the tolerance of the 0.1 Hz and 1 Hz positions is checked.

l. Set the LOW FREQ —3 dB POINT selector to DC and disconnect all signal connections to the Type 1A7A, sine wave generator and test oscilloscope.

NOTES

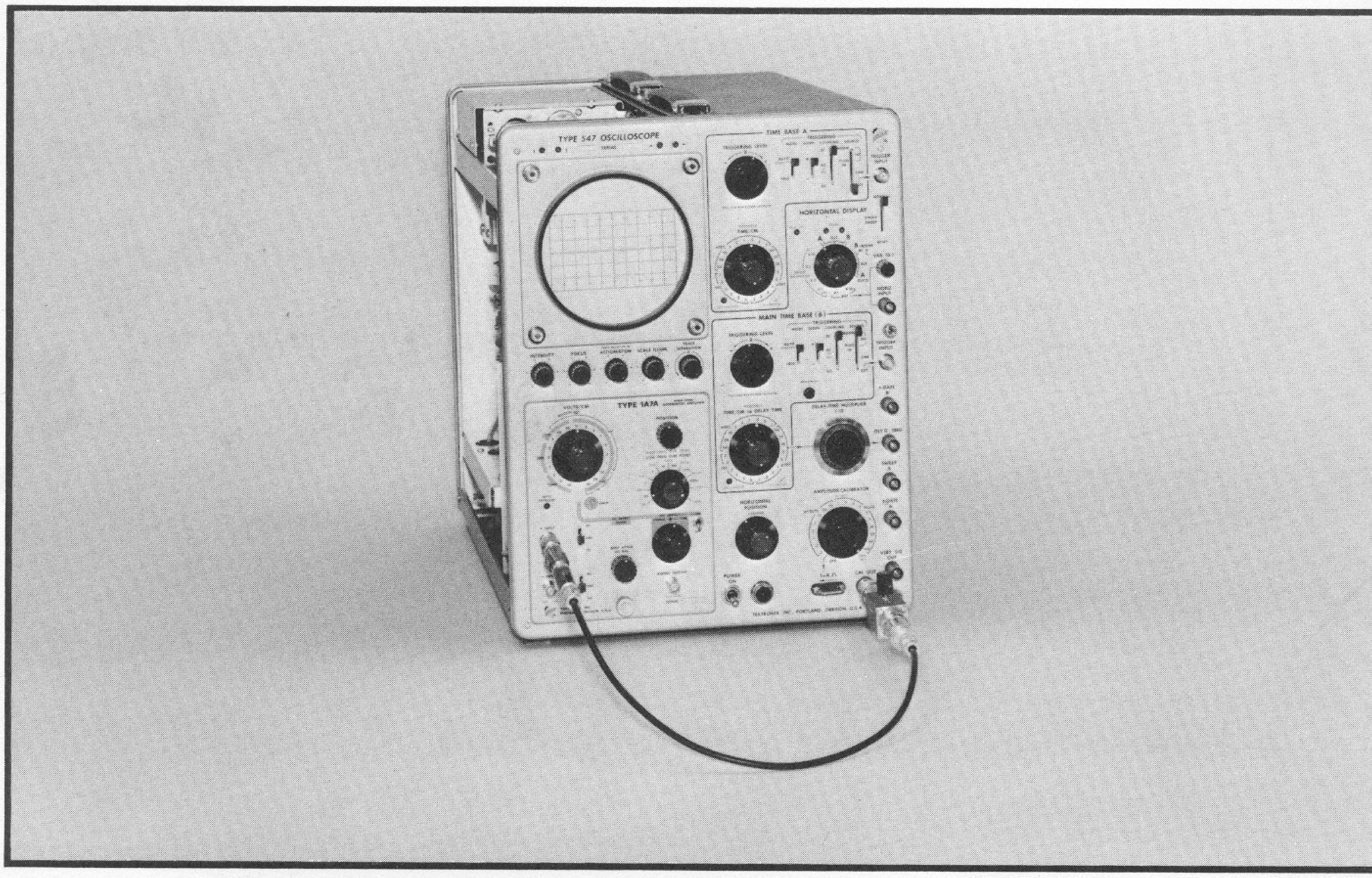


Fig. 5-30. Test equipment setup for step 28.

28. Check Overall Noise Level Tangentially

a. Test equipment setup is shown in Fig. 5-30.

b. Connect a 50 ohm terminator to the + INPUT connector of the Type 1A7A. Connect two 10× attenuators to the 50 ohm terminator.

c. Connect a GR to BNC adapter to the oscilloscope CAL OUT connector and connect the Variable Attenuator to the GR connector. Connect a GR to BNC adapter to the variable attenuator. Connect a coaxial cable from the 10× attenuators to the variable attenuator.

d. Set the oscilloscope Amplitude Calibrator to 5 mV.

e. Set the Type 1A7A VOLTS/CM switch to 10 μV.

f. Turn the variable attenuator control fully clockwise (minimum resistance).

g. Free run the oscilloscope and observe two noise bands displayed on the CRT (noise and free running square wave). See Fig. 5-31A.

h. Reduce the output amplitude of the calibrator by slowly turning the variable attenuator counterclockwise, until the two noise bands merge to the point where the darker band between the two noise bands just disappears (see Fig. 5-31B).

i. Remove the two 10× attenuators and connect the coaxial cable to the 50 ohm terminator.

j. Set the Type 1A7A VOLTS/CM switch to 1 mV and the oscilloscope TIME/CM switch to .5 ms.

k. Measure the square wave amplitude. Then calculate the tangentially measured display noise as follows: $\frac{\text{square wave amplitude.}}{100}$ The tangentially measured display noise should not exceed 16 μV.

This completes the Performance Check or calibration of the Type 1A7A. Disconnect all signal connections. Replace the left side panel on the oscilloscope if calibration was performed. If the unit has been completely checked and/or calibrated to the tolerances given in the procedure, it will perform to the limits given in the Characteristics Section of this Manual.

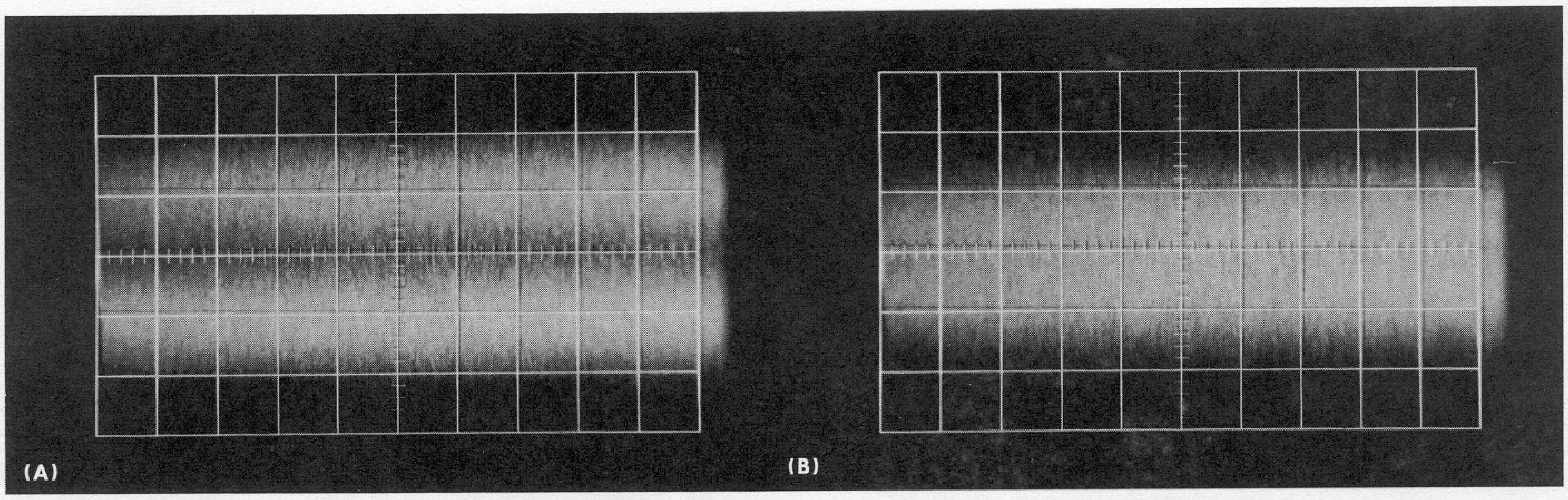


Fig. 5-31. Display showing two noise bands when checking overall noise level, tangentially.

NOTES

PARTS LIST ABBREVIATIONS

BHB	binding head brass
BHS	binding head steel
cap.	capacitor
cer	ceramic
comp	composition
conn	connector
CRT	cathode-ray tube
csk	countersunk
DE	double end
dia	diameter
div	division
elect.	electrolytic
EMC	electrolytic, metal cased
EMT	electrolytic, metal tubular
ext	external
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
h	height or high
hex.	hexagonal
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
ID	inside diameter
inc	incandescent
int	internal
lg	length or long
met.	metal
mtg hdw	mounting hardware
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
P/O	part of
PHB	pan head brass
PHS	pan head steel
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
RHB	round head brass
RHS	round head steel
SE	single end
SN or S/N	serial number
S or SW	switch
TC	temperature compensated
THB	truss head brass
thk	thick
THS	truss head steel
tub.	tubular
var	variable
w	wide or width
WW	wire-wound

PARTS ORDERING INFORMATION

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

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

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

SPECIAL NOTES AND SYMBOLS

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

SECTION 6
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Bulbs			
B174	150-0035-00			Neon A1D T2			

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt No.	Tektronix Part No.	Eff	Disc	Description			
C101	281-0518-00			47 pF	Cer	500 V	
C102[1]	*295-0081-00			0.1 μF	MT	600 V	
C105A	281-0508-00			12 pF	Cer	500 V	±0.6 pF
C105B	281-0081-00			1.8-13 pF, Var	Air		
C105C	281-0078-00			1.4-7.3 pF, Var	Air		
C105D	283-0601-00			22 pF	Mica	300 V	10%
C107A	281-0508-00			12 pF	Cer	500 V	±0.6 pF
C107B	281-0081-00			1.8-13 pF, Var	Air		
C107C	281-0078-00			1.4-7.3 pF, Var	Air		
C107D	283-0620-00			470 pF	Mica	300 V	1%
C109A	281-0508-00			12 pF	Cer	500 V	±0.6 pF
C109B	281-0081-00			1.8-13 pF, Var	Air		
C109C	281-0078-00			1.4-7.3 pF, Var	Air		
C109D	283-0617-00			4700 pF	Mica	300 V	10%
C111	281-0508-00			12 pF	Cer	500 V	±0.6 pF
C112	281-0081-00			1.8-13 pF, Var	Air		
C131	281-0080-00			1.7-11 pF, Var	Air		
C158	285-0862-00			0.001 μF	PTM	100 V	10%
C162	281-0116-00			1.6-9.1 pF, Var	Air		
C164	283-0003-00			0.01 μF	Cer	150 V	
C176	285-0576-00			1 μF	PTM	100 V	10%
C201	281-0518-00			47 pF	Cer	500 V	
C202[2]	*295-0081-00			0.1 μF	MT	600 V	
C205A	281-0508-00			12 pF	Cer	500 V	±0.6 pF
C205B	281-0081-00			1.8-13 pF, Var	Air		
C205C	281-0078-00			1.4-7.3 pF, Var	Air		
C205D	283-0601-00			22 pF	Mica	300 V	10%
C207A	281-0508-00			12 pF	Cer	500 V	±0.6 pF
C207B	281-0081-00			1.8-13 pF, Var	Air		
C207C	281-0078-00			1.4-7.3 pF, Var	Air		

[1]Furnished as a matched pair with C202.

[2]Furnished as a matched pair with C102.

Capacitors *(cont)*

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
C207D	283-0620-00			470 pF	Mica	300 V	1%
C209A	281-0508-00			12 pF	Cer	500 V	±0.6 pF
C209B	281-0081-00			1.8-13 pF, Var	Air		
C209C	281-0078-00			1.4-7.3 pF, Var	Air		
C209D	283-0617-00			4700 pF	Mica	300 V	10%
C211	281-0508-00			12 pF	Cer	500 V	±0.6 pF
C212	281-0081-00			1.8-13 pF, Var	Air		
C231	281-0080-00			1.7-11 pF, Var	Air		
C258	285-0862-00			0.001 μF	PTM	100 V	10%
C275	290-0134-00			22 μF	Elect.	15 V	
C276	285-0576-00			1 μF	PTM	100 V	10%
C285	290-0134-00			22 μF	Elect.	15 V	
C291	290-0183-00			1 μF	Elect.	35 V	10%
C295	290-0134-00			22 μF	Elect.	15 V	
C335	283-0003-00			0.01 μF	Cer	150 V	
C336	283-0059-00			1 μF	Cer	25 V	+80%—20%
C414	281-0540-00			51 pF	Cer	500 V	5%
C433	283-0095-00			56 pF	Cer	200 V	10%
C445A	285-0703-00			0.1 μF	PTM	100 V	5%
C445B	285-0702-00			0.033 μF	PTM	100 V	5%
C445C	285-0598-00			0.01 μF	PTM	100 V	5%
C445D	285-0627-00			0.003 μF	PTM	100 V	5%
C445E	285-0862-00			0.001 μF	PTM	100 V	10%
C445F	283-0518-00			330 pF	Mica	500 V	10%
C445H	281-0637-00			91 pF	Cer	500 V	5%
C445J	281-0564-00			24 pF	Cer	500 V	5%
C452	290-0134-00			22 μF	Elect.	15 V	
C452	290-0134-00			4.7 μF	Elect.	50 V	
C554	281-0081-00			1.8-13 pF, Var	Air		
C558	283-0010-00			0.05 μF	Cer	50 V	

Semiconductor Device, Diodes

Ckt No.	Tektronix Part No.	Eff	Disc	Description	
D132	*152-0323-00			Silicon	Tek Spec
D133	*152-0324-00			Silicon	Tek Spec
D142	*152-0185-00			Silicon	Replaceable by 1N4152
D162	*152-0185-00			Silicon	Replaceable by 1N4152
D232	*152-0323-00			Silicon	Tek Spec
D233	*152-0324-00			Silicon	Tek Spec
D242	*152-0185-00			Silicon	Replaceable by 1N4152
D262	*152-0185-00			Silicon	Replaceable by 1N4152
D272	*152-0185-00			Silicon	Replaceable by 1N4152
D275	152-0212-00			Zener	1N936 9 V, 5%, 0.005%/°C, TC

Semiconductor Device, Diodes *(cont)*

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
D281	*152-0185-00			Silicon	Replaceable by 1N4152
D282	152-0281-00			Zener	1N969B 400 mW, 22 V, 5%
D285	152-0280-00			Zener	1N753A 400 mW, 6.2 V, 5%
D292	152-0147-00			Zener	1N971B 400 mW, 27 V, 5%
D295	152-0212-00			Zener	1N936 9 V, 5%, 0.005%/°C, TC
D352	152-0212-00			Zener	1N936 9 V, 5%, 0.005%/°C, TC
D422	*152-0185-00			Silicon	Replaceable by 1N4152
D452	152-0243-00			Zener	1N965B 400 mW, 15 V, 5%
D454	152-0294-00			Zener	1N3033B 1 W, 36 V, 5%
D522	*152-0185-00			Silicon	Replaceable by 1N4152
D558	*152-0061-00			Silicon	Tek Spec

Fuses

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
F131	159-0024-00 (2)			1/16 A	3AG Fast-Blo
F231	159-0024-00 (2)			1/16 A	3AG Fast-Blo

Connectors

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
P11	131-0017-00			16 Contact, Male
J101	131-0106-00			Coax, 1 Contact, Female
J201	131-0106-00			Coax, 1 Contact, Female
J559	131-0106-00			Coax, 1 Contact, Female

Transistors

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
Q133A,B	151-1020-00	B010100	B039999	Silicon, Dual	FET
Q133A,B	151-1027-00	B040000		Silicon, Dual	FET
Q144A,B	*151-0178-00			Silicon, Dual	Replaceable by 2N3808
Q154	151-1006-00			Silicon	FET
Q163	*151-0195-00			Silicon	Replaceable by MPS - 6515
Q164	151-0208-00			Silicon	2N4036
Q254	151-1006-00			Silicon	FET
Q283	151-0220-00			Silicon	2N4122
Q284	151-0208-00			Silicon	2N4036
Q294	*151-0136-00			Silicon	Replaceable by 2N3053
Q314A,B	*151-0178-00			Silicon, Dual	Replaceable by 2N3808
Q324	*153-0563-00			Silicon	Selected FET
Q326	*151-0192-00			Silicon	Replaceable by MPS - 6521
Q334	*153-0563-00			Silicon	Selected FET
Q404A,B	151-1010-00			Silicon, Dual	FET
Q414	151-0188-00			Silicon	2N3906
Q424	*151-0192-00			Silicon	Replaceable by MPS - 6521
Q434	*151-0192-00			Silicon	Replaceable by MPS - 6521
Q514	151-0188-00			Silicon	2N3906

Transistors *(cont)*

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
Q524	*151-0192-00			Silicon	Replaceable by MPS - 6521		
Q534	*151-0192-00			Silicon	Replaceable by MPS - 6521		
Q553	151-1025-00			Silicon	FET		

Resistors

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

Ckt No.	Tektronix Part No.	Eff	Disc	Description			
R101	315-0105-00			1 MΩ	¼ W		5%
R105C	323-0611-03			900 kΩ	½ W	Prec	¼%
R105D	321-1389-03			111 kΩ	⅛ W	Prec	¼%
R107C	323-0614-03			990 kΩ	½ W	Prec	¼%
R107D	321-1289-03			10.1 kΩ	⅛ W	Prec	¼%
R109C	323-0623-03			999 kΩ	½ W	Prec	¼%
R109D	321-0193-03			1 kΩ	⅛ W	Prec	¼%
R111	315-0102-00			1 kΩ	¼ W		5%
R113	323-0481-03	B010100	B010199	1 MΩ	½ W	Prec	¼%
R113	323-0481-01	B010200		1 MΩ	½ W	Prec	½%
R115	311-0433-00			100 Ω, Var			
R121	321-0344-00			37.4 kΩ	⅛ W	Prec	1%
R122	307-0181-00			100 kΩ	Thermal		
R123	321-0155-00			402 Ω	⅛ W	Prec	1%
R124	307-0181-00			100 kΩ	Thermal		
R126	315-0302-00			3 kΩ	¼ W		5%
R131	315-0512-00			5.1 kΩ	¼ W		5%
R132	315-0510-00			51 Ω	¼ W		5%
R134	308-0495-00			4.5 kΩ	2.5 W	WW	1%
R143	321-0306-00			15 kΩ	⅛ W	Prec	1%
R151	308-0497-00			105 Ω	2.5 W	WW	1%
R152	308-0495-00			4.5 kΩ	2.5 W	WW	1%
R153	321-0114-00			150 Ω	⅛ W	Prec	1%
R154	315-0511-00			510 Ω	¼ W		5%
R156	321-0043-00			27.4 Ω	⅛ W	Prec	1%
R157	308-0498-00			2.94 kΩ	2.5 W	WW	1%
R163	315-0105-00			1 MΩ	¼ W		5%
R164	315-0105-00			1 MΩ	¼ W		5%
R166	315-0163-00			16 kΩ	¼ W		5%
R167	315-0102-00			1 kΩ	¼ W		5%
R171	315-0223-00			22 kΩ	¼ W		5%
R172	315-0334-00			330 kΩ	¼ W		5%
R174	315-0223-00			22 kΩ	¼ W		5%
R176	321-0408-00			174 kΩ	⅛ W	Prec	1%
R177	321-0300-00			13 kΩ	⅛ W	Prec	1%
R179	301-0165-00			1.6 MΩ	½ W		5%

Resistors *(cont)*

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R201	315-0105-00			1 MΩ	¼ W		5%
R205C	323-0611-03			900 kΩ	½ W	Prec	¼%
R205D	321-0389-03			110 kΩ	⅛ W	Prec	¼%
R205E	311-0609-00			2 kΩ, Var			
R207C	323-0614-03			990 kΩ	½ W	Prec	¼%
R207D	321-0289-03			10 kΩ	⅛ W	Prec	¼%
R207E	311-0605-00			200 Ω, Var			
R209C	323-0623-03			999 kΩ	½ W	Prec	¼%
R209D	321-0192-00			976 Ω	⅛ W	Prec	1%
R209E	311-0643-00			50 Ω, Var			
R211	315-0102-00			1 kΩ	¼ W		5%
R213	323-0481-03	B010100	B010199	1 MΩ	½ W	Prec	¼%
R213	323-0481-01	B010200		1 MΩ	½ W	Prec	½%
R215	311-0433-00			100 Ω, Var			
R231	315-0512-00			5.1 kΩ	¼ W		5%
R232	315-0510-00			51 Ω	¼ W		5%
R234	308-0495-00			4.5 kΩ	2.5 W	WW	1%
R243	321-0306-00			15 kΩ	⅛ W	Prec	1%
R251	308-0497-00			105 Ω	2.5 W	WW	1%
R252	308-0495-00			4.5 kΩ	2.5 W	WW	1%
R253	321-0114-00			150 Ω	⅛ W	Prec	1%
R254	315-0511-00			510 Ω	¼ W		5%
R256	321-0043-00			27.4 Ω	⅛ W	Prec	1%
R257	308-0498-00			2.94 kΩ	2.5 W	WW	1%
R258	301-0435-00			4.3 MΩ	½ W		5%
R259	311-0369-00			100 kΩ, Var			
R273	323-0194-00			1.02 kΩ	½ W	Prec	1%
R276	321-0408-00			174 kΩ	⅛ W	Prec	1%
R277	321-0300-00			13 kΩ	⅛ W	Prec	1%
R279	301-0165-00			1.6 MΩ	½ W		5%
R282	315-0473-00			47 kΩ	¼ W		5%
R283	315-0512-00			5.1 kΩ	¼ W		5%
R284	321-0260-00			4.99 kΩ	⅛ W	Prec	1%
R292	315-0101-00			100 Ω	¼ W		5%
R293	315-0242-00			2.4 kΩ	¼ W		5%
R294	308-0413-00			16 kΩ	3 W	WW	1%
R314	315-0205-00			2 MΩ	¼ W		5%
R321	308-0496-00			1 kΩ	2.5 W	WW	1%
R326	308-0313-00			20 kΩ	3 W	WW	1%
R331	308-0496-00			1 kΩ	2.5 W	WW	1%
R334	315-0205-00			2 MΩ	¼ W		5%
R341	308-0498-00			2.94 kΩ	2.5 W	WW	1%
R342	321-0180-00			732 Ω	⅛ W	Prec	1%
R343	321-0180-00			732 Ω	⅛ W	Prec	1%
R345	311-0532-00			1.5 kΩ, Var			
R347	308-0498-00			2.94 kΩ	2.5 W	WW	1%
R348	321-0180-00			732 Ω	⅛ W	Prec	1%

Resistors *(cont)*

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R349	308-0212-00			10 kΩ	3 W	WW	5%
R351	321-0130-00	B010100	B029999	221 Ω	1/8 W	Prec	1%
R351	321-0158-00	B030000		432 Ω	1/8 W	Prec	1%
R352	321-0385-00	B010100	B029999	100 kΩ	1/8 W	Prec	1%
R352	321-0413-00	B030000		196 kΩ	1/8 W	Prec	1%
R353	321-0385-00	B010100	B029999	100 kΩ	1/8 W	Prec	1%
R353	321-0413-00	B030000		196 kΩ	1/8 W	Prec	1%
R354	321-0130-00	B010100	B029999	221 Ω	1/8 W	Prec	1%
R354	321-0158-00	B030000		432 Ω	1/8 W	Prec	1%
R355A	311-0843-00			50 kΩ, Var			
R355B	311-0360-01			5 kΩ, Var			
R401	315-0222-00			2.2 kΩ	1/4 W		5%
R404	321-0602-00			3.908 kΩ	1/8 W	Prec	1/4%
R405	321-0068-00			49.9 Ω	1/8 W	Prec	1%
R407	321-0315-00			18.7 kΩ	1/8 W	Prec	1%
R408A	321-0001-01			10 Ω	1/8 W	Prec	1/2%
R408B	321-0762-01			20.1 Ω	1/8 W	Prec	1/2%
R408C	321-1068-01			50.5 Ω	1/8 W	Prec	1/2%
R408D	321-0098-01			102 Ω	1/8 W	Prec	1/2%
R408E	321-0127-01			205 Ω	1/8 W	Prec	1/2%
R408F	321-1166-01			530 Ω	1/8 W	Prec	1/2%
R408H	321-0763-07			1.12 kΩ	1/8 W	Prec	1/10%
R408J	321-1231-01			2.52 kΩ	1/8 W	Prec	1/2%
R408K	321-1289-01			10.1 kΩ	1/8 W	Prec	1/2%
R412	321-0393-00			121 kΩ	1/8 W	Prec	1%
R414	321-0291-00			10.5 kΩ	1/8 W	Prec	1%
R423	321-0293-00			11 kΩ	1/8 W	Prec	1%
R424	321-0219-00	B010100	B059999	1.87 kΩ	1/8 W	Prec	1%
R424	321-0218-00	B060000		1.82 kΩ	1/8 W	Prec	1%
R425	311-0462-00			1 kΩ, Var			
R429	315-0101-00			100 Ω	1/4 W		5%
R431	321-0354-00			47.5 kΩ	1/8 W	Prec	1%
R433	321-0196-00			1.07 kΩ	1/8 W	Prec	1%
R435	311-0663-00			500 Ω, Var			
R437	321-0385-00			100 kΩ	1/8 W	Prec	1%
R440	311-0575-00			2 X 100 kΩ, Var			
R446	321-0274-00			6.98 kΩ	1/8 W	Prec	1%
R447	321-0197-00			1.1 kΩ	1/8 W	Prec	1%
R448	321-0286-00			9.31 kΩ	1/8 W	Prec	1%
R449	321-0314-00			18.2 kΩ	1/8 W	Prec	1%
R451	308-0406-00			1.2 kΩ	3 W	WW	1%
R501	315-0222-00			2.2 kΩ	1/4 W		5%
R504	321-0602-00			3.908 kΩ	1/8 W	Prec	1/4%
R505	311-0514-00			100 Ω, Var			
R512	321-0393-00			121 kΩ	1/8 W	Prec	1%
R519	308-0096-00			500 Ω	20 W	WW	5%
R523	321-0293-00			11 kΩ	1/8 W	Prec	1%
R524	321-0219-00	B010100	B059999	1.87 kΩ	1/8 W	Prec	1%
R524	321-0218-00	B060000		1.82 kΩ	1/8 W	Prec	1%
R529	315-0101-00			100 Ω	1/4 W		5%
R531	321-0354-00			47.5 kΩ	1/8 W	Prec	1%

Resistors *(cont)*

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R533	321-0196-00			1.07 kΩ	1/8 W	Prec	1%
R535[3]	311-0417-00			5 kΩ, Var			
R537	321-0385-00			100 kΩ	1/8 W	Prec	1%
R546	321-0274-00			6.98 kΩ	1/8 W	Prec	1%
R547	321-0196-00			1.07 kΩ	1/8 W	Prec	1%
R550	311-0508-00			50 kΩ, Var			
R551	315-0104-00			100 kΩ	1/4 W		5%
R552	315-0205-00			2 MΩ	1/4 W		5%
R554	318-0004-00			1 MΩ	1/8 W	Prec	1%
R556	301-0683-00			68 kΩ	1/2 W		5%
R558	315-0682-00			6.8 kΩ	1/4 W		5%
R559	315-0101-00			100 Ω	1/4 W		5%

Switches

Ckt No.	Unwired or Wired	Tektronix Part No.	Description	
SW101		260-0600-00	Lever	AC-GND-DC
SW175A } SW175B }	Wired	*262-0829-00	Rotary	LOW FREQ 3 dB POINT HIGH FREQ 3 dB POINT
SW175A } SW175B }		260-0980-00	Rotary	LOW FREQ 3 dB POINT HIGH FREQ 3 dB POINT
SW201		260-0600-00	Lever	AC-GND-DC
SW205 }	Wired	*262-0830-00	Rotary	VOLTS/CM
SW535[4] }		311-0417-00		
SW205		260-0979-00	Rotary	VOLTS/CM
SW355		260-0613-00	Toggle	ON-OFF

[3]Furnished as a unit with SW535.

[4]Furnished as a unit with R535.

FIGURE AND INDEX NUMBERS

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

INDENTATION SYSTEM

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

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

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

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

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

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

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

ABBREVIATIONS AND SYMBOLS

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

INDEX OF MECHANICAL PARTS LIST ILLUSTRATIONS
(Located behind diagrams)

SECTION 7
MECHANICAL PARTS LIST

FIG. 1 MECHANICAL PARTS

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
1-1	366-0038-00			1	KNOB, red—VARIABLE
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-2	366-0144-00			1	KNOB, charcoal—VOLTS/CM
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-3	262-0830-00			1	SWITCH, wired—VOLTS/CM
	- - - - - -			-	switch includes:
	260-0979-00			1	SWITCH, unwired
-4	384-0695-00			1	SHAFT, extension, 7.625 inches long
-5	352-0071-00			4	HOLDER, plastic
	213-0189-00			4	SCREW, set, 4-40 x 3/8 inch, HSS
-6	670-0189-00			1	ASSEMBLY, circuit board—ATTENUATOR
	- - - - - -			-	assembly includes:
	388-0981-00			1	BOARD, circuit
-7	131-0505-00	B010100	B051529	4	TERMINAL, stud
	214-0579-00	B051530		4	PIN, test point
	- - - - - -			-	mounting hardware: (not included w/assembly)
-8	129-0175-00			4	POST, plastic
-9	131-0371-00			7	CONNECTOR, single contact
-10	376-0014-00			1	COUPLING
	361-0233-00	XB050000		1	RESTRAINT, shaft coupling
	361-0234-00	XB050000		1	RESTRAINT, shaft coupling
-11	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-12	210-0413-00			2	NUT, hex., 3/8-32 x 1/2 inch
	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	- - - - - -			-	mounting hardware: (not included w/switch)
-13	210-0449-00			4	NUT, hex., 5-40 x 1/4 inch
-14	210-0004-00			2	LOCKWASHER, internal, #4
	210-0840-00			1	WASHER, flat, 3/8 ID x 9/16 inch OD
-15	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-16	337-1026-00			1	SHIELD
	- - - - - -			-	mounting hardware: (not included w/shield)
	211-0008-00			4	SCREW, 4-40 x 1/4 inch, PHS
-17	210-0227-00			4	LUG, solder, SE #6
	- - - - - -			-	mounting hardware: (not included w/lug)
	211-0597-00			1	SCREW, 6-32 x 1/4 inch, RHS
	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
-18	366-0215-01			2	KNOB, charcoal—AC GND DC
-19	260-0600-00			2	SWITCH, lever—AC GND DC
	- - - - - -			-	mounting hardware for each: (not included w/switch)
	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
-20	366-0113-00			1	KNOB, charcoal—STEP ATTEN DC BAL
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS

©

FIG. 1 MECHANICAL PARTS *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description (1 2 3 4 5)
1-21	------			1	RESISTOR, variable
	------			-	mounting hardware: (not included w/resistor)
	210-0840-00			1	WASHER, flat, $\frac{3}{8}$ ID x $\frac{9}{16}$ inch OD
-22	210-0413-00			1	NUT, hex., $\frac{3}{8}$-32 x $\frac{1}{2}$ inch
-23	366-0113-00			1	KNOB, charcoal—POSITION
	------			-	knob includes:
-24	213-0004-00			1	SCREW, set, 6-32 x $\frac{3}{16}$ inch, HSS
	------			1	RESISTOR, variable
	------			-	mounting hardware: (not included w/resistor)
	210-0840-00			1	WASHER, flat, $\frac{3}{8}$ ID x $\frac{9}{16}$ inch OD
-25	210-0413-00			1	NUT, hex., $\frac{3}{8}$-32 x $\frac{1}{2}$ inch
-26	366-0491-00			1	KNOB, red—HIGH FREQ —3 dB POINT
	------			-	knob includes:
	213-0020-00			1	SCREW, set, 6-32 x $\frac{1}{8}$ inch, HSS
-27	366-0142-00			1	KNOB, charcoal—LOW FREQ —3 dB POINT
	------			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x $\frac{3}{16}$ inch, HSS
-28	262-0829-00			1	SWITCH, wired—HIGH FREQ LOW FREQ
	------			-	switch includes:
	260-0980-00			1	SWITCH, unwired
-29	131-0371-00			6	CONNECTOR, single contact
	------			-	mounting hardware: (not included w/switch)
	210-0803-00			2	WASHER, flat, 0.150 ID x $\frac{3}{8}$ inch OD
-30	210-0457-00			2	NUT, keps, 6-32 x $\frac{5}{16}$ inch
-31	210-0012-00			1	LOCKWASHER, internal, $\frac{3}{8}$ ID x $\frac{1}{2}$ inch OD
-32	210-0413-00			1	NUT, hex., $\frac{3}{8}$-32 x $\frac{1}{2}$ inch
-33	366-0270-00	B010000	B019999	1	KNOB, charcoal—COARSE
	366-1061-00	B020000		1	KNOB, charcoal—COARSE
	------			-	knob includes:
	213-0075-00			1	SCREW, set, 4-40 x $\frac{3}{32}$ inch, HSS
-34	366-0142-00			1	KNOB, charcoal—DC OFFSET
	------			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x $\frac{3}{16}$ inch, HSS
-35	426-0289-00			1	MOUNT, plastic
	------			-	mounting hardware: (not included w/mount)
	210-0840-00			1	WASHER, flat, 0.390 ID x $\frac{9}{16}$ inch OD
-36	210-0413-00			1	NUT, hex., $\frac{3}{8}$-32 x $\frac{1}{2}$ inch
-37	------			1	RESISTOR, variable
	------			-	mounting hardware: (not included w/resistor)
-38	211-0017-00	B010100	B049999	2	SCREW, 4-40 x $\frac{3}{4}$ inch, RHS
	211-0018-00	B050000		2	SCREW, 4-40 x $\frac{7}{8}$ inch, RHS
	210-0938-00	XB050000		2	WASHER, flat, 0.109 ID x 0.250 inch OD
-39	166-0025-00			4	SPACER, $\frac{1}{4}$ inch long
-40	354-0325-00			1	RING, brake friction
	213-0075-00			2	SCREW, set, 4-40 x $\frac{3}{32}$ inch, HSS (not shown)
-41	------			1	RESISTOR, variable
	------			-	mounting hardware: (not included w/resistor)
-42	210-0413-00			1	NUT, hex., $\frac{3}{8}$-32 x $\frac{1}{2}$ inch

FIG. 1 MECHANICAL PARTS *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
1-43	384-0696-00			1	SHAFT, extension
	- - - - - -			-	mounting hardware: (not included w/shaft)
	213-0075-00			2	SCREW, set, 4-40 x 3/32 inch, HSS (not shown)
-44	260-0613-00			1	SWITCH, toggle, w/mounting hardware—ON OFF
	- - - - - -			-	mounting hardware: (not included w/switch)
-45	210-0940-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD
	210-1064-00			1	WASHER, key, 0.250 ID x 0.469 inch OD
-46	131-0106-00			1	CONNECTOR, coaxial, 1 contact, BNC
	- - - - - -			-	mounting hardware for each: (not included w/connector)
	210-0255-00			1	LUG, solder, 3/8 inch
-47	210-0494-00			1	NUT, hex., 3/8-32 x 1/2 x 11/16 inch long
-48	131-0106-00			2	CONNECTOR, coaxial, 1 contact, BNC w/mounting hardware
	129-0053-00			1	ASSEMBLY, binding post
	- - - - - -			-	assembly includes:
-49	200-0103-00			1	CAP
-50	355-0507-00			1	STEM
	- - - - - -			-	mounting hardware: (not included w/assembly)
-51	210-0223-00			1	LUG, solder, 1/4 ID x 7/16 inch OD, SE
-52	210-0455-00			1	NUT, hex., 1/4-28 x 3/8 inch
-53	358-0216-00			1	BUSHING, plastic
-54	384-0690-01			1	SHAFT, extension
-55	376-0029-00			1	COUPLING, shaft
	- - - - - -			-	coupling includes:
	213-0075-00			2	SCREW, set, 4-40 x 3/32 inch, HSS
-56	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-57	210-0046-00			1	LOCKWASHER, internal, 0.261 ID x 0.400 inch OD
	210-0940-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD
-58	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch
-59	352-0084-00			1	HOLDER, neon, single
-60	378-0541-00			1	FILTER, lens, neon
-61	200-0609-00			1	CAP, neon holder
-62	366-0125-00			1	KNOB, plug-in securing
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-63	210-0894-00			1	WASHER, plastic, 0.190 ID x 7/16 inch OD
-64	384-0510-00			1	ROD, plug-in securing
-65	354-0025-00			1	RING, retaining

FIG. 1 MECHANICAL PARTS *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
1-66	333-1044-01	B010100	B029999	1	PANEL, front
	333-1044-03	B030000		1	PANEL, front
-67	386-1359-00			1	PLATE, sub-panel
-68	407-0434-00			1	BRACKET
	- - - - - -			-	mounting hardware: (not included w/bracket)
-69	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
-70	343-0088-00			5	CLAMP, cable, small
-71	354-0068-00			2	RING, securing, plastic, 1/2 ID x 9/16 inch OD
-72	337-0996-00			1	SHIELD
	- - - - - -			-	mounting hardware: (not included w/shield)
-73	211-0008-00			2	SCREW, 4-40 x 1/4 inch, PHS
-74	352-0136-00			1	HOLDER, fuse (spare)
	- - - - - -			-	mounting hardware: (not included w/holder)
-75	213-0088-00			2	SCREW, thread forming, #4 x 1/4 inch, PHS
-76	407-0436-00			1	BRACKET, switch
	- - - - - -			-	mounting hardware: (not included w/bracket)
-77	211-0504-00			2	SCREW, 6-32 x 1/4 inch, PHS
-78	441-0774-00			1	CHASSIS
	- - - - - -			-	mounting hardware: (not included w/chassis)
-79	211-0504-00			2	SCREW, 6-32 x 1/4 inch, PHS
-80	211-0538-00			3	SCREW, 6-32 x 5/16 inch, 100° csk, FHS
-81	210-0457-00			3	NUT, keps, 6-32 x 5/16 inch
-82	348-0063-00			1	GROMMET, plastic, 1/2 inch diameter
-83	348-0056-00			1	GROMMET, plastic, 3/8 inch diameter
-84	348-0055-00			1	GROMMET, plastic, 1/4 inch diameter
-85	344-0124-00			2	CLIP, capacitor mounting
	- - - - - -			-	mounting hardware for each: (not included w/clip)
	213-0055-00			1	SCREW, thread forming, 2-32 x 3/16 inch, PHS
-86	179-1248-00	B010100	B049999	1	CABLE HARNESS, chassis
	179-1248-01	B050000		1	CABLE HARNESS, chassis
	- - - - - -			-	cable harness includes:
	131-0371-00			26	CONNECTOR, single contact

 ©

FIG. 1 MECHANICAL PARTS *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
1-87	670-0188-00			1	ASSEMBLY, circuit board—AMPLIFIER
	- - - - - -			-	assembly includes:
	388-0980-00			1	BOARD, circuit
-88	136-0183-00			3	SOCKET, transistor, 3 pin
-89	136-0220-00			12	SOCKET, transistor, 3 pin
-90	136-0235-00			4	SOCKET, transistor, 6 pin
-91	136-0235-01			1	SOCKET, transistor, 6 pin
-92	385-0149-00			1	ROD, plastic
	- - - - - -			-	mounting hardware: (not included w/post)
-93	211-0008-00			1	SCREW, 4-40 x 1/4 inch, PHS
-94	214-0506-00			39	PIN, connector
-95	344-0154-00			4	CLIP
-96	200-0687-01			4	COVER, transistor
	- - - - - -			-	mounting hardware: (not included w/assembly)
-97	211-0116-00			4	SCREW, sems, 4-40 x 5/16 inch, PHB
-98	200-0828-00			1	COVER
	- - - - - -			-	mounting hardware: (not included w/cover)
-99	211-0008-00			1	SCREW, 4-40 x 1/4 inch, PHS
-100	- - - - - -			1	RESISTOR
	- - - - - -			-	mounting hardware: (not included w/resistor)
-101	212-0037-00			1	SCREW, 8-32 x 1 3/4 inch, Fil HS
-102	210-0808-00			1	WASHER, centering
-103	210-0462-00			1	NUT, resistor mounting
-104	212-0004-00			1	SCREW, 8-32 x 5/16 inch, PHS
-105	131-0017-00			1	CONNECTOR, 16 pin, male
	- - - - - -			-	mounting hardware: (not included w/connector)
-106	211-0008-00			2	SCREW, 4-40 x 1/4 inch
-107	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
-108	210-0202-00			1	LUG, solder, SE #6
	- - - - - -			-	mounting hardware: (not included w/lug)
-109	211-0007-00			1	SCREW, 6-32 x 1/4 inch, PHS
	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
-110	384-0631-00			4	ROD, spacer
-111	386-0219-00			1	PLATE, rear
	- - - - - -			-	mounting hardware: (not included w/plate)
-112	212-0044-00			4	SCREW, 8-32 x 1/2 inch, BHS
	212-0023-00			4	SCREW, 8-32 x 3/8 inch, PHS

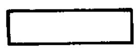
STANDARD ACCESSORIES

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description
	070-0782-00			2	MANUAL, instruction (not shown)

SECTION 8
DIAGRAMS

The following symbols are used on the diagrams:


Screwdriver adjustment

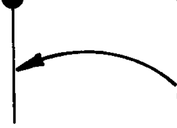

Front panel control or connector

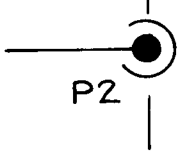

Clockwise control rotation in direction of arrow

Refer to indicated diagram

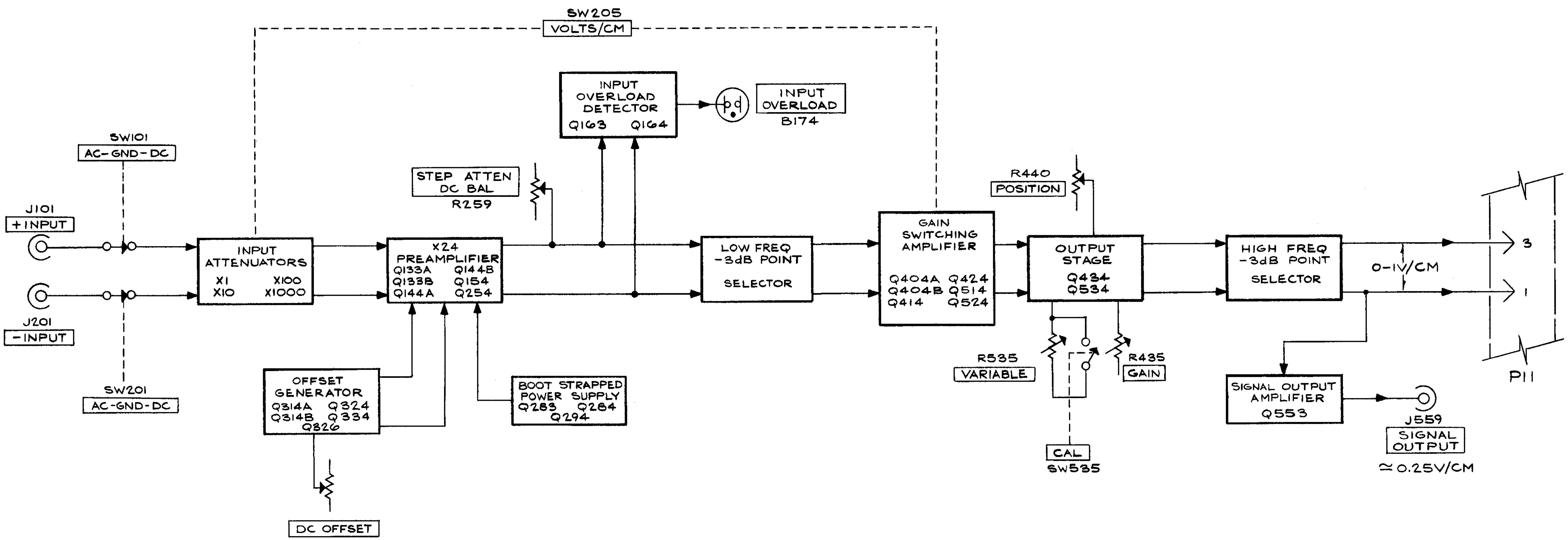
Connection to circuit board made with pin connector at indicated pin


Connector soldered to circuit board


Blue line encloses components located on circuit board



Indicates coaxial connector



168

TYPE 1A7A PLUG-IN A BLOCK DIAGRAM

VOLTAGE AND WAVEFORM TEST CONDITIONS

Typical voltage measurments and waveform photographs were obtained under the following conditions unless noted otherwise on the individual diagrams:

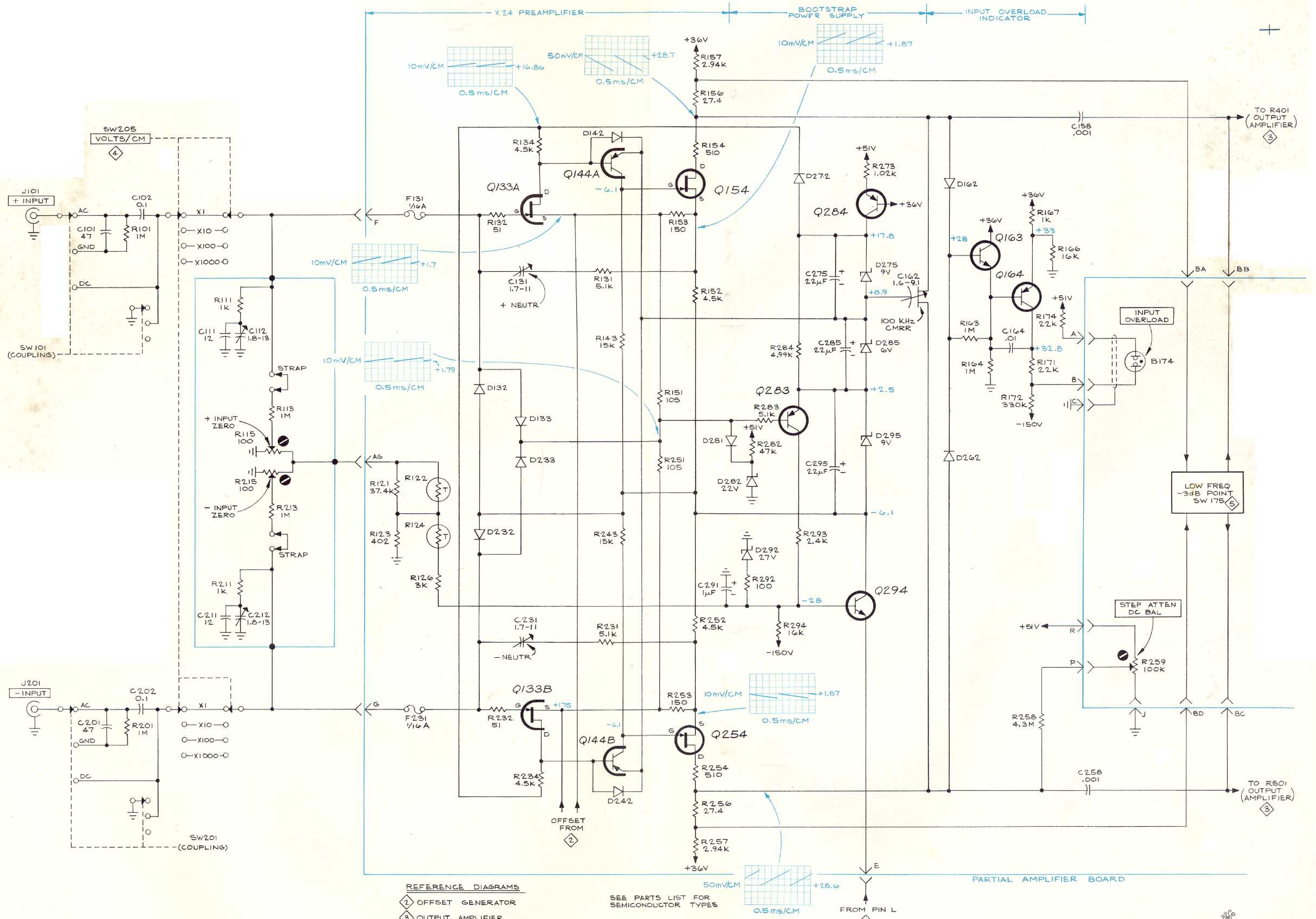
WAVEFORMS

Test Oscilloscope

Frequency Response	DC to 8 MHz
Deflection Factor (with 10X probe)	10 mV to 0.5 V
Input Impedance (with 10X probe)	10 Megohm paralleled by 7 pF
Probe ground	Type 1A7A chassis ground
Trigger Source	Int.
Type used for waveforms on diagrams	Type 545B with Type W plug-in unit

Type 1A7A Controls

VOLTS/CM	10 mV
VARIABLE (VOLTS/CM)	CAL
POSITION	Centered
AC-GND-DC (+ Input)	DC
AC-GND-DC (— Input)	GND
STEP ATTEN DC BAL	Properly adjusted for DC balance
LOW FREQ — 3 dB POINT	DC
HIGH FREQ — 3 dB POINT	1 MHz
DC OFFSET ON-OFF	OFF
DC OFFSET COARSE	CENTERED
DC OFFSET FINE	CENTERED
Signal Applied	10 mV sawtooth to + INPUT



REFERENCE DIAGRAMS
(2) OFFSET GENERATOR
(3) OUTPUT AMPLIFIER
(4) VOLTS/CM SWITCH
(5) BANDWIDTH SWITCH

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

VOLTAGES and WAVEFORMS obtained under conditions given on Diagram (1).

TYPE 1A7A PLUG-IN

INPUT AMPLIFIER (1)

168

VOLTAGES

DC reference voltage for the waveform photographs were obtained from the oscilloscope under the conditions set up for waveforms.

Voltmeter

Type	AC (RMS) — DC volt-ohm-meter
Sensitivity	20,000 ohms/volt
Range	0 to 300 volts
Reference Voltage	Type 1A7A chassis ground
Type used for voltages on diagrams	Triplett Model 630 NA

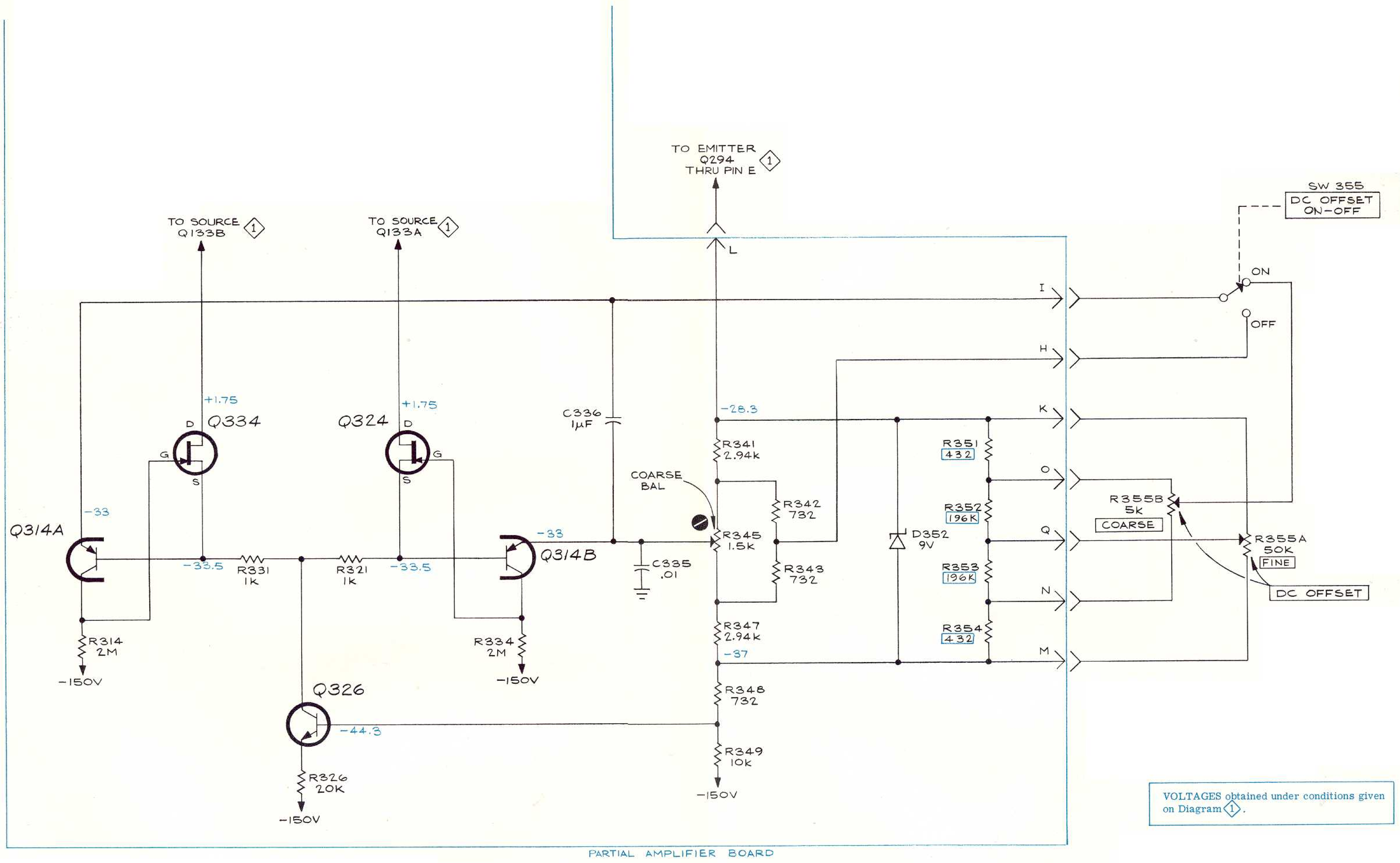
Type 1A7A controls

Same control settings as for waveforms except for the following:

AC-GND-DC (+ Input)	GND
Signal Applied	None

All voltages given on the diagrams are in volts. Waveforms shown are actual waveform photographs taken with a Tektronix Oscilloscope Camera System and Projected Graticule.

Voltages and waveforms on the diagrams (shown in blue) are not absolute and may vary between instruments because of differing component tolerances, internal calibration, front panel control settings or meter accuracy. Any apparent differences between voltage levels measured in a voltmeter and those shown on the waveforms could be due to meter loading.



REFERENCE DIAGRAMS

1 INPUT AMPLIFIER

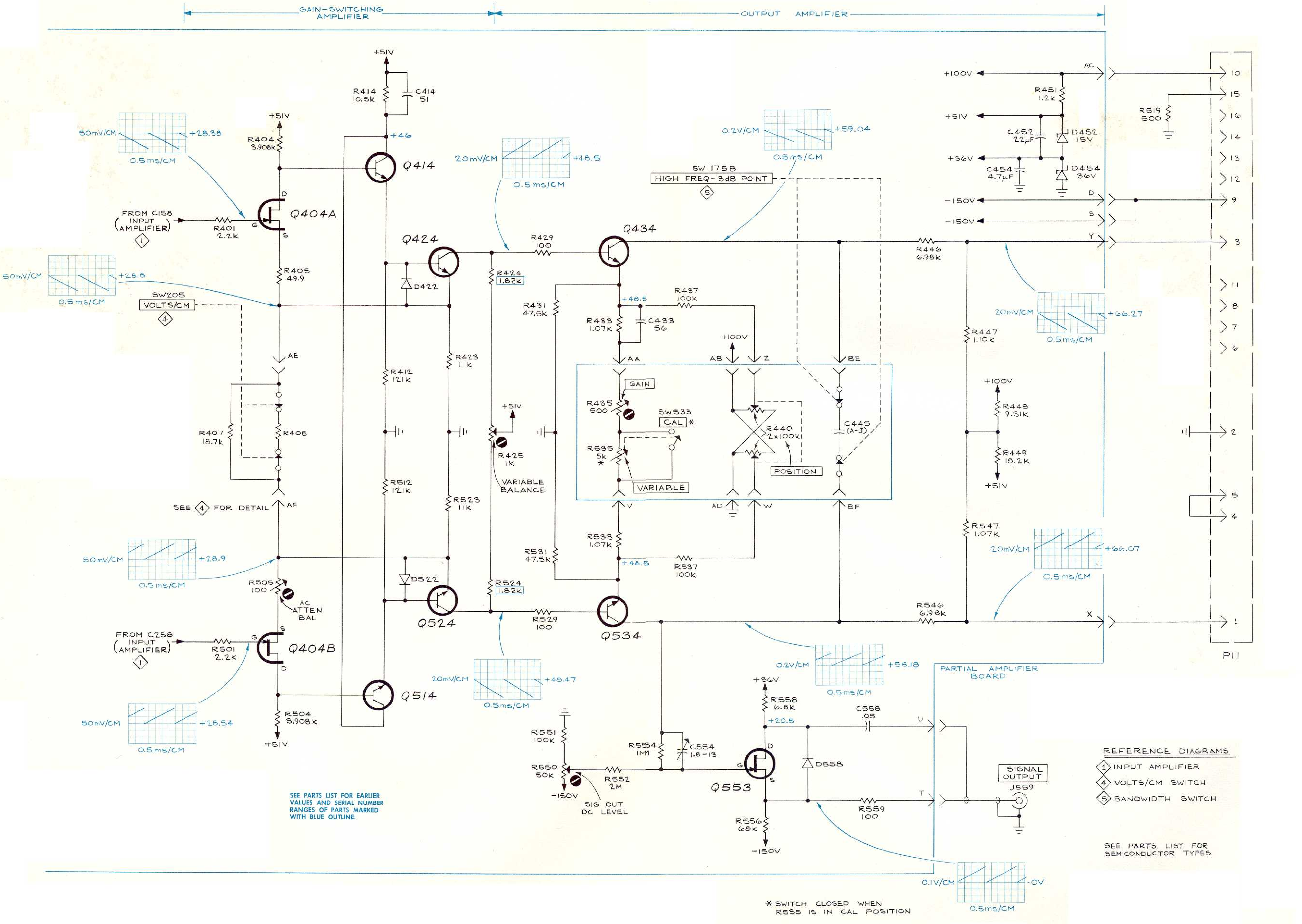
SEE PARTS LIST FOR SEMICONDUCTOR TYPES

968

TYPE 1A7A PLUG-IN

B

OFFSET GENERATOR 2



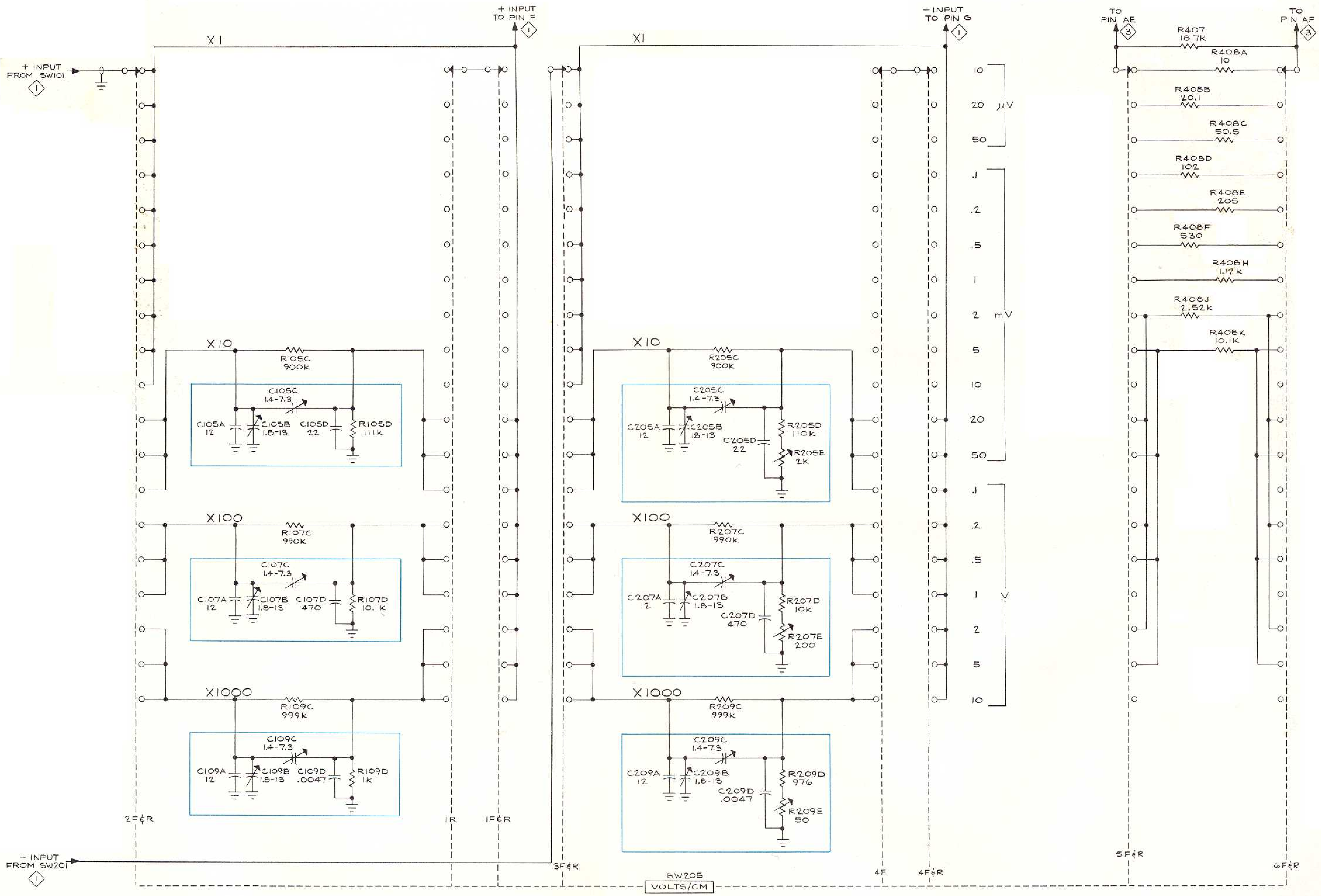
0370

TYPE 1A7A PLUG-IN

B

VOLTAGES and WAVEFORMS obtained under conditions given on Diagram 1

OUTPUT AMPLIFIER 3



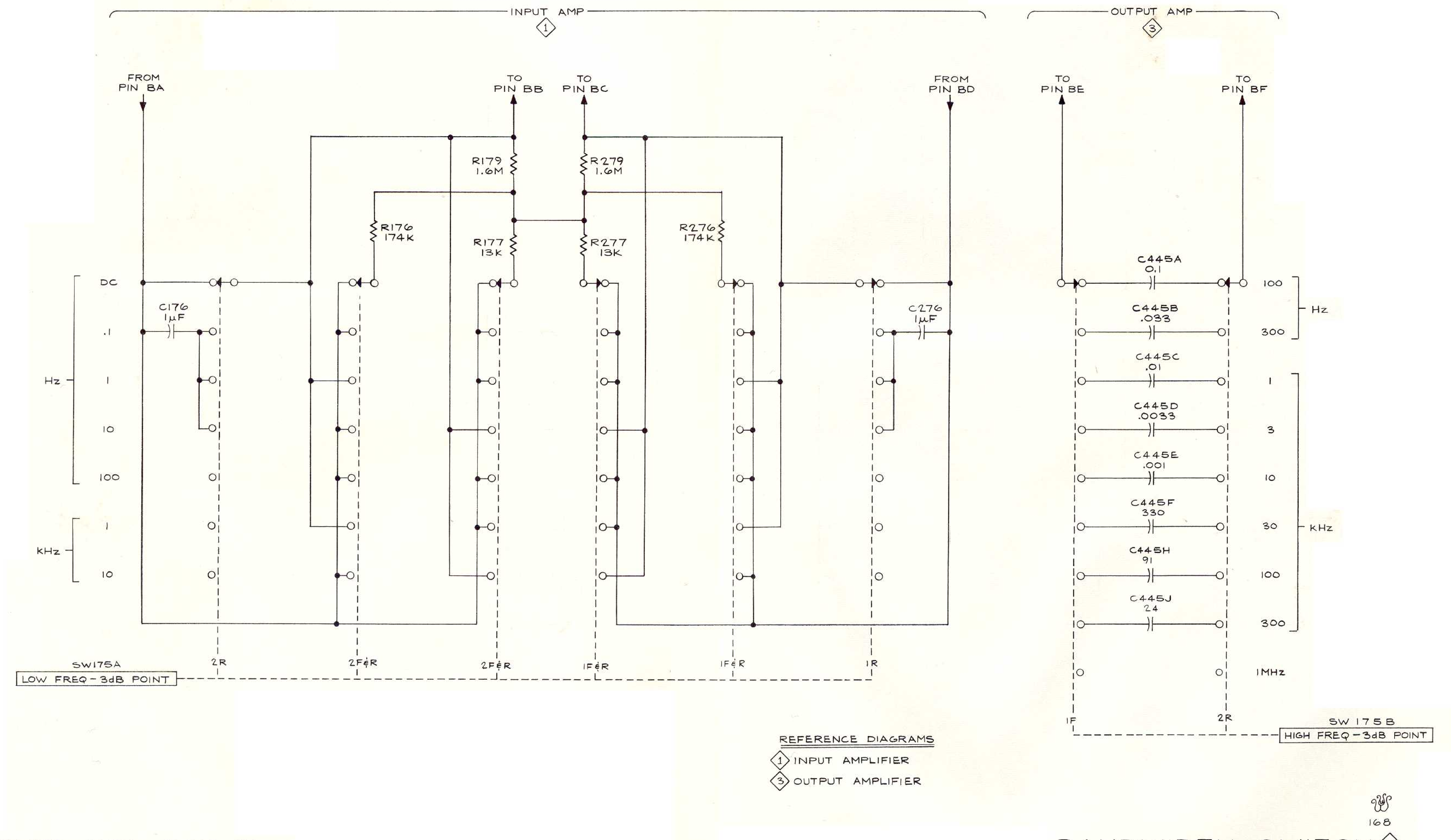
REFERENCE DIAGRAMS
1 INPUT AMPLIFIER
3 OUTPUT AMPLIFIER

168

TYPE 1A7A PLUG-IN

A

VOLTS/CM SWITCH 4

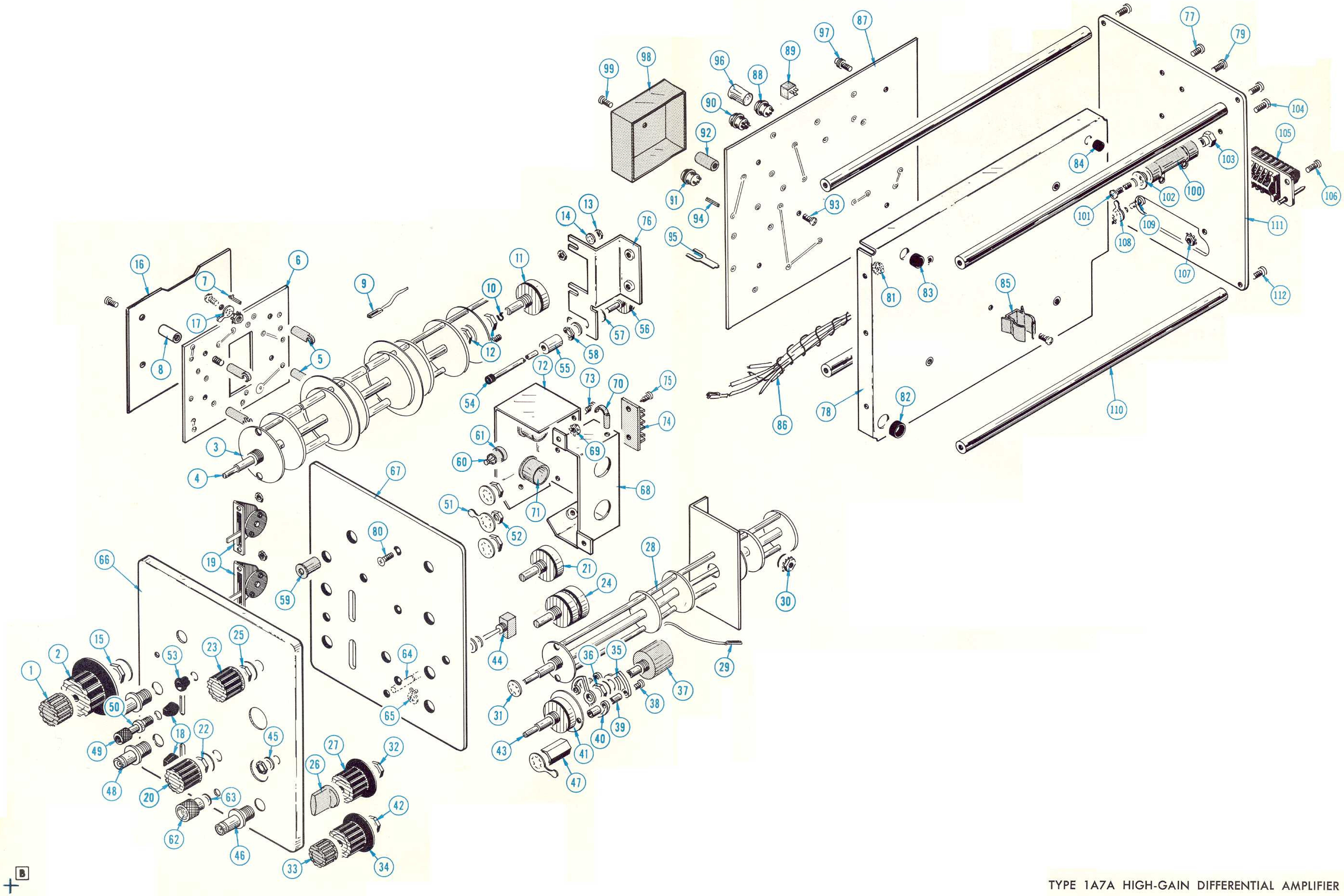


TYPE 1A7A PLUG-IN

A

BANDWIDTH SWITCH 5

FIG. 1 MECHANICAL PARTS



B

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.

ELECTRICAL PARTS LIST CORRECTIONS

CHANGE TO:

R424	321-0218-00	1.82 kΩ	1/8 W	1%
R524	321-0218-00	1.82 kΩ	1/8 W	1%